

# **Agilent 6000 Series Oscilloscopes**

## **Service Guide**



**Agilent Technologies**

# Notices

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# In This Service Guide

This book provides the service information for the Agilent 6000 Series Oscilloscopes. This manual is divided into these chapters:

## **1 Characteristics and Specifications**

This chapter lists characteristics and specifications for the Agilent 6000 Series Oscilloscopes.

## **2 Testing Performance**

This chapter explains how to verify correct oscilloscope operation and perform tests to ensure that the oscilloscope meets the performance specifications.

## **3 Calibrating and Adjusting**

This chapter explains how to adjust the oscilloscope for optimum operating performance.

## **4 Troubleshooting**

This chapter begins with suggestions for solving general problems that you may encounter with the oscilloscope. Procedures for troubleshooting the oscilloscope follow the problem solving suggestions.

## **5 Replacing 6000A Assemblies**

This chapter describes how to remove assemblies from the 6000A Series oscilloscope.

## **6 Replacing 6000L Assemblies**

This chapter describes how to remove assemblies from the 6000L Series oscilloscope.

## **7 Replaceable Parts**

This chapter describes how to order replaceable assemblies and parts for the Agilent 6000 Series Oscilloscopes. It

includes diagrams and parts lists for hardware that you can order.

At the front of the book you will find safety notice descriptions and document warranties.

#### **Using this book with the 6000L Series oscilloscopes**

The 6000L Series oscilloscopes do not have a built-in display or front panel control keys. If you are using a 6000L Series oscilloscope, and this book refers to using front panel controls, you can use the built-in Web control feature described in the *6000 Series Oscilloscopes User's Guide* to complete the instructions. If you do not have the *6000 Series Oscilloscopes User's Guide*, you may obtain a printable electronic copy at [www.agilent.com/find/mso6000](http://www.agilent.com/find/mso6000).

#### **Digital Channels**

Because all of the oscilloscopes in the Agilent 6000 Series have analog channels, the analog channel topics in this book apply to all instruments. Whenever a topic discusses the digital channels, that information applies only to Mixed-Signal Oscilloscope (MSO) models or DSO models that have been upgraded to an MSO.

#### **Abbreviated instructions for pressing a series of keys**

Instructions for pressing a series of keys are written in an abbreviated manner. Instructions for pressing Key1, then pressing Key2, then pressing Key3 are abbreviated as follows:

Press **Key1** → **Key2** → **Key3**.

The keys may be front panel keys, or softkeys, which are located directly below the oscilloscope display.



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This chapter lists characteristics and specifications for the Agilent 6000 Series Oscilloscopes.



## 6000A Series and 6000L Series Environmental Conditions

### Overvoltage Category

This product is intended to be powered by MAINS that comply to Overvoltage Category II, which is typical of cord-and-plug connected equipment.

### Pollution Degree

The 6000 Series Oscilloscope may be operated in environments of Pollution Degree 2 (or Pollution Degree 1).

### Pollution Degree Definitions

Pollution Degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. Example: A clean room or climate controlled office environment.

Pollution Degree 2. Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation may occur. Example: General indoor environment.

Pollution Degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. Example: Sheltered outdoor environment.

## 6000A Series and 6000L Series Measurement Category

### Measurement Category

The 6000 Series oscilloscope is intended to be used for measurements in Measurement Category I.

### Measurement Category Definitions

Measurement category I is for measurements performed on circuits not directly connected to MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable; for that reason, the transient withstand capability of the equipment is made known to the user.

Measurement category II is for measurements performed on circuits directly connected to the low voltage installation. Examples are measurements on household appliances, portable tools and similar equipment.

Measurement category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

Measurement category IV is for measurements performed at the source of the low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.

## 6000A Series and 6000L Series Transient Withstand Capability

**CAUTION**



Maximum input voltage for analog inputs:

CAT I 300 Vrms, 400 Vpk; transient overvoltage 1.6 kVpk

CAT II 100 Vrms, 400 Vpk

with 10073C or 10074C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk

---

**CAUTION**



Do not exceed 5 Vrms in 50  $\Omega$  mode on the 2-channel models. Input protection is enabled in 50  $\Omega$  mode, and the 50  $\Omega$  load will disconnect if greater than 5 Vrms is detected. However, the input could still be damaged, depending on the time constant of the signal.

---

**CAUTION**

The 50  $\Omega$  input protection mode only functions when the oscilloscope is powered on.

---

**CAUTION**

Maximum input voltage for logic channels:

$\pm 40$  V peak CAT I; transient overvoltage 800 Vpk

---

## 6000A Series Oscilloscope Specifications

All specifications are warranted. Specifications are valid after a 30-minute warm-up period and within  $\pm 10^{\circ}\text{C}$  of last “User Cal” temperature.

**Table 1** Warranted specifications

### Vertical system: oscilloscope channels

Bandwidth (–3dB)	MSO/DSO601xA: DC to 100 MHz MSO/DSO603xA: DC to 300 MHz MSO/DSO605xA: DC to 500 MHz MSO/DSO610xA: DC to 1 GHz
DC vertical gain accuracy	$\pm 2.0\%$ full scale
Dual cursor accuracy <sup>1</sup>	$\pm\{\text{DC vertical gain accuracy} + 0.4\% \text{ full scale } (\sim 1 \text{ LSB})\}$ <i>Example:</i> for 50 mV signal, oscilloscope set to 10 mV/div (80 mV full scale), 5 mV offset, accuracy = $\pm\{2.0\% (80 \text{ mV}) + 0.4\% (80 \text{ mV})\} = \pm 1.92 \text{ mV}$

### Vertical system: logic channels (MSO6000A or MSO-upgraded DSO6000A only)

Threshold accuracy	$\pm(100 \text{ mV} + 3\% \text{ of threshold setting})$
--------------------	--

### Scope channel triggering

Sensitivity	$< 10 \text{ mV/div}$ : greater of 1 div or 5mV; $\geq 10 \text{ mV/div}$ : 0.6 div
-------------	---

### Logic (D15 - D0) channel triggering (MSO6000A or MSO-upgraded DSO6000A only)

Threshold accuracy	$\pm(100 \text{ mV} + 3\% \text{ of threshold setting})$
--------------------	--

<sup>1</sup> 1 mV/div is a magnification of 2 mV/div setting for 100 MHz models and 2 mV/div is a magnification of 4 mV/div setting for 300 MHz - 1 GHz models. For vertical accuracy calculations, use full scale of 16 mV for 1 mV/div sensitivity setting and 32 mV for 2 mV/div sensitivity setting.

## 6000A Series Oscilloscope Characteristics

All characteristics are the typical performance values and are not warranted. Characteristics are valid after a 30-minute warm-up period and within  $\pm 10^{\circ}\text{C}$  of last “User Cal” temperature.

**Table 2** Characteristics

### Acquisition: oscilloscope channels

Sample rate	MSO/DSO601xA/603xA: 2 GSa/sec each channel MSO/DSO605xA/610xA: 4 GSa/sec half channel*, 2 GSa/sec each channel
Standard memory depth	With logic channels turned off, 1 Mpts half channel*, 500 kpts each channel With logic channels turned on, 625 kpts half channel*, 312 kpts each channel
Optional memory depth	With logic channels turned off, Option 2ML or 2MH – 2 Mpts half channel*, 1 Mpts each channel Option 8ML or 8MH – 8 Mpts half channel*, 4 Mpts each channel With logic channels turned on, Option 2ML or 2MH – 1.25 Mpts half channel*, 625 kpts each channel Option 8ML or 8MH – 5 Mpts half channel*, 2.5 Mpts each channel
Vertical resolution	8 bits
Peak detection	MSO/DSO601xA: 1-ns peak detect MSO/DSO603xA: 500-ps peak detect MSO/DSO605xA/610xA: 250-ps peak detect
Averaging	Selectable from 2, 4, 8, 16, 32, 64 ... to 65536
High resolution mode	Average mode with #avg = 1 12 bits of resolution when $\geq 10 \mu\text{s}/\text{div}$ , at 4 GSa/s or $\geq 20 \mu\text{s}/\text{div}$ , at 2 GSa/s
Filter	Sin $x/x$ interpolation (single shot BW = sample rate/4 or bandwidth of oscilloscope, whichever is less) with vectors on and in real-time mode


\* Half channel is when only one of channel pair 1 or 2 is turned on, or only channel pair 3 or 4 is turned on.



**Acquisition: logic channels (MSO6000A or MSO-upgraded DSO6000A only)**

Sample rate	2 GSa/sec one pod, 1 GSa/sec each pod
Maximum input frequency	250 MHz
Standard memory depth	With oscilloscope channels turned off, 1 Mpts one pod, 500 kpts each pod With oscilloscope channels turned on, 312 kpts one pod, 156 kpts each pod
Optional memory depth	With oscilloscope channels turned off, Option 2ML or 2MH – 2 Mpts one pod, 1 Mpts each pod Option 8ML or 8MH – 8 Mpts one pod, 4 Mpts each pod With oscilloscope channels turned on, Option 2ML or 2MH – 625 kpts one pod, 312 kpts each pod Option 8ML or 8MH – 2.5 Mpts one pod, 1.25 Mpts each pod
Vertical resolution	1 bit
Glitch detection	2 ns (min pulse width)

**Vertical system: oscilloscope channels**

Scope channels	MSO/DSO6xx2A: Ch 1 and 2 simultaneous acquisition MSO/DSO6xx4A: Ch 1, 2, 3 and 4 simultaneous acquisition
AC coupled	MSO/DSO601xA: 3.5 Hz to 100 MHz MSO/DSO603xA: 3.5 Hz to 300 MHz MSO/DSO605xA: 3.5 Hz to 500 MHz MSO/DSO610xA: 3.5 Hz to 1 GHz
Calculated rise time (= 0.35/bandwidth)	MSO/DSO601xA: 3.5 nsec MSO/DSO603xA: 1.17 nsec MSO/DSO605xA: 700 psec MSO/DSO610xA: 350 psec
Single-shot bandwidth	MSO/DSO601xA: 100 MHz MSO/DSO603xA: 300 MHz MSO/DSO605xA: 500 MHz MSO/DSO610xA: 1 GHz (in half-channel mode, i.e., one channel of channel pair is on)
Range <sup>1</sup>	MSO/DSO601xA: 1 mV/div to 5 V/div (1 M $\Omega$ ) MSO/DSO603xA and MSO/DSO605xA: 2 mV/div to 5 V/div (1 M $\Omega$ or 50 $\Omega$ ) MSO/DSO610xA: 2 mV/div to 5 V/div (1 M $\Omega$ ), 2 mV/div to 1 V/div (50 $\Omega$ )
Maximum input	 CAT I 300 Vrms, 400 Vpk; transient overvoltage 1.6 kVpk CAT II 100 Vrms, 400 Vpk With 10073C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk
Offset range	$\pm 5$ V on ranges <10 mV/div; $\pm 20$ V on ranges 10 mV/div to 200 mV/div; $\pm 75$ V on ranges >200 mV/div

<sup>1</sup> 1 mV/div is a magnification of 2 mV/div setting for 100 MHz models and 2 mV/div is a magnification of 4 mV/div setting for 300 MHz - 1 GHz models. For vertical accuracy calculations, use full scale of 16 mV for 1 mV/div sensitivity setting and 32 mV for 2 mV/div sensitivity setting.

## 1 Characteristics and Specifications

### Vertical system: oscilloscope channels (continued)

Dynamic range	±8 div
Input impedance	MSO/DSO601xA: 1 MΩ ± 1%    11 pF MSO/DSO603xA/605xA/610xA: 1 MΩ ± 1%    14 pF or 50 Ω ± 1.5%, selectable
Coupling	AC, DC
BW limit	25 MHz selectable, on the 300 MHz, 500 MHz, and 1 GHz bandwidth models 20 MHz selectable, on the 100 MHz bandwidth models
Channel-to-channel isolation	DC to max bandwidth >40 dB
Standard probes	MSO/DSO601xA: 10:1 10074C shipped standard for each oscilloscope channel MSO/DSO603xA/605xA/610xA: 10:1 10073C shipped standard for each oscilloscope channel
Probe ID	MSO/DSO601xA: Auto probe sense MSO/DSO603xA/605xA/610xA: Auto probe sense and AutoProbe interface Agilent- and Tektronix-compatible passive probe sense
ESD tolerance	±2 kV
Noise peak-to-peak	MSO/DSO601xA: 3% full scale or 2 mV, whichever is greater MSO/DSO603xA: 3% full scale or 3 mV, whichever is greater MSO/DSO605xA: 3% full scale or 3.6 mV, whichever is greater MSO/DSO610xA: 3% full scale or 4 mV, whichever is greater
DC vertical offset accuracy	≤ 200 mV/div: ±0.1 div ±2.0 mV ±0.5% offset value; >200 mV/div: ±0.1 div ±2.0 mV ±1.5% offset value
Single cursor accuracy <sup>1</sup>	±{DC vertical gain accuracy + DC vertical offset accuracy + 0.2% full scale (~1/2 LSB)} <i>Example:</i> for 50 mV signal, oscilloscope set to 10 mV/div (80 mV full scale), 5 mV offset, accuracy = ±{2.0% (80 mV) + 0.1 (10 mV) + 2.0 mV + 0.5% (5 mV) + 0.2%(80 mV)} = ± 4.785 mV

### Vertical system: logic channels (MSO6000A or MSO-upgraded DSO6000A only)

Number of channels	16 logic timing channels – labeled D15 - D0
Threshold groupings	Pod 1: D7 - D0 Pod 2: D15 - D8
Threshold selections	TTL, CMOS, ECL and user-definable (selectable by pod)
User-defined threshold range	±8.0 V in 10 mV increments
Maximum input voltage	±40 V peak CAT I; transient overvoltage 800 Vpk
Input dynamic range	±10 V about threshold
Minimum input voltage swing	500 mV peak-to-peak
Input capacitance	~8 pF
Input resistance	100 kΩ ±2% at probe tip
Channel-to-channel skew	2 ns typical, 3 ns maximum

<sup>1</sup> 1 mV/div is a magnification of 2 mV/div setting for 100 MHz models and 2 mV/div is a magnification of 4 mV/div setting for 300 MHz - 1 GHz models. For vertical accuracy calculations, use full scale of 16 mV for 1 mV/div sensitivity setting and 32 mV for 2 mV/div sensitivity setting.

**Horizontal**

Range	MSO/DSO601xA: 5 nsec/div to 50 sec/div MSO/DSO603xA: 2 nsec/div to 50 sec/div MSO/DSO605xA: 1 nsec/div to 50 sec/div MSO/DSO610xA: 500 psec/div to 50 sec/div
Resolution	2.5 psec
Timebase accuracy	15 ppm ( $\pm 0.0015\%$ )
Vernier	1-2-5 increments when off, ~25 minor increments between major settings when on
Delay range	Pre-trigger (negative delay): Greater of 1 screen width or 1 ms (with 8 Mpts memory option) Greater of 1 screen width or 250 $\mu$ s (with 2 Mpts memory option) Greater of 1 screen width or 125 $\mu$ s (with standard memory) Post-trigger (positive delay): 1 s - 500 seconds
Analog delta-t accuracy	Same channel: $\pm 0.0015\%$ reading $\pm 0.1\%$ screen width $\pm 20$ ps Channel-to-channel: $\pm 0.0015\%$ reading $\pm 0.1\%$ screen width $\pm 40$ ps <i>Same channel example (MSO/DSO605xA):</i> For signal with pulse width of 10 $\mu$ s, oscilloscope set to 5 $\mu$ s/div (50 $\mu$ s screen width), delta-t accuracy = $\pm\{0.0015\% (10 \mu\text{s}) + 0.1\% (50 \mu\text{s}) + 20 \text{ps}\} = 50.17 \text{ns}$
Logic delta-t accuracy	Same channel: $\pm 0.005\%$ reading $\pm 0.1\%$ screen width $\pm(1$ logic sample period, 1 ns) Channel-to-channel: $\pm 0.005\%$ reading $\pm 0.1\%$ screen width $\pm(1$ logic sample period) $\pm$ chan-to-chan skew <i>Same channel example:</i> For signal with pulse width of 10 $\mu$ s, oscilloscope set to 5 $\mu$ s/div (50 $\mu$ s screen width), delta-t accuracy = $\pm\{0.005\% (10 \mu\text{s}) + 0.1\% (50 \mu\text{s}) + 1 \text{ns}\} = 51.5 \text{ns}$
Modes	Main, delayed, roll, XY
XY	Bandwidth: Max bandwidth Phase error @ 1 MHz: <0.5 degrees Z Blanking: 1.4 V blanks trace (use external trigger on MSO/DSO6xx2A, channel 4 on MSO/DSO6xx4A)
Reference positions	Left, center, right

**Trigger system**

Sources	MSO6xx2A: Ch 1, 2, line, ext, D15 - D0 DSO6xx2A h 1, 2, line, ext MSO6xx4A: Ch 1, 2, 3, 4, line, ext, D15 - D0 DSO6xx4A: Ch 1, 2, 3, 4, line, ext
Modes	Auto, Normal (triggered), single
Holdoff time	~60 ns to 10 seconds
Trigger jitter	15 ps rms

## 1 Characteristics and Specifications

### Trigger system (continued)

Selections	Edge, pulse width, pattern, TV, duration, sequence, CAN, LIN, USB, I <sup>2</sup> C, SPI, Nth edge burst.
Edge	Trigger on a rising, falling, alternating or either edge of any source
Pattern	Trigger at the beginning of a pattern of high, low, and don't care levels and/or a rising or falling edge established across any of the analog and digital channels, but only after a pattern has been established for a minimum of 2 nsec. The oscilloscope channel's high or low level is defined by that channel's trigger level. The logic channel's trigger level is defined by the threshold for the pod, 0 - 7 or 8 - 15.
Pulse width	Trigger when a positive- or negative-going pulse is less than, greater than, or within a specified range on any of the source channels. Minimum pulse width setting: 5 ns (MSO/DSO601xA/603xA oscilloscope channels) 2 ns (MSO/DSO605xA/610xA oscilloscope channels) 2 ns (logic channels on MSO6000A or MSO-upgraded DSO6000A) Maximum pulse width setting: 10 s
TV	Trigger using any oscilloscope channel on most analog progressive and interlaced video standards including HDTV/EDTV, NTSC, PAL, PAL-M or SECAM broadcast standards. Select either positive or negative sync pulse polarity. Modes supported include Field 1, Field 2, all fields, all lines, or any line within a field. TV trigger sensitivity: 0.5 division of sync signal. Trigger holdoff time can be adjusted in half field increments.
Sequence	Arm on event A, trigger on event B, with option to reset on event C or time delay.
CAN	Trigger on CAN (Controller Area Network) version 2.0A and 2.0B signals. Trigger on the start of frame (SOF) bit (standard). N5424A option supports triggering on remote frame ID (RTR), data frame ID (~RTR), remote or data frame ID, data frame ID and data, error frame, all errors, acknowledge error and overload frame.
LIN	Trigger on LIN (Local Interconnect Network) sync break at beginning of message frame (standard). N5424A option supports triggering on frame ID.
USB	Trigger on USB (Universal Serial Bus) start of packet, end of packet, reset complete, enter suspend, or exit suspend on the differential USB data lines. USB low speed and full speed are supported.
I <sup>2</sup> C	Trigger on I <sup>2</sup> C (Inter-IC bus) serial protocol at a start/stop condition or user defined frame with address and/or data values. Also trigger on missing acknowledge, restart, EEPROM read, and 10-bit write.
SPI	Trigger on SPI (Serial Protocol Interface) data pattern during a specific framing period. Supports positive and negative Chip Select framing as well as clock Idle framing and user-specified number of bits per frame.

Duration	Trigger on a multi-channel pattern whose time duration is less than a value, greater than a value, greater than a time value with a timeout, or inside or outside of a set of time values. Minimum duration setting: 2 ns Maximum duration setting: 10 s
Nth Edge Burst	Trigger on the Nth edge of a burst that occurs after an idle time.

**Trigger system (continued)**


AutoScale	Finds and displays all active oscilloscope and logic (for MSO6000A series MSO) channels, sets edge trigger mode on highest-numbered channel, sets vertical sensitivity on oscilloscope channels and thresholds on logic channels, time base to display ~1.8 periods. Requires minimum voltage >10 mVpp, 0.5% duty cycle and minimum frequency >50 Hz.
-----------	---

**Oscilloscope channel triggering**

Range (internal)	±6 div from center screen
Coupling	AC (~3.5 Hz on MSO/DSO601xA, ~10 Hz on MSO/DSO603xA/605xA/610xA), DC, noise reject, HF reject and LF reject (~50 kHz)

**Logic (D15 - D0) channel triggering (MSO6000A or MSO-upgraded DSO6000A only)**

Threshold range (user defined)	±8.0 V in 10 mV increments
Predefined thresholds	TTL = 1.4 V, CMOS = 2.5 V, ECL = -1.3 V

	<b>MSO/DSO6xx2A (2-/2+16-ch models)</b>	<b>MSO/DSO6xx4A (4-/4+16-ch models)</b>
<b>External (EXT) triggering</b>		
Input impedance	MSO/DSO6012A: 1 MΩ ±3%    11 pF or 50 Ω MSO/DSO6032A/6052A/6102A: 1 MΩ ±3%    14 pF or 50 Ω	MSO/DSO6014A: 1.015 kΩ ±5% MSO/DSO6034A/6054A/ 6104A: 2.14 kΩ ±5%
Maximum input	 CAT I 300 Vrms, 400 Vpk, CAT II 100 Vrms, 400 Vpk With 10073C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk 5 Vrms with 50-ohm input	±15 V
Range	DC coupling: trigger level ± 1V and ± 8V	±5 V

## 1 Characteristics and Specifications

Sensitivity	For $\pm 1V$ range setting: DC to 100 MHz, 100 mV; MSO/DSO6032A/6052A/6102A >100 MHz to bandwidth of oscilloscope: 200 mV	MSO/DSO6014A: DC to 100 MHz: 500 mV
	For $\pm 8V$ range setting: DC to 100 MHz, 250 mV; MSO/DSO6032A/6052A/6102A >100 MHz to bandwidth of oscilloscope: 500 mV	MSO/DSO6034A/6054A/ 6104A: DC to 500 MHz: 500 mV
Coupling	AC (~3.5 Hz), DC, noise reject, HF reject and LF reject (~50 kHz)	
Probe ID	MSO/DSO601xA: Auto probe sense MSO/DSO603xA/605xA/610xA: Auto probe sense and AutoProbe interface Agilent- and Tektronix-compatible passive probe sense	
<b>Display system</b>		
Display	6.3-inch (161 mm) diagonal color TFT LCD	
Throughput of oscilloscope channels	Up to 100,000 waveforms/sec in real-time mode	
Resolution	XGA – 768 vertical by 1024 horizontal points (screen area); 640 vertical by 1000 horizontal points (waveform area) 256 levels of intensity scale	
Controls	Waveform intensity on front panel. Vectors on/off; infinite persistence on/off, 8 x 10 grid with intensity control	
Built-in help system	Key-specific help (in English) displayed by pressing and holding key or softkey of interest	
Real-time clock	Time and date (user adjustable)	
<b>Measurement features</b>		
Automatic measurements	Measurements are continuously updated. Cursors track last selected measurement.	
Voltage (scope channels only)	Peak-to-peak, maximum, minimum, average, amplitude, top, base, overshoot, preshoot, RMS, standard deviation	
Time	Frequency, period, + width, – width and duty cycle on any channel. Rise time, fall time, X at max Y (time at max volts), X at min Y (time at min volts), delay, and phase on oscilloscope channels only.	
Counter	Built-in 5-digit frequency counter on any channel. Counts up to the oscilloscope's bandwidth (1 GHz max). The counter resolution can be increased to 8 digits with an external 10 MHz reference.	
Threshold definition	Variable by percent and absolute value; 10%, 50%, 90% default for time measurements	

Cursors	Manually or automatically placed readout of Horizontal (X, $\Delta X$ , $1/\Delta X$ ) and Vertical (Y, $\Delta Y$ ). Additionally logic or oscilloscope channels can be displayed as binary or hex values.
Waveform math	One function of 1-2, 1x2, FFT, differentiate, integrate. Source of FFT, differentiate, integrate: oscilloscope channels 1 or 2, 1-2, 1+2, 1x2.

**FFT**

Points	Fixed at 1000 points
Source of FFT	Scope channels 1 or 2 (or 3 or 4 on MSO/DSO6xx4A only), 1+2, 1-2, 1*2
Window	Rectangular, flattop, hanning
Noise floor	-50 to -90 dB depending on averaging
Amplitude	Display in dBV, dBm at 50 $\Omega$
Frequency resolution	0.05/time per div
Maximum frequency	50/time per div

**Storage**

Save/recall	10 setups and traces can be saved and recalled using internal non-volatile memory
Storage type and format	USB 1.1 host ports on front and rear panels Image formats: BMP (8-bit), BMP (24-bit), PNG (24-bit) Data formats: X and Y (time/voltage) values in CSV format, ASCII XY format, BIN format Trace/setup formats: Recalled

**I/O**

Standard ports	USB 2.0 high speed device, two USB 1.1 host ports, 10/100-BaseT LAN, IEEE488.2 GPIB, XGA video output
Max transfer rate	IEEE488.2 GPIB: 500 kbytes/sec USB (USBTMC-USB488): 3.5 Mbytes/sec 100 Mbps LAN (TCP/IP): 1 Mbytes/sec
Printer compatibility	Selected HP Deskjet and Officejet printers

**General characteristics**

Physical size	35.4 cm wide x 18.8 cm high x 28.2 cm deep (without handle) 39.9 cm wide x 18.8 cm high x 28.2 cm deep (with handle)
Weight	Net: 4.9 kgs (10.8 lbs) Shipping: 9.4 kgs (20.7 lbs)
Probe comp output	Frequency ~1.2 kHz, Amplitude ~2.5 V

## 1 Characteristics and Specifications

Trigger out	When "Triggers" is selected (delay ~17 ns; 23 ns for 100 MHz bandwidth models) 0 to 5 V into open circuit 0 to 2.5 V into 50 $\Omega$ When "Source Frequency" or "Source Frequency/8" is selected 0 to 580 mV into open circuit 0 to 290 mV into 50 $\Omega$ Max frequency output: 350 MHz (in Source Frequency mode when terminated in 50 $\Omega$ ) 125 MHz (in Source Frequency/8 mode when terminated in 50 $\Omega$ )
10 MHz ref in/out	TTL out, 180 mV to 1 V amplitude with 0 to 2 V offset
Kensington lock	Connection on rear panel for security

### Power requirements

Line Rating	~Line 120 W max, 96-144 V/48-440 Hz, 192-288 V/48-66 Hz, automatic selection
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### Environmental characteristics

Ambient temperature	Operating -10 °C to +55 °C; non-operating -51 °C to +71 °C
Humidity	Operating 95% RH at 40 °C for 24 hr; non-operating 90% RH at 65 °C for 24 hr
Altitude	Operating to 4,570 m (15,000 ft); non-operating to 15,244 m (50,000 ft)
Vibration	Agilent class B1 and MIL-PRF-28800F; Class 3 random
Shock	Agilent class B1 and MIL-PRF-28800F; (operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks)
Pollution degree2	Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.
Indoor use	Rated for indoor use only

### Other

Measurement categories	CAT I: Mains isolated CAT II: Line voltage in appliance and to wall outlet
Regulatory information	Safety IEC 61010-1:2001 / EN 61010-1:2001 Canada: CSA C22.2 No. 61010-1:2004 USA: UL 61010-1:2004
Supplementary information	The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, and carries the CE-marking accordingly. The product was tested in a typical configuration with HP/Agilent test systems.

Product specifications, characteristics, and descriptions in this document are subject to change without notice.



**WARNING**

**Use this instrument only for measurements within its specified measurement categories.**

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## 6000L Series Specifications and Characteristics

### Performance characteristics

#### Scope input

Channels	Ch 1, 2, 3 and 4 simultaneous acquisition
Bandwidth (-3 dB)*	DSO6014L: DC to 100 MHz DSO6054L: DC to 500 MHz DSO6104L: DC to 1 GHz
Maximum input	CAT I 300 Vrms, 400 Vpk, CAT II 100 Vrms, 400 Vpk With 10073C/10074C 10:1 probe: CAT I 500 Vpk, CAT II 400 Vpk 5 Vrms with 50 $\Omega$ input
Full Scale range <sup>1</sup>	DSO6014L: 1 mV/div to 5 V/div (1 M $\Omega$ ) DSO6054L: 2 mV/div to 5 V/div (1 M $\Omega$ or 50 $\Omega$ ) DSO6104L: 2 mV/div to 5 V/div (1 M $\Omega$ ), 2 mV/div to 1 V/div (50 $\Omega$ )
Input impedance	DSO6014L2: 1 M $\Omega$ $\pm$ 1%    11pF DSO6054L/6104L: 1 M $\Omega$ $\pm$ 1%    14pF or 50 M $\Omega$ $\pm$ 1.5%, selectable
Offset range	Coupling AC, DC $\pm$ 5 V on ranges < 10 mV/div $\pm$ 20 V on ranges 10 mV/div to 200 mV/div $\pm$ 75 V on ranges $\geq$ 200 mV/div
Connector	BNC
BW limit	DSO6014L: 20MHz DSO6054L/6104L: 25 MHz selectable
Noise peak-to-peak	DSO6014L: 3% full scale or 2 mV, whichever is greater DSO6054L: 3% full scale or 3.6 mV, whichever is greater DSO6104L: 3% full scale or 4.5 mV, whichever is greater

\* Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and  $\pm 10$  °C from firmware calibration temperature.

<sup>1</sup> 1 mV/div is a magnification of 2 mV/div. 2 mV/div is a magnification of 4 mV/div setting. For vertical accuracy calculations, use full scale of 16 mV for 1 mV/div sensitivity setting and 32 mV for 2 mV/div sensitivity setting.

<sup>2</sup> Four 50  $\Omega$  termination adapters are supplied with DSO6014L.

### Logic channels (with MSO option)

Number of channels	16 logic timing channels - labeled D15 - D0
Maximum input frequency	250 MHz
Sample rate	2 GSa/sec one pod, 1 GSa/sec each pod
Standard memory depth	2.5 Mpts one pod, 1.25 Mpts each pod
Vertical resolution	1 bit
Threshold selections	TTL, CMOS, ECL, user-definable (selectable by pod)
Maximum input voltage	±40 V peak CAT I
Glitch detection	2 ns (min pulse width)

### Analog to digital conversion

Vertical resolution	8 bits
Sample rate	DSO6014L: 2 GSa/sec DSO6054L/6104L: 4 GSa/sec half channel, 2 GSa/sec each channel Equivalent-time sample rate: 400 GSa/s (when realtime mode is turned off)
Standard memory depth	8 Mpts per half channel, 4 Mpts per each channel
Time range	5 nsec/div to 50 sec/div (DSO6014L) 1 nsec/div to 50 sec/div (DSO6054L) 500 psec/div to 50 sec/div (DSO6104L)

### Acquisition

Acquisition mode	Normal, Peak Detect, Averaging, High Resolution
Peak detection	DSO6014L: 1 nsec peak detect DSO6054L/6104L: 250 psec peak detect
Averaging	Selectable from 2,4,8,16,32,64... to 65536
High resolution mode	Time base    Bits of resolution < 100 nsec/div    8 500 nsec/div    9 2 μsec/div    10 10 μsec/div    11 ≥ 50 μsec/div    12
Filter	Sin $\times$ /x interpolation

### Trigger system

Sources	DSO6xx4L: Ch 1, 2, 3, 4, line, ext and D0 - D15 for MSO enabled DSO
Modes	Auto, Normal, Single
Holdoff time range	~60 ns to 10 seconds
Trigger jitter	15 psec rms
Selections	Edge, pulse width, pattern, TV, duration, sequence, CAN, LIN, USB, I2C, SPI, Nth edge burst

### Scope channel triggering

Range (internal)	$\pm 6$ div from center screen
Sensitivity*	< 10 mV/div: greater of 1 div or 5 mV $\geq 10$ mV/div: 0.6 div
Coupling	AC (~10 Hz), DC, noise reject, HF reject and LF reject (~ 50 kHz)

\* Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and  $\pm 10$  °C from firmware calibration temperature.

### Logic (D15 - D0) channel triggering (with MSO option)

Threshold range (user defined)	$\pm 8.0$ V in 10 mV increments
Threshold accuracy*	$\pm(100$ mV + 3% of threshold setting)
Predefined thresholds	TTL = 1.4 V, CMOS = 2.5 V, ECL = -1.3 V

\* Denotes warranted specifications, all others are typical. Specifications are valid after a 30-minute warm-up period and  $\pm 10$  °C from firmware calibration temperature.

### External (EXT) triggering

Input resistance	1.015 k $\Omega$ $\pm$ 5% (DSO6014L) 2.14 k $\Omega$ $\pm$ 5% (DSO6054L/6104L)
Maximum input	$\pm 15$ V Range $\pm 5$ V
Sensitivity	DC to 100 MHz: 500 mV (DSO6014L) DC to 500 MHz: 500 mV (DSO6054L/6104L)
Coupling	AC (~ 3.5 Hz), DC, noise reject, HF reject and LF reject (~ 50 kHz)
Probe ID	Auto probe sense (DSO6014L) Auto probe sense and AutoProbe interface (DSO6054L/6104L)

### Measurement features

Automatic measurements	Measurements are continuously updated. Cursors track last selected measurement.
Voltage (scope channels only)	Peak-to-peak, maximum, minimum, average, amplitude, top, base, overshoot, preshoot, RMS, standard deviation (AC RMS)
Time	Frequency, period, + width, -width and duty cycle on any channels Rise time, fall time, X at max Y (time at max volts), X at min Y (time at min volts), delay, and phase on scope channels only
Counter	Built-in 5-digit frequency counter on any scope channel. Counts up to the scope's bandwidth (1 GHz max). The counter resolution can be increased to 8 digits with an external 10 MHz reference.
Threshold definition	Variable by percent and absolute value; 10%, 50%, 90% default for time measurements
Cursors	Manually or automatically placed readout of horizontal (X, $\Delta X$ , $1/\Delta X$ ) and vertical (Y, $\Delta Y$ ) Additionally logic or scope channels can be displayed as binary or hex values
Waveform math	One function of 1-2, 1x2, FFT, differentiate, integrate. Source of FFT, differentiate, integrate: scope channels 1 or 2, 1-2, 1+2, 1x2

### FFT

Points	Fixed at 1000 points
Source of FFT	Scope channels 1, 2, 3 or 4, 1+2, 1-2, 1x2
Window	Rectangular, flattop, Hanning
Noise floor	-50 to -90 dB depending on averaging
Amplitude	Display in dBV, dBm at 50 $\Omega$
Frequency resolution	0.05/(time per div)
Maximum frequency	50/(time per div)

## 1 Characteristics and Specifications

### Storage

Save/recall (non-volatile)	10 setups and traces can be saved and recalled internally. Secure environment mode (-SEC) ensures setups and traces are stored to volatile memory.
Storage type and format	USB 1.1 drive on front (/drive0) and rear (/drive5) panels Image formats: BMP (8 bit), BMP (24 bit) and PNG (24 bit) Data formats: X and Y (time/voltage) values in CSV, ASCII XY and binary format Trace/setup formats: Recalled

### I/O

Standard ports	USB 2.0 high speed, 10/100-BaseT LAN, IEEE488.2 GPIB, XGA video output
Max transfer rate	IEEE488.2 GPIB: 500 kbytes/sec USB (USBTMC-USB488): 3.5 Mbytes/sec 100 Mbps LAN (TCP/IP): 1 Mbytes/sec

### General characteristics

Rack mounting	Supplied with all necessary hardware (except tools) for installation into a standard EIA 19-inch rack
Physical size	43.5 cm W x 27 cm D x 4.2 cm H (without brackets)
Weight	Net: 2.45 kg (5.4 lbs.) Shipping: 6.2 kg (13.6 lbs.)
Probe comp output	Frequency ~1.2 kHz Amplitude ~2.5 V
Trigger out	
When Triggers is selected (delay ~17 ns)	0 to 5 V into high impedance 0 to 2.5 V into 50 $\Omega$
When Source Frequency or Source Frequency/8 is selected	0 to 580 mV into high impedance 0 to 290 mV into 50 $\Omega$
Max frequency output	350 MHz (in source frequency mode when terminated in 50 $\Omega$ ) 125 MHz (in source frequency/8 mode when terminated in 50 $\Omega$ )
10 MHz ref in/out	TTL out, 180 mV to 1 V amplitude within 0 to 2 V offset

**Power requirements**

Line Rating ~Line 80 W max, 100-240 VAC, 50/60 Hz

**Environmental characteristics**

Ambient temperature	Operating -10 °C to +50 °C; non-operating -51 °C to +71 °C
Humidity	Operating 95% RH at 40 °C for 24 hours; Non-operating 90% RH at 65 °C for 24 hours
Altitude	Operating to 4,570 m (15,000 ft); non-operating to 15,244 m (50,000 ft)
Vibration	Agilent class GP and MIL-PRF-28800F; Class 3 random
Shock	Agilent class GP and MIL-PRF-28800F; (operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks)
Pollution degree 2	Normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.
Indoor use	This instrument is rated for indoor use only

**Other**

Installation categories	CAT I: Mains isolated CAT II: Line voltage in appliance and to wall outlet
EMC	IEC 61326-1:1997, EN 61326-1:1997
Safety	IEC 61010-1:2001, EN 61010-1:2001 Canada: CSA-C22.2 No. 61010-1:2004 USA: UL 61010-1:2004
Supplementary information	The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, and carries the CE-marking accordingly.

## 1 Characteristics and Specifications

### Ordering information

Model number	Description
DSO6104L	1 GHz 4-ch DSO
DSO6054L	500 MHz 4-ch DSO
DSO6014L	100 MHz 4-ch DSO

See data sheet for more information. You can find the data sheet online at [www.agilent.com/find/mso6000](http://www.agilent.com/find/mso6000).





## 2 Testing Performance

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This chapter explains how to verify correct oscilloscope operation and perform tests to ensure that the oscilloscope meets the performance specifications.



# Overview

To completely test and troubleshoot the mixed-signal oscilloscope, you will create and use a test connector accessory, as described in this chapter.

- The test connector is only required for oscilloscopes that have the MSO option licensed (enabled).
- The connector is used in the digital channel threshold accuracy test.
- The test connector makes it easy for you to connect the oscilloscope probes to function generators and measurement equipment with minimum electrical distortion.

### Let the Equipment Warm Up Before Testing

For accurate test results, let the test equipment and the oscilloscope warm up 30 minutes before testing.

### Verifying Test Results

During the tests, record the readings in the Performance Test Record on [page 70](#). To verify whether a test passes, verify that the reading is within the limits in the Performance Test Record.

**If a performance test fails**

If a performance test fails, first perform the User Cal procedure

## Conventions

The following conventions will be used when referring to oscilloscope models throughout this chapter.

**Table 3** Conventions

Models	Referred to as:
MSO/DSO6012A, MSO/DSO6014A, DSO6014L	100 MHz Models
MSO/DSO6032A, MSO/DSO6034A	300 MHz Models
MSO/DSO6052A, MSO/DSO6054A, DSO6054L	500 MHz Models
MSO/DSO6102A, MSO/DSO6104A, DSO6104L	1 GHz Models

## Fluke MET/CAL Procedures

Fluke MET/CAL procedures are available for the 6000A Series oscilloscopes.



The MET/CAL badge with "PROCEDURES AVAILABLE" signifies that Fluke has created Warranted MET/CAL procedures to verify the performance of this instrument using MET/CAL metrology software. These procedures can be obtained from Fluke. Please see <http://www.fluke.com> and search for MET/CAL for more information.

### NOTE

Please Note: Agilent Technologies, Inc. provides this link for the convenience of its customers and does not warrant the suitability or performance of the software.

## List of Test Equipment

Below is a list of test equipment and accessories required to perform the performance test verification procedures.

**Table 4** List of test equipment

Equipment	Critical Specifications	Recommended Model/ Part Number
Test connector, 8-by-2*	See <a href="#">page 41</a> for instructions on building test connector.	n/a
Digital Multimeter	0.1 mV resolution, 0.005% accuracy	Agilent 34401A
Power Splitter	Outputs differ by 0.15 dB	Agilent 11667B
Oscilloscope Calibrator	DC offset voltage of -5.5 V to 35.5 V, 0.1 V resolution	Fluke 5820A
Signal Generator	25 MHz, 100 MHz, 300 MHz, 500 MHz, and 1 GHz sine waves	Agilent E4400B or Agilent 8648A
Power Meter/Sensor	1 GHz $\pm$ 3% accuracy	Agilent E4418B/8482A
Oscilloscope Calibrator	25 MHz—500 MHz sine wave, 5 ppm	Fluke 5820A
BNC banana cable		Agilent 11001-66001
BNC cable (qty 3)		Agilent 10503A
Cable	Type N (m) 609.6 mm (24 in.)	Agilent 11500B
Probe cable*		Agilent 01650-61607
Shorting Cap BNC		Agilent 1250-0774
Adapter	BNC(f) to banana(m)	Agilent 1251-2277
Adapter	BNC Tee (m) (f) (f)	Agilent 1250-0781
Adapter	Type N (m) to BNC (m)	Agilent 1250-0082 or Pomona 3288 with Pomona 3533
Blocking capacitor		Agilent 10240-60001
Adapter (qty 3)	N(m) to BNC(f)	Agilent 1250-0780
Feedthrough (qty 2)	50 $\Omega$ BNC (f) to BNC (m)	Agilent 0960-0301

\* Required only for testing digital channels of oscilloscopes that have the MSO option.

Some parts and equipment are available at [www.agilent.com](http://www.agilent.com) or [www.parts.agilent.com](http://www.parts.agilent.com).

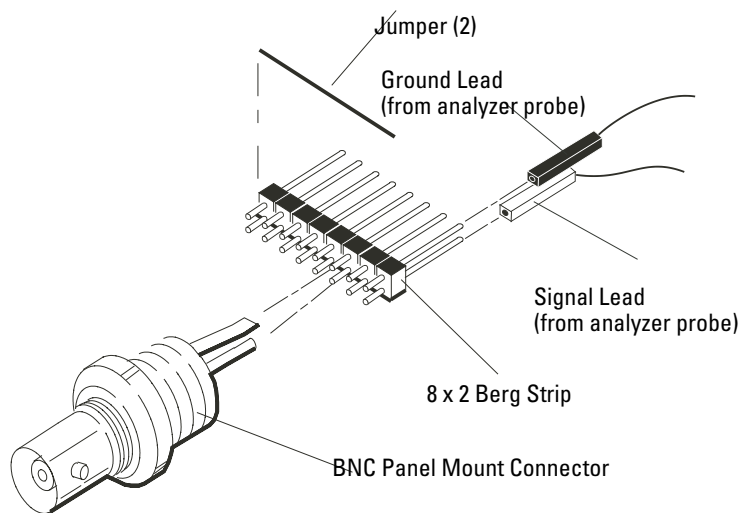
## To construct the test connector (for use with MSO models only)

Agilent 6000 Series Oscilloscopes that have digital channels enabled require the test connector described below. Follow the steps to build the test connector.

**Table 5** Materials required to construct the test connectors

Description	Recommended Part	Qty
BNC (f) Connector	Agilent 1250-1032 or Pomona 4578	1
Berg Strip, 8-by-2		1
Jumper wire		

- 1** Obtain a BNC connector and an 8-by-2 section of Berg strip.
- 2** On one side of the Berg strip, solder a jumper wire to all of the pins (shown in [Figure 1](#) on page 42).
- 3** On the other side of the Berg strip, solder another jumper wire to all of the pins.
- 4** Solder the center of the BNC connector to a center pin on one of the rows on the Berg strip.
- 5** Solder the ground tab of the BNC connector to a center pin on the other row on the Berg strip.



**Figure 1** Constructing the 8-by-2 Connector

## To test digital channels (MSO models only)

The acquisition system testing provides confidence that the acquisition system is functioning correctly. It does not, however, check a particular specification.

- 1 Disconnect all probes from the circuit under test and from any other input source.
- 2 Using probe leads and grabbers, connect digital channels D0, D1, D2, and D3 to the Probe Comp signal on the center of the front panel.
- 3 Press the **AutoScale** key.

If four square waves appear, the acquisition system is functioning correctly.

If the square waves do not appear, go to the “Troubleshooting” chapter. Then return here to finish testing the digital channels.

- 4 Disconnect the digital channels from the calibration point.
- 5 Use steps 2 and 3 to test the following sets of digital channels. After you test one set of digital channels, remove them before connecting the next set.
  - D4, D5, D6, D7
  - D8, D9, D10, D11
  - D12, D13, D14, D15

## To verify digital channel threshold accuracy (MSO models only)

This test verifies the digital channel threshold accuracy specification of the Agilent 6000 Series Oscilloscopes.

Threshold accuracy test limits=  $\pm(100 \text{ mV} + 3\% \text{ of threshold setting})$

### When to Test

You should perform this test every 12 months or after 2000 hours of operation, whichever comes first.

### What to Test

Use these instructions to test the threshold settings of digital channels D7-D0. Then, use the same instructions to test digital channels D15-D8.

### Verifying Test Results

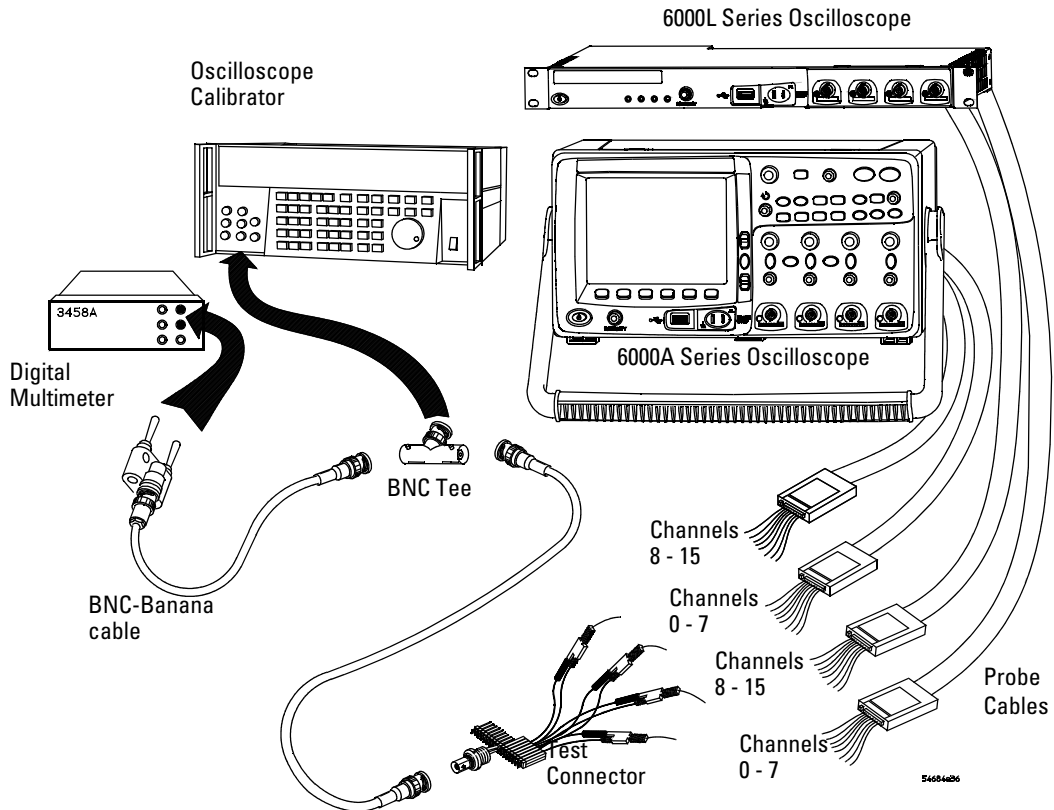
After each threshold test, record the voltage reading in the Performance Test Record on [page 70](#). To verify whether a test passes, verify that the voltage reading is within the limits in the Performance Test Record.



**Table 6** Equipment Required to Test Digital Channel Threshold Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Digital Multimeter	0.1 mV resolution, 0.005% accuracy	Agilent 34401A
Oscilloscope Calibrator	DC offset voltage 6.3 V	Fluke 5820A
BNC-Banana Cable		Agilent 11001-60001
BNC Tee		Agilent 1250-0781
BNC Cable		Fluke 50Ω cable, P/N 686318
BNC Test Connector, 8-by-2		User-built (See <a href="#">page 41.</a> )
Probe Cable		Agilent 01650-61607

- 1** Turn on the test equipment and the oscilloscope. Let them warm up for 30 minutes before starting the test.
- 2** Set up the oscilloscope calibrator.
  - a** Set the oscilloscope calibrator to provide a DC offset voltage at the Channel 1 output.
  - b** Use the multimeter to monitor the oscilloscope calibrator DC output voltage.
- 3** Use the 8-by-2 test connector and the BNC cable assembly to connect digital channels D0-D7 to one side of the BNC Tee. Then connect the D0-D7 ground lead to the ground side of the 8-by-2 connector. See [Figure 2.](#)



**Figure 2** Setting Up Equipment and Test Connector for the Threshold Test

- 4 Use a BNC-banana cable to connect the multimeter to the other side of the BNC Tee.
- 5 Connect the BNC Tee to the Channel 1 output of the calibrator as shown in [Figure 2](#).
- 6 On the oscilloscope, press the **D15 Thru D0** key, then press the **Thresholds** softkey, then press the **D15 Thru D0** softkey repeatedly until the check mark is next to **User**.

- 7 Press the oscilloscope **User** softkey, then turn the Entry knob (↻) on the front panel on the oscilloscope to set the threshold test settings as shown in [Table 7](#).

**Table 7** Threshold Accuracy Voltage Test Settings

Threshold voltage setting (in oscilloscope <b>User</b> softkey)	DC offset voltage setting (on oscilloscope calibrator)	Limits
+5.00 V	+5.250 V ±1 mV dc	Lower limit = +4.750 V Upper limit = +5.250 V
-5.00 V	-4.750 V ±1 mV dc	Lower limit = -5.250 V Upper limit = -4.750 V
0.00 V	+100m V ±1 mV dc	Upper limit = +100 mV Lower limit = -100 mV

- 8 Do the following steps for each of the threshold voltage levels shown in [Table 7](#).
- Set the threshold voltage shown in the **User** softkey using the Entry knob on the oscilloscope.
  - Enter the corresponding DC offset voltage on the oscilloscope calibrator front panel. Then use the multimeter to verify the voltage.

Digital channel activity indicators are displayed on the status line at the top of the oscilloscope display. The activity indicators for D7-D0 should show all of the channels at digital high levels.

- Use the knob on the oscilloscope calibrator to decrease the offset voltage, in increments of 10 mV, until the activity indicators for digital channels D7-D0 are all at digital low levels. Record the oscilloscope calibrator voltage in the Performance Test Record (see [page 70](#)).
- Use the knob on the oscilloscope calibrator to increase the offset voltage, in increments of 10 mV, until the activity indicators for digital channels D7-D0 are all at

digital high levels. Record the oscilloscope calibrator voltage in the Performance Test Record (see [page 70](#)).

Before proceeding to the next step, make sure that you have recorded the oscilloscope calibrator voltage levels for each of the threshold settings shown in [Table 7](#).

- 9 Use the 8-by-2 test connector to connect digital channels D15-D8 to the output of the oscilloscope calibrator. Then connect the D15-D8 ground lead to the ground side of the 8-by-2 connector.
- 10 Repeat this procedure (steps 7 and 8) for digital channels D15-D8 to verify threshold accuracy and record the threshold levels in the Performance Test Record (see [page 70](#)).

## To verify voltage measurement accuracy

This test verifies the accuracy of the analog channel voltage measurement for each channel (DC Vertical Gain Accuracy and Dual Cursor Accuracy specifications). In this test, you will measure the dc voltage output of an oscilloscope calibrator using dual cursors on the oscilloscope, and compare the results with the multimeter reading.

Test limits:  $\pm 2.0\%$  of full scale  $\pm 1$  LSB\*

- On 300 MHz, 500 MHz, and 1 GHz models, full scale is defined as 32 mV on the 2 mV/div range.
- On 100 MHz models full scale is defined as 16 mV on the 1 mV/div range.
- Full scale on all other ranges is defined as 8 divisions times the V/div setting.

\*1 LSB = 0.4% of full scale

**Table 8** Equipment Required to Verify Voltage Measurement Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Oscilloscope Calibrator	14 mV to 35 Vdc, 0.1 V resolution	Fluke 5820A
Digital multimeter	Better than 0.01% accuracy	Agilent 34401A
Cable	BNC, Qty 2	Agilent 10503A
Shorting cap	BNC	Agilent 1250-0774
Adapter	BNC (f) to banana (m)	Agilent 1251-2277
Adapter	BNC tee (m) (f) (f)	Agilent 1250-0781
Blocking capacitor		Agilent 10240B

- 1 Set up the oscilloscope.
  - a Adjust the channel 1 position knob to place the baseline at 0.5 major division from the bottom of the display.
  - b Set the Volts/Div setting to the value in the first line in [Table 9](#).

**Table 9** Settings Used to Verify Voltage Measurement Accuracy

<b>Volts/Div Setting</b>	<b>Oscilloscope Calibrator Setting</b>	<b>Test Limits</b>		
5 V/Div	35 V	34.04 V	to	35.96 V
2 V/Div	14 V	13.616 V	to	14.384 V
1 V/Div	7 V	6.808 V	to	7.192 V
500 mV/Div	3.5 V	3.404 V	to	3.596 V
200 mV/Div	1.4 V	1.3616 V	to	1.4384 V
100 mV/Div	700 mV	680.8 mV	to	719.2 mV
50 mV/Div	350 mV	340.4 mV	to	359.6 mV
20 mV/Div	140 mV	136.16 mV	to	143.84 mV
10 mV/Div	70 mV	68.08 mV	to	71.92 mV
5 mV/Div	35 mV	34.04 mV	to	35.96 mV
2 mV/Div <sup>1</sup> (for 1 GHz, 500 MHz, and 300 MHz models)				
	14 mV	13.232 mV	to	14.768 mV
2 mV/Div (for 100 MHz models)				
	14 mV	13.616 mV	to	14.384 mV
1 mV/Div <sup>2</sup>	7 mV	6.616 mV	to	7.384 mV


<sup>1</sup> Full scale is defined as 32 mV on the 2 mV/div range for 300 MHz, 500 MHz, and 1 GHz models.

<sup>2</sup> Full scale is defined as 16 mV on the 1 mV/div range for 100 MHz models.

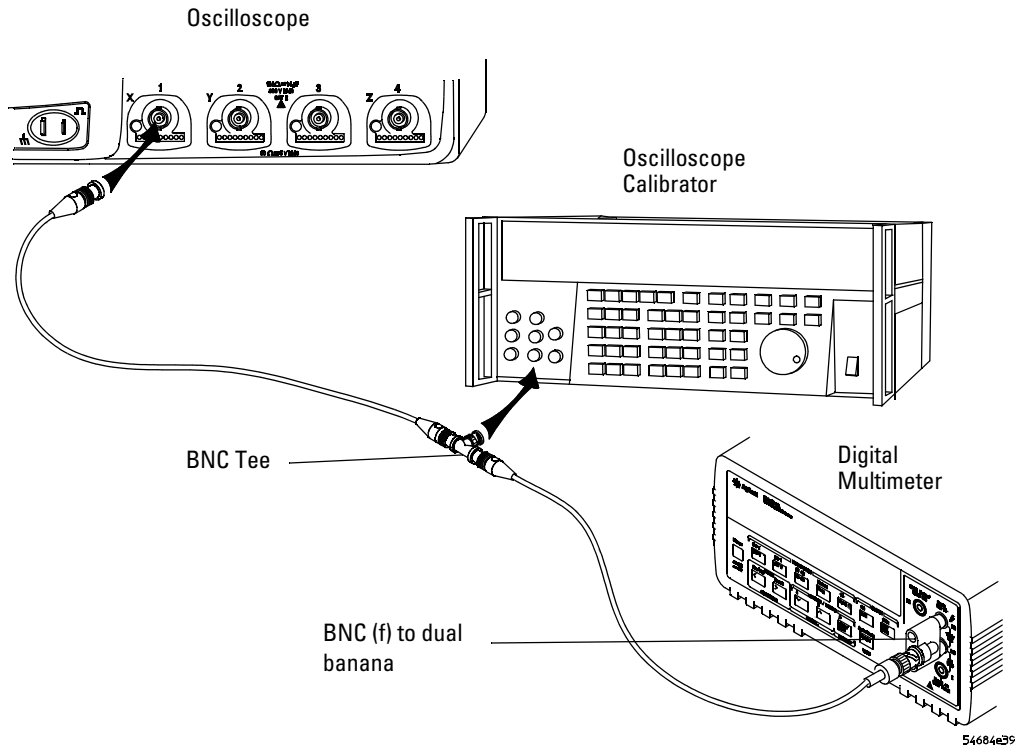
Full scale on all other ranges is defined as 8 divisions times the V/div setting.

- c** Press the **Acquire** key. Then press the **Averaging** softkey and set **#Avgs** to 64.

Wait a few seconds for the measurement to settle.

- 2** Press the **Cursors** key, set the **Mode** softkey to **Normal**, then press the **XY** softkey and select **Y**. Press the **Y1** softkey, then use the Entry knob (labeled  on the front panel) to set the Y1 cursor on the baseline of the signal.

- 3 Use the BNC tee and cables to connect the oscilloscope calibrator /power supply to both the oscilloscope and the multimeter (see [Figure 3](#)).



**Figure 3** Connect equipment for voltage measurement accuracy test

- 4 Adjust the output so that the multimeter reading displays the first Volts/div calibrator setting value in [Table 9](#).

Wait a few seconds for the measurement to settle.

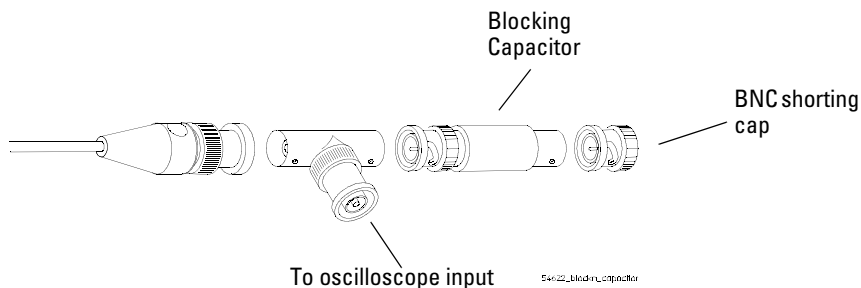
- 5 Press the **Y2** softkey, then position the Y2 cursor to the center of the voltage trace using the Entry knob.

The  $\Delta Y$  value on the lower line of the display should be within the test limits of [Table 9](#). If a result is not within the test limits, go to the “Troubleshooting” chapter. Then return here.

- 6 Continue to check the voltage measurement accuracy with the remaining Volts/div setting values in [Table 9](#).
- 7 When you are finished checking all of the voltage values, disconnect the oscilloscope calibrator from the oscilloscope.
- 8 Repeat this procedure for the remaining channels to be tested.

### Use a Blocking Capacitor to Reduce Noise

On the more sensitive ranges, such as 2 mV/div and 5 mV/div, noise may be a factor. To eliminate the noise, add a BNC Tee, blocking capacitor, and BNC shorting cap at the oscilloscope channel input to shunt the noise to ground. See [Figure 4](#).



**Figure 4** Using a Blocking Capacitor to Reduce Noise



## To verify bandwidth

This test checks the bandwidth of the oscilloscope. In this test you will use a signal generator and a power meter.

### 1 GHz Models

Test limits at 2 mV/div to 5 V/div

- All channels ( $\pm 3$  dB)
  - dc to 1 GHz

### 500 MHz Models

Test limits at 2 mV/div to 5 V/div

- All channels ( $\pm 3$  dB)
  - dc to 500 MHz

### 300 MHz Models

Test limits at 2 mV/div to 5 V/div

- All channels ( $\pm 3$  dB)
  - dc to 300 MHz

### 100 MHz Models

Test limits at 1 mV/div to 5 V/div

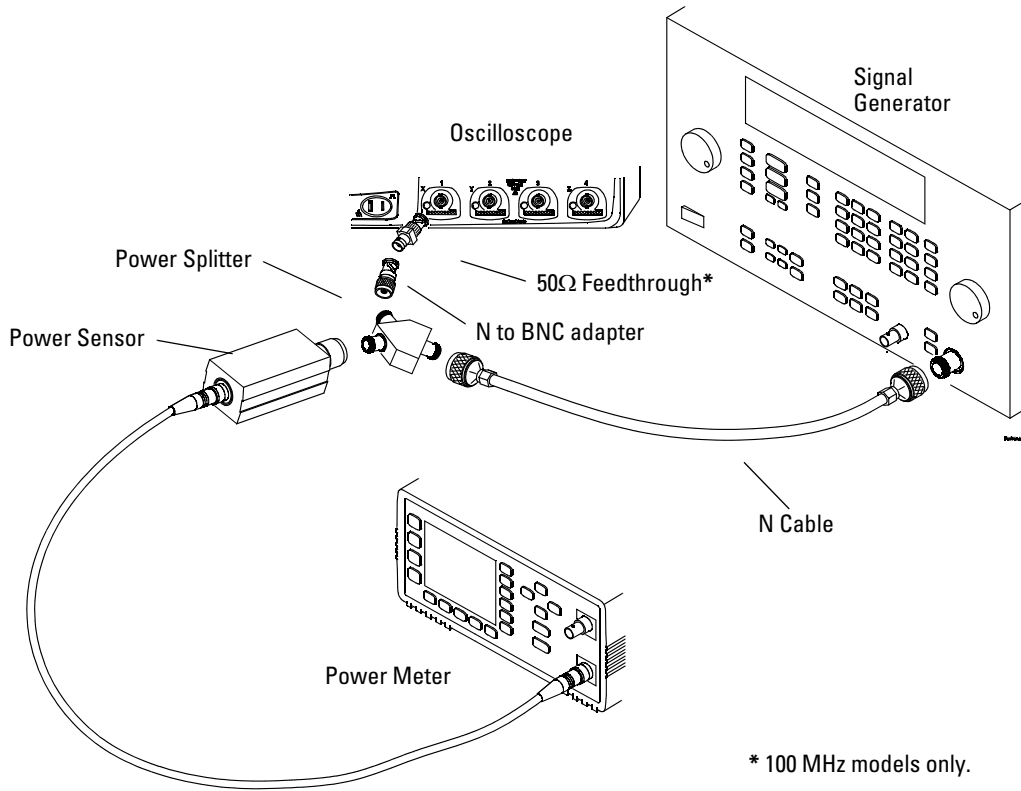
- All channels ( $\pm 3$  dB)
  - dc to 100 MHz

**Table 10** Equipment Required to Verify Bandwidth

Equipment	Critical Specifications	Recommended Model/Part
Signal Generator	100 kHz - 1 GHz at 200 mVrms	Agilent E4400B/8648A
Power Meter/Sensor	1 MHz - 1 GHz $\pm 3\%$ accuracy	Agilent E4418B/8482A
Power Splitter	outputs differ by $< 0.15$ dB	Agilent 11667A
Cable	Type N (m) 24 inch	Agilent 11500B
Adapter	Type N (m) to BNC (m)	Agilent 1250-0082
Feedthrough	50 $\Omega$ BNC (f) to BNC (m)	Agilent 0960-0301

**1** Connect the equipment (see [Figure 5](#)).

- a** Use the N cable to connect the signal generator to the input of the power splitter input.
- b** Connect the power sensor to one output of the power splitter.
- c** For 300 MHz, 500 MHz, and 1 GHz oscilloscope models use an N-to-BNC adapter to connect the other splitter output to the channel 1 input.
- d** For 100 MHz oscilloscopes, use an N-to-BNC adapter and 50 $\Omega$  feedthrough termination to connect the other splitter output to the channel 1 input on the oscilloscope.



**Figure 5** Connect equipment for bandwidth test

**2** Set up the power meter.

Set the power meter to display measurements in units of watts.

- 3 Set up the oscilloscope.
  - a Press the **Save/Recall** key, then press the **Default Setup** softkey.
  - b Press the **Acquire** key, then press the **Realtime** softkey to unselect Realtime.
  - c Set channel 1 **Coupling** to **DC**.
  - d On 300 MHz, 500 MHz, and 1 GHz models only, set channel 1 **Imped** to **50 Ohm**.
  - e Set the time base to 500 ns/div.
  - f Set the Volts/Div for channel 1 to 200 mV/div.
  - g Press the **Acquire** key, then press the **Averaging** softkey.
  - h Turn the Entry knob to set **# Avgs** to 8 averages.
- 4 Set the signal generator for 1 MHz and six divisions of amplitude.

The signal on the oscilloscope screen should be about five cycles at six divisions amplitude.

- 5 Set up the Amplitude measurement
  - a Press the **Quick Meas** key.
  - b Press the **Clear Meas** softkey.
  - c Press the **Select:** softkey and use the Entry knob to select **Std Deviation** within the select menu.
  - d Press the **Measure Std Dev** softkey.
- 6 Note the oscilloscope Std Dev(1) reading at the bottom of the screen. (This is the RMS value with any dc offset removed.)
- 7 Set the power meter Cal Factor % to the 1 MHz value on the calibration chart on the power sensor.
- 8 Note the reading on the power meter and covert to Vrms using the expression:

$$V_{in_{1MHz}} = \sqrt{P_{meas_{1MHz}} \times 50\Omega}$$

For example, if the power meter reading is 892 uW, then  $V_{in_{1MHz}} = (892 \times 10^{-6} * 50\Omega)^{1/2} = 211.2 \text{ mV}_{\text{rms}}$ .

- 9** Change the signal generator output frequency according to the maximum frequency for the oscilloscope using the following:
- 1 GHz Models: 1 GHz
  - 500 MHz Models: 500 MHz
  - 300 MHz Models: 300 MHz
  - 100 MHz Models: 100 MHz
- 10** Referencing the frequency from step 9, set the power meter Cal Factor % to the frequency value on the calibration chart on the power sensor.
- 11** Set the oscilloscope sweep speed according to the following:
- 1 GHz Models: 500 ps/div
  - 500 MHz Models: 1 ns/div
  - 300 MHz Models: 2 ns/div
  - 100 MHz Models: 5 ns/div
- 12** Note the oscilloscope Std Dev(1) reading at the bottom of the screen.
- 13** Note the reading on the power meter and convert to  $V_{rms}$  using the expression:

$$V_{in_{max\_freq}} = \sqrt{P_{meas_{max\_freq}} \times 50\Omega}$$

- 14** Calculate the response using the expression:

$$\text{response(dB)} = 20 \log_{10} \left[ \frac{V_{out_{max\_freq}} / V_{in_{max\_freq}}}{V_{out_{1MHz}} / V_{in_{1MHz}}} \right]$$

**Example** If:

$$\begin{aligned} P_{meas_{1\_MHz}} &= 892 \text{ uW} \\ \text{Std Dev}(n)_{1MHz} &= 210.4 \text{ mV} \\ P_{meas_{max\_freq}} &= 687 \text{ uW} \\ \text{Std Dev}(n)_{max\_freq} &= 161.6 \text{ mV} \end{aligned}$$

Then after converting the values from the power meter to  $V_{rms}$ :

$$\text{response(dB)} = 20 \log_{10} \left[ \frac{161.6 \text{ mV} / 185.3 \text{ mV}}{210.4 \text{ mV} / 211.2 \text{ mV}} \right] = -1.16 \text{ dB}$$

- 15** The result from step 14 should be between +3.0 dB and -3.0 dB. Record the result in the Performance Test Record (see [page 70](#)).
- 16** Move the power splitter from the channel 1 to the channel 2 input.
- 17** Turn off the current channel and turn on the next channel using the channel keys.
- 18** Repeat steps 3 through 17 for the remaining channels, setting the parameters of the channel being tested where appropriate.

### To verify horizontal $\Delta t$ accuracy

The following test is optional because horizontal  $\Delta t$  accuracy is a characteristic, not a specification.

This test verifies the horizontal  $\Delta t$  accuracy. In this test, you will use the oscilloscope to measure the output of a time mark generator.

Test limits:  $\pm 0.0015\%$  of reading  $\pm 0.1\%$  of full scale  $\pm 20$  ps (same channel)

**Table 11** Equipment Required to Verify Horizontal  $\Delta t$  Accuracy

Equipment	Critical Specifications	Recommended Model/Part
Oscilloscope Calibrator	Stability 5 ppm after 1/2 hour	Fluke 5820A
Cable	BNC, 3 feet	Agilent 10503A
Feedthrough	50 $\Omega$ BNC (f) to BNC (m)	Agilent 0960-0301

- 1 Connect the equipment:
  - a For 300 MHz, 500 MHz, and 1 GHz oscilloscope models, connect the calibrator output to the oscilloscope channel 1 input.
  - b For 100 MHz oscilloscopes, use a 50 $\Omega$  feedthrough termination to connect the calibrator output to the oscilloscope channel 1 input.
- 2 Set up the signal source.
  - 1 Select **Marker** on the oscilloscope calibrator.
  - 2 Set the calibrator for 100  $\mu$ s markers (period = 100  $\mu$ s).
- 3 Set up the oscilloscope.
  - a Set channel 1 **Coupling** to **DC**.
  - b On 1 GHz, 500 MHz and 300 MHz models only, set channel 1 **Imped** to **50 Ohm**.
  - c Press the **Display** key, then set the **Vectors** softkey to off.
  - d Press the **AutoScale** key.
  - e Set the time base to 20  $\mu$ s/div.
  - f Press the **Main/Delayed** key, then set the **Time Ref** softkey to **Left**.
  - g Adjust the Trigger Level knob to obtain a stable display.
- 4 Press the **Quick Meas** softkey, set the **Source** softkey to **1**, then press **Select** and choose **Period**. Press the **Measure** softkey and measure the following:
 

Period 100  $\mu$ s – The test limits are 99.8  $\mu$ s to 100.2  $\mu$ s.

If the measurements are not within the test limits, go to the “Troubleshooting” chapter. Then return here.

- 5 Change the calibrator to 100 ns markers. Change the time base to 20 ns/div. Adjust the trigger level to obtain a stable display.
- 6 Measure the following. If the measurements are not within the test limits, go to the “Troubleshooting” chapter. Then return here.

Period 100 ns— The test limits are 99.8 ns to 100.2 ns.

- 7 Change the time base and calibrator markers as follows:
  - a On 300 MHz, 500 MHz, and 1 GHz models, change time base to 2 ns/div and the calibrator to 5 ns markers
  - b On 100 MHz models, change time base to 5 ns/div and the calibrator to 10 ns markers
- 8 Make the following measurements. If the measurements are not within the test limits, go to the “Troubleshooting” chapter. Then return here.
  - a For 300 MHz, 500 MHz, and 1 GHz models, period 5 ns – the test limits are 4.96 ns to 5.04 ns.
  - b For 100 MHz models, period 10 ns – the test limits are 9.93 ns to 10.07 ns.

## To verify trigger sensitivity

This test verifies the trigger sensitivity. In this test, you will apply a sine wave to the oscilloscope at the upper bandwidth limit. You will then decrease the amplitude of the signal to the specified levels, and check to see if the oscilloscope is still triggered.

The internal trigger sensitivity test is mandatory because it is a specification. The external trigger test is optional because it is a characteristic, not a specification.



Test limits for:

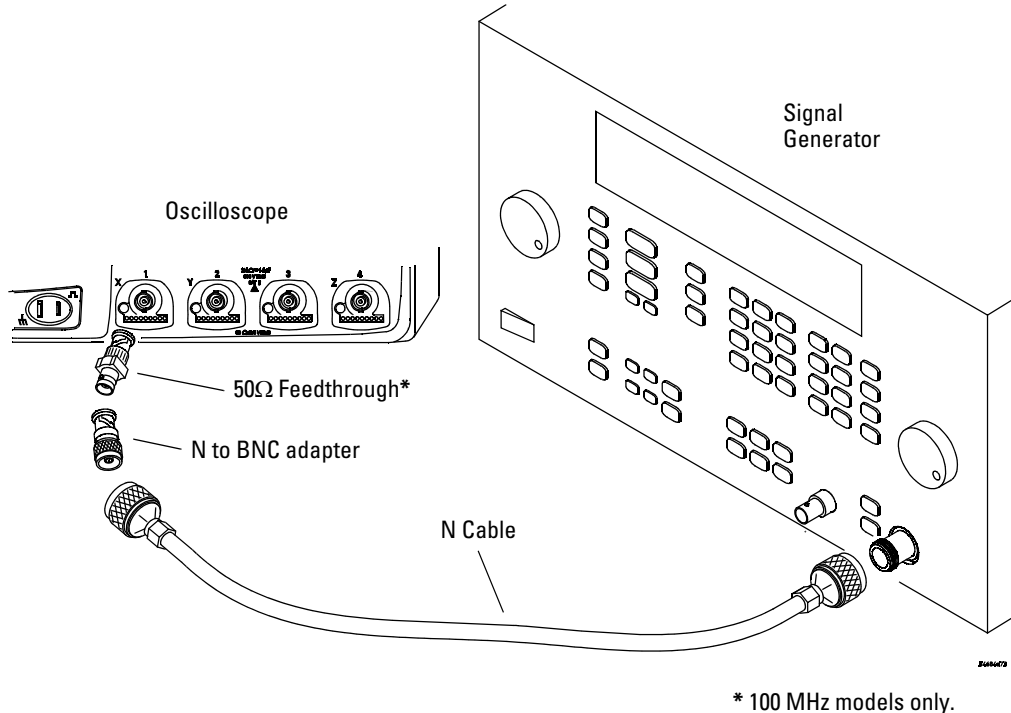
- Internal trigger on all models:
  - < 10 mV/div: greater of 1 div or 5 mV<sub>pp</sub>
  - ≥10 mV/div: 0.6 div
- External trigger on all 2-channel models (DSO/MSO6xx2A):
  - Trigger range: 1.0V
    - DC to 100 MHz: < 100 mV<sub>pp</sub>
    - >100 MHz to max bandwidth: < 200 mV<sub>pp</sub>
  - Trigger range: 8.0V
    - DC to 100 MHz: < 250 mV<sub>pp</sub>
    - >100 MHz to max bandwidth: < 500 mV<sub>pp</sub>
- External trigger on 4-channel models:
  - 4-channel 1 GHz, 500 MHz, and 300 MHz models:  
(MSO/DSO6104A/6054A/6034A, DSO6104L/6054L)  
DC to 500 MHz: < 500 mV<sub>pp</sub>
  - 4-channel 100 MHz models:  
(MSO/DSO6014A, DSO6014L)  
DC to 100 MHz: < 500 mV<sub>pp</sub>

**Table 12** Equipment Required to Verify Trigger Sensitivity

Equipment	Critical Specifications	Recommended Model/Part
Signal Generator	25-MHz, 100-MHz, 300-MHz, 500-MHz, and 1 GHz sine waves	Agilent E4400B/8648A
Power splitter	Outputs differ < 0.15 dB	Agilent 11667A
Cable	BNC, Qty 3	Agilent 10503A
Adapter	N (m) to BNC (f), Qty 3	Agilent 1250-0780
Feedthrough	50Ω BNC (f) to BNC (m) Qty 2	Agilent 0960-0301

## Test Internal Trigger Sensitivity (all models)

- 1 Connect the equipment (see Figure 6).
  - a For 300 MHz, 500 MHz, and 1 GHz models, connect the signal generator output to the oscilloscope channel 1 input.
  - b For 100 MHz models, use a 50 $\Omega$  feedthrough termination to connect the signal generator output to the oscilloscope channel 1 input.



**Figure 6** Connect equipment for internal trigger sensitivity test

- 2 Verify the trigger sensitivity at maximum bandwidth.  
1 GHz models: 1 GHz  
500 MHz models: 500 MHz  
300 MHz models: 300 MHz  
100 MHz models: 100 MHz
  - a Press the **Save/Recall** key, then press the **Default Setup** softkey.
  - b On 300 MHz, 500 MHz, and 1 GHz models, set channel 1 **Imped** to **50 Ohm**.
  - c Set the output frequency of the signal generator to the maximum bandwidth of the oscilloscope and set the amplitude to about  $10 \text{ mV}_{\text{pp}}$ .
  - d Press the **AutoScale** key.
  - e Set the time base to 10 ns/div.
  - f Set channel 1 to 5 mV/div.
  - g Decrease the amplitude from the signal generator until 1 vertical division of the signal is displayed.

The trigger is stable when the displayed waveform is stable. If the trigger is not stable, try adjusting the trigger level. If adjusting the trigger level makes the trigger stable, the test still passes. If adjusting the trigger does not help, see the "Troubleshooting" chapter. Then return here.
  - h Record the result as Pass or Fail in the Performance Test Record (see [page 70](#)).
- 3 Repeat this procedure for the remaining oscilloscope channels.

## Test External Trigger Sensitivity (2-channel models)

The following test is optional because External Trigger Sensitivity is a characteristic, not a specification.

This test applies to 2-channel models only.

Verify the external trigger sensitivity at these settings:

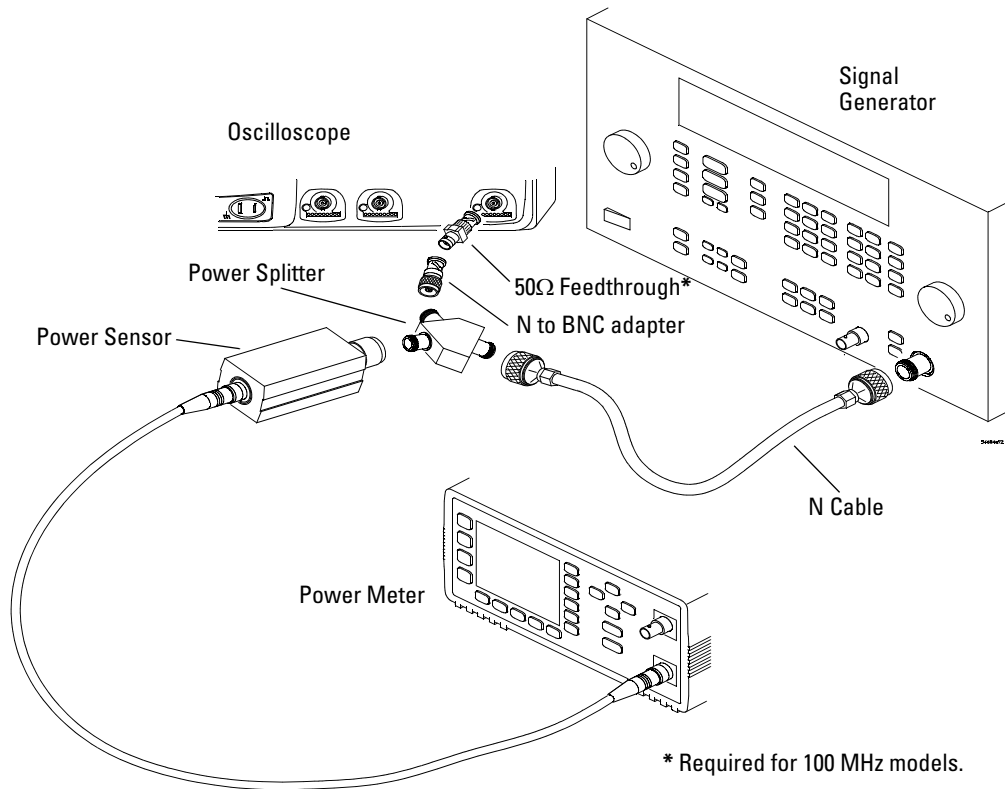
Trigger range = +/- 1 V

- 1 GHz (MSO/DSO6102A), 200 mV<sub>pp</sub>
- 500 MHz (MSO/DSO6052A), 200 mV<sub>pp</sub>
- 300 MHz (MSO/DSO6032A), 200 mV<sub>pp</sub>
- 100 MHz (MSO/DSO6012A), 200 mV<sub>pp</sub>

Trigger range = +/- 8 V

- 1 GHz (MSO/DSO6102A), 500 mV<sub>pp</sub>
- 500 MHz (MSO/DSO6052A), 500 mV<sub>pp</sub>
- 300 MHz (MSO/DSO6032A), 500 mV<sub>pp</sub>
- 100 MHz (MSO/DSO6012A), 500 mV<sub>pp</sub>

- 1 Connect the equipment (see [Figure 7](#)).
  - a Use the N cable to connect the signal generator to the power splitter input.
  - b Connect one output of the power splitter to the Ext Trigger input.
  - c Connect the power sensor to the other output of the power splitter.



**Figure 7** Connect equipment for external trigger sensitivity test (2-channel models)

- 2 Set up the oscilloscope.
  - a Press the **Save/Recall** key, then press the **Default Setup** softkey.
  - b On 300 MHz, 500 MHz, and 1 GHz models, set the External Trigger impedance to **50 Ohm**. 100 MHz models do not have this option, so you need to use a 50 ohm feedthrough terminator as shown in [Figure 7](#).
  - c Change the trigger **Mode** from Auto to **Normal**.
  - d Use the **Range** softkey and the Entry knob to set the range to 1.0 V.
- 3 Verify the trigger sensitivity at maximum frequency.
  - a Change the signal generator output frequency:  
MSO/DSO6102A: 1 GHz  
MSO/DSO6052A: 500 MHz  
MSO/DSO6032A: 300 MHz  
MSO/DSO6012A: 100 MHz
  - b Set the power meter Cal Factor % to the appropriate value (100, 300, 500 MHz or 1 GHz) on the calibration chart on the power sensor. If necessary, do a linear interpolation if the correct factor is not included in the power meter's calibration chart.
  - c Adjust the signal generator output for a reading on the power meter of 100 $\mu$ W. ( $200\text{ mV}_{pp} = 70.71\text{mV rms}$ ,  
 $\text{Power} = V_{in}^2/50\Omega = 70.71\text{ mV}^2/50\Omega = 100\mu\text{W}$ .)
  - d Press the Trigger **Edge** key, then press the **Source** softkey to set the trigger source to external trigger.
  - e Check for stable triggering and adjust the trigger level if necessary. Triggering is indicated by the **Trig'd** indicator at the top of the display. When it is flashing, the oscilloscope is not triggered. When it is not flashing, the oscilloscope is triggered.
  - f Record the results as Pass or Fail in the Performance Test Record (see [page 70](#)).

If the test fails, see the "Troubleshooting" chapter. Then return here.

- 4 Verify the trigger sensitivity at maximum frequency for trigger range of 8.0 V.
- a Press the **Mode/Coupling** key, press the **External** softkey, then press the **Range** softkey and use the Entry knob to set the range to 8.0 V.
  - b Adjust the signal generator output for reading on the power meter of  $625\mu\text{W}$ . ( $500\text{mV}_{\text{pp}} = 176.78\text{mV rms}$ ,  
Power =  $V_{\text{in}}^2/50\Omega = 176.78\text{ mV}^2/50\Omega = 625\mu\text{W}$ .)
  - c Check for stable triggering and adjust the trigger level if necessary. Triggering is indicated by the **Trig'd** indicator at the top of the display. When it is flashing, the oscilloscope is not triggered. When it is not flashing, the oscilloscope is triggered.
  - d Record the results as Pass or Fail in the Performance Test Record (see [page 70](#)).

## Test External Trigger Sensitivity (4-channel models)

The following test is optional because External Trigger Sensitivity is a characteristic, not a specification.

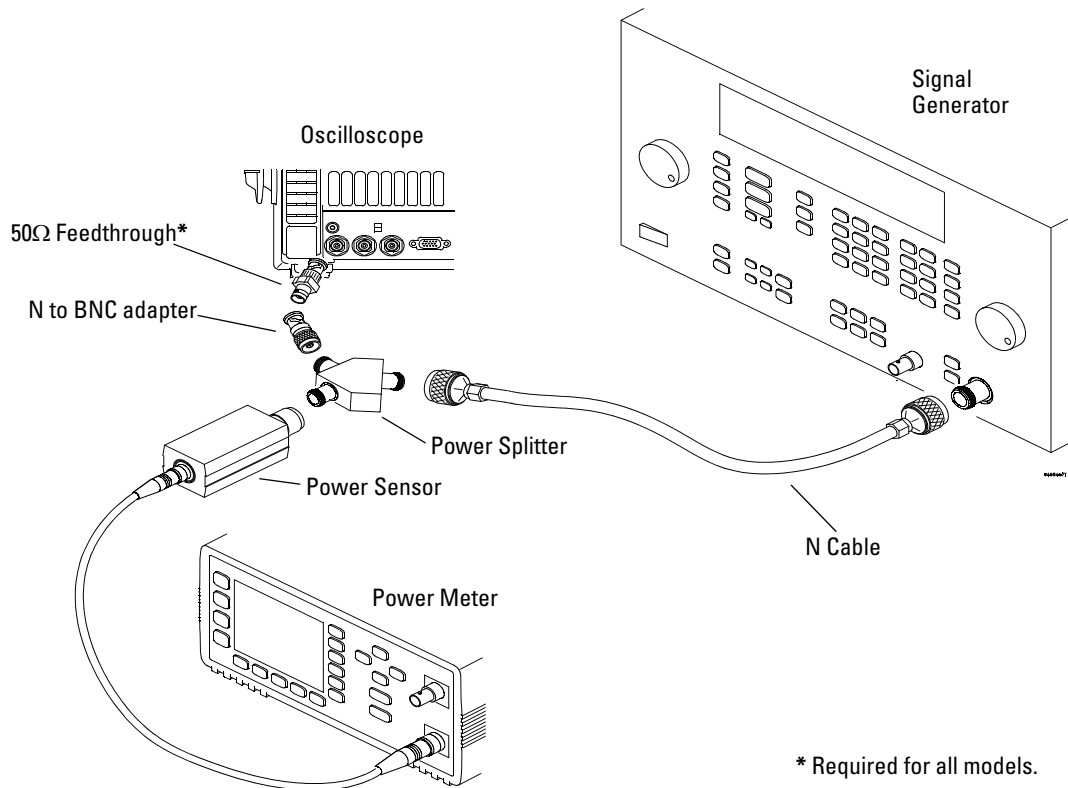
This test applies to 4-channel models only.

Verify the external trigger sensitivity at these settings:

- 1 GHz, 500 MHz, and 300 MHz bandwidth models:  
500 MHz,  $500\text{ mV}_{\text{pp}}$
- 100 MHz bandwidth models:  
100 MHz,  $500\text{ mV}_{\text{pp}}$

## 2 Testing Performance

- 1 Connect the equipment (see [Figure 8](#)).
  - a Use the N cable to connect the signal generator to the power splitter input.
  - b Connect one output of the power splitter to the Aux Trig input through a 50Ω feedthrough termination.
  - c Connect the power sensor to the other output of the power splitter.



**Figure 8** Connect equipment for external trigger sensitivity test (4-channel models)



- 2 Set up the oscilloscope.
  - a Press the **Save/Recall** key, then press the **Default Setup** softkey.
- 3 Change the signal generator output frequency as follows:
  - For 300 MHz, 500 MHz, and 1 GHz models, set the signal generator output frequency to 500 MHz
  - For 100 MHz models, set the signal generator output frequency to 100 MHz
- 4 Set the power meter Cal Factor % to the appropriate value (500 MHz or 100 MHz) on the calibration chart on the power sensor. If necessary, do a linear interpolation if a 500 MHz or 100 MHz factor is not included in the power meter's calibration chart.
- 5 Adjust the signal generator output for reading on the power meter of  $625\mu\text{W}$ . ( $500\text{mV}_{\text{pp}} = 176.78\text{mV rms}$ , Power =  $V_{\text{in}}^2/50\Omega = 176.78\text{ mV}^2/50\Omega = 625\mu\text{W}$ .)
- 6 Press the Trigger **Edge** key, then press the **Source** softkey to set the trigger source to **External**.
- 7 Check for stable triggering and adjust the trigger level if necessary. Triggering is indicated by the **Trig'd** indicator at the top of the display. When it is flashing, the oscilloscope is not triggered. When it is not flashing, the oscilloscope is triggered.
- 8 Record the results as Pass or Fail in the Performance Test Record (see [page 70](#)).

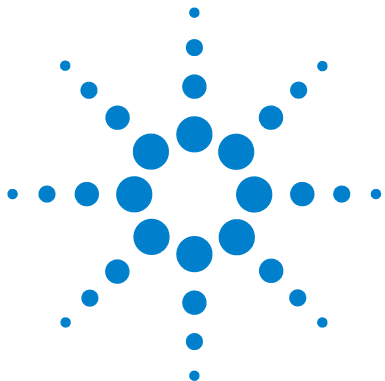
If the test fails, see the "Troubleshooting" chapter. Then return here.

# Agilent 6000 Series Oscilloscopes Performance Test Record

Serial No. _____			Test by _____			
Test Interval _____			Work Order No. _____			
Recommended Next Testing _____			Temperature _____			
<b>Threshold</b>	<b>Specification</b>	<b>Limits</b>	<b>Ch D7-D0</b>	<b>Ch D15-D8</b>		
<b>Accuracy Test</b>	5 V - 250 mV	4.750 V	_____	_____		
<b>(100 mV + 3% of threshold setting)</b>	5 V + 250 mV	5.250 V	_____	_____		
	-5 V - 250 mV	-5.250 V	_____	_____		
	-5 V + 250 mV	-4.750 V	_____	_____		
	0 V - 100 mV	-100 mV	_____	_____		
	0 V + 100 mV	100 mV	_____	_____		
<b>Voltage Measurement Accuracy</b>						
<b>Range</b>	<b>Power Supply Setting</b>	<b>Test Limits</b>	<b>Channel 1</b>	<b>Channel 2</b>	<b>Channel 3*</b>	<b>Channel 4*</b>
5 V/Div	35 V	34.04 V to 35.96 V	_____	_____	_____	_____
2 V/Div	14 V	13.616 V to 14.384 V	_____	_____	_____	_____
1 V/Div	7 V	6.808 V to 7.192 V	_____	_____	_____	_____
500 mV/Div	3.5 V	3.404 V to 3.596 V	_____	_____	_____	_____
200 mV/Div	1.4 V	1.3616 V to 1.4384 V	_____	_____	_____	_____
100 mV/Div	700 mV	680.8 mV to 719.2 mV	_____	_____	_____	_____
50 mV/Div	350 mV	340.4 mV to 359.6 mV	_____	_____	_____	_____
20 mV/Div	140 mV	136.16 mV to 143.84 mV	_____	_____	_____	_____
10 mV/Div	70 mV	68.08 mV to 71.92 mV	_____	_____	_____	_____
5 mV/Div	35 mV	34.04 mV to 35.96 mV	_____	_____	_____	_____
2 mV/Div (300 MHz, 500 MHz, and 1 GHz models)	14 mV	13.232 mV to 14.768 mV	_____	_____	_____	_____
2 mV/Div (100 MHz models)	14 mV	13.616 mV to 14.384 mV	_____	_____	_____	_____
1 mV/Div (MSO/DSO6012A)	7 mV	6.616 mV to 7.384 mV	_____	_____	_____	_____
<b>Bandwidth</b>	<b>Model</b>	<b>Test Limits</b>	<b>Channel 1</b>	<b>Channel 2</b>	<b>Channel 3*</b>	<b>Channel 4*</b>
	610x	3 dB at 1 GHz	_____	_____	_____	_____
	605x	3 dB at 500 MHz	_____	_____	_____	_____
	603x	3 dB at 300 MHz	_____	_____	_____	_____
	601x	3 dB at 100 MHz	_____	_____	_____	_____

<b>Horizontal <math>\Delta t</math> Accuracy</b>						
	<b>Generator Setting</b>	<b>Test Limits</b>	<b>Results</b>			
Period	100 $\mu$ s	99.8 $\mu$ s to 100.2 $\mu$ s	_____			
Period	100 ns	99.8 ns to 100.2 ns	_____			
Period	10 ns <sup>1</sup>	9.93 ns to 10.07 ns	_____			
Period	5 ns <sup>2</sup>	4.96 ns to 5.04 ns	_____			
<sup>1</sup> 100 MHz models <sup>2</sup> 300 MHz, 500 MHz, and 1 GHz models						
<b>Trigger Sensitivity</b>		<b>Test Limits</b>	<b>Channel 1</b>	<b>Channel 2</b>	<b>Channel 3*</b>	<b>Channel 4*</b>
	Internal trigger					
		1 division at 25 MHz	_____	_____	_____	_____
	1 GHz models	0.6 division at 1 GHz	_____	_____	_____	_____
	500 MHz models	0.6 division at 500 MHz	_____	_____	_____	_____
	300 MHz models	0.6 division at 300 MHz	_____	_____	_____	_____
	100 MHz models	0.6 division at 100 MHz	_____	_____	_____	_____
<b>Trigger Sensitivity</b>		<b>Test Limits</b>	<b>Channel 1</b>	<b>Channel 2</b>	<b>Channel 3*</b>	<b>Channel 4*</b>
	External trigger (6102A, 6052A, 6032A, 6012A)					
	$\pm 1$ V range:					
		100 mV at 25 MHz	_____	_____	_____	_____
	6102A	200 mV at 1 GHz	_____	_____	_____	_____
	6052A	200 mV at 500 MHz	_____	_____	_____	_____
	6032A	200 mV at 300 MHz	_____	_____	_____	_____
	6012A	200 mV at 100 MHz	_____	_____	_____	_____
	External trigger (6102A, 6052A, 6032A, 6012A)					
	$\pm 8$ V range:					
		250 mV at 25 MHz	_____	_____	_____	_____
	6102A	500 mV at 1 GHz	_____	_____	_____	_____
	6052A	500 mV at 500 MHz	_____	_____	_____	_____
	6032A	500 mV at 300 MHz	_____	_____	_____	_____
	6012A	500 mV at 100 MHz	_____	_____	_____	_____
	External trigger (6014, 6034A, 6054, 6104)					
	6104, 6054, 6034	500 mV at 500 MHz	_____	_____	_____	_____
	6014	500 mV at 100 MHz	_____	_____	_____	_____
* Where applicable						

## 2 Testing Performance



## 3 Calibrating and Adjusting

User Calibration 75

This chapter explains how to adjust the oscilloscope for optimum operating performance. You should perform self-calibration according to the following recommendations:

- Every 12 months or after 2000 hours of operation
- If the ambient temperature is  $>10$  °C from the calibration temperature
- If you want to maximize the measurement accuracy

The amount of use, environmental conditions, and experience with other instruments help determine if you need shorter adjustment intervals.

### **Let the Equipment Warm Up Before Adjusting**

Before you start the adjustments, let the oscilloscope and test equipment warm up for at least 30 minutes.

### **Read All Cautions and Warnings**

Read the following cautions and warning before making adjustments or performing self-calibration.

#### **WARNING**

#### **HAZARDOUS VOLTAGES!**

Read the safety notice at the front of this book before proceeding. Maintenance is performed with power supplied to the oscilloscope and with the protective covers removed. Only trained service personnel who are aware of the hazards involved should perform the maintenance. Whenever possible, perform the procedures with the power cord removed from the oscilloscope.



#### CAUTION

##### **REMOVE POWER TO AVOID DAMAGE!**

Do not disconnect any cables or remove any assemblies with power applied to the oscilloscope. Otherwise, damage to the oscilloscope can occur.

---

#### CAUTION

##### **USE EXTERNAL FAN TO REDUCE TEMPERATURE!**

When you must operate the oscilloscope with its cover and main shield removed, use an external fan to provide continuous air flow over the samplers (the ICs with heat sinks on them). Air flow over the samplers is reduced when the cover and main shield is removed, which leads to higher than normal operating temperatures. Have the fan blow air across the system board where the heat sinks are located. If the cover is removed but the main shield remains installed and the bottom holes are not blocked, the instrument will cool properly.

---

#### CAUTION

##### **AVOID DAMAGE TO ELECTRONIC COMPONENTS!**

Electrostatic discharge (ESD) can damage electronic components. When you use any of the procedures in this chapter, use proper ESD precautions. As a minimum, place the oscilloscope on a properly grounded ESD mat and wear a properly grounded ESD strap.

---

## User Calibration

Perform user-calibration:

- Each year or after 2000 hours of operation.
- If the ambient temperature is  $>10^{\circ}$  C from the calibration temperature.
- If you want to maximize the measurement accuracy.

The amount of use, environmental conditions, and experience with other instruments help determine if you need shorter User Cal intervals.

User Cal performs an internal self-alignment routine to optimize the signal path in the oscilloscope. The routine uses internally generated signals to optimize circuits that affect channel sensitivity, offset, and trigger parameters. Disconnect all inputs and allow the oscilloscope to warm up before performing this procedure.

Performing User Cal will invalidate your Certificate of Calibration. If NIST (National Institute of Standards and Technology) traceability is required perform the procedures in [Chapter 2](#) in this book using traceable sources.

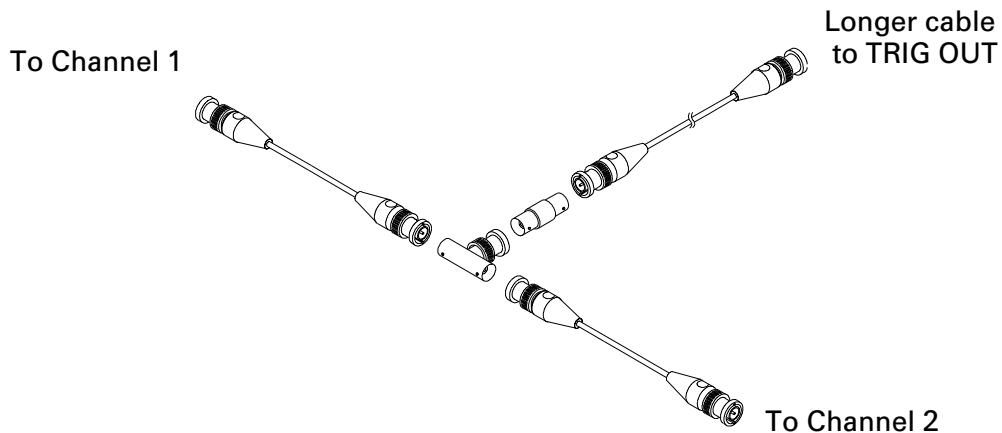
### To perform User Cal

- 1 Set the rear-panel CALIBRATION switch to UNPROTECTED.
- 2 Connect short (12 inch maximum) equal length cables to each analog channel's BNC connector on the front of the oscilloscope. You will need two equal-length cables for a 2-channel oscilloscope or four equal-length cables for a 4-channel oscilloscope.

### 3 Calibrating and Adjusting

Use 50 $\Omega$  RG58AU or equivalent BNC cables when performing User Cal.

- a For a 2-channel oscilloscope, connect a BNC tee to the equal length cables. Then connect a BNC(f)-to-BNC(f) (also called a barrel connector) to the tee as shown below.

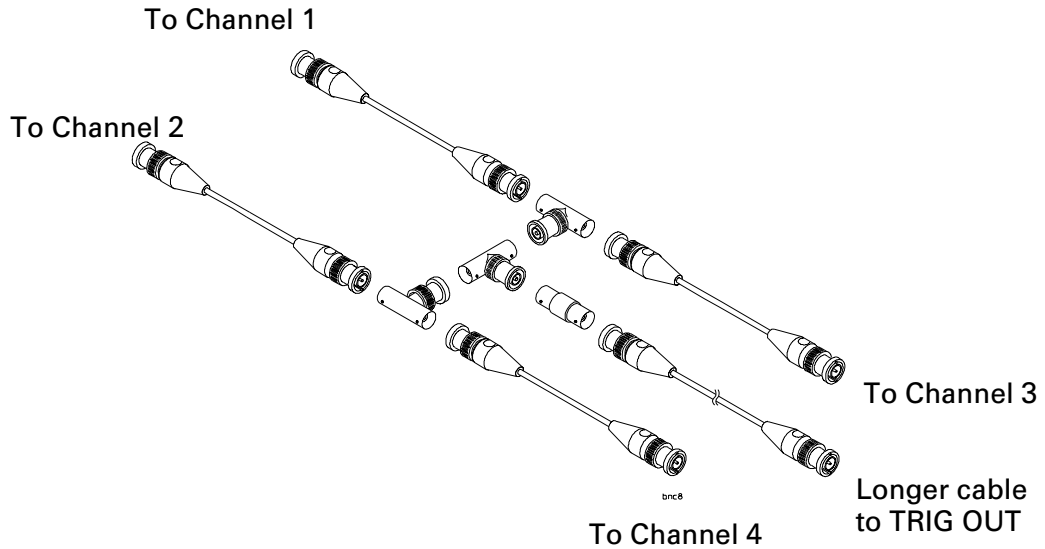


**Figure 9** User Calibration cable for 2-channel oscilloscope

- b For a 4-channel oscilloscope, connect BNC tees to the equal-length cables as shown below. Then connect a



BNC(f)-to-BNC(f) (barrel connector) to the tee as shown below.



**Figure 10** User Calibration cable for 4-channel oscilloscope

- 3** Connect a BNC cable (40 inches maximum) from the TRIG OUT connector on the rear panel to the BNC barrel connector.
- 4** Press the **Utility** key, then press the **Service** softkey.
- 5** Begin the Self Cal by pressing the **Start User Cal** softkey.
- 6** When the User Cal is completed, set the rear-panel CALIBRATION switch to PROTECTED.

## User Cal Status

Pressing the **User Cal Status** softkey displays the following summary results of the previous User Cal, and the status of probe calibrations for probes that can be calibrated. Note that AutoProbes do not need to be calibrated, but InfiniiMax can be calibrated.

Results:

User Cal date:

Change in temperature since last User Cal:

Failure:

Comments:

Probe Cal Status:



## 4 Troubleshooting

Solving General Problems with the Oscilloscope 80

Troubleshooting the Oscilloscope 83

This chapter begins with suggestions for solving general problems that you may encounter with the oscilloscope. It tells you what to do in these cases:

- If there is no trace display
- If the trace display is unusual or unexpected
- If you cannot see a channel
- If you cannot get any response from the oscilloscope

Procedures for troubleshooting the oscilloscope follow the problem solving suggestions. The troubleshooting section shows you how to:

- Check out the oscilloscope
- Check power supply
- Check the system board
- Check the display
- Check the fan
- Run internal self-tests
- Verify default setup

**Read All Cautions and Warnings**

Before you begin any troubleshooting, read all Warning and Cautions in the “Troubleshooting” section.



## Solving General Problems with the Oscilloscope

This section describes how to solve general problems that you may encounter while using the Agilent 6000 Series Oscilloscopes to make measurements.

After troubleshooting the oscilloscope, if you need to replace parts, refer to the “Replaceable Parts” chapter.

On 6000L Series oscilloscopes, connect an XGA display to the display port on the rear panel before you begin troubleshooting. Then connect the oscilloscope to the network, establish communication, and use the Remote Front Panel feature described in the *6000 Series Oscilloscopes User’s Guide* to control the oscilloscope. If you do not have the user’s guide, you can download it from [www.agilent.com/find/mso6000](http://www.agilent.com/find/mso6000).

### If there is no display

- ✓ Check that the power cord is firmly seated in the oscilloscope power receptacle.
- ✓ Check that the power source is live.
- ✓ Check that the front-panel power switch is on.
- ✓ If there is still no display, go to the troubleshooting procedures in this chapter.

### If there is no trace display

- ✓ Check that the INTENSITY knob on the front panel is adjusted correctly.
- ✓ Recall the default setup by pressing **Save/Recall** then **Default Setup**. This will ensure that the trigger mode is Auto.

- ✓ Check that the probe clips are securely connected to points in the circuit under test, and that the ground is connected.
- ✓ Check that the circuit under test is powered on.
- ✓ Press the **AutoScale** key.
- ✓ Obtain service from Agilent Technologies, if necessary.

### **If the trace display is unusual or unexpected**

- ✓ Check that the Horizontal time/division setting is correct for the expected frequency range of the input signals.
- ✓ The sampling speed of the oscilloscope depends on the time/division setting. It may be that when time/division is set to slower speeds, the oscilloscope is sampling too slowly to capture all of the transitions on the waveform. Use peak detect mode.
- ✓ Check that all oscilloscope probes are connected to the correct signals in the circuit under test.
- ✓ Ensure that the probe's ground lead is securely connected to a ground point in the circuit under test. For high-speed measurements, each probe's individual ground lead should also be connected to a ground point closest to the signal point in the circuit under test.
- ✓ Check that the trigger setup is correct.
- ✓ A correct trigger setup is the most important factor in helping you capture the data you desire. See the User's Guide for information about triggering.
- ✓ Check that infinite persistence in the Display menu is turned off, then press the **Clear Display** softkey.
- ✓ Press the **AutoScale** key.

### **If you cannot see a channel**

- ✓ Recall the default setup by pressing **Save/Recall** then **Default Setup**. This will ensure that the trigger mode is Auto.

- ✓ Check that the oscilloscope probe's BNC connector is securely attached to the oscilloscope's input connector.
- ✓ Check that the probe clips are securely connected to points in the circuit under test.
- ✓ Check that the circuit under test is powered on.

You may have pressed the **AutoScale** key before an input signal was available.

Performing the checks listed here ensures that the signals from the circuit under test will be seen by the oscilloscope. Perform the remaining checks in this topic to make sure the oscilloscope channels are on, and to obtain an automatic setup.

- ✓ Check that the desired oscilloscope channels are turned on.
  - a** Press the analog channel key until it is illuminated (6000A Series models) or switch on the analog channel by selecting **Analog** from the menu bar of the Remote Front Panel (6000L Series models).
  - b** Press the digital channels (**D15 Thru D0**) key until it is illuminated (6000A Series models with the MSO option) or switch on the digital channels by selecting **Digital** from the menu bar (6000L Series models with the MSO option). Ensure that the desired channels are turned on.
- ✓ Press the **AutoScale** key to automatically set up all channels.

## Troubleshooting the Oscilloscope

The service policy for the Agilent 6000 Series Oscilloscopes is assembly level replacement. If you need parts or assistance from Agilent Technologies to repair your instrument, go to [www.agilent.com](http://www.agilent.com) and locate the service facility for your area.

### WARNING

#### HAZARDOUS VOLTAGES EXIST — REMOVE POWER FIRST !

The procedures described in this section are performed with power supplied to the oscilloscope and with the protective covers removed. Only trained service personnel who are aware of the hazards involved should perform the procedures. Whenever possible, perform the procedures with the power cord removed from the oscilloscope. Read the safety notice at the back of this book before proceeding.

---

### WARNING



#### HAZARDOUS VOLTAGES EXIST — HIGH VOLTAGE IS PRESENT ON DS06000L SERIES POWER SUPPLY HEAT SINKS !

The power supply heat sinks of the 6000L Series oscilloscopes are at a high potential. This presents an electric shock hazard. Protect yourself from electric shock by keeping this area covered or by not coming in contact with the heat sinks when the power cord is attached to the oscilloscope!

---

### CAUTION

#### REMOVE POWER TO AVOID DAMAGE !

Do not disconnect any cables or remove any assemblies while power is applied to the oscilloscope, or damage to the oscilloscope can occur.

---

### CAUTION

#### AVOID ESD DAMAGE TO COMPONENTS !

ELECTROSTATIC DISCHARGE (ESD) can damage electronic components. Use proper ESD precautions when doing any of the procedures in this chapter. As a minimum, place the oscilloscope on a properly grounded ESD mat and wear a properly grounded ESD strap.

---

## Equipment required for troubleshooting

The equipment listed in this table is required to troubleshoot the oscilloscope.

**Table 13** Equipment Required to Troubleshoot the Oscilloscope

Equipment	Critical Specifications	Recommended Model/Part
Digital multimeter	Accuracy $\pm 0.05\%$ , 1 mV resolution	Agilent 34401A
Oscilloscope	Capable of measuring $\geq 500$ MHz signal. 1 M $\Omega$ input impedance.	Agilent DS06102A, MS06102A, DS06102A, or MS06104A

## To check out the oscilloscope

- 1 Disconnect any external cables from the front panel.
- 2 Disconnect the power cord, then remove the cabinet following the instructions on [page 104](#) for Agilent 6000A Series models or [page 145](#) for Agilent 6000L Series models.

### CAUTION

#### USE AN EXTERNAL FAN TO AVOID OVERHEATING COMPONENTS !

When you remove the oscilloscope cover and main shield, use an external fan to provide continuous air flow over the heat sinks. Air flow over the heat sinks is reduced when the cover and main shield are removed, which leads to higher than normal operating temperatures. Have the fan blow air across the system board where the heat sinks are located. Otherwise, damage to the components can occur.

If the cover of a 6000A Series oscilloscope is removed but the main shield remains installed and the bottom holes are not blocked, the instrument will cool properly.

### WARNING



#### HAZARDOUS VOLTAGES EXIST — HIGH VOLTAGE IS PRESENT ON DS06000L SERIES POWER SUPPLY HEAT SINKS !

The power supply heat sinks of the 6000L Series oscilloscopes are at a high potential. This presents an electric shock hazard. Protect yourself from electric shock by keeping this area covered or by not coming in contact with the heat sinks when the power cord is attached to the oscilloscope!



- 3 Connect the power cord to the rear of the oscilloscope, then to a suitable ac voltage source.

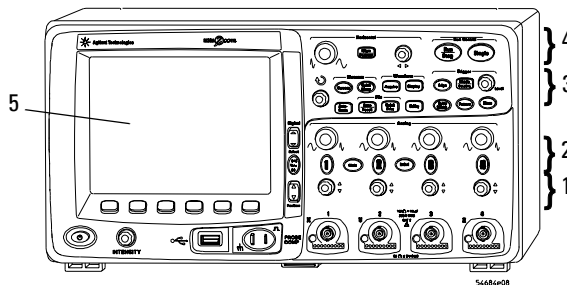
The oscilloscope power supply automatically adjusts for input line voltages in the range of 100 to 240 VAC. Ensure that you have the correct line cord (see [Table 16](#) on page 160 or [Table 4](#) on page 169). The power cord provided is matched to the country of origin.

**WARNING**

**AVOID INJURY.**

Always operate the oscilloscope with an approved three conductor power cable. Do not negate the protective action of the three conductor power cable.

- On 6000A Series models, press the power switch.
  - When the oscilloscope is turned on, the front panel LEDs will light up in the sequence shown in [Figure 11](#) on page 85.
  - Next the Agilent logo and advisory screen will appear on the LCD before the trace display appears.
  - It will take about 3 to 4 seconds for the instrument to turn on. The instrument will go through the basic self test to make sure all the major hardware is working correctly.

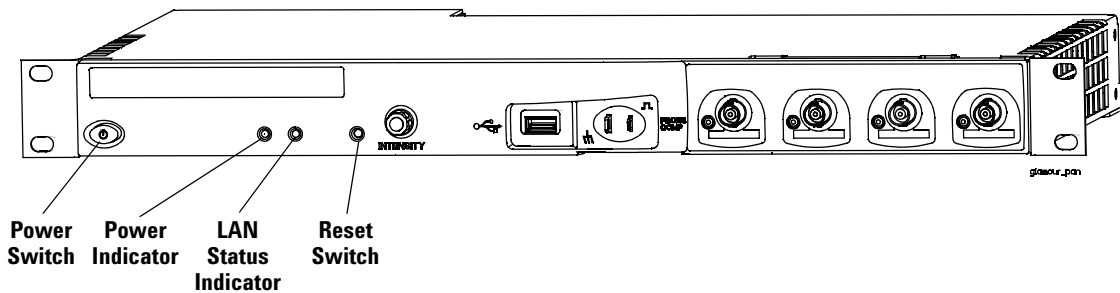


**Figure 11** 6000A Series start up sequence

- On 6000L Series models, press the power switch.

The Power indicator LED is green. The LAN indicator LED is bi-color (green and/or red).

- Shortly after pressing the power switch, the power indicator and LAN indicator will illuminate.
- Both will extinguish.
- Both will illuminate again. If a LAN is connected, the LAN indicator will illuminate red. It will turn green when the LAN is connected as it is configured. The amount of time it takes the indicator to turn green depends on the network and the oscilloscope's LAN configuration setup.



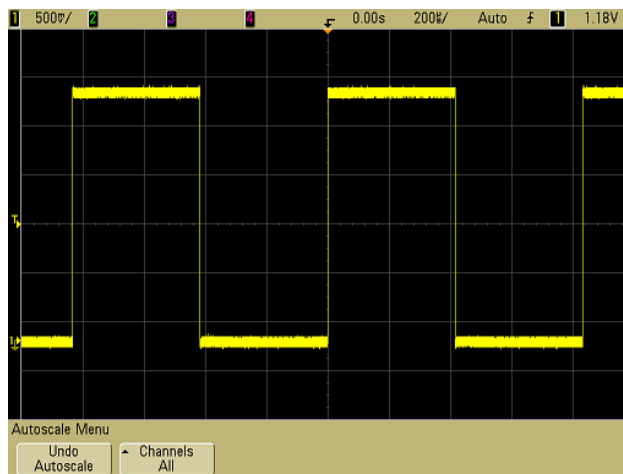
**Figure 12** 6000L Series LED indicators

- 4 If the lights illuminate, then the power supply is probably working correctly.
- 5 Proceed to [“To verify basic oscilloscope operation”](#) on page 87.

## To verify basic oscilloscope operation

For 6000L Series oscilloscopes, connect the oscilloscope to your network or establish a point-to-point connection, and use the Remote Front Panel feature described in the *6000 Series Oscilloscopes User's Guide* to control the oscilloscope. If you do not have the user's guide, you can download it from [www.agilent.com/find/mso6000](http://www.agilent.com/find/mso6000).

- 1 Press the **Save/Recall** key on the front panel, then press the **Default Setup** softkey under the display. The oscilloscope is now configured to its default settings.
- 2 Connect an oscilloscope probe from channel 1 to the **Probe Comp** signal terminal on the front panel.
- 3 Connect the probe's ground lead to the ground terminal that is next to the **Probe Comp** terminal.
- 4 Press **AutoScale**.
- 5 You should see a waveform on the oscilloscope's display similar to this:



If you see the waveform, but the square wave is not shaped correctly as shown above, perform the procedure [“To compensate the analog probes”](#) on page 88.

If you do not see the waveform, ensure your power source is adequate, the oscilloscope is properly powered-on, and the probe is connected securely to the front-panel analog channel input BNC and to the Probe Comp terminal.

- 6 If you still do not see the waveform, use the troubleshooting flowchart in this chapter to isolate the problem.

## To compensate the analog probes

You should compensate your analog probes to match their characteristics to the oscilloscope’s channels. A poorly compensated probe can introduce measurement errors.

- 1 Perform the procedure [“To verify basic oscilloscope operation”](#) on page 87
- 2 Use a nonmetallic tool to adjust the trimmer capacitor on the probe for the flattest pulse possible. The trimmer capacitor is located on the probe BNC connector.

**Perfectly compensated**



**Over compensated**



**Under compensated**



comp.cdr

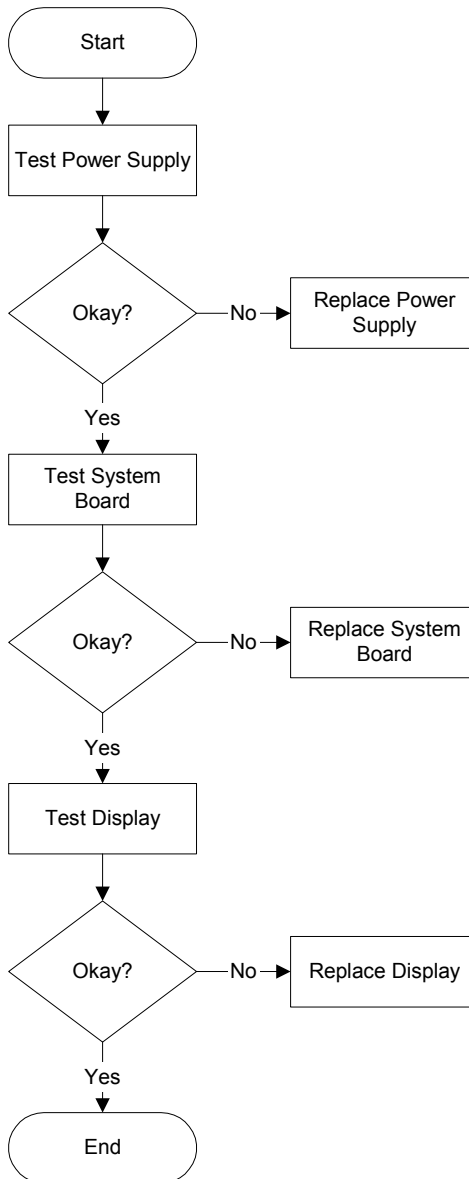
**Figure 13** Example pulses

- 3** Connect probes to all other analog channels (channel 2 of a 2-channel oscilloscope, or channels 2, 3, and 4 of a 4-channel oscilloscope). Repeat the procedure for each channel. This matches each probe to each channel.

The process of compensating the probes serves as a basic test to verify that the oscilloscope is functional.

## Troubleshooting Flowchart

The following flowchart describes how to troubleshoot 6000A Series and 6000L Series models.



## To check the 6000A Series oscilloscope power supply

- 1 Disconnect the power cord from the oscilloscope. Then remove the oscilloscope cover.

### CAUTION

#### USE AN EXTERNAL FAN TO AVOID OVERHEATING COMPONENTS !

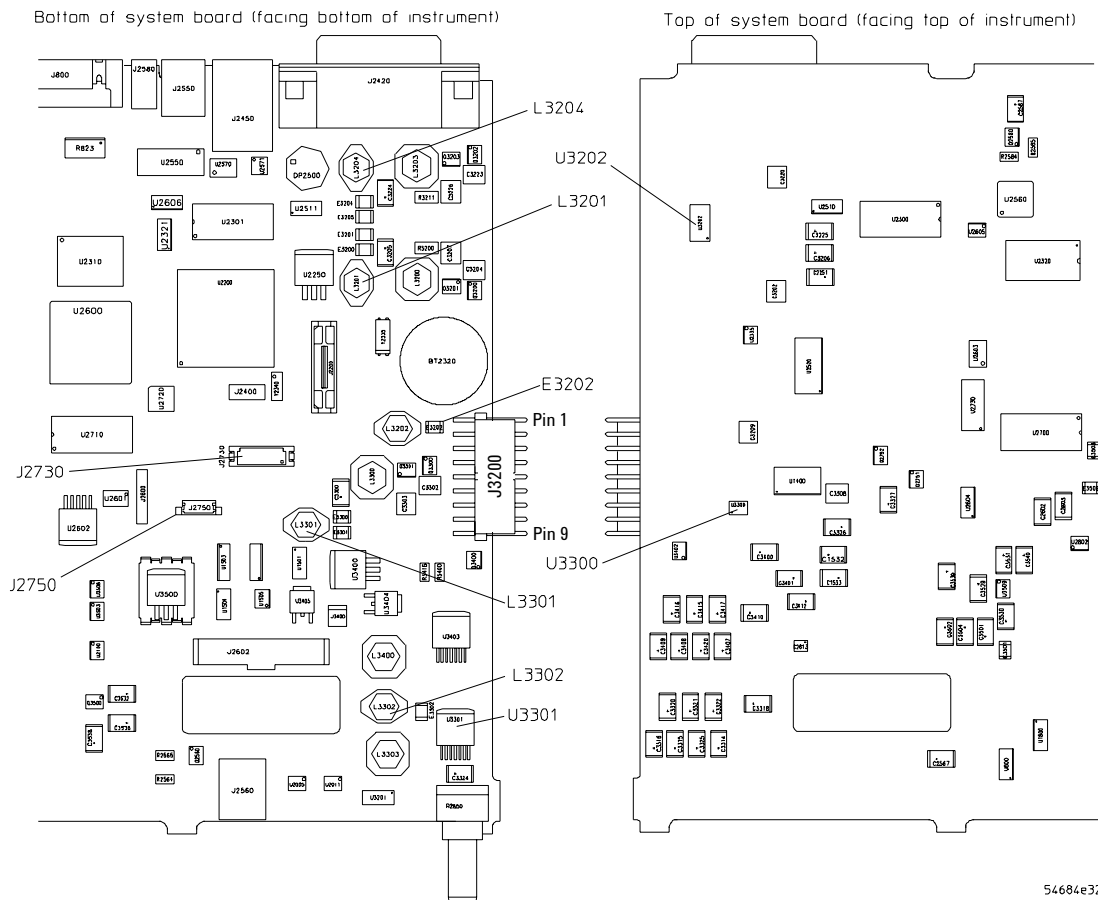
When you remove the oscilloscope cover and main shield, use an external fan to provide continuous air flow over the heat sinks. Air flow over the heat sinks is reduced when the cover and main shield are removed, which leads to higher than normal operating temperatures. Have the fan blow air across the system board where the heat sinks are located. Otherwise, damage to the components can occur.

If the cover of a 6000A Series oscilloscope is removed but the main shield remains installed and the bottom holes are not blocked, the instrument will cool properly.

---

- 2 Connect the negative lead of the multimeter to a ground point on the oscilloscope.
- 3 Connect the power cord and turn on the oscilloscope.
- 4 Measure the power supply voltage at J3200, pin 9 on the system board. See [Figure 14](#) on page 92. The voltage should be 15 V  $\pm$ 10%.
  - If the voltage is not correct, continue to the next step.
  - If the voltage is correct, the power supply is good.

## 4 Troubleshooting



**Figure 14** System Board Test Points

- 5 Disconnect the cable from the system board and check the voltage between pins 9 & 5 of the connector coming from the power supply.
- 6 If it is less than 14 V, the problem is in the cable or the power supply. Remove the cable and test it for shorts or opens using the DMM. Replace the defective assembly.



- 7 If the voltage is  $15\text{ V} \pm 10\%$  only when the cable is disconnected from the system board, then test the system board.

## To check the 6000L Series oscilloscope power supply

### WARNING



#### HAZARDOUS VOLTAGES EXIST — HIGH VOLTAGE IS PRESENT ON DS06000L SERIES POWER SUPPLY HEAT SINKS !

The power supply heat sinks of the 6000L Series oscilloscopes are at a high potential. This presents an electric shock hazard. Protect yourself from electric shock by keeping this area covered or by not coming in contact with the heat sinks when the power cord is attached to the oscilloscope!

### CAUTION

#### USE AN EXTERNAL FAN TO AVOID OVERHEATING COMPONENTS !

When you remove the oscilloscope cover and main shield, use an external fan to provide continuous air flow over the heat sinks. Air flow over the heat sinks is reduced when the cover and main shield are removed, which leads to higher than normal operating temperatures. Have the fan blow air across the system board where the heat sinks are located. Otherwise, damage to the components can occur.

### NOTE

If the power supply fuse is blown, the power supply is defective, and you must replace it. See the “Replaceable Parts” chapter for information about removing the power supply.

- 1 Disconnect the power cord from the oscilloscope. Then remove the oscilloscope cover.
- 2 Connect the negative lead of the multimeter to a ground point on the oscilloscope.
- 3 Connect the power cord and turn on the oscilloscope.
- 4 Measure the power supply voltage at J3200, pin 9 on the system board. See [Figure 14](#) on page 92. The voltage should be 15 V  $\pm$ 10%. If the voltage is correct, the power supply is working correctly.
- 5 If the voltage is not correct:
  - 1 Disconnect the power cord.
  - 2 Remove the fan. See [“To remove the fan”](#) on page 152.
  - 3 Disconnect plug J3 from the power supply and from the system board.

- 4 Perform a continuity check on the “DC cable” (item W1 on [page 167](#)). If the cable is shorted or open, replace it. If not, continue to the next step.
- 5 Reconnect the “DC cable” to the power supply, but not to the system board.

**WARNING****HAZARDOUS VOLTAGES EXIST — HIGH VOLTAGE IS PRESENT ON DS06000L SERIES POWER SUPPLY HEAT SINKS !**

The power supply heat sinks of the 6000L Series oscilloscopes are at a high potential. This presents an electric shock hazard. Protect yourself from electric shock by keeping this area covered or by not coming in contact with the heat sinks when the power cord is attached to the oscilloscope!

---

- 6 Connect the power cord and check the power supply voltage between pins 1 and 6 of the system board side of the “DC cable”. The voltage should be 15 V  $\pm$ 10%.
  - If the voltage is correct, then test the system board (see [page 96](#)).
  - If the voltage is not correct, then replace the power supply (see [page 150](#)).

## To check the 6000A Series or 6000L Series system board

- 1 Remove the cabinet.
- 2 Check that all cable connections are securely connected from the system board to:
  - Power supply
  - Keyboard (6000A Series only)
  - Display (6000A Series only)
  - Inverter board (6000A Series only)
  - Fan
- 3 Verify the voltages at the system board test points listed in the table below. Refer to [Figure 14](#) on page 92 to locate the test points.

**Table 14** System Board Test Points

Test point	Voltage	Output from regulator:
L3204	3.3 (+- 0.1)	U3202
L3201	5.0 (+- 0.1)	U3202
L3301	1.5 (+- 0.1)	U3300
L3302	-5.2 (+- 0.1)	U3301

- 4 If the voltage at test point L3301 and/or L3302 is not within the specified range, replace the system board.
- 5 (This step applies to 6000A Series models only)  
If the voltage at test point L3204 and/or L3201 is not correct:
  - Disconnect J2730 from the system board and measure pins 19 and 20 on the system board connector. This is the voltage to the display, and it should be 3.3V. If it is not, replace the system board. If the voltage is correct, replace the display.
  - Disconnect J2750 from the system board and measure pins 3 and 4. This is the voltage to the inverter, and it should be 5 V. If it is not, replace the system board. If the voltage is correct, replace the display.

- 6 If all cables are properly connected and none of the previous tests confirm a failure on another assembly, replace the system board.

## To check the 6000A Series display

- 1 Disconnect the power cord.
- 2 Check to verify that the backlight inverter cable is connected.
- 3 Ensure the display LCD cable is connected.
- 4 Connect the power cord.
- 5 Use the DMM to check the Inverter Power voltage (see table below).
- 6 If the voltage is incorrect, replace the system board.
- 7 If the voltage is correct, use an oscilloscope to check the LCD clock (see table below).

**Table 15** Display Signals on the System Board

	<b>Signal</b>	<b>Normal/Typical Result</b>
<b>Inverter Power</b>	J2750 Pin 3 or 4	5 V
<b>Video Signal</b>	J2730 Pin 6 and 7	480 MHz clock

- 8 If the clock signal is good, replace the LCD.
- 9 If the clock signal is absent, replace the system board.

## To check the 6000L Series display output

- 1 Connect a known good external XGA display and power-up the display and the oscilloscope.
- 2 If the known good display does show an output from the XGA port of the oscilloscope, replace the system board.

## To check the fan

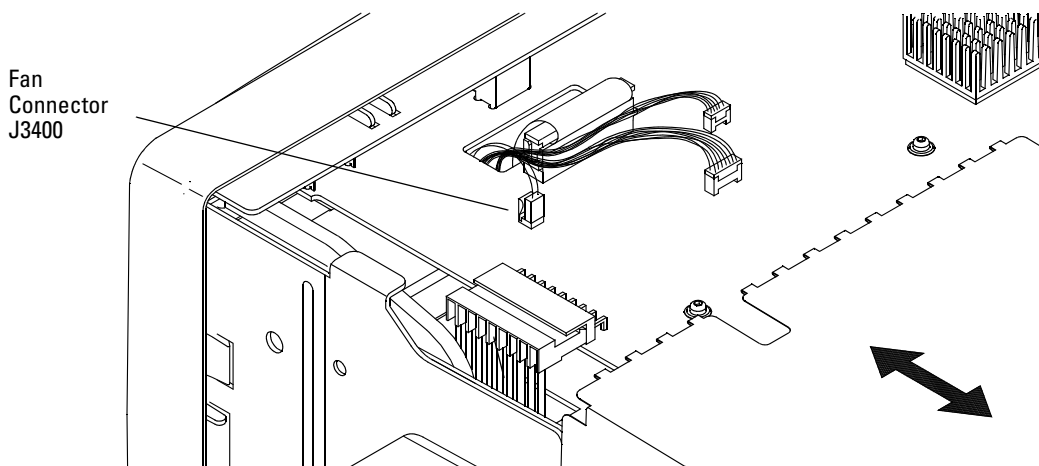
The fan speed is controlled by a circuit on the system board.

- 1 If the fan is running, perform the internal self-tests. Go to [“To run the internal self-tests”](#) on page 99.
- 2 If the fan is not running, it may be defective. Follow these steps:
  - a Disconnect the fan cable from the system board.
  - b Measure the fan voltage at the connector on the system board.

See the figure below for the location of the fan connector.

- c If the fan voltage is approximately +8.5 Vdc at room temperature, replace the fan. If the fan voltage is not approximately +8.5 Vdc, replace the system board.

The proper voltage range depending on temperature is between +6.0 Vdc to +11.5 Vdc.



**Figure 15** Location of the Fan Connector (shown on 6000A model)

## To run the internal self-tests

Self Test performs a series of internal procedures to verify that the oscilloscope is operating properly.

It is recommended that you run the Self Test:

- after experiencing abnormal operation
- for additional information to better describe an oscilloscope failure
- to verify proper operation after the oscilloscope has been repaired

Successfully passing Self Test does not guarantee 100% of the oscilloscope's functionality. Self Test is designed to provide an 80% confidence level that the oscilloscope is operating properly.

- 1 Press the **Utility** key, then press the **Service** softkey. Use the Remote Front Panel feature if you are testing a 6000L Series model.
- 2 Begin the internal self tests by pressing the **Start Self Test** softkey.

## To verify default setup

The oscilloscope is designed to turn on with the setup from the last turn on or previous setup. However, if the Secure Environment option is installed, the oscilloscope will always execute a Default Setup upon power-up.

To recall the factory default setup:

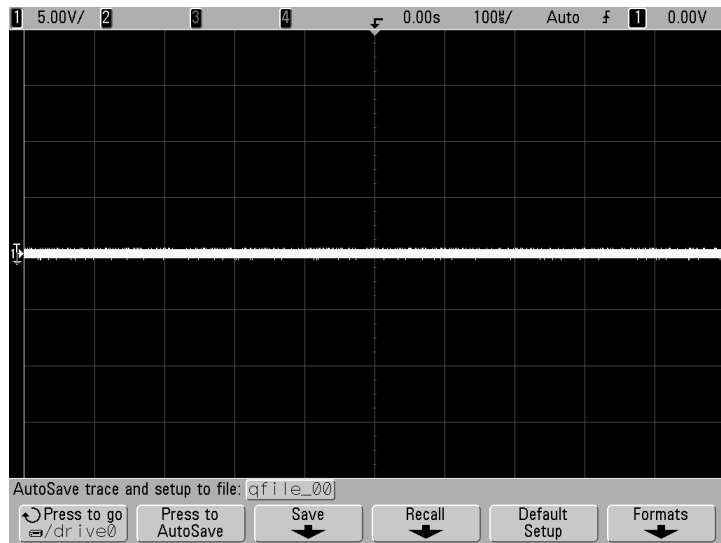
- 1 Press the **Save/Recall** key.
- 2 Press the **Default Setup** softkey.

This returns the oscilloscope to its factory default settings and places the oscilloscope in a known operating condition. The major default settings are:

- **Horizontal** - main mode, 100 us/div scale, 0 s delay, center time reference

## 4 Troubleshooting

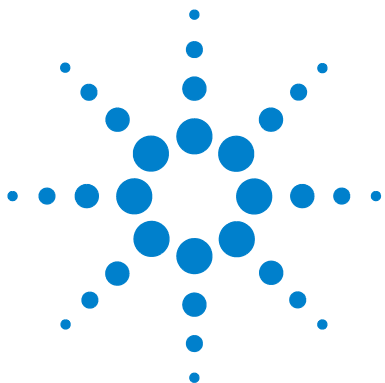
- **Vertical** - Channel 1 on, 5 V/div scale, dc coupling, 0 V position, probe factor to 1.0 if an AutoProbe probe is not connected to the channel
- **Trigger** - Edge trigger, Auto sweep mode, 0 V level, channel 1 source, dc coupling, rising edge slope, 60 ns holdoff time
- **Display** - Vectors on, 20% grid intensity, infinite persistence off
- **Other** - Acquire mode normal, Run/Stop to Run, cursor measurements off



**Figure 16** Default setup screen

- 3 If your screen looks substantially different, replace the system board.





## 5 Replacing 6000A Assemblies

- To remove the cabinet 104
- To remove the handle 105
- To remove the storage lid 106
- To remove the front panel assembly 107
- To remove the keyboard assembly 110
- To remove the display assembly 113
- To remove the display assembly 113
- To remove the backlight inverter board and e-field shield 117
- To remove the LCD, gasket, and protective lens from the display mount 122
- To remove the power supply shield 125
- To remove the power supply 129
- To remove the power shaft 130
- To remove the AC input board 131
- To remove the batteries (Option BAT only) 133
- To remove the battery controller board (Option BAT only) 135
- To remove the fan 137
- To remove the system board 139

This chapter describes how to remove assemblies from the Agilent 6000A Series Oscilloscopes. After you have removed an assembly, to install the replacement assembly, follow the instructions in reverse order.

The parts shown in the following figures are representative and may look different than what you have in your oscilloscope.



### Tools Used for Disassembly

Use these tools to remove and replace the oscilloscope assemblies:

- T6, T10, and T20 TORX drivers
- 5/8-inch and 9/32-inch socket drivers

### See how the Oscilloscope Parts Fit Together

An exploded view of the oscilloscope is included in the “Replaceable Parts” chapter. It shows the individual part numbers used in the assemblies, and shows you how the parts fit together.

### Read All Warnings and Cautions

Read the following warnings and cautions before removing and replacing any assemblies in the oscilloscope.

#### WARNING

##### HAZARDOUS VOLTAGES!

Read the safety summary at the back of this book before proceeding. Maintenance is performed with power supplied to the oscilloscope and with the protective covers removed. Only trained service personnel who are aware of the hazards involved should perform the maintenance. Whenever possible, perform the procedures with the power cord removed from the oscilloscope.

---

#### WARNING



##### AVOID ELECTRICAL SHOCK !

Hazardous voltages exist on the LCD assembly and power supply. To avoid electrical shock:

- 1 Disconnect the power cord from the oscilloscope.
- 2 Wait at least three minutes for the capacitors in the oscilloscope to discharge before you begin disassembly.

Read the Safety Summary at the back of this manual before you begin.

---

#### CAUTION

##### REMOVE POWER TO AVOID DAMAGE !

Remove power before you begin to remove and replace assemblies. Do not remove or replace assemblies while the oscilloscope is turned on, or damage to the components can occur.

---

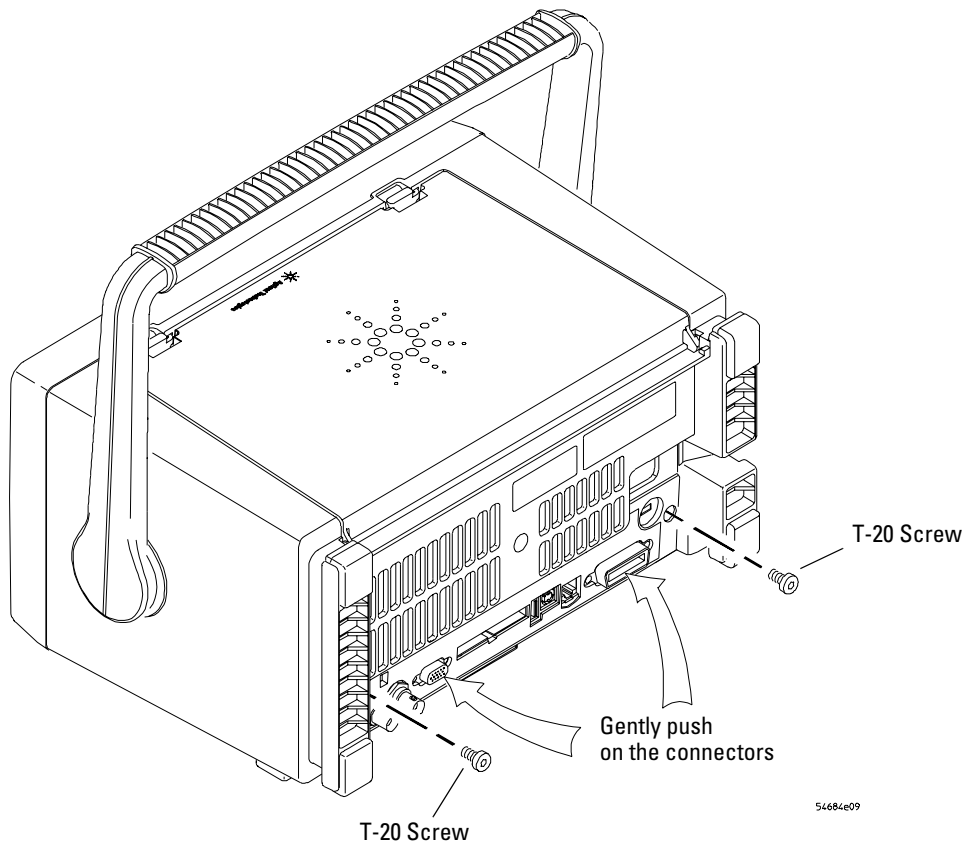
**CAUTION****AVOID DAMAGE TO ELECTRONIC COMPONENTS !**

ELECTROSTATIC DISCHARGE (ESD) can damage electronic components. When doing any of the procedures in this chapter, use proper ESD precautions. As a minimum, you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD strap.

---

## To remove the cabinet

- 1 Turn off the oscilloscope and disconnect the power cable.
- 2 Using the T20 TORX driver, remove the two screws from the rear of the cabinet.
- 3 Using your thumbs, gently push on the rear-panel connectors to slide the oscilloscope out of the cabinet.

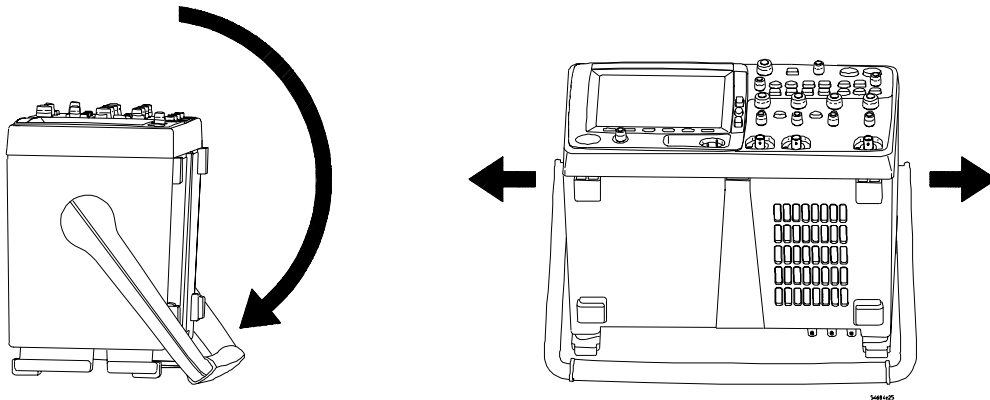


**Figure 17** Removing the cabinet

## To remove the handle

If you are mounting the instrument on a rack, you will probably need to remove the handle.

- 1 Rotate the handle downward until it just passes the last detent position; this is about 1/2 inch before the handle touches the bottom of the oscilloscope.
- 2 Pull the sides of the handle out of the cabinet and remove.



**Figure 18** Removing handle

## To remove the storage lid

The storage lid is designed to come off without breaking.

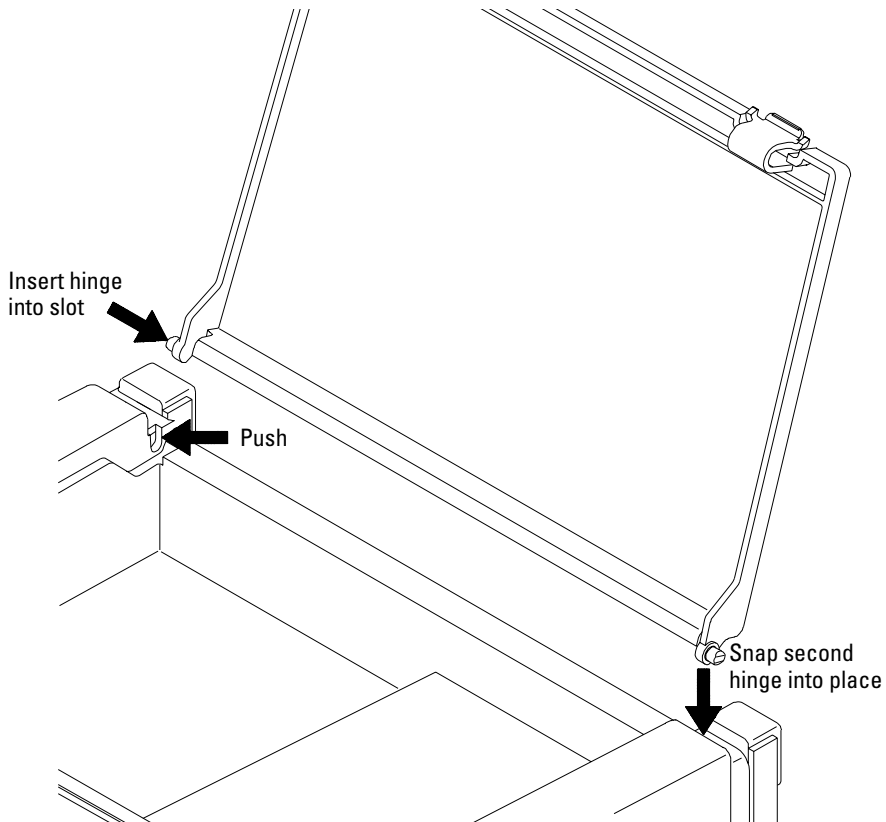
**1** Push back on the lid until it snaps out of the slots.

**2** To reinstall the lid:

**a** Insert the left hinge into the slot.

**b** Push the lid all the way to the left.

**c** Snap the right hinge into the slot.

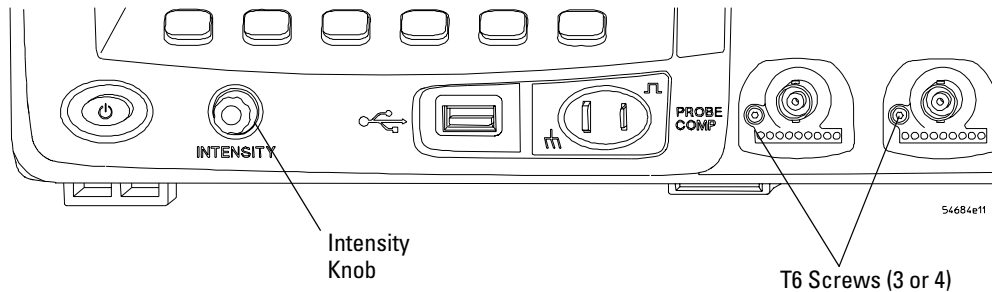


**Figure 19** Installing the hinged storage lid

## To remove the front panel assembly

- 1 Perform the following procedures:
  - “To remove the cabinet” on page 104
- 2 Insert a flat-blade screwdriver under the center of the intensity knob and gently twist it as you pull the knob off.  
Using a twisting motion rather than prying prevents marking or damaging the front panel.
- 3 Remove the T6 screws securing the BNC assembly to the deck.

This step helps prevent the BNC connectors from binding when removing and reinstalling the front panel.

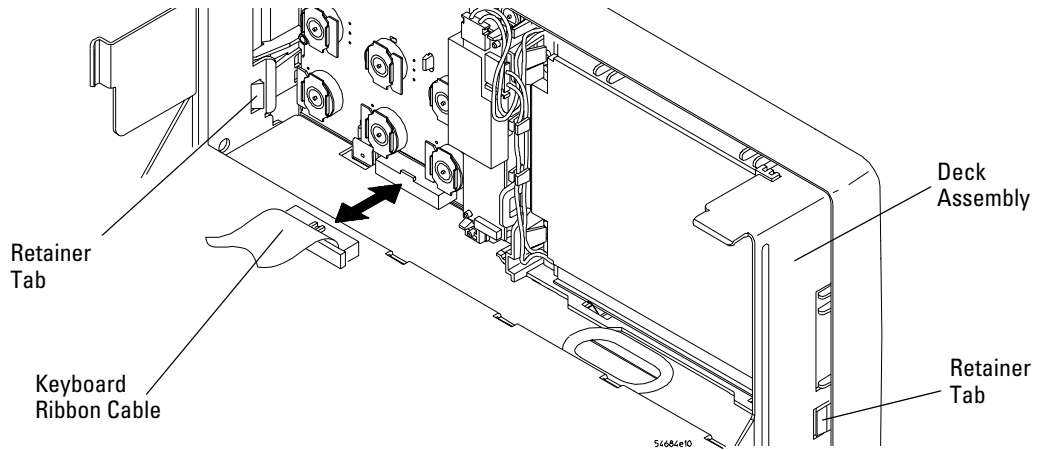


**Figure 20** Removing the intensity knob and T6 screws

- 4 Disconnect the keyboard ribbon cable from the keyboard.
- 5 Use a flat-blade screwdriver to the release retainer tabs and then push the panel forward.

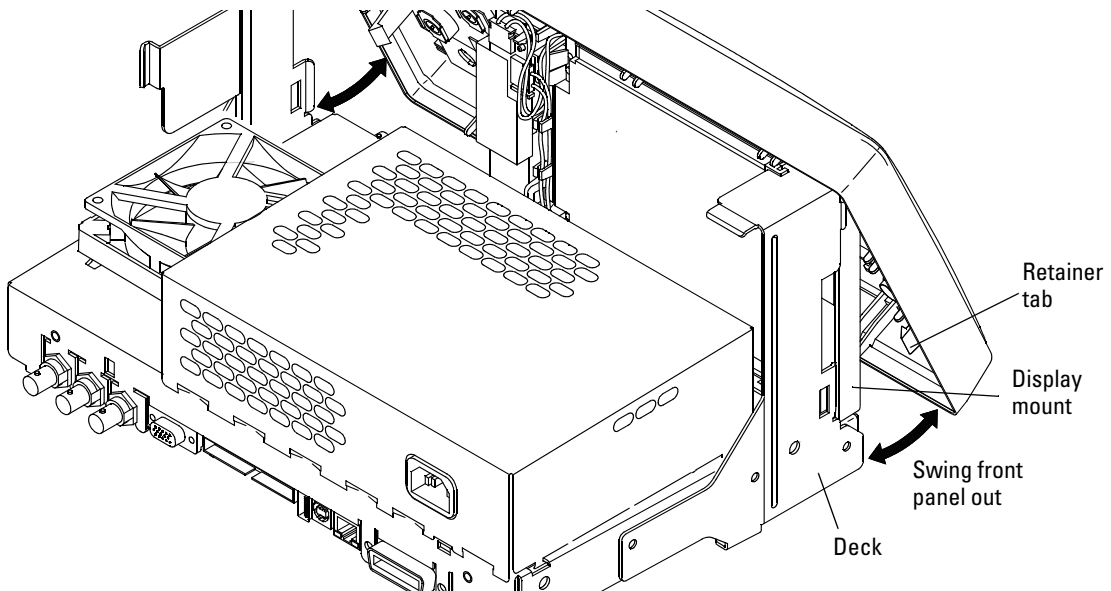
Ensure that the retainer tab on the display side moves past the rear edge of the display mount.

## 5 Replacing 6000A Assemblies



**Figure 21** Disconnecting ribbon cable and releasing tab retainers

- 6 Swing the front panel out until the bottom clears the deck assembly, then lift it up to free the hooks on top and pull it away from the deck.



**Figure 22** Removing the front panel



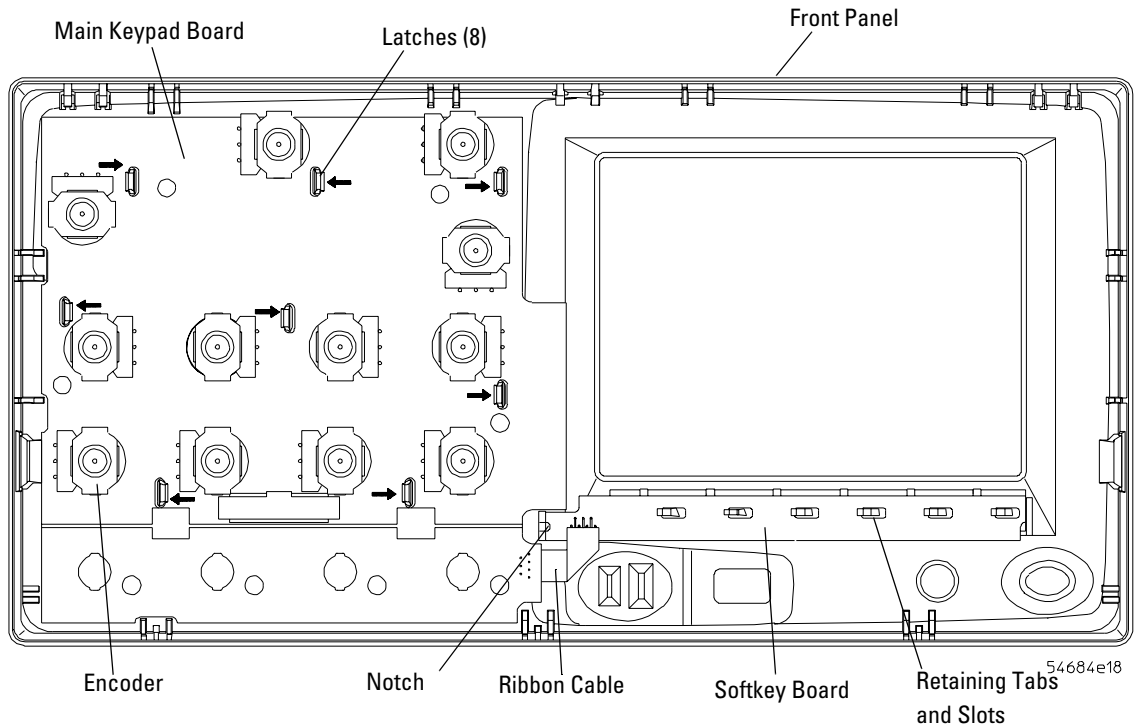
- 7** To reinstall the front panel:
  - a** Align the hooks on top of the front panel with their connection holes in the sheet metal and display mount.
  - b** Swing the front panel down and ensure that the power switch, intensity shaft and BNC connectors are aligned with the holes in the front panel.
  - c** Push the front panel until the two retainer tabs click into place in the deck.
  - d** Reinstall the T6 screws on the BNC connectors.
  - e** Connect the keyboard ribbon cable.

## To remove the keyboard assembly

- 1 Perform the following procedures:
  - “To remove the cabinet” on page 104
  - “To remove the front panel assembly” on page 107
- 2 If removing the softkey pad only skip steps 3, 4c, and 4d below.
- 3 Remove all of the knobs by pulling them straight out. You may need to use a flat-blade screwdriver to gently pry them as you pull.

Using a twisting motion rather than prying prevents marking or damaging the front panel.

- 4 Remove the main keyboard and softkey board as follows.
  - a Lift the left end of the softkey board enough to clear the tab holding it in place.
  - b Slide the softkey board to the left to release it from the retaining tabs.
  - c Release the 8 latches holding the main keypad board to the front panel.
  - d You will notice the latches do not all face the same direction. This is shown with arrows in the following figure.
  - e Lift the board up just enough to clear the latches.
  - f Lift both boards out being careful not to damage the ribbon cable between them.
- 5 Remove and replace keypads as needed.



**Figure 23** Removing the keyboard assembly

**6** When reinstalling the boards:

- a** If you have a new main board assembly, you will need to separate the softkey board from the main keypad board.

Using a needle nose pliers, carefully remove the two process tabs.

Using a needle nose pliers, carefully remove the two break away tabs connecting the two boards.

- b** Carefully turn the softkey board so that the gold metal contacts face the keypad. Note the way the ribbon cable is dressed in the previous figure.
- c** Align the main keypad board over the keypad inserting the knob shafts into their holes.
- d** Snap the main keypad board in place by pressing on the encoders near each latch. Ensure all 8 catch.
- e** Align the slots in the softkey board over the retaining tabs.
- f** Push down on the softkey board. Using a tool (such as a soldering aid) in the notch of the board, slide it to the right until it seats between the tabs.
- g** Replace the knobs by supporting the back of each encoder and pushing the knob fully onto the shaft.

## To remove the display assembly

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the front panel assembly” on page 107
- 2 Remove the main shield covering the system board by sliding it toward the back of the instrument.

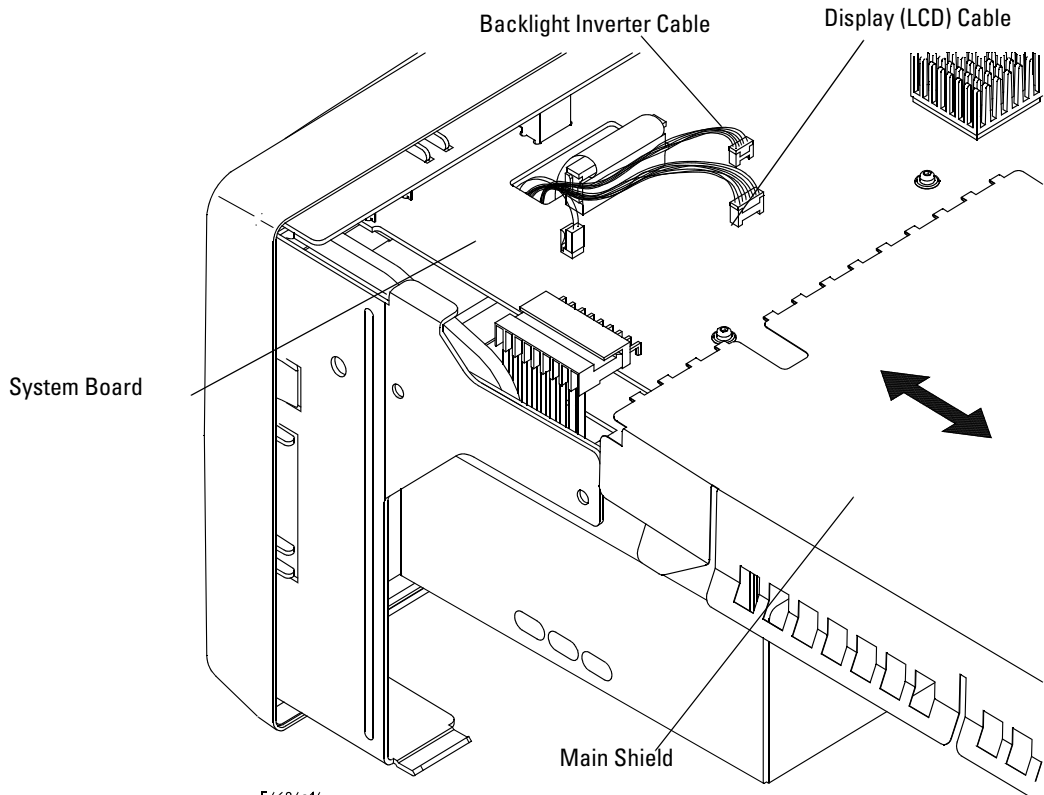
**WARNING**

Thin sheet metal parts may have sharp edges. Handle with care to avoid injury.

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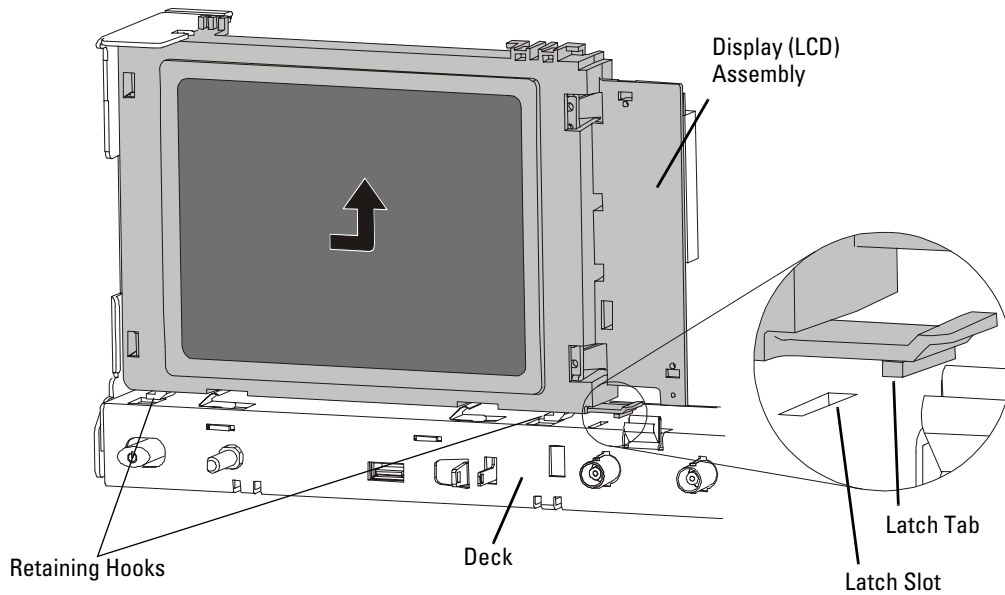
- 3 Using a small flat blade screw driver, gently pry the display and backlight inverter cables to disconnect them from the system board.

Note the cable routing through the system board for reinstallation.



**Figure 24** Removing the main shield and disconnecting the display cables

- 4 Using a flat-blade screwdriver, lift the latch tab at the bottom of the display assembly just enough to clear the slot in the deck.
- 5 Push the entire display assembly to the right to release the retaining hooks from their slots in the deck
- 6 Lift and remove the display assembly.

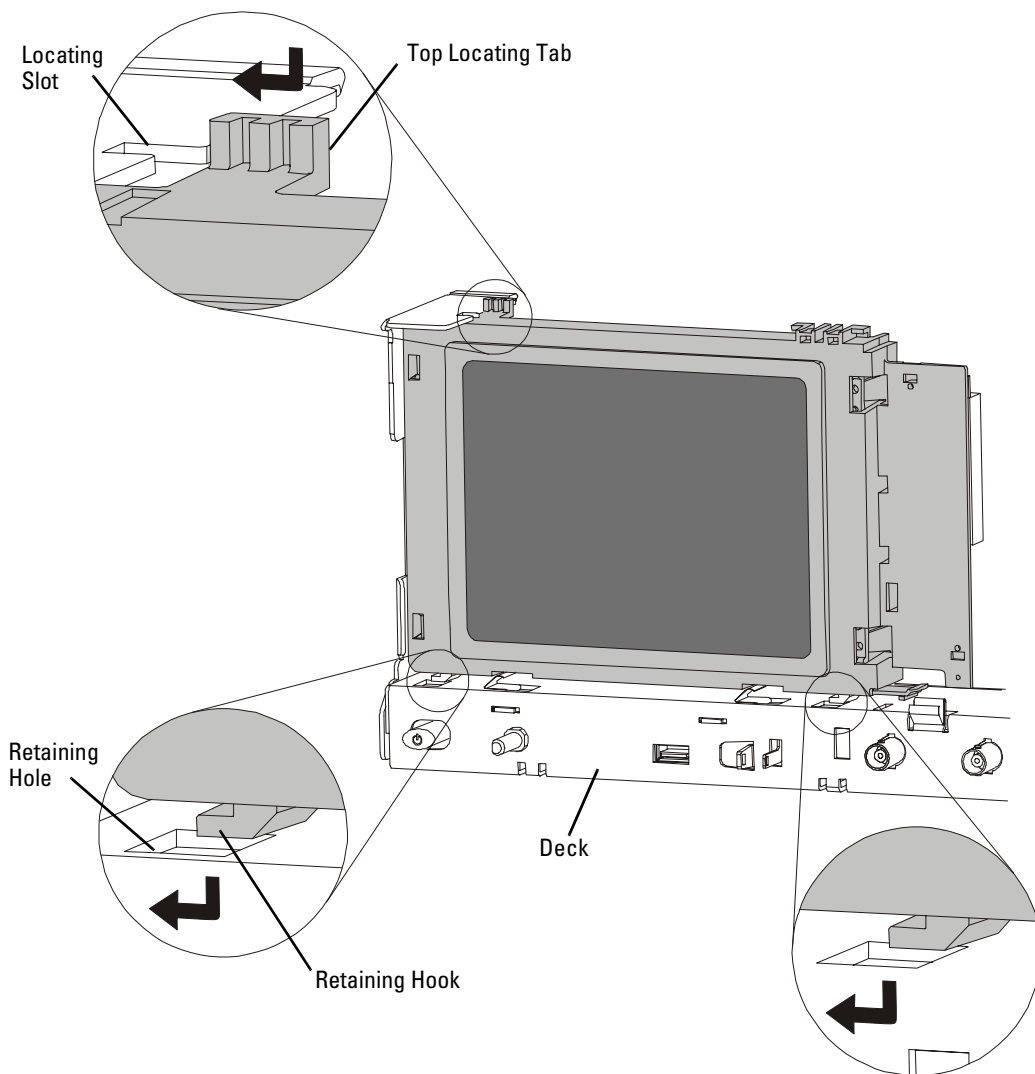


**Figure 25** Removing the display assembly

**7** To reinstall the display:

- a** Align the top locating tab with the locating slot in the sheet metal and the retaining hooks with their retaining holes.
- b** Push down on the LCD until it is flat with the deck and at the same time push the LCD to your left.
- c** Ensure the latch tab is seated in its hole as shown in [Figure 25](#).
- d** Route the cables down through the deck hole and reconnect to the system board as shown in [Figure 24](#).

## 5 Replacing 6000A Assemblies



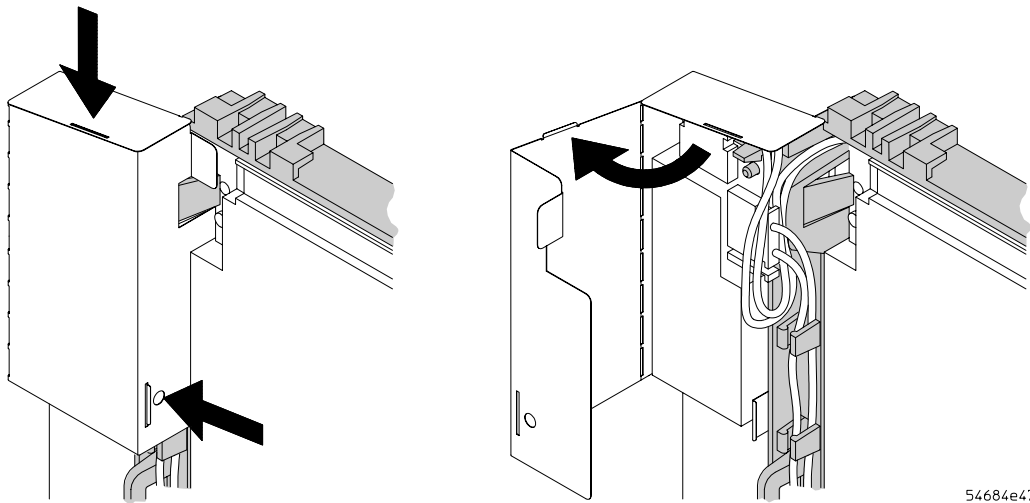
**Figure 26** Installing the display



## To remove the backlight inverter board and e-field shield

Some older oscilloscope models may not have the e-field shield mentioned in this procedure.

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the power supply shield” on page 125
- 2 Press to release the top tab and use the hole to aid in releasing the side tab. Then open the shield. Do not bend it past the vertical position as shown.



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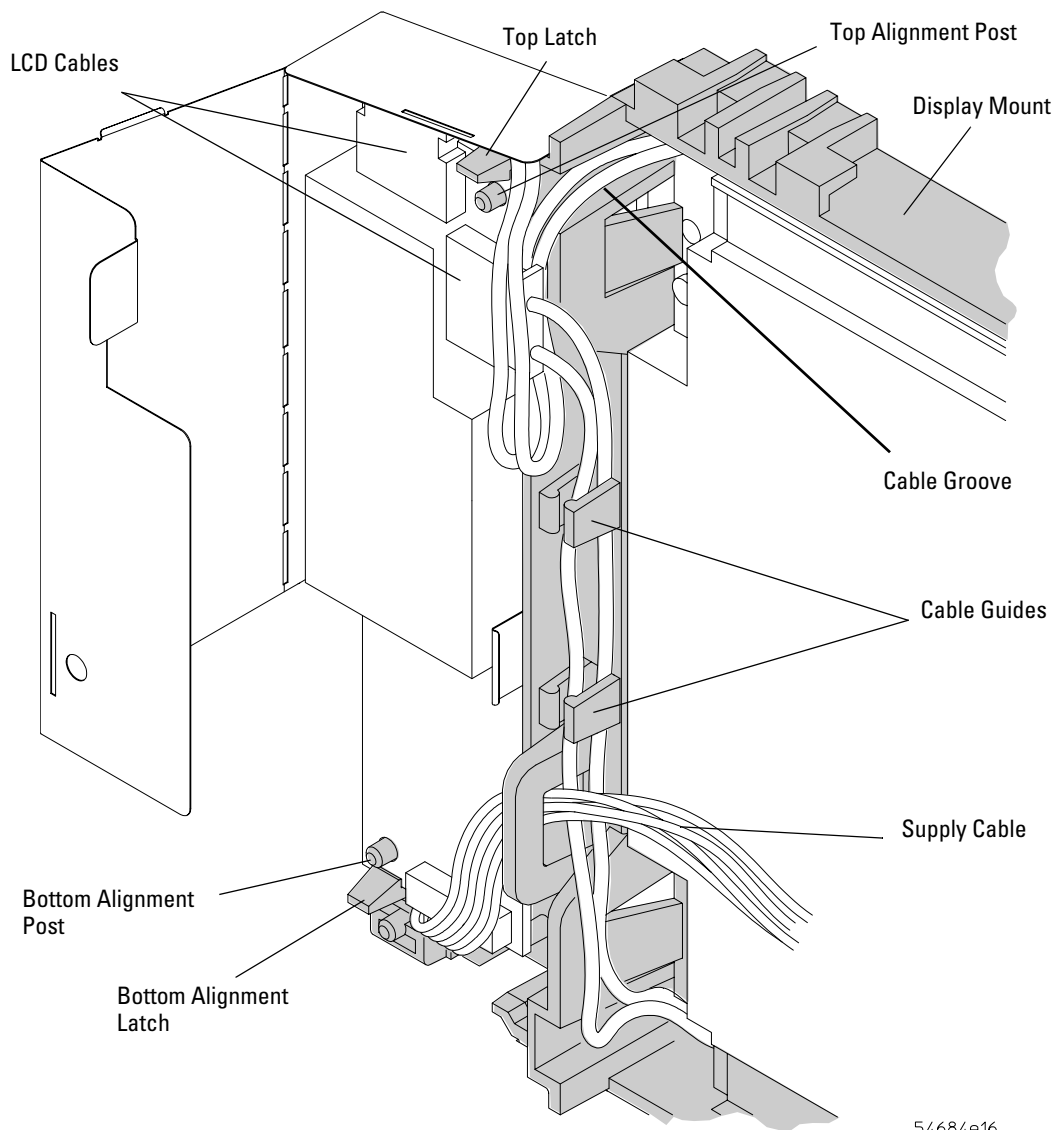
**Figure 27** Opening the backlight inverter shield

- 3 Remove the LCD cables from the cable guides.
- 4 Release the top latch and lift the top of the board off the top alignment post.
- 5 Release the bottom latch and lift the board off the bottom alignment post.

## 5 Replacing 6000A Assemblies

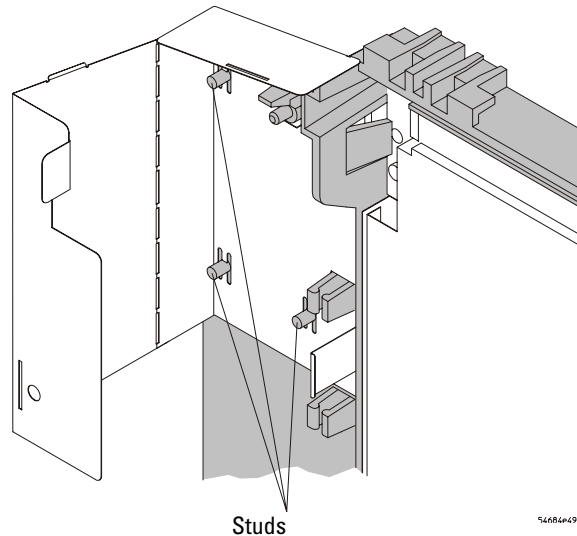
**6** Disconnect the LCD cables from the backlight inverter board.

**7** Unplug the supply cable from the inverter board.



**Figure 28** Removing the backlight inverter

- 8 If the e-field shield requires replacement, use a screwdriver to pry the shield off the studs.

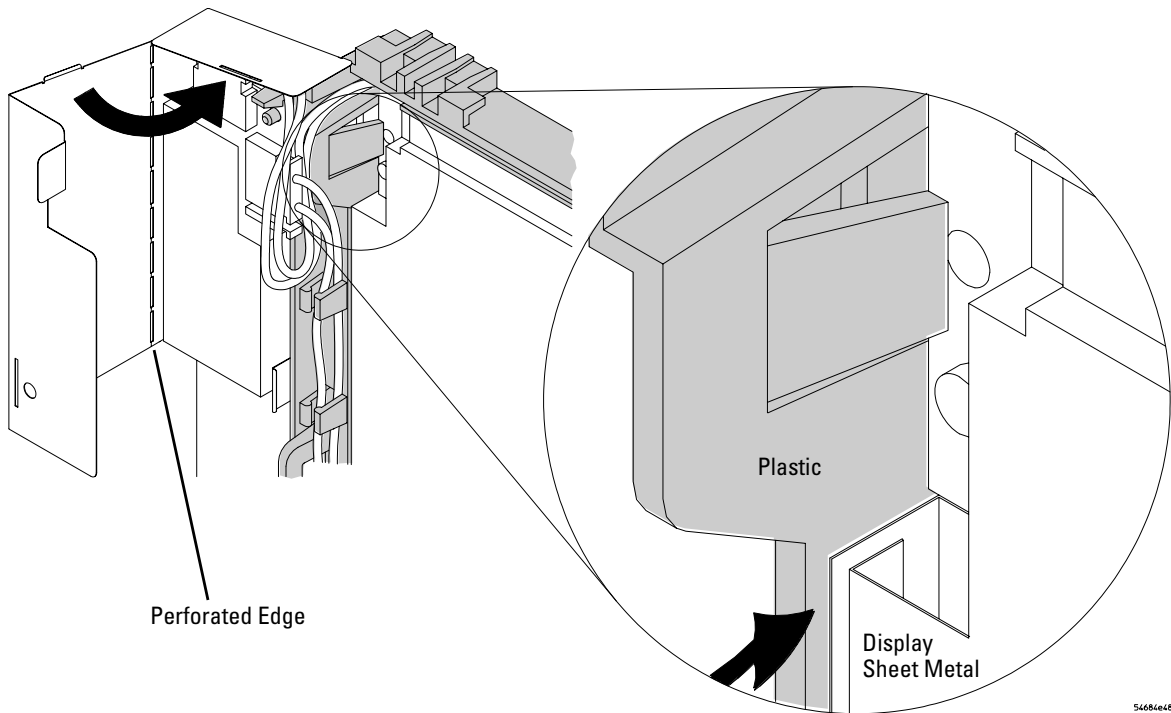


**Figure 29** Removing the backlight inverter shield

- 9 To reinstall the backlight inverter board:
- a Align the shield over the studs and push it all the way down on the studs.
  - b Reconnect the LCD cables looping them around each other and through the cable guides as shown in [Figure 28](#).
  - c Reconnect the supply cable.
  - d Align the holes in the inverter board with the posts on the display mount and push down until the latches snap over the board (refer to [Figure 28](#)).
  - e Route the cables through the cable guides as shown.

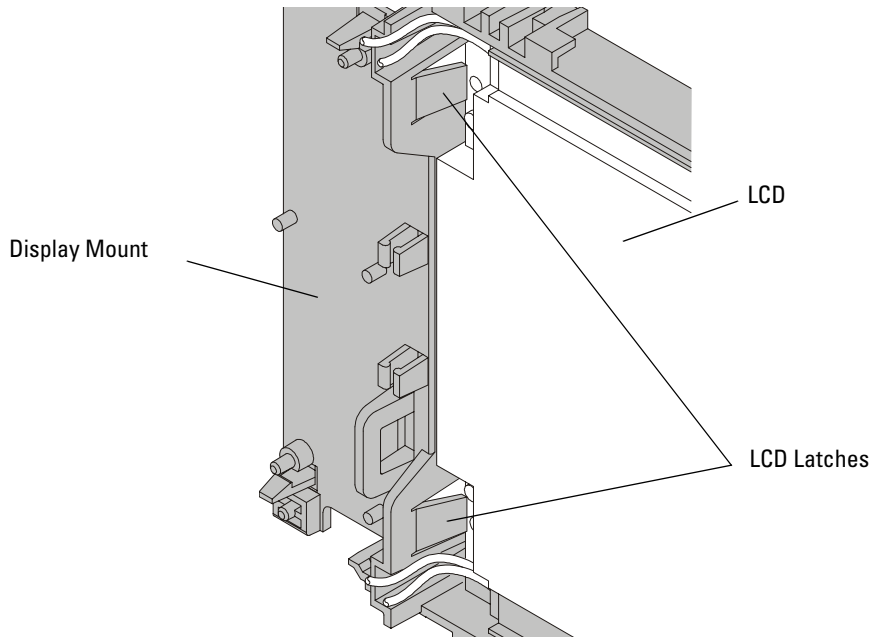
**f** Close the shield.

- Insert the shield between the plastic and sheet metal of the display.
- Ensure the cables do not get pinched.
- After closing, use your fingers to gently pinch along the perforated edge of the shield to square the corner and ensure that the release tabs are in their slots.

**Figure 30** Closing the shield

## To remove the LCD, gasket, and protective lens from the display mount

- 1 Perform the following procedures:
  - “To remove the cabinet” on page 104
  - “To remove the front panel assembly” on page 107
  - “To remove the display assembly” on page 113
  - “To remove the backlight inverter board and e-field shield” on page 117
- 2 Use a long-nose pliers or flat-blade screwdriver to push and release the two LCD latches on the left side of the display mount.

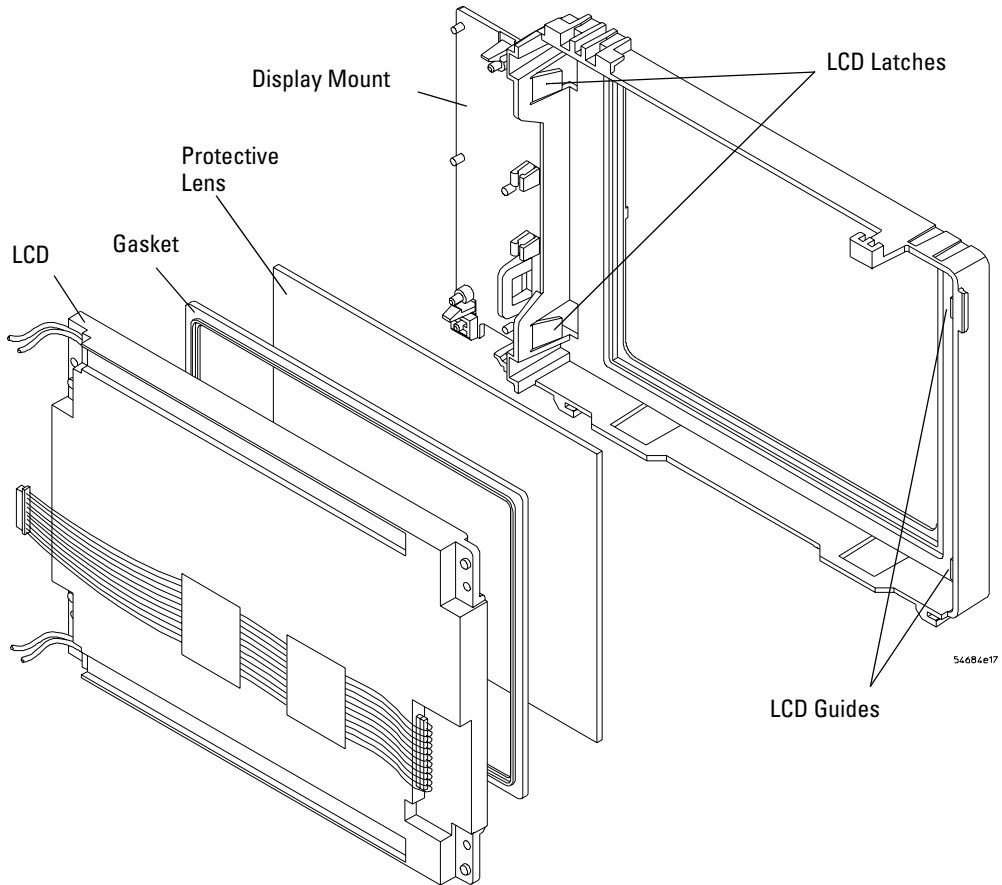


**Figure 31** Release display mount latches

3 Lift and remove the LCD from under the guides on the right side of the display mount.

4 Remove the gasket and protective lens if necessary.

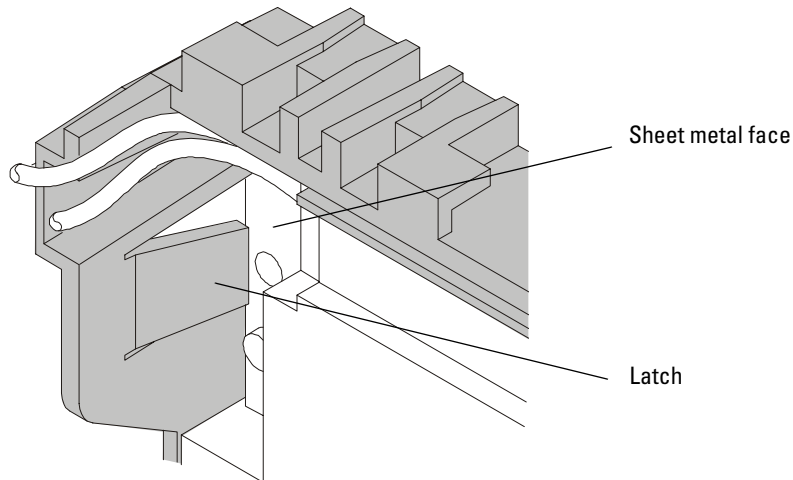
Note the orientation of the gasket.



**Figure 32** Removing the LCD, gasket, and protective lens

5 To reinstall:

- a Place the protective lens into the pocket in the display mount and ensure that the inside of the lens is clean.
- b Place the gasket into the slot around the lens making sure it is fully seated in the slot all the way around.
- c Clean the LCD window and insert the LCD under the guides on the right side of the display mount.
- d Push the left side of the LCD down until it clicks under the latches so that the latches are fully over the face of the sheet metal housing.



**Figure 33** Latch over face of sheet metal housing

- e Reinstall the backlight inverter (see [step 9](#) on [page 120](#)).

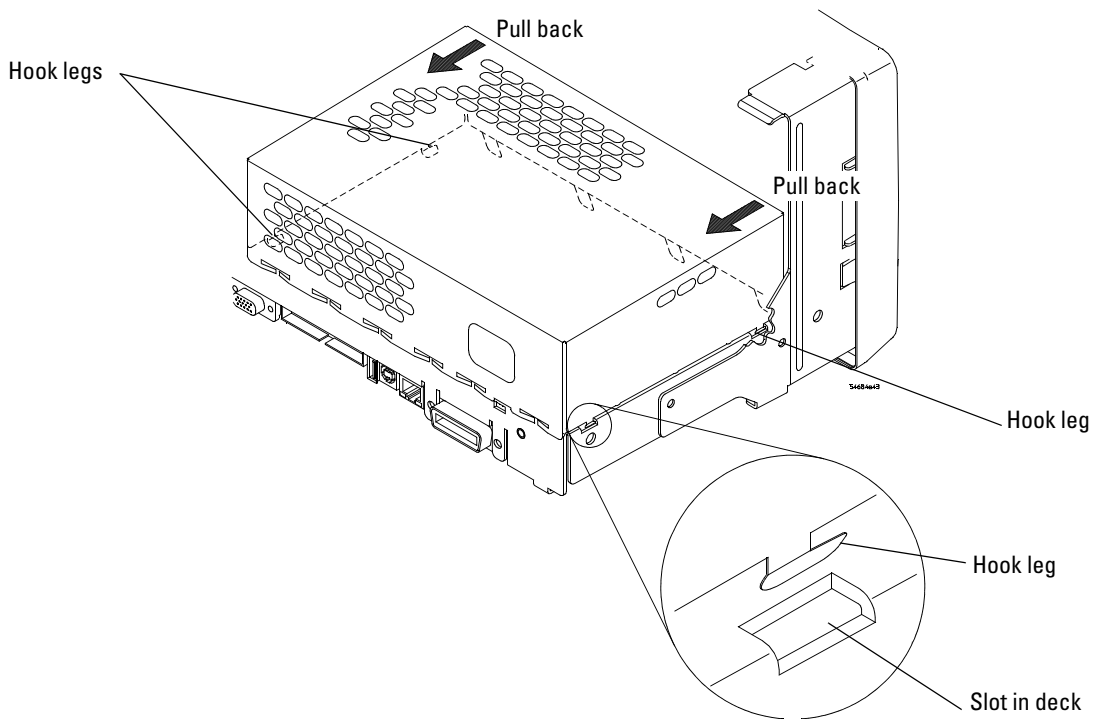


## To remove the power supply shield

- 1 Perform the previous procedures:  
“To remove the cabinet” on page 104
- 2 Pull the shield back to release the 4 side hook legs from the deck.

**WARNING**

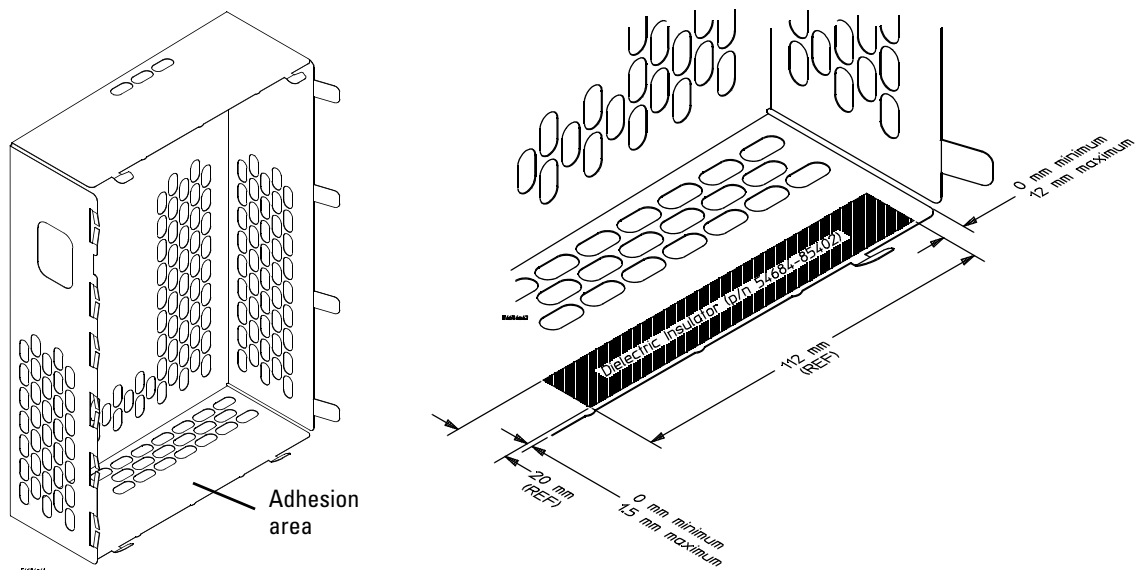
Thin sheet metal parts may have sharp edges. Handle with care to avoid injury.



**Figure 34** Release hook legs from deck.

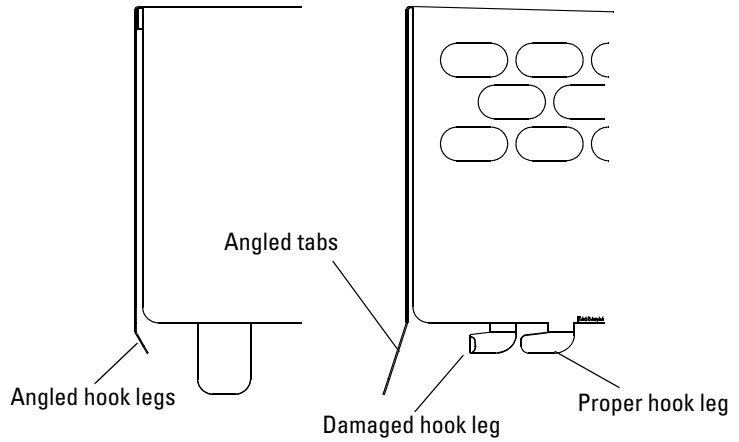
## 5 Replacing 6000A Assemblies

- 3 Lift to remove the shield.
- 4 When reinstalling:
  - a Ensure dielectric insulator tape is in place.



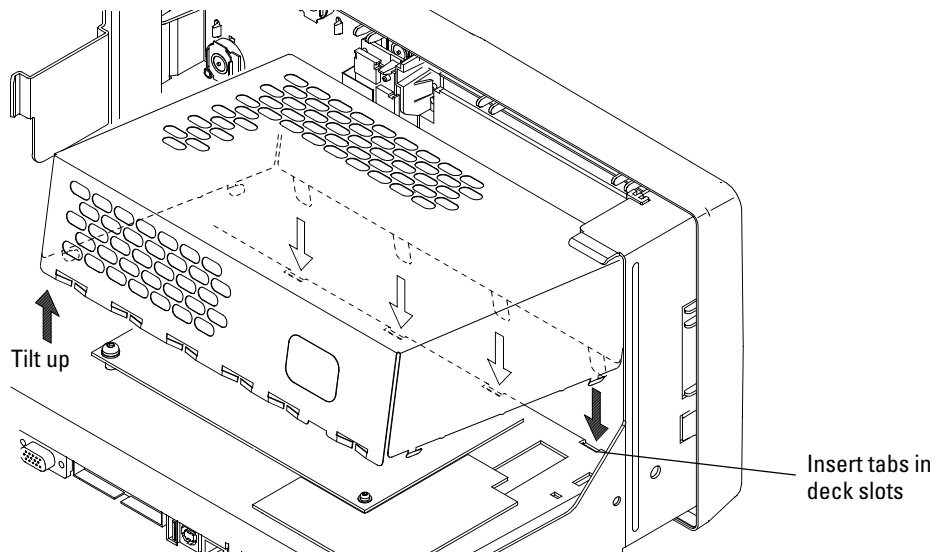
**Figure 35** Dielectric insulator tape.

**b** Ensure that tabs and hook legs have not been damaged.



**Figure 36** Proper angles for tabs and hook legs.

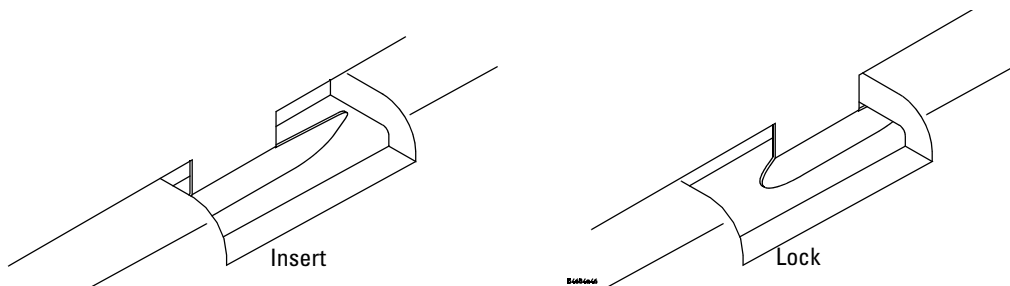
**c** Insert the 4 tabs at the front of the shield by tilting the shield up.



**Figure 37** Tilt to insert tabs.

- d Tilt the shield down and pull back slightly to insert the 4 side hook legs into their deck slots.
- e Push the shield forward to lock into place.

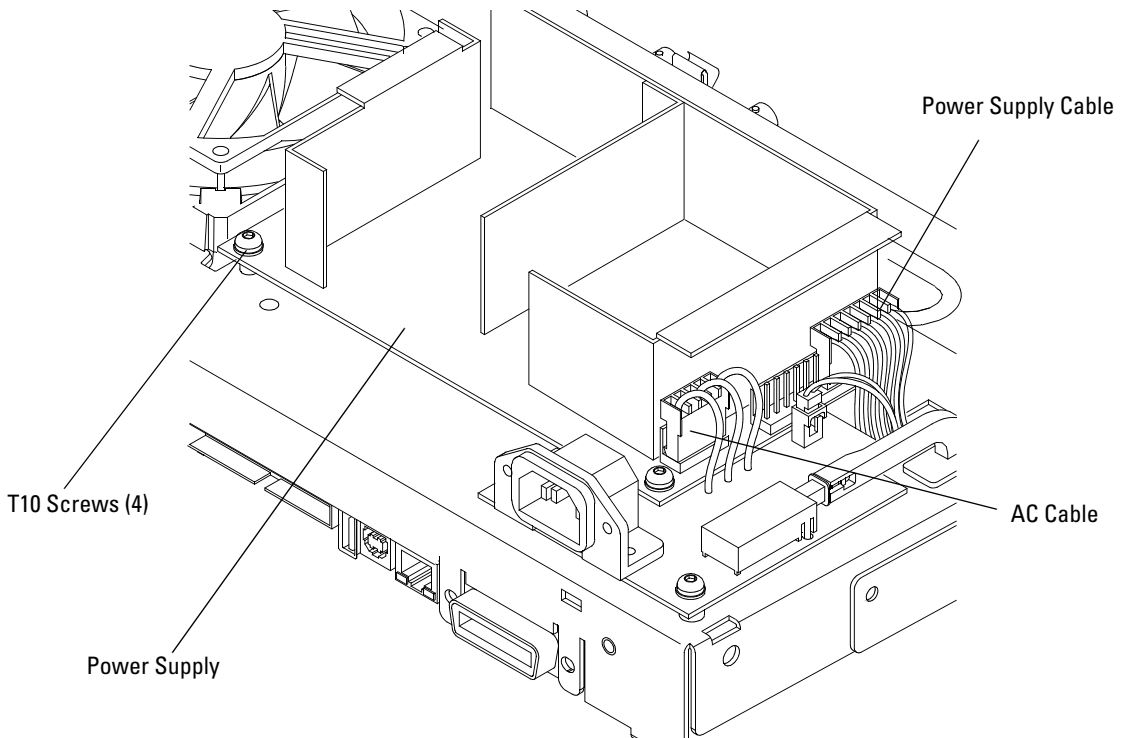
Ensure all hooks and tabs are correctly in their holes.



**Figure 38** Insert hook legs and lock in place.

## To remove the power supply

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the power supply shield” on page 125
- 2 Disconnect the power supply and AC cables.
- 3 Remove the 4 T10 screws securing the power supply to the deck, then remove the power supply.



**Figure 39** Removing the power supply

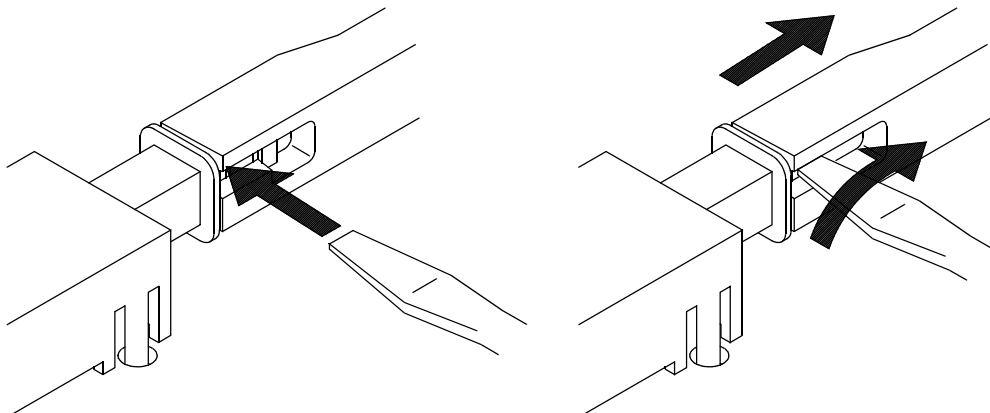
- 4 Reverse this procedure to install the power supply.

## To remove the power shaft

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the power supply shield” on page 125
- 2 Use a flat-blade screwdriver to gently spread the latch while pushing the power shaft forward.

**CAUTION**

Twisting the latch too much could cause it to break!



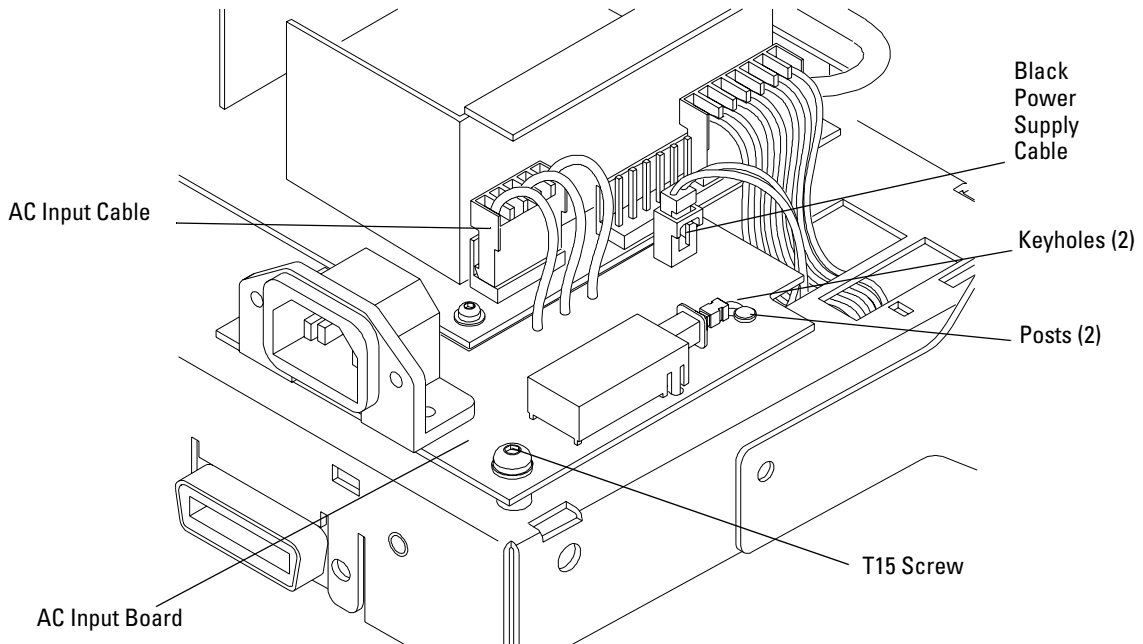
54684a28

**Figure 40** Removing the power shaft latch

- 3 Lift and remove it from the deck.
- 4 When reinserting the power shaft, push the shaft into the power switch until the shaft snaps onto the switch.

## To remove the AC input board

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the power supply shield” on page 125
  - “To remove the power shaft” on page 130
- 2 Disconnect the black power supply cable and the AC input cable.
- 3 Remove the T15 screw securing the input board to the deck.
- 4 Slide the board to the right to release it from the 2 posts.
- 5 Remove the board.



**Figure 41** Removing the AC input board

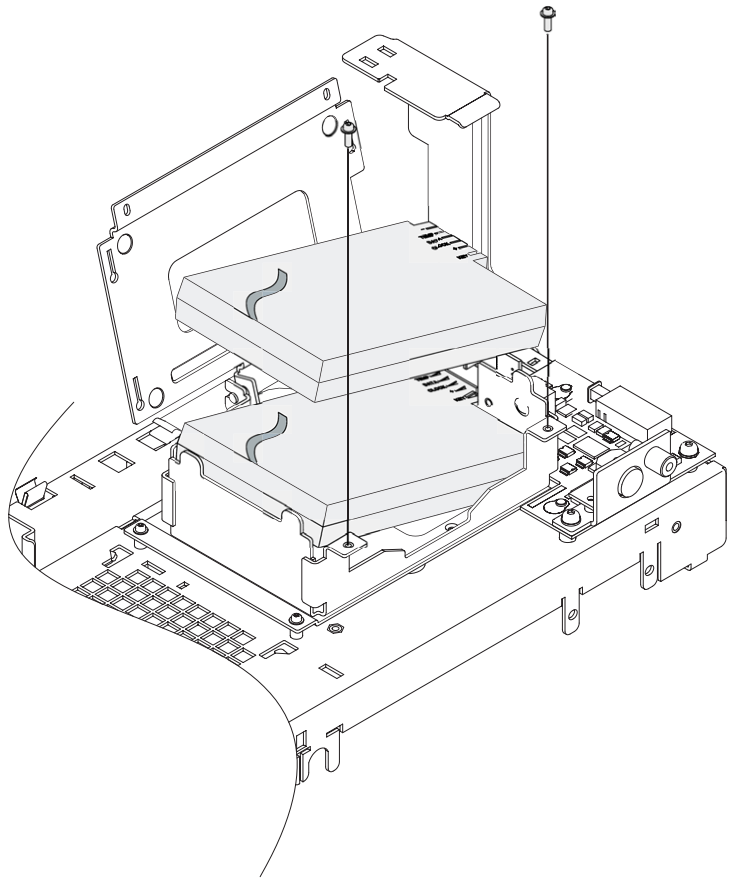
## **5 Replacing 6000A Assemblies**

**6** Reverse this procedure to reinstall.



## To remove the batteries (Option BAT only)

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
- 2 Remove the two T15 screws from the battery enclosure lid, and open the battery enclosure lid.
- 3 Pull upward on the battery straps to remove the batteries.



**Figure 42** Removing the batteries

4 Reverse this procedure to replace the batteries.

---

**WARNING**

Shock hazard. Be careful not to touch the connectors on the battery connection board when re-seating the board.

---

**WARNING**

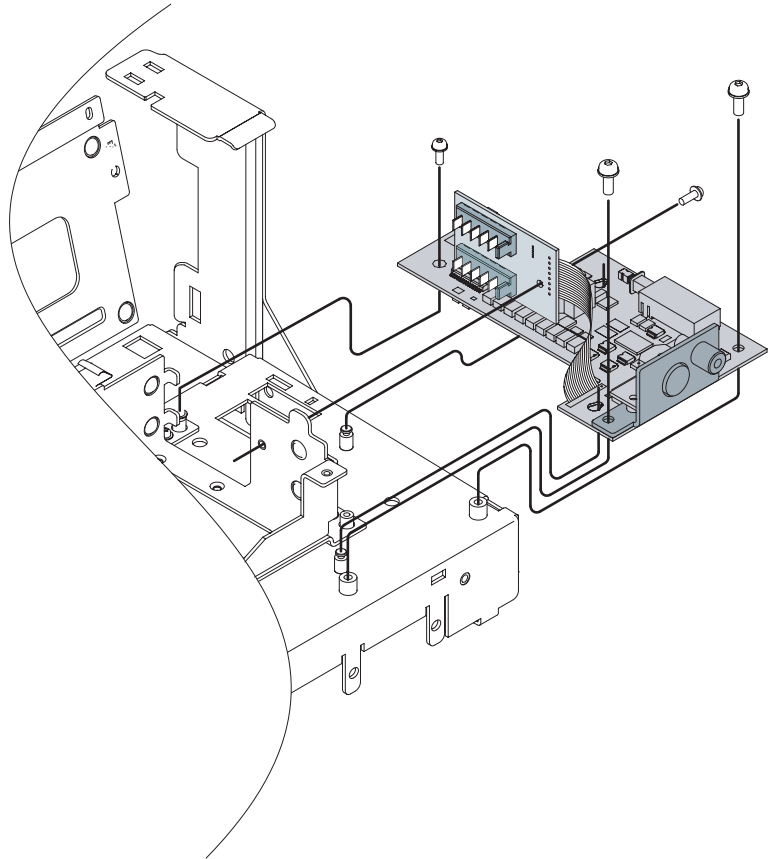
Be careful not to short-circuit the connectors on the battery connection board when re-seating the board. Short-circuited batteries may ignite, explode, leak, or get hot, causing personal injury.

---

- When re-installing batteries, you may have to re-seat the battery connection board.
- If disposing old batteries, follow the disposal instructions on the batteries.

## To remove the battery controller board (Option BAT only)

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the batteries (Option BAT only)” on page 133
  - “To remove the power shaft” on page 130
- 2 Disconnect the DC cable from the battery controller board (to the system board).
- 3 Disconnect the keyboard cable from the battery controller board (to the front panel assembly).
- 4 Remove the one T15 screw securing the battery connection board to the battery enclosure.
- 5 Remove the two T10 and one T15 screws securing the battery controller board to the deck.
- 6 Slide the battery controller board away from the battery enclosure to the board’s slot opening, and lift the board upward to remove it from the deck.



**Figure 43** Removing the battery controller board

**7** Reverse this procedure to replace the battery controller board.

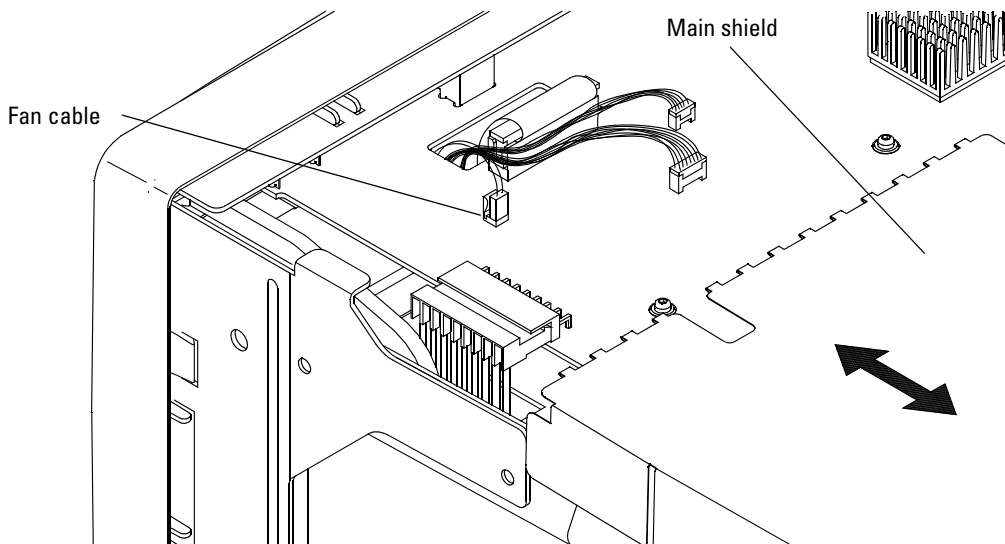
## To remove the fan

- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
  - “To remove the power supply shield” on page 125
  - “To remove the power supply” on page 129
- 2 Remove the main shield covering the system board by sliding it toward the back of the instrument.

**WARNING**

Thin sheet metal parts may have sharp edges. Handle with care to avoid injury.

- 3 Disconnect the fan cable from the system board.



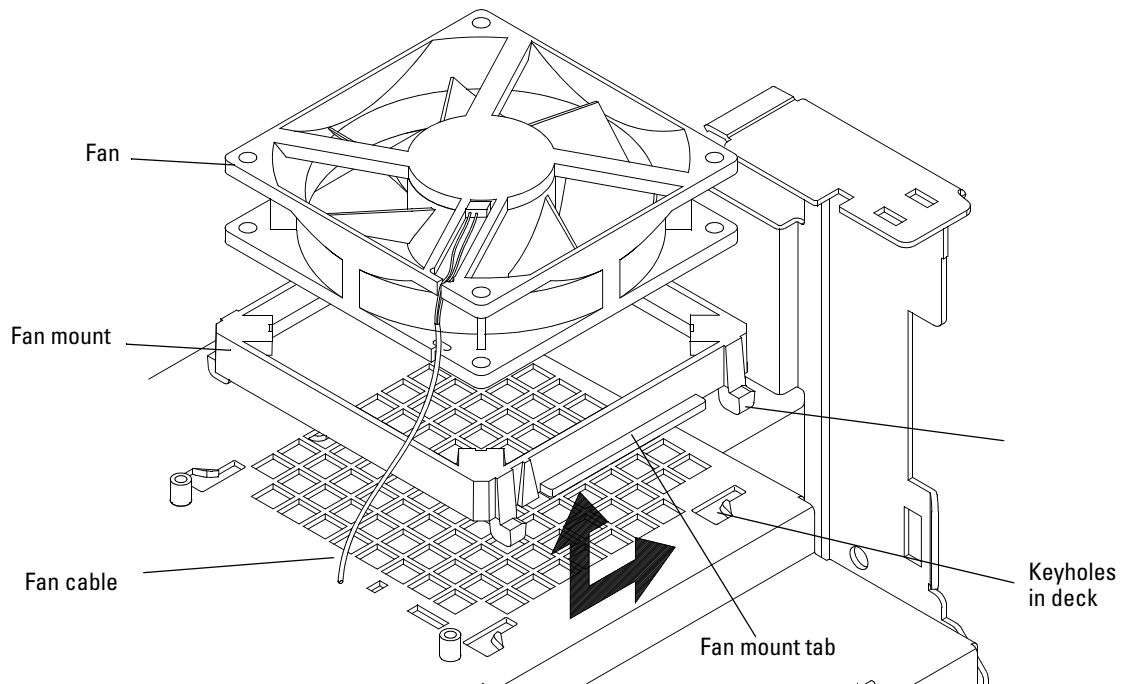
**Figure 44** Removing main shield and disconnecting fan cable.

## 5 Replacing 6000A Assemblies

- 4 Slide the fan mount to the side to remove the 4 retainer hooks from their keyholes and lift out.

It may help to push on each of the hooks to keep from tearing them.

- 5 Peel the rubber fan mount off the corners of the fan.



**Figure 45** Removing the fan

- 6 Reverse this procedure to replace the fan assembly.
  - When re-installing, note the position of the tab on the fan mount and the direction of the fan cable.
  - Ensure that the assembly is locked into the keyholes

## To remove the system board

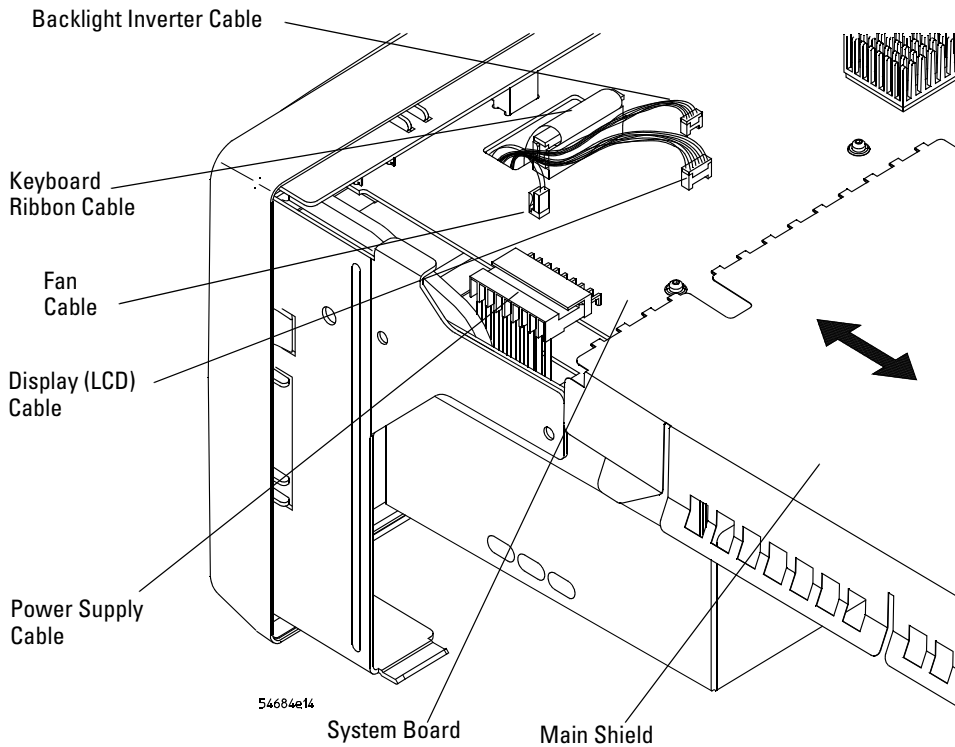
- 1 Perform the previous procedures:
  - “To remove the cabinet” on page 104
- 2 Remove the main shield covering the system board by sliding it toward the back of the instrument.

**WARNING**

Thin sheet metal parts may have sharp edges. Handle with care to avoid injury.

---

- 3 Using a small flat blade screw driver, gently pry and remove the display cable and backlight inverter cable.
- 4 Disconnect the fan cable and keyboard ribbon cable then push all cables back through the hole in the system board.

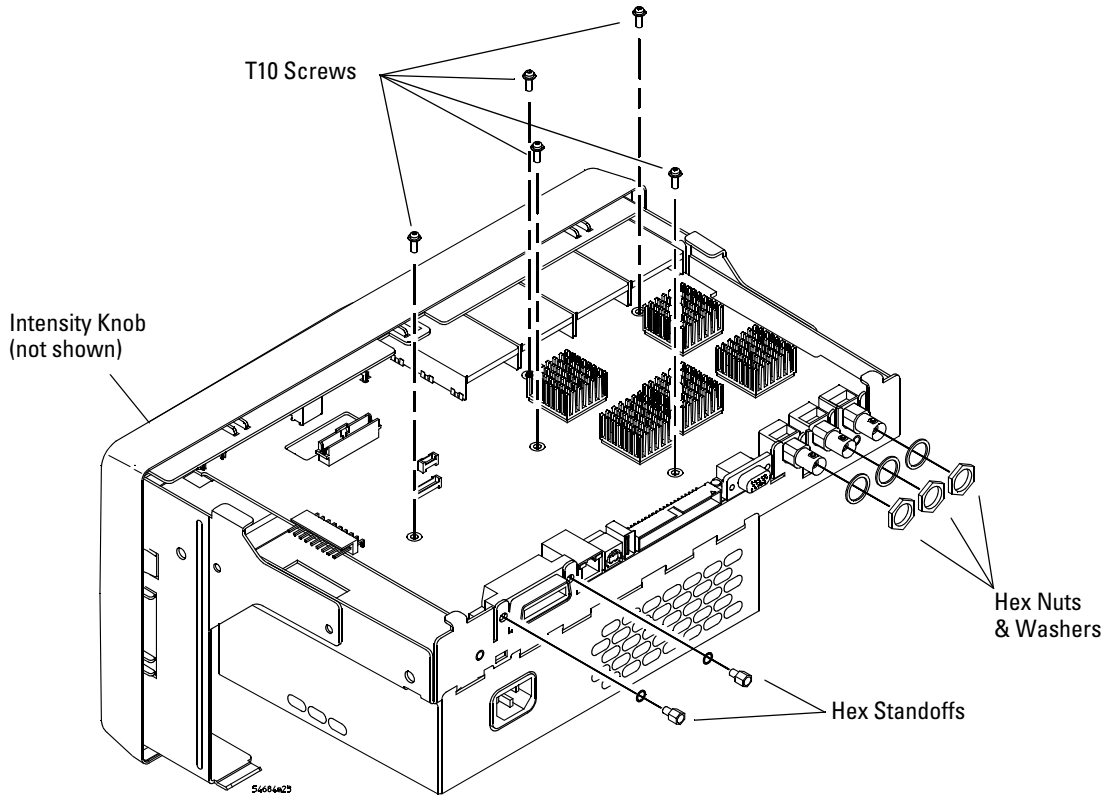


**Figure 46** Preparing to remove the system board

- 5** Disconnect the power supply cable.
- 6** Remove the intensity knob by grasping the knob with one hand and gently prying using a flat-blade screwdriver with the other hand.  
  
Using a twisting motion with the screwdriver rather than prying prevents marking or damaging the front panel.
- 7** Remove the 3 or 4 T6 screws located by the BNCs on the front panel (see [Figure 20](#) on [page 107](#)).
- 8** Remove the three hex nuts and washers from the rear BNCs using the 5/8-inch socket driver.
- 9** Using the 9/32 hex driver, remove two hex standoffs and washers from GPIB connector.



**10** Using the T10 TORX driver, remove the five screws that hold the system board to the deck.

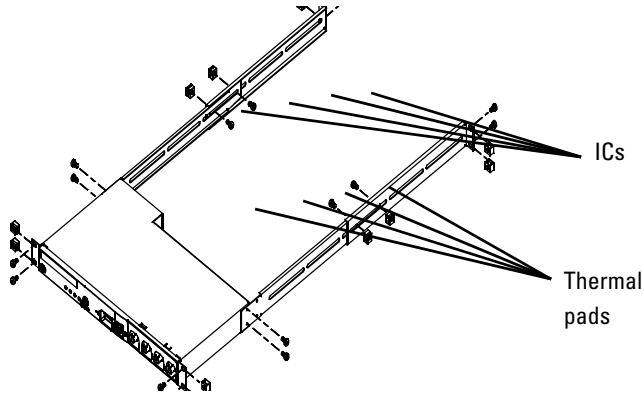


**Figure 47** Removing the system board

**11** Lift the back of the board to clear the main deck and then gently pull the board straight out.

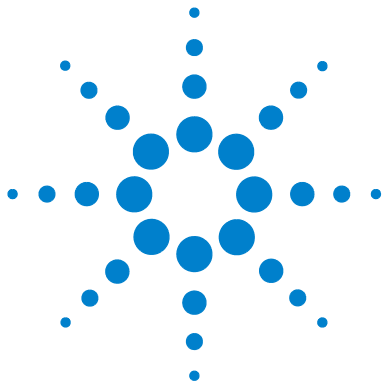
### CAUTION

To avoid tearing the thermal pads (on MS0/DS0601xA models) when removing or installing the system board, hold the board up, away from the thermal pads until the BNCs and other components are clear.



#### 12 To reinstall the system board:

- a** Insert the tabs on the board into the slots in the front of the sheet metal; the intensity shaft, BNCs, and CAL lug into their holes.
- b** Push the back of the board down to seat.
- c** Reinstall the T6 screws on the front panel (shown in [Figure 20](#) on [page 107](#)).
- d** Reinstall the GP-IB hex standoffs, BNC hex nuts and washers, and then the five T10 screws.
- e** Reconnect the cables.
- f** Ensure that the backlight, fan, and LCD cables are routed to the left of the keyboard ribbon cable as shown in [Figure 46](#) on [page 140](#).
- g** Replace the intensity knob by supporting the back of the encoder and pushing the knob fully onto the shaft.



## 6 Replacing 6000L Assemblies

- To remove the bottom cover [145](#)
- To remove the front panel assembly [146](#)
- To remove the system board [148](#)
- To remove the power supply [150](#)
- To remove the fan [152](#)
- To remove the AC power input assembly [154](#)
- To remove the power shaft [156](#)

This chapter describes how to remove assemblies from the Agilent 6000L Series Oscilloscopes. After you have removed an assembly, to install the replacement assembly, follow the instructions in reverse order.

The parts shown in the following figures are representative and may look different than what you have in your oscilloscope.

### Tools Used for Disassembly

Use these tools to remove and replace the oscilloscope assemblies:

- T10 TORX drivers
- 5/8-inch and 9/32-inch socket drivers

### See how the Oscilloscope Parts Fit Together

An exploded view of the oscilloscope is included in the [Chapter 8](#), “Replaceable Parts for the Agilent 6000L Oscilloscope,” starting on page 163. It shows the individual



part numbers used in the assemblies, and shows you how all of the assemblies fit together.

### Read All Warnings and Cautions

Read the following warnings and cautions before removing and replacing any assemblies in the oscilloscope.

#### WARNING

##### HAZARDOUS VOLTAGES !

Read the safety summary at the back of this book before proceeding. Maintenance is performed with power supplied to the oscilloscope and with the protective covers removed. Only trained service personnel who are aware of the hazards involved should perform the maintenance. Whenever possible, perform the procedures with the power cord removed from the oscilloscope.

---

#### WARNING



##### AVOID ELECTRICAL SHOCK !

Hazardous voltages exist on the LCD assembly and power supply. To avoid electrical shock:

- 1 Disconnect the power cord from the oscilloscope.
- 2 Wait at least three minutes for the capacitors in the oscilloscope to discharge before you begin disassembly.

Read the Safety Summary at the back of this manual before you begin.

---

#### CAUTION

##### REMOVE POWER TO AVOID DAMAGE !

Remove power before you begin to remove and replace assemblies. Do not remove or replace assemblies while the oscilloscope is turned on, or damage to the components can occur.

---

#### CAUTION

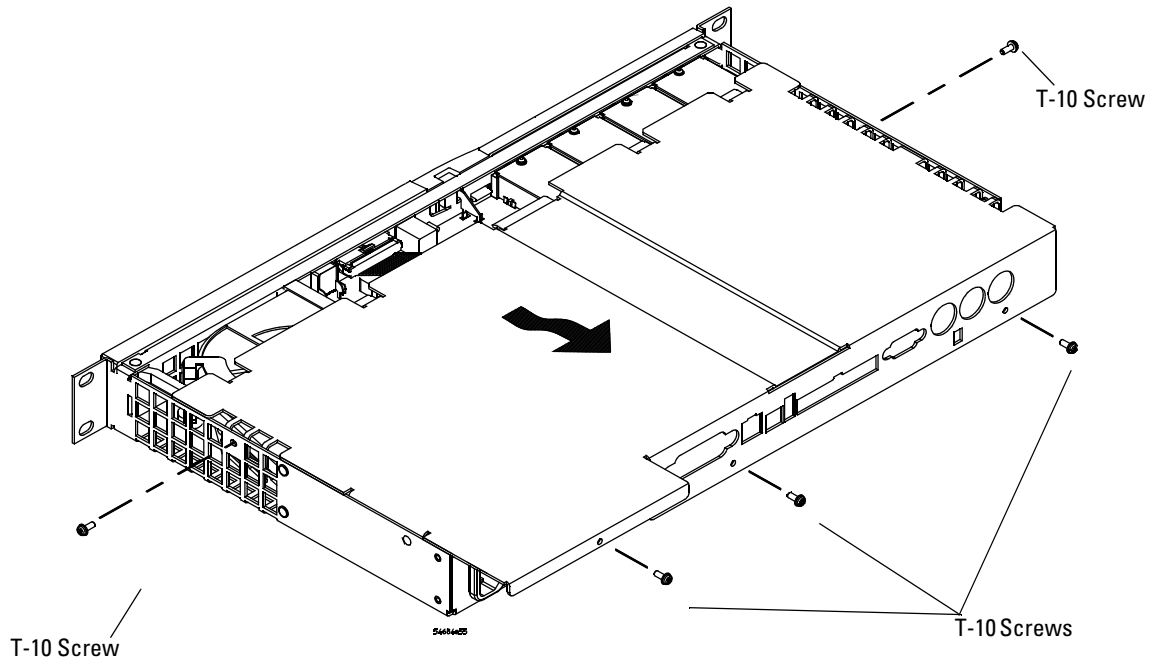
##### AVOID DAMAGE TO ELECTRONIC COMPONENTS !

ELECTROSTATIC DISCHARGE (ESD) can damage electronic components. When doing any of the procedures in this chapter, use proper ESD precautions. As a minimum, you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD strap.

---

## To remove the bottom cover

- 1 Turn off the oscilloscope and disconnect the power cable.
- 2 Turn the oscilloscope so the bottom is facing up.
- 3 Using a T10 screwdriver, remove 5 screws from the rear and sides of the cabinet.
- 4 Slide the bottom cover back and up to remove.

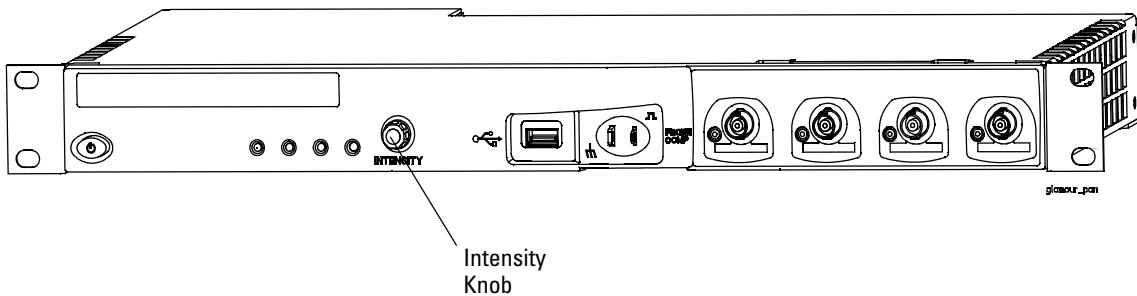


**Figure 48** Removing the cover

## To remove the front panel assembly

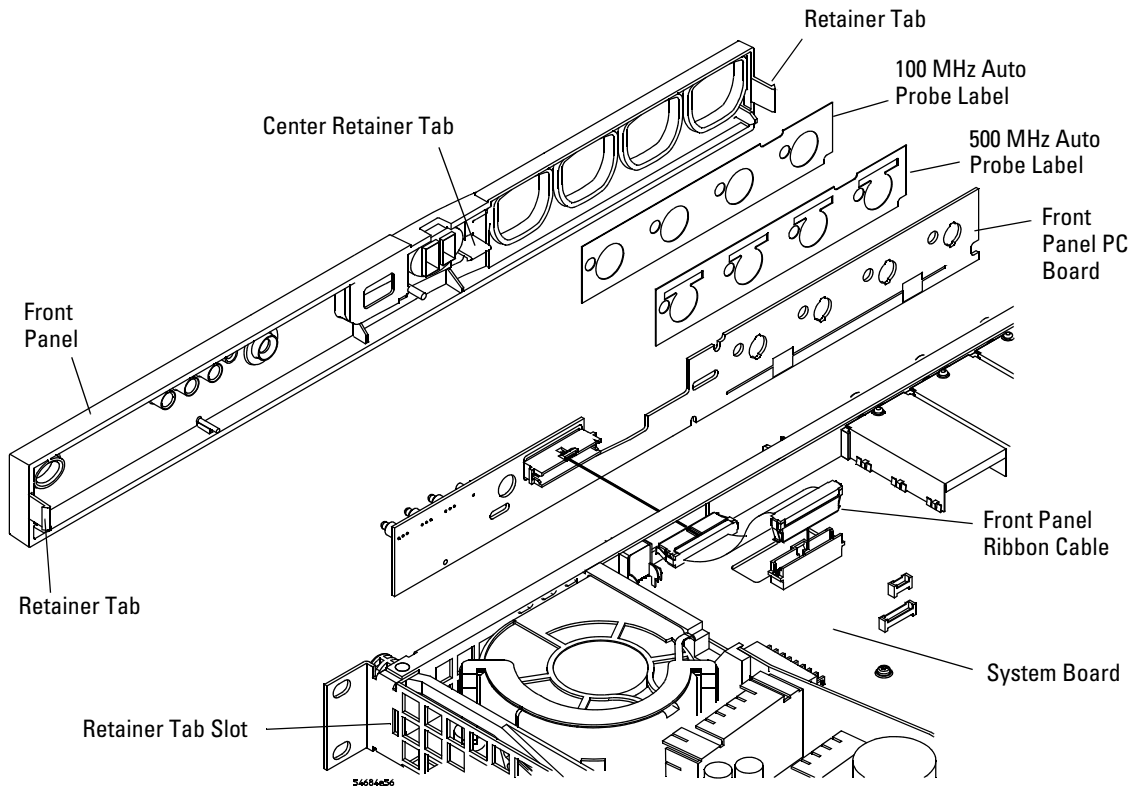
- 1 Perform the following procedures:
  - “To remove the bottom cover” on page 145
- 2 Insert a flat-blade screwdriver under the center of the intensity knob and gently twist the screwdriver as you pull the knob off.

Using a twisting motion on the screwdriver rather than prying prevents marking or damaging the front panel.



**Figure 49** Removing the intensity knob

- 3 Disconnect the front panel ribbon cable from the system board by pressing the release tabs and then disconnect it from the front panel PC board.
- 4 Use a flat-blade screwdriver to release the center retainer tab and push it slightly out of the slot.
- 5 Use a flat-blade screwdriver to release the 2 side retainer tabs and remove them from their slots.

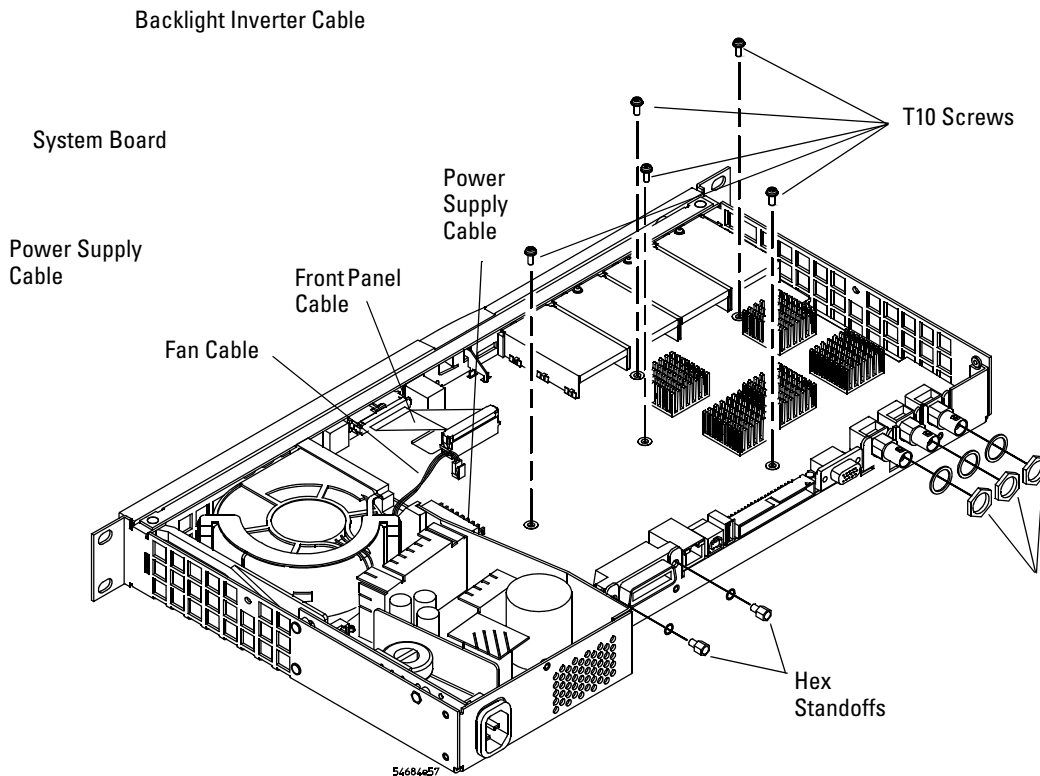


**Figure 50** Disconnecting ribbon cable and releasing tab retainers

- 6** Pull the front panel off of the oscilloscope.
- 7** Lift the front panel PC board to remove it from the front panel.
- 8** Reverse this procedure to replace the front panel.

## To remove the system board

- 1 Perform the previous procedures:
  - “To remove the bottom cover” on page 145
- 2 Remove the intensity knob as described in step 2 on page 146.
- 3 Disconnect the front panel ribbon cable from the system board by pressing the release tabs.
- 4 Disconnect the fan cable.
- 5 Remove the 3 hex nuts and washers from the rear BNC connectors using a 5/8-inch socket driver.



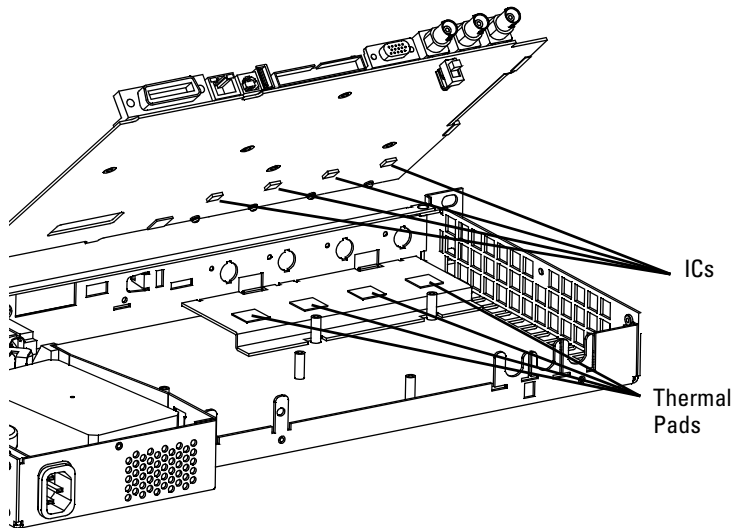


**Figure 51** Preparing to remove the system board

- 6 Using a 9/23-inch hex driver, remove the two hex standoffs and washers from the GPIB connector
- 7 Using a T10 Torx driver, remove the 5 screws that hold the system board to the deck.
- 8 Remove the system board
  - a Lift the back of the board to clear the chassis.
  - b Gently pull the board out until you can disconnect the power supply cable.
  - c Continue to remove the board from the chassis.

**CAUTION**

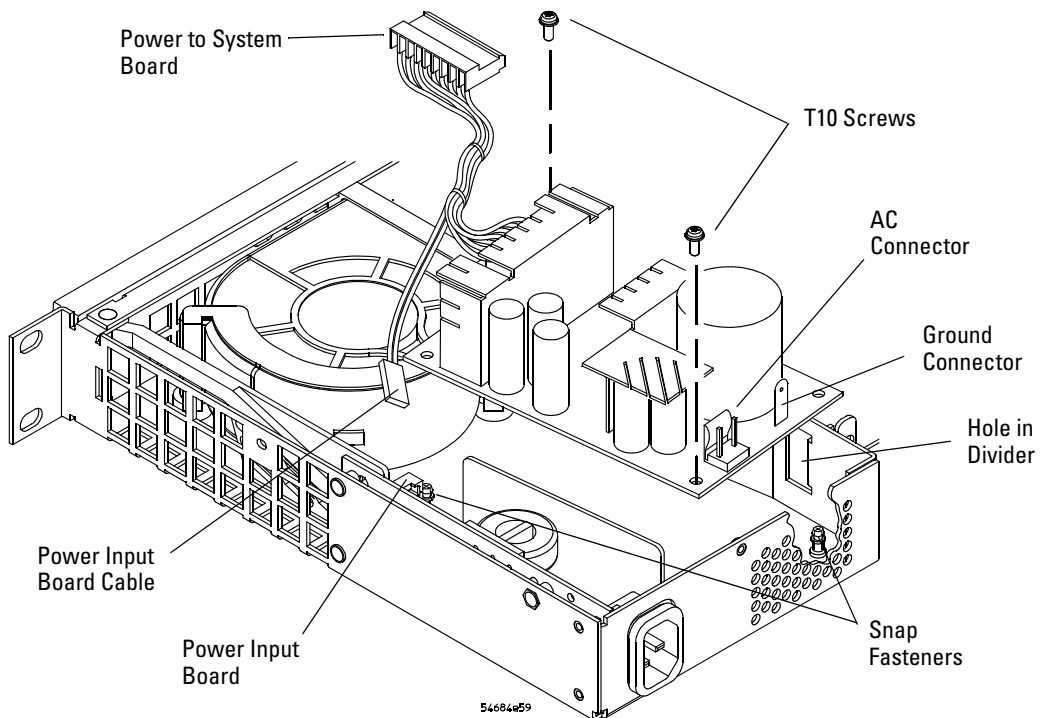
To avoid tearing the thermal pads on a 500 MHz oscilloscope when removing or installing the system board, hold the board up, away from the thermal pads until all components are clear.

**Figure 52** Avoid damage to thermal pads (500 MHz models only)

- 9 Reverse this procedure to reinstall the system board:

## To remove the power supply

- 1 Perform the previous procedures:
  - “To remove the bottom cover” on page 145
  - “To remove the system board” on page 148
- 2 Disconnect the ground cable and AC cables from the power supply using a needle nose pliers if necessary.
- 3 Press the release latch to disconnect the power input board cable from the power input board.



**Figure 53** Removing the power supply.

- 4 Using a T10 Torx driver, remove the 2 screws securing the power supply to the chassis.
- 5 Using a flat-blade screwdriver through the hole in the divider, gently pry the power supply board up enough to snap the power supply board off the rear snap fastener.
- 6 Using a twisting motion, with a flat-blade screwdriver gently snap the power supply board off the front snap fastener.
- 7 Reverse this procedure to install the power supply.

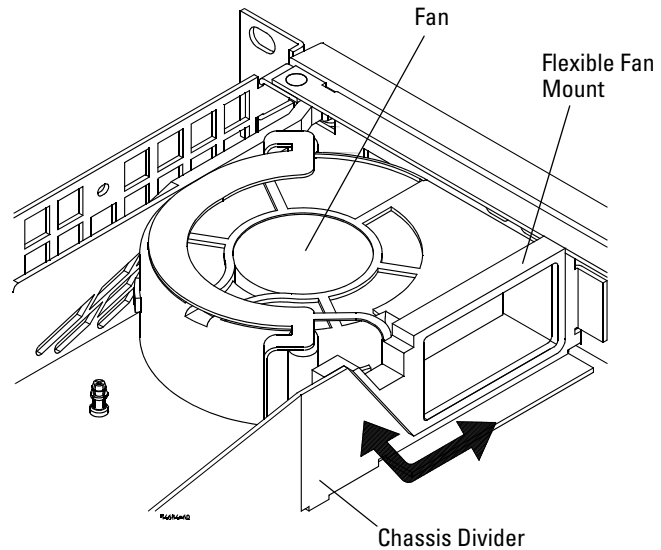
## To remove the fan

**1** Perform the previous procedures:

- “To remove the bottom cover” on page 145
- “To remove the system board” on page 148
- “To remove the power supply” on page 150

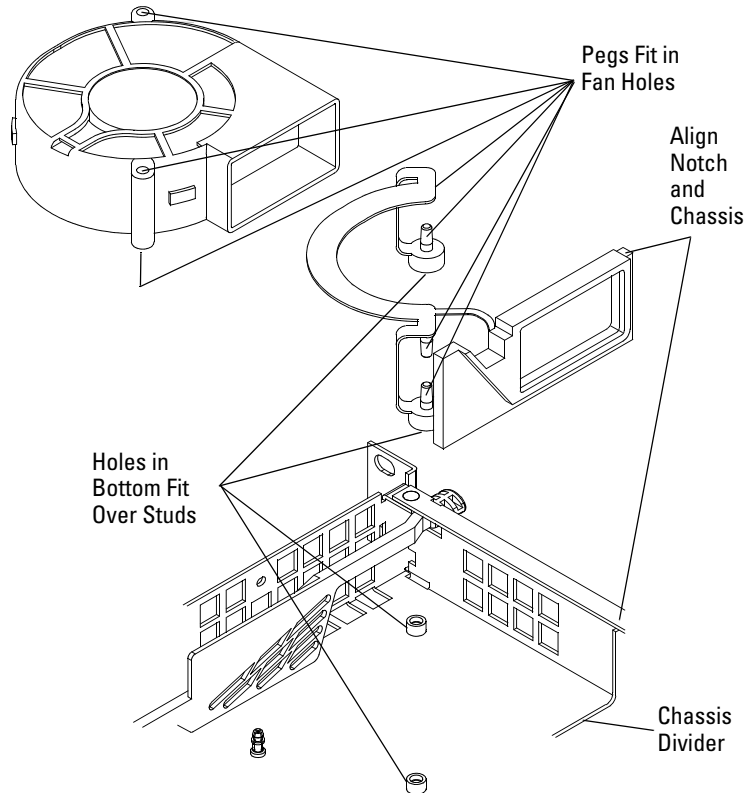
Though the fan can be removed without performing all of the above, it is difficult to reinstall it.

- 2** Slide the fan and fan mount slightly up and out of the chassis.
- 3** Remove the fan from the flexible fan mount.



**Figure 54** Removing the fan.

- 4 Replace the fan.
  - a Place the rectangular part of the flexible fan mount over the fan.
  - b Place the pegs in the flexible fan mount into the holes in the top and bottom of the fan.
  - c Align the holes in the bottom of the flexible fan mount over the studs on the chassis as you slide the fan over the divider in the chassis.
  - d Ensure that the notch in the rectangular portion of the fan mount aligns with the front of the chassis.



**Figure 55** Installing the fan.

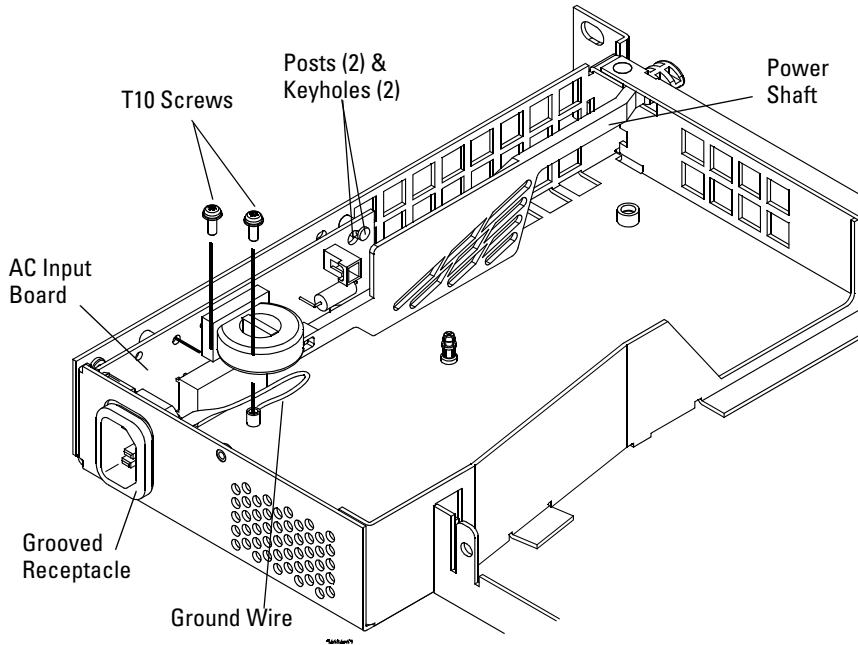
## To remove the AC power input assembly

- 1 Perform the previous procedures:
  - “To remove the bottom cover” on page 145
  - “To remove the power supply” on page 150
  - “To remove the fan” on page 152
- 2 Using a TORX T10 screwdriver, remove the screw securing the power receptacle ground wire to the chassis.
- 3 Using a TORX T10 screwdriver, remove the screw securing the input board to the chassis.
- 4 Lift and rotate the grooved input receptacle just enough to free it from the opening in the chassis.
- 5 Slide the assembly toward the front of the chassis to remove the posts from the keyholes.
- 6 Lift the whole assembly up and back to free the power shaft from the chassis.

**CAUTION**

Avoid breaking the power shaft. Use one hand on each of the 2 pieces of the assembly to keep it in alignment as you remove it.

---



**Figure 56** Removing the AC power input board.

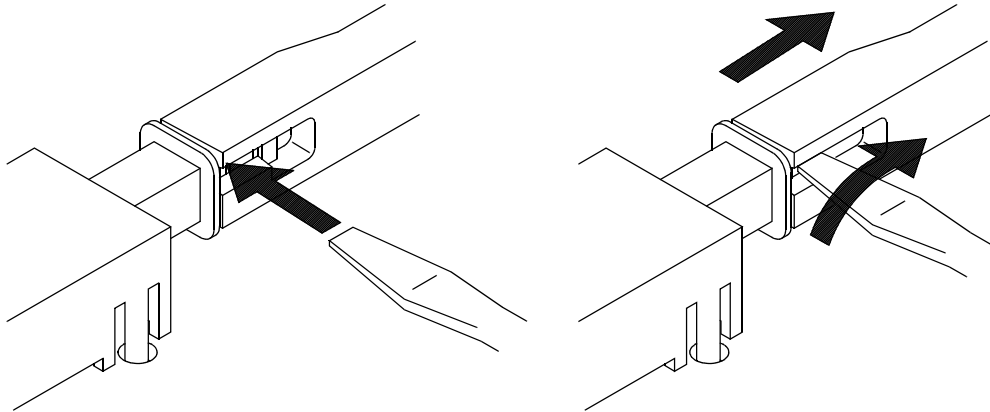
**7** Reverse this procedure to install the AC power input board.

## To remove the power shaft

- 1 Perform the previous procedures:
  - “To remove the bottom cover” on page 145
  - “To remove the power supply” on page 150
  - “To remove the fan” on page 152
- 2 Use a flat-blade screwdriver to gently spread the latch while pushing the power shaft forward.

**CAUTION**

Twisting the latch too much could cause it to break!



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**Figure 57** Removing the power shaft.

- 3 Lift and remove it from the deck.
- 4 When reinserting the power shaft, push the shaft into the power switch until the shaft snaps onto the switch.





## 7 Replaceable Parts

Ordering Replaceable Parts	158
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Replaceable Parts for 6000A Series Oscilloscopes	162
Replaceable Parts for 6000A Series Option BAT Oscilloscopes	170
Replaceable Parts for 6000L Series Oscilloscopes	173

This chapter describes how to order replaceable assemblies and parts for the Agilent 6000 Series Oscilloscopes.

Diagrams and parts lists are included for assemblies and hardware that you can order.

Before working on the oscilloscope, read the safety summary at the back of this book.



## Ordering Replaceable Parts

### Listed Parts

To order a part in the parts list, quote the Agilent Technologies part number, indicate the quantity desired, and address the order to the nearest Agilent Technologies Sales Office. To find your nearest sales office go to [www.agilent.com](http://www.agilent.com).

### Unlisted Parts

To order a part not listed in the parts list, include the instrument part number, instrument serial number, a description of the part (including its function), and the number of parts required. Address the order to the nearest Agilent Technologies Sales Office.

### Direct Mail Order System

Within the USA, Agilent Technologies can supply parts through a direct mail order system. There are several advantages to this system:

- Direct ordering and shipping from the Agilent Technologies parts center in California, USA.
- No maximum or minimum on any mail order. (There is a minimum amount for parts ordered through a local Agilent Technologies Sales Office when the orders require billing and invoicing.)
- Prepaid transportation. (There is a small handling charge for each order.)
- No invoices.

In order for Agilent Technologies to provide these advantages, please send a check or money order with each order.

Mail order forms and specific ordering information are available through your local Agilent Technologies Sales Office. Addresses and telephone numbers are located in a separate document shipped with the manuals.











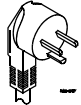

## Exchange Assemblies

Some parts used in this instrument have been set up for an exchange program. This program allows the customer to exchange a faulty assembly with one that has been repaired, calibrated, and performance-verified by the factory. The cost is significantly less than that of a new part. The exchange parts have a part number in the form XXXXX-695XX.

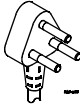
After receiving the repaired exchange part from Agilent Technologies, a United States customer has 30 days to return the faulty assembly. For orders not originating in the United States, contact the local Agilent Technologies service organization. If the faulty assembly is not returned within 30 days, the customer will be charged an additional amount. The additional amount will be the difference in price between a new assembly and that of an exchange assembly.

## Power Cords

**Table 16** Power Cords

Plug Type	Cable Part Number	Plug Type	Cable Part Number
Opt 900 (U.K.) 	8120-1703	Opt 918 (Japan) 	8120-4754
Opt 901 (Australia) 	8120-0696	Opt 919 (Israel) 	8120-6799
Opt 902 (Europe) 	8120-1692	Opt 920 (Argentina) 	8120-6871
Opt 903 (U.S.A.) 	8120-1521	Opt 921 (Chile) 	8120-6979
Opt 906 (Switzerland) 	8120-2296	Opt 922 (China) 	8120-8377
Opt 912 (Denmark) 	8120-2957	Opt 927 (Thailand) 	8120-8871

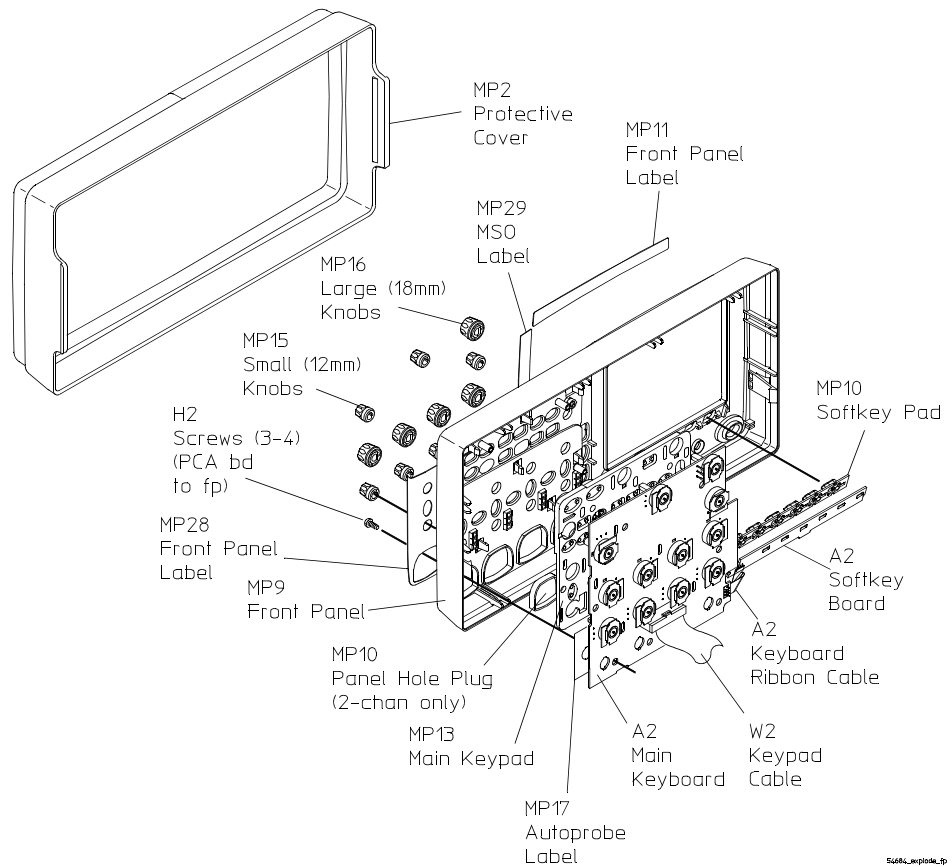
**Table 16** Power Cords (continued)

Plug Type	Cable Part Number	Plug Type	Cable Part Number
Opt 917 (South Africa) 	8120-4600		

## Replaceable Parts for 6000A Series Oscilloscopes

### 6000A Series Oscilloscope Exploded Views

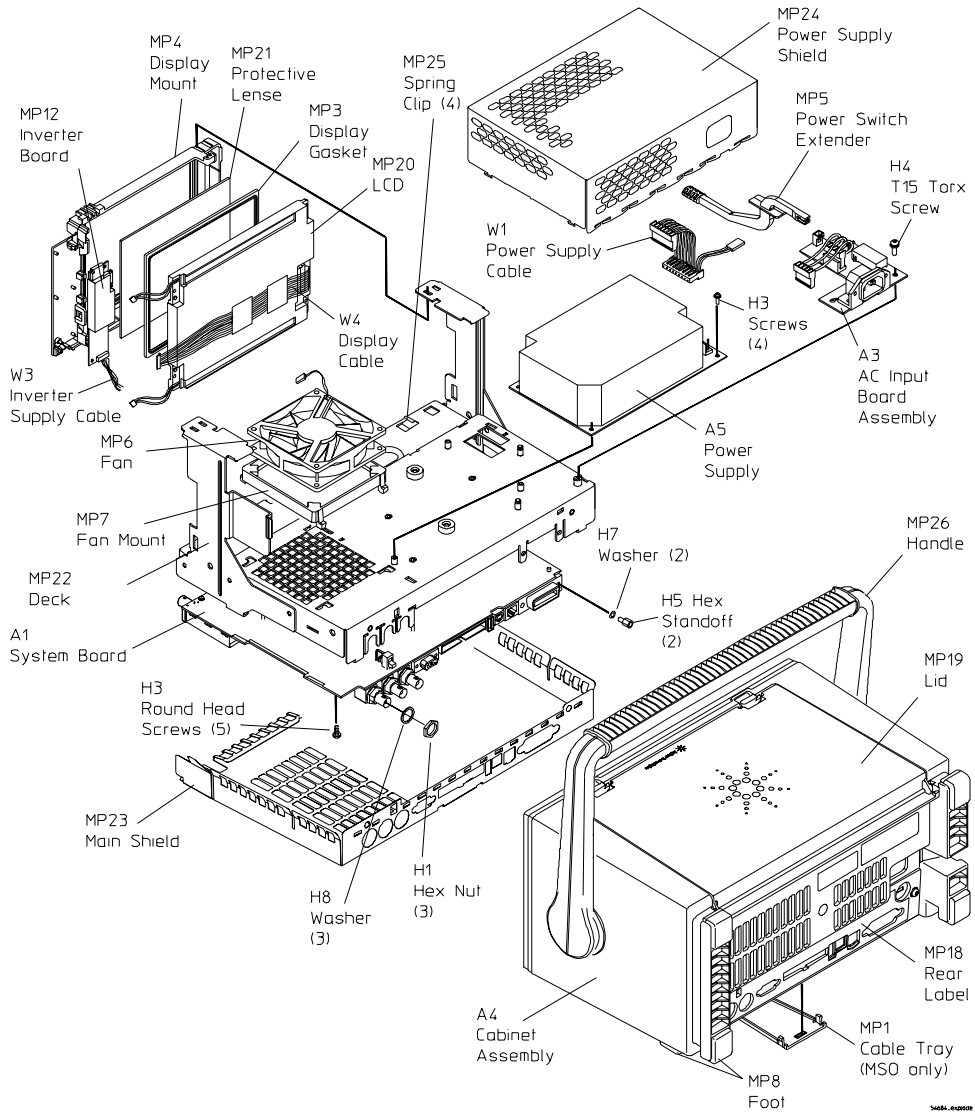
The following exploded views provide a graphical representation of the oscilloscope at the time this manual was released. Not all parts are shown. Your parts may be slightly different than those shown. These views provide reference designator numbers that map to those used in the replaceable parts list table that follows.



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**Figure 58** 6000A Series Oscilloscope Exploded View 1 of 2

## 7 Replaceable Parts



**Figure 59** 6000A Series Oscilloscope Exploded View 2 of 2



## 6000A Series Oscilloscope Replaceable Parts List

The information given for each part consists of the following:

- Reference designation.
- Agilent Technologies part number.
- Total quantity (QTY) in the instrument or on assembly.
- Description of the part.

**Table 17** 6000A Series Oscilloscope Replaceable Parts

Ref Des	Agilent Part Number	Qty	Description
A1	54632-66501	1	2-ch 100 MHz system board
A1	54634-66501	1	4-ch 100 MHz system board
A1	54662-66506	1	2-ch 300 MHz system board
A1	54664-66506	1	4-ch 300 MHz system board
A1	54672-66506	1	2-ch 500 MHz system board
A1	54674-66506	1	4-ch 500 MHz system board
A1	54682-66506	1	2-ch 1 GHz system board
A1	54684-66506	1	4-ch 1 GHz system board
A2	54682-66511	1	2-ch keyboard assembly
A2	54684-66511	1	4-ch keyboard assembly
A3	54684-66516	1	AC line filter/power switch PC board assembly (not in Option BAT)
A4	54684-64401	1	Cabinet assembly
A5	0950-4664	1	Power Supply (not in Option BAT)
H1	2950-0054	3	Hex Nut - 1/2-28 thd
H2	0515-0658	4	Screw - machine m2 x 0.4 - 6 mm lg T6 - w/washer
H3	0515-0372	9	Screw - machine m3 x 0.5 - 8 mm lg T10 - w/washer

## 7 Replaceable Parts

**Table 17** 6000A Series Oscilloscope Replaceable Parts (continued)

Ref Des	Agilent Part Number	Qty	Description
H4	0515-0380	3	Screw - machine m4 x 0.7 - 10 mm lg T15 - w/washer
H5	0380-0643	2	Standoff - hex 0.255 in. lg 6-32 thd
H6	2190-0068	3	Washer - internal tooth lock 0.505 in. id
H7	2190-0009	2	Washer - internal tooth lock 0.168 in. id
MP1	54684-42301	1	Cable tray/guide - MSO only
MP2	54684-44101	1	Cover, protective front
MP3	54684-47101	1	Display gasket
MP4	54684-44702	1	Display mount
MP5	54684-43901	1	Extender, power switch
MP6	54684-68501	1	Fan
MP7	54684-44701	1	Fan mount
MP8	54684-41001	6	Foot pad
MP9	54684-60201	1	Front panel
MP10	54684-42202	1	Hole plug front panel - 2 ch only
MP11	54632-94301	1	ID label 2-ch 100 MHz DSO
MP11	54632-94302	1	ID label 2-ch 100 MHz MSO
MP11	54634-94301	1	ID label 4-ch 100 MHz DSO
MP11	54634-94302	1	ID label 4-ch 100 MHz MSO
MP11	54662-94301	1	ID label 2-ch 300 MHz DSO
MP11	54662-94302	1	ID label 2-ch 300 MHz MSO
MP11	54664-94301	1	ID label 4-ch 300 MHz DSO

**Table 17** 6000A Series Oscilloscope Replaceable Parts (continued)

Ref Des	Agilent Part Number	Qty	Description
MP11	54664-94302	1	ID label 4-ch 300 MHz MSO
MP11	54672-94301	1	ID label 2-ch 500 MHz DSO
MP11	54672-94302	1	ID label 2-ch 500 MHz MSO
MP11	54674-94301	1	ID label 4-ch 500 MHz DSO
MP11	54674-94302	1	ID label 4-ch 500 MHz MSO
MP11	54682-94301	1	ID label 2-ch 1 GHz DSO
MP11	54682-94302	1	ID label 2-ch 1 GHz MSO
MP11	54684-94301	1	ID label 4-ch 1 GHz DSO
MP11	54684-94302	1	ID label 4-ch 1 GHz MSO
MP12	0950-4438	1	Inverter, dual backlight
MP13	54684-41901	1	Keypad, main
MP14	54684-41902	1	Keypad, softkey
MP15	54801-47401	4	Knob - 12 mm flint gray
MP15	54801-47404	1	Knob - 12 mm yellow
MP15	54801-47405	1	Knob - 12 mm green
MP15	54801-47406	1	Knob - 12 mm purple
MP15	54801-47407	1	Knob - 12 mm pink
MP16	54801-47402	1	Knob - 18 mm gray
MP16	54801-47408	1	Knob - 18 mm yellow
MP16	54801-47409	1	Knob - 18 mm green
MP16	54801-47410	1	Knob - 18 mm purple

## 7 Replaceable Parts

**Table 17** 6000A Series Oscilloscope Replaceable Parts (continued)

Ref Des	Agilent Part Number	Qty	Description
MP16	54801-47411	1	Knob - 18 mm pink
MP17	54634-94304	1	Label, autoprobe, 100 MHz models
MP17	54684-94307	1	Label, autoprobe, 300 MHz, 500 MHz, 1 GHz models
MP18	54682-94304	1	Label rear 2 ch
MP18	54684-94304	1	Label rear 4 ch
MP19	54684-40301	1	Lid, storage compartment
MP20	2090-0881	1	Liquid crystal display
MP21	54684-88001	1	Protective lens
MP22	54684-00102	1	Deck
MP23	54684-00601	1	Shield, main
MP24	54684-00602	1	Shield, power supply
MP25	0363-0313	4	Spring clips
MP26	54684-44901	1	Handle
MP27	54684-00604		E-field shield (not shown)
MP28	54632-94303	1	Label, front panel, 2-channel 100 MHz
MP28	54634-94303	1	Label, front panel, 4-channel 100 MHz
MP28	54682-94305	1	Label, front panel, 2-ch 300 MHz, 500 MHz, 1 GHz
MP28	54684-94305	1	Label, front panel, 4-ch 300 MHz, 500 MHz, 1 GHz
MP29	54684-94306	1	Label, MSO
W1	54684-61607	1	Cable, DC
W2	54684-61601	1	Cable, keyboard
W3	54684-61602	1	Inverter supply cable

**Table 17** 6000A Series Oscilloscope Replaceable Parts (continued)

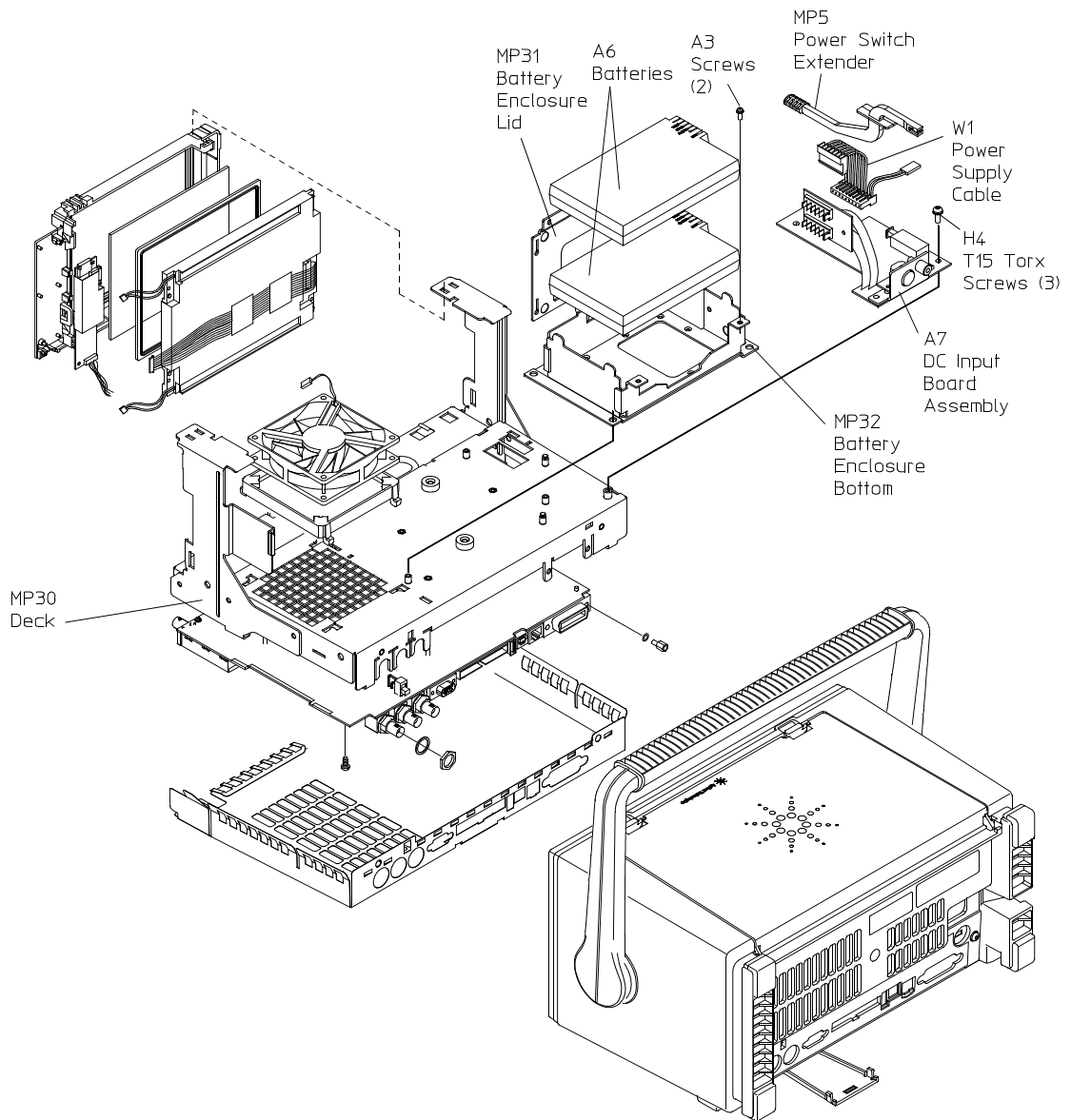
Ref Des	Agilent Part Number	Qty	Description
W4	54684-61603	1	LVDS display cable
W5	8120-1703	0-1	Power cord option 900 3-COND 2-M-LG 13A-FUS
W5	8120-0696	0-1	Power cord option 901, Australia
W5	8120-1692	0-1	Power cord option 902, Europe
W5	8120-1521	0-1	Power cord option 903, U.S.A.
W5	8120-2296	0-1	Power cord option 906, Switzerland
W5	8120-2957	0-1	Power cord option 912, Denmark
W5	8120-4600	0-1	Power cord option 917, Africa
W5	8120-4754	0-1	Power cord option 918, Japan
W5	8120-6799	0-1	Power cord option 919, Israel
W5	8120-6871	0-1	Power cord option 920, Argentina
W5	8120-6979	0-1	Power cord option 921, Chile
W5	8120-8377	0-1	Power cord option 922, China
W5	8120-8871	0-1	Power cord option 927, Thailand
	54620-61801	0-1	Cable assembly, logic
	10073C	2-4	Passive Probe 10:1, 500 MHz
	10074C	2-4	Passive Probe 10:1, 150 MHz
	5090-4833	0-1	Grabber kit assembly
	5959-9334	1	Probe grounds, 2-inch, quantity 5

## Replaceable Parts for 6000A Series Option BAT Oscilloscopes

This section describes the replaceable parts that are unique to the 6000A Series Option BAT battery powered oscilloscopes.

### 6000A Series Option BAT Oscilloscope Exploded View

The following exploded view provides a graphical representation of the oscilloscope at the time this manual was released. Not all parts are shown. Your parts may be slightly different than those shown. This view provides reference designator numbers that map to those used in the replaceable parts list table that follows.



52646682\_explosive

**Figure 60** 6000A Series Option BAT Oscilloscope Exploded View

## 6000A Series Option BAT Oscilloscope Replaceable Parts List

The information given for each part consists of the following:

- Reference designation.
- Agilent Technologies part number.
- Total quantity (QTY) in the instrument or on assembly.
- Description of the part.

**Table 18** 6000A Series Option BAT Replaceable Parts

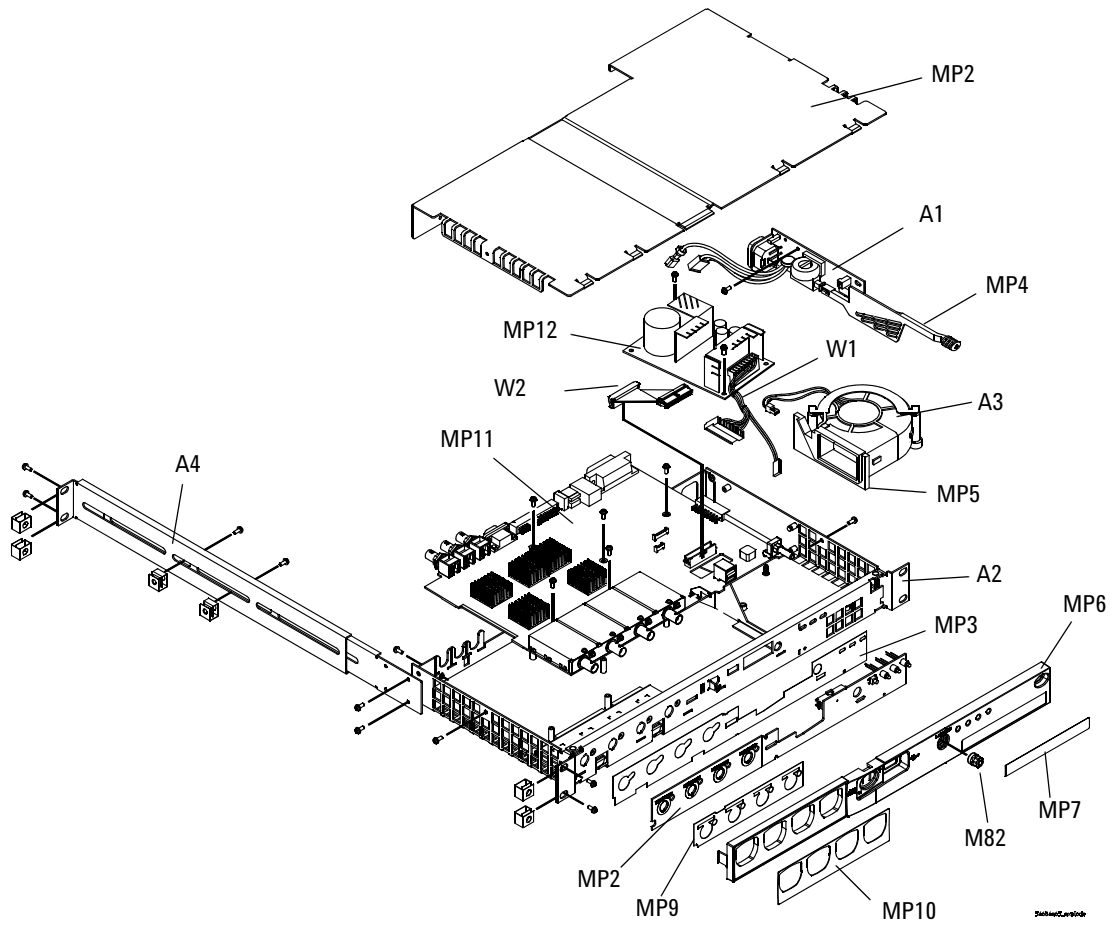
Ref Des	Agilent Part Number	Qty	Description
	54684-68709		Deck subassembly, battery (complete subassembly containing parts listed below plus: fan mount, fan, power switch extender, and DC cable)
A6	1420-0895	2	Battery LI-ION 10.8V 7.2 Ah
A7	54684-66417	1	Battery controller board
H3	0515-0372	+8	Screw - machine m3 x 0.5 - 8 mm lg T10 - w/washer
H4	0515-0380	+2	Screw - machine m4 x 0.7 - 10 mm lg T15 - w/washer
MP30	54684-01202	1	Battery lid
MP31	54684-01205	1	Battery enclosure
	0950-4866	1	AC adapter
	54684-61615	1	External ground cable
	N5429A		12V DC automotive adapter cable (accessory, not included)



## Replaceable Parts for 6000L Series Oscilloscopes

### 6000L Series Oscilloscope Exploded Views

The following exploded views provide a graphical representation of the oscilloscope at the time this manual was released. Not all parts are shown. Your parts may be slightly different than those shown. These views provide reference designator numbers that map to those used in the replaceable parts list table that follows.



**Figure 61** 6000L Series Oscilloscope Exploded View

## 6000L Series Oscilloscope Replaceable Parts List

The information given for each part consists of the following:

- Reference designation from the exploded view.
- Agilent Technologies part number.
- Total quantity (QTY) in the instrument or on assembly.
- Description of the part.

**Table 19** 6000L Series Oscilloscope Replaceable Parts

Ref Des	Agilent Part Number	Qty	Description
A1	D6104-66422	1	AC line filter/power switch/PC board assembly
A2	D6104-00101	1	Deck assembly
A3	D6104-68501	1	Fan assembly
A4	D6104-60001	1	Rackmount kit
MP1	D6104-66421	1	Autoprobe board
MP2	D6104-00104	1	Cover assembly
MP3	D6104-85401	1	Dielectric insulator panel
MP4	D6104-43901	1	Extender - power switch
MP5	D6104-44701	1	Fan mount
MP6	D6104-42201	1	Front panel bezel
MP7	D6104-94301	1	ID Label - 4 Ch, DSO 1 GHz
MP7	D6104-94302	1	ID Label - 4 Ch, DSO 500 MHz
MP7	D6104-94303	1	ID Label - 4 Ch, DSO 100 MHz
MP8	54801-47401	1	Knob - 12 mm flint gray
MP9	54684-94314	1	Label - auto probe

**Table 19** 6000L Series Oscilloscope Replaceable Parts (continued)

<b>Ref Des</b>	<b>Agilent Part Number</b>	<b>Qty</b>	<b>Description</b>
MP10	54634-94303	1	Label - main 4 Ch, 100 MHz
MP10	D6104-94304	1	Label - main 4 Ch, 500 MHz/1 GHz
MP11	54684-66506	1	PC board assembly - 4 Ch, 1 GHz
MP11	54634-66501	1	PC board assembly - 4 Ch, 100 MHz
MP11	54674-66506	1	PC board assembly - 4 Ch, 500 MHz
MP12	0950-4853	1	Power supply
W1	D6104-61607	1	DC cable
W2	D6104-61601	1	Keyboard cable

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## Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

### Warnings

Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be connected to the earth terminal of the power source.

Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.

Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not use the instrument in a manner not specified by the manufacturer.

### To clean the instrument

If the instrument requires cleaning: (1) Remove power from the instrument. (2) Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water. (3) Make sure that the instrument is completely dry before reconnecting it to a power source.

## Safety Symbols



Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.



Hazardous voltage symbol.



Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.