

THS3000 Series Oscilloscopes Performance Verification and Adjustments Technical Reference



**THS3000 Series Oscilloscopes
Performance Verification and Adjustments
Technical Reference**

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Table of Contents

General Safety Summary	iii
Service Safety Summary	v
Preface	vi
Performance Verification	1
Test Equipment	1
Test Setup	2
Display and Backlight Test	3
Vertical Accuracy Test	4
DC Voltage Accuracy Test	6
AC Voltage Accuracy Test	8
AC-Coupled Low Frequency Test	9
Peak Measurement Accuracy Test	10
Frequency Measurement Accuracy Test	11
Input Phase Measurement Test	12
Time Base Test	13
Trigger Sensitivity Test	16
AC Voltage Accuracy and Bandwidth Test	17
Video Trigger Test	18
Probe Calibration Generator Test	19
Test Record	20
Adjustments	24
Prerequisites	24
Calibration Procedure Outline	24
Calibration Procedure	25

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

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

Only qualified personnel should perform service procedures.

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

To Avoid Fire or Personal Injury

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

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

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

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

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

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

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

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

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

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

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

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Terms in This Manual

These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



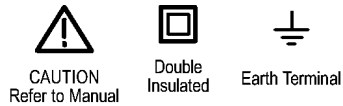
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and Terms on the Product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:



Service Safety Summary

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

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

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

To avoid electric shock, do not touch exposed connections.

Preface

This manual contains procedures for checking the oscilloscope performance and for making adjustments to achieve the warranted specifications of the THS3000 Series Oscilloscopes.



WARNING. *The procedures included in this manual are for use by qualified service personnel only.*

Performance Verification

Use these performance verification procedures to verify that the oscilloscope meets the warranted specifications. These procedures should be performed in the order given using the equipment recommended in the following table. (See Table 1.) The values given here are valid for ambient temperatures between 18 °C and 28 °C.

If your oscilloscope fails to qualify under these conditions, service-level adjustments are required. These adjustments must be done by a trained service person.



WARNING. The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not disassemble the oscilloscope while it is connected to a signal source other than those specified in this procedure.

Test Equipment

Table 1: Recommended test equipment

Equipment	Minimum requirements	Recommended test equipment ¹
Calibration generator	Multiple signal outputs, including television video signals ²	Fluke 5500A with SC300 or SC600 oscilloscope calibration option, or Wavetek 9100 and Wavetek 9500 with active head
Coaxial cable (4)	BNC, 50 Ω, 36 in	012-0482-xx
Coaxial cable	75 Ω, 36 in	012-1339-xx
Termination, feedthrough	50 Ω male-to-female BNC	011-0049-xx
Termination, feedthrough	75 Ω male-to-female	011-0055-xx
Adapter	BNC female-to-female barrel	103-0028-xx
Adapter (3)	BNC male-to-dual female (T-connector)	103-0030-xx
Adapter	BNC female-to-dual banana plug	103-0090-xx
Voltage probe	10X	THP0301

¹ Nine digit part numbers (xxx-xxxx-xx) are Tektronix part numbers.

² If the SC600 option is not available, a separate television signal generator may be substituted. The generator must be capable of producing video in the format(s) that you want to test on the THS3000 series oscilloscope; PAL, PALplus, SECAM, and NTSC standards are supported.

Test Setup

All tests should be performed with the batteries installed and the oscilloscope powered by the AC adapter.

1. Connect the AC adapter to the oscilloscope and turn on the oscilloscope.
2. Turn on the generators and let the probe and test equipment warm up for 20 minutes.
3. Make a copy of the test record to tabulate the test results. (See page 20, *Test Record*.)

Using the Menus to Set the Input Channel Characteristics



For each channel that you test, you must set some parameters through the instrument menu. To access the menus and settings, do the following:

1. Press the Ch 1 button once (for channel 1). The menu that appears on the bottom of the screen allows you to change settings using the buttons below the display (referred to as F1 through F4, from left to right). From left to right on this menu, you can set the:

- input on/off
- input coupling
- probe type and attenuation
- polarity and bandwidth

A menu item highlighted in white indicates the current setting. A menu item highlighted in black indicates the selection cursor is on that item.

In menus that have multiple options, use the arrow buttons to navigate to your selection and then press the Enter button to set that selection.

2. Press the  button once to access the Glitch and Zoom on/off controls.
3. Press the  button again to access the MEASURE and ACQUIRE OPTIONS controls. In this menu, press the MEASURE button to display a menu that allows you to select the characteristics and units of measure for the signals that are applied to all of the instrument inputs.

For example, for MEASUREMENT A, select on Ch1, V dc. Then, press the MEASURE A B C D button to toggle to MEASUREMENT B and then select on Ch2, V ac.

Also from this menu, pressing the ACQUIRE OPTIONS button displays a menu to select averaging options and other waveform characteristics.

Display and Backlight Test

1. Verify that the AC adapter is connected to the oscilloscope and that the oscilloscope is powered on.
2. Disconnect the AC adapter and verify that the display backlight dims.
3. Connect the AC adapter and verify that the display backlight brightens.
4. Press and hold the Utility button.
5. Press and release the Menu Off button.
6. Release the Utility button. The calibration menu displays at the bottom of the display.
7. Press F1 (PREVIOUS) three times. The oscilloscope displays Contrast (CL 0100):
8. Press F3 (CALIBRATE). The oscilloscope shows a dark display; the test pattern may be not visible or hardly visible. Observe the display closely, and verify that the display shows no abnormalities, as for example very light pixels or lines.
9. Press F2 (NEXT). The oscilloscope displays Contrast (CL 0100):
10. Press F2 (NEXT) again to display Contrast (CL 0110):
11. Press F3 (CALIBRATE). The oscilloscope shows a test pattern at default contrast. (See Figure 1.) Observe the display closely, and verify that the display shows no abnormalities. Also verify that the contrast of the upper left and upper right square of the test pattern is equal.

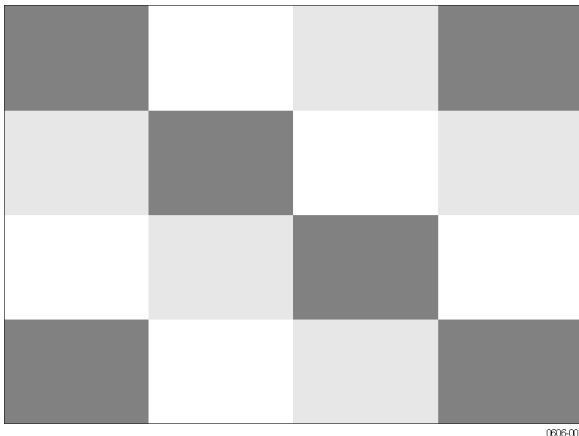


Figure 1: Display test pattern

12. Press F2 (NEXT). The oscilloscope displays Contrast (CL 0110):
13. Press F2 (NEXT) again to display Contrast (CL 0120):
14. Press F3 (CALIBRATE). The oscilloscope shows a light display; the test pattern may be not visible or hardly visible. Observe the display closely, and verify that the display shows no abnormalities.
15. Turn off the oscilloscope to exit the test.

Vertical Accuracy Test



WARNING. Dangerous voltages will be present on the calibration generator output terminals and connection cables. Always verify that the generator is in the standby mode before you make any connections to the generator.

1. Connect the test setup as shown. (See Figure 2.)

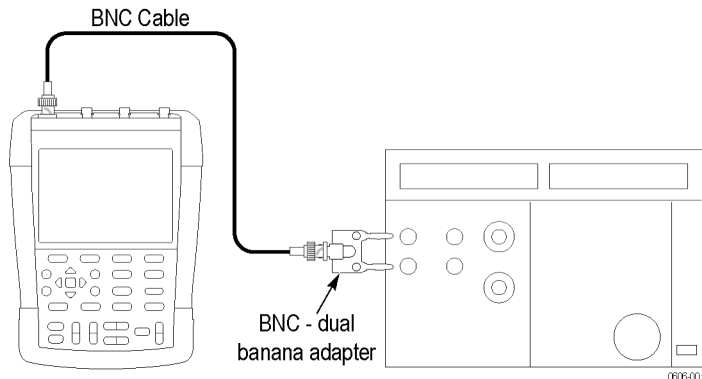


Figure 2: Setup for vertical accuracy test

2. Press the Ch 1 button once (for channel 1). The menu that appears on the bottom of the screen allows you to change settings. Set all channels on the oscilloscope to the settings below:
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 kHz (HF Reject)
 - Measure: Measurement on, V dc
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 10 ms/div
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to the first value in the table. (See Table 2.)
5. Set the calibration generator to the first value in the table.
6. Enable the generator output and adjust the generator output voltage until the displayed trace amplitude is 6 divisions.
7. Verify that the generator output voltage is within the range shown under the appropriate column.
8. Continue through the test values remaining in the table for Channel 1.
9. Disable the generator output and move the output cable to the next oscilloscope channel.
10. Repeat steps 3 through 9 for the remaining channels on the oscilloscope.

Table 2: Vertical accuracy test setup values

Range	Initial generator setting (VAC, sine, 50 Hz)	Output limits
2 mV/div	4.243 mV	3.951 mV to 4.517 mV
5 mV/div	10.606 mV	10.183 mV to 11.028 mV
10 mV/div	21.213 mV	20.368 mV to 22.058 mV
20 mV/div	42.426 mV	40.735 mV to 44.117 mV
50 mV/div	106.06 mV	101.83 mV to 110.28 mV
100 mV/div	212.13 mV	203.67 mV to 220.58 mV
200 mV/div	424.26 mV	407.35 mV to 441.16 mV
500 mV/div	1.0607 V	1.0184 V to 1.1030 V
1 V/div	2.1213 V	2.0367 V to 2.2058 V
2 V/div	4.2426 V	4.0735 V to 4.4117 V
5 V/div	10.606 V	10.183 V to 11.028 V
10 V/div	21.213 V	20.368 V to 22.058 V
20 V/div	42.426 V	40.735 V to 44.117 V
50 V/div	106.06 V	101.83 V to 110.29 V
100 V/div	212.13 V	203.67 V to 220.58 V

DC Voltage Accuracy Test



WARNING. Dangerous voltages will be present on the calibration generator output terminals and connection cables. Always verify that the generator is in the standby mode before you make any connections to the generator.

1. Connect the test setup as shown. (See Figure 3.)

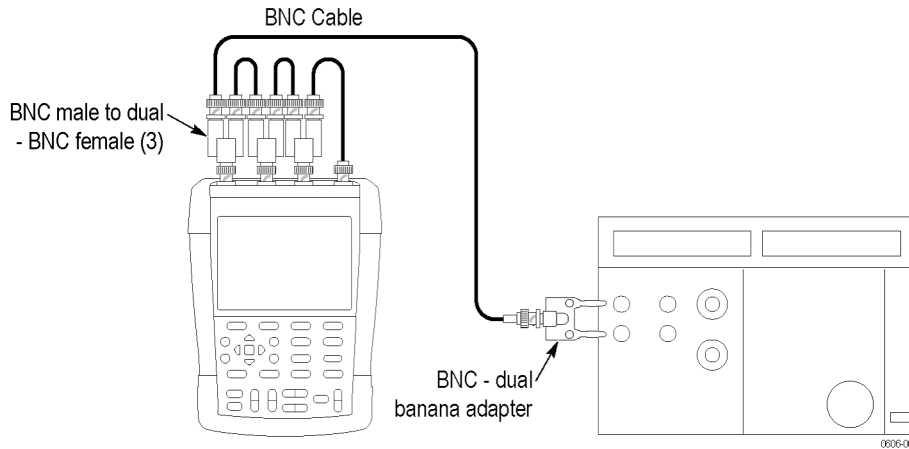


Figure 3: Setup for DC voltage accuracy test

2. Press the Ch 1 button once (for channel 1). The menu that appears on the bottom of the screen allows you to change settings. Set all channels on the oscilloscope to the settings below:
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 kHz (HF Reject)
 - Measure: Measurement on, V dc
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 10 ms/div
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to the first value in the table. (See Table 4 on page 8.)
5. Set the calibration generator to the first value in the table.
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is within the range shown under the appropriate column.
8. Continue through the test values remaining in the table for Channel 1.
9. Set the generator output to 0 V and to standby.
10. Repeat steps 3 through 9 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.

Table 3: DC voltage accuracy test setup values

Range	Generator output (VDC)	Output limits
2 mV/div	+6.0 mV	+4.9 mV to +7.1 mV
	-6.0 mV	-4.9 mV to -7.1 mV
5 mV/div	+15.0 mV	+14.3 mV to +15.7 mV
	-15.0 mV	-14.3 mV to -15.7 mV
10 mV/div	+30.0 mV	+29.1 mV to +30.9 mV
	-30.0 mV	-29.1 mV to -30.9 mV
20 mV/div	+60.0 mV	+58.6 mV to +61.4 mV
	-60.0 mV	-58.6 mV to -61.4 mV
50 mV/div	+150 mV	+143 mV to +157 mV
	-150 mV	-143 mV to -157 mV
100 mV/div	+300 mV	+291 mV to +309 mV
	-300 mV	-291 mV to -309 mV
200 mV/div	+600 mV	+586 mV to +614 mV
	-600 mV	-586 mV to -614 mV
500 mV/div	+1.50 V	+1.43 V to +1.57 V
	-1.50 V	-1.43 V to -1.57 V
1 V/div	+3.00 V	+2.91 V to +3.09 V
	-3.00 V	-2.91 V to -3.09 V
2 V/div	+6.00 V	+5.86 V to +6.14 V
	-6.00 V	-5.86 V to -6.14 V
5 V/div	+15.0 V	+14.3 V to +15.7 V
	-15.0 V	-14.3 V to -15.7 V
10 V/div	+30.0 V	+29.1 V to +30.9 V
	-30.0 V	-29.1 V to -30.9 V
20 V/div	+60.0 V	+58.6 V to +61.4 V
	-60.0 V	-58.6 V to -61.4 V
50 V/div	+150 V	+143 V to +157 V
	-150 V	-143 V to -157 V
100 V/div	+300 V	+291 V to +309 V
	-300 V	-291 V to -309 V

AC Voltage Accuracy Test



WARNING. Dangerous voltages will be present on the calibration generator output terminals and connection cables. Always verify that the generator is in the standby mode before you make any connections to the generator.

1. Connect the test setup as shown in the previous test. (See Figure 3 on page 6.)
2. Press the Ch 1 button once (for channel 1). The menu that appears on the bottom of the screen allows you to change settings. Set all channels on the oscilloscope to the settings below:
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Measure: Measurement on, V ac
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 10 ms/div for the 60 Hz signal used in the 2 mV and 500 mV range tests only; otherwise set to 20 μ s/div for the remaining ranges tested at 20 kHz
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to the first value in the table. (See Table 4.)
5. Set the calibration generator to the first value in the table.
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is within the range shown under the appropriate column.
8. Continue through the test values remaining in the table for Channel 1.
9. Set the generator output to 0 V and to standby.
10. Repeat steps 3 through 9 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.

Table 4: AC voltage accuracy test setup values

Range	Generator output		Output limits
	V (AC)	Frequency	
2 mV/div (select 10 ms/div) Set Channel 1 and 2 bandwidth to 20 kHz to prevent OL due to calibrator noise: see step 2.	4 mV	60 Hz	3.0 mV to 5.0 mV
5 mV/div (select 20 μ s/div). Set Channel 1 and 2 bandwidth 20 MHz	10 mV	20 kHz	8.3 mV to 11.7 mV
10 mV/div	20 mV	20 kHz	18.0 mV to 22.0 mV
20 mV/div	40 mV	20 kHz	37.5 mV to 42.5 mV
50 mV/div	100 mV	20 kHz	96.0 mV to 104.0 mV
100 mV/div	200 mV	20 kHz	180 mV to 220 mV
200 mV/div	400 mV	20 kHz	375 mV to 425 mV

Table 4: AC voltage accuracy test setup values (cont.)

Range	Generator output		Output limits
	V (AC)	Frequency	
500 mV/div (select 10 ms/div)	900 mV	60 Hz	877 mV to 923 mV
500 mV/div (select 20 μ s/div)	900 mV	20 kHz	863 mV to 937 mV
1 V/div	2 V	20 kHz	1.80 V to 2.20 V
2 V/div	4 V	20 kHz	3.75 V to 4.25 V
5 V/div	9 V	20 kHz	8.63 V to 9.37 V
10 V/div	20 V	20 kHz	18.0 V to 22.0 V
20 V/div	40 V	20 kHz	37.5 V to 42.5 V
50 V/div	90 V	20 kHz	86.3 V to 93.7 V
100 V/div	200 V	20 kHz	180 V to 220 V

AC-Coupled Low Frequency Test

1. Connect the test setup as shown in the previous test. (See Figure 3 on page 6.)
2. Set all channels on the oscilloscope to:
 - Coupling: AC
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Measure: Measurement on, V ac
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 40 ms/div
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to 500 mV/div.
5. Set the calibration generator to 900 mV, 60 Hz.
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is 873 mV to 927 mV.
8. Set the calibration generator to 900 mV, 5 Hz.
9. Verify that the measured output voltage on the oscilloscope is >630 mV.
10. Repeat steps 3 through 9 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.
11. Set the generator output to 0 V and to standby.

Peak Measurement Accuracy Test

1. Connect the test setup as shown in the previous test. (See Figure 3 on page 6.)
2. Set all channels on the oscilloscope to:
 - Coupling: AC
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Measure: Measurement on, Peak, Peak Type: Peak-Peak
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 1 ms/div
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to 100 mV/div.
5. Set the calibration generator to 212.13 mV (0.6 V pp).
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is 0.56 Vpp to 0.64 Vpp.
8. Repeat steps 3 through 7 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.
9. Set the generator output to 0 V and to standby.

Frequency Measurement Accuracy Test

1. Connect the test setup as shown. (See Figure 4.)

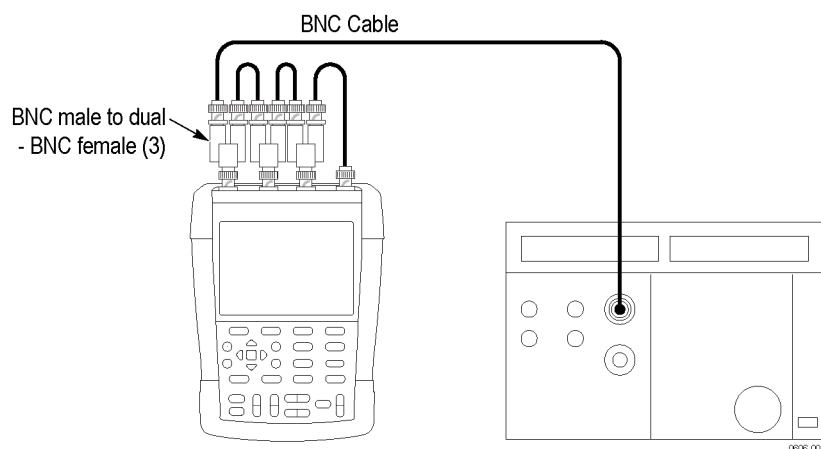


Figure 4: Frequency measurement accuracy test setup

2. Set all channels on the oscilloscope to:
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Measure: Measurement on, Hz
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to 100 mV/div.
5. Set the calibration generator to the first value in the table. (See Table 5.)
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is within the range shown under the appropriate column.
8. Continue through the test values remaining in the table for Channel 1.
9. Repeat steps 3 through 8 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.
10. Set the generator output to 0 V and to standby.

Table 5: Frequency measurement accuracy test setup values

Model	Time base	Output mode	Voltage	Frequency	Measured value
all	20 ms/div	wavegen, sine	600 mV pp	16 Hz	15.90 to 16.10
THS3014	20 ns/div	leveled-sine	300 mV pp	100 MHz	99.3 to 100.7
THS3024	20 ns/div	leveled-sine	300 mV pp	200 MHz	198.8 to 201.2

Input Phase Measurement Test

1. Connect the test setup as shown in the previous test. (See Figure 4 on page 11.)
2. Set all channels on the oscilloscope to:
 - Coupling: AC
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Measure: Measurement A on Ch1, Phase, Measurement B on Ch2, Phase, Measurement C on Ch3, Phase, Measurement D on Ch4, Phase
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to 100 mV/div for all channels.
5. Set the calibration generator to the first value in the table. (See Table 6.) Note: Without a 50 Ω termination installed, the leveled sine wave output amplitude will be twice the set value.
6. Enable the calibration generator output.
7. Verify that the measured output voltage on the oscilloscope is within the range shown under the appropriate column.
8. Continue through the test values remaining in the table for Channel 1.
9. Repeat steps 3 through 8 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.
10. Set the generator output to 0 V and to standby.

Table 6: Phase measurement accuracy test setup values

Time base	Output mode	Voltage	Frequency	Measured value
20 ms/div	wavegen, sine, 1 M Ω	600 mV pp	10 Hz	–2 to +2
200 ns/div	leveled-sine	300 mV pp	1 MHz	–2 to +2
20 ns/div	leveled-sine	300 mV pp	10 MHz	–3 to +3

Time Base Test

1. Connect the test setup as shown. (See Figure 5.)

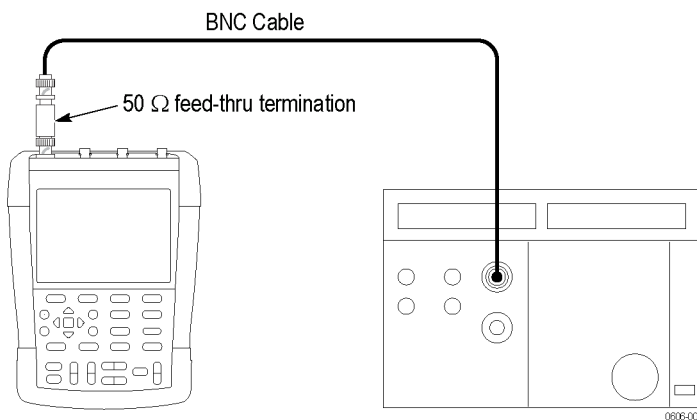


Figure 5: Time base test setup

2. Set the generator to source a 8 ms time marker (MODE marker).
3. Reset the oscilloscope: Power off, press and hold Utility, power on, wait for double beep then release Utility button.
4. Set Channel 1 on the oscilloscope to:
 - Coupling: AC
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: 20 MHz
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Vertical sensitivity to 500 mV/div
 - Ground level centered vertically
 - Horizontal scale: 10 ms/div
5. Position the trace to the left until the trigger delay time is indicated in the bottom-right corner of the display. Adjust the trigger delay time to 8.00 ms. This value represents the delay time with respect to the first vertical grid line.
6. Set the time base to 10 μ s/div.
7. Position the trace to the right until the indicated trigger delay is 7.990 ms. (See Figure 6 on page 14.)

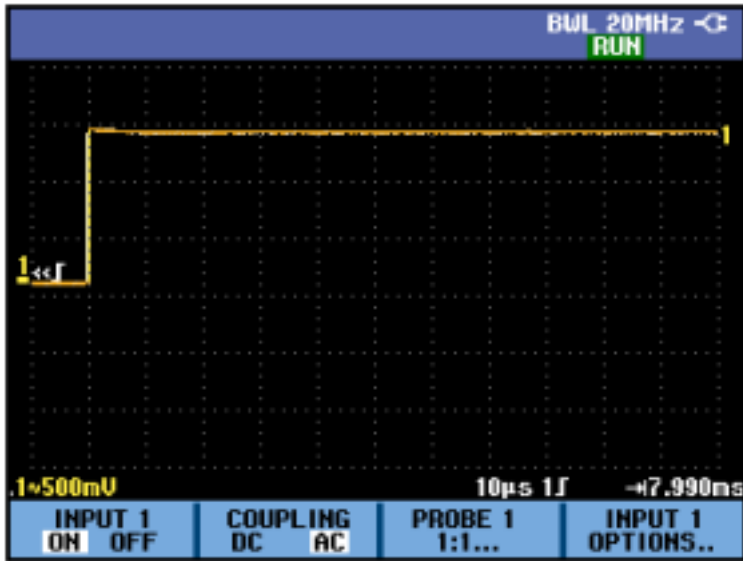


Figure 6: 8 ms time marker

8. Examine the rising edge of the time marker pulse at the height of the trigger level indicator top. (You may need to adjust the horizontal position to view the pulse edge.) Verify that the rising edge is at the second grid line from the left. The allowed deviation is ± 3 pixels. (See Figure 7 on page 14.)

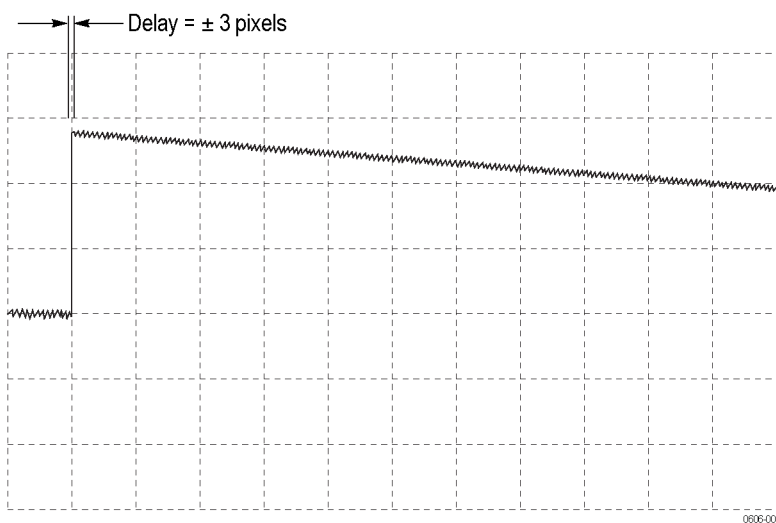


Figure 7: Allowable variance in time base

9. Set the horizontal scale to 10 ms/div.
10. Position the trace to the right until the indicated trigger delay is 800.0 μ s.
11. Set the horizontal scale to 1 μ s/div.

12. Set the generator to source a 0.8 ms time marker (MODE marker).
13. Position the trace to the right until the indicated trigger delay is 799.0 μs .

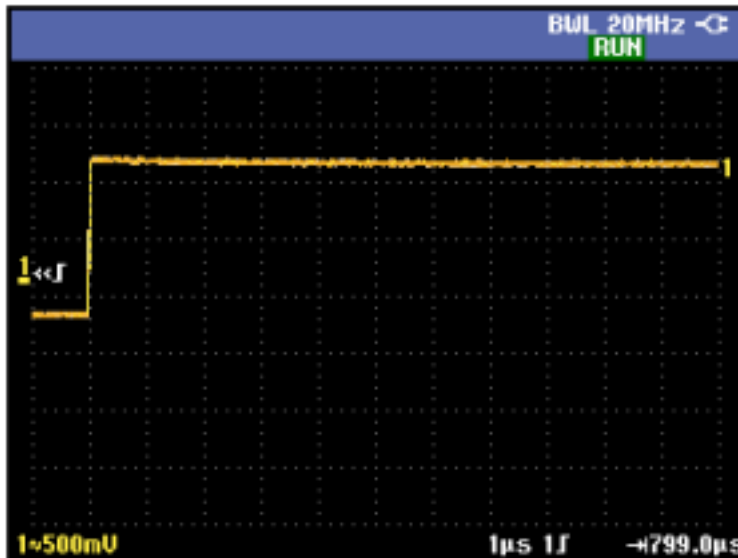


Figure 8: 0.8 ms time marker

14. Examine the rising edge of the time marker pulse at the height of the trigger level indicator top. (You may need to adjust the horizontal position to view the pulse edge.) Verify that the rising edge is at the second grid line from the left. The allowed deviation is ± 3 pixels. (See Figure 7.)
15. Set the generator output to 0 V and to standby.

Trigger Sensitivity Test

1. Connect the test setup as shown in the previous test. (See Figure 5 on page 13.)
2. Reset the oscilloscope: Power off, press and hold Utility, power on, wait for double beep then release Utility button.
3. Set all channels on the oscilloscope to:
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: Full
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
 - Horizontal scale: 10 ms/div
4. Set the oscilloscope to display Channel 1.
5. Set the oscilloscope vertical sensitivity to 2 V/div.
6. Set the calibration generator to the initial value in the table for the oscilloscope model that you are testing. (See Table 7.)
7. Enable the calibration generator output.
8. Adjust the calibration generator output voltage until the displayed waveform amplitude matches the value listed in the last column of the table. (See Table 7.)
9. Verify that the oscilloscope has triggered on the signal. If it has not, manually adjust the trigger level to display a stable signal.
10. Continue through the test values remaining in the table for Channel 1.
11. Set the generator output to 0 V and to standby.
12. Repeat steps 4 through 11 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.

Table 7: Trigger sensitivity test setup values

Oscilloscope			Generator		Output
Model	Horizontal	Vertical	Initial input voltage	Frequency	Waveform amplitude
All	200 ns/div	2 V/div	100 mV pp	5 MHz	0.5 div
THS3014	10 ns/div	100 mV/div	400 mV pp	100 MHz	1 div
	10 ns/div	100 mV/div	800 mV pp	150 MHz	2 div
THS3024	10 ns/div	100 mV/div	400 mV pp	200 MHz	1 div
	10 ns/div	100 mV/div	800 mV pp	250 MHz	2 div

AC Voltage Accuracy and Bandwidth Test

1. Connect the test setup as shown. (See Figure 5 on page 13.)
2. Set all channels on the oscilloscope to:
 - Coupling: AC
 - Probe Type: Voltage, Attenuation: 1:1
 - Input Options: Polarity: Normal, Bandwidth: Full
 - Measure: Measurements V ac
 - Acquire Options: Glitch: Off, Memory: Short, Average: Off, Waveform: Normal
 - Ground level centered vertically
3. Set the oscilloscope to display Channel 1.
4. Set the oscilloscope vertical sensitivity to 500 mV/div.
5. Set the oscilloscope horizontal sensitivity to 400 nS/div.
6. Set the calibration generator output voltage to 2.545 Vpp.
7. Set the calibration generator frequency to the first value in the table. (See Table 8.)
8. Enable the calibration generator output.
9. Verify that the measured output voltage is within the range shown in the measured value column.
10. Continue through the test values remaining in the table for Channel 1.
11. Set the generator output to 0 V and to standby.
12. Repeat steps 3 through 11 for the remaining channels on the oscilloscope. Trigger on the appropriate channel as needed.

Table 8: AC voltage accuracy and bandwidth test setup values

Oscilloscope		Generator		Measured value
Model	Horizontal setting	Voltage	Frequency	
all	400 nS/div	2.545 Vpp	1 MHz	835 mV to 965 mV
all	20 nS/div	2.545 Vpp	25 MHz	790 mV to 1.010 V
THS3014	5 nS/div	2.545 Vpp	100 MHz	>630 mV
THS3024	2 nS/div	2.545 Vpp	200 MHz	>630 mV

Video Trigger Test

Only one of the video systems (NTSC, PAL, PALplus, or SECAM) must be verified.

1. Connect the test setup as shown. (See Figure 9.)

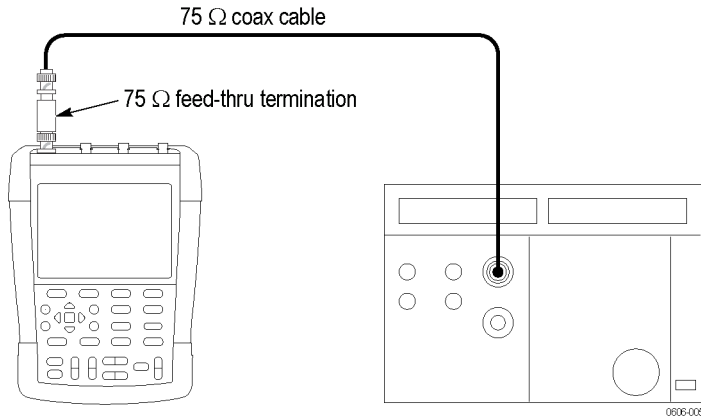


Figure 9: Video trigger test setup

2. Reset the oscilloscope: Power off, press and hold Utility, power on, wait for double beep then release Utility button.
3. Press TRIGGER, then press F4 to open the Trigger Options menu.
4. Choose VIDEO on 1..., then press Enter.
5. Choose Polarity: POSITIVE, then press Enter.
6. Choose NTSC (or the standard that you want to test), then press Enter.
7. Press F2 to select ALL LINES.
8. Press F3 to enable the arrow buttons for selecting the video line number.
9. Use the arrow buttons to select line number: ⇒ 622 for PAL, PALplus, or SECAM ⇒ 525 for NTSC. Note: Hold down the arrow buttons to scroll through faster.
10. Use the Vertical Scale button to set the Input A sensitivity to 200 mV/div (the actual probe setting is 1:1).
11. Use the Horizontal Scale button to set the time base to 20 μs/div.
12. Set the TV Signal Generator to source a signal with the following properties:
 - NTSC (or the standard that you want to test)
 - Gray scale
 - Sync pulse amplitude > 0.7 div
 - Chroma amplitude zero
13. Check to see that the oscilloscope triggers on line number 622 for PAL or SECAM, or 525 for NTSC.
14. Use the arrow buttons to select line number 310 for PAL or SECAM, or 262 for NTSC.
15. Check to see that the oscilloscope triggers on line number 310 for PAL or SECAM, or 262 for NTSC.

16. Press F4 TRIGGER OPTIONS to open the Trigger Options menu.
17. Choose Video on 1 and then press Enter.
18. Choose Polarity: Negative and then press Enter.
19. Choose NTSC (or the standard that you want to test), then press Enter.
20. Use the arrow buttons to select line number 310 for PAL or SECAM, or 262 for NTSC.
21. Check to see that the oscilloscope triggers on line number 310 for PAL or SECAM, or 262 for NTSC.

Probe Calibration Generator Test

1. Connect the test setup as shown. (See Figure 10.)

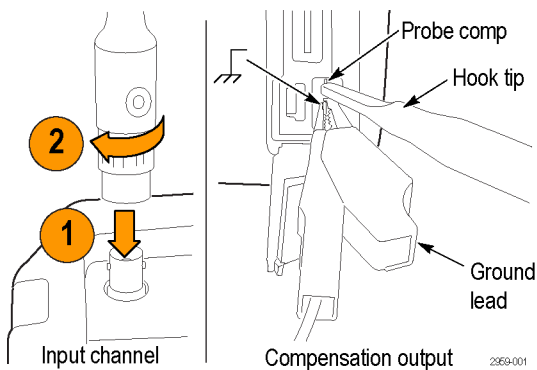


Figure 10: Probe calibration connections

2. Press the Ch 1 button and then F3 to open the PROBE ON 1 menu.
3. Set the Probe Type to Voltage and the Attenuation to 10:1.
4. Press F1 - PROBE CAL and then press F4 - YES.
5. Using the probe compensation adjustment on the probe, adjust the square wave response to a pure square wave (pulse top must be straight).
6. Press F4 - CONTINUE to start the DC calibration that is performed automatically.
7. Repeat the test for the remaining channels on the oscilloscope.

The Probe Calibration Generator performance is verified when all of the on-screen functions finish successfully.

End of performance verification procedures.

Test Record

Photocopy this test record for recording the results of the performance verification procedures.

Table 9: THS3000 series oscilloscope test record

Oscilloscope Model Number:

Certificate Number:

Oscilloscope Serial Number:

RH %:

Temperature:

Technician:

Date of Calibration:

Test	Minimum	Incoming	Outgoing	Maximum
Vertical Accuracy				
2 mV/div	3.951 mV			4.517 mV
5 mV/div	10.183 mV			11.028 mV
10 mV/div	20.368 mV			22.058 mV
20 mV/div	40.735 mV			44.117 mV
50 mV/div	101.83 mV			110.28 mV
100 mV/div	203.67 mV			220.58 mV
200 mV/div	407.35 mV			441.16 mV
500 mV/div	1.0184 V			1.1030 V
1 V/div	2.0367 V			2.2058 V
2 V/div	4.0735 V			4.4117 V
5 V/div	10.183 V			11.028 V
10 V/div	20.368 V			22.058 V
20 V/div	40.735 V			44.117 V
50 V/div	101.83 V			110.29 V
100 V/div	203.67 V			220.58 V

Test	Minimum	Incoming	Outgoing	Maximum
DC Voltage Accuracy				
2 mV/div	4.9 mV			7.1 mV
	-4.9 mV			-7.1 mV
5 mV/div	14.3 mV			15.7 mV
	-14.3 mV			-15.7 mV
10 mV/div	29.1 mV			30.9 mV
	-29.1 mV			-30.9 mV
20 mV/div	58.6 mV			61.4 mV
	-58.6 mV			-61.4 mV
50 mV/div	143 mV			157 mV
	-143 mV			-157 mV
100 mV/div	291 mV			309 mV
	-291 mV			-309 mV
200 mV/div	586 mV			614 mV
	-586 mV			-614 mV
500 mV/div	1.43 V			1.57 V
	-1.43 V			-1.57 V
1 V/div	2.91 V			3.09 V
	-2.91 V			-3.09 V
2 V/div	5.86 V			6.14 V
	-5.86 V			-6.14 V
5 V/div	14.3 V			15.7 V
	-14.3 V			-15.7 V
10 V/div	29.1 V			30.9 V
	-29.1 V			-30.9 V
20 V/div	58.6 V			61.4 V
	-58.6 V			-61.4 V
50 V/div	143 V			157 V
	-143 V			-157 V
100 V/div	291 V			309 V
	-291 V			-309 V

Test	Minimum	Incoming	Outgoing	Maximum
AC Voltage Accuracy				
2 mV/div	3.0 mV			5.0 mV
5 mV/div	8.3 mV			11.7 mV
10 mV/div	18.0 mV			22.0 mV
20 mV/div	37.5 mV			42.5 mV
50 mV/div	96 mV			104 mV
100 mV/div	180 mV			220 mV
200 mV/div	375 mV			425 mV
500 mV/div (@10 ms/div)	877 mV			923 mV
500 mV/div (@20 μ s/div)	863 mV			937 mV
1 V/div	1.80 V			2.20 V
2 V/div	3.75 V			4.25 V
5 V/div	8.63 V			9.37 V
10 V/div	18.0 V			22.0 V
20 V/div	37.5 V			42.5 V
50 V/div	86.3 V			93.7 V
100 V/div	180 V			220 V
AC-Coupled LF				
500 mV/div	873 mV			927 mV
500 mV/div	>630 mV			—
Peak Measurement Accuracy				
100 mV/div	0.56 Vpp			0.64 Vpp
Frequency Measurement Accuracy				
20 ms/div	15.90 Hz			16.10 Hz
20 ns/div	99.3 MHz			100.7 MHz
20 ns/div	198.8 MHz			201.2 MHz

Test	Minimum	Incoming	Outgoing	Maximum
Input Phase Measurement Accuracy				
20 ms/div	-2 °			+2 °
200 ns/div	-2 °			+2 °
20 ns/div	-3 °			+3 °
Time Base				
8.00 ms	-3 pixels			+3 pixels
800.0 µs	-3 pixels			+3 pixels
Trigger Sensitivity				
100 mVpp @ 5 MHz	Stable trigger			—
400 mVpp @ 100 MHz	Stable trigger			—
800 mVpp @ 150 MHz	Stable trigger			—
400 mVpp @ 200 MHz	Stable trigger			—
800 mVpp @ 250 MHz	Stable trigger			—
AC Voltage Accuracy and Bandwidth				
1 MHz	835 mV			965 mV
25 MHz	790 mV			1.010 V
100 MHz	>630 mV			—
200 MHz	>630 mV			—
Video Trigger				
Line 622 (PAL)/525 (NTSC)	Triggers on line			—
Line 310 (PAL)/262 (NTSC)	Triggers on line			—
Line 310 (PAL)/262 (NTSC) <Neg Trig>	Triggers on line			—
Probe Calibration Generator				
	Pass/Fail			—

Adjustments

The following adjustment procedures provide closed-case calibration for the THS3000 Series Oscilloscopes using known reference sources. It measures the reference signals, calculates the correction factors, and stores the correction factors in RAM. After completing the calibration, the correction factors can be stored in Flash ROM.

The oscilloscope should be calibrated after repair, or if it fails the performance test. The oscilloscopes have a normal calibration cycle of one year.

Prerequisites

- Use the equipment listed for the performance verification procedures. (See Table 1 on page 1.)
- Allow the oscilloscope and test equipment to warm up for 30 minutes.
- For each calibration point, wait for the oscilloscope to settle.
- Verify that the oscilloscope battery is charged sufficiently
- Power the oscilloscope with the Battery Charger/Power Adapter (Tektronix part number 119-7900-xx).

Calibration Procedure Outline

To do a complete calibration adjustment you must do all of the following steps:

1. Check the instrument date and adjust if necessary (the calibration date will become the instrument date when you save the calibration data)
2. Select the Calibration Mode
3. Do the Contrast Calibration Adjustment
4. Do the Warm Up & Pre Calibration
5. Do the Final Calibration
6. Save the calibration data and exit the calibration mode

The following calibrations can also be done separately:

- Contrast Calibration: If during normal operation the display cannot be made dark or light enough, or if the display is too light or too dark after an instrument reset, you can do this calibration separately.
- Probe Calibration

Calibration Procedure

Begin the calibration procedure here.

Check the Instrument Date

1. Press the Utility button and select OPTIONS.
2. Use the arrow buttons to select DATE ADJUST and then press the ENTER button.
3. Adjust the date if necessary and then press the ENTER button.

Select the Calibration Mode

1. Press and hold the Utility button.
2. Press and release the Menu Off button.
3. Release the Utility button.

The CAL MODE (Calibration Adjustment) screen appears and shows:

- the calibration step Warming Up (CL 0200)
- the calibration status :IDLE (valid) or :IDLE (invalid)
- the softkey menu

NOTE. You can leave the calibration mode without changing the calibration data by turning the instrument off.

Screen messages and key functions. When the instrument is in the calibration mode, only the four soft keys at the bottom of the screen, the power key, and the Menu Off key can be operated, unless otherwise stated. The calibration adjustment screen shows the actual calibration step (name and number) and its status: Cal Name (CL nnnn) :Status (...).

Table 10: Screen message and key function descriptions

Item	Description
Cal Name	Name of the selected calibration step, for example, WarmingUp
(CL nnnn)	Number of the calibration step
Status (...) can be:	
IDLE (valid)	After (re)entering this step, the calibration process is not started. The calibration data of this step are valid. This means that the last time this step was done, the calibration was successful. It does not necessarily mean that the unit meets the specifications related to this step!
IDLE (invalid)	After (re)entering this step, the calibration process is not started. The calibration data are invalid. This means that the last time this step was done, the calibration was not successful. Most probably the unit will not meet the specifications if the actual calibration data are saved.
BUSY aaa% bbb%	Calibration adjustment step in progress; progress % for Input A and Input B. During WarmingUp the elapsed time is shown.

Table 10: Screen message and key function descriptions (cont.)

Item	Description
READY	Calibration adjustment step finished.
Error :xxxx	Calibration adjustment failed, due to wrong input signal(s) or because the instrument is defective. If the error code is <5000 you can repeat the failed step. If the error code is ≥5000 you must repeat the complete final calibration.
Key functions	
PREVIOUS	select the previous step
NEXT	select the next step
CALIBRATE	start the calibration adjustment of the actual step
EXIT	leave the calibration mode

Calibrate Contrast

After you enter the calibration mode, the display shows: WarmingUp (CL 0200):IDLE (valid). Do not press F3 now! If you did, turn the instrument off and on, and enter the calibration mode again. Proceed as follows to adjust the maximum display darkness (CL 0100), the default contrast (CL 0110), and the maximum display brightness (CL 0120).

1. Press F1 three times to select maximum darkness calibration Contrast (CL 0100).
2. Press CALIBRATE. The display shows a dark test pattern.
3. Using the arrow keys, adjust the display to the maximum darkness at which the test pattern is only just visible.
4. Press F3 to return to the softkey menu.
5. Press F2 to select default contrast calibration Contrast (CL 0110).
6. Press F3 CALIBRATE. The display shows the test pattern at default contrast.
7. Using the arrow keys, set the display to optimal (becomes default) contrast.
8. Press F3 to return to the softkey menu.
9. Press F2 to select maximum brightness calibration Contrast (CL 0120):
10. Press F3 CALIBRATE. The display shows a bright test pattern.
11. Using the arrow keys, adjust the display to the maximum brightness, at which the test pattern is only just visible.
12. Press F3 to return to the softkey menu.
13. The contrast calibration is complete. If you are only adjusting the contrast, you can select EXIT and then YES to save the contrast settings. (The calibration date will not update.)

If you are performing the complete calibration, press F2 to select the next step.

Warm-Up & PreCalibration

You enter the Warm-Up & PreCalibration state either after you enter the calibration mode, or after you select the next step if you have done the Contrast Calibration step CL 120. The display shows WarmingUp (CL 0200):IDLE (valid) or (invalid). Unless you want to calibrate the display contrast only, you must always start the calibration adjustment at the Warming Up (CL 0200) step. If you start at another step, you will make the calibration invalid! The Warm-Up & PreCalibration consists of a 30 minute warm-up period, followed by several internal calibration adjustment steps that do not require input signals.

1. Remove all input connections from the instrument.
2. Press F3 to start the Warm-Up & PreCalibration. The display shows the calibration step in progress, and its status. The first step is WarmingUp (CL 0200) :BUSY 00:29:59. The warm-up period is counted down from 00:29:59 to 00:00:00. Then the remaining precalibration steps are performed automatically. The entire procedure takes about 60 minutes.
3. Wait until the display shows End Precal: READY The PreCal data have now been stored in FlashROM. If you turn off the instrument now by accident, turn it on again immediately; now you can select the calibration mode, and continue with step 4 below. If you turn off the instrument now, and you do not turn it on immediately, you must repeat the WarmUp and PreCalibration steps (select the calibration mode and start at CL 0200).
4. Press F2 NEXT.

Error Messages. If error message 1000 is displayed during WarmingUp or PreCalibration step CL0215, the Main PCA hardware version is not suitable for the installed software version. Other error messages during WarmingUp or PreCalibration indicate that the instrument is defective, and should be repaired.

Calibration Using External Signals

This part of the calibration requires an external signal generator that provides input conditions that are described in each step. After you start a step, the following steps that require the same input conditions will be done automatically.

You must always start this part of the calibration at step 1 below. Starting at another step will make the calibration invalid. You can repeat a step that shows the status :READY by pressing F3 again.

Do not skip ahead to another calibration step and then return to a previous step; the complete final calibration becomes invalid. If you have done this, then you must restart the calibration process starting at step 1.

1. Remove any connections to the instrument inputs.
2. Press F3 to start the calibration.
3. Wait until the display shows calibration status :READY.
4. Press F2 to select the next calibration step (CL 0570).
5. Connect the instrument to the 5500A SCOPE output as shown. (See Figure 11 on page 28.)
6. Set the 5500A to generate a sine wave 50 MHz / 0.5 V pp (mode LEVSINE) at the SCOPE output.
7. Set the 5500A in operate (OPR).
8. Press F3 to start the calibration.
9. Wait until the display shows calibration status :READY.
10. Set the 5500A in standby (STBY).
11. Proceed to the next section.

Input LF-HF Gain

1. Connect the instrument to the 5500A as shown. (See Figure 11.)

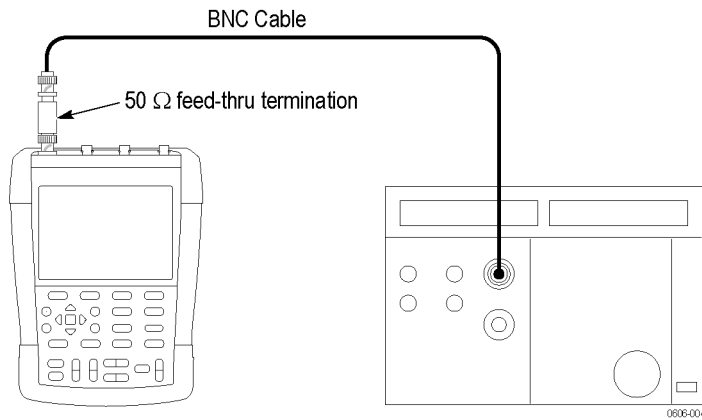


Figure 11: Input LF-HF gain test setup

2. The display must show step CL 0654. If it does not, then press F1 or F2 to select the first calibration step shown in the table. (See Table 11.)
3. Set the 5500A SCOPE output to source the signal required for the first calibration point. (See Table 11.)
4. Set the 5500A in operate (OPR) or standby (STBY) as indicated.
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status :READY.
7. Press F2 to select the next calibration step, set the 5500A to the next calibration point signal, and start the calibration. Continue through all calibration points in the table.
8. Move the generator signal cable to the next input channel on the instrument and repeat steps 3 through 7.
9. When you are finished, set the 5500A to Standby.

Table 11: Input channel LF-HF gain calibration points

Calibration step					
Ch 1	Ch 2	Ch 3	Ch 4	UUT input signal	5500A Setting
CL 0654	CL 0674	CL 0656	CL 0675	0.5 Vpp square wave, 1 kHz	SCOPE edge, 0.5 Vpp, 1 kHz
CL 0400	CL 0410	CL 0470	CL 0490	0.5 Vpp square wave, 1 kHz	SCOPE edge, 0.5 Vpp, 1 kHz
CL 0704	CL 0724	CL 0714	CL 0734	0.5 Vpp square wave, 1 kHz	SCOPE edge, 0.5 Vpp, 1 kHz
CL 0408	CL 0418	CL 0478	CL 0498	0.5 Vpp square wave, 1 kHz	SCOPE edge, 0.5 Vpp, 1 kHz
CL 0480	CL 0482	CL 0484	CL 0486	0.62 Vpp sine wave, 50 kHz	SCOPE levsine, 0.62 Vpp, 50 kHz
CL 0481	CL 0483	CL 0485	CL 0487	0.62 Vpp sine wave THS3014: 141 MHz THS3024: 221 MHz	SCOPE levsine, 0.62 Vpp THS3014: 141 MHz THS3024: 221 MHz

Input LF-HF Gain

1. Press F2 to select the first calibration step in the table. (See Table 12.)
2. Connect the instrument to the 5500A as shown. (See Figure 12.)

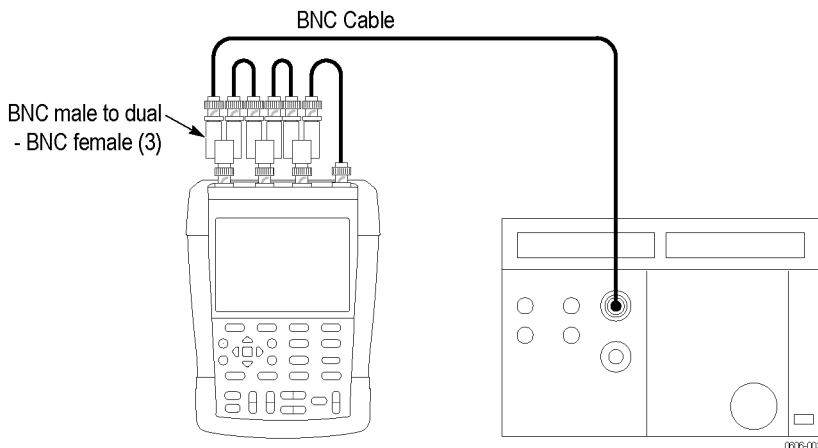


Figure 12: Input LF-HF gain test setup

3. Set the 5500A to supply a 1 kHz square wave (SCOPE, MODE volt, SCOPE Z 1 M Ω), to the first calibration point in the table.



WARNING. Dangerous voltages will be present on the calibration source and connection cables during the following steps. Verify that the calibrator is in standby mode before making any connection between the calibrator and the instrument.

4. Set the 5500A to operate (OPR).
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status :READY.
7. Press F2 to select the next calibration step, set the 5500A to the next calibration point, and start the calibration. Continue through all calibration points in the table.

Table 12: Input LF-HF gain calibration points

Cal step	UUT input value (5500A SCOPE, MODE volt, SCOPE Z 1 M Ω , 1 kHz)
CL 0660	300 mV
CL 0604	500 mV
CL 0637	none (5500 standby)
CL 0504	500 mV
CL 0624	none (5500 standby)
CL 0599	10 mV
CL 0600	25 mV

Table 12: Input LF-HF gain calibration points (cont.)

Cal step	UUT input value (5500A SCOPE, MODE volt, SCOPE Z 1 M Ω , 1 kHz)
CL 0601	50 mV
CL 0602	100 mV
CL 0603	250 mV
CL 0662	2 V
CL 0605	1 V
CL 0606	2.5 V
CL 0607	5 V
CL 0664	20 V
CL 0608	10 V
CL 0609	25 V
CL 0610	50 V (set 5500A to OPR!)

8. Set the 5500A to Standby.

Input Position

Proceed as follows to do the Input Position calibration:

1. Press F2 to select calibration adjustment step CL 0619.
2. Remove all connections to the channels (open inputs).
3. Press F3 to start the calibration.
4. Wait until the display shows calibration status :READY.
5. Proceed to the next step.

Input Voltage Gain



WARNING. Dangerous voltages will be present on the calibration source and connection cables during the following steps. Verify that the calibrator is in standby mode before making any connection between the calibrator and the instrument.

1. Connect the generator to the oscilloscope as shown. (See Figure 13.)

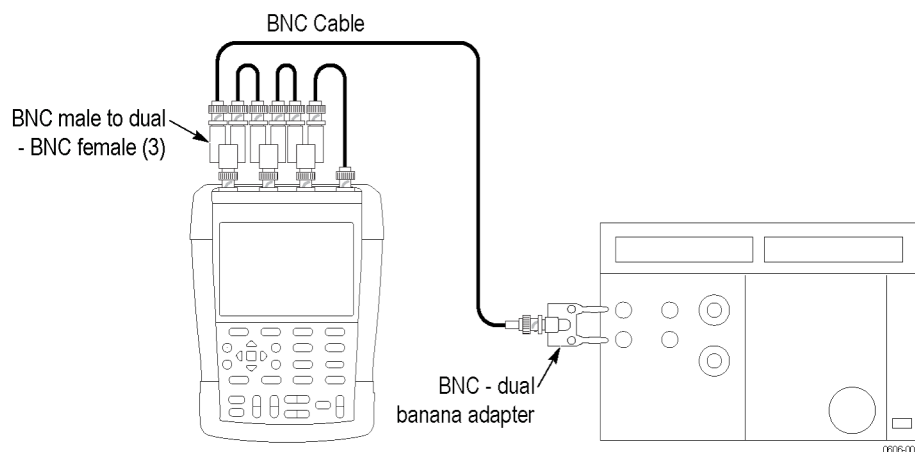


Figure 13: Input to 5500A normal output test setup

2. Press F2 to select the first calibration step in the table. (See Table 13.)

Table 13: Input voltage gain calibration points

Cal step	UUT input value (5500A NORMAL)
CL 0799	5 mV
CL 0800	12.5 mV
CL 0801	25 mV
CL 0802	50 mV
CL 0803	125 mV
CL 0804	250 mV
CL 0805	500 mV
CL 0806	1.25 V
CL 0807	2.5 V
CL 0808	5 V
CL 0809	12.5 V
CL 0810	25 V
CL 0811	50 V (set 5500A to OPR!)

Table 13: Input voltage gain calibration points (cont.)

Cal step	UUT input value (5500A NORMAL)
CL 0812	125 V
CL 0813	250 V

3. Set the 5500A to supply a DC voltage (NORMAL output), to the first calibration point in the table.
4. Set the 5500A to operate (OPR).
5. Press F3 to start the calibration.
6. Wait until the display shows calibration status :READY.
7. Press F2 to select the next calibration step, set the 5500A to the next calibration point, and start the calibration. Continue through all calibration points in the table.
8. Set the 5500A to Standby, and continue to the next section.

Input Zero

1. Press F2 to select calibration adjustment step CL0852.
2. Short circuit Inputs 1–4.
3. Press F3 to start the zero calibration.
4. Wait until the display shows the status :READY.
5. Remove the input terminations.

This completes the data gathering section of the procedure. Continue to the next section to save the calibration data.

Save Calibration Data and Exit

Proceed as follows to save the calibration data, and to exit the Maintenance mode:

1. Remove all test leads from the instrument inputs.
2. Press EXIT. The instrument displays: Calibration data valid. Save data and exit maintenance mode?
3. Press YES to save and exit.

NOTE. Calibration data valid indicates that the calibration adjustment procedure was performed correctly. It does not necessarily mean that the instrument meets the specifications.

After saving the calibration data, the calibration number and date will be updated if the calibration data have been changed and the data are valid. The calibration number and date will not change if the calibration mode is entered and left without doing a calibration adjustment, or only the contrast calibration adjustment and/or the probe calibration is done.

If you press NO, the instrument returns to the calibration mode. You can either calibrate the instrument again, or press EXIT, YES to save and exit.

Error Messages

The following messages may occur on the instrument display:

WARNING: Calibration data not valid. Save data and exit maintenance mode?

1. If you did the WarmingUp and PreCalibration successfully, and you want to store the PreCalibration data before continuing with the Final Calibration, press YES.
2. Turn the instrument off and on again. It will display the message:
The instrument needs calibration. Please contact your service center.
3. The calibration date and number will not be updated. You must continue with the Final Calibration.
4. To return to the Maintenance mode, to repeat the complete calibration, press NO.
5. Press F1 until the display shows WarmingUp (CL 0200):IDLE, and calibrate the instrument.
6. To exit and maintain the old calibration data, turn the instrument off.