FLUKE®
Calibration

9500C

Oscilloscope Calibrator

Users Manual

10/2024 (English)

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Table of Contents

Introduction

The Fluke 9500C (the Product or Calibrator) is an oscilloscope calibrator that generates signals and makes measurements used to calibrate and test oscilloscopes. See Figure 1. The Product uses Fluke 9540C Active Heads™ to deliver signals to multi-channel oscilloscopes. See Figure 2. An Active Head or trigger cable can deliver the trigger signal to the oscilloscope.

Figure 1. The Product

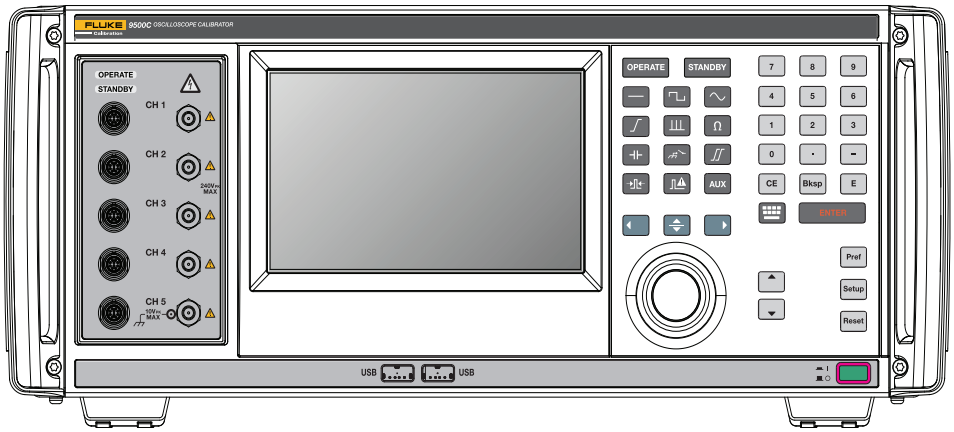
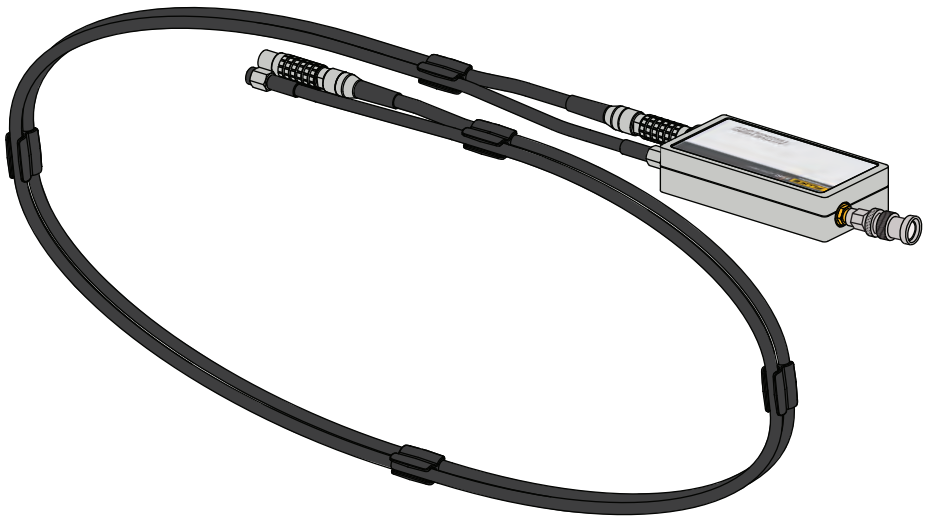


Figure 2. Active Head



Contact Fluke

Fluke Corporation operates worldwide. For local contact information, go to our website: www.fluke.com

To register your product, or to view, print, or download the latest manual or manual supplement, go to our website: www.fluke.com/productinfo

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Safety Information

General Safety Information is located in the printed Safety Information document that ships with the Product. It can also be found online at www.fluke.com. More specific safety information is listed where applicable.

A **Warning** identifies hazardous conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

Specifications

Safety Specifications are located in the Safety Specifications section of the *9500C Safety Information*. Complete specifications are at www.fluke.com.

Service Information

Contact an authorized Fluke Calibration Service Center if the Product needs calibration or repair during the warranty period. Please have Product information such as the purchase date and serial number ready when you schedule a repair.

Operation Overview

Operate the Product manually, from the front panel, or remotely using a controller connected to the IEEE-488 interface. In both cases, connect the Active Heads and trigger cable to the oscilloscope under test.

For manual operation, use the Product front-panel controls (keypad and touch screen) to select the signals required by the DUT (Device Under Test) manufacturer's calibration procedure. You can also manually configure, and adjust or verify the DUT.

For remote operation, the system controller runs a procedure that selects the required Product output signals and configures the DUT. You can also adjust or verify the DUT remotely. You can configure the Product to respond to different controllers for system compatibility.

The Product rear-panel GPIB port is a fully programmable parallel interface bus that meets the GPIB (IEEE-488.1) standard and supplemental IEEE-488.2 standard. The interface is for automatic calibration of DUT oscilloscopes, and for automatic calibration of the Product itself. See the *9500C Remote Programmers Manual* at www.fluke.com for how to connect to the system controller and the IEEE-488.2 command codes. Under the remote control of an instrument controller, the Product operates exclusively as a talker/listener. Use the IEEE-488 command set or run MET/CAL™ software (optional) to write your own programs.

The Product has these basic modes of operation:

MET/CAL™ Software

The Product is supported in MET/CAL™ software through the 9500C Function Select Code (FSC) starting in version 11.1.0. Procedures written using the 9500 and 9500B FSCs will also work with this Product through device mapping functionality. For more information on configuring the instrument in MET/CAL, device mapping, or authoring and running procedures, see the MET/CAL Help System.

Manual and Remote Calibration of the Product

Periodically verify or calibrate the Product against suitable traceable standards. The calibration processes for the Base Unit and Active Heads are available manually, but these process commands are also available via the remote interface. The Product communicates with programmable standards under the direction of external Control Software.

Active Head Technology

The Active Head Technology connects the Product to a DUT oscilloscope. The main function of a head is to route the output of the Product to the DUT oscilloscope input channel without intervening cables that could degrade the signal.

Each head contains output circuitry that generates and supports the transmission of edges with very fast rise times that have low distortion. The fast edges have low amplitude variation and good load matching. The head has low-loss substrate dielectrics, with wide-band components, attenuators, and relays. The heads also control the amplitude of the sine, DCV, and square function outputs.

For available head modules, see Table 1.

Options and Accessories

Table 1 lists available options.

Table 1. Options and Accessories

	Part	Description
Active Head™	Model 9540C	Active Head with 125 ps edge capability along with sine, DCV, and square function outputs.
	5599594	Output cable for Active Head.
	5209782	Control cable for Active Head
	4197064	Torque tightening tool for installing Active Heads.
Trigger Cable	5209374	The Trigger Cable connects between the Product SMA trigger output and the DUT oscilloscope input BNC as an alternative to doing this with an Active Head. Generally only one Trigger Cable can be active, except in the Skew function where you can use up to five Trigger Cables.
SMA-BNC adapter	5599414	Adapter fitted to the Active Head SMA output before the active Head calibration to convert it to a BNC output.

Table 1. Options and Accessories (cont.)

	Part	Description
Current loop output adapter	3127944	Adapter that can be fitted to the Active Head output to calibrate current probes.
Head Carry Case	6000074	Case to store and transport up to 5 Active Heads and cables.
Rack Mounting Kit	5341848	Kit used to mount the Product into a rack or cabinet.

Installation

Use this section to unpack and install the Product.

Unpack and Inspect the Product

Carefully unpack the equipment and check for external damage to the case, sockets, controls, and other parts of the Product.

- If the shipping container and cushioning material are not damaged, keep the packing for use in subsequent shipments.
- If you notice damage, keep the shipping container, inner carton, and cushioning material for inspection by the carrier. Notify the carrier immediately.

Standard accessories supplied with the Product are described in Table 1 and on your delivery note.

Move the Product

⚠⚠ Warning

To avoid injury, take special care when lifting and carrying the Product. The Product weighs >12 kg.

Place product on a flat stable surface. Do not place product where vents are covered. Do not place product where access to the mains power cord is blocked.

To lift and carry from bench height:

1. Disconnect and remove any cables from the Product.
2. Disconnect Active Heads from the front panel.
3. Tilt the Product so the Product stands vertically on the rear panel, with the feet towards you, at the edge of the bench.

   The center of gravity for the Product is concentrated at the rear.
4. Grasp the Product at the bottom (rear panel) corner furthest away from you, and tilt the Product slightly to rest against you.
5. Take the weight and carry the Product vertically at the same height, making sure the Product remains resting against you.

6. Place the Product down at the same level by setting the Product vertically onto the surface, and then swivel the Product so that it can be tilted back on to the feet.

To lift and put down at a lower level:

1. Always bend your knees, not your back, when going down. Keep your back as straight and as vertical as possible.
2. Use the technique described above to hold the Product center of gravity close to you.

Connect to Line Power

⚠⚠ Warning

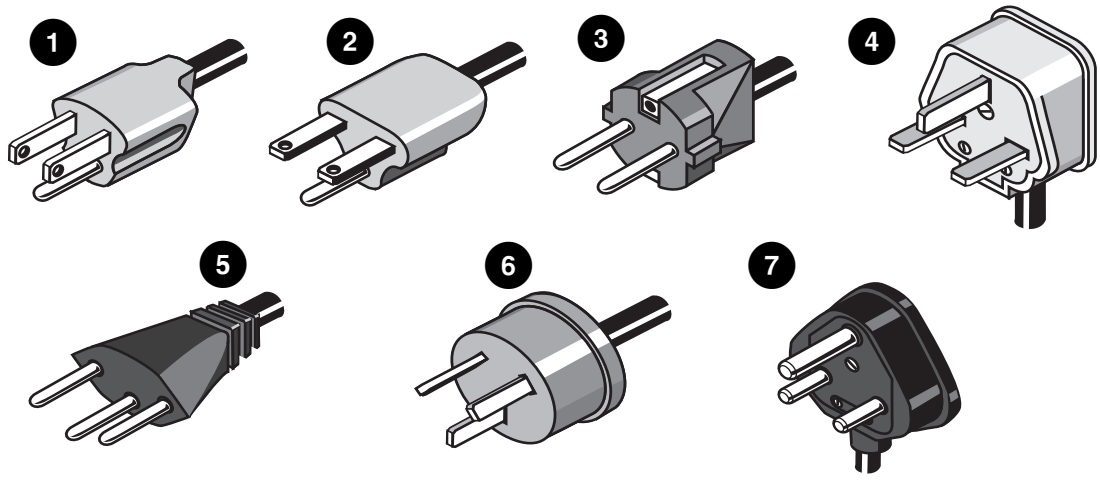
To prevent possible electrical shock, fire, or personal injury:

- **Do not put the Product where access to the mains power cord is blocked.**
- **Use only the mains power cord and connector approved for the voltage and plug configuration in your country and rated for the Product.**
- **Connect an approved three-conductor mains power cord to a grounded power outlet.**
- **Make sure the ground conductor in the mains power cord is connected to a protective earth ground. Disruption of the protective earth could put voltage on the chassis that could cause death.**
- **Use only specified replacement parts.**
- **Replace the mains power cord if the insulation is damaged or if the insulation shows signs of wear.**

The Product comes with the appropriate line power plug for the country of purchase. If you need a different type, see Table 2 for the line power plug types available from Fluke Calibration.

The Product uses one type of line fuse for all line configurations. To change line configuration, replace the line cord with an appropriate cord from Table 2.

Table 2. Line Power Cord Types Available from Fluke Calibration

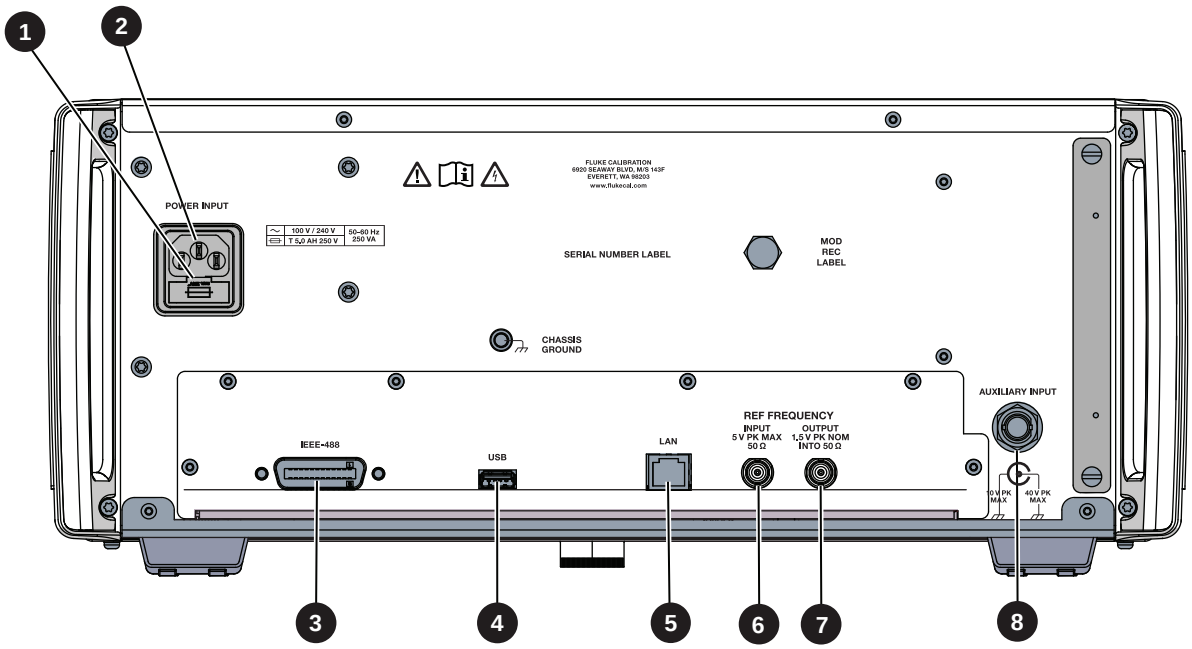


Number	Type	Voltage/Current	Fluke Option Number
1	North America	120 V/15 A	LC-1
2	North America	240 V/15 A	LC-2
3	Universal Euro	220 V/15 A	LC-3
4	United Kingdom	240 V/13 A	LC-4
5	Switzerland	220 V/10 A	LC-5
6	Australia	240 V/10 A	LC-6
7	South Africa	240 V/5 A	LC-7

Back Panel

Table 3 shows the connections available on the rear panel.

Table 3. Back Panel

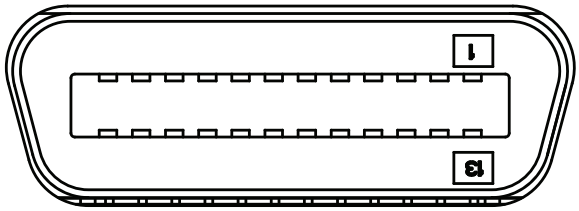


Item	Description
1	Fuse Compartment
2	Power Input
3	IEEE-488 Serial Port
4	USB Port
5	LAN Port (not used)
6	Reference Frequency (Input)
7	Reference Frequency (Output)
8	Auxiliary Input

IEEE-488

The 24-way input/output connector on the rear panel, is directly compatible with the IEEE-488 and IEC-625 Interface Bus standards.

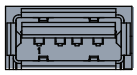
Table 4. Serial Port Pin Designations



Pin	Name	Description
1	DIO 1	Data Input Output Line 1
2	DIO 2	Data Input Output Line 2
3	DIO 3	Data Input Output Line 3
4	DIO 4	Data Input Output Line 4
5	EOI	End or Identify
6	DAV	Data Valid
7	NRFD	Not ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on cable (connected to Safety Ground)
13	DIO 5	Data Input Output Line 5
14	DIO 6	Data Input Output Line 6
15	DIO 7	Data Input Output Line 7
16	DIO 8	Data Input Output Line 8
17	REN	Remote Enable
18	GND 6	Ground wire of twisted pair with DAV
19	GND 7	Ground wire of twisted pair with NRFD
20	GND 8	Ground wire of twisted pair with NDAC
21	GND 9	Ground wire of twisted pair with IFC
22	GND 10	Ground wire of twisted pair with SRQ
23	GND 11	Ground wire of twisted pair with ATN
24	0V_F	Logic Ground (Internally associated with Safety Ground)

USB

Figure 3. USB Port



USB port on the back panel is for firmware updates.

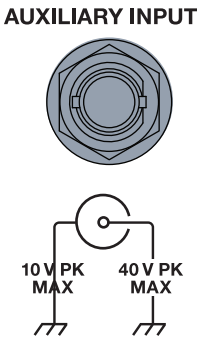
Auxiliary Input (AUX IN)

This BNC connector provides an internal, passive, relay switched route to the Active Head output. Apply signals from your equipment to the inputs of a DUT oscilloscope for specific calibration or test purposes.

Select Auxiliary Input and use front-panel controls to do a wideband passive route from a rear-panel 50 Ω BNC input through to the selected channel output. Use the front-panel keys or the remote interface to switch the signal between channels. There is no trigger pickoff, and internal triggers are not available.

The Auxiliary Input connector shield can float a maximum of 10 V pk from earth ground. A maximum of 40 V pk relative to earth ground can be applied to the input.

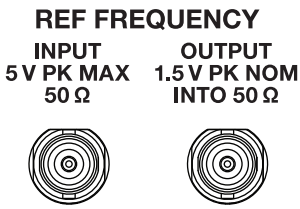
Figure 4. Auxiliary Input



REF Frequency

BNC connectors provide input and output references. Use front-panel keys to select the signal as reference.

Figure 5. Reference Frequency Input and Output



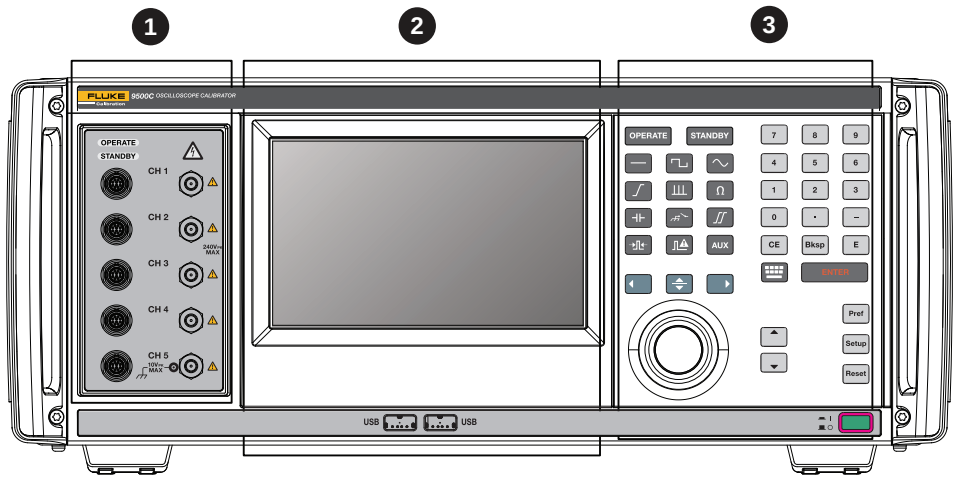
- INPUT - Accepts reference frequency inputs from 1 MHz to 20 MHz in 1 MHz steps, from a TTL or sine wave source. Provides an input for a signal of good frequency accuracy as a frequency reference in the Product.

- OUTPUT - Provides a reference frequency output at either 1 MHz or 10 MHz, from a 50 Ω source. Use OUTPUT to enhance the frequency accuracy of other devices. The output reference signal is the same frequency accuracy as the Product.

Controls and Features

The main areas on the front panel are shown in Table 5.

Table 5. Front Panel Main Areas

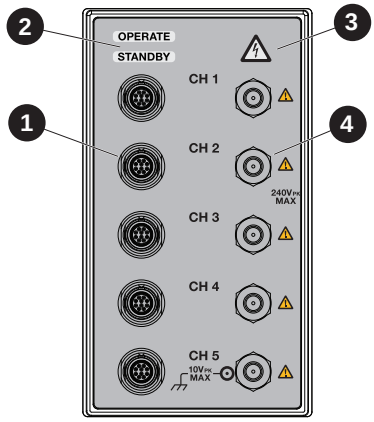


Item	Description
1	The Output Connectors for the Active Heads™ and trigger cable.
2	A touch LCD screen, for output display and menus. The display shows essential information and menu selections. Use the touch buttons on the display, to select sub-functions and individual parameters. USB ports for firmware updates and to save self-test results.
3	The control panel for Functions. This panel has the main controls for the operational functions of the calibrator.

Front Panel

Familiarize yourself with the display and the front-panel controls. Table 6 shows the output connections.

Table 6. Output Connector Panel

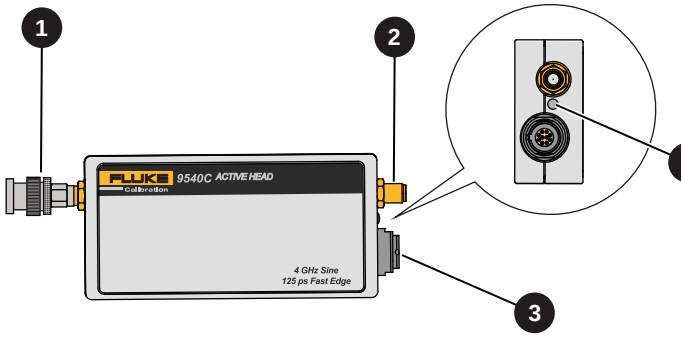


Item	Description
1	Active Head data/control connection
2	Operation mode lights
3	High voltage indicator
4	Trigger/Signal connection

Active Head

Table 7 shows the Active Head and connections.

Table 7. Active Head



Item	Description
1	DUT SMA connection with BNC adapter attached
2	Signal cable SMA connection
3	Data and control SMA connection
4	LED indicator (See Table 8)

Table 8. Active Head LED indications

Color	Head Condition
Not illuminated	Not selected
Amber	Signal channel output off
Green	Signal channel low voltage output on
Red	Signal channel high voltage output on
Blue	Trigger channel output off
Cyan	Trigger channel output on
Flashing magenta	Firmware update

Connections to the DUT Oscilloscope

You can connect to the DUT Oscilloscope with an Active Head or directly with a trigger cable. Each Active Head has these connections:

- 10-way cable to power the Active Head and to control and sense signals.
- Coaxial cable of the signal or clock. The Active Head output signal goes to the input channel for the DUT oscilloscope.

To make the Active Head SMA connections:

1. Align SMA connectors carefully and lightly tighten to avoid cross threading.
2. Do the final tightening with torque wrench to 0.45 Nm.

Note

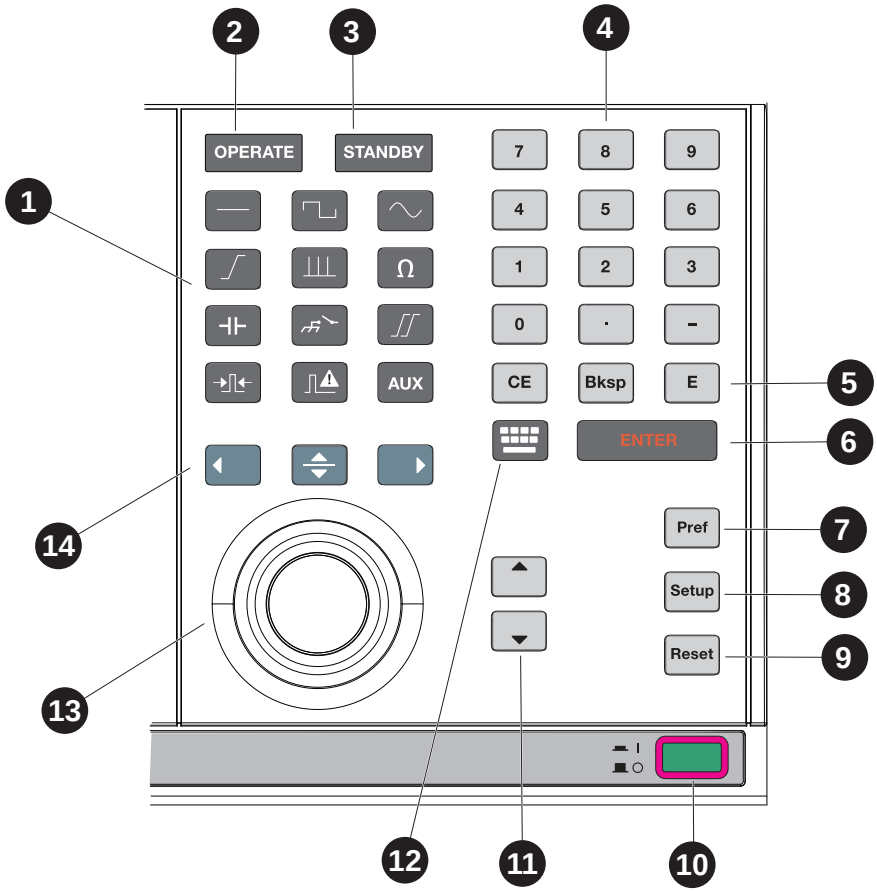
Torque setting 0.45 Nm applies to base, Active Head, and DUT.

The BNC adapter requires a different torque setting. Use1.0 Nm for BNC adapters.

Control Panel

Table 9 shows the front panel controls.

Table 9. Control Panel

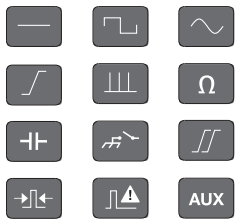


Item	Function	Description
1	Function Keys	See Table 10. Use the Function keys to manually configure the Product output.
2	OPERATE	Push to turn on the signal. Toggles normal operation (LED green) and Standby (LED orange).
3	STANDBY	Push to turn off the signal. Toggles normal operation (LED green) and Standby (LED orange).
4	Numeric Keys	Use the numeric key pad to enter numeric values.

Table 9. Control Panel (cont.)

Item	Function	Description
5	CE	Clear Entry - clears the current input.
	Bksp	Backspace - deletes digits in an entry.
	E	Exponent - use to enter exponent values.
6	ENTER	Enter - use to complete an entry.
7	Pref	Adjust user-preferences. (See *Preferences*.)
8	Setup	Configure the Product and access adjustment (calibration) and diagnostic tests.
9	Reset	Changes setting to the Product to the default state.
10		Power on or power off the Product.
11		Increments or decrements the selected value.
12		Shows an alpha keyboard on the touch screen. Use to enter alpha characters.
13		Knob Select and increment or decrement values.
14		Cursor keys. and move the cursor to select a digit for adjustment. selects the next field.

Table 10. Function Keys



Icon	Function	Description
—	DCV	Select output channel and amplitudes.
⊓	Square	Select output channel, amplitudes, and frequency.
~	Leveled sine wave	Select output channel, amplitude, and frequency.
∫	Edge	Select polarity, amplitude and frequency.
⫼	Time Markers	Marker types are: • Square/Sine • Pulse • Narrow Triangle waveform
Ω	Resistance	Measures load resistance in the output circuit of the Active Head.
⊣⊢	Capacitance	Measures load capacitance in the output circuit of the Active Head.
	Input Leakage	Tests oscilloscope input leakage current using short/open outputs directly to the output connector.
	Zero Skew	Permits channels/heads transit times to be harmonized, to test DUT input channel trigger synchronization.
	Pulse Width	Generate variable width pulses for the testing trigger timing circuitry within an Oscilloscope.
	Pulse Overload	Generate Overload Pulses to test oscilloscope 50 Ω terminator protection.

Table 10. Function Keys (cont.)

Icon	Function	Description
AUX	Auxiliary Functions	
		DC Current Source - Current outputs from 100 µA to 100 mA are derived from the DC/Square voltage source.
		Square Current Source - Current outputs from 100 µA to 100 mA are derived from the DC/Square voltage source.
		Composite Video - Video voltage outputs pass directly via the output connector to test TV sync separator functions.
		Linear Ramp - Symmetrical triangular 1 V_{pk-pk} waveforms of period 3 ms to 3 s pass through the DC/Square voltage route to the output connector. These calibrate trigger level markers and check DSOs for missing ADC codes.
		AUX IN - Routes external calibration waveforms to an Active Head connector output.

Edit Values

Use the softkey to toggle between Direct mode  and Scope mode  . If you switch from Direct mode to Scope mode, the values shift to align with the correct mode steps. See Table 11 for edit modes.

Table 11. Edit Modes

Mode key	Mode name	Operation
	Direct Edit	The display shows triangular cursors above and below the selected digit. You can manually edit the value.  Edit options: • Digit Edit • Numeric-Entry Edit

Table 11. Edit Modes

Mode key	Mode name	Operation
	Scope Edit (default)	The display shows a barred cursor above and below the selected digit. Edit the value in pre-defined step sequences, see *Preferences*.  Edit options: • Sequence Scroll In Scope Mode, the only variable which uses the triangular cursor is Deviation, whose resolution is a constant.

Edit Options

- Digit Edit - (default) Edit values digit by digit. Use to select a field. Use or to select a digit or to quickly change the resolution of the value. Use or or use the knob to increment or decrement the value.
- Numeric-Entry Edit - Replace the value with a complete new value. Use the numeric keypad to enter the value in an edit box or edit the units with the softkeys on the screen.
- Sequence scroll - Edits use preselected step sequences. For example, 1:2:5 factor steps. Use or or use the knob to increment or decrement the whole value through the pre-defined steps. To change the factor sequence see *Preferences*.

Resolution

When you move the cursor off the end of the number, if the resolution can be changed, the resolution automatically updates to accommodate an extra digit. You can continue until you reach the maximum resolution. For example if the display shows 20.000, use to quickly change to 020.00.

Preferences

Use Pref to adjust the options in Table 12. You can adjust Preferences in all modes and functions without changing the function setup (output is turned off). The Product remembers preferences through different modes and functions, and preferences are restored after Power off/Power on.

To change or view preferences:

1. Tap the setting.
2. Use ◀ or ▶ to position the cursor.
3. Use the knob or ▲▼ to adjust the value.
4. To exit, tap **Exit** or push Pref.

Table 12. Preferences

Parameter	Value	Description
Amplitude Step	**1—2—5** **1—2—2.5—4—5**	For most DUT oscilloscopes, amplitude sensitivity is increased or decreased with these sequences.
Time Step	**1—2—5** **1—2—2.5—4—5**	Change the output period (and frequency) in the specified factor steps.
Deviation Mode	**Deviation** **UUT Error**	Control the deviation of an output signal amplitude from the factored output step within ±11.2 % from the function screen. For example, use the deviation control to adjust the signal of 1 V dc from 0.8880 V to 1.1120 V. See *Deviation Display*.

Deviation Display

You can control the deviation of an output signal amplitude from the factored output step within ±11.2 % from the function screen.

For DUT Error - Use the deviation control to adjust the Product output until the DUT oscilloscope presentation shows the required value. You can read the Product output value and the DUT error also shows. Both the DUT error and the deviation are expressed as a percentage (ratios). For example, if the deviation must be adjusted to +10.00 %, the DUT error is -9.091 %.

Example of DUT Error:

- Assume a 1 V DUT nominal cal point.
- The Product set to 1 V: DUT reading is low.
- Increase the Deviation Display until the DUT reading is 1 V nominal—Deviation value is +10 % and Product output is 1.1 V.

- A DUT reading of 1 V represents 1.1 V x 1 V, so the DUT original reading for 1 V input was 1 V ÷ 1.1 V = 0.909091 V.
- The DUT Error is: 0.909091 V – 1 V = -0.09091 V.
- The DUT percentage Error is: (0.09091 V ÷ 1 V) x 100 %, = -9.09091 %.

To change the Deviation parameter:

1. Use ◀ or ▶ to position the cursor on the Deviation display parameter.
2. Use the knob or ▲▼ to toggle between **Deviation** and **UUT Error**.

Parameter Context

If the Deviation units are changed to ΔV (absolute voltage) instead of Δ% (relative voltage), then the Product adjusts. For example:

For an Amplitude of 20.000 mV:

- If you enter **.002** - the Product respects the change of units. The result also changes the available unit labels on the right screen keys.
- If you push ENTER to implement the value, (in this case) the units will be Volts. If you entered 2 followed by ENTER, an error message will appear, as 2 V is obviously outside the deviation range of ±10 % for the set value of 20 mV.
- If you enter 2, then tap **mV** for the correct result.

The new deviation of +2 mV is equivalent to +10 % of the set value. Push Δ% Δ to confirm.

Setup

You can change the settings of user-defined parameters.

Passwords

The Product requires a password for adjustment (calibration). For security reasons, Fluke Calibration recommends you change the password on the first use.

The initial Calibration password is: 9500.

Setup Menu

To view the parameters:

- Push Setup to show the available parameters.

  Only some parameters can be changed.

To change the configuration options:

1. Tap the softkey for the parameter.
2. Use direct edit to make the entry or select the default parameter.

3. Tap **Exit** to return to the Setup menu.

Table 13 shows the options in the Configuration menu.

Table 13. Configuration Parameters

Parameter	Values	Description
Bus address	Range: 0 to 30	When the Product is set for remote operation, an external controller controls the Product. The controller addresses commands to the Product with an address code from 0 to 30. The Product must match the address code. *Note* *The Product must have the correct bus address to use remote commands.* Remote operation is described in the *9500C Remote Command Manual.*
IDN Config	**9500C** **9500B** **9500**	Use to retain compatibility with software applications that depend on the keeping the existing response to *IDN? the same. The **Output** field shows the actual response to *IDN?
New Password		To change the password: 1. Enter the new password. • Push to use the on screen alphanumeric keyboard then tap **Continue**. • Tap to toggle the actual password and * characters. 2. Re-enter the password to confirm and then tap **Save**.
Ext ref IN (Reference Frequency Input)	**Internal** **External**	A BNC connector on the rear panel accepts reference frequency inputs from 1 MHz to 20 MHz in 1 MHz steps, from a TTL source. Range: 1 MHz to 20 MHz Select the type of reference and use the cursor keys or knob to change the reference value.

Table 13. Configuration Parameters (cont.)

Parameter	Values	Description
Ext ref OUT (Reference Frequency Output)	**DISABLE** **1 MHz** **10 MHz**	A BNC connector on the rear panel provides a reference frequency output at either 1 MHz or 10 MHz, from a 50 Ω source (VSWR < 1.2 to 100 MHz). This can use the internal clock to enhance the frequency accuracy of other devices. Select the external reference frequency to apply to the REF FREQUENCY OUTPUT BNC connector or disable the reference output.
Date **Time**	**Change Date** **Change Time**	A real-time clock, supported by an internal battery, shows the date and time on many screens. Select the format for the date and time from the right softkeys. Select **Change Date** to select the date from a calendar. The date shows as the selected format. Use **Toggle Delim** to switch between slash (/) and period (.). Select **Change Time** to use the cursor keys or knob to set the time. The date will display in the selected format.
Head Config	View only	Each Active Head stores details and calibration corrections, specific to that head, regardless of the base unit to which it is fitted. The display shows details derived from the fitted heads. Tap **Head Config** to view the type, serial number, firmware version, and calibration date for each head fitted. Select **Firmware Update** to update the firmware. See *Active Head Firmware Update*.
Display	**Brightness** **Backlight Dimmer** **Dimmer Brightness**	Use ⇕ to select the option. Then use the touchscreen to adjust the sliders or ⇕ to adjust the backlight timer. Brightness is the screen brightness. To select default brightness of 50 % tap **Default Brightness.** Backlight Dimmer is how long to leave the display on when there is no activity. Setting the timer to 0:00 will turn off the dim function. Dimmer Brightness adjusts how bright the screen is when it is in dim mode.

Table 13. Configuration Parameters (cont.)

Parameter	Values	Description
Instrument Adjust.	**Adjust Defaults** **Relay Usage** **Base** **Head** **Voltage Reference**	Password protected to adjust the calibration of the Product.
SelfTest	**UI Tests** **Start Test**	Select **SelfTest**. Use the knob to select the tests. • All • Base • Head Before you start the SelfTest test, make sure all Active Head outputs are disconnected from any DUT, loads, adapters, or cabling. To start the test, tap **Start Test**. To stop the SelfTest, tap **Abort**. When the test is complete, tap **View Failures**, to see errors. Options for UI Tests are: • Touchscreen-To test the display tap anywhere on the display. An indicator shows. Push ⬍ to exit. • Keys/Knob-Push a key and the name displays and a tone sounds. Push ⬍ to exit • Display-Push ◀ or ▶ to step through the test screens. Push ⬍ to exit.

Active Head Firmware Update

To update Active Head firmware:

1. Connect the Active Heads to be updated.
2. Push Setup.
3. Tap **Head Config** > **Firmware Updates**.
4. To update all connected heads, tap **Update All Heads** and tap **Update** to confirm.
5. To update heads one at a time, use **Previous Head** and **Next Head** to select the Active Head, and then tap **Update** to confirm.
6. Tap **Exit** when done.

Manual Operation

Use the information in this section to control the Product from the front panel.

Turn on the Product

To turn on the Product, connect the Product to line power and push [redacted].

The Product powers on. Allow a warm-up period of 20 minutes or twice the time the Product has been powered off, whichever is less. The default state is the Square function.

Channel, Cable Select, and Trigger Ratio are stored in non-volatile memory. These selections do not change when modes and functions change or you power on or off the Product.

⚠ Caution

When you see the ⚠ symbol, on the front panel and heads, check the Product manual and *9500C Specifications* for maximum output voltages and currents.

Basic Manual Operation

To do the calibration:

1. Attach the Active Head to the Product and to the DUT. (See *Connections to the DUT Oscilloscope*.)
2. Select the waveform from the function key or tap **WaveForm**.
3. Use **Channel Select** on the bottom menu to set up the channel and Triggers. See *Channel Select*.
4. Use the menus and front panel keys to adjust the values.

See *Edit Values* for more information about editing. Use [redacted] to scroll through the values. The cursor changes to the editing mode available.

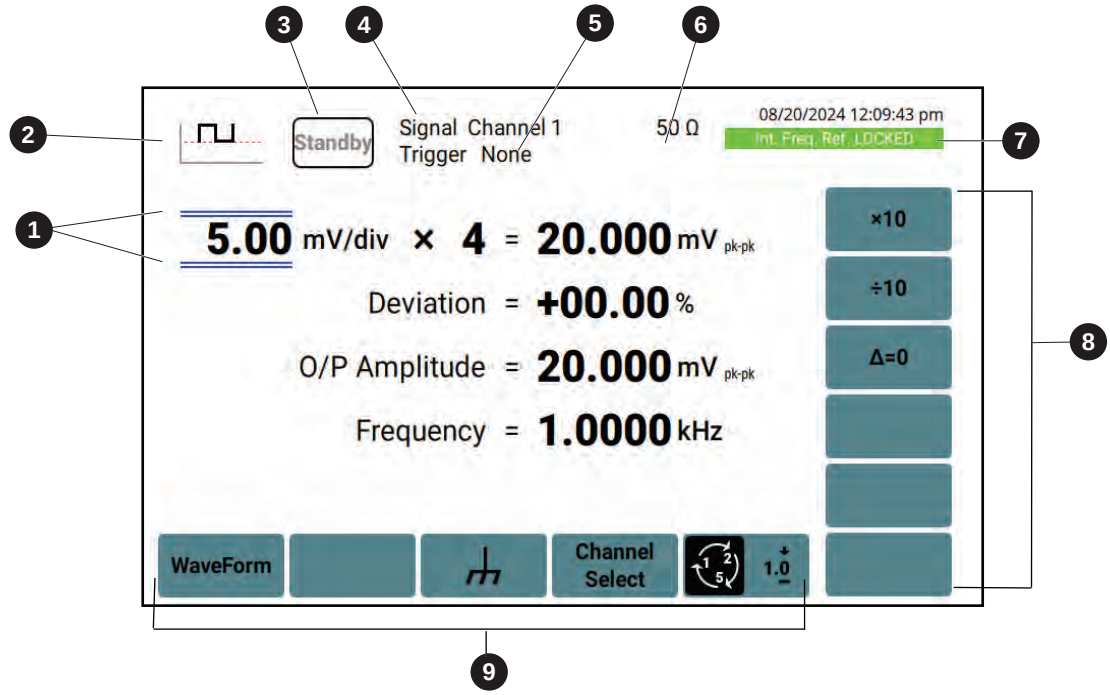
Typical Screen

For more detailed instructions of front-panel controls, see *Controls and Features*. The key labels will change depending on the cursor position and function.

Note

Contrast inversions of symbols and fields indicate those elements which have been selected, for example, in Table 14 the figure shows 'Scope Mode' (1-2-5) as selected.

Table 14. Square Mode Screen



Item	Description
1	Example of barred selection cursor. For more information see *Edit Values*.
2	Indicates the selected function.
3	The current output state. For example, Standby.
4	Indicates the channel selected for the trigger.
5	Indicates the channel selected for the signal.
6	Indicates the expected impedance for the signal and trigger.
7	Frequency reference indicates LOCK or UNLOCKED.
8	Right touch menu. The label of the softkey changes based on the location of the cursor and the selected function. See Table 16.
9	Bottom touch menu. The label of the softkey changes based on the selected function. See Table 15

Touch Menu Selections

Table 15 shows the touch keys on the bottom of the display. Options depend on cursor location and function.

Table 15. Touch Menu - Bottom

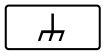
Key	Description
WaveForm	Open the waveform menu. The waveforms are specific to the selected function.
+/-	Change the polarity.
	With Output ON, the output to the DUT is grounded, for any waveform or DC selection.
Channel Select	Selects the signal route to any of the five heads. Set up trigger channel, trigger ratio, and cable channel. See *Channel Select*.
	Scope mode is selected. See *Edit Values*.
	Direct mode is selected. See *Edit Values*.
	Select High Edge pulse.
	Select 500 ps Edge pulse.
	Select Fast Edge pulse.
Auto Trigger	Produces triggers at 100 Hz to continuously trigger the DUT oscilloscope
Adjust Align	Tap to adjust the alignment on each active channel, and store the result.
Default Align	In the alignment state, tap to change to **Precise Align**.
Precise Align	In the alignment state, tap to return to **Default Align**.
Signal Channel	Select how the measurement setup is routed to the heads, also allows selection of expected load.
	Open-circuit output. Tap to select short-circuit output, and provide a one-shot trigger to the DUT.
	Short-circuit output. Tap to select open-circuit output, and provide a one-shot trigger to the DUT.

Table 16 shows the touch keys on the right of the display. Options depend on cursor location and function, and can change for digit edit/sequence scroll and for numeric entry.

Table 16. Touch Menu - Right

Cursor Location	Key	Description
Units/div Multiplier Deviation Frequency/Period (Digit Edit / Sequence Scroll)	**X10**	Multiplies the value by ten.
	÷10	Divides the value by ten.
	Δ=∅	Toggle the marked value and zero.
	∅	Toggle the value between positive and negative (DC only).
	f 1/f	Frequency is selected.
	f 1/f	Period is selected.
		When HV edge is selected. Selects edge rise or fall.
Units/div Deviation (Numeric Entry)	**%**	Evaluates the selection in Deviation percentage.
	V	Evaluates the selection in volts.
	mV	Evaluates the selection in millivolts.
	μ**V**	Evaluates the selection in microvolts.
Deviation	Δ% Δ	Deviation value is percent of set value. Tap to set deviation value in absolute units.
	Δ% Δ	Deviation value is in absolute units. Tap to set deviation value in percent of set value.
Frequency/Period (Numeric Entry)	**Hz**	Evaluates the selection in hertz.
	kHz	Evaluates the selection in kilohertz.
	MHz	Evaluates the number in the box in megahertz.
	GHz	Evaluates the number in the box in gigahertz.
Specific Function Menus		
Sine	**Apply f Ref**	Toggle between the marked frequency and reference frequency.
	Change f Ref	Set the reference frequency, default 50 kHz.
Overload Pulse	**+/-**	Toggles the value between positive and negative pulses.
	Trigger Pulse	Push to trigger a single shot of the specified pulse output. No further pulse can be triggered within three seconds, otherwise a screen message will appear.
	V	Evaluates the number in the box in Volts.
	J	Evaluates the number in the box in Joules.
Timing Marks	**Line Frequency**	Set the Line Frequency.

Table 16. Touch Menu - Right (cont.)

Cursor Location	Key		Description
Composite Video Function	**625 50Hz**	**525 60Hz**	Toggle 50 Hz line supply (with 625 raster lines) and 60 Hz line supply (with 525 raster lines).
	Trig Cmp	**Trig Frme**	On the Trigger channel, toggle Composite sync pulses and Frame sync pulse.
Linear Ramp Function	**Trig Start**	**Trig Mid**	Toggle whether the DUT is at start code or center (mid) code.

Channel Select

Table 17 shows the options for the Channel Select menu. Menu selections depend on the function that is selected.

For most changes:

1. Use the right-side menu to select signal channels.
2. Select the load.
3. To set a trigger, tap **Trigger Channel**.
4. Tap **Exit** to return to the function screen.

Table 17. Channel Select Menu Options

Function Key	Right-side Key	Description
Signal Channel	**Signal CH 1** **Signal CH 2** **Signal CH 3** **Signal CH 4** **Signal CH 5**	Select the channel for the signal output. Each channel corresponds to a pair of Active Head connectors, and a head (if fitted). A legend at the top of the display shows the settings. *Note* *When an Active Head for the channel is connected to the DUT oscilloscope, and the Product output is ON, the Product measures the DUT load. If the measured load is outside the specification for the expected load, an error or warning message appears.*
		Toggle the selection. The selection applies to all signal channels.

Table 17. Channel Select Menu Options (cont.)

Function Key	Right-side Key	Description
Trigger Channel	**Trigger CH 1** **Trigger CH 2** **Trigger CH 3** **Trigger CH 4** **Trigger CH 5** **Trigger NONE**	Select any channel for the trigger that is not selected as a signal channel. If a channel is in use, de-select the channel before you asign the channel to the trigger. The channel selected as the trigger channel cannot be used as a signal channel. Select NONE to not use a trigger channel.
Trigger Ratio	**÷1** **÷10** **÷100**	The ratio of the trigger frequency to the frequency of the waveform. *Note* *A low frequency that is subdivided can lead to a very long delay before a trigger occurs.*
Cable Select	**Cable CH 1** **Cable CH 2** **Cable CH 3** **Cable CH 4** **Cable CH 5**	If the trigger channel does not have a head attached, you must select the channel to have a trigger cable. A cable channel cannot be used as a signal channel. The legend on the display shows the trigger cable assignment.
Exit	--	Return to the main screen

DCV Function

Use dc voltages for amplitude calibration of oscilloscopes.

Push ⎓ to access the dc function.

To change the polarity, tap **+/-** to toggle positive and negative DC Voltage.

The icon in the top left corner indicates the wave form.

⎓ - positive DC waveform

⎓ - negative DC waveform

Low Voltage (LV) and High Voltage (HV) States

When the Product generates any signals >42 V, a red warning symbol appears on the front panel above the head connectors and any heads selected as signal channels display a red indicator. This indicates hazardous voltages are present, use caution.

DCV Operation

Amplitude

Provided they do not exceed the output voltage limits shown, the contributors have these adjustments shown in Table 18.

Table 18. DCV Output Voltage Editing

Selection	Default	Description
Units/Division (V/division)	5 mV	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through10 mV/div, 20 mV/div, 50 mV/div, up to 200 V/div, unless the other contributors will not take the output voltage value above 5.56 V p-p (50 Ω load) or 222.40 V p-p (1 MΩ load). • Use ▼ to reduce to 10 µV/div, unless the output voltage is <35.52 µV p-p (both 50 Ω and 1 MΩ loads).
Scaling Multiplier	4	Adjust by integer increments 1 to 10. Use ▼ or ▲ to adjust. The Product of the units/division and multiplier show on the right side of the = (equals) sign.
Deviation	00.00 %	A triangular cursor indicates direct edit is available. Use the cursor keys or direct edit to change the deviation percentage to any value within the resolution between -11.20 % and +11.20 %.
Output Voltage	20.000 mV	The O/P Amplitude is only adjustable by changing Units/ Division, Scaling Multiplier, and Deviation. The output voltage can be changed to any value within its resolution between 35.52 $\mu V_{pk\text{-}pk}$ (both 50 Ω and 1 MΩ loads) and 5.56 $V_{pk\text{-}pk}$ (50 Ω load) or 222.40 $V_{pk\text{-}pk}$ (1 MΩ load).

At maximum and minimum output voltages, the screen settings of the contributors' values (units/division, scaling multiplier and deviation) are limited by the output voltage. For example, see Table 19.

Table 19. DC Output Voltage Limits

Contributor	Ω LOAD = 1 MΩ		Ω LOAD = 50 Ω	
	Minimum	Maximum	Minimum	Maximum
Output Voltage Limit	35.52 µV p-p	222.4 V p-p	35.52 µV p-p	5.56 V p-p
Units/Division	100 µV/div	200 V/div	100 µV/div	5 V/div
Scaling Multiplier	1	10	1	10
Deviation	-11.20 %	+11.20 %	-11.20 %	+11.20 %

DC Amplitude Calibration

The options for amplitude calibration are:

- Use the Product as a fixed source of dc voltage, and adjust the oscilloscope.
- Use the Product as an adjustable source, and read the oscilloscope deviations on the Product screen.

Refer to the table or list of DUT amplitude calibration points in the oscilloscope manufacturer's calibration guide.

To do the manual calibration:

1. Make the appropriate connections:
   a. Use the Active Head to connect from the Product channel output to the input of the DUT signal channel to be calibrated. This function supports multiple simultaneous signal channels.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect from the Product channel output to the input of the DUT Trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered on and warmed up.
3. On the DUT, select the required function for amplitude calibration.

   Follow the sequence of calibration stages as directed by the calibration guide, and repeat the remaining steps for each stage.
4. On the Product,
   a. Push ⎓ to access the dc function.
   b. Push STANDBY to set Output OFF.
   c. Tap **WaveForm** and select the waveform.
   d. Use the front-panel controls to set voltage, polarity and load impedance for the DUT amplitude calibration point.
5. On the DUT:
   a. Select the correct channel for the calibration point.

b. Select **DC-Coupled**, if required.

c. Select the correct range for the calibration point.

6. On the Product:

a. Push ⏚ to provide a zero reference.

b. Push OPERATE to set Output ON.

7. On the DUT, set the Y controls to place the trace on graticule zero.

8. On the Product, push ⏚ again to remove a zero reference.

9. On the DUT:

a. Auto-trigger the oscilloscope or use the 100 Hz trigger from the Product.

b. Adjust the DUT for a stable display.

c. Observe and note the dc level change from graticule zero.

10. Calibration when the Product is a fixed source of dc voltage:

a. If a calibration adjustment is provided, adjust the response on the DUT to be appropriate to the settings on the Product screen, as detailed in the DUT oscilloscope manufacturer's calibration guide.

b. If no adjustment is provided on the DUT, record the response at the calibration point as detailed in the DUT calibration guide.

11. Calibration when the Product is an adjustable source of dc voltage:

a. On the Product, use the deviation control to slew the Output voltage until the response on the DUT is appropriate to the Product settings, as detailed in the DUT calibration guide.

b. Record the screen output from the Product as detailed in the DUT calibration guide.

12. On the Product, push STANDBY to set Output OFF.

Square Function

Use square waves for amplitude calibration of oscilloscopes.

Push ⊓ to access the Square function.

The icon in the top left corner indicates the wave form.

⊓ - positive square waveform

⊔ - negative square waveform

⊓ - neutral square waveform

LV and HV States for the Square Function

For information about the high voltage warning indicator, see *Low Voltage (LV) and High Voltage (HV) States*.

Square Operation

Amplitude

Provided they do not exceed the output voltage limits shown, the contributors have these adjustments shown in Table 20.

Table 20. Square Output Voltage Editing

Setting	Default	Description
Units/Division (V/division)	5 mV	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through10 mV/div, 20 mV/div, 50 mV/div, up to 200 V/div, unless the other contributors will not take the output voltage value above 5.56 V p-p (50 Ω load) or 222.40 V p-p (1 MΩ load). • Use ▼ to reduce to 10 µV/div, unless the output voltage will fall below 35.52 µV p-p (both 50 Ω and 1 MΩ loads).
Multiplier	4	Adjust by integer increments 1 to 10. Use ▼ or ▲ to adjust. The product of the units/division and multiplier show on the right side of the = (equals) sign
Deviation	00.00 %	The triangular cursor indicates direct edit is available. Use the cursor keys or direct edit to change the deviation percentage to any value within the resolution between -11.20 % and +11.20 %.
Output Voltage	20.000 mV	The O/P Amplitude is only adjustable by changing Units/Division, Scaling Multiplier and Deviation. The output voltage can be changed to any value within its resolution between 35.52 $\mu V_{pk\text{-}pk}$ (both 50 Ω and 1 MΩ loads) and 5.56 $V_{pk\text{-}pk}$ (50 Ω load) or 222.40 V p-p (1 MΩ load).
Frequency	1 kHz	The output frequency can be changed to any value with its resolution between 10 Hz and 100 kHz.

At maximum and minimum output voltages, the screen settings of the contributors' values (units/division, scaling multiplier and deviation) are limited by the output voltage itself. For example, see Table 21.

Table 21. Square Output Voltage Limits

Contributor	Ω LOAD = 1 MΩ		Ω LOAD = 50 Ω	
	Minimum	Maximum	Minimum	Maximum
Output Voltage Limit	35.52 $\mu V_{pk\text{-}pk}$	222.4 $V_{pk\text{-}pk}$	35.52 $\mu V_{pk\text{-}pk}$	5.56 $V_{pk\text{-}pk}$
Units/Division	10 µV/div	200 V/div	10 µV/div	5 V/div
Scaling Multiplier	1	10	1	10
Deviation	-11.20 %	+11.20 %	-11.20 %	+11.20 %

Square Amplitude Calibration

The options for amplitude calibration are:

- Use the Product as a fixed source and adjust the oscilloscope.
- Use the Product as an adjustable source, and read the oscilloscope deviations on the Product.

To do the manual calibration:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel to be calibrated. This function supports multiple simultaneous signal channels.
   b. If a trigger is required, use the appropriate Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for amplitude calibration.
4. On the Product
   a. Select the Square Function (⊓).
   b. Push STANDBY to set Output OFF.

   Use the table or list of DUT amplitude calibration points in the DUT oscilloscope manufacturer's calibration guide. Follow the sequence of calibration stages as directed by the guide, and do these steps at each stage:
5. On the Product, use the front-panel controls to set the Output to the required square wave p-p voltage, polarity, frequency, and load impedance for the DUT amplitude calibration point.
6. On the DUT:
   a. Select the correct channel for the calibration point.
   b. Select the correct range for the calibration point.

7. On the Product, push OPERATE to set Output ON.
8. On the DUT:
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Observe and note the amplitude response.
9. To calibrate amplitude as a fixed source:
   a. If a calibration adjustment is provided, adjust the DUT response to be appropriate to the settings on the Product, as detailed in the DUT oscilloscope manufacturer's calibration guide.
   b. If no adjustment is provided on the DUT, record its response at the calibration point as detailed in the DUT calibration guide.
10. To calibrate amplitude as an adjustable source:
    a. On the Product, use the deviation control to slew the Output voltage until the DUT response is appropriate to the settings on the Product, as detailed in the DUT oscilloscope manufacturer's calibration guide.
    b. Record the output voltage shown on the screen as detailed in the DUT calibration guide.
11. On the Product, push STANDBY to set Output OFF.

Sine Function

The Product can generate sine waves for flatness and bandwidth calibration of oscilloscopes.

To select the Sine function, push [~].

Sine Function Operation

Provided they do not exceed the output voltage limits shown, the contributors have these adjustments shown in Table 22.

Table 22. Sine Output Voltage Editing

Setting	Mode	Default	Description
Units/Division (V/division)	Scope	5 mV	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use [▲] to step through the sequence up to 5 V/div, if the other contributors do not take the output voltage value above 5.56 $V_{pk\text{-}pk}$ (≤2.02 GHz) or 3.336 $V_{pk\text{-}pk}$ (≤3 2 GHz) or 2.224 $V_{pk\text{-}pk}$ (>3.2 GHz). • Use [▼] to reduce to step backwards through the sequence to 1 mV/div, unless the output voltage would fall below 4.44 $mV_{pk\text{-}pk}$ (all frequencies).

Table 22. Sine Output Voltage Editing (cont.)

Setting	Mode	Default	Description
Multiplier	Direct	6	Adjust by integer increments 1 to 10 Use ▼ or ▲ to adjust. The product of the units/division and multiplier shows on the right side of the = (equals) sign.
Deviation	Direct	00.00 %	The triangular cursor indicates direct edit is available. Use the cursor keys or direct edit to change the deviation percentage to any value within the resolution between -11.20 % and +11.20 %. (Approximately Units/Division x Multiplier.) Up to 4 significant digits with 2 decimal places.
Output Voltage	--	30.000 mV	The O/P Amplitude is only adjustable by means of its contributor (units/division, multiplier and deviation).
Frequency	Direct	50 kHz	Frequency is variable between 100 mHz and 4.2 GHz (≤2.224 V_{pk-pk}) or 3.2 GHz (≤3.336 V_{pk-pk}) or 2.02 GHz (≤5.56 V_{pk-pk})

At maximum and minimum output voltages, the value of the screen settings are limited by the output voltage itself. See Table 23.

Table 23. Sine Output Voltage Limits

	Frequency 100 mHz to 2.02 GHz		Frequency >2.02 GHz to 3.2 GHz		Frequency >3.2 GHz to 4.2 GHz	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Output Voltage Limit	4.44 mV_{pk-pk}	5.56 V_{pk-pk}	4.44 mV_{pk-pk}	3.336 V_{pk-pk}	4.44 mV_{pk-pk}	2.224 V_{pk-pk}
Units / Division	1 mV/div	5 V/div	1 mV/div	2 V/div	1 mV/div	2 V/div
Scaling Multiplier	1	10	1	10	1	10
Deviation	-11.20 %	+11.20 %	-11.20 %	+11.20 %	-11.20%	+11.20%

Limitations for Scope Input Impedance of 1 MΩ

When you use the sine function at high frequency (for example, >100 MHz), Fluke Calibration recommends the selection of oscilloscope input impedance of 50 Ω. This is so the output signal of the Product is correctly terminated within the DUT.

There are many oscilloscopes that do not feature an input 50 Ω terminator. For these DUTs, the Product can apply a 50 Ω terminator within the Active Head when configured to drive 1 MΩ. The effectiveness of this approach is limited by short but finite signal path length to the DUT input amplifiers and their input capacitance. Substantial sine amplitude errors can result from this unterminated transmission line.

Error magnitude and the frequency at which the error becomes significant can vary as DUT input attenuators are selected (V/div adjustment). The errors are highly dependent upon DUT design and construction.

Use a BNC 50 Ω through termination from the Product to the DUT to reduce errors due to signal path length. Effectiveness will be limited by remaining path length and capacitance within the DUT.

Fluke Calibration does not recommend frequencies >500 MHz for use as DUT input with through termination.

Calibrate the Flatness/Bandwidth

The options for flatness and bandwidth calibration are:

- Use the Product as a fixed source, where the oscilloscope can be adjusted.
- Use the Product as an adjustable source, reading oscilloscope deviations on the screen.

To do the manual calibration:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel to be calibrated. This function supports multiple simultaneous signal channels.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for flatness calibration.
4. On the Product,
   a. Push [~] to select the Sine function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope flatness calibration points in the DUT Oscilloscope Manufacturer's Calibration Guide.

   Follow the sequence of calibration stages as directed by the guide and do these steps for each stage.
5. On the Product, set the required sine wave p-p voltage, frequency and load impedance for the DUT scope flatness calibration point.
6. On the DUT:

a. Select the correct channel for the calibration point.

b. Select the correct range for the calibration point.

7. On the Product, push OPERATE to set Output ON.
8. On the DUT:
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Observe and note the amplitude response.
9. To calibrate using the Product as a fixed source:
   a. If a calibration adjustment is provided, adjust the DUT response to be appropriate to the settings on the Product screen, as detailed in the DUT Oscilloscope Manufacturer's Calibration Guide.
   b. If no adjustment is provided on the DUT, record its response at the calibration point as detailed in the DUT Oscilloscope Manufacturer's Calibration Guide.
10. To calibrate using the Product as an adjustable source:
    a. On the Product, use the deviation control to slew the Output voltage until the DUT response is appropriate, as detailed in the DUT Oscilloscope Manufacturer's Calibration Guide.
    b. Record the Product screen output voltage as detailed in the DUT Oscilloscope Manufacturer's Calibration Guide.
11. Push STANDBY to set Output OFF.

Edge Function

Use this section to generate defined pulse edges to examine oscilloscope pulse response.

To select the Edge function, push ⎍.

LV and HV States for the Edge Function

For information about the high voltage warning indicator, see *Low Voltage (LV) and High Voltage (HV) States*.

Edge Function Operation

Amplitude

Provided they do not exceed the output voltage limits shown, the contributors have these adjustments shown in Table 24.

Table 24. Edge Function Editing

Setting	Default	Description
Units/Division (V/division)	0.5 V	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through the sequence. • Use ▼ to reduce to step backwards through the sequence. HV Edge: 0.1 V/div to 5 V/div for 50 Ω load (amplitude limit 5.56 V), 200 V/div for 1 MΩ load. Others: 1 mV/div to 2 V/div if the other contributors will not take the output voltage value above 2.5 V (<100 kHz), 3.336 V up to 2 MHz.
Multiplier	HV Edge: 10 Others: 2	Use ▼ or ▲ to adjust by integer increments. • 1 to 10 The product of the units/division and multiplier show on the right side of the = (equals) sign.
Deviation	00.00 %	The triangular cursor indicates direct edit is available. Use the cursor keys or direct edit to change the deviation percentage to any value within the resolution between -11.20 % and +11.20 %. (Approximately Units/Division x Multiplier.) Up to 4 significant digits with 2 decimal places.
Output Voltage	HV Edge: 5.0000 V_{pk-pk} Others: 1.0000 V_{pk-pk}	HV Edge: Change the output voltage to any value within its resolution between 888 mV_{pk-pk} and 5.56 V_{pk-pk} (50 Ω load), 222.4 V (1 MΩ load only). The software makes sure the contributors' values remain within their limits. For others: Change the output voltage to any value within its resolution between 4.44 mV_{pk-pk} and 3.336 V_{pk-pk}. (>100 kHz) 2.5 Vpkpk (<100 kHz). The software makes sure the contributors' values remain within their limits.
Frequency	HV Edge: 1 kHz others: 1 MHz	HV Edge: Change to any value within the resolution between 10 Hz and 100 kHz. For others: Change to any value within the resolution between 10 Hz and 2 MHz.
Rise Time	500 ps	When each head is calibrated, the head measured (10 % to 90 %) transition times for each type of fast edge are stored in non-volatile memory. During normal use, this figure is recalled and presented on the Rise Time field for the selected head (channel) and selected type of edge.

At maximum and minimum output voltages, the value of the screen settings are limited by the output voltage itself. See Table 25.

Table 25. Edge Function - Output Voltage Limits

	HV Edge Frequency 10 Hz to 100 kHz		500ps Edge and Fast Edge Frequency 100 kHz to 2 MHz		500 ps Edge and Fast Edge 10 Hz to 100 kHz	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Output Voltage Limit	888 mV_{pk-pk}	222.4 V_{pk-pk}	4.44 mV_{pk-pk}	3.336 V_{pk-pk}	4.44 mV_{pk-pk}	2.5 V_{pk-pk}
Units / Division	0.1 V/div	200 V/div	1 mV/div	2 V/div	1 mV/div	2 V/div
Scaling Multiplier	1	10	1	2	1	2
Deviation	-11.20 %	+11.20 %	-11.20 %	+11.20 %	-11.20 %	+11.20 %

Calibrate the Pulse Response

The options for pulse response calibration are:

- Use the Product as a fixed source, where the oscilloscope can be adjusted.
- Use the Product as an fixed source, where the oscilloscope cannot be adjusted.

To do the manual calibration:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel to be calibrated.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for pulse response calibration.
4. On the Product
   a. Push ⎍ to select the Edge function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT oscilloscope flatness calibration points in the DUT Oscilloscope Manufacturer's Calibration Guide. Follow the sequence of calibration stages as directed by the guide, and do the remaining steps for each stage.
5. On the Product set the Output to the required edge p-p voltage, frequency, and load impedance for the DUT pulse response calibration point.

6. On the DUT:
   a. Select the correct channel for the calibration point.
   b. Select the correct range for the calibration point.
7. On the Product, push OPERATE to set Output ON.
8. On the DUT:
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Observe and note the pulse shape response.
9. For calibration:
   a. If a calibration adjustment is provided, adjust the DUT pulse shape. Note rise time and aberration, as detailed in the DUT oscilloscope manufacturer's calibration guide.
   b. If no adjustment is provided, on the DUT, note rise time and aberration, as detailed in the DUT calibration guide.
10. On the Product, push STANDBY to set Output OFF.

Time Markers Function

Use Time Markers to generate square waves and DC voltages for use for amplitude calibration of oscilloscopes.

To access the Time Markers function, push .

To select a wave shape (marker style), tap **WaveForm**. Available wave shapes are shown in Table 26. The selected waveform shows at the top left of the display. Each marker style is available in a version where each tenth marker is raised to higher amplitude (highlighted) for Output Periods of 1 µs and longer.

Table 26. Time Marker WaveForms

Icon	Waveform	Highlighted style	
	Square (default)		Square with highlights (does not extend into sine frequency band)
	Pulse		Pulse with highlights
	Spike		Spike with highlights

The default is the square waveform. Period is variable between 10 ns and 50 s (sine waveform is above approximately 111 MHz). The sine waveform period is variable between 240 ps and 10 ns (period is defaulted to 1 µs (square), deviation Δ to zero, and output voltage to 1.0000 $V_{pk\text{-}pk}$.

The Duty Cycle is fixed at a nominal 50 %.

Time Markers Operation

Provided they do not exceed the output period limits shown, the contributors have the adjustments shown in Table 27.

Table 27. Time Marker Function Editing

Setting	Default	Description
Time Marker Period	1.0000 µs	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through in increments for example: 2 µs, 5 µs, 10 µs, up to 50 s, providing that the other contributors do not make the output period longer than 55 s. • Use ▼ to step backwards through the sequence down to 500 ps unless the output voltage > 500 mV.
Square/Sine Waveform Changeover		The changeover from square to sine occurs at a frequency of 111.101 MHz (Period = 9.000819 ns), chosen to avoid normal calibration points.
Frequency Parameter Resolution Conflict		Due to resolution and the step sequence, some periods cannot be converted exactly into frequencies. To direct attention towards period at any point at which its reciprocal cannot be defined exactly, the frequency parameter display is given as approximately equal to (≃).
Percentage Deviation	00.00 %	*Note* *In the Time Markers function, the Deviation operates on the Time Marker interval, to modify the output Period or Frequency, and does not modify the O/P Amplitude, as in the other functions.* The combination of the Time Marker interval and Deviation show as the value of the output Period or Frequency. The deviation percentage can be changed to any value within its resolution between -45 % and +45 %, if the Time Marker interval does not take the output Period or Frequency value out of its limits.
Output Voltage	1.0000 $V_{pk\text{-}pk}$	The default 1.0000 $V_{pk\text{-}pk}$ is the maximum output available. The output voltage can be changed to any step value of 100 $mV_{pk\text{-}pk}$, 250 $mV_{pk\text{-}pk}$, 500 $mV_{pk\text{-}pk}$, or 1 $V_{pk\text{-}pk}$.
Output Period Frequency	1 µs/1 MHz	From the default, the output period/frequency can be changed to any value within its limits as shown in Table 28.

Output Period/Frequency

At maximum and minimum output period, the screen settings of the contributors' values (Time Marker and Deviation) are limited by the output period/frequency. For example, see Table 28.

Table 28. Time Marker - Output Limits

Marker Style	O/P Amplitude	Time Marker Period		Deviation		O/P Period	
		Min	Max	Min	Max	Min	Max
	100 mV to 1 V	164.21 ps	100 s	-45 %	+45 %	238.10 ps	55 s
	100 mV to 1 V	621.32 ns	100 s	-45 %	+45 %	900.91 ns	55 s
	100 mV to 1 V	621.32 ns	100 s	-45 %	+45 %	900.91 ns	55 s
	100 mV to 1 V	6.2132 ns	100 s	-45 %	+45 %	9.0091 ns	55 s
	100 mV to 1 V	621.32 ns	100 s	-45 %	+45 %	900.91 ns	55 s
	100 mV to 1 V	621.32 ns	100 s	-45 %	+45 %	900.91 ns	55 s

Calibrate the Time Base

The options for pulse response calibration are:

- Use the Product as a fixed source, where the oscilloscope can be adjusted or a measurement can be taken.
- Use the Product as an adjustable source, reading the oscilloscope deviations from the Product display.

To do the manual calibration:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel to be calibrated.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for time base calibration.
4. On the Product:
   a. Push to select the Time Markers function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope time base calibration points in the DUT oscilloscope manufacturer's calibration guide. Follow the sequence of calibration stages as directed by the guide, and do the remaining steps for each stage.
5. On the Product, set the Output to the required channel, expected load impedance, trigger channel, waveshape, period and p-p voltage for the DUT time base calibration point.
6. On the DUT:

a. Select the correct channel for the calibration point.

b. Select the correct time base speed for the calibration point.

c. Select the correct amplitude range for the calibration point.

7. On the Product, push OPERATE to set Output ON.
8. On the DUT:
   a. Adjust the sweep speed and trigger level for a stated display.
   b. Note the accuracy of marker alignment, indicating any mis-adjustment in the time base speed or linearity.
9. For calibration with the Product as a fixed source:
   a. If calibration adjustments for time base speed and linearity are provided, adjust the DUT time base to be appropriate to the settings on the Product display screen, as detailed in the DUT oscilloscope manufacturer's calibration guide.
   b. If no adjustment is provided on the DUT, record the time base condition at the calibration point as detailed in the DUT calibration guide.
10. For calibration with the Product as an adjustable source:
    a. On the Product, use the deviation control to slew the Product Output period/frequency until the DUT alignment is appropriate to the Product settings, as detailed in the DUT oscilloscope manufacturer's calibration guide.
    b. Record the Product screen output voltage and period/frequency as detailed in the DUT calibration guide.
11. On the Product, push STANDBY to set Output OFF.

Pulse Width Function

Generate variable width pulses for the testing trigger timing circuitry within an oscilloscope.

Modern digital Oscilloscopes often feature sophisticated trigger circuitry capable of distinguishing events within a time window, for example, detection of a pulse narrower (or wider) than a user-determined time. The oscilloscope uses its internal (sampling) clock to measure the time between rising and falling edges of the trigger waveform.

However, in many cases the resolution of this measurement is extended by a short duration analog timer. This timer requires independent verification, and sometimes adjustment, using a short duration pulse of known width.

Use the Pulse Width function to set a narrow pulse of suitable and known width and to apply to the DUT input.

To select the Pulse Width function, push  .

Defaults are shown in Table 29.

Table 29. Pulse Width Defaults

Setting	Edit Mode	Default
Pulse Width	Direct	50.000 ns
Output Amplitude	Direct	1.0000 V_{pk-pk}
Frequency	Direct	1.0000 kHz
Signal Channel	--	50 Ω

Zero Skew Function

Skew is the relative delay between two or more selected channels. If the channel delays are equalized, then the condition is known as Zero Skew. The Zero Skew function aligns two or more channel heads in turn, on the same input channel of an oscilloscope (can be the DUT oscilloscope), while triggering from another channel or external trigger.

Use the Zero Skew function to:

- Adjust selected channels to equalize their delays.
- Use the same channels as sources for measuring the skew between input channels of a DUT oscilloscope.
- Precision align two cable channels.

To select the Zero Skew function, push [⨍].

In the Zero Skew function, expected load is fixed at 50 Ω on all Signal Channels and the Trigger Channel key is not available.

Defaults are shown in Table 30.

Table 30. Zero Skew Defaults

Setting	Default	Description
Skew type	Default Alignment	Default Alignment displays the alignment. Select **Adjust Align** to adjust the alignment.
Skew	≤ ±50 ps	The unequallized (default) alignment has a maximum skew of ±50 ps between channels.
O/P Amplitude	1.0000 V_{pk-pk}	Cannot be edited.

Table 30. Zero Skew Defaults

Setting	Default	Description
Frequency	1.0000 kHz	For Direct edit, enter a frequency value directly. For Scope edit, adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through in increments for example: 10.0 Hz, 20.0 Hz, 50.0 Hz, 100.0 Hz, 200.0 Hz, 500.0 Hz, 1.0 kHz, 2.0 kHz, 5.0 kHz, up to 100.0 MHz. • Use ▼ to step backwards through the sequence down to 10.0 Hz.
Period		For Direct edit, enter a period value directly. For Scope edit, adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through in increments for example: 10.0 ns, 20.0 ns, 50.0 ns, 100.0 ns 200 ns, 500.0 ns, 1.0 us, 2.0 µs, 5.0 µs, up to 100.0 ms. • Use ▼ to step backwards through the sequence down to 10.0 ns.

Note

When you change from Direct mode to Scope mode, the Product rounds the selected frequency/period point selected to the nearest cardinal point in the preset frequency or period list. For example, if the Direct mode value is 3.4 kHz, the value becomes2.0 kHz in Scope mode. If the Direct mode value is 3.5 kHz, the value becomes 5.0 kHz in scope mode. When changing from Scope mode to Direct mode, the value does not change.

Precision Alignment

Use this procedure to align two or more channel heads.

To precision align the channel heads:

1. Connect the Active Heads to the Product and to the DUT input channel.
2. Push ⎍ to select Zero Skew.
3. Tap **Channel Select** and select the channels for adjustment, see *Channel Select*.

   The Active channels show at the top of the display. Channels that have Active Heads or trigger cables can be used for zero skew. Do not select both head channels and cable channels at the same time. You must select more than one channel Select Precise Align.
4. On the Product:

   a. Push STANDBY to set Output OFF.

b. Connect the first Active Head to the DUT.

c. At the required frequency, push OPERATE to set Output ON.

d. Mark the channel delay at half-amplitude with a cursor.

e. To adjust the delay for a particular screen alignment, tap **Adjust Align**.

5. On the Product, push STANDBY to set Output OFF.
6. Disconnect the first Active Head from the DUT and connect the second Active Head to the same input channel of the DUT.
7. On the Product,

   a. Push OPERATE to set Output ON.

   b. Tap **Adjust Align**, and adjust the delay to the same cursor mark.
8. Repeat the adjustment for all other channels to achieve accurate common alignment.

   After you align all the output channels, they can be used to apply signals simultaneously to measure the relative delays between the input channels of a DUT oscilloscope.
9. Tap **Store Align** to save the current alignment values to non-volatile storage.

Preservation of Alignment

The Zero Skew function allows only the aligned channels to be used together with their aligned heads. Unless channels have been reconfigured, you can select another function and that will not affect the alignment when you reenter the Zero Skew function. Deselect a channel to use other aligned channels. Reselect the deselected channel to restore the alignment if the same head is fitted.

If one of the heads is removed from the output channel, and another substituted, the Product will recognize the new head as being unaligned, and will not allow the new head to be used until another precision alignment is complete.

The stored alignment is only used if **Precise Align** is selected, otherwise the Product behaves as if all skew alignment values are set to zero.

Measurement of DUT Channel Skew

The procedure requires pre-alignment of the Active Heads (if better than ±50 ps calibrator alignment is required—when DUT specification is <200 ps or better).

To do measure channel skew:

1. Connect the Active Head to the DUT Signal Channel.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for the input channel skew test.
4. On the Product:

   a. Push ⎍ to select Zero Skew.

b. Push STANDBY to set Output OFF.

c. Make sure the required channels are selected and complete *Precision Alignment*.

Refer to the table or list of DUT Oscilloscope input delay measurement points in the DUT Oscilloscope Manufacturer's Calibration Guide. Follow the sequence of calibration stages as directed by the guide, and do the remaining steps for each stage.

5. On the DUT:
   a. Select the correct signal test channels.
   b. Select trigger for the test from the correct channel.
   c. Select the correct Y sensitivity range.
   d. Select the correct time base speed for the test.
   e. If required, adjust the sweep speed and trigger level for a stable display.
6. On the Product, push OPERATE to set Output ON.
7. On the DUT:
   a. Adjust each channel Y position control to superimpose the waveforms, equally disposed across the X axis.
   b. Use the DUT controls to measure the relative delays on each channel (at half amplitude).
   c. Record the DUT input channels' relative delays as detailed in the DUT Oscilloscope Manufacturer's Test Guide.
8. On the Product, push STANDBY to set Output OFF.

Overload Pulse Function

Use the Product to generate Overload Pulses to test oscilloscope 50 Ω terminator protection.

Overload Protection Test

Some oscilloscope manufacturers protect the internal 50 Ω terminator with a voltage or thermal detector. The pulse is triggered as a single event, and cannot be repeated at intervals <3 seconds. Sync or 100 Hz triggers are provided if required.

To verify the protection function, apply limited-duration overload. The protection should react and open circuit the 50 Ω terminator.

Select the Overload Pulse function and set to the DUT test requirements.

To select the Overload Pulse function, push ⎍⚠.

⚠ Caution

When you apply the overload pulse to DUT oscilloscope inputs, the ⚠ is a reminder to take special care.

Defaults are shown in Table 31.

Table 31. Overload Pulse Function Defaults

Setting	Default	Description
Amplitude	10.0 V	Variable between 5 V and 20 V
Pulse Energy	500 mJ	Variable between 100 mJ and 800 J (limited by amplitude and duration)
Power in 50 Ω	2.000 W	Calculated from the voltage and energy settings, duration limited to between 200 ms and 100 s
Duration	250.00 ms	

Overload Pulse Operation

Overload Protection

Different oscilloscope manufacturers have different ways to define the overload which activates their protection system. For example, into 50 Ω, the specifications ±20 V for 200 ms and 1.6 J at a power of 8 W are equivalent.

Normally, where voltage and time are specified, you set the voltage and adjust the energy to achieve the specified time.

The Product can output single pulses with the adjustable constituents of Amplitude and Pulse Energy. The limits on these parameters are:

- Amplitude: ±5 V to ±20 V
- Pulse Energy: 100 mJ to 800 J

For a fixed Pulse Amplitude the power into 50 Ω remains constant, regardless of pulse duration. Adjust the Pulse Energy to affect the pulse duration at fixed amplitude. Control these two parameters to adapt to all specifications between the above limits.

Maximum and minimum power values into 50 Ω are:

- Power: 0.5 W to 8 W
- Amplitude ±5 V to ±20 V

Test the Overload Response

For the test procedure, enter a single pulse as specified in the oscilloscope manufacturer's overload protection test, and check that the protection reacts to open circuit the 50 Ω input termination. The form of input overload indication will vary between oscilloscopes.

To test the overload response:

1. Make the appropriate connections:
    a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel.

b. If a trigger is required, use the Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the channel.

2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for overload pulse protection test.
4. On the Product:

   a. Push ⎍⚠ to select the Overload Pulse Function.

   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope overload test points in the DUT Oscilloscope Manufacturer's Test Guide. Follow the sequence of calibration stages as directed by the guide, and do the remaining steps for each stage.

5. On the Product,

   a. Set the Output to the required overload pulse and polarity for the DUT test point.

   b. If the DUT requires a repetitive trigger, tap **Auto Trigger**.

6. On the DUT:

   a. Select the correct channel for the test point.

   b. Select the correct range for the test point.

   c. If required, adjust the sweep speed and trigger level for a stable display.

7. On the Product:

   a. Push OPERATE to set Output ON.

   b. Tap **Trig Pulse** once. Observe and note the DUT response.

   c. If required, tap **Trig Pulse** again as detailed in the DUT Oscilloscope Manufacturer's Test Guide; observe and note the DUT scope responses.

8. On the DUT, record the DUT response at the test point as detailed in the DUT Oscilloscope Manufacturer's Test Guide. If required, reset the scope protection circuit.
9. On the Product, push STANDBY to set Output OFF.

Input Leakage Test Function

Use the Product to short-circuit and open-circuit channel inputs of a DUT oscilloscope to test for input leakage. To test DUT Oscilloscope input leakage current note the difference in deflection when a channel's input is open-circuited and when it is short-circuited.

With the Input Leakage function selected, open and short circuits can be imposed on the selected channel input, using the Product.

Scope triggers at 100 Hz are provided if required.

To test the overload response:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the input of the DUT Signal Channel. This function supports multiple simultaneous signal channels.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect the channel output from the Product to the input of the DUT Trigger for the Channel.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for Input Leakage test.
4. On the Product:
   a. Push to select the Input Leakage function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope input leakage test points in the DUT Oscilloscope Manufacturer's Test Guide. Follow the sequence of calibration stages as directed by the guide, and do the remaining steps for each stage.
5. On the Product, if the DUT requires a repetitive trigger, tap **Auto Trigger**.
6. On the DUT:
   a. Select the correct channel for the test point.
   b. Select the correct range for the test point.
   c. If required, adjust the sweep speed and trigger level.
7. On the Product:
   a. Push OPERATE to set Output ON.
   b. Tap to select short circuit output, and provide a one shot trigger to the DUT.
8. On the DUT, adjust the 'Y' position control to place the display on the zero axis.
9. On the Product, tap to select open circuit output, and provide a one-shot trigger to the DUT.
10. DUT Response: Record the DUT Scope Y deflection at the test point as detailed in the DUT Oscilloscope Manufacturer's Test Guide.
11. On the Product, push STANDBY to set Output OFF.

Current Function

Use the Current function to generate square waves and DC currents for use in calibrating oscilloscope current probes.

To access the current function, select AUX and then select the appropriate current source.

Square Current Function Operation

Amplitude

Provided they do not exceed the output period limits shown, the contributors have the adjustments shown in Table 27.

Table 32. Current Function - Square Function Editing

Setting	Default	Description
Units/Division	1.0000 µs	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 • Use ▲ to step through in increments. From 1 mA/div, 2 mA/div, 5 mA/div, 10 mA/div, up to 50 mA/div, if the other contributors will not take the output current value above 111.2 mA_{pk-pk}. • Use ▼ to step backwards through the sequence down to 20 µA/div, unless the output current would fall below 88.8 μA_{pk-pk}.
Scaling Multiplier	4	Adjustable in integers from 1 to 10. Providing that the other contributors do not take the output current value out of its limits. The product of the units/division and multiplier are shown on the right side of the = (equal sign).
Percentage Deviation	00.00 %	Changed to any value within its resolution between -11.20 % and +11.20 %, providing that the other contributors do not take the output current value out of its limits. The resolution is 4 significant digits, with 2 decimal places.
Output Current	4.000 mA	Adjustable only by manipulation of the other contributors (units/division, multiplier and deviation). Output current can be changed to any value within its resolution from 88.8 μA_{pk-pk} to 111.2 mA_{pk-pk}.
Frequency	1 kHz	Output frequency can be changed to any value within its resolution between 10 Hz and 100 kHz.

At maximum and minimum output currents, the screen settings of the contributors' values (units/division, scaling multiplier and deviation) are limited by the output current itself. See Table 33.

Table 33. Current Function - Output Voltage Limits

Contributor	Limits	
	Minimum	Maximum
Output Current Limit	88.8 $\mu A_{pk\text{-}pk}$	111.2 $mA_{pk\text{-}pk}$
Units/Division	20 µA/div	100 mA/div
Scaling Multiplier	1	10
Deviation	-11.20 %	+11.20 %

Calibrate the Pulse Response of a Current Probe (Square)

The options for amplitude calibration are:

- Use the Product as a fixed source, and adjust the oscilloscope.
- Use the Product as an adjustable source, and read the oscilloscope deviations on the Product screen.

To calibrate the current probe:

1. Make the appropriate connections:
   a. Use the Active Head and current probe accessory to connect from the Product signal output channel to the DUT current probe.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect from the required Product channel output to the scope input.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT probe, select the required function for probe pulse response calibration.
4. On the Product:
   a. Select AUX and then tap to select Square Current source.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope amplitude calibration points in the DUT Oscilloscope Manufacturer's Calibration Guide. Follow the sequence of calibration stages as directed by the guide, and do these steps at each stage:
5. On the Product, use the front panel controls to set the Output to the required square wave pk-pk current and frequency for the DUT amplitude calibration point.
6. On the DUT:
   a. Select the correct channel for the calibration point.
   b. Select the correct range for the calibration point.
7. On the product, push OPERATE to set Output ON.
8. On the DUT:

a. Adjust the sweep speed and trigger level for a stable display.

b. Observe and note the amplitude response.

9. To calibrate amplitude as a fixed source:

   a. If a calibration adjustment is provided, adjust the DUT response to be appropriate to the settings on the Product, as detailed in the DUT oscilloscope manufacturer's calibration guide.

   b. If no adjustment is provided on the DUT, record its response at the calibration point as detailed in the DUT calibration guide.

10. To calibrate amplitude as an adjustable source:

    a. On the Product, use the deviation control to slew the Output voltage until the DUT response is appropriate to the settings on the Product, as detailed in the DUT oscilloscope manufacturer's calibration guide.

    b. Record the output voltage shown on the screen as detailed in the DUT calibration guide.

11. On the Product, push STANDBY to set Output OFF.

Measurement Functions

Resistance

Use the Product to measure the resistive load presented by the channel inputs of a DUT.

To access Load Resistance, push Ω.

Capacitance

Use the Product to measure the capacitive load presented by the channel inputs of a DUT.

To access Capacitance, push ⊣⊢.

Measurement Method

Oscilloscope input load resistance or capacitance can be measured directly by any Active Head. No triggers are provided.

Note

Measurement is available only when OUTPUT is ON.

Measure Load Resistance or Load Capacitance

Both measurement procedures consists of connecting an Active Head to each channel input in turn, and checking that the resulting resistance or capacitance reading is within specification limits.

To test the load resistance or capacitance:

1. Connect the Active Head signal output channel to the DUT input channel.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for Load Resistance or Load Capacitance.

4. On the Product:
   a. Push [Ω] for Load Resistance or [⊣⊢] for Load Capacitance
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope Load Resistance or Load Capacitance measurement points in the DUT Oscilloscope Manufacturer's Calibration Guide. Follow the sequence of calibration stages as directed by the guide, and do these steps at each stage:
5. On the Product:
   a. Tap **Signal Channel**.
   b. Select the required Signal Channel. (See *Channel Select*.)
   c. For Resistance measurements, select the appropriate load (50 Ω or 1 MΩ).
   d. Tap **Exit**.
6. On the DUT:
   a. Select the correct channel for the test point.
   b. Select DC Coupling, if required.
7. On the Product:
   a. Push OPERATE to set Output ON.
   b. Read the Load Resistance/Load Capacitance value from the screen.
8. On the DUT, record the DUT channel load resistance/capacitance at the test point as detailed in the DUT Oscilloscope Manufacturer's Test/Calibration Guide.
9. On the Product, push STANDBY to set Output OFF.

Auxiliary Input

Despite the flexibility of on the Product, sometimes you must apply signals from your equipment to the inputs of a DUT oscilloscope, for specific calibration or test purposes.

Use the Auxiliary Input function for wideband passive routing from a rear-panel 50 Ω SMA input through to the selected channel output.

Trigger pickoff is not provided, and internal triggers are not available.

To access the Auxiliary Input function push [AUX] and then tap [AUX In].

You can automate routing of user calibration signals.

To route a signal from a user source to a specified channel input:

1. Make the connections:
   a. Use the Active Head from the required signal output channel to the DUT input channel.

b. Connect the auxiliary source to the input connector on the rear panel. (See ❽ in Table 2.)

2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function that requires the user-specific signal.
4. On the Product, select AUX and then tap AUX In to select the Auxiliary Input function.
5. Set up the signal source to provide the required signal.

   Refer to the table or list of DUT Oscilloscope calibration points in the DUT Oscilloscope Manufacturer's Calibration Guide. Do the next steps for each stage.
6. On the signal source, make sure the correct signal is output.
7. On the DUT.
   a. Select the correct channel for the calibration point.
   b. Select the correct range for the calibration point.
8. On the Product, push OPERATE to set Output ON.
9. On the DUT
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Observe and record the DUT response to the signal as detailed in the DUT Oscilloscope Manufacturer's Calibration Guide.
10. On the Product, push STANDBY to set Output OFF.

Composite Video Function

Generate composite video for video trigger sensitivity calibration of oscilloscopes.

The composite video signal generated by the Product is standard 625 line or 525 line video and an inverted version of the composite waveform is available. The trigger channel can output either composite or frame synchronizing pulses, without the video.

To access the Composite Video function, push AUX and then tap .

Composite Video Function Operation

Composite Video options are shown in Table 34.

Table 34. Composite Video Editing

Setting	Default	Description
Amplitude	White (1.0 V_{pk-pk})	Options are: • White: (1.0 V_{pk-pk}) • Mid-grey: (0.65 V_{pk-pk}) • Black: (0.3 V_{pk-pk})

Table 34. Composite Video Editing (cont.)

Setting	Default	Description
Video Inversion		Use **+/-** to toggle upright and inverse.
Video Standards	**625 50Hz**	Toggle 50 Hz field rate (with 625 raster lines) and 60 Hz field rate (with 525 raster lines).
Trigger Interval Selection	**Trig Cmp**	On the Trigger channel, toggle Composite sync pulses and Frame sync pulse. Either composite or frame sync can be selected as trigger on the assigned trigger channel.

Use Composite Video Function to Calibrate Video Trigger

The composite video amplitude variation is limited.

To use the composite video function:

1. Make the appropriate connections:
   a. Use the Active Head to connect the channel output from the Product to the video input of the DUT Signal Channel to be calibrated.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect the required channel output from the Product to the DUT trigger for the channel to be calibrated.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for video and trigger calibration.
4. On the Product,
   a. Push AUX and then tap  to select the Composite Video function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope calibration points in the DUT oscilloscope manufacturer's calibration guide. Follow the sequence of calibration stages as directed by the guide, and do these steps at each stage:
5. On the Product, use the front panel controls to set the Output to the required Luminance level, Composite Video, and line standard for the DUT calibration point.
6. On the DUT:
   a. Select the correct channel for the calibration point.
   b. Select the correct range for the calibration point.
   c. Select the correct presentation setup for the calibration point.
7. On the Product, push OPERATE to set Output ON.

8. On the DUT, make sure the display is stable from TV trigger in accordance with the DUT oscilloscope manufacturer's calibration guide.
9. On the Product, push STANDBY to set Output OFF.

Linear Ramp Function

Use the Product to generate Linear Ramps for error code detection and trigger level marker calibrations.

To access the linear ramp function, push AUX and then tap  .

Linear Ramp options are shown in Table 35.

Table 35. Linear Ramp Editing

Setting	Default	Description
O/P Amplitude	1.0000 $V_{pk\text{-}pk}$	Cannot be edited
Ramp Time	1.0000 s	Adjust by step sequence: 1-2-5 or 1-2-2.5-4-5 Ramp Time is the only signal variable. The ramp time can be changed in decades from 1 ms to 1 s Ramp times are part of waveforms with the periods in Table 36.
Trigger Interval Selection	**Trig** **Start**	The rising edge of the trigger signal can correspond to the start of the ramp up or the start of the ramp down.
Bias	-	The waveform is symmetrical about ground.

Table 36. Wafeform Period

Ramp Time	Waveform Period
1 s	3 s
100 ms	300 ms
10 ms	30 ms
1 ms	3 ms

Use the Linear Ramp Function for Error Code Detection

The type of procedure, to generate Linear Ramps for error code detection and trigger level marker calibrations uses the Product as a fixed source.

To use the Linear Ramp function for error code detection:

1. Make the appropriate connections:
   a. Use the Active Head to connect from the Product signal output channel to the DUT signal channel input. This function supports multiple simultaneous signal channels.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect from the required Product channel output to the DUT trigger.
2. Make sure that the Product and the DUT are powered ON and warmed up.

3. On the DUT, select the required function for pulse response calibration.
4. On the Product,
   a. Push AUX and then tap ⌊⩘⌋ to select the Linear Ramp function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope calibration points in the DUT Oscilloscope Manufacturer's Calibration Guide. Follow the sequence of calibration stages as directed by the guide, and do these steps at each stage:
5. On the Product, select the required channel and use the controls to set the Product Output to the required trigger point, ramp time, and expected load for the DUT test point.
6. On the DUT:
   a. Select the correct channel for the test point.
   b. Select the correct range for the test point.
7. On the Product, push OPERATE to set Output ON.
8. On the DUT,
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Error Code Check: Observe and record the DUT response to the codes at the test point, as detailed in the DUT Oscilloscope Manufacturer's Test/Calibration Guide.
9. On the Product, push STANDBY to set Output OFF.

Use the Linear Ramp Function for Trigger Level

To use the Linear Ramp function for trigger level:

1. Make the appropriate connections:
   a. Use the Active Head to connect from the Product signal output channel to the DUT signal channel input.
   b. If a trigger is required, use the Active Head (or trigger cable) to connect from the required Product channel output to the DUT trigger.
2. Make sure that the Product and the DUT are powered ON and warmed up.
3. On the DUT, select the required function for pulse response calibration.
4. On the Product,
   a. Push AUX and then tap ⌊⩘⌋ to select the Linear Ramp function.
   b. Push STANDBY to set Output OFF.

   Refer to the table or list of DUT Oscilloscope test/calibration points in the DUT oscilloscope manufacturer's test guide. Follow the sequence of test stages as directed by the guide, and carry out the remaining steps for each stage.

5. On the Product, select the required channel and use the front panel controls to set the Output to the required trigger point, ramp time and expected load for the DUT test point.
6. On the DUT:
   a. Select the correct channel for the test point.
   b. Select the correct range for the test point.
7. On the Product, push OPERATE to set Output ON.
8. On the DUT, adjust the sweep speed and trigger level for a stable display.
9. Trigger Level Marker Check
   a. If a trigger level calibration is provided, adjust the DUT trigger response to the ramp to be appropriate to the settings on the Product, as detailed in the DUT Oscilloscope Manufacturer's Test Guide.
   b. If no adjustment is provided on the DUT, record its trigger response at the test point as detailed in the DUT Oscilloscope Manufacturer's Test Guide.
10. On the Product, push STANDBY to set Output OFF.

Maintenance

This section includes information to maintain and dispose of the Product.

Follow all applicable local and/or national safety regulations and rules while performing any work. Do not remove covers. Any adjustment, parts replacement, maintenance, or repair should be carried out only by the manufacturer's authorized technical personnel. See the *9500C Calibration Manual*.

Cleaning

To clean the Product, wipe with a cloth. Use mild detergent. Take care not to wet connectors.

Care of Microwave Connectors

Use basic precautions for microwave connectors for accurate and repeatable calibration and measurement results. These precautions also help extend connector life:

- Keep connectors clean when not in use. Use a plastic end cap. Avoid touching components whose function is to make electrical contact.
- Visually inspect all connectors, looking for dents, scratches, and metal particles. Never use damaged connectors.

- Clean connectors properly, particularly connector threads and dielectric faces. Clean connectors with compressed air. If more cleaning is required, use isopropyl alcohol. Avoid spillage and never use abrasives.
- When making connections, align connectors carefully to avoid bending forces. Always make the initial connection lightly to avoid cross threading, and use a correctly-set torque wrench for final tightening. (Torque setting for cable connectors is 0.45 Nm. Torque setting for BNC adapter is 1.0 Nm.)

Storage and Transportation

Store the Product under a cover. The shipping container provides the necessary shock isolation for normal handling operations.

To store the product:

1. Disconnect the Product from power and all signal sources.
2. Put the Product and an active desiccant sachet inside a sealed bag.
3. Put the bag into the cushioning material in the inner carton, and put this within the corner cushioning blocks inside the outer shipping container.
4. Put the whole package in a storage environment that meets the specified storage requirements.

To transport the Product, use the carry case.

1. Prepare the Product as for storage.
2. If you do not have the original shipping container. Use a container that is double-cushioned, providing similar shock isolation to the following approximate internal packing dimensions:

	Length	Width	Depth
Outer Box	800 mm	700 mm	440 mm
Inner Box	675 mm	575 mm	315 mm
Cushioned to	490 mm	450 mm	190 mm

3. Secure the whole package.

Power Fuse Replacement

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury:

- **Use only specified replacement fuses.**
- **Turn the Product off and remove the mains power cord. Stop for 2 minutes to let the power assemblies discharge before you open the fuse door.**

The power input, power fuses, and line voltage selector are contained in an integral filtered module on the rear panel.

The fuses are fitted into the reverse side of the Fuse Drawer. If the fuse continues to fail, contact the Service Center.

⚠ Warning

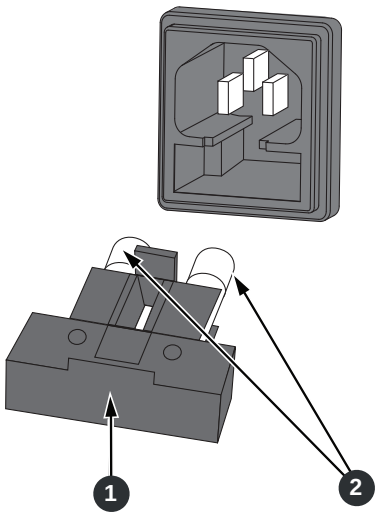
Make sure that only fuses with the required rated current and of the specified type are used for replacement.

See the Safety Information printed with the Product or on the web:.

To replace the power fuses:

1. Turn off the Product.
2. Remove the mains power cord.
3. Before you open the fuse door, wait 2 minutes to let the power assemblies discharge.
4. Insert a small screwdriver blade in the narrow recess beneath the catch under the fuse drawer. Gently push downwards until the catch releases.
5. Pull the drawer out.
6. Hook a small finger into the block in the square recess in its base then pull to disengage its contacts, and remove from the module.
7. Check the fuse and replace, if necessary.
8. Insert the fuse drawer into the module.

Table 37. Fuse Locations



Item	Description
1	Fuse Drawer
2	Fuses

Product Disposal

Dispose of the Product in a professional and environmentally appropriate manner:

- Delete personal data on the Product before disposal.
- Remove batteries that are not integrated into the electrical system before disposal and dispose of batteries separately.
- If this Product has an integral battery, put the entire Product in the electrical waste.