Keysight Infiniium S-Series Oscilloscopes

KEYSIGHT TECHNOLOGIES

Service Guide

Notices

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CAUTION

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WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

In This Service Guide

This guide provides service information for Infiniium S-Series oscilloscopes. It covers these areas:

Chapter 1, “General Information", lists the oscilloscope models that are covered by this guide, the supplied accessories, and the specifications and characteristics for the Infiniium S-Series oscilloscopes.

Chapter 2, “Calibration", describes the types of calibrations, and how and when to run the user calibration procedure.

Chapter 3, “Testing Performance", provides instructions for testing the oscilloscope to verify that it performs according to specifications.

Chapter 4, “Troubleshooting", provides flowcharts and procedures for diagnosing problems for assembly-level repair.

Chapter 5, “Replacing Assemblies", provides instructions for removing and replacing assemblies in the oscilloscope.

Chapter 6, “Replaceable Parts", provides exploded parts diagrams and a list of orderable replacement parts.

Chapter 7, “Theory of Operation", briefly describes the basic structure of the oscilloscope and how its parts interact.

Chapter 8, “Safety Notices", provides warnings and describes icons used on the oscilloscopes.

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To contact Keysight, see www.keysight.com/find/contactus.

KEYSIGHT TECHNOLOGIES

Instruments Covered by this Service Guide

Oscilloscopes manufactured after the date this manual was released may be different from those described in this manual. The release date of this manual is shown on the back of the title page. This manual will be revised when necessary.

If you have an oscilloscope that was manufactured after the release of this manual, please check the Keysight Technologies website at www.keysight.com to see whether a newer version of this manual is available.

The following S-Series oscilloscopes are covered in this guide. The oscilloscope model is identified by the product number on the front panel.

Model	Bandwidth
DSOS804A/MSOS804A	8 GHz
DSOS604A/MSOS604A	6 GHz
DSOS404A/MSOS404A	4 GHz
DSOS254A/MSOS254A	2.5 GHz
DSOS204A/MSOS204A	2 GHz
DSOS104A/MSOS104A	1 GHz
DSOS054A/MSOS054A	500 MHz

Accessories Supplied

- mouse
- keyboard
- accessory pouch
- front panel cover
- localized power cord
- calibration cable
- N2873A 10:1 500 MHz Divider Passive Probe (one per scope channel)
- 17-channel Flying Lead Set Logic Probe, MSO Cable, and BNC probe tip adapter (MSO models only)
- Keysight I/O Libraries Media Suite
- Quick Start poster

Characteristics and Environmental Conditions

The following table contains a partial list of specifications and characteristics for the Infiniium S-Series oscilloscopes. For a full list of specifications and characteristics, see the data sheets at www.keysight.com/find/S-series.

Warranted specifications are tested in Chapter 3. Specifications are valid after a 30-minute warm-up period, and within ± 5° C from the temperature at which the last user calibration was performed.

Environment	Indoor use only
Ambient temperature	Operating: 5 °C to +40 °C Non-operating: –40 °C to +65 °C
Humidity	Operating: up to 80% relative humidity (non-condensing) at +40 °C Non-operating: up to 90% relative humidity at +65 °C
Altitude	Operating: up to 3,000 meters (9,842 feet) Non-operating: up to 15,300 meters (50,000 feet)
Weight	11.8 kg (26 lbs)
Dimensions	16.8 in (43 cm) wide, 12.9 in (33 cm) tall, and 9 in (23 cm) deep
Safety	UL61010-1 3rd edition CAN/CSA-22.2 No. 61010-1-12 3rd edition
Installation Category	II
Power Requirements	100-120 V, 50/60/400 Hz 100-240 V, 50/60 Hz 380 W Max
Voltage Fluctuations	Note that the main supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
Pollution Degree	The Infiniium S-Series oscilloscopes may be operated in environments of Pollution Degree 2.
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.

2 Calibration

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What is a Calibration?

A calibration is simply an oscilloscope self-adjustment. The purpose of a calibration is performance optimization.

There are two ways to calibrate an Infiniium S-Series oscilloscope:

- A *user* calibration, also known as a *self* calibration, includes the minimum set of calibrations and is intended to be run by oscilloscope users. It can include a time scale calibration.
- A *service* calibration is performed only by Keysight Service Center technicians.

The following section describes how to run a user (self) calibration.

Running a User Calibration

NOTE **The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature before starting the calibration procedure. Failure to allow warm up may result in inaccurate calibration.**

The user calibration uses signals generated in the oscilloscope to calibrate channel scale, offsets, and trigger parameters.

When to perform a user calibration:

- Standard calibration only—When the oscilloscope's operating temperature (after the 30-minute warm-up period) is more than ±5 °C different from that of the last calibration. Be sure to perform a standard user calibration (do not perform the time scale cal)—even if one was recently performed—when environmental temperature conditions cause the oscilloscope's operating temperature to change, such as when the oscilloscope is moved to a test rack or chamber.
- Standard and time scale cal—When it has been more than 1 year since the last time scale calibration, and when you replace the acquisition board.

Performing a user calibration will invalidate the oscilloscope's Certificate of Calibration. If NIST (National Institute of Standards and Technology) traceability is required, perform the procedures in Chapter 3 using traceable sources.

Equipment required

Equipment	Critical specifications	Recommended part number
50 Ω BNC Cable	50 Ω characteristic impedance BNC cable	54609-61609
10 MHz Signal Source (required for time scale calibration)	Frequency accuracy better than ±41 ppb	53131A with Opt. 012
MSO calibration fixture that ships with the oscilloscope (MSO models only)		1250-3817
MSO cable that ships with the oscilloscope (MSO models only)		54904-61622

Calibration time

It takes approximately 1 hour to run the user calibration on the oscilloscope, including the time required to change cables from channel to channel.

Procedure

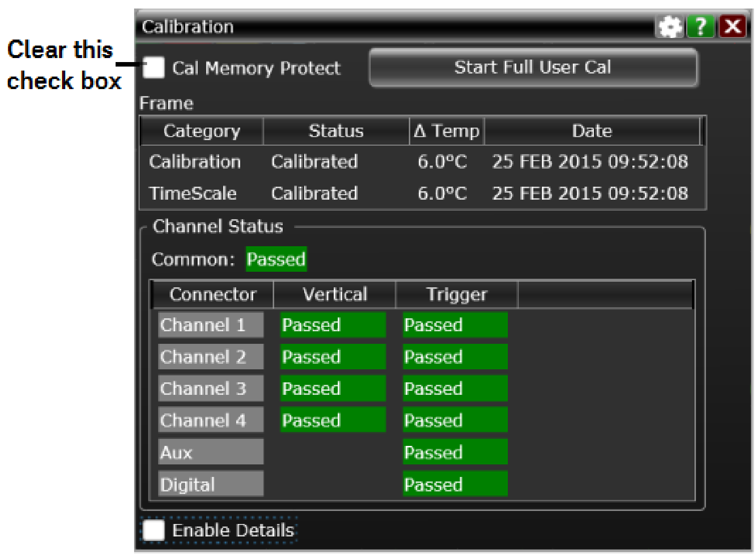
1 Let the oscilloscope warm up before running the calibration.

The user calibration should be done only after the oscilloscope has run for 30 minutes at ambient temperature with the cover installed. Calibration of an oscilloscope that has not warmed up may result in an inaccurate calibration.

2 Click **Utilities > Calibration...**.

3 Clear the **Cal Memory Protect** check box.

You cannot run a user calibration if this check box is selected. See the following figure.



4 Click **Start Full User Cal**, then follow the instructions on the screen.

The routine will prompt you to follow these steps:

a Disconnect everything from all inputs and Aux Out.

b Select the level of calibration you want to perform.

- Standard Calibration—Time scale calibration will not be performed. Time scale calibration factors from the previous time scale calibration will be used and the 10 MHz reference signal will not be required. The remaining calibration procedure will continue.

- Standard Calibration and Time Scale Calibration—Time scale calibration will be performed. This option requires you to connect a 10 MHz reference signal to channel 1 that meets the following specifications. Failure to use a reference signal that meets these specifications will result in an inaccurate calibration.

  Frequency: 10 MHz, max ±41 ppb = 10 MHz, max ±0.41 Hz
  Amplitude: 0.2 V peak-to-peak to 5.0 V peak-to-peak
  Wave shape: Sine or Square

NOTE **When performing the time scale calibration using the 53131A-012 universal frequency counter/timer, the precision 10 MHz reference is available from the 10 MHz Out connector on the rear panel of the 53131A counter/timer.**

c Connect the 50 Ω BNC cable from Aux Out to each of the channel inputs as requested.

d Connect the 50 Ω BNC cable to Aux Trig In as requested.

e Follow the directions for calibrating the digital channels (MSO models only).

f A Passed/Failed indication is displayed for each calibration section.

If any section has failed, wait until the calibration is complete and then select the **Enable Details** check box for information on the failures. Also check the cable connections.

5 When the calibration procedure is complete, click **Close**.

3 Testing Performance

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Full performance verification for the S-Series oscilloscopes consists of three main procedures:

1 Performing the internal oscilloscope self-tests to ensure that the measurement system is functioning properly. To perform the self-tests, click **Utilities > Self Test...**. Then select **Scope SelfTest** from the Available Self Test drop-down list box, click **Start**, and follow the on-screen instructions. If any of the self tests fail, ensure that the failure is diagnosed and repaired before calibrating and testing performance.

2 Calibrating the oscilloscope, as described in Chapter 2.

3 Testing the oscilloscope to ensure that it is performing to specification. This chapter describes these performance test procedures.

Performance Verification General Information

Performance Test Interval

The procedures in this section may be performed for incoming inspection and should be performed periodically to verify that the oscilloscope is operating within specification. The recommended test interval is once per year or after 2000 hours of operation. Performance should also be tested after repairs or major upgrades.

Performance Test Record

A test record form is provided at the end of this section. This record lists performance tests and test limits, and provides space to record test results.

Test Order

The tests in this section may be performed in any order. However, we recommend conducting the tests in the order presented, as the order represents an incremental approach to performance verification. This approach may be useful when you are troubleshooting a suspected problem.

Test Equipment

Lists of equipment needed to conduct each test are provided for each test procedure. The procedures are written to minimize the number and types of test equipment and accessories required. The test equipment in these lists are currently available for sale by Keysight at the time this document was written. In some cases, the test procedures use features specific to the test equipment in the recommended equipment list. However, other equipment, cables, and accessories that satisfy the critical specifications in these lists may be substituted for the recommended models with some modification to the test procedures.

Contact Keysight Technologies for more information about the Keysight products in these lists.

Vertical Performance Verification

This section describes the following vertical performance verification tests:

- Input Impedance Test
- Offset Accuracy Test
- DC Gain Accuracy Test
- Analog Bandwidth—Maximum Frequency Test
- Time Scale Accuracy (TSA) Test

Input Impedance Test

This test checks the input impedance of the vertical inputs. A four-wire measurement is used to accurately measure the 50 Ω and 1 MΩ inputs.

Specifications

- 1 MΩ ±1%
- 50 Ω ±3.5%

Equipment Required

Description	Critical specifications	Recommended model or part number
Digital Multimeter	Measure resistance (4-wire) at better than ±0.1% accuracy	34411A or 3458A
Cables (2)	BNC	10503A
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to dual banana (m)	1251-2277

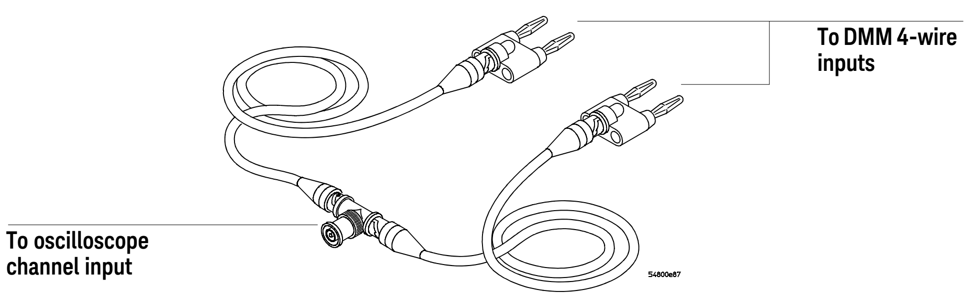
Procedure

1 Set up the multimeter to make a four-wire resistance measurement.

2 Assemble the test cables:

   a Use the two BNC-to-banana adapters to connect one end of each BNC cable to the four-wire resistance connections on the multimeter.

   b Connect the free ends of the cables to the BNC tee as shown here.



3 Connect the male end of the BNC tee to the channel 1 input of the oscilloscope.

4 Click **Control > Factory Default** to set the oscilloscope to default conditions.

5 Open the Channel dialog box for channel 1 (**Setup > Channel 1...**). Set the scale to 5 mV/div and set the channel input impedance to 50 Ω. Verify a resistance reading of 50 Ω ±1.75 Ω.

6 Record the readings in the Input Impedance Test table of the Performance Test Record at the end of this chapter.

7 Repeat steps 5 and 6 for the remaining 50 Ω vertical scale settings in the Impedance Test table.

8 Repeat steps 3 through 7 on the remaining channels of the oscilloscope.

9 Repeat steps 3 through 8 using an input resistance of 1 MΩ instead of 50 Ω and verify resistance readings of 1 MΩ ±10 kΩ.

NOTE Due to the current source limitations of the 34411A/3458A DMM, be sure to set it to 10 MΩ range instead of Auto Range when testing the 1 MΩ resistance.

Offset Accuracy Test

CAUTION Ensure that the input voltage to the oscilloscope never exceeds ±5 V.

NOTE The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

Specifications

Offset Accuracy	± 0.1div ± 2 mV ±1.0% of offset setting for offsets < 2V ± 0.1div ± 2 mV ±1.5% of offset setting for offsets ≥ 2V
50 Ω Input Impedance: Full scale is defined as 8 vertical divisions. Magnification is used below 2 mV/div. Below 2 mV full scale is defined as 16 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV and 1 V. **1 MΩ Input Impedance:** Full scale is defined as 8 vertical divisions. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, and 5 V.	

Equipment Required

Description	Critical specifications	Recommended model or part number
Digital Multimeter	DC voltage measurement accuracy better than ±0.1% of reading	34411A or 3458A
Cable Assembly (2 required)	50 Ω characteristic impedance, BNC (m) connectors	8120-1840
DC Power Supply	40 V	6614C
Adapter	BNC Tee (m)(f)(f)	1250-0781
Adapters (2)	BNC (f) to dual banana	1251-2277

Procedure

1 Disconnect all cables from the oscilloscope channel inputs.

2 Click **Control > Factory Default**. The input impedance for channel 1 should be 50 Ω.

3 Click **Setup > Acquisition...**. In the Acquisition dialog box, enable averaging and set # of Averages to 256.

4 Configure the oscilloscope to measure the average voltage (V avg) on channel 1 as follows:

   a Change the vertical scale of channel 1 to 5 mV/div.

   b Click the Vertical Meas tab on the left side of the screen, then drag and drop the Average measurement icon onto the channel 1 waveform.

Average measurement (V avg)

5 Press **[Clear Display]** on the oscilloscope and wait for the number of averages display (top right area of screen) to return to 256. Record the oscilloscope's mean V avg reading in the $V_{zero\text{-}error}$ column of the Offset Accuracy Test (50 Ω) table. Use the Channel dialog box to select 1 MΩ impedance and then repeat steps 3 to 5. Record the reading in the Offset Accuracy Test (1 MΩ) table for channel 1.

NOTE

- For all oscilloscope readings in this procedure, use the mean value in the Measurement Results pane at the bottom of the screen.
- If a question mark appears in front of any values in the Results pane, press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the oscilloscope reading. The question mark indicates that the oscilloscope could not make a reliable measurement.

Number of averages

Record the mean reading

6 Change the vertical scale of channel 1 to 10 mV/div, press **[Clear Display]**, wait for the number of averages to return to 256, and then record the oscilloscope's mean V avg reading in the $V_{zero\text{-}error}$ column of the Offset Accuracy Test (50 Ω) table. Use the Channel dialog box to select 1 MΩ impedance and repeat for 1 MΩ. Record the results in the 1 MΩ table.

7 Repeat step 6 for the remaining vertical scale settings for channel 1 in both Offset Accuracy Test tables of the Performance Test Record.

8 Click **Control > Factory Default**, turn off channel 1, and turn the channel 2 display on.

9 Configure the oscilloscope to measure V avg on channel 2 as follows:

   a In the Acquisition dialog box, enable averaging and set # of Averages to 256.

   b Change the vertical scale of channel 2 to 5 mV/div.

   c Drag and drop the Average voltage measurement icon onto the channel 2 waveform.

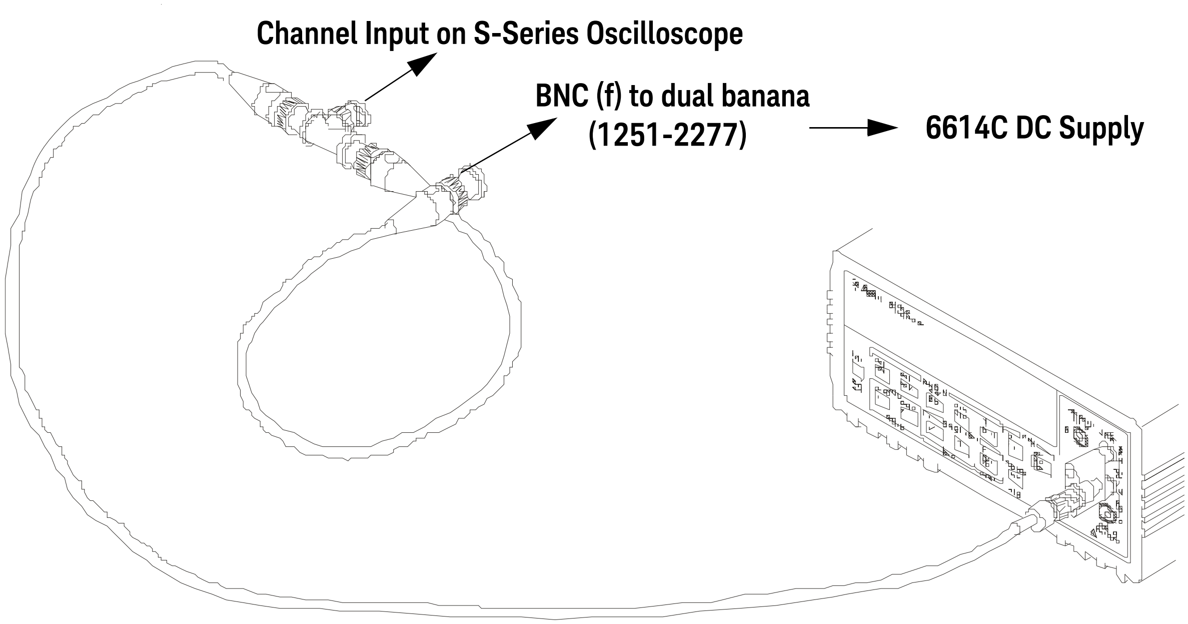
10 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the oscilloscope's mean V avg reading in the $V_{zero\text{-}error}$ column of the Offset Accuracy Test (50 Ω) table. Use the Channel dialog box to select 1 MΩ impedance and repeat for 1 MΩ. Record the results in the 1 MΩ table.

11 Repeat steps 9b and 10 for the remaining vertical scale settings for channel 2.

12 Repeat steps 8 through 11 for channels 3 and 4.

13 Ensure that each $V_{zero\text{-}error}$ is less than the corresponding $V_{zero\text{-}error}$ Limit entry in the Offset Accuracy Test table.

14 Make the connections to oscilloscope channel 1 as shown below.



NOTE

- Where the BNC Tee adapter is used, it is important to connect it directly to the oscilloscope channel input to minimize ground potential differences and to ensure that the DMM measures the input voltage to the oscilloscope channel as accurately as possible. Differences in ground potential can be a significant source of measurement error, particularly at high scope sensitivities.
- It also helps to reduce ground potential differences if the oscilloscope and DMM are connected to the same AC supply circuit.
- 256 averages are used in the oscilloscope measurements of this section to reduce measurement noise and to reduce the measurement error due to resolution.

15 Set up the DMM to perform DC voltage measurements.

16 Click **Control > Factory Default** to default to channel 1.

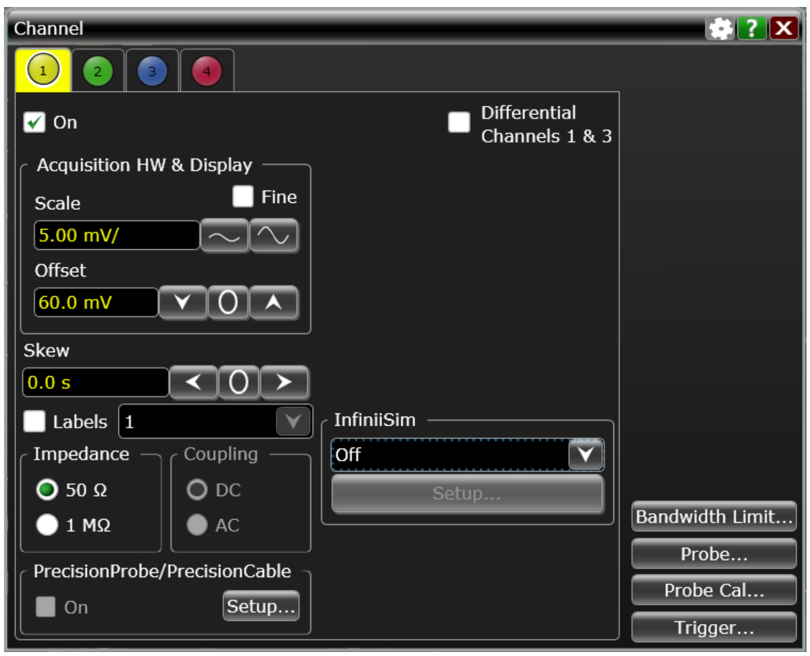
17 Configure the oscilloscope to measure the average voltage on channel 1 as follows:

   a Click **Setup > Acquisition...**. In the Acquisition dialog box, enable averaging and set # of Averages to 256.

   b Change the vertical scale of the channel under test to 5 mV/div.

   c Drag and drop the Average voltage measurement icon onto the channel 1 waveform.

18 Using the Channel dialog box, set the channel's offset value to 60.0 mV and the impedance to 50 **Ω** (or to an offset of 2 V and the impedance to 1 M**Ω** if this is your second pass through this test and you are using the 1 M**Ω** input impedance version).



19 Set the DC supply voltage (External Supply Setting) to +60.0 mV (or +2 V for the 1 M**Ω** version of this test).

20 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as V_{DMM+} and the scope V avg reading as V_{Scope+} in the Offset Accuracy Test table (either the 50 **Ω** or the 1 M**Ω** version depending on which version of the test you are on). Fill in the V_{error+} column by using the following equation:

$$V_{error+} = V_{DMM+} - V_{scope+}$$

V_{error+} must be within the limits specified by the corresponding Offset Accuracy Limit listed in the table.

21 Change the channel 1 offset value to -60.0 mV (or -2 V for the 1 M**Ω** version of this test).

22 Set the DC supply voltage to -60.0 mV (or -2 V for the 1 MΩ version of this test).

23 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as V_{DMM-} and the scope V avg reading as V_{Scope-} in the Offset Accuracy Test table (either the 50 Ω or the 1 MΩ version of the table depending on which version of the test you are using). Fill in the V_{error-} column by using the following equation:

$$V_{error-} = V_{DMM-} - V_{scope-}$$

V_{error-} must be within the limits specified by the corresponding Offset Accuracy Limit listed in the table.

24 Repeat steps 17b and 18 to 23 for the remaining channel 1 vertical scale settings in the Offset Accuracy Test section of the Performance Test Record (either the 50 Ω or the 1 MΩ version of the table depending on which version of the test you are performing). For each measurement, set both the DC supply voltage (External Supply Setting) and the Channel offset voltage to the positive External Supply Setting value and then to the negative External Supply Setting value in the External Supply Setting column of the Offset Accuracy Test table for each of the vertical scale settings.

25 Move the Tee connector to the next channel input and repeat steps 17 to 24 for channels 2 to 4.

26 Repeat steps 16 through 24 for the 1 MΩ channel input impedance setting. This means you should follow the directions exactly as stated except in step 18 you will select the 1 MΩ button instead of the 50 Ω one and all values will be entered in the Offset Accuracy Test (1 MΩ) section of the Performance Test Record rather than the Offset Accuracy Test (50 Ω) section. Also be sure to use the external supply settings and offset values from the 1 MΩ version of the Offset Accuracy Test table as they are different than the 50 Ω version.

DC Gain Accuracy Test

CAUTION Ensure that the input voltage to the oscilloscope never exceeds ±5 V.

NOTE The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

Specifications

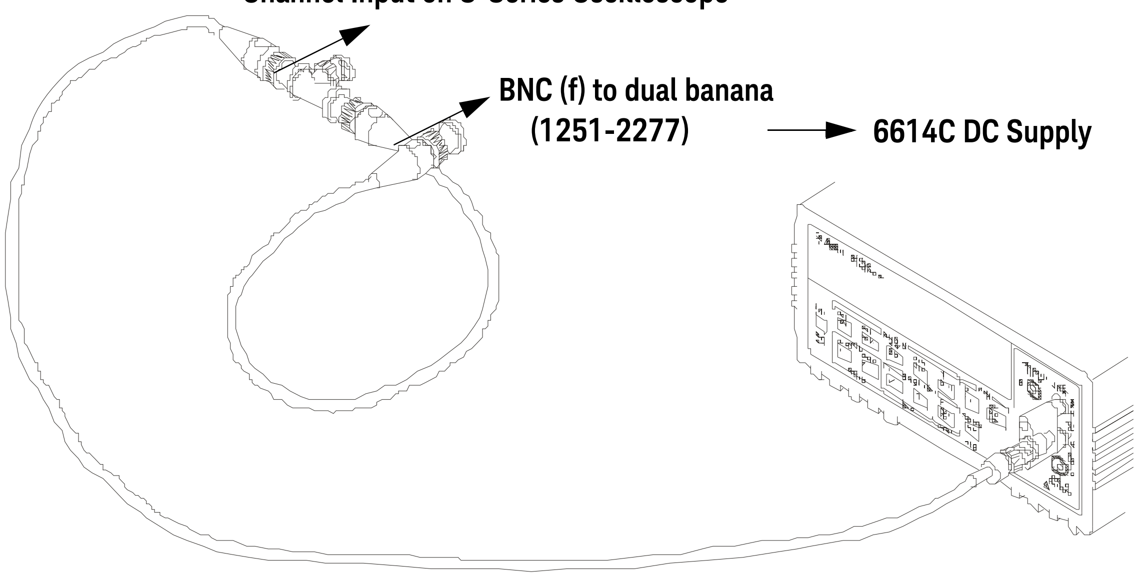
DC Gain Accuracy	±2% of full scale at full resolution channel scale (±5 °C from calibration temperature)
50 Ω Input Impedance: Full scale is defined as 8 vertical divisions. Magnification is used below 2 mV/div. Below 2 mV full scale is defined as 16 mV. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV and 1 V. **1 MΩ Input Impedance**: Full scale is defined as 8 vertical divisions. The major scale settings are 5 mV, 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, and 5 V.	

Equipment Required

Description	Critical specifications	Recommended model or part number
Digital Multimeter	DC voltage measurement accuracy better than ±0.1% of reading	34411A or 3458A
Cable Assembly (2 required)	50 Ω characteristic impedance, BNC (m) connectors	8120-1840
DC Power Supply	40 V	6614C
Adapter	BNC Tee (m)(f)(f)	1250-0781
2 Adapters	2 BNC (f) to dual banana	1251-2277

Procedure

1 Make the connections to oscilloscope channel 1 as shown below.



NOTE

- Where the BNC Tee adapter is used, it is important to connect it directly to the oscilloscope channel input to minimize ground potential differences and to ensure that the DMM measures the input voltage to the oscilloscope channel as accurately as possible. Differences in ground potential can be a significant source of measurement error, particularly at high scope sensitivities.
- It also helps to reduce ground potential differences if the oscilloscope and DMM are connected to the same AC supply circuit.
- 256 averages are used in the oscilloscope measurements of this section to reduce measurement noise and to reduce the measurement error due to resolution.

2 Click **Control > Factory Default**, then configure the oscilloscope as follows:

   a Click **Setup > Acquisition...**.

   b In the Acquisition dialog box, enable averaging and set # of Averages to 256.

3 Set the DC Supply voltage (External Supply Setting) to +15 mV.

4 Use the Channel dialog box to set the channel 1 vertical scale to 5 mV/div, and make sure the input impedance is set to 50 Ω.

5 Drag and drop the Average voltage measurement icon onto the channel 1 waveform.

6 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading as V_{DMM+} and the scope mean V avg reading as V_{Scope+} in the DC Gain Accuracy Test (50 Ω) section of the Performance Test Record.

7 Change the DC Supply voltage to -15 mV.

8 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading (V_{DMM-} column) and the scope V avg reading (Vscope- column) in the DC Gain Accuracy Test (50 Ω) section of the Performance Test Record.

9 Repeat step 8 for the remaining vertical scale settings for channel 1 shown in the DC Gain Accuracy Test (50 Ω) section of the Performance Test Record.

10 Click **Control > Factory Default**, turn off channel 1 and turn the channel 2 display on.

11 Set the DC Supply voltage (External Supply Setting) to +15 mV.

12 Configure the oscilloscope to measure the average voltage on channel 2:

  a Click **Setup > Acquisition...**. In the Acquisition dialog box, enable averaging and set # of Averages to 256.

  b Change the vertical scale of channel 2 to 5 mV/div.

  c Drag and drop the Average voltage measurement icon onto the channel 2 waveform.

13 Press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 256, and then record the DMM voltage reading (V_{DMM+}) and the scope V avg reading (V_{Scope+}) in the DC Gain Accuracy Test (50 Ω) section of the Performance Test Record.

14 Repeat step 13 for the remaining vertical scale settings for channel 2 in the DC Gain Accuracy Test (50 Ω) section of the Performance Test Record.

15 Repeat step 10 through step 14 for channels 3 and 4.

16 Repeat steps 2 through 15 using 1 MΩ for the scope input impedance rather than 50 Ω. The steps should be followed exactly except in step 4, you should select the 1 MΩ button from the Impedance section of the Channel dialog box rather than 50 Ω and all values should be entered in the DC Gain Accuracy Test (1 MΩ) section rather than the DC Gain Accuracy Test (50 Ω) section.

17 Calculate the offset gains for the 50 Ω test and the 1 MΩ test using the following expression and record this value in the DC Gain Accuracy Test section of the Performance Test Record.

$$DCGainError = \frac{\Delta V_{out}}{\Delta V_{in}} = \left(\frac{V_{scope+} - V_{scope-}}{V_{DMM+} - V_{DMM-}} - 1\right)75$$

Analog Bandwidth—Maximum Frequency Test

CAUTION Ensure that the input voltage to the oscilloscope never exceeds ±5 V.

NOTE The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature prior to the start of any performance test.

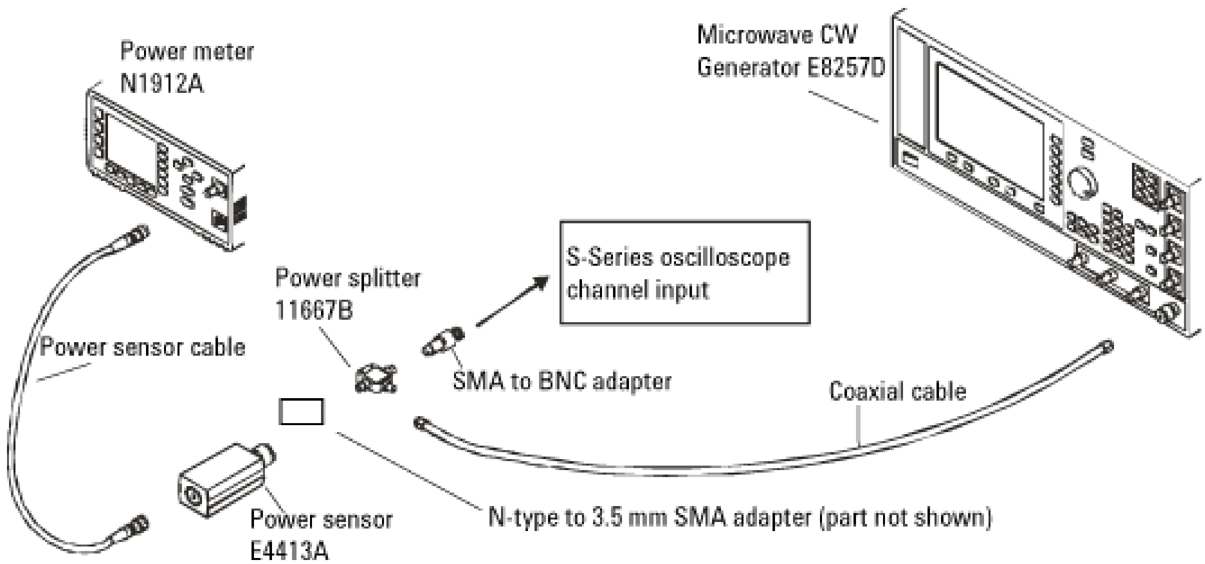
Specifications

Analog Bandwidth (-3 dB)	
DSO/MSOS804A	8 GHz
DSO/MSOS604A	6 GHz
DSO/MSOS404A	4 GHz
DSO/MSOS254A	2.5 GHz
DSO/MSOS204A	2 GHz
DSO/MSOS104A	1 GHz
DSO/MSOS054A	500 MHz

Equipment Required

Description	Critical specifications	Recommended model/ part number
Microwave CW Generator	Maximum Frequency ≥ 14 GHz Power range: -20 dBm to +16 dBm into 50 Ω Output resistance = 50 Ω	E8257D with Opt 520
Power Sensor Cable		N1912-61020
Power Splitter	2 Resistor Power Splitter (f) Max Frequency ≥18 GHz	11667B
Power Meter	Keysight P-series with power sensor compatibility	N1912A
Power Sensor	Maximum Frequency ≥ 14 GHz Power range: -24 dBm to +16 dBm	E4413A
Coaxial Cable	50 Ω Characteristic Impedance 3.5 mm (m) to 3.5 mm (m) SMA connectors Max Frequency ≥ 8 GHz	8120-4948
N-Type to SMA Adapter	N-type to 3.5 mm (m) SMA	1250-1750
SMA to BNC Adapter	SMA (m) to Precision BNC (No Substitute)	1250-1200

Connections



NOTE

- Connect output 1 of the 11667B splitter to the oscilloscope Channel n input directly using the 1250-1200 adapter, without any additional cabling or adapters.
- Connect output 2 of the 11667B power splitter to the power sensor using the 1250-1750 N-type to 3.5mm adapter, without any additional cabling or adapters.
- Minimize the use of other adapters.
- Ensure that SMA and 3.5 mm connectors are tightened properly:
  8 in-lbs (90 N-cm) for 3.5 mm
  5 in-lbs (56 N-cm) for SMA

Procedure

1 Preset the power meter.

2 Ensure that the power sensor is disconnected from any source and zero the meter.

3 Connect the power sensor to the power meter's Power Ref connector and calibrate the meter.

4 Make the connections to oscilloscope channel 1 as shown in the preceding connection diagram.

5 Set up the power meter to display measurements in units of Watts.

6 Click **Control > Factory Default**, then configure the oscilloscope as follows:

  a Ensure the channel under test is displayed and all other channels are turned off.

  b In the Channel dialog box, set the vertical scale of the channel under test to 5 mV/div and the input impedance to 50 Ohms.

  c Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).

  d Click **Setup > Acquisition...** and ensure the acquisition parameters are set up as follows:

  Sin(x)/x Interpolation = Auto

  Analog Averaging = Enabled with # of Averages set to 16 samples

  Analog Memory Depth = Automatic

  Analog Sampling rate = Maximum (select the Manual button and click the up-arrow as high as it goes)

  e Click **Measure > Add Measurement...**.

  f In the Add Measurement dialog box, click Vertical and RMS, and configure the measurement as follows:

  Source = Channel 1

  Measurement Area = Entire Display

  RMS Type = AC

7 Set the generator to apply a 50 MHz sine wave with a peak-to-peak amplitude of about four divisions.

Use the following table to determine the approximate required signal amplitude.

The amplitude values in the table are not absolutely required. If your generator is unable to produce the recommended amplitude, then set the generator to the highest value that does not produce a vertically clipped signal on the oscilloscope.

Nominal Generator Amplitude Settings

Oscilloscope Vertical Scale	Generator Signal Amplitude (Vp-p)	Generator Signal Amplitude (dBm)
5 mV/div	0.02	-30
10 mV/div	0.04	-24
20 mV/div	0.08	-18
50 mV/div	0.20	-10
100 mV/div	0.40	-4
200 mV/div	0.80	+2
500 mV/div	2.0	+10
1 V/div	4.0	+16

8 Measure the input power to the oscilloscope channel and convert this measurement to Volts RMS using the expression:

$$V_{in} = \sqrt{P_{meas} \times 50\Omega}$$

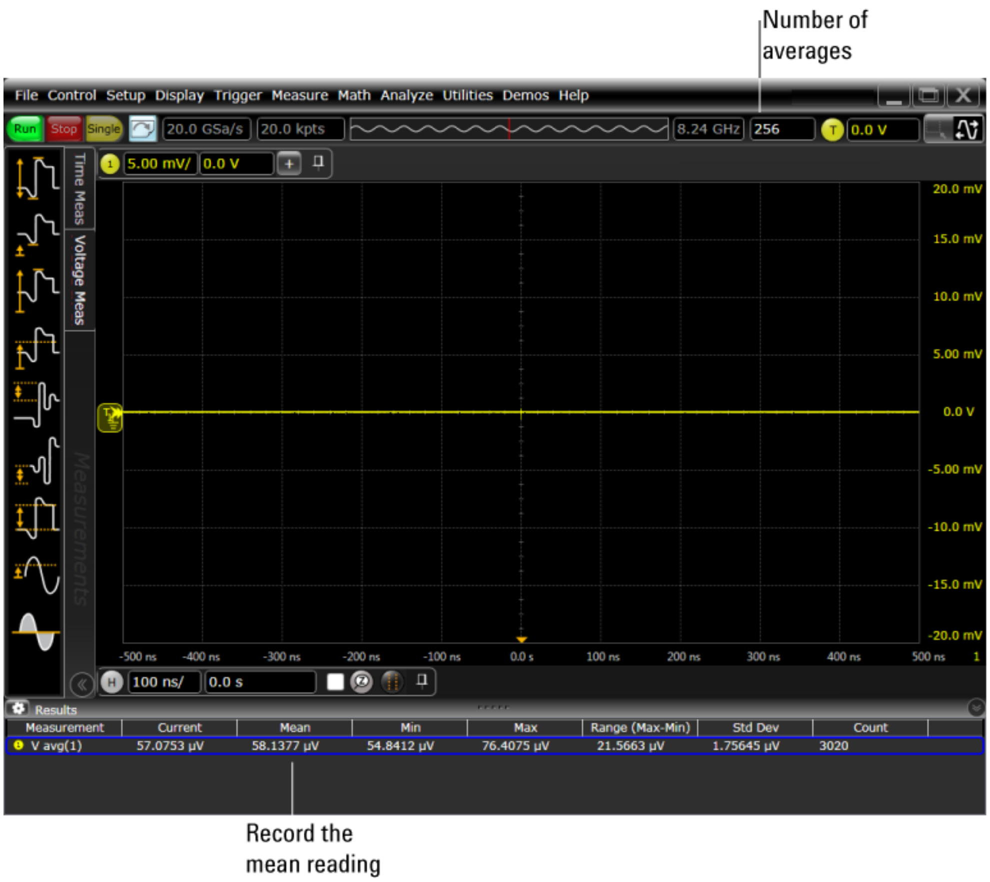
For example, if the power meter reading is 4.0 μW, then Vin = $(4.0*10^{-6} * 50\Omega)^{1/2}$ = 14.1 mVrms.

Record the RMS voltage in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record (in the Vin @ 50 MHz column).

9 Press **[Clear Display]** on the oscilloscope and record the scope V rms reading in the Analog Bandwidth—Maximum Frequency Test section of the Performance Test Record (Vout @ 50 MHz).

NOTE

- For all oscilloscope readings in this procedure, use the mean value in the Measurement Results area at the bottom of the screen.
- If a question mark appears in front of any value at the bottom of the screen, press **[Clear Display]** on the oscilloscope, wait for the number of averages to return to 16, and then record the oscilloscope reading.



10 Calculate the reference gain as follows:

$$Gain_{50\ MHz} = \frac{V_{out\ @50\ \mathrm{MHz}}}{V_{in\ @50\ \mathrm{MHz}}}$$

Record this value in the Calculated Gain @50 MHz column in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record.

11 Change the generator frequency to the maximum value for the model being tested as shown in the table below. It is not necessary to adjust the signal amplitude at this point in the procedure.

Setting	Model						
	DSOS804A MSOS804A	DSOS604A MSOS604A	DSOS404A MSOS404A	DSOS254A MSOS254A	DSOS204A MSOS204A	DSOS104A MSOS104A	DSOS054A MSOS054A
Maximum Frequency	8 GHz	6 GHz	4 GHz	2.5 GHz	2 GHz	1 GHz	500 MHz
Scope Horizontal Scale	100 ps/div	150 ps/div	200 ps/div	320 ps/div	400 ps/div	800 ps/div	1.6 ns/div

12 Change the oscilloscope horizontal scale to the value for the model under test in the preceding table.

13 Measure the input power to the oscilloscope channel at the maximum frequency and convert this measurement to Volts RMS using the expression:

$$V_{in} = \sqrt{P_{meas} \times 50\Omega}$$

For example, if the power meter reading is 4.0 μW, then Vin = $(4.0*10^{-6} * 50\Omega)^{1/2}$ = 14.1 mVrms.

Record the RMS voltage in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record (Vin @ Max Freq).

14 Press **[Clear Display]** on the oscilloscope and record the scope V rms reading in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record (Vout @ Max Freq).

15 Calculate the gain at the maximum frequency using the expression:

$$Gain_{Max\ \mathrm{Freq}} = 20\ \log_{10}\left[\frac{(V_{out\ Max\ Freq})/(V_{in\ Max\ Freq})}{Gain_{50\ MHz}}\right]$$

For example, if (Vout @ Max Frequency) = 13.825 mV, (Vin @ Max Frequency) = 13.461 mV and Gain @ 50MHz = 1.0023, then:

$$Gain_{Max\ \mathrm{Freq}} = 20\ \log_{10}\left[\frac{13.825\ mV/13.461\ mV}{1.0023}\right] = 0.212\ \mathrm{dB}$$

Record this value in the Calculated Gain @Max Freq column in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record. To pass this test, this value must be greater than -3.0 dB.

16 Change the scope setup as follows:

- **a** Change the channel vertical scale to 10 mV/div.
- **b** Reset the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).

17 Change the generator output as follows:

- **a** Reset the generator frequency to 50 MHz.
- **b** Change the amplitude to the value suggested for this scale setting in the Nominal Generator Amplitude Settings table.

18 Repeat steps 8, 9, and 10 to measure the reference gain at 50 MHz for this scale.

19 Repeat steps 11 through 15 to measure the gain at maximum frequency for this scale setting.

20 Repeat steps 15 through 19 to complete measuring gains for remaining scale settings for channel 1 in the Analog Bandwidth—Maximum Frequency Check section of the Performance Test Record.

21 Move the splitter to channel 2 and change the oscilloscope configuration as follows:

  a Click **Control > Factory Default**.

  b Ensure channel 2 is displayed and all other channels are turned off.

  c Set the vertical scale of channel 2 to 5 mV/div.

  d Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).

  e Click **Trigger> Setup Trigger...** and change the source to channel 2.

  f Click **Measure > Add Measurement...**. Select the Vertical RMS voltage measurement, Channel 2 as the source, Entire Display as the Measurement Area, and AC for the RMS Type.

22 Repeat steps 6d and 7 to 20 to complete measuring gains for channel 2.

23 Move the splitter to channel 3 and change the scope configuration as follows:

  a Click **Control > Factory Default**.

  b Ensure channel 3 is displayed and all other channels are turned off.

  c Set the vertical scale of channel 3 to 5 mV/div.

  d Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).

  e Click **Trigger> Setup Trigger...** and change the source to channel 3.

  f Click **Measure > Add Measurement...**. Select the RMS voltage measurement, Channel 3 as the source, Entire Display as the Measurement Area, and AC for the RMS Type.

24 Repeat steps 7 to 20 to complete measuring gains for channel 3.

25 Move the splitter to channel 4 and change the scope configuration as follows.

  a Click **Control > Factory Default**.

  b Ensure channel 4 is displayed and all other channels are turned off.

  c Set the vertical scale of channel 4 to 5 mV/div.

  d Set the horizontal scale to 16 ns/div (to display 8 cycles of a 50 MHz waveform).

  e Click **Trigger> Setup Trigger...** and change the source to channel 4.

  f Click **Measure > Add Measurement...**. Select the RMS voltage measurement, Channel 4 as the source, Entire Display as the Measurement Area, and AC for the RMS Type.

26 Repeat steps 7 to 20 to complete measuring gains for channel 4.

Time Scale Accuracy (TSA) Test

This procedure verifies the maximum TSA specification for the oscilloscope.

Description

TSA refers to the absolute accuracy of an oscilloscope's time scale. Because TSA depends directly on frequency of a crystal oscillator, it is comprised of two components: an initial setting accuracy component and an aging component.

The initial setting accuracy component applies to the oscilloscope's 10 MHz OCXO frequency accuracy immediately after a calibration, whether performed at the factory, by a customer, or by a Keysight service center. The aging component scales linearly from the time since the last time scale calibration and adds to the initial setting accuracy component.

Specifications

TSA is published as a warranted specification, expressed by the following formula. The aging component is specified by the 10 MHz OCXO manufacturer while the initial setting accuracy component is derived from absolute frequency measurements of the 10 MHz OCXO in a large sample of production units after a time scale calibration prior to shipment. **These measurements require the 10 MHz OCXO to be powered on for a minimum of 2 hours.** Longer is better to further reduce the uncertainty and allow the OCXO frequency to settle onto the aging trajectory of the crystal inside the oscillator.

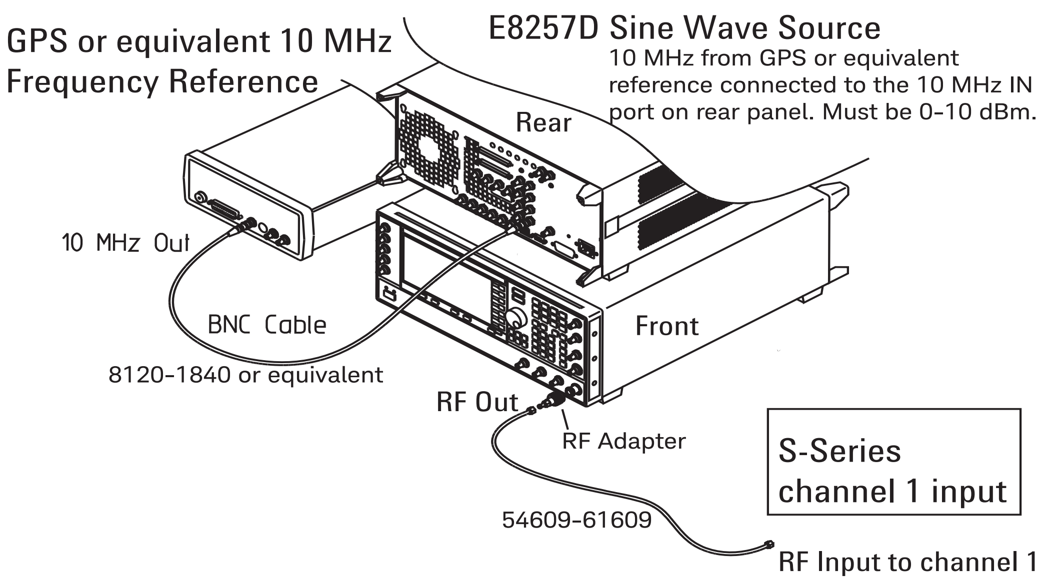
TSA = ±(12 ppb initial + 75 ppb/year aging)

To see the number of years since the last time scale calibration, open the oscilloscope application and click **Utilities > Calibration...**. The TimeScale entry in the Calibration dialog box shows the date of the last time scale calibration.

Equipment Required

Description	Critical specifications	Recommended model/ part number
Synthesized sine wave source	Output Frequency: ≥ 10 MHz Output Amplitude: 0 dBm Frequency Resolution: 0.1 Hz	E8257D PSG w/opt. 520
10 MHz frequency reference	Output Frequency: 10 MHz Output Amplitude: 0 dBm to 10 dBm Absolute Freq. accuracy: < ±1 ppb	GPS or equivalent 10 MHz reference
High-frequency cable (provided)	50 ohm characteristic impedance	54609-61609
RF cable	50 ohm characteristic impedance BNC (m) connectors	8120-1840
RF adapter	APC 3.5 (f) to BNC (f) or equivalent For example: APC 3.5 (f) to (f) plus SMA (m) to BNC (f)	

Connections



Procedure

1 Make sure the 10 MHz OCXO has been powered on for at least 2 hours, preferably longer if possible.

2 Configure the E8257D sine wave source to output a 0 dBm (633 mVpp) sine wave into 50 ohms with a frequency of 10.00002000 MHz. **Note: Make sure the E8257D is locked to the GPS or equivalent reference.** The EXT REF indicator on the E8257D will be on when locked.

3 Click **Control > Factory Default** on the oscilloscope.

4 Set the vertical scale of channel 1 to 100 mV/div.

5 Set the oscilloscope sampling rate to 100 kSa/s (**Setup > Acquisition...**). (The resulting measurement will be aliased.)

6 Set the horizontal scale of the oscilloscope to 20 ms/div.

7 Set the measurement thresholds for all waveforms to a fixed voltage level of 0 V and ±20 mV hysteresis:

   a Click **Measure > Thresholds...**.

   b Select Custom: level +/- hysteresis from the Thresholds drop-down list box.

   c Enter 20 mV in the Hysteresis field and 0 V in the Threshold Level field.

8 Enable a frequency measurement on channel 1.

9 On the oscilloscope, press **[Stop]**.

10 Press **[Clear Display]**.

11 Press **[Run]**, wait until 10 acquisitions have accumulated, and then press **[Stop]**.

12 Convert the average frequency value to time scale error by subtracting 20 Hz and dividing by 0.01 Hz/ppb. Record the result in the Measured Time Scale Error (ppb) column of the Time Scale Accuracy table.

13 Record the time since the previous calibration (in years) in the table. Click **Utilities > Calibration...** to find the most recent Time Scale calibration.

14 Calculate the specification for Time Scale Accuracy based on the oscilloscope's last time scale calibration using the following formula:

   TSA = ±(12 ppb + 75 ppb(years since last time scale calibration)

15 Compare the measured time scale error to the TSA specification.

16 Record the results in the Performance Test Record.

Performance Test Record

Keysight Technologies	**Keysight Infiniium S-Series Oscilloscopes**
Model Number ______________________	Tested by___________________
Serial Number _______________________	Work Order No.________________
Recommended Test Interval—1 Year/2000 hours	Date______________________
Recommended next test date ______________	Ambient temperature ___________

Input Impedance Test

Input Resistance	Vertical Scale	Channel 1	Channel 2	Channel 3	Channel 4	Limits
50 Ω	5 mV/div					48.25 Ω to 51.75 Ω
50 Ω	10 mV/div					48.25 Ω to 51.75 Ω
50 Ω	20 mV/div					48.25 Ω to 51.75 Ω
50 Ω	50 mV/div					48.25 Ω to 51.75 Ω
50 Ω	100 mV/div					48.25 Ω to 51.75 Ω
50 Ω	200 mV/div					48.25 Ω to 51.75 Ω
50 Ω	500 mV/div					48.25 Ω to 51.75 Ω
50 Ω	1 V/div					48.25 Ω to 51.75 Ω
1 MΩ	5 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	10 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	20 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	50 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	100 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	200 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	500 mV/div					990 kΩ to 1.010 MΩ
1 MΩ	1 V/div					990 kΩ to 1.010 MΩ
1 MΩ	2 V/div					990 kΩ to 1.010 MΩ
1 MΩ	5 V/div					990 kΩ to 1.010 MΩ

Offset Accuracy Test (50 Ω)

Vertical Scale	External Supply Setting	V_{DMM+}	V_{scope+}	V_{error+}	V_{DMM-}	V_{Scope-}	V_{error-}	Offset Accuracy Limit (±)	$V_{zero-error}$	$V_{zero-error}$ Limit (±)
Channel 1										
5 mV/div	±60 mV							3.1 mV		2.5 mV
10 mV/div	±120 mV							4.2 mV		3.0 mV
20 mV/div	±240 mV							6.4 mV		4.0 mV
50 mV/div	±600 mV							13.0 mV		7.0 mV
100 mV/div	±1.2 V							24.0 mV		12.0 mV
200 mV/div	±2.4 V							58.0 mV		22.0 mV
500 mV/div	±4.0 V							112.0 mV		52.0 mV
1 V/div	±4.0 V							162.0 mV		102.0 mV
Channel 2										
5 mV/div	±60 mV							3.1 mV		2.5 mV
10 mV/div	±120 mV							4.2 mV		3.0 mV
20 mV/div	±240 mV							6.4 mV		4.0 mV
50 mV/div	±600 mV							13.0 mV		7.0 mV
100 mV/div	±1.2 V							24.0 mV		12.0 mV
200 mV/div	±2.4 V							58.0 mV		22.0 mV
500 mV/div	±4.0 V							112.0 mV		52.0 mV
1 V/div	±4.0 V							162.0 mV		102.0 mV
Channel 3										
5 mV/div	±60 mV							3.1 mV		2.5 mV
10 mV/div	±120 mV							4.2 mV		3.0 mV
20 mV/div	±240 mV							6.4 mV		4.0 mV
50 mV/div	±600 mV							13.0 mV		7.0 mV
100 mV/div	±1.2 V							24.0 mV		12.0 mV
200 mV/div	±2.4 V							58.0 mV		22.0 mV
500 mV/div	±4.0 V							112.0 mV		52.0 mV
1 V/div	±4.0 V							162.0 mV		102.0 mV
Channel 4										
5 mV/div	±60 mV							3.1 mV		2.5 mV
10 mV/div	±120 mV							4.2 mV		3.0 mV
20 mV/div	±240 mV							6.4 mV		4.0 mV
50 mV/div	±600 mV							13.0 mV		7.0 mV
100 mV/div	±1.2 V							24.0 mV		12.0 mV
200 mV/div	±2.4 V							58.0 mV		22.0 mV
500 mV/div	±4.0 V							112.0 mV		52.0 mV
1 V/div	±4.0 V							162.0 mV		102.0 mV

Offset Accuracy Test (1 MΩ)

Vertical Scale	External Supply Setting	V_{DMM+}	V_{scope+}	V_{error+}	V_{DMM-}	V_{Scope-}	V_{error-}	Offset Accuracy Limit (±)	$V_{zero-error}$	$V_{zero-error}$ Limit (±)
Channel 1										
5 mV/div	±2 V							32.5 mV		2.5 mV
10 mV/div	±5 V							78.0 mV		3.0 mV
20 mV/div	±10 V							154.0 mV		4.0 mV
50 mV/div	±10 V							157.0 mV		7.0 mV
100 mV/div	±20 V							312.0 mV		12.0 mV
200 mV/div	±20 V							322.0 mV		22.0 mV
500 mV/div	±20 V							352.0 mV		52.0 mV
1 V/div	±40 V							702.0 mV		102.0 mV
2 V/div	±40 V							802.0 mV		202 mV
5 V/div	±40 V							1.102 V		502 mV
Channel 2										
5 mV/div	±2 V							32.5 mV		2.5 mV
10 mV/div	±5 V							78.0 mV		3.0 mV
20 mV/div	±10 V							154.0 mV		4.0 mV
50 mV/div	±10 V							157.0 mV		7.0 mV
100 mV/div	±20 V							312.0 mV		12.0 mV
200 mV/div	±20 V							322.0 mV		22.0 mV
500 mV/div	±20 V							352.0 mV		52.0 mV
1 V/div	±40 V							702.0 mV		102.0 mV
2 V/div	±40 V							802.0 mV		202 mV
5 V/div	±40 V							1.102 V		502 mV
Channel 3										
5 mV/div	±2 V							32.5 mV		2.5 mV
10 mV/div	±5 V							78.0 mV		3.0 mV
20 mV/div	±10 V							154.0 mV		4.0 mV
50 mV/div	±10 V							157.0 mV		7.0 mV
100 mV/div	±20 V							312.0 mV		12.0 mV
200 mV/div	±20 V							322.0 mV		22.0 mV
500 mV/div	±20 V							352.0 mV		52.0 mV
1 V/div	±40 V							702.0 mV		102.0 mV
2 V/div	±40 V							802.0 mV		202 mV
5 V/div	±40 V							1.102 V		502 mV
Channel 4										
5 mV/div	±2 V							32.5 mV		2.5 mV
10 mV/div	±5 V							78.0 mV		3.0 mV
20 mV/div	±10 V							154.0 mV		4.0 mV
50 mV/div	±10 V							157.0 mV		7.0 mV
100 mV/div	±20 V							312.0 mV		12.0 mV
200 mV/div	±20 V							322.0 mV		22.0 mV
500 mV/div	±20 V							352.0 mV		52.0 mV
1 V/div	±40 V							702.0 mV		102.0 mV
2 V/div	±40 V							802.0 mV		202 mV
5 V/div	±40 V							1.102 V		502 mV

DC Gain Accuracy Test (50 Ω)

Vertical Scale	Ext. Supply Setting	V_{DMM+}	V_{Scope+}	V_{DMM-}	V_{Scope-}	Calculated DC Gain Error	DC Gain Error Test Limits
Channel 1							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
Channel 2							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
Channel 3							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
Channel 4							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %

DC Gain Accuracy Test (1 MΩ)

Vertical Scale	Ext. Supply Setting	V_{DMM+}	V_{Scope+}	V_{DMM-}	V_{Scope-}	Calculated DC Gain Error	DC Gain Error Test Limits
Channel 1							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 2							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 3							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %
Channel 4							
5 mV/div	±15 mV						±2 %
10 mV/div	±30 mV						±2 %
20 mV/div	±60 mV						±2 %
50 mV/div	±150 mV						±2 %
100 mV/div	±300 mV						±2 %
200 mV/div	±600 mV						±2 %
500 mV/div	±1.5 V						±2 %
1 V/div	±3.0 V						±2 %
2 V/div	±6.0 V						±2 %
5 V/div	±15.0 V						±2 %

Analog Bandwidth—Maximum Frequency Test

Vertical Scale	Measurement					
	Vin @ 50 MHz	Vout @ 50 MHz	Calculated Gain @ 50 MHz	Vin @ Max Freq	Vout @ Max Freq	Calculated Gain @ Max Freq Test Limit is > -3dB
Channel 1						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 2						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 3						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						
Channel 4						
5 mV/div						
10 mV/div						
20 mV/div						
50 mV/div						
100 mV/div						
200 mV/div						
500 mV/div						
1 V/div						

Time Scale Accuracy

Measured Time Scale Error (ppb)	Years Since Calibration	Calculated TSA Spec	Pass/Fail

4 Troubleshooting

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KEYSIGHT TECHNOLOGIES

Troubleshooting Overview

The service strategy for troubleshooting Infiniium S-Series oscilloscopes is to isolate problems to a faulty assembly, then use the disassembly and assembly procedures in Chapter 5, “Replacing Assemblies”, to replace the defective assembly.

Read the Safety Notices in the last chapter before servicing the oscilloscope. Before performing any procedure, review it for any cautions and warnings.

The only equipment you need for troubleshooting to the assembly level is basic electronic troubleshooting tools such as a digital multimeter. If you need to remove and replace any assemblies, refer to Chapter 5, “Replacing Assemblies”.

A default setup is provided to return the oscilloscope to a known state. You can use the default setup to undo previous setups so they do not interfere with the current measurement. Use the default setup when a procedure requires it by pressing **[Default Setup]** on the front panel.

WARNING **INJURY CAN RESULT! Use caution when the oscilloscope fan blades are exposed as they can cause injury.**

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. Failure to follow proper ESD procedures may cause immediate failure or latent damage. Latent damage may result in equipment failure after a period of time. As a minimum, place the oscilloscope on a properly grounded ESD mat and wear a properly grounded ESD strap.

WARNING **SHOCK HAZARD! Maintenance should be performed by trained service personnel. Lack of training and awareness could result in electrical shock or other injury. When maintenance can be performed without power applied, the power cord should be removed from the oscilloscope.**

Verifying Basic Operation

Follow the procedures in this section to verify the basic operation of the oscilloscope. Where problems occur, you are directed to the section that provides detailed troubleshooting help.

Power Up the oscilloscope

1 Connect the power cord to the oscilloscope, then to a suitable AC voltage source. Route the power cord so the oscilloscope's feet do not pinch the cord.

   The power cord is the disconnecting device for Mains. Position the equipment so the power cord is easily reached by the operator.

   Use *only* the power cord that came with the oscilloscope.

   The power cord provided is matched to the country of origin.

2 Press the power button in the lower left corner of the front panel. If the oscilloscope is working properly, it will take several minutes to start up, and the grid will appear on the screen. The exact appearance may look slightly different than shown below, depending on the setup selected before the oscilloscope was turned off.

If the oscilloscope turns off without you pressing the front panel power button, unplug the AC power cord from the rear of the instrument and wait 20 to 30 seconds. Then plug the AC power cord back into the oscilloscope and press the front panel power button. (Or, you can perform a hard shutdown by holding the power button down for 5-6 seconds so the power turns off, and then pressing the power button again to restart the oscilloscope.)

If it turns off again, look through the rear fan slots to see the upper right corner of the acquisition board (as viewed from the rear of the oscilloscope). A series of LEDs is located in this corner of the acquisition board. Refer to the Power Supply Troubleshooting section (page 58) of this chapter for more information on decoding these LEDs.

Check the display

If the screen is black or has a scrambled display, go to the “Display Troubleshooting” section of this chapter.

Run the oscilloscope self tests

Running the oscilloscope self tests performs a series of internal procedures to verify that the oscilloscope is working properly.

1 Click **Utilities > Self Test...**.
2 Select **Scope SelfTest** from the Available Self Tests drop-down list box.
3 Click **Start** and follow the instructions on the screen.

If any of the self tests fail, replace the acquisition board.

Run the keyboard, LED, and touch screen self tests.

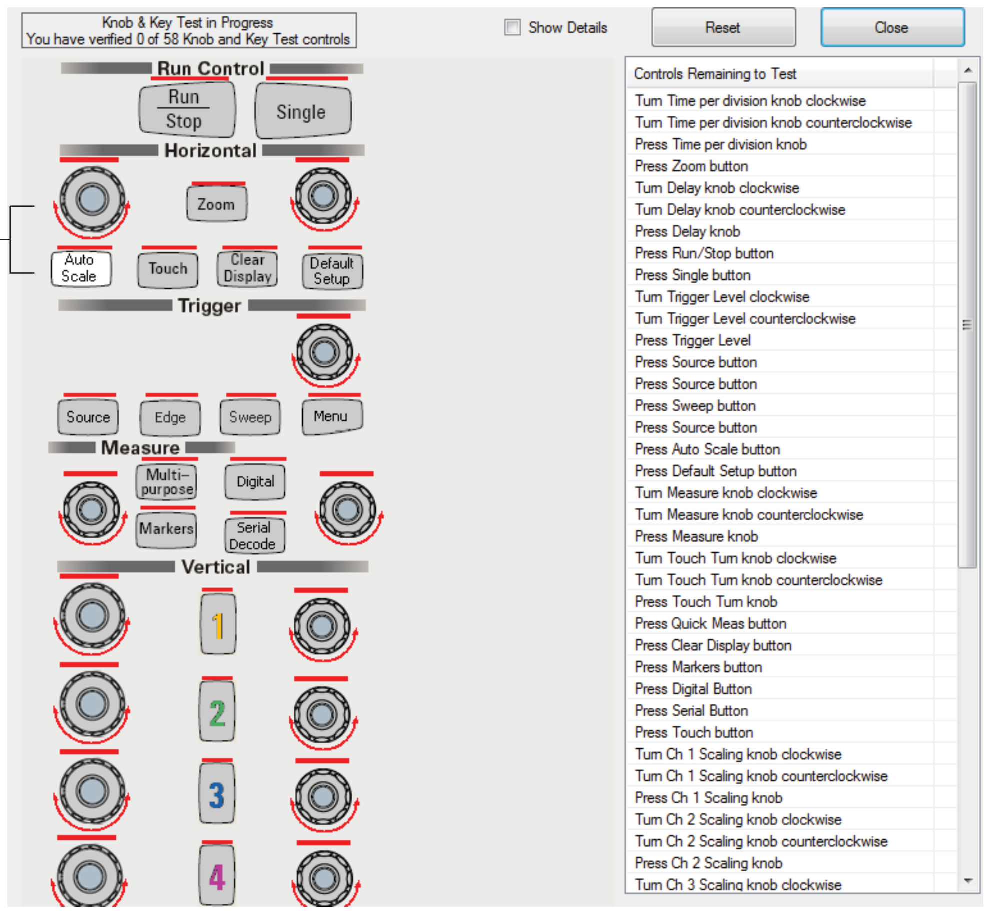
To verify correct keyboard operation:

1 Click **Utilities > Self Test...**.

2 Select **Keyboard Test** from the drop-down list box, then click **Start**.

The Front Panel Keyboard Test window appears, showing a symbolic representation of the keyboard.

When you push a key or turn a knob, the corresponding symbol turns green.



3 Press each key on the keyboard until you have pressed all keys. When you press a key or push a knob, the bar above the corresponding key/knob symbol on the display should change from red to green.

4 Turn each knob in both directions until you have turned all knobs. When you turn a knob in one direction, half the rotation arrow under the corresponding knob symbol should turn green. When you then turn the knob in the other direction, the entire rotation arrow under the knob symbol should turn green.

5 When you are finished, click **Close**.

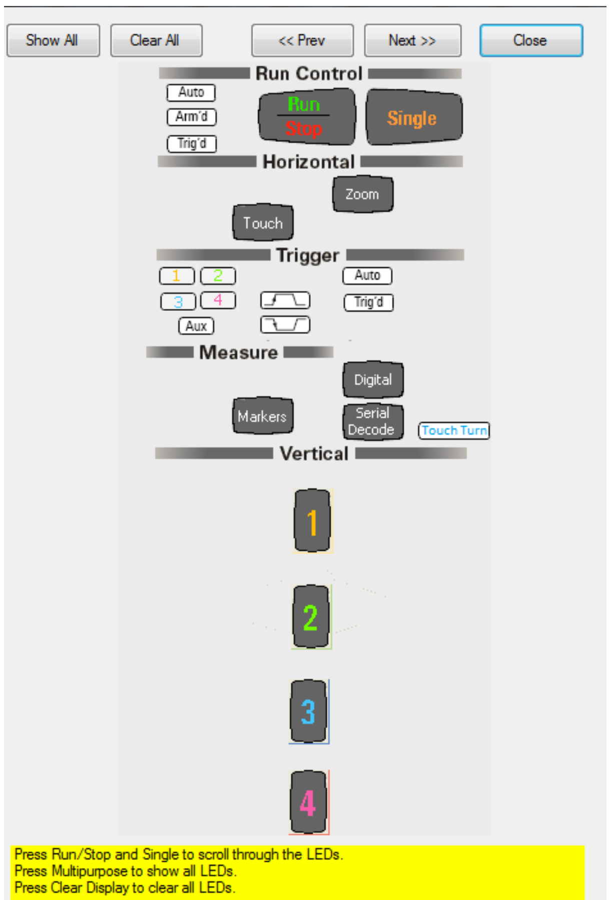
6 If any of the knobs or keys do not work, go to “Keyboard Troubleshooting” later in this chapter.

To test the front panel LED indicators:

1 Click **Utilities > Self Test...**.

2 Select **LED Test** from the drop-down list box, then click **Start**.

The Front Panel LED Test window appears, showing a symbolic representation of all front panel LED indicators.



3 Repeatedly press the **[Single]** button on the front panel to step through and highlight each LED symbol in the test screen. You can also step through the LEDs by pressing the **<<Prev** or **Next>>** buttons on the display screen. Verify that the corresponding LEDs on the front panel are the only ones illuminated. Pressing the **[Multi Purpose]** button on the front panel illuminates all the LEDs, and pressing **[Clear Display]** turns off all the LEDs.

4 When you are finished, click **Close**.

If any of the LEDS do not work, go to “LED Troubleshooting” later in this chapter.

To verify correct touch screen operation:

1. Click **Utilities > Self Test...**.
2. Select Touch Screen Test from the Available Self Tests drop-down list box, then click **Start** and follow the on-screen instructions.

If the touch screen is not working properly, go to “Touch Screen Troubleshooting” in this chapter.

Run a user calibration

1. Complete a user calibration by following the procedures in Chapter 2.
2. If the calibration test fails, replace the acquisition board.

Verify system performance

After you have verified the basic operation of the oscilloscope, you need to verify that it meets all warranted specifications by following the procedures in the “Testing Performance” chapter.

Power Supply Troubleshooting

This section provides information to help you isolate the problem to the assembly level when the power system is not operating properly.

By looking at the pattern of LEDs on the acquisition board, you can determine the cause of the fault.

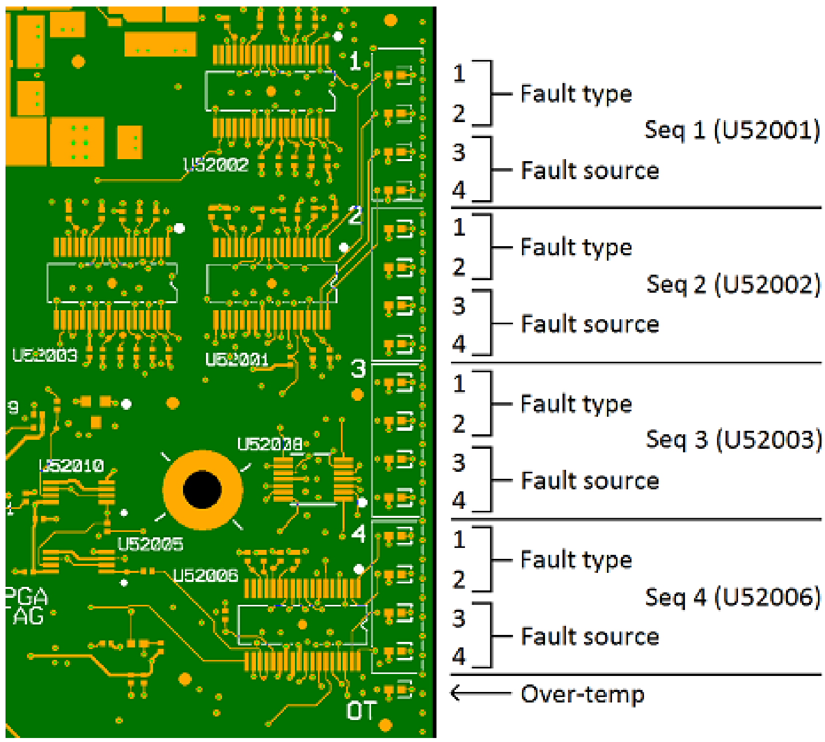
WARNING

SHOCK HAZARD! The maintenance described in this section 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. Read the safety notices at the back of this guide before proceeding. Failure to observe safety precautions may result in electric shock.

To locate the LEDs, look through the rear fan slots in the upper right corner as viewed from the rear of the oscilloscope. After a power fault, the oscilloscope will restart. The LED pattern will illuminate briefly.

Using the Power Fault LEDs

A series of 16 LEDs is separated into four sections of four LEDs each, with the over-temperature LED by itself at the bottom as shown in the following figure.



By looking at the pattern of LEDs that illuminate briefly after a power failure, you can determine the cause of the fault.

The LEDs are interpreted in groups of four. The upper two LEDs in each group indicate the type of failure and the lower two LEDs indicate the source of the failure.

In most cases, LEDs from only one of the four sequencers will be lit and the others should all be off. If a shutdown occurs, use the following tables to decode the LEDs. If a supply is causing a fault, check its inputs (incoming voltage, enable line, clock) and the load (in case it is drawing too much).

Fault Type	LED1	LED2
Sequence	ON	ON
Reset	ON	OFF
Command	OFF	ON
External	OFF	OFF

Fault Source	LED3	LED4
1	ON	ON
2	ON	OFF
3	OFF	ON
4	OFF	OFF

The fault source refers to the input channel of the corresponding sequencer. Below is a listing of the inputs for each sequencer.

Sequencer 1

Input	Supply
1	+12 V Bulk
2	+5 V
3	+3.3 V
4	+5 V

Sequencer 2

Input	Supply
1	+3.3 V Bulk
2	+2.5 V
3	+1.8 V
4	+1.8 V

Sequencer 3

Input	Supply
1	+1.2 V
2	+1.3 V
3	+1.1 V
4	+0.9 V

Sequencer 4

Input	Supply
1	+5.5 V
2	-12 V Bulk
3	-5.3 V
4	-1.1 V

Types of Faults

The fact that a fault on one sequencer causes LEDs corresponding to other sequencers to illuminate will help you determine which LED is the root of the problem.

When a fault occurs on a given sequencer, it notifies the other three using the Fault signal. The other three sequencers also report it as an External Fault. For example, if the first sequencer has an over-voltage on channel 1, it will report an External Fault with channel 1 as the source. The other three sequencers will report it as an External Fault with the source as Channel 4.

Similarly, if the first sequencer has an under-voltage failure on +12V, it will report a Reset Fault on channel 1 and the other three sequencers will report External Faults on channel 4. Any fault on one of the sequencers always reports an External Fault on channel 4 on the other three sequencers. Look for the fault that is not an External Fault on channel 4 as the cause of the shutdown.

If all four sequencers report an External Fault on channel 4, it is more difficult to determine the real source. It could be on any of the Channel 4 sources, an over-temperature fault (look for the over-temperature LED to light), or an FPGA-issued fault.

Sequence Fault: Occurs when a supply does not come up in time during a power-on sequence.

Reset Fault: Occurs if the oscilloscope shuts down during the monitor phase because a supply went under voltage. This fault is probably due to the supply failing to an off state or the load becoming too much for the supply.

Command Fault: Occurs when the ON sequence to one of the sequencers goes HIGH to initiate a turn-on, but then goes LOW before the turn-on sequencing finishes. Similarly, if the ON signal goes HIGH during sequencing off, a Command Fault occurs. This kind of fault indicates something is going wrong with the ON signal. This problem will most likely happen on the first sequencer. The ON signal is driven by the minimum on-time limiter. There could be a problem here as well.

External Fault: An External Fault can be caused by several failures. If a supply goes over-voltage, an external fault is issued. If the over-temperature sensor or FPGA issues a fault, it will be displayed as an external fault on channel 4. This presents an ambiguous case as an External Fault on channel 4 could occur for multiple reasons. To help determine the cause, the over-temperature LED will light during an over-temperature fault. However, this LED does not latch to failure. Once the oscilloscope cools to below the over-temperature condition, the LED will turn off. The main cause of an over-temperature fault is a stopped fan or blocked air inlet. Check for these causes and power the oscilloscope back up. If it continues to shut down, it could be a bad over-temperature sensor or comparator circuit.

Sequencer Group Faults

Sequencer 1 Group Faults If the fault occurs in the first group of LEDs (Sequencer 1) then the problem is with the 12 V bulk power supply, the power cables, or the acquisition board. You should check the power cables first, then the bulk power supply, and finally the acquisition board. Reinstall any power supplies, cables, or acquisition boards that turned out not to be the problem.

Sequencer 2, 3, or 4 Groups Faults If the fault occurs in any of the other groupings, the problem is most likely the acquisition board. If replacing the acquisition board does not fix the fault, the power cables may be causing the problem.

Over Temp LED Fault If the Over Temp LED is lit, first make sure the air flow is not blocked. The oscilloscope must be placed directly on a hard, flat surface with nothing under it (such as a piece of paper) that could block the vents. There also must be proper clearance behind the oscilloscope.

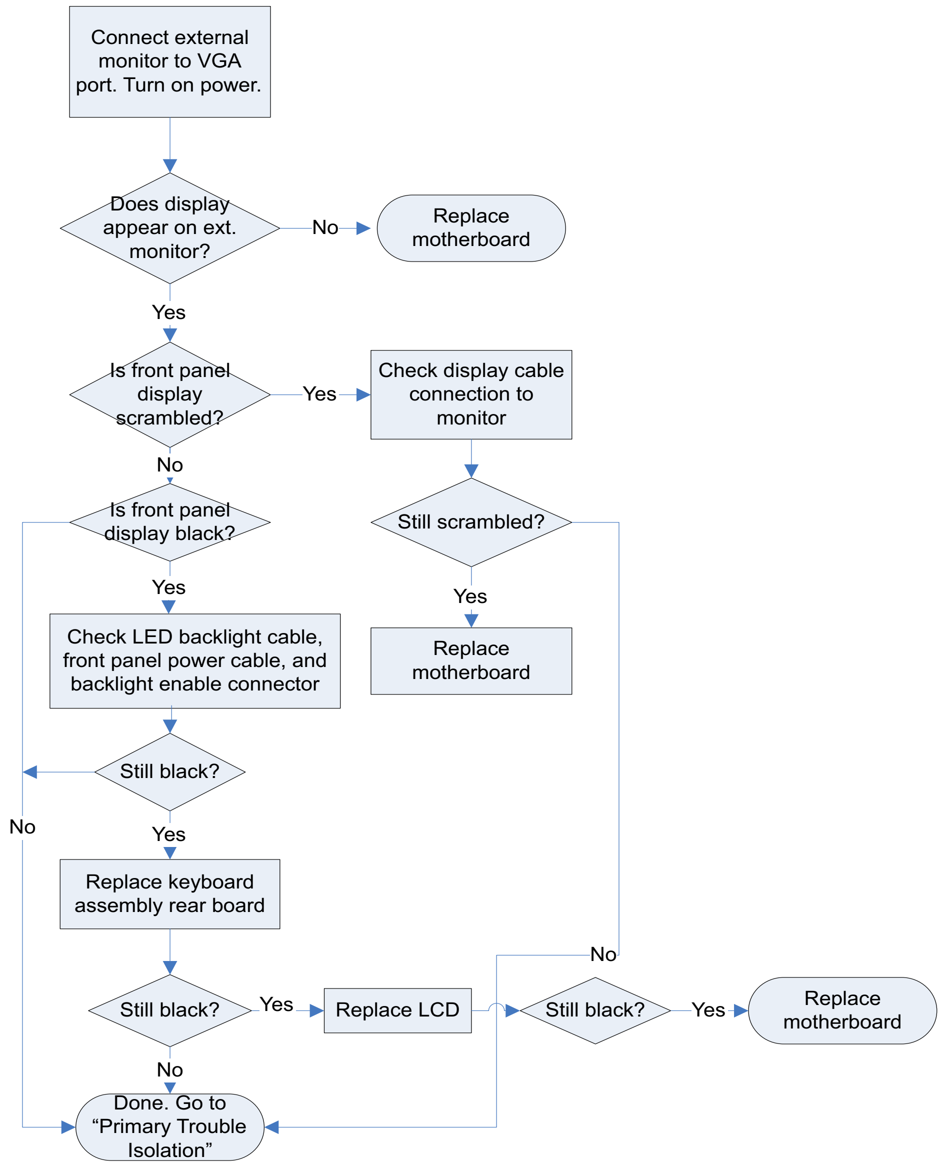
If the clearance is adequate, then investigate the fans. If one or more are not turning, the problem is with one or more of the fans or fan cables.

If the oscilloscope still will not power on after you have followed the required steps, refer to the "Motherboard Verification" section in this chapter for more diagnosis suggestions.

Motherboard Verification

If you have been through the “Power Supply Troubleshooting” section of this chapter and the oscilloscope still does not stay powered up, the problem may be with the motherboard.

Display Troubleshooting



NOTE

When you connect an external monitor the first time, it may display the start-up BIOS information and then go blank when Windows starts up. If so, use the Windows settings to enable the external monitor.

Setting up the BIOS

If the BIOS settings become corrupt, the Infiniium oscilloscope PC motherboard will not recognize the hard drive and the oscilloscope may not start. To configure the motherboard BIOS parameters to the default settings, follow these steps:

1. Connect the power cable to the oscilloscope.
2. Connect the external keyboard to the rear panel.
3. Press **[Del]** as soon as the following prompt appears on the bottom of the screen:

Press DEL to enter SETUP, F12 to select boot device.

4. Go to **F3 Optimized Defaults** and press **[Enter]**. Select **Yes** to load the defaults, then press **[Enter]**.
5. Go to the **Save and Exit Setup** option and press **[Enter]** to save and exit the setup. Select **Yes** to save and exit, then press **[Enter]**.

Keyboard Troubleshooting

If some of the knobs fail the keyboard self test but some work properly, replace the rear board of the keyboard assembly.

If none of the knobs work properly, replace the front board of the keyboard assembly.

If any of the keys do not work properly but the LEDs light up, replace the front board of the keyboard assembly.

If the keys still do not work properly, check the incoming cables.

LED Troubleshooting

If any of the front panel LEDs are not working, check these cables:

- The power cable to the front panel
- The USB cable to the front panel
- The backlight connector to the motherboard

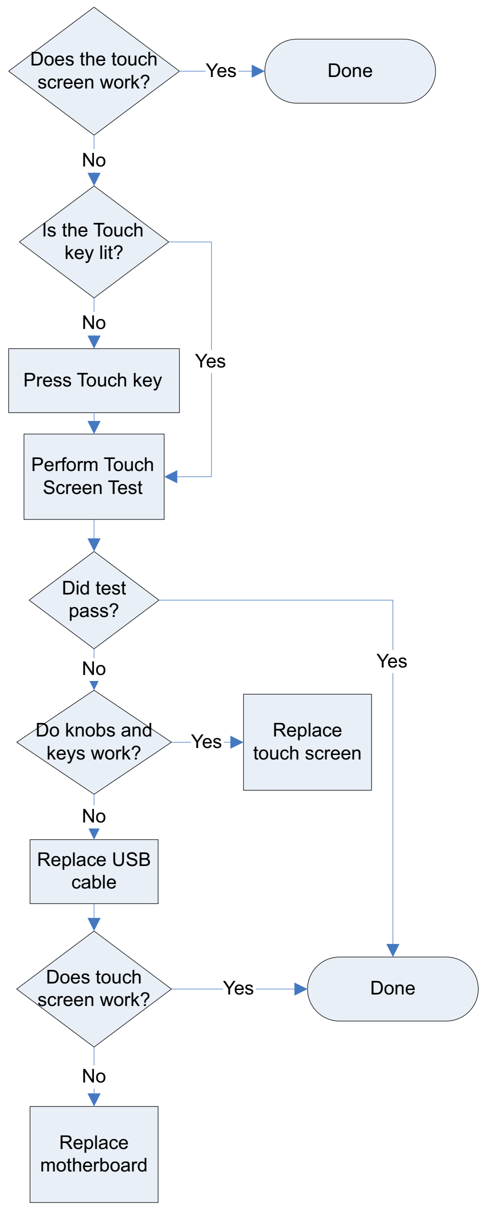
If the cables are connected and working properly, but the LEDs are still not working, then troubleshoot the acquisition assembly to make sure it is working. If it is, replace the front board of the keyboard assembly. If the LEDs still do not illuminate, reload the oscilloscope software.

Replace the front board of the keyboard assembly in these cases:

- Only some of the LEDs illuminate
- No LEDs and no knobs work
- The knobs work but the LEDs don’t illuminate

When reassembling the oscilloscope, be sure to reinstall all boards that were replaced, but that were not causing the problem.

Touch Screen Troubleshooting



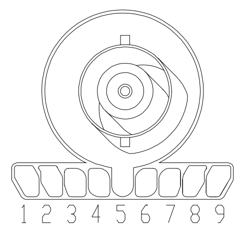
Checking probe power outputs

Probe power outputs are on the front panel, surrounding each BNC input.

Refer to the following figure to check the power output at the connectors. Measure the +5 V, -5 V, +12 V, and -12 V voltages with respect to the Probe Comp ground terminal on the front panel.

Do not try to measure voltages at pins 3 through 7.

Pin	Supply
1	+5 V
2	–5 V
3	Offset
4	Data
5 & ring	Probe ID
6	Clk
7	Unused
8	–12 V
9	+12 V



Any failure is likely caused by a problem with the front panel board.

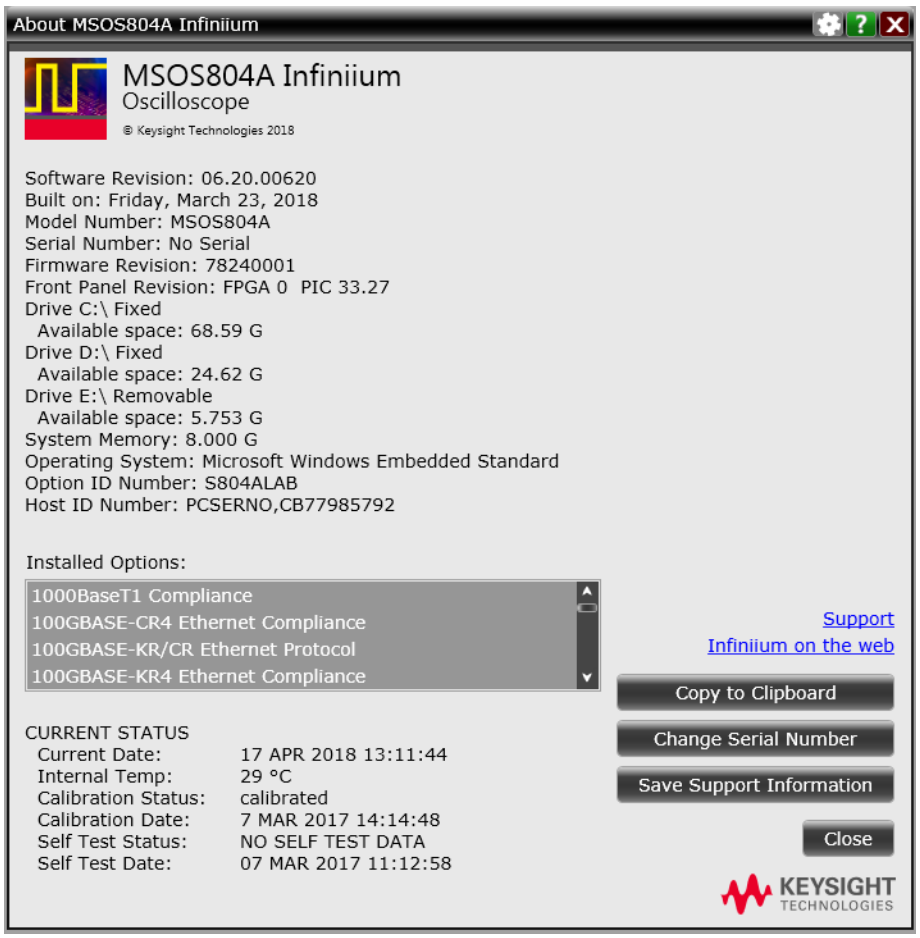
Before You Contact Keysight

If you have read this Troubleshooting chapter and have unresolved questions about troubleshooting the oscilloscope, be ready to provide system information such as the current software version and installed options. This information will be useful when you contact Keysight Technologies.

To find and save system information, follow these steps:

1 Click **Help > About Infiniium...**.

A dialog box similar to this one appears.



2 Click **Save Support Information**. A zip file containing useful information is created and saved to the desktop. You can email this file to your Keysight Technical Support representative.

5 Replacing Assemblies

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Use the procedures in this chapter when removing and replacing assemblies and parts in the Infiniium S-Series oscilloscopes.

The pictures in this chapter are representative of the oscilloscope at the time of this printing. Your unit may look different.

KEYSIGHT TECHNOLOGIES

ESD Precautions

When using any of the procedures in this chapter you must use proper ESD precautions. As a minimum you must place the oscilloscope on a properly grounded ESD mat and wear a properly grounded ESD wrist strap.

CAUTION Failure to implement proper antistatic measures may result in damage to the oscilloscope.

Tools Required

The following tools are required for these procedures.

- Torx drivers: T6, T10, T20
- Power driver vertical with T-20 bit (18 in-lbs)
- Power driver vertical with T-10 bit (5 in-lbs)
- Power driver vertical with T-6 bit (3 in-lbs)

CAUTION Remove power before removing or replacing assemblies.

Do not remove or replace any circuit board assemblies in this oscilloscope while power is applied. The assemblies contain components that may be damaged if the assembly is removed or replaced while power is connected to the oscilloscope.

WARNING **To avoid electric shock, adhere closely to the following procedures. Also, after disconnecting the power cable, wait at least 3 minutes for the capacitors on the power supply to discharge before servicing this oscilloscope.**

WARNING **Use caution when the oscilloscope fan blades are exposed as they can cause injury.**

Returning the Oscilloscope to Keysight Technologies for Service

Before shipping the oscilloscope, contact Keysight Technologies for more details.

1. Write the following information on a tag and attach it to the oscilloscope.
   - name and address of owner
   - oscilloscope model numbers
   - oscilloscope serial numbers
   - description of the service required or failure indications
2. Remove all accessories from the oscilloscope.

   Accessories include all cables. Do not include accessories unless they are associated with the failure symptoms.
3. Protect the oscilloscope by wrapping it in plastic or heavy paper.
4. Pack the oscilloscope in foam or other shock-absorbing material and place it in a strong shipping container.

   If the original shipping materials are not available, place 8 to 10 cm (3 to 4 inches) of shock-absorbing material around the oscilloscope and place it in a box that does not allow movement during shipping.
5. Seal the shipping container securely.
6. Mark the shipping container as FRAGILE.

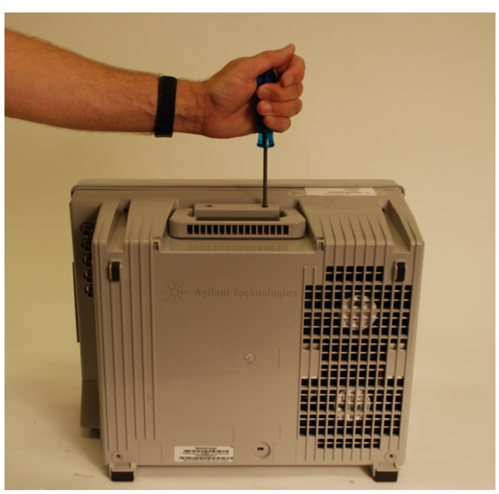
   In any correspondence, refer to the oscilloscope by model number and full serial number.

Removing and Replacing the Rear Cover and Rear Fan Assembly

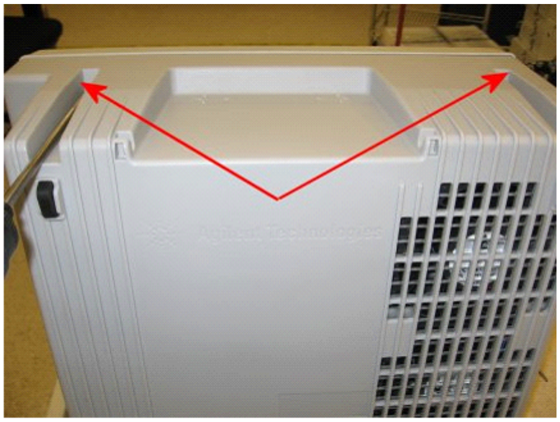
1 Disconnect the power cable.
2 Disconnect all probes and BNC input cables from the front panel.
3 Disconnect any other cables, such as mouse, keyboard, printer, USB, or LAN cables.
4 Make sure the accessory pouch is removed from the rear of the oscilloscope.
5 Loosen the two screws on back of the hard disk drive and remove the drive.

6 Remove the two M4 screws securing the handle on the top of the oscilloscope. Remove the handle.

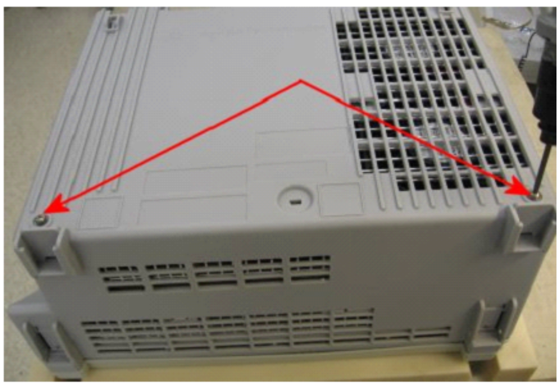
WARNING **Keep track of which screws go with the handle because using different screws to reattach it could result in a safety hazard.**



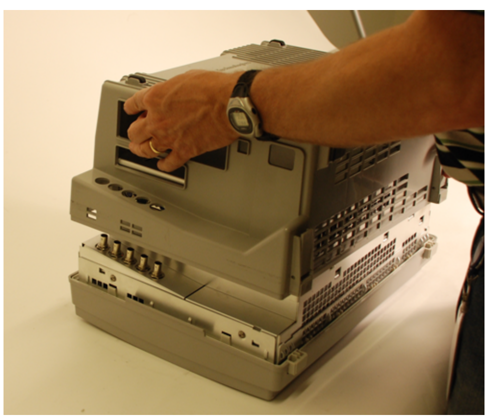
7 Remove the two M4 screws from the upper rear cover of the instrument.



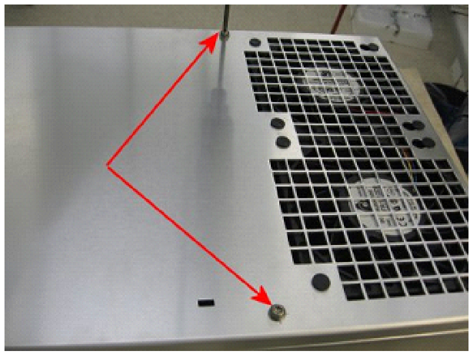
8 Remove the two M4 screws from the bottom rear cover of the oscilloscope.

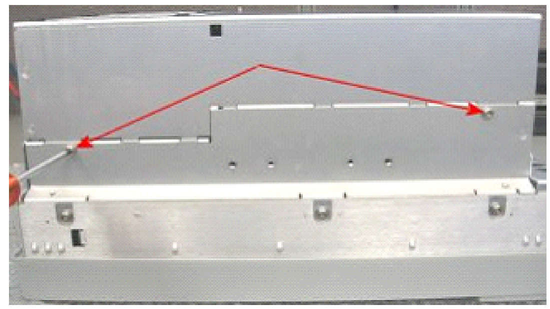


9 With the front cover installed, put the oscilloscope on its face and lift up on the rear cover to remove it from the chassis.

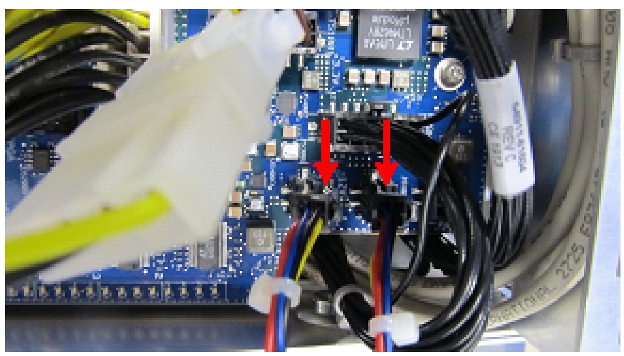


10 To remove the rear fan assembly, first remove the four M4 screws from the rear cover. When replacing, torque the screws to 18 in-lbs using a power driver and T-20 bit.





11 To finish removing the rear fan assembly, unplug the two fan cables and lift out the fan assembly.



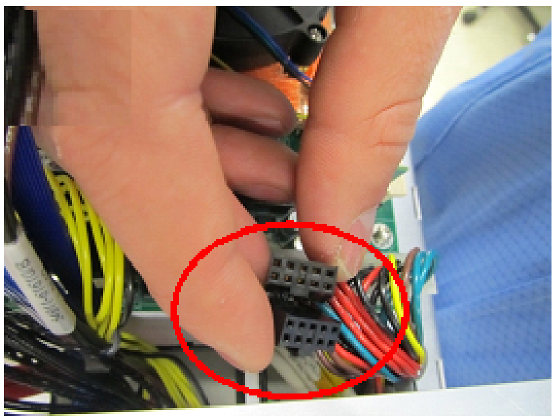
12 To replace the fan assembly, rear cover, and handle, reverse this procedure. Remember to replace the removable hard drive and hand-tighten the screws.

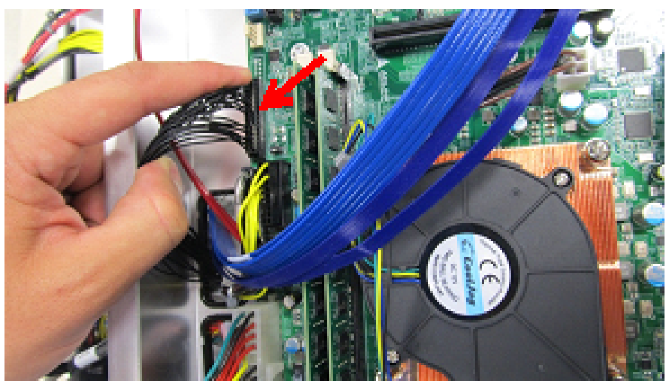
CAUTION Be sure to tighten the handle screws to 21 in-lbs and the four rear cover screws to 18 in-lbs.

Removing and Replacing the Front Panel, Bezel, Keyboards, Display/Touch Screen Assembly, and AutoProbe Board

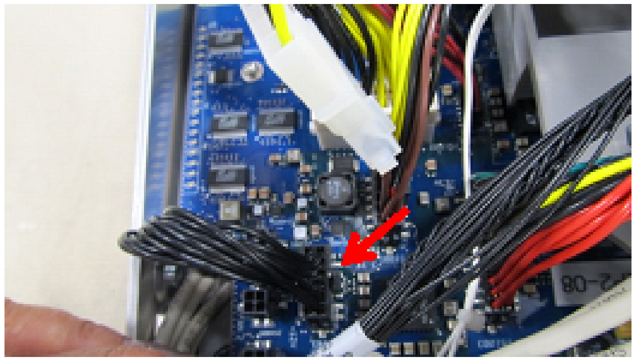
1 Disconnect the power cable and remove the handle, rear cover, and rear fan assembly as described in the previous section.

2 To begin removing the front panel, disconnect the two USB cables and the LVDS cable from the motherboard.

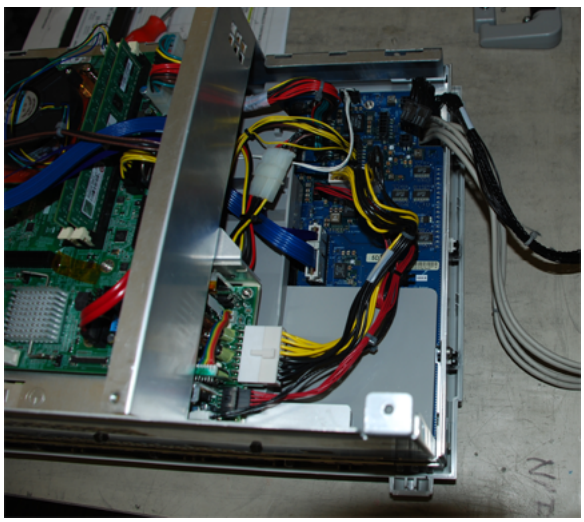




3 Disconnect the front panel power cable from the acquisition assembly.



4 Pull all four cables through the openings so they lay over the side of the frame.



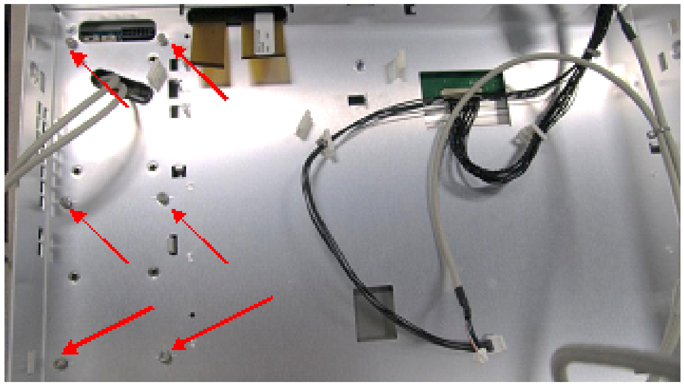
5 Remove the four M4 screws, two from each side.

6 Flip the assembly over and lift off the front panel while feeding the cables through the opening in the acquisition deck. Make sure the grounded signal lugs are aligned with their holes.

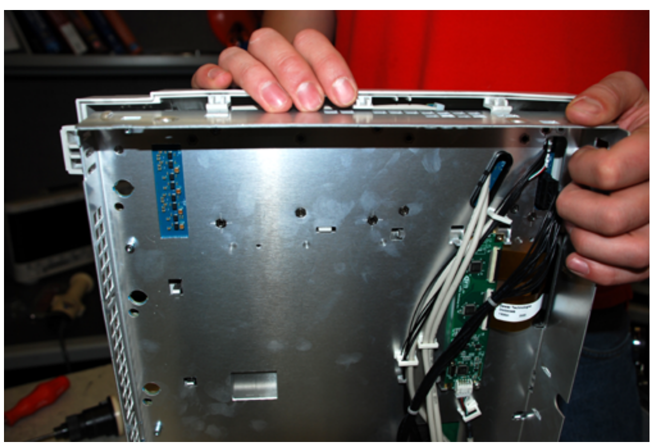
With the front panel removed, you can now remove the front panel bezel.

1 To begin removing the bezel, pull up on each of the front panel knobs to remove them from the front panel keyboard.

2 Remove the six M3 screws from the deck. Each removable screw is marked with an X in the deck. When replacing, tighten to 5 in-lbs.

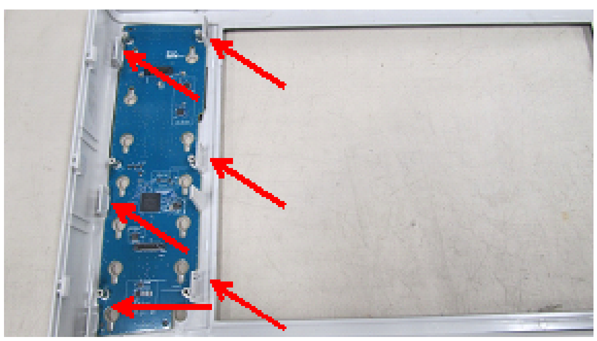


3 To finish removing the bezel, disengage the seven bezel snaps—two on each side, one near the middle, and one each on the top and bottom.

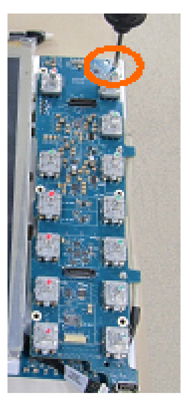


With the front panel bezel removed, you can now remove either the front keyboard or (rear) keyboard.

1 To remove the front keyboard, disengage the six clips connecting the front keyboard to the bezel.

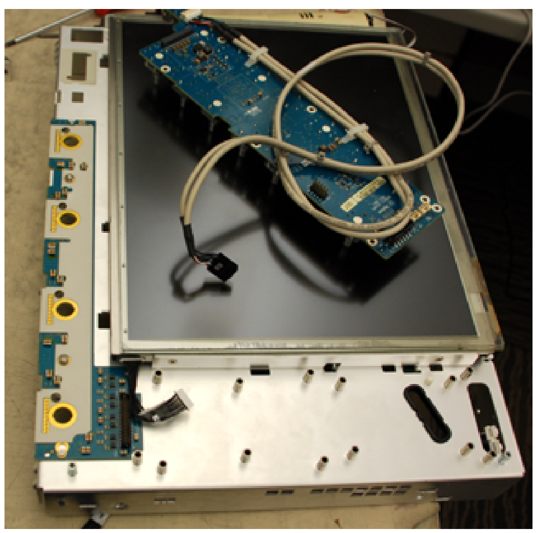


2 To begin removing the (rear) keyboard, remove the two M3 screws from the keyboard.



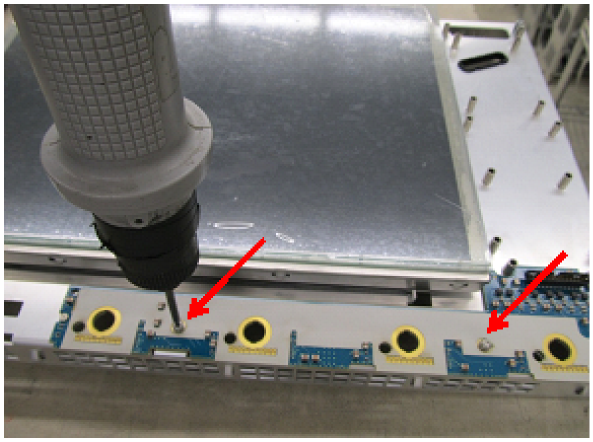
3 Disconnect the three cables from the rear of the keyboard.
4 Unroute the USB double cable from the cable clips.
5 Disconnect the backlight cable from the front of the keyboard.

6 Pull the USB double cable through the opening to finish removing the keyboard.



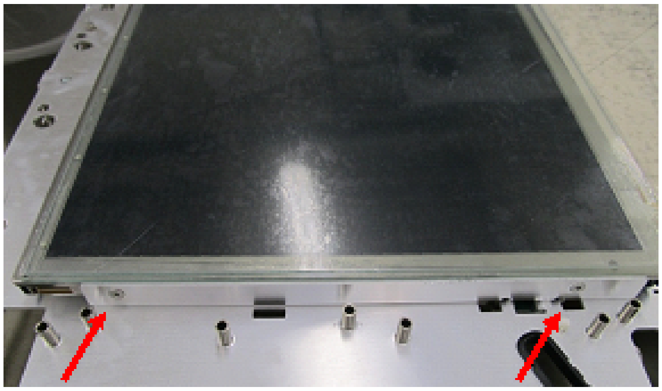
With the keyboard removed, you can now remove either the AutoProbe board or the display/touch screen assembly.

1 To remove the AutoProbe board, remove the two M3 screws connecting the board to the deck.



2 Slide the AutoProbe board off the deck to disengage the keyholes.

3 To remove the display/touch screen assembly, first remove the four M3 screws, two on each side, connecting the display to the deck.



4 Disconnect the LVDS cable.

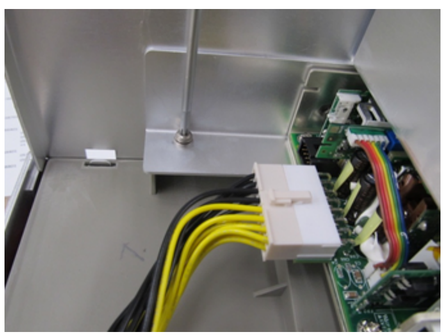
CAUTION

When replacing the display/touch screen assembly, make sure the backlight cable is securely seated. If it is not, the display may be dim in one corner of the display.

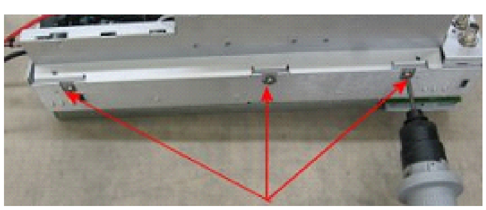
Removing and Replacing the Processor Assembly

1 Remove the cover and rear fan assembly as described earlier.
2 Remove the M4 screw connecting the acquisition deck to the processor bracket on the I/O bracket side near the rear of the instrument.

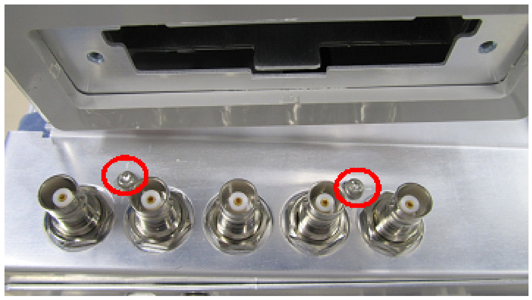
3 Remove the M4 screw connecting the acquisition deck to the processor bracket near the power supply.



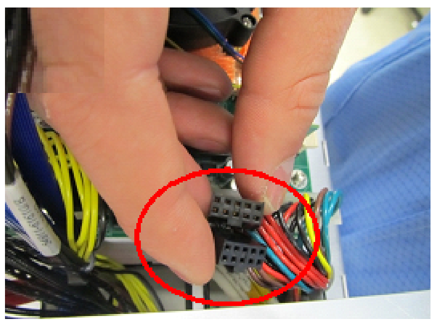
4 Remove the three M4 screws connecting the acquisition deck to the processor bracket at the top of the instrument.

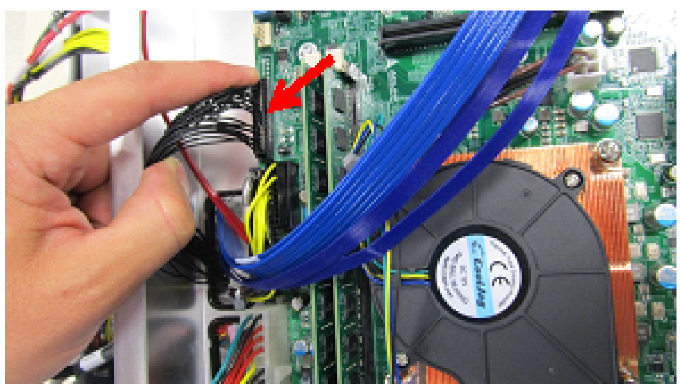


5 Remove the two M3 screws connecting the rear cover and the BNC plate, near the BNC. When replacing, torque the screws to 5 in-lbs.



6 Disconnect the two USB cables and the LVDS cable from the motherboard.





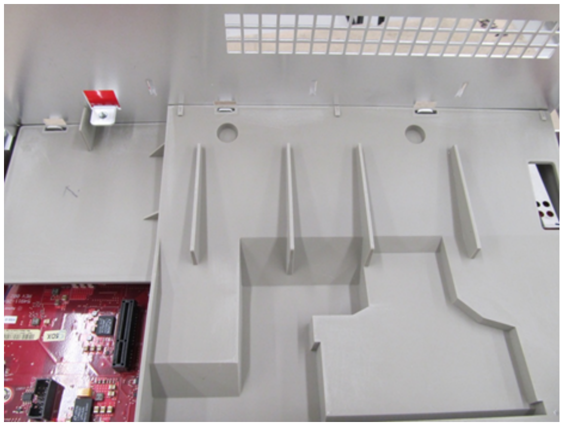
7 Disconnect the six cables connected to the acquisition board (main DC cable, AC input cable, standby on/off cable, CPU power cable, hard disk power cable, and PCIe cable).

8 Lift out the entire processor assembly.

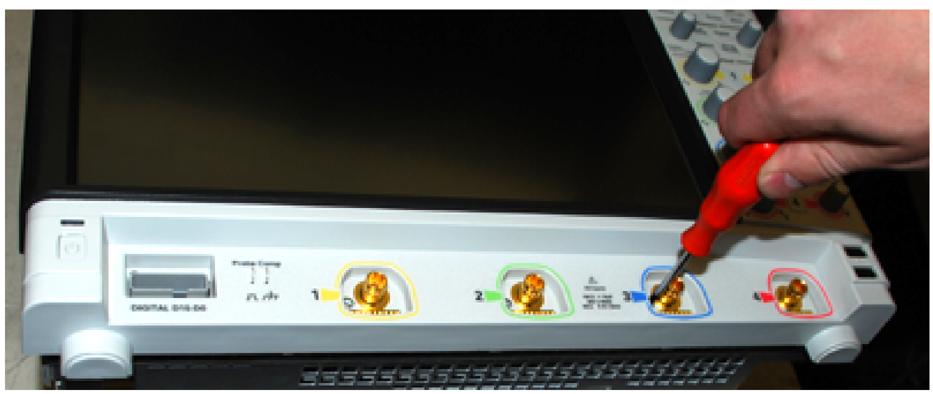
Once the processor assembly has been removed, you can remove the acquisition board, motherboard, or power supply.

Removing and Replacing the Acquisition Board

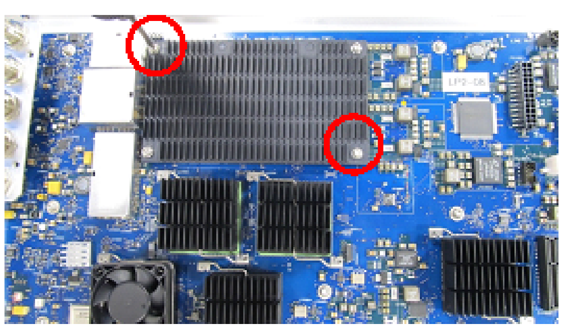
1 Remove the air duct from the acquisition board by lifting it straight up.



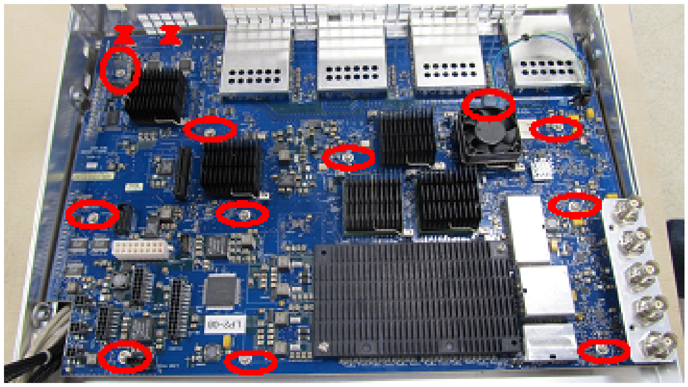
2 Reposition the oscilloscope so you can access the front panel, and remove the four M2 screws next to each BNC. When replacing, torque to 3 in-lbs using a power driver and T-6 bit.



3 Remove the two M3 screws that connect the heat sink to the chassis. Do not remove the other two screws.



4 Remove the 11 M3 screws surrounded by an X on the acquisition board. When replacing, torque to 5 in-lbs.



You can now remove the acquisition board.

Setting the Calibration Factors after Replacing the Acquisition Board

After you replace the acquisition board you must run a service calibration on the oscilloscope. This procedure needs to be performed only once after the acquisition board is replaced.

NOTE The oscilloscope must be warmed up (with the oscilloscope application running) for at least 30 minutes at ambient temperature before starting the calibration procedure. Failure to allow warm up may result in inaccurate calibration.

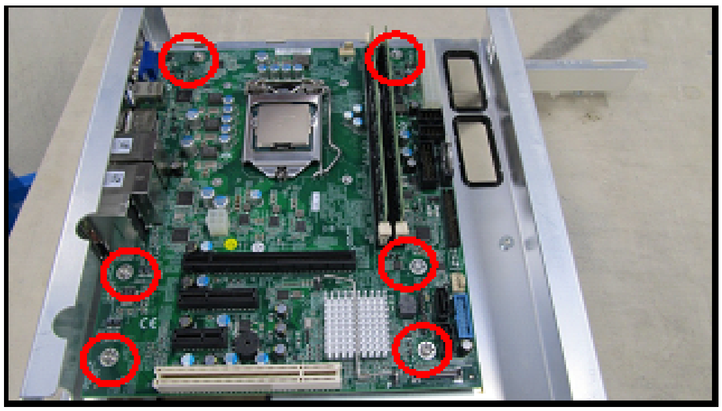
Equipment Required

Description	Critical specifications	Recommended model/part number
Digital Multimeter	No substitute	34411A
10 MHz Signal Source (required for time scale calibration)	Frequency accuracy better than 0.1 ppm	53131A with Opt. 010
Cable Assembly	No substitute	54855-61620
USB Cable		34398A
Cable Assembly	50 Ω characteristic impedance BNC (m) connectors ~ 36 inches (91 cm) to 48 inches (122 cm) long	8120-1840
Adapter	BNC Barrel (f)(f)	1250-0080
Adapter (Qty. 2)	No substitute	54855-67604
Adapter	BNC (f) to dual banana	1251-2277

1 Perform self tests as described on page 19.
2 Allow the oscilloscope to warm up for 30 minutes.
3 Perform a service calibration.

Removing and Replacing the Motherboard

1 Remove the processor assembly as described earlier.
2 Remove the six M3 screws from the motherboard. When replacing, torque the screws to 5 in-lbs.



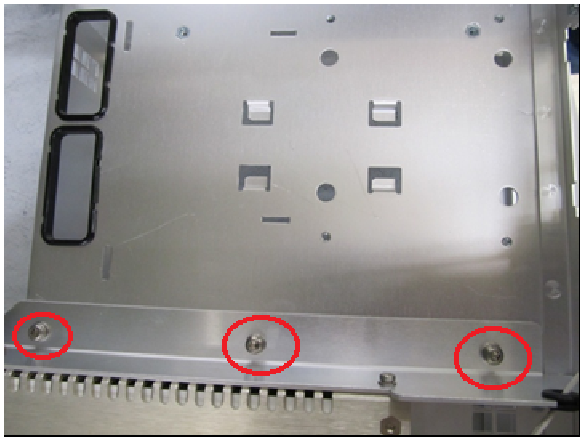
3 Slide the locking plate off of the four tabs, away from the I/O. If any cables are in the way you may want to disconnect them, though it is not necessary.
4 When the replacement motherboard has non-functional audio connectors, be sure to affix the motherboard I/O label and insert the audio connector port caps that come with the replacement motherboard kit.

If you need to replace the battery on the motherboard, it is a Rayovac BR2032.

Removing and Replacing the Power Supply

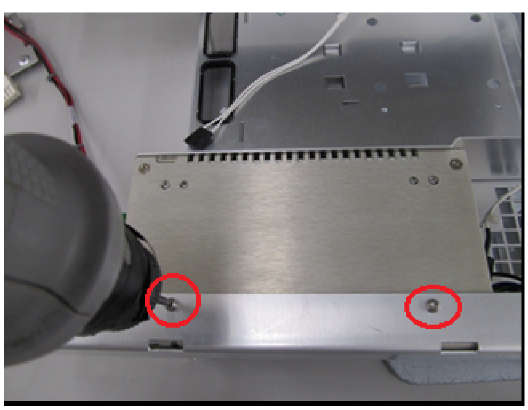
1 Remove the processor assembly as described earlier.

2 Remove the three M3 screws from the power supply bracket. When replacing, torque to 5 in-lbs.

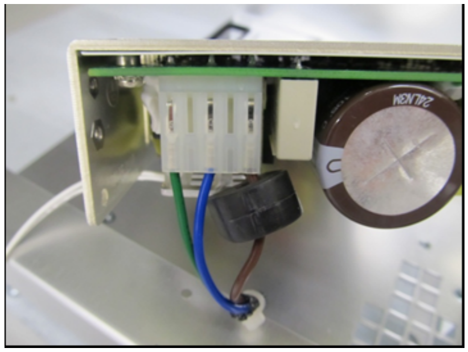


3 Remove the two M3 screws from the power supply.

CAUTION When replacing the power supply, be sure to use the M3 screws. Using longer screws will cause irreparable damage to the power supply.



4 Disconnect the AC input cable.



5 Remove the power supply from the bracket.

6 Replaceable Parts

Ordering Replaceable Parts 94
Exploded Views 95
Replaceable Parts List 100

This chapter describes how to order replaceable assemblies and parts for the Infiniium S-Series oscilloscopes. Service support for this oscilloscope is replacement of parts to the assembly level.

Ordering Replaceable Parts

Listed Parts

To order a part in the parts list, quote the Keysight Technologies part number, indicate the quantity desired, and address the order to the nearest Keysight Technologies Sales Office.

Unlisted Parts

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

Direct Mail Order System

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

- Direct ordering and shipping from the Keysight 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 Keysight Technologies Sales Office when the orders require billing and invoicing.)
- Prepaid transportation. (There is a small handling charge for each order.)
- No invoices.

For Keysight Technologies to provide these advantages, please send a check or money order with each order.

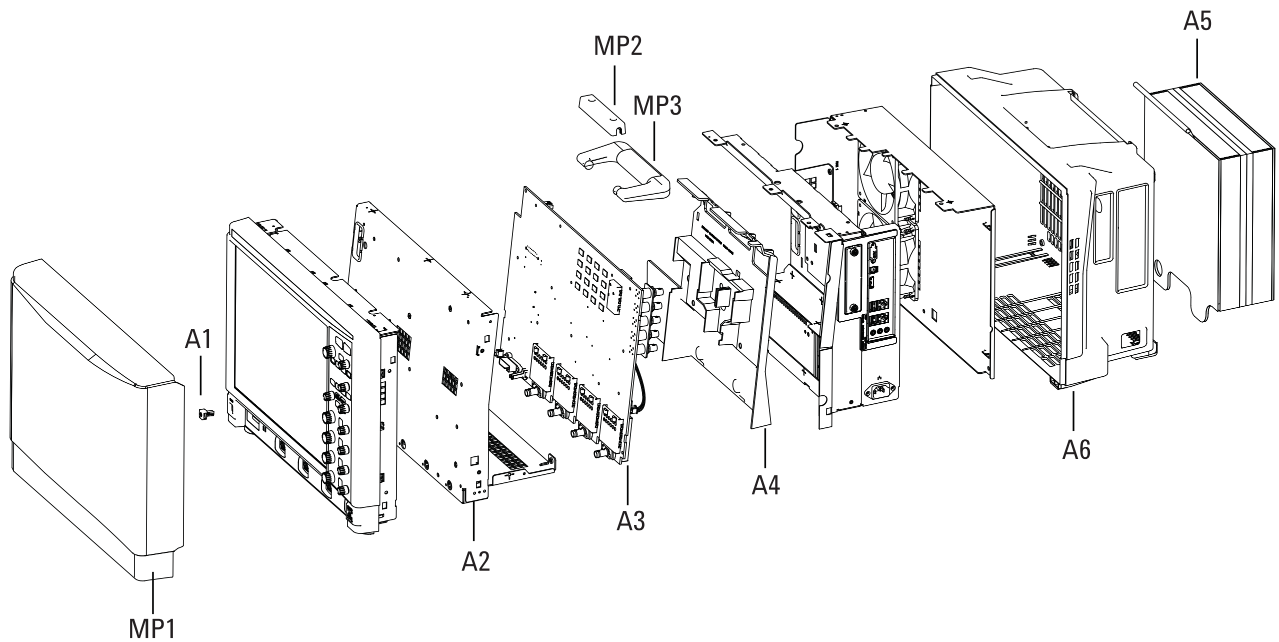
Mail order forms and specific ordering information are available through your local Keysight Technologies Sales Office. Addresses and telephone numbers are located in a separate document shipped with the manuals.

Exchange Assemblies

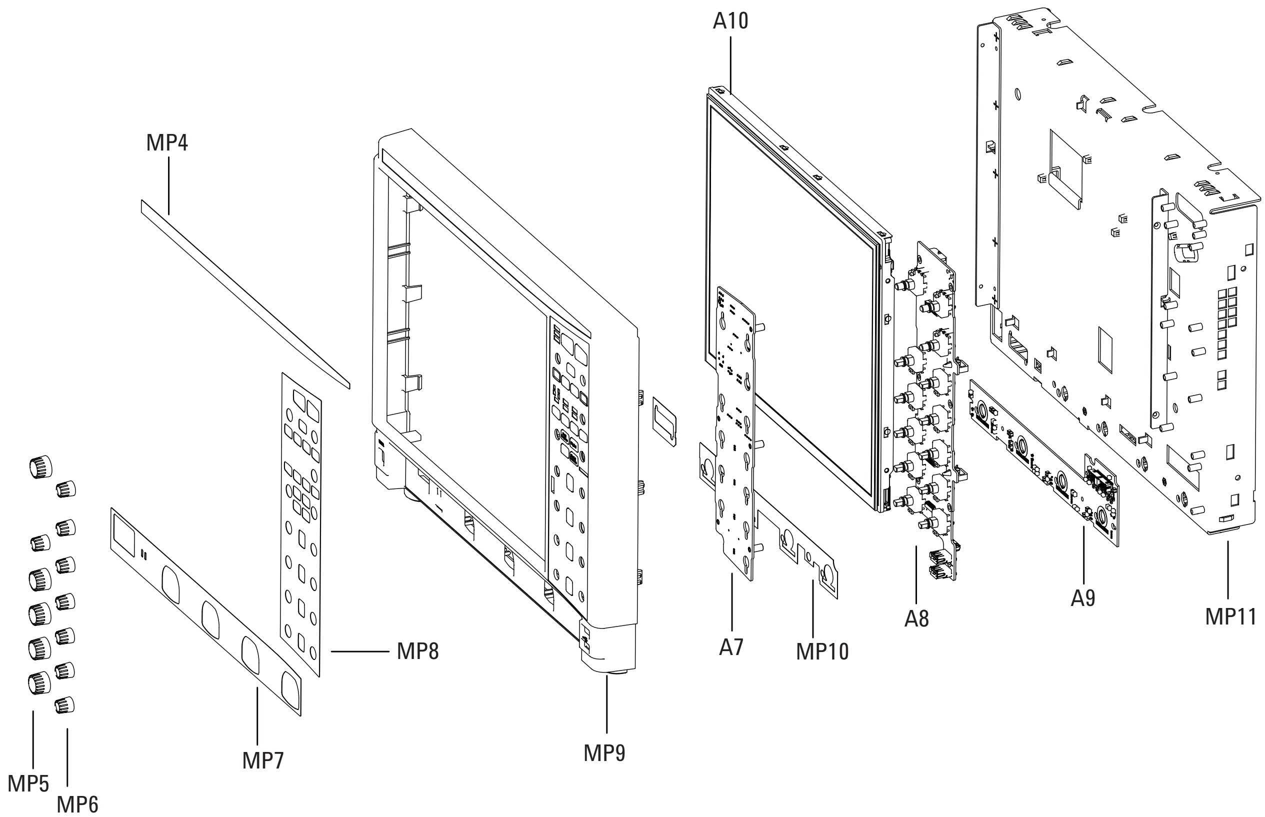
Exchange assemblies have been set up for Keysight Service Center use only.

Exploded Views

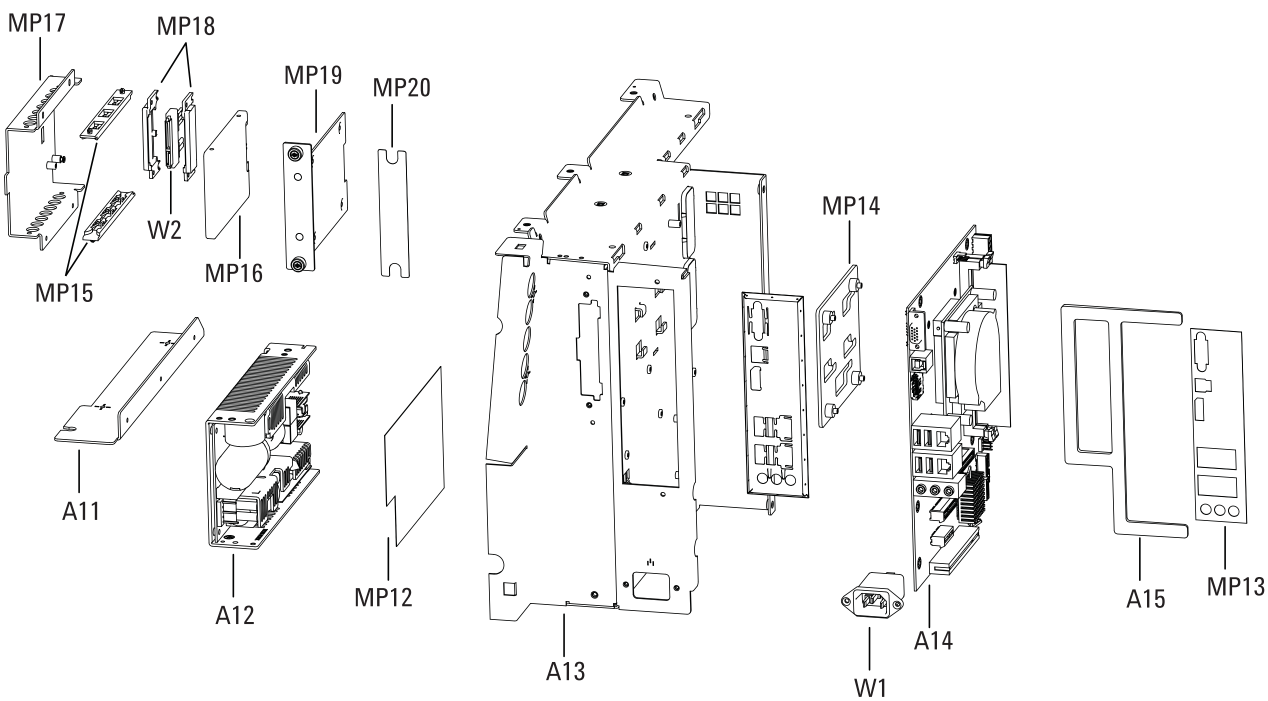
Main Frame



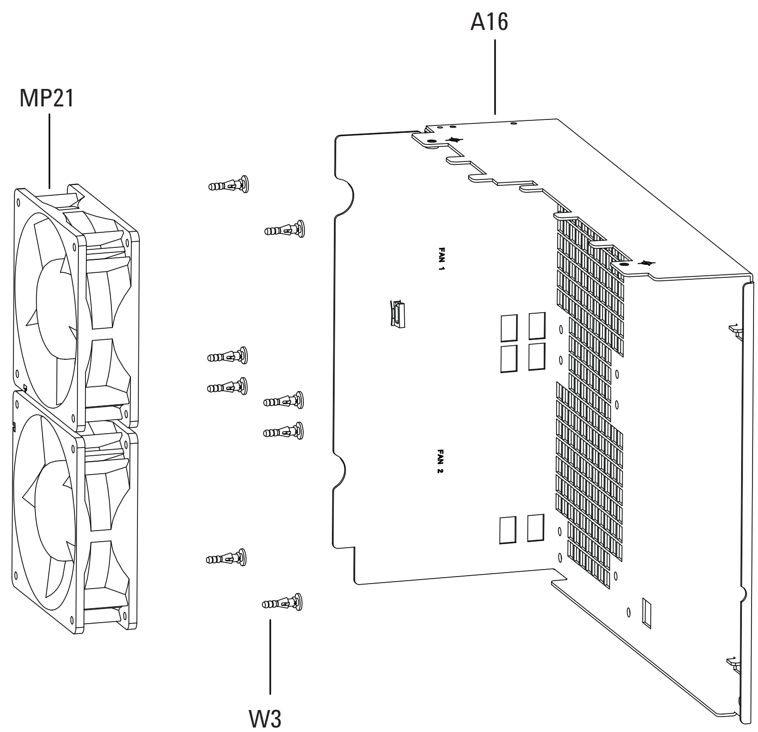
Front Panel



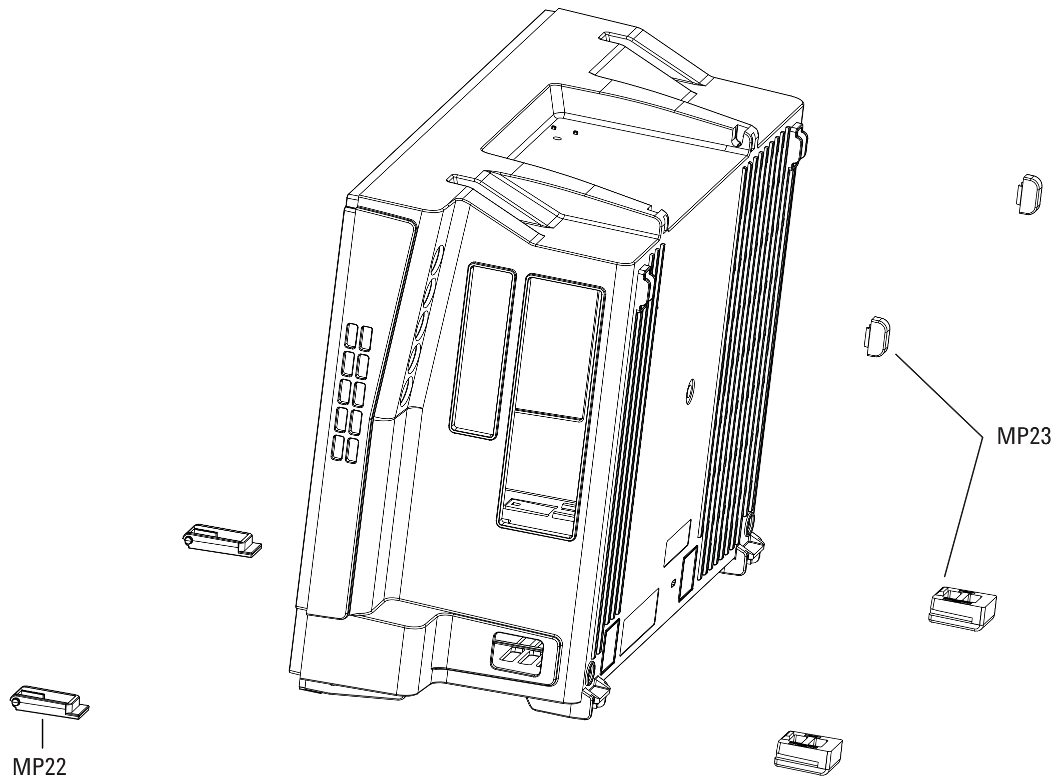
Power Supply and Motherboard



Fan



Cabinet



Replaceable Parts List

The following table is a list of replaceable parts. The information given for each part includes:

- Reference designation in exploded views
- Keysight Technologies part number
- Total quantity (QTY) in the oscilloscope or an assembly
- Description of the part

Ref. des.	Part number	Qty	Description
A1	54911-43901	1	Power switch
A2	54911-00102	1	Deck - Acquisition
A3	54911-66511 or 54911-66521	1	PCA Acquisition Board (tested)
A3	54911-69511 or 54911-69521	1	PCA Acquisition Board, refurbished (tested, exch)
A4	54911-44102	1	Air Duct
A5	54904-62301	1	Accessory Pouch
A6	54911-64401	1	Cabinet Assembly
A7	54911-66404	1	PCA Keyboard - Front
A8	54911-66405	1	PCA Keyboard - Rear
A9	54911-66403	1	PCB - AutoProbe
A10	2090-1075	1	Display LCD 15-in with capacitive touch screen
A11	54911-00108	1	Bracket - Power Supply
A12	0950-5468	1	Power Supply 500 W 8-output
A13	54911-00104	1	Deck - Processor Assembly
A14	54911-68724	1	Motherboard 8GB (Without Audio) Kit
A15	54911-47101	1	Filler Plate
A16	54911-00105	1	Rear Cover
MP1	54911-44101	1	Cover - protective front
MP2	54904-44902	1	Handle Keeper
MP3	54904-44901	1	Handle
MP4	54911-94310	1	Label DSOS504A
MP4	54911-94311	1	Label MSOS504A
MP4	54911-94313	1	Label DSOS104A
MP4	54911-94314	1	Label DSOS254A
MP4	54911-94315	1	Label MSOS254A

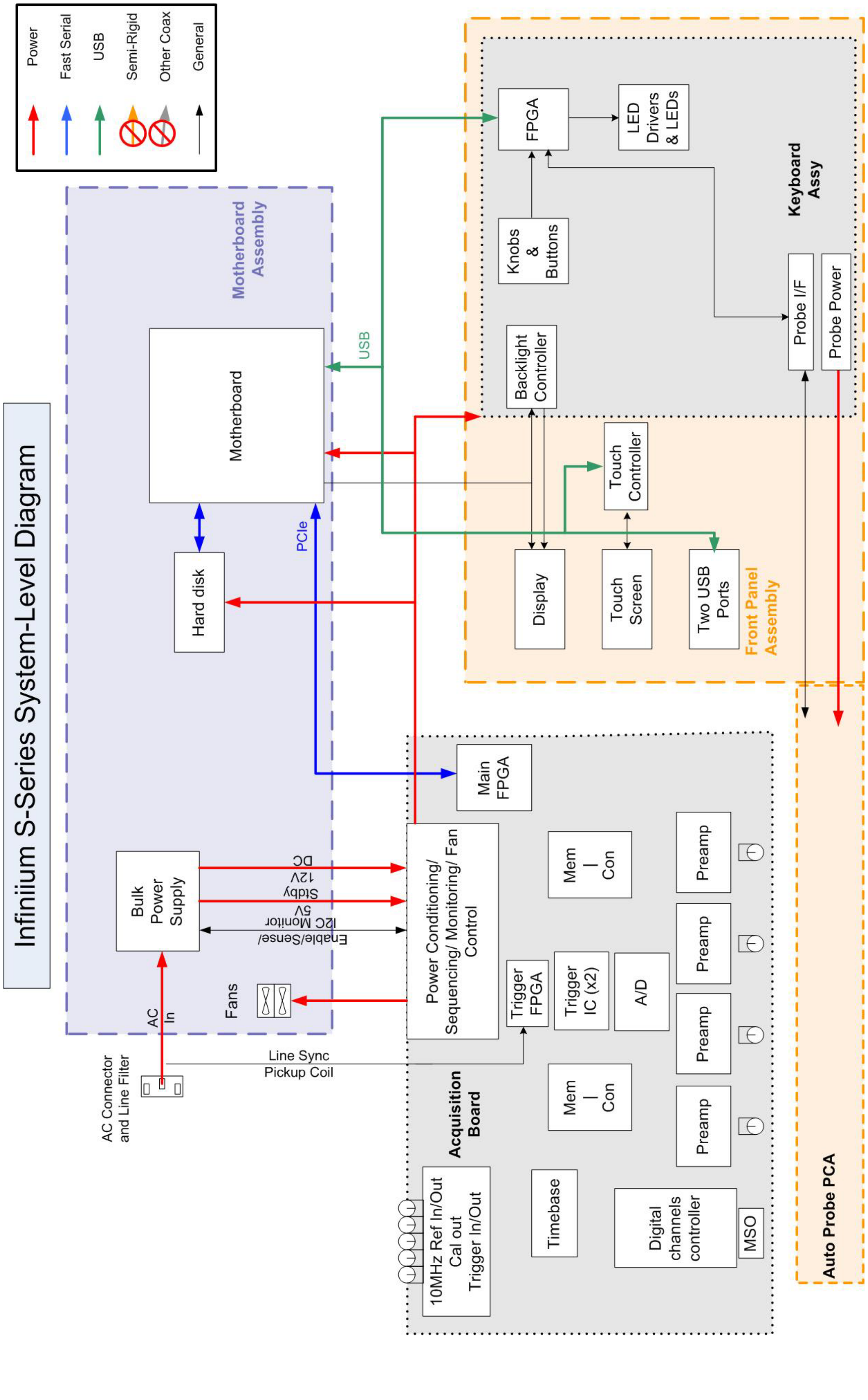
Ref. des.	Part number	Qty	Description
MP4	54911-94316	1	Label DSOS404A
MP4	54911-94317	1	Label MSOS404A
MP4	54911-94318	1	Label DSOS804A
MP4	54911-94319	1	Label MSOS804A
MP4	54911-94320	1	Label DSOS204A
MP4	54911-94321	1	Label DSOS604A
MP4	54911-94322	1	Label MSOS204A
MP4	54911-94323	1	Label MSOS604A
MP4	54911-94324	1	Label MSOS104A
MP5	75019-47401	5	Knob - Large Rotary, Flint Gray
MP6	75019-47402	8	Knob - Small Rotary, Flint Gray
MP7	54911-94325	1	Label - I/O Front
MP8	54911-94301	1	Label - keyboard
MP9	54911-60201	1	Panel Bezel Assembly
MP10	54911-94304	1	Label - AutoProbe
MP11	54911-00101	1	Deck - front
MP12	54911-94305	1	Label - Power Supply
MP13	54911-94309	1	Label - PCIO. This label is for motherboards with functional audio connectors.
	54911-94339		Label - PCIO (With Disabled Audio) - Flint Gray. This label is included with the 54911-68724 Motherboard 8GB (Without Audio) Kit.
MP14	54932-21204	1	Bracket - Motherboard
MP15	0403-1116	2	Guide - PC BD BLK POLYC .05-.1 in BD thickness
MP16	54911-83502	1	Imaged HDD for M900/Win7-based 9000X and S-Series scopes (Service Centers only)
MP16	54911-83512	1	Imaged HDD for M900/Win10-based 9000X and S-Series scopes (Service Centers only)
MP17	54904-01201	1	Bracket - Removable HDD
MP18	54904-41202	2	Clamp - SATA
MP19	54904-04101	1	Plate - Removable HDD
MP20	54911-94307	1	Label - Removable HDD Tray
MP21	54904-68709	1	Fan with Extra Fan Mounts w/wires
MP22	54904-41001	2	Tilt Leg (part of cabinet assembly)
MP23	54904-44001	2	One lower rear foot and one upper rear bumper (order twice to get both pairs of rear feet/bumpers)
W1	54911-61606	1	Cable - AC Input
W2	54904-61614	1	Cable - HDD Power

Ref. des.	Part number	Qty	Description
W3	1520-0686	6	Shock mount for fan
	54904-61622	1	MSO Cable
	1250-0080	1	Adapter coaxial female BNC - female BNC
	1250-3817	1	BNC Probe Tip Adapter
	E5383-68701	1	17-channel Flying Lead Kit
	5090-4833	1	Bag of 20 grabbers for Flying Lead Set
	5959-9334	1	Bag of 5 two-inch ground leads for use with the Flying Lead Set
	1250-0080	1	BNC (f)-(f) barrel
	54911-61608	1	Cable - Standby/on-off
	54911-61601	1	Cable - USB, split
	54911-61605	1	Cable - Panel Supply
	54911-61604	1	Cable - LVDS
	54609-61609	1	Cable - Calibration, 50 Ohm BNC to BNC
	54911-61607	1	Cable - DC main
	54911-61609	1	Cable - CPU Power
	54911-61610	4	Cable - HDD Power
	8120-4420	1	power cord - United Kingdom, Singapore, Malaysia, Hong Kong
	8120-4419	1	power cord - Australia and New Zealand
	8121-1226	1	power cord - Continental Europe, Korea, Indonesia, Viet Nam
	8120-6825	1	power cord - United States and Canada (125 V)
	8120-3996	1	power cord - United States and Canada (240 V)
	8120-4416	1	power cord - Switzerland
	8121-1655	1	power cord - Denmark
	8121-1690	1	power cord - India
	8121-0743	1	power cord - Japan (100 V)
	8121-0724	1	power cord - Israel
	8121-0725	1	power cord - Argentina
	8121-0722	1	power cord - Chile
	8120-8376	1	power cord - China
	8121-0564	1	power cord - South Africa
	8120-0674	1	power cord - Thailand and Philippines
	8121-1607	1	power cord - Japan (250 V)
	8121-1809	1	power cord - Brazil
	8121-1635	1	power cord - Taiwan
	8121-1638	1	power cord - Cambodia

7 Theory of Operation

Motherboard Assembly 106
Acquisition Assembly 107
Front Panel Assembly 107

KEYSIGHT TECHNOLOGIES


Infiniium S-Series System-Level Diagram
Power
Fast Serial
USB
Semi-Rigid
Other Coax
General
Motherboard Assembly
Motherboard
Hard disk
PCIe
USB
Bulk Power Supply
DC
12V
Stdby
5V
I2C Monitor
Enable/Sense/
AC In
Fans
AC Connector and Line Filter
Line Sync Pickup Coil
Power Conditioning/ Sequencing/ Monitoring/ Fan Control
Main FPGA
Trigger FPGA
Trigger IC (x2)
A/D
Mem I Con
Mem I Con
Preamp
Preamp
Preamp
Preamp
Acquisition Board
10MHz Ref In/Out
Cal out
Trigger In/Out
Timebase
Digital channels controller
MSO
FPGA
LED Drivers & LEDs
Knobs & Buttons
Keyboard Assy
Backlight Controller
Probe I/F
Probe Power
Touch Controller
Display
Touch Screen
Two USB Ports
Front Panel Assembly
Auto Probe PCA

Theory of Operation

This chapter describes the basic structure of the Infiniium S-Series oscilloscope and how the parts interact.

The Infiniium S-Series oscilloscopes are comprised of three main assemblies: a motherboard assembly, an acquisition assembly, and a front panel assembly. Each oscilloscope also has several fans.

Users can interact with the oscilloscope and connect signals through the front panel and the right side panel of the oscilloscope.

The front panel provides:

- Dedicated knobs and pushbuttons for major oscilloscope functions
- A 15-inch, 1024 x 768 pixel, XGA, color, capacitive touch display with LED back lighting for measurement, waveform, and user interface display
- Two front panel USB ports
- Four precision BNC connectors for channel input signal
- An MSO cable connector
- An AutoProbe interface for probe power and probe control
- A connection for probe compensation and ground
- The power button

The right side panel provides:

- Auxiliary Trigger Output BNC
- 10 MHz Reference Input BNC
- 10 MHz Reference Output BNC
- Auxiliary Trigger Input BNC
- Trigger Out BNC
- Removable hard drive
- AC plug
- Connections to the motherboard

Motherboard Assembly

The motherboard assembly provides all system control and interface functions for the oscilloscope. It consists of the Windows-based motherboard, the hard disk drive, and the bulk power supply.

Motherboard

The motherboard contains a microprocessor, a hard disk drive interface, ROM, RAM, keyboard and mouse interfaces, connections to the front panel assembly, and serial and parallel interfaces.

It is common for the motherboard to be revised during the life of the oscilloscope, so if a motherboard is replaced during a repair procedure, check to make sure it matches the image on the hard drive. It is important for the hard disk drive image to match the motherboard. If they do not match, the oscilloscope may not have the correct Windows software drivers.

Disk drive

The hard disk drive is a high-capacity, removable, solid state, shock-resistant unit that stores the oscilloscope operating system, the oscilloscope application, compliance application information, calibration data, other data files, drivers for the boards and oscilloscope, and user data files.

The hard disk drive can also be used to store and recall oscilloscope setups and waveforms.

Power supply

The power supply is a safety-approved +12 V bulk supply. It transforms AC power to the main +12 V 40A supply and a 2A +5 V supply. The +5 V supply is used only by supervisory circuits that monitor and control all other supplies. In the event of a safety shutdown from the supervisory circuits, LEDs turn on to indicate the cause of the shutdown. They remain lit for a few seconds until the motherboard reboots.

The +12 V bulk supply is used to create all other supplies in the instrument. +12 V is turned on by the power switch on the front panel. It is turned off under software control when a shutdown is requested, or by the supervisory circuits when a fault occurs.

The oscilloscope runs from 100-120 V at AC input frequencies of 50, 60, and 400 Hz. It runs from 100-240 V at 50 and 60 Hz. Maximum input power is 380 W.

Acquisition Assembly

The single acquisition board is a PCIe device attached to the motherboard with a PCIe extension cable. The x4 PCIe link includes nine differential pairs: four transmit pairs, four receive pairs, and one reference clock pair. These pairs are all run from the PCIe connector to the main FPGA. The motherboard also sends over a PCIe reset line. Other than the motherboard power connections, the PCIe link is the only connection between the acquisition board and the motherboard.

Front Panel Assembly

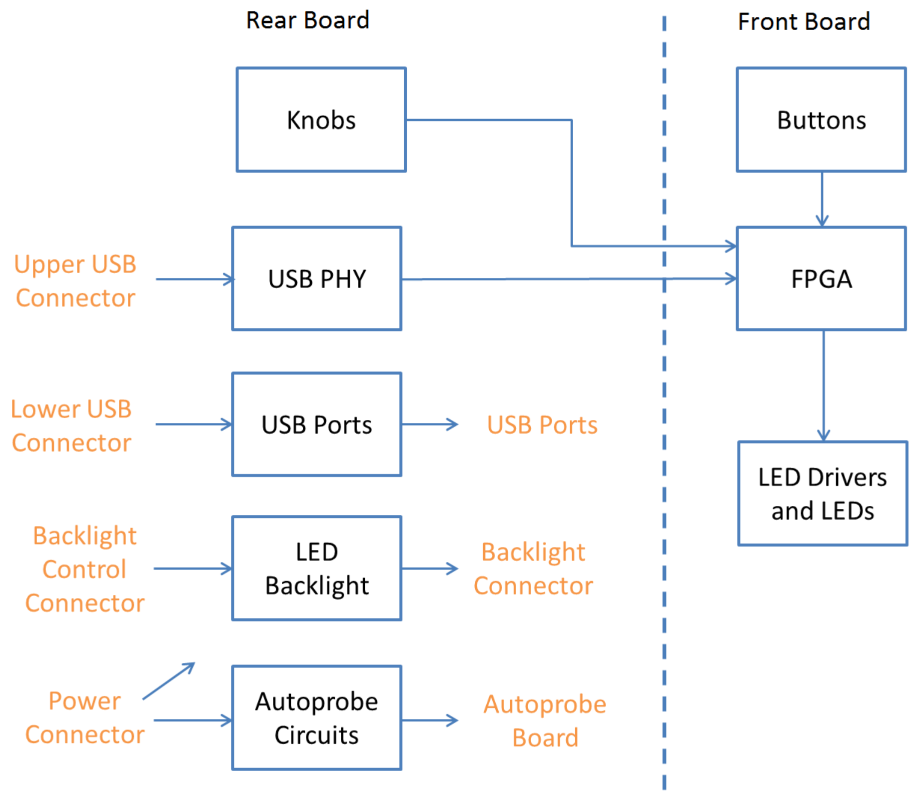
The front panel assembly consists of a passive AutoProbe board and a keyboard assembly, which is two boards that sit with one behind the other, connected with a pair of 60-pin board-to-board connectors.

Keyboard assembly

The two boards that comprise the keyboard assembly work together to provide the main user interface to the oscilloscope, and power and communication to the probe interface.

The rear board has all the external connectors, AutoProbe circuits, LED backlight power supply, and knobs. The front board has the FPGA, buttons, and LEDs.

The following figure shows a block diagram of the oscilloscope keyboard assembly.



System Fans

S-Series oscilloscopes have five fans: two larger fans that draw air out of the rear of the instrument, two medium fans that are positioned over the ADC to provide additional cooling, and one small fan positioned over the trigger IC. They are all controlled by the main FPGA.

8 Safety Notices

Warnings 109
Cleaning the Instrument 110
Safety Symbols 110

This apparatus has been designed and tested in accordance with IEC Publication EN 61010-1:2001, 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 be inserted only 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 fuse holders. 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.

KEYSIGHT TECHNOLOGIES

- 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 gases 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.

Cleaning 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 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 to protect against damage to the product.

Hazardous voltage symbol.

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

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