9500B

High Performance Oscilloscope Calibrator

Calibration Manual

November 2019

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available only if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product’s specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

Fluke Europe B.V.
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

ООО «Флюк СИАЙЭС»
125167, г. Москва,
Ленинградский проспект дом 37,
корпус 9, подъезд 4, 1 этаж

11/99

Table of Contents

Title	Page
Introduction	1
Contact Fluke Calibration Calibration	1
Safety Information	2
Product Use	2
Specifications	2
Routine Maintenance	2
General Cleaning	2
Air Intake Filter	2
Removing the Top Cover	3
Top Guard Shield and Calibration Seal	3
Removing the Filter Element	3
Cleaning the Filter Element	3
Refitting the Filter Element	4
Refitting the Top Cover	4
Replacement Parts	4
Firmware Upgrade	4
Introduction	4
Procedure	5
Active Heads	7
Model 9500B Test and Selftest	7
Types of Tests	7
Test Mode	7
Base, Heads, All and Fast Selftest	8
Aborting the Selftest	9
Selftest Runs to Completion	10
Viewing the Test Results	11
Printing the Test Results	12
Selftest at Power-On	12
Interface Test	13
Access to Interface Tests	13
Display Memory Checks	14
Keyboard Checks	15
Display Checks	16
Memory Card Checks	17
Tracker Ball Checks	21
Printer Checks	22

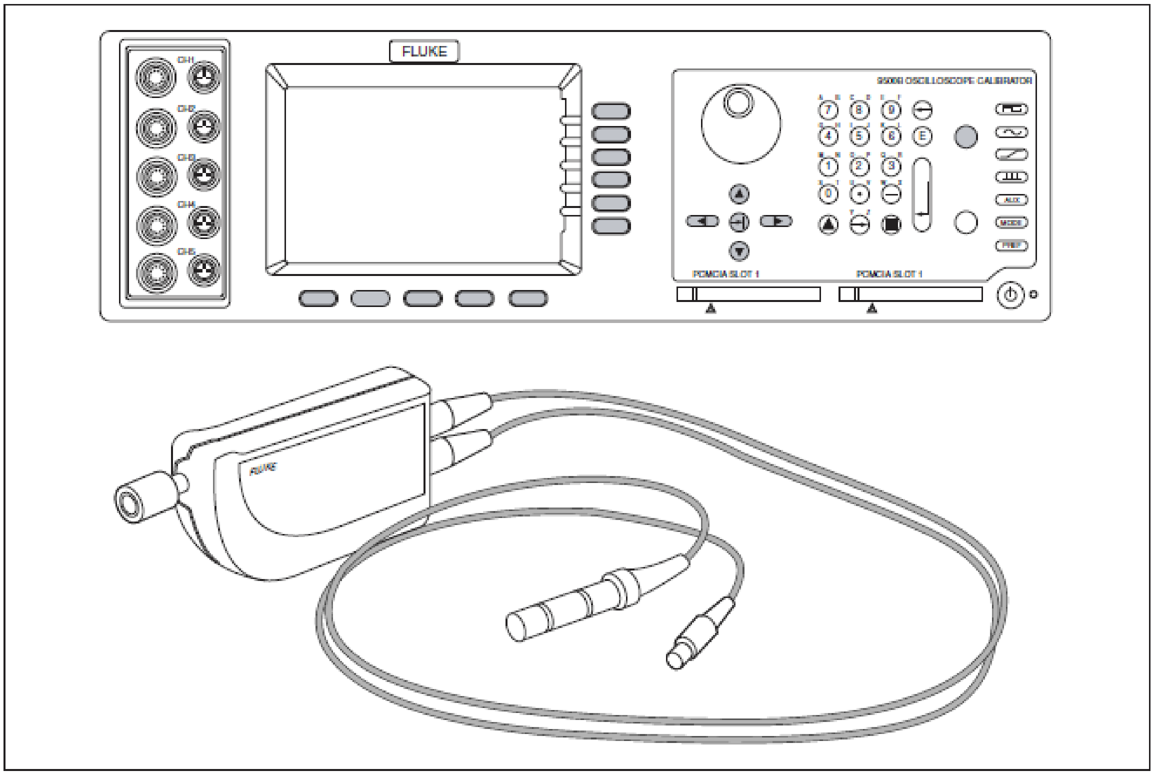
Printing Selftest Results 23
Introduction 23
Parallel Port (Rear Panel) 23
Printing Setup 24
Printer Type 24
Data Formatting 25
Results Printout 25
Error Reporting Subsystem 25
Error Detection 25
Error Messages 26
System Trip Errors 26
Recoverable Errors 26
Type of Errors 26
Error Reporting 26
Command Errors (CME) 27
Execution Errors (EXE) 28
Query Errors (QYE) 28
Device-Dependent Errors (DDE) 29
Device-Dependent Errors Reported only Locally on the Front Panel Screen 29
Device-Dependent Errors Reported only Remotely via the IEEE-488 Interface 30
Device-Dependent Errors Reported both Locally and Remotely 31
Verification 36
Need for Verification 36
Factory Calibration and Traceability 36
Verification on Receipt from the Factory 36
Verification after User-Calibration 36
Equipment Requirements 36
Interconnections 37
Verification Points 37
Specification Limits 37
Verification Procedure 37
9500B Mainframe Verification by Functions 37
Verifying the DC/Square Function: DC Voltage 38
Verifying the DC/Square Function: Square Voltage 42
Verifying the LF Sine Voltage Function 45
Verifying the Time Markers Function 48
Verifying the Load Resistance Measurement Function 50
Verifying the Pulse Width Function 53
9510/9530/9550/9560 Head Verification by Functions 54
Verifying the Leveled Sine Function: LF Gain 55
Verifying the Leveled Sine Function: Flatness 58
Verifying the Edge Function 65
Verifying the Load Capacitance Measurement Function (E) 70
Calibration 74
9500B Mainframe Calibration and Active Head™ Calibration 74
Mainframe Unit Calibration 74
Active Head Calibration 75
Other Functions 75
Mainframe Unit Manual Calibration 76
The Model 9500B Calibration Mode 76
Mode Selection 77
'Mode' Key 77
'Mode Selection' Screen 78

Selection of Calibration Mode 78
Calibration Enable Switch 78
Password 79
Calibration Mode Display 79
Calibration Mode Screen Softkeys 80
Special Calibration 80
Selecting Special Calibration 80
When to Characterize 81
How to Characterize 81
Form of Characterization 81
Special Cal: 'Adjust FREQ' 82
When to Adjust 82
Equipment Requirements 82
Interconnections 83
9500B and Counter Setup 83
Sequence of Operations 83
Mainframe Standard Calibration (BASE CAL) 84
Function Selection 84
Cal Mode Function Screens 85
‘Hardware Configurations' 86
'Target Calibration Values' 86
Overview of Calibration Operations 86
Standard Calibration — Basic Sequences 88
Aim of Calibration 89
General Calibration Process 89
Target Selection Screen — Selecting Hardware Configurations 89
Waveform Selection 90
Hardware Configurations 90
Channel Selections 90
Retained Channel Memory 91
Default' or 'Saved' Targets 91
The Adjustment Screen 91
Setting Target Values 91
Selecting Default Calibration Targets 92
Modifying a Calibration Target 92
Calibrating the Model 9500B at Target Values 93
Adjust Output Amplitude 93
Target Selection 94
'RESET CAL POINT' 95
Standard Calibration of AC Functions 95
Output Frequency Synthesis 95
Changing the Output Frequency of Target Calibration Points 95
Exit from Base Calibration - Cal Date and Cal Due Date 96
Exit: Mode Key — Warning Screen 97
Exit Only 97
Update the Date Stamp on a Certificate 97
Setting the Cal Due Date and Advance Warning Period 98
Front Panel Base Calibration by Functions 99
Introduction 99
Summary of Calibration Process 100
General Procedure 100
Sequencing Calibrations 102
DC/Square — DC Voltage Calibration 103
DC/Square — Square Calibration 107
LF Sine Voltage Calibration 111

Load Resistance Measurement Calibration 115
9510/9530/9550/9560 Head Calibration Procedures 118
Levelled Sine Function: LF Gain 118
Levelled Sine Function: HF Calibration 120
Calibrating the Edge Function 128
Calibrating the Timing Markers (9510 only) 140
Load Capacitance Function Calibration (9510 and 9530 only) 141
50 Ω / 1 MΩ Ratio Calibration 142
Exit from Head Calibration 144

Introduction

The Model 9500B is a state-of-the-art calibrator offering oscilloscope test and calibration capabilities from a single source, providing wide functionality (shown in Figure 1). (Variant 9500B/1100 is described—for other variants, refer to the *9500B Extended Specifations*. See *Specifications*.)



Erw001

Figure 1. General View of Model 9500B with an Active Head

Contact Fluke Calibration Calibration

To contact Fluke Calibration Calibration, call one of the following telephone numbers:

- Technical Support USA: 1-877-355-3225
- Calibration/Repair USA: 1-877-355-3225
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-40-2675-200
- Japan: +81-3-6714-3114
- Singapore: +65-6799-5566
- China: +86-400-810-3435
- Brazil: +55-11-3759-7600
- Anywhere in the world: +1-425-446-6110

To see product information and download the latest manual supplements, visit Fluke Calibration Calibration's website at www.flukecal.com.

To register your product, visit http://flukecal.com/register-product.

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.flukecal.com. More specific safety information is listed where applicable.

Product Use

User instructions for Product operation are located in these manuals at www.flukecal.com:

- *9500B Operators Manual*
- *9500B Users Guide*

Specifications

Safety Specifications are located in the Safety Specifications section of the *9500B Safety Sheet*. Complete specifications are at www.flukecal.com. See the *9500B Extended Specifications.*

Routine Maintenance

General Cleaning

⚠ Warning

To prevent fire, explosion, or personal injury, disconnect the power line cord before cleaning.

Remove dust from the top cover using a soft brush (do not use a cloth unless it is lint-free). Keep the controls clean using a soft, lint-free cloth, dampened with a non-toxic, noncorrosive detergent. The display screen should be cleaned using a soft, lint-free cloth, dampened with an anti-static cleanser. Avoid extreme pressure on the face of the screen and do not spray the screen directly.

Air Intake Filter

⚠ Warning

To prevent fire, explosion, or personal injury, disconnect the power line cord before removing any covers.

The internal airflow is powered by an axial fan which draws cooling air through the interior (directed mainly through the RF module) to be exhausted on the left side via holes in the cover. Replacement air is drawn into the instrument through holes in the right side of the top cover, then through a 20 ppi (pores per inch) reticulated filter. This filter is accessed by removing the top cover.

Once the cover is removed, holes can be seen in the chassis assembly right side, with the reticulated filter located over these holes, attached by four black nylon snap rivets through four holes to the chassis assembly.

Inspect and clean the filter element by vacuuming at intervals of no more than 90 days. Remove the filter for thorough cleaning at least once per year, immediately prior to routine calibration of the unit.

Removing the Top Cover

⚠ Warning

To prevent fire, explosion, or personal injury, disconnect the power line cord before removing any covers.

The side edges of the top cover are located in slots in both side extrusions, and secured to the rear panel by two screws. A solid plastic block protects each of the rear corners.

To access the filter element, remove the top cover as follows:

1. Release the four screws securing the two rear-corner blocks and remove the blocks.
2. Release the two screws securing the top cover to the rear panel.
3. Pull the top cover to the rear to clear the front bezel, then lift off to the rear.

Top Guard Shield and Calibration Seal

⚠ Caution

With the cover removed, a 'Calibration seal' can be seen covering a countersunk screwhead on the front of the top guard shield. The seal is set in position following a calibration of the instrument, so that removal of the guard shield can be detected.

The calibration seal must NOT be broken unless the guard shield is to be removed for Authorized work inside the chassis assembly.

Removal of the guard shield will compromise the traceable calibration of the instrument, and a full recalibration of the 9500B will be required. If removal of the guard shield is authorized, take care to heed the WARNING printed on it next to the ⚠⚠ symbols.

Removing the Filter Element

The filter is removed as follows:

Carefully lever out the center pin of each of the four black nylon snap rivets and pull out the snap latches. Lift off the filter element.

Cleaning the Filter Element

Once the filter is removed, wash it in warm water and household detergent, rinse thoroughly and allow to dry.

Refitting the Filter Element

1. Hold the filter element in position to cover the chassis holes, and the four securing holes. Separate the latch and center pin of a black nylon snap rivet, and push the latch through the filter into a securing hole at the top. Fit the center pin into the latch and push fully home, so that the pin opens the splits in the rear of the latch.
2. Slightly stretch the filter element into the correct position; fit and secure the other four snap rivets.

Refitting the Top Cover

Carefully refit the top cover into the slots in the side extrusions, with the front edge immediately behind the front bezel; push forward to locate inside the bezel, and secure to the rear panel using the two screws. Refit and secure the corner blocks.

Replacement Parts

Should the filter or snap rivets become damaged by removal or refitting, the following parts can be ordered through your Fluke Calibration Sales and Service Center.
See Table 1.

Table 1. Order Details for Replacement Parts

Part No.	Description	Manufacturer	Type	Qty
451004	20 ppi Reticulated Foam Filter	-----	-----	1
617020	Snap Rivet, Black Nylon	Richco.	SR4050B	5

Firmware Upgrade

Introduction

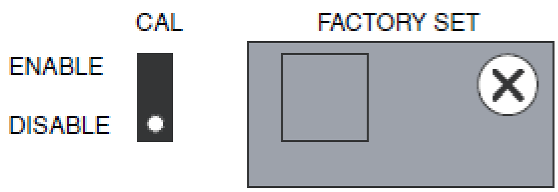
The Model 9500B firmware can be upgraded using a 'Personal Computer Memory Card Interface Adaptor' (PC-Card). To do this, the Model 9500B has been fitted with FLASH memory chips to provide the update capability.

If an upgrade is required for your Model 9500B unit(s), your Service Center will inform you and provide the appropriate PC-Card.

This section describes the routine procedure for upgrading the firmware. Note that the 'All' Self Test appears twice in the procedure: before and after carrying out the upgrade. This is included on two occasions to determine whether any difficulties were present before the upgrade, or whether they have arisen as a result of the upgrade.

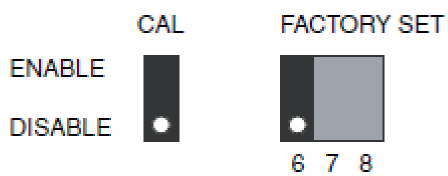
Procedure

1. 'All' Self Test (Refer to Types of Test and Viewing the Test Results): Execute a 'All' Self Test and record any errors. If printing facilities are available, select the PRINT option to obtain a hard copy of the results.
2. Prepare the 9500B:
   a. Switch 9500B Power OFF.
   b. Locate the FACTORY SET switches on the 9500B rear panel:



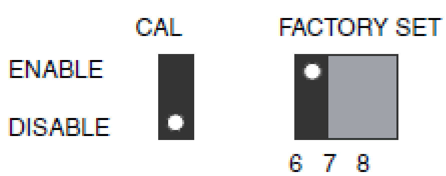
erw162

      1) Remove the switch cover by releasing its retaining screw.



erw163

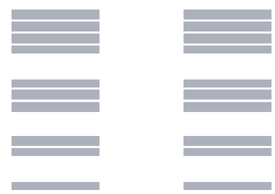
      2) Set Switch 6 to the ENABLE position (up) Do not disturb any of the other switches.



erw164

3. Insert the PC-Card:
   a. Locate 'PCMCIA SLOT 1' in the 9500B front panel.
   b. Insert the PC-Card into 'PCMCIA SLOT 1', exerting just enough pressure to push out the black button by the side of the slot.

4. Re-Program the Firmware:
   a. Switch 9500B Power ON.
   b. Observe the following growth pattern on the 9500B LCD display:



erw165

The process takes approximately 2 minutes to complete. When complete, a repetitive, pulsed audible tone will be heard.

If for any reason a continuous audible tone is heard, the update has not been successful. Note the current state of the growth pattern on the display, and relay this information back to the Service Center

5. Recover the Operational State of the 9500B:
   a. Switch 9500B Power OFF.
   b. Return Switch 6 to the DISABLE position. Do not disturb any of the other switches.
   c. Replace and secure the switch cover.
   d. Remove the PC-Card, switch the 9500B Power ON and wait for approximately 40 seconds until the Power-On Selftest is complete.
   e. On the right of the 9500B front panel, press the Mode key.
   f. At the bottom of the 9500B LCD display, press the soft CONFIG key, and check that the firmware issue, shown on the screen, matches that on the PC-Card.
   g. Transfer back to the Mode Selection screen by pressing the Mode key.
6. 'All' Self Test (Refer to Types of Test and Viewing the Test Results):
   a. Execute an 'All' Self Test and record any errors. If printing facilities are available, select the PRINT option to obtain a hard copy of the results (refer also to Printing Selftest Results).
   b. Note any differences between the self tests at items 1 and 6.
   c. Report the results of the upgrade procedure back to the Service Center.

The Model 9500B firmware upgrade is now complete. Please return your PCMCIA to the Service Center.

Active Heads

A range of Active Heads are available for the 9500B Oscilloscope calibrator. Active head connector wear can seriously impact product specifications. Fluke Calibration recommends that connectors are inspected for wear or damage before use. The recommended interval for connector replacement based on average use is every two years, and once per year for Active heads with higher than average use.

Contact a Fluke Calibration authorized service center for replacement. Attempts to change connectors without the correct tools, training or calibration system is not recommended.

Model 9500B Test and Selftest

Types of Tests

There are four main types of selftest, 'Base', 'Heads', 'All' and 'Fast'. The Fast selftest is also performed automatically at power-on. In addition, the interface for front panel operation can be selectively tested, covering such areas as display memory integrity, keyboard operation, the display itself, integrity and formatting of static RAM memory cards for Procedure mode, the correct operation of a connected tracker-ball, and the correct operation of a connected printer. These tests are detailed in the following paragraphs.

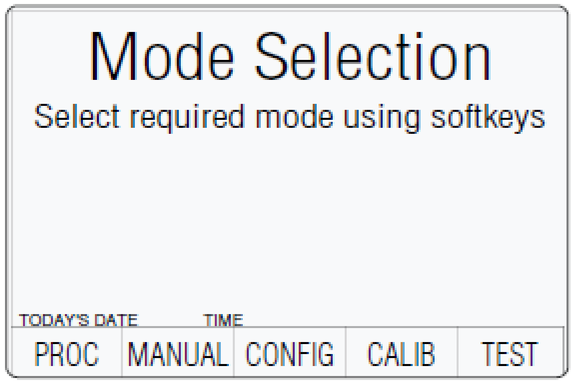
Please Note that all Heads should be disconnected from the UUT Oscilloscope before initiating a Self Test. Failure to disconnect may result in failed tests.

Test Mode

Test mode is selected from the Mode Selection menu, which is displayed by pressing the front panel 'Mode' key, highlighted in Figure 2:

erw166

Figure 2. 'Mode' Key



erw167

This menu can be exited only by pressing one of the five screen keys.

TEST: This key enters Test mode, displaying the following screen:

erw168

BASE: Runs a selftest of the Base Unit.

HEADS: Runs a selftest of all fitted Active Heads.

ALL: Runs a selftest of the Base Unit and all fitted Active Heads.

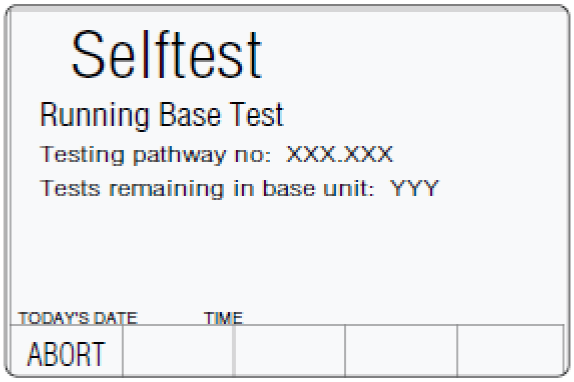
FAST: Runs the same confidence selftest as at Power On.

INTERFACE: This key allows checks of the display and display memory, the front panel keyboard, the (Procedure mode) memory card slots, the tracker ball and printer interfaces.

Base, Heads, All and Fast Selftest

BASE, HEADS, ALL and FAST selftests follow the same format. By pressing one of these four screen keys on the 'Select test' menu screen, the 9500B runs that selftest. The first screen shows the type of test, the pathway under test and the number of tests remaining.

For example:



erw169

(In the following descriptions, it is assumed that a BASE selftest was selected. Other selftests have the selftest name appearing on the screen).

Aborting the Selftest

ABORT: Stops the selftest and displays the appropriate 'ABORTED' screen.

For example:

erw170

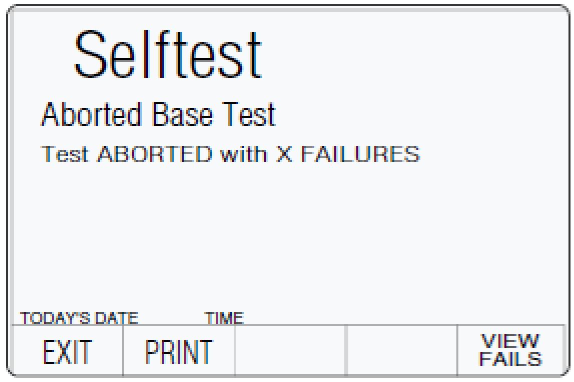
If there were no failures up to the point of aborting, this is shown on the screen.

EXIT: Returns to the 'Select test' menu screen.

PRINT: Prints out the results of the test, up to the point of aborting.

Refer to Printing Selftest Results.

If failures were encountered up to the point of aborting, EXIT and PRINT are available. Also, the number of failures is shown on the screen, and an extra selection will be available:



erw171

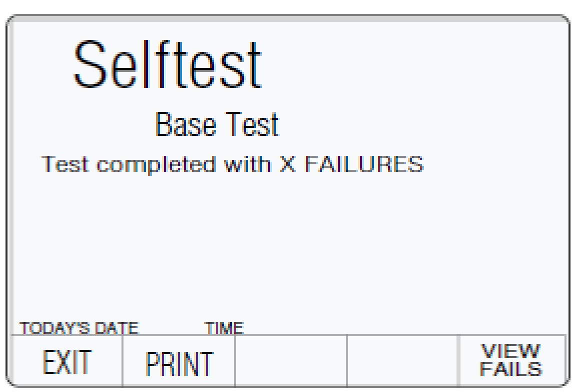
VIEW FAILS: Sets up a special screen for detailing the parameters of the failures encountered (described later in Viewing the Test Results)

Selftest Runs to Completion

If the selftest is not aborted, it will run to completion, and if the test is successful with no failures, a screen will appear:

erw172

If failures were encountered during the test, the 9500B will display a completion screen. For example:



erw173

EXIT: Returns to the 'Select test' menu screen.

PRINT: Prints out the results of the test.

Refer to Printing Selftest Results.

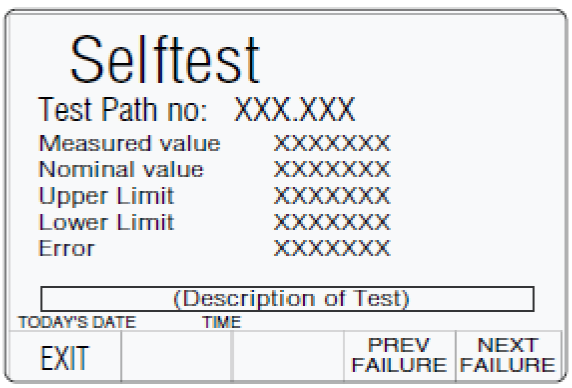
If failures were encountered, EXIT and PRINT remain available. Also, the number of failures is shown on the screen, and an extra selection will be available:

VIEW FAILS: Sets up a special screen for detailing the parameters of the failures encountered (described later in Viewing the Test Results).

Viewing the Test Results

By pressing the VIEW FAILS screen key, each of the failed tests can be viewed in turn, on a screen which shows the test number (pathway), measured value, upper and lower limits, and the value of the error. A brief description of the test is also given in a box beneath the values.

The screen for viewing the test results is shown below. This can also appear when a test has been aborted:



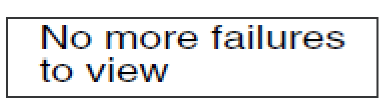
erw174

Note

If the cause of failure is not immediately obvious, and it is intended to consult your Fluke Calibration Service Center, please ensure that you either: copy the details from the screen for all the reported failures, or: print out the results.

NEXT FAILURE:

Once the details of the first failure have been noted, the next failure in the list can be viewed by pressing the NEXT FAILURE screen key. The list of failures remains in memory until the next selftest is started, and the PREV FAILURE screen key can be used to help scan the list one at a time. Once the last failure in the list is on the screen, and the NEXT FAILURE screen key is pressed, the following error message will appear in the top right of the screen:



erw175

Pressing the NEXT FAILURE screen key will have no further effect.

Printing the Test Results

The PRINT screen key is present on the 'ABORTED' or 'completed' screens after the test has run to completion or has been aborted. Pressing the PRINT key will print out all the available results.

Printing will only be possible if a suitable printer is set up, connected and on line. Refer to Printing Selftest Results.

Selftest at Power-On

Note

Certain catastrophic 'System Trip Errors' may cause the display to flash on and off, at the point of setting power on. In this case, immediately switch Power Off and report the fault to your Service Center.

The first normal action at power on is to show the Fluke Calibration logo and Product name, and then the 9500B will run a fast selftes.

If System Trip failures are encountered the 9500B will show the System Trip screen ('RESUME').

If non-trip failures are encountered the 9500B will lapse into Test mode at the following stage:

erw177

Subsequent action to view the failures and print the results follows as for a Fast selftest which has run to completion (Selftest Runs to Completion and Viewing the Test Results).

EXIT will return to the 'Select test' menu screen, where, to return to the 'Mode Selection' menu screen, press the front panel Mode key.

PRINTcan be used to print out the results of the power-on Fast test.

Refer also to Printing Selftest Results.

Interface Test

The interface test selectively checks the 9500B front panel operations, covering display memory integrity, keyboard operation, the display itself, integrity and formatting of static RAM memory cards for Procedure mode, the correct operation of a connected tracker ball, and the correct operation of a connected printer.

Access to Interface Tests

Once the Test mode has been selected, Interface Test is selected by pressing the INTERFACE screen key in the 'Select test' menu:

erw178

Pressing INTERFACE transfers to the 'Select test' menu screen:

erw179.eps

The required check can be selected from the list on the right of the screen, using the corresponding screen key.

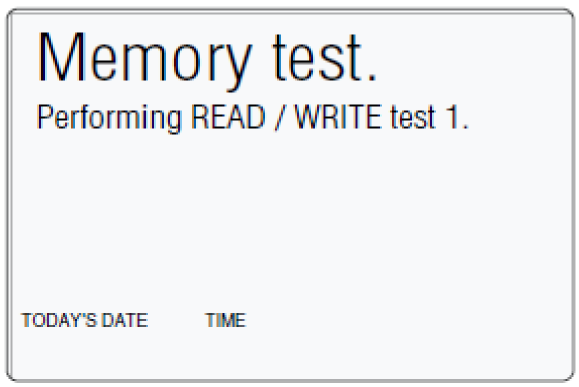
EXIT returns to the previous 'Select required test' menu screen.

The six available checks are detailed, in list order, in the following paragraphs.

Display Memory Checks

Pressing the DISPLAY MEMORY key on the 'Select test' menu screen transfers to the 'Memory test.' screen, and the sequence of tests begins. The test in progress is reported on the screen:

erw180

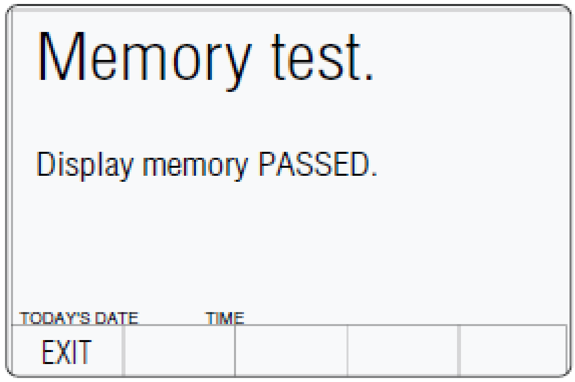


erw181

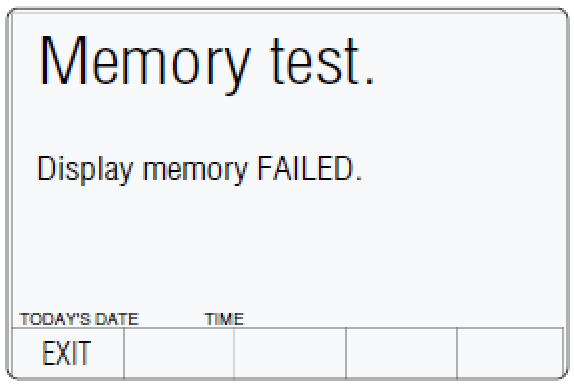
The other tests reported are:

- Performing WALKING ONES test 1
- Performing READ/WRITE test 2
- Performing WALKING ONES test 2

The result of the whole Memory test is reported once testing is complete:



erw18s



erw183

If a failure is reported, rectification will require access to the internal circuitry, so no further user action is recommended, except to report the result to your Fluke Calibration Service Center.

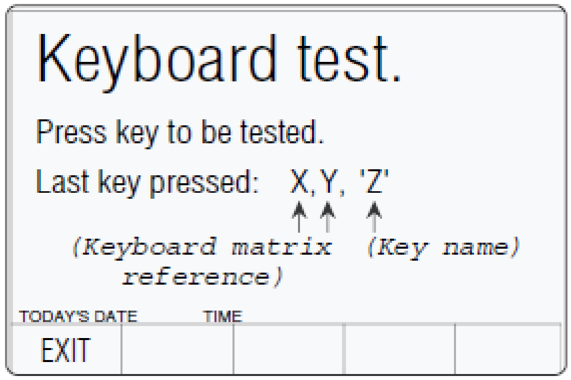
EXIT returns to the Interface 'Select test' menu screen.

Keyboard Checks

Keyboard checks are initiated by pressing the KEYBOARD key on the 'Select test' menu screen:

erw184

Selecting 'KEYBRD' transfers to the 'Keyboard test.' screen. This invites a user to press the front panel key to be tested, and reports on the screen the details of the last key to be pressed:



erw185

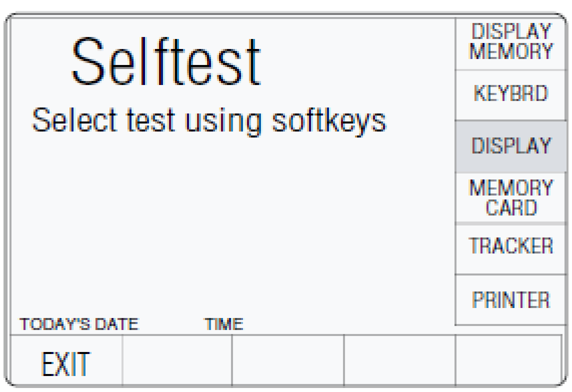
The 'Keyboard matrix reference' (X, Y) relates to the electronic matrix which is used to transfer keypress information to the internal processor, and does not relate closely to the physical layout of keys. The 'Key name' (Z) is the name, in words, which describes the last key to be pressed.

If the reported key name does not coincide with the function of the last key to be physically pressed, a failure is implied. Rectification will require access to the internal circuitry, so no further user action is recommended, except to report the result to your Fluke Calibration Service Center.

EXIT returns to the Interface 'Select test' menu screen.

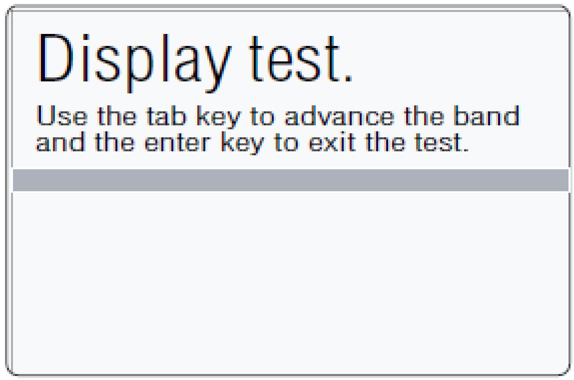
Display Checks

Display checks are initiated by pressing the DISPLAY key on the 'Select test' menu screen:



erw186

Selecting 'DISPLAY' transfers to the 'Display test.' screen. This invites a user to use the front panel 'tab' (Δ) key to move the dark band down the screen, up to the top, and down again, thus testing all the display elements on the screen:



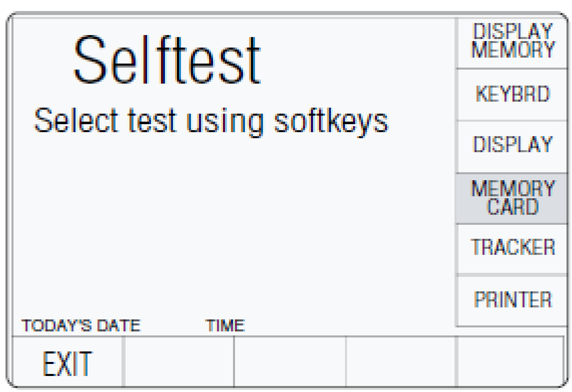
erw187

The screen text will shift automatically so as not to obscure the band as it jumps back to the top of the screen. If there are elements of the screen which do not show light in the light background or dark in the dark band as it is advanced down the screen, then this implies a failure. Rectification will require access to the internal circuitry, so no further user action is recommended, except to report the result to your Fluke Calibration Service Center.

The 'Enter' Key (ξ) returns to the Interface 'Select test' menu screen.

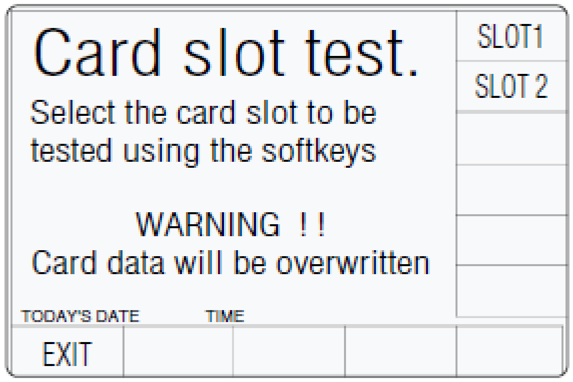
Memory Card Checks

Memory Card checks are initiated by pressing the MEMORY CARD key on the 'Select test' menu screen:



erw188

Pressing the MEMORY CARD key on the 'Select test' menu screen transfers to the 'Card slot test.' screen. This invites a user to select the memory card slot to be tested, and presents an 'Overwrite' warning:



erw189

SLOT 1: Selects 'PCMCIA SLOT 1' for testing.

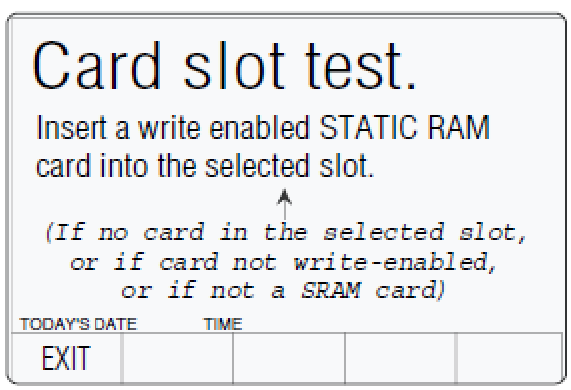
SLOT 2: Selects 'PCMCIA SLOT 2' for testing.

EXIT: Returns to the Interface 'Select test' menu screen.

Either slot can be used for the test. If one particular slot is suspect then that, naturally, will be the one to choose.

The WARNING!! gives notice that the inserted memory card will be overwritten by this test. This is because reformatting is required to perform the checks and the card inserted into the slot will be reformatted as a Results card.

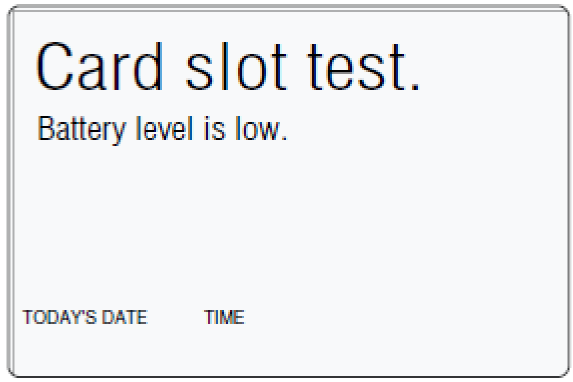
The 9500B first checks for the presence of the correct SRAM card. If there is no card in the slot, if the card in the slot is not a SRAM card, or if it is a SRAM card but not write-enabled, then the following screen is displayed:



erw190

After correcting the defect, press the OK screen key. This transfers to a new screen, and the sequence of tests begins. The test in progress is reported on the screen.

The 9500B first checks the state of the card's internal battery. If the battery voltage is low, this will be stated on the screen:



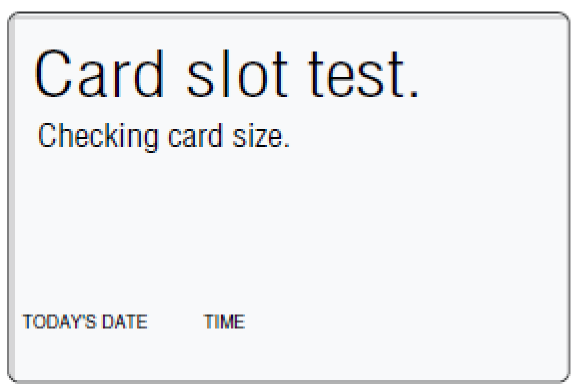
erw191

If there is no battery in the card, or if the battery cannot support read/write operations, then the statement will be 'Battery level is dead.'.

Note

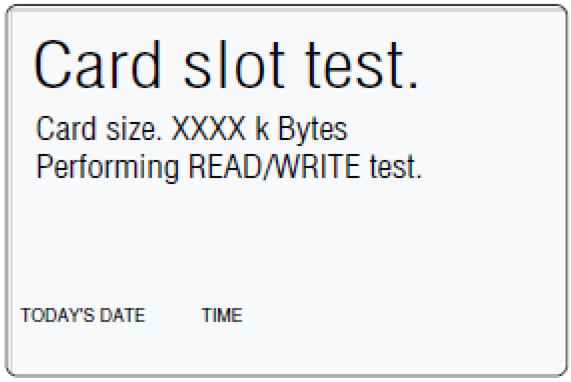
For a re-chargeable card with a low battery, the low/dead message may take several minutes to clear after pressing OK.

The next test is to check the size of the card memory. While the 9500B is checking, it will place the following message on the screen:



erw192

Once the size check is completed, the 9500B starts on a 'read/write' check; meanwhile the display changes to:



erw193

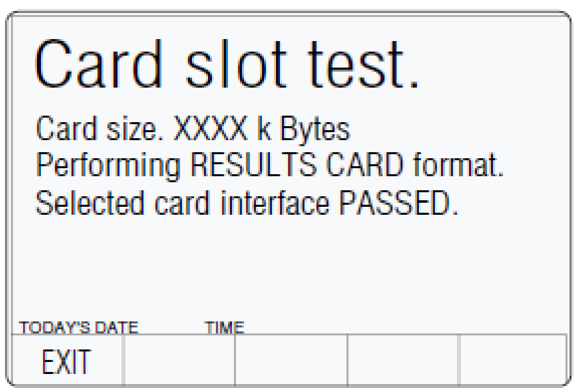
After the read/write check, the 9500B starts on a 'walking ones' check, and the message on the display changes to:

Performing WALKING ONES test.

The test continues, this time to format the memory into 'Results Card' format. A new message appears on the display:

Performing RESULTS CARD format.

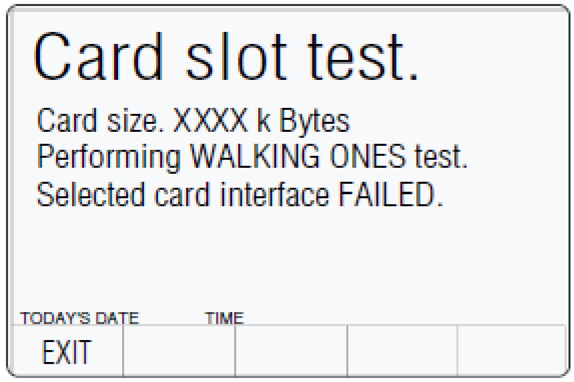
Providing that the full range of tests and formatting is completed successfully, the PASS statement is added to the screen:



erw194

EXIT returns to the Interface 'Select test' menu screen.

If the test fails at any point, then the test will stop, leaving the heading for the failed test on the screen, followed by a failure statement. For example, if the failure occurred during the 'walking ones' check, then the following screen would be presented:



erw19s

To diagnose the reason for a failure, there are several further checks which can be made to localize the fault. Firstly, an attempt should be made to re-check the same card in the other slot, then if this is successful, check a new card in the original slot. This should narrow the fault down to one slot or one card. If it is suspected that the 9500B is at fault, it is wise to report the result to your Fluke Calibration Service Center.

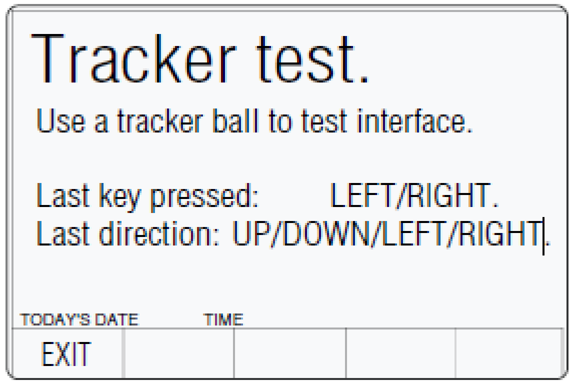
EXIT returns to the Interface 'Select test' menu screen.

Tracker Ball Checks

Checks of a connected tracker ball are initiated by pressing the TRACKER key on the 'Select test' menu screen:

erw196

Selecting 'TRACKER' transfers to the 'Tracker test.' screen. This invites a user to use a tracker ball to test the interface, and reports on the screen the details of the last key to be pressed, and the last movement of the ball:



erw197

The possible responses are shown on the diagram. Note that the center key on the tracker has no function in its operation with the 9500B, and is not tested, so pressing this key should have no effect, unless the tracker is defective.

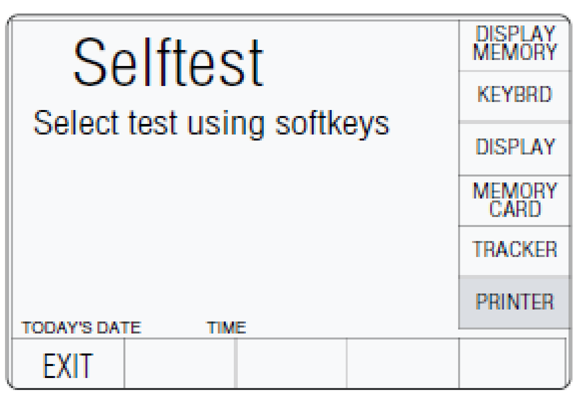
If the last key to be named does not coincide with the last key to be physically pressed, or if the last direction shown does not correspond to the last physical movement; then a failure is implied. It is possible to diagnose the defect source by checking a second tracker unit on the same 9500B, or the same tracker unit on a different 9500B. Rectification may require access to the internal circuitry of the 9500B or tracker unit, so no further user action is recommended, except to report the result to your Fluke Calibration Service Center.

EXIT returns to the Interface 'Select test' menu screen.

Printer Checks

Checks of a connected printer are initiated by pressing the PRINTER key on the 'Select test' menu screen.

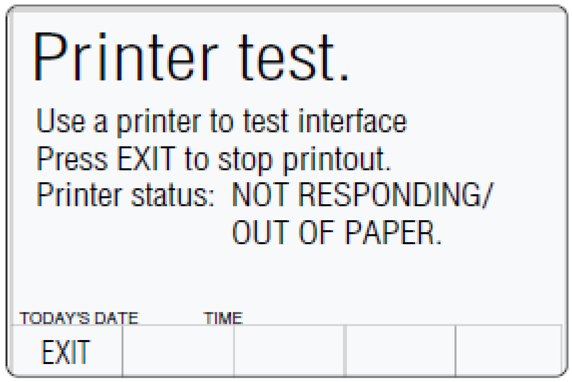
Selecting 'PRINTER' transfers to the 'Printer test.' screen. This invites a user to use a printer to test the interface (e.g. by switching the printer off-line, or removing the paper), and reports on the status of the printer:



erw198

Note

If the printer is disabled (Config mode), the printer will not be set up when starting to print for the first time.



erw199

The possible responses are shown on the diagram. They are updated automatically as the printer status changes. When operating correctly, the printer will print a character-set continuously until the EXIT screen key is pressed.

If the reported status of the printer interface does not match the known physical status, then this implies a failure. It is possible to diagnose the defect source by checking a second printer unit on the same 9500B, or the same printer unit on a different 9500B. Rectification may require access to the internal circuitry of the 9500B or printer unit, so no further user action is recommended, except for obvious setup errors. Otherwise it is advisable to report the result to your Fluke Calibration Service Center.

EXIT returns to the Interface 'Select test' menu screen.

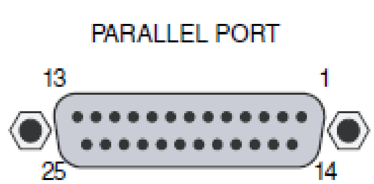
Printing Selftest Results

Introduction

The results of All and Fast selftests can be printed out by a printer connected to the parallel port J103 on the rear panel. It can also be used to print out certificates for UUTs calibrated in Procedure mode.

Parallel Port (Rear Panel)

Pin Layout



erw200

Pin Designations

9500B Pin No.	9500B Signal Name	9500B I/O	Description or Common Meaning
1	STROBE_L	Output	1 µs pulse to cause printer to read one byte of data from data bus DO1—DO8
2	DO1	Output	Data bit 1
3	DO2	Output	Data bit 2
4	DO3	Output	Data bit 3
5	DO4	Output	Data bit 4
6	DO5	Output	Data bit 5
7	DO6	Output	Data bit 6
8	DO7	Output	Data bit 7
9	DO8	Output	Data bit 8
10	ACKNLG_L	Input	Pulse to indicate that the printer has accepted a data byte, and is ready for more data
11	BUSY_H	Input	Printer is temporarily busy and cannot receive data
12	P_END_H	Input	Printer is out of paper
13	SLCT_H	Input	Printer is in online state, or connected
14	AUTO_FEED_L	Output	Paper is automatically fed 1 line after printing. This line is fixed _H (high) by the 9500B to disable autofeed
15	ERROR_L	Input	Printer is in 'Paper End', 'Offline' or 'Error' state
16	INIT_L	Output	Commands printer to reset to power-up state, and in most printers to clear its print buffer
17	SLCT_IN_L	Output	Commands some printers to accept data. This line is fixed _L (low) by the 9500B
18-25	0V_F	Output	Digital Common
_H ≡ Logic-1 active; _L ≡ Logic-Ø active			

Printing Setup

The results of Base, Heads, All and Fast selftest operations can be printed directly via the rear panel parallel port J103. A suitable printer must be connected and switched on-line; then the 9500B internal program will generate the required results.

Printer Type

The printer to be used should be capable of printing 120 characters per line, and must be able to print the Code Page 437 character set. Most printers compatible with Epson FX, Canon Bubble-Jet or Hewlett-Packard Desk-Jet are suitable.

Data Formatting

The required printout style, format and data is pre-determined depending on whether Base, Heads, All and Fast test results are being printed, and on the type of printer to be used. It is necessary to enable a particular printer type via Configuration mode, only if the format for that printer is required.

Note

If the printer is disabled, the printer will not be set up when starting to print for the first time.

Results Printout

Apart from the heading: Base, Heads, All and Fast test results have the same printed layout. The results of tests on all test pathways are collected together in a table. A typical sample of a table is given below:

Serial No: XXXXXX S/W Issue: X.XX Date: XX/YY/ZZZZ Time: 12:41 Type: FAST

TEST PT	MEAS VALUE	NOMINAL	MIN LIMIT	MAX LIMIT	ERR %	FAILURES
DØ8.ØØ1	+5.289216	+5.ØØØØØØ	+4.5ØØØØØ	+5.ØØØØØØ	+6Ø	
DØ8.ØØ2	-5.486493	-5.2ØØØØØ	-5.6ØØØØØ	4.ØØØØØØ	-72	
DØ8.ØØ3	+14.646128	+15.ØØØØØØ	+14.25ØØØØ	+15.75ØØØØ	-47	

ERR %: Gives the achieved percentage of full tolerance for that test.

FAILURES: In this column a failure is shown by the figure '1' against the relevant test.

Error Reporting Subsystem

Note

For the sake of completeness, this section collects together the error codes which might be generated either on the instrument front panel, or via the IEEE 488 system bus.

Error Detection

All errors which cannot be recovered without the user's knowledge result in some system action to inform the user via a message, and where possible restore the system to an operational condition. Errors are classified by the method with which they are handled. Recoverable errors report the error and then continue. System errors which cannot be recovered cause the system to reset via the Power-on state to a system trip error report state, from which a 'resume' may clear the error, but generally such messages are caused by hardware or software faults, which require user action.

Error Messages

System Trip Errors

For all system trip errors, the error condition is reported only via the front panel. The error will pull the processor reset line to restart the system as at power-on. The screen will display a message indicating that there has been a system trip error and thus the processor has been reset. A user may continue by use of the 'resume' key, or from power on, and initiate repair if the fault persists.

The following is a list of error numbers, which will be displayed with their fault descriptions:

```
9501   -  DAC Default Characterisation. Failed
9502   -  Failed to clear Flash RAM
9504   -  No ADC ready bit after 160ms
9505   -  Flash RAM protected by switch
9510   -  Measurement failed to complete
9512   -  Output off request did not complete
9514   -  Output Off Expected
9515   -  Main unit control loop failure
9516   -  Internal overheating: Check air vents
9517   -  Internal frequency Failed to re-lock
9518   -  ADC failed to complete measurement
9519   -  Rf DAC control loop failure
9520   -  TV waveform control loop failure
```

For the following errors, an error number will be allocated at run time:

```
UNDEFINED SYSTEM TRIP ERROR
OPERATING SYSTEM ERROR
```

Recoverable Errors

Type of Errors

These consist of Command Errors, Execution Errors, Query Errors and Device-Dependent Errors. Command, Query and Execution Errors are generated due to incorrect remote programming. Device-Dependent Errors can be generated by manual as well as remote operation. Each of the reportable errors is identified by a code number.

Error Reporting

In response to a bus or a keyboard error, there are certain categories of error reporting. Primarily, the error will be reported to the original source of the error, but in some cases will be reported to both local and remote operators. Locally, the error will be displayed on the front-panel screen; remotely, it will set the relevant ESR bit, and add the error to the Error Queue.

Note about the ERROR Queue (accessible via the IEEE-488 Interface)

The Error Queue is a sequential memory stack. Each reportable error has been given a listed number and explanatory message, which are entered into the error queue as the error occurs. The queue is read destructively as a First-In/First-Out stack, using the query command SYSTem :ERRor? to obtain a code number and message.

Repeated use of the query SYSTem :ERRor? will read successive Device-Dependent, Command and Execution errors until the queue is empty, when the 'Empty' message (0,"No error") will be returned.

It would be good practice to repeatedly read the Error Queue until the 'Empty' message is returned.

The common command *CLS clears the queue.

Command Errors (CME)

(Remote operation only)

Command Error Generation

A Command Error is generated when the remote command does not conform, either to the device command syntax, or to the IEEE 488.2 generic syntax. The CME bit (5) is set true in the Standard-defined Event Status Byte, and the error code number is appended to the Error Queue.

Command Error Reporting

The error is reported by the mechanisms that deal with status reporting.

The Command Errors implemented in the 9500B are listed below; their error numbers conform to those defined in the SCPI Standard document:

```
-100,"Command error"
-101,"Invalid character"
-103,"Invalid separator"
-104,"Data type error"
-105,"GET not allowed"
-108,"Parameter not allowed"
-110,"Command header error"
-113,"Undefined header"
-120,"Numeric data error"
-121,"Invalid character in number"
-123,"Exponent too large"
-124,"Too many digits"
-150,"String data error"
-160,"Block data error"
-161,"Invalid block data"
-178,"Expression data not allowed"
```

ALWAYS: record the total message content for possible use by the Service Center.

Execution Errors (EXE)

(Remote operation only)

Execution Error Generation

An Execution Error is generated if a received command cannot be executed due to it being incompatible with the current device state, or because it attempts to command parameters which are out-of-limits.

In remote operation, the EXE bit (4) is set true in the Standard-defined Event Status Byte, and the error code number is appended to the Error queue.

Execution Error Reporting

The error is reported by the mechanisms which deal with status reporting.

The Execution Error numbers are given below, with their associated descriptions.

```
-220,"Parameter error"
-221,"Settings conflict"
-222,"Data out of range"
-223,"Too much data"
-224,"Illegal parameter value"
-241,"Hardware missing"
-258,"Media protected"
```

Query Errors (QYE)

(Remote operation only)

Query Error Generation

A Query Error is generated when the controller fails to follow the Message Exchange Control Protocol as follows:

- **DEADLOCK State**

  The device has been asked to buffer more data than it has room to store; the Output Queue is full, blocking the Response Formatter, Execution Control and Parser; the Input Buffer is full, and the controller is waiting to send more data bytes to the device.

- **UNTERMINATED Action**

  The controller attempts to read a Response Message from the device without first having sent a complete Query Message, including the Program Message Terminator.

- **INTERRUPTED Action**

  The device is interrupted by a new Program Message before it finishes sending a Response Message.

Query Error Reporting

The QYE bit (2) is set true in the Standard-defined Event Status Byte, and the error code number is appended to the Error queue. The error is reported by the mechanisms described in the *9500B Users Guide, Retrieval of Device Status Information* section, which deals with status reporting.

The specific reason for a query error must be determined by inspection of the command program. No error codes are provided from within the 9500B.

Device-Dependent Errors (DDE)

A Device-Dependent Error is generated if the device detects an internal operating fault (eg. during self-test). The DDE bit (3) is set true in the Standard-defined Event Status Byte, and the error code number is appended to the Error queue. The error description appears on the display, remaining visible until the next key press or remote command.

Errors are reported by the mechanisms which deal with status reporting.

Device-Dependent Errors Reported only Locally on the Front Panel Screen

The error list for local operations, which are not reported to the remote operator, is given below:

Note that the error number will not be presented on the screen.

```
-7001, "Entry contains illegal characters"
-7002, "Entered value is outside the allowed range"
-7003, "Day entry is not a valid number"
-7004, "Day separator is incorrect"
-7005, "Month entry is not a valid number"
-7006, "Month separator is incorrect"
-7007, "Century entry is not a valid number";
-7008, "Year entry is not a valid number"
-7009, "Year separator is incorrect"
-7010, "Month entry is not a valid month"
-7011, "Day entry is not a valid day"
-7012, "Hours entry is not a valid number"
-7013, "Minutes entry is not a valid number"
-7014, "Entry does not give a valid time setting"
-7016, "Bus address must be within the range 0 - 30"
-7017, "Safety voltage must be within the range 10V and 110V"
-7018, "Borderline value must be within the range 10.00 - 99.99%"
-7019, "Entry does not match previous password entry"
-7020, "New string contains illegal characters or values."
-7024, " WARNING Instrument near cal due date"
-7025, " WARNING Instrument past cal due date"
-7026, "Ref frequency must be within the range 0.1 Hz and 1.3 GHz"
-7027, "Ref frequency must be within the range 0.1 Hz and 3.2 GHz"
-7029, "Ext Ref must be locked for selection to be allowed"

-9001, "No calibration necessary for this function"
-9002, "Target factor is corrupt - select defaults"
-9008, "Edge speed outside limits"
-9009, "Restricted period for this amplitude"
-9010, "Maximum limit"
-9011, "Minimum limit"
-9012, "Outside amplitude range"
-9013, "Maximum amplitude for 50Ω load";
-9014, "Outside frequency range"
-9015, "Outside amplitude range for DC";
-9016, "Outside Period range"
-9017, "Outside deviation range"
-9018, "Deviation restricted by frequency range"
-9019, "Deviation restricted by amplitude range";
-9020, "Syntax error"
-9021, "Outside numeric range"
```

```
-9022, “Only a restricted setting available”
-9023, “Maximum frequency for this waveform is 1.11MHz”
-9024, “Minimum highlight period is 20ns”
-9025, “No further display ranges available”
-9026, “No further options”
-9027, “Current probe accessory must be fitted to active head”
-9028, “Outside energy range”
-9029, “Entered number exceeds limits”
-9030, “Channel already in use”
-9031, “Outside skew range”
-9032, “VCO characterisation failed”
-9041, “Invalid number of divisions”
-9042, “Invalid units per division”
-9043, “Units per div, number of div’s combination outside range”
-9044, “Maximum units per division for 50Ω load”
-9050, “Printer is not responding”
-9051, “Printer out of paper”
-9053, “Previous test point failed - exceeded UUT spec. limits”
-9060, “Invalid test number”
-9062, “No more failures to view”
-9063, “No more tests to execute”
-9067, “Search procedure - NO test point”
-9068, “Search procedure - Function ID expected”
-9069, "Test .... must be executed first"
-9070, "Please wait - safety delay"
-9071, "Dual channel sine amplitude restricted to 2.78V"
-9072, "Dual channel sine amplitude restricted to 1.668V"
-9073, "Maximum frequency for 1M\352 load";3
-9074, "Selected head restricts frequency to 1.1GHz";
-9075, "Multi-channel DC requires 1M\352 impedance"
-9076, "Outside Pulse Width range"
-9077, "9560 Dual channel sine frequency restricted to 3.2GHz"
```

ALWAYS: record the total message content for possible use by the Service Center.

Device-Dependent Errors Reported only Remotely via the IEEE-488 Interface

The error list for remote operations, which are not reported on the front panel screen, is given below:

```
-300,"Device specific error"
-312,"PUD memory lost"
-315,"Selftest failed"
-330,"Configuration memory lost"
-350,"Queue overflow"
```

Device-Dependent Errors Reported both Locally and Remotely

Errors are reported both on the front panel screen and via the IEEE-488 interface. Note that the locally-presented error message will not include the error number.

General

```
1001, “Active head removed with output on”
1002, “Softkey label too long”
1003, “Confirm with ON”
1004, “Unknown keycode”
1006, “CH1 head control update failure”
1007, “CH2 head control update failure”
1008, “CH3 head control update failure”
1009, “CH4 head control update failure”
1010, “CH5 head control update failure”
1011, “Loss of external reference frequency lock”
1012, “Load <50Ω detected, output off to avoid damage”
1013, “Internal frequency lock has been performed”
1014, “Load mismatch detected: UUT <50kΩ”
1015, “Load mismatch detected: UUT >150Ω”
1016, “Loss of internal reference frequency lock”
1017, “Trigger cable deselected with output on”
1018, “No head present on channel 1”
1019, “No head present on channel 2”
1020, “No head present on channel 3”
1021, “No head present on channel 4”
1022, “No head present on channel 5”
1023, “Active signal cable removed with output on”
1024, “Head interrupt - OFF timeout”
1025, “Zero Skew requires at least two heads”
1026, “Output must be ON”
1027, “Alignment must be adjusted before deselecting default”
1028, "Head on channel 1 has not been recognised"
1029, "Head on channel 2 has not been recognised"
1030, "Head on channel 3 has not been recognised"
1031, "Head on channel 4 has not been recognised"
1032, "Head on channel 5 has not been recognised"
1033, "9520 head or better required for 150ps edge"
1034, "9530 head required for sine greater than 1.1GHz"
1035, "Command not available for single channel configuration"
1036, "Base unit cannot calibrate at required frequency"
1037, "9550 head required for 25ps edge"
1038, "9550 head can only be used for 25ps edge"
1039, "At least one signal channel must always be selected"
1040, "CH1 Load <50k\352 detected, output off to avoid damage"
1041, "CH2 Load <50k\352 detected, output off to avoid damage"
1042, "CH3 Load <50k\352 detected, output off to avoid damage"
1043, "CH4 Load <50k\352 detected, output off to avoid damage"
1044, "CH5 Load <50k\352 detected, output off to avoid damage"
1045, "CH1 Load mismatch detected: UUT <50k\352"
1046, "CH2 Load mismatch detected: UUT <50k\352"
1047, "CH3 Load mismatch detected: UUT <50k\352"
1048, "CH4 Load mismatch detected: UUT <50k\352"
1049, "CH5 Load mismatch detected: UUT <50k\352"
1050, "CH1 Load mismatch detected: UUT >150\352"
```

```
1051, "CH2 Load mismatch detected: UUT >150\352"
1052, "CH3 Load mismatch detected: UUT >150\352"
1053, "CH4 Load mismatch detected: UUT >150\352"
1054, "CH5 Load mismatch detected: UUT >150\352"
1055, "9560 head required for sine greater than 3.2GHz"
1056, "This function is not available from a 9560 head"
1057, "9560 head does not provide 1M\352 in this function"
1058, "9560 cannot source 1M\352 trigger signals"
1059, "9560 requires a 3.2GHz option base"
1060, "Incompatable heads for dual sine mode"
1061, "9560 head required for timing marker < 450ns"
1062, "9560 head required for 70ps edge"
1063, "Calibration of this function not allowed with a 9560"
1064, "Multi-channel DC cannot mix 9560 with other head types"
1065, "Pulse Width characterisation requires 9500B hardware"

5010, “Priority OFF received”
5011, “Gain request limited”
5012, “Failed to read from flash RAM”
5013, “Corrupt VCO correction”
5014, “Failed to save VCO correction”
5015, "Corrupt lf sin dc offset correction"
5016, "Failed to save lf sin dc offset correction"
5017, "Corrupt timing marker zero correction"
5018, "Failed to save timing marker zero correction"
5019, "Corrupt timing marker peak correction"
5020, "Failed to save timing marker peak correction"
5021, "Timing marker peak failed, setting defaults"
5022, "Octal dac value out of range, using default"
5023, "Peak detect not cleared, setting defaults"
5025, "VCO unchrs'd - Using default"
5027, "Frequency Crystal DAC unchrs'd - Using default"
5028, "LF sine DC offset unchrs'd - Using default"
5029, "Triangular TMks unchrs'd - Using default"
5030, "Crystal DAC chrsn corrupt - Using default"
5031, "Square TMk chrsn failed - setting defaults"
5032, "Failed to save Square TMk chrsn failed"
5033, "Square TMk chrsn unchrs'd - Using default"
5034, "Square TMk chrsn corrupt - Using default"
5035, "Pulse Width Failed to characterise"
5036, "Pulse width uncharacterised - Using default"
```

ALWAYS: record the total message content for possible use by the Service Center.

Calibration

```
4001, “Corrupt calibration store, using default”
4002, “NVRAM Failed to save configuration”
4003, “Password incorrect”
4004, “Calibration switch not enabled”
4005, “Password incorrect”
4007, “Amplitude outside limits”
4008, “Calibration is password protected”
4009, “Frequency outside limits”
4010, “Invalid calibration function”
4011, “Output must be ON for CAL”
4021, “No more targets available”
4022, “Failed to save (sv_tgt) factor”
4023, “Failed to save (sv_frq) factor”
4024, “Failed to save (act) factor”
4025, “Failed to save (tgt) factor”
4026, “Failed to save (frq) factor”
4027, "NVRAM Failed to save (R-eqV) factor"
4028, "Limits: R-eqV"
4029, "NVRAM Failed to save (act) R-dervd"
4030, "NVRAM Failed to save (tgt) R-dervd"
4031, "NVRAM Failed to save (act) C-ref"
4032, "NVRAM Failed to save (tgt) C-ref"
4033, "NVRAM Failed to save (frq) C-ref"
4034, "NVRAM Failed to save (C-eqV) factor"
4035, "NVRAM Failed to save (cjc) factor"
4051, "Cap meas no 1st reading"
4052, "Cap meas no 2nd reading"
4053, "Cap meas outside limits"
4055, "Corrupt calibration factors"
4056, "Failed --------"
4057, "Corrupt selfcal factor"
4058, "Corrupt res. ref. factor"
4059, "Corrupt offset DAC factor"
4060, "DAC un-characterised, using defaults"
4201, “Head calibration store corrupt, using default”
4202, “Incompatible head inserted”
4203, “Head data area corrupt”
4204, “Insufficient memory to save head cal factors”
4205, “Could not locate head cal factors, using defaults”
4206, "9560 requires a 16k EEPROM fitted in the head"
4207, "Head read failed"
4208, "Head write failed"
4209, "WARNING: Head on channel 1 is past cal due date"
4210, "WARNING: Head on channel 2 is past cal due date"
4211, "WARNING: Head on channel 3 is past cal due date"
4212, "WARNING: Head on channel 4 is past cal due date"
4213, "WARNING: Head on channel 5 is past cal due date"
4214, "WARNING: Head on channel 1 is near cal due date"
4215, "WARNING: Head on channel 2 is near cal due date"
4216, "WARNING: Head on channel 3 is near cal due date"
4217, "WARNING: Head on channel 4 is near cal due date"
4218, "WARNING: Head on channel 5 is near cal due date"
4219, "WARNING: Unable to restore previous cal data"
```

```
4220, "WARNING: Previous cal outside limits - using defaults"
4221, "WARNING: Cal data not stored: Exit again to abandon data"
```

Characterization

```
4501, "Limits: main DAC gain"
4502, "Limits: composite DAC zero"
4503, "Limits: trim DAC gain"
4504, "Limits: offset DAC gain"
4505, "Limits: main DAC linearity"
4506, "Failed to write to flash RAM"
4507, "Limits: gain of 2 zero"
4508, "Limits: gain of 0.5 zero"
4509, "Limits: DAC output zero"
4510, "Limits: 0.75 buffer zero"
4511, "Limits: DAC positive zero"
4512, "Limits: DAC negative zero"
4513, "Limits: DAC positive FR"
4514, "Limits: DAC negative FR"
4515, "Limits: DAC ±FR ratio"
4516, "Limits: DAC max - DAC min"
4517, "Limits: resistor ratios"
4518, "Failed to save resistor ratios"
4519, "Limits: main DAC offset"
4520, "Failed to save impedance offset"
4521, "LF AC Chrctn impossible: default set"
4522, "Excess LF AC flatness"
4523, "Failed to save DDS lfac error"
4524, "Limits: Gain of 1 zero"
```

ALWAYS: record the total message content for possible use by the Service Center.

DAC Compensation

```
5001, "Corrupt main DAC gain"
5002, "Corrupt trim DAC gain"
5003, "Corrupt composite DAC zero"
5004, "Corrupt lookup table"
5005, "Corrupt Vmax. Vmin"
5006, "Corrupt +ve zero (DAC)"
5007, "Corrupt -ve zero (DAC)"
5008, "Corrupt polarity gain (DAC)"
5009, "Corrupt LFAC correction"
5011, "Gain request limited"
```

Configuration

```
4002, "Failed to save configuration"

-7003, "Day entry is not a valid number"
-7004, "Day separator is incorrect"
-7005, "Month entry is not a valid number"
-7006, "Month separator is incorrect"
-7007, "Century entry is not a valid number"
-7008, "Year entry is not a valid number"
-7009, "Year separator is incorrect"
-7010, "Month entry is not a valid month"
-7011, "Day entry is not a valid day"
-7012, "Hours entry is not a valid number"
-7013, "Minutes entry is not a valid number"
-7014, "Entry does not give a valid time setting"
-7015, "Cannot have duplicate bus addresses"
-7016, "Bus address must be within the range 0 - 30"
-7017, "Safety voltage must be within the range 10V and 110V"
-7018, "Borderline value must be within the range 10.00 - 99.99 %"
-7019, "Entry does not match previous password entry"
-7020, "New string contains illegal characters or values."
-7024, "WARNING Instrument near cal due date"
-7025, "WARNING Instrument past cal due date"
-7026, "Ref frequency must be within the range 0.1 Hz and 1.1 GHz"
-7027, "Ref frequency must be within the range 0.1 Hz and 3.2 GHz"
-7028, "Ref frequency must be within the range 0.1 Hz and 2.2 GHz"
-7029, "Ext Ref must be locked for selection to be allowed"
-7030, "Ref frequency must be within the range 0.1 Hz and 400 MHz"
-7031, "Ref frequency must be within the range 0.1 Hz and 600 MHz"

9990, "Program ASSERTION Trip:"
```

ALWAYS: record the total message content for possible use by the Service Center.

Verification

This section introduces the verification of Model 9500B performance, including the issue of traceability and a verification procedure.

Need for Verification

Factory Calibration and Traceability

Factory calibration of the Model 9500B ensures full traceability up to and including National Standards. Its traceable accuracy figures are quoted in the specifications and all relate to a 1-year calibration interval. See *Specifications*. These figures include all calibration uncertainties, including those of National Standards, and therefore constitute absolute accuracies.

Verification on Receipt from the Factory

Each 9500B is dispatched from the factory with a Certificate of Calibration, which gives detailed results of its pre-shipment performance. However, organizations may wish to confirm that all instruments perform within published specifications, on receipt from their manufacturers.

Such verification is only possible, however, if the user's organization possesses suitable standards equipment, of the necessary traceable accuracy. Without these standards, users may rely on an external support organization for verification, probably also using these organizations to recalibrate the unit at appropriate intervals.

Verification after User-Calibration

Calibration against standards, as detailed in *Calibration*, covers only the possible adjustments used to place corrections in the Mainframe calibration memory. Pre-calibration and post-calibration performance at each adjustment point can be assessed as part of the adjustment procedure. However, to cover all the required points, the procedure in this section should be used to verify pre- and post-calibration performance.

Equipment Requirements

As stated earlier, the standards required to verify that 9500B is within its published specifications must possess the necessary traceable accuracy.

Also note that the standards must operate within the optimum output conditions of the 9500B, as defined in the accuracy tables given in the specifications—i.e. the measurement equipment should be able to operate within the relevant 9500B limits so that no additional accuracy figures have to be taken into account.

The specific equipment requirements for verifying individual functions are listed in the sub-sections detailing their verification procedures.

Interconnections

The form of interconnection required to ensure optimum conditions for verification measurements will depend on the individual function being verified, and on the measuring equipment connected to the 9500B's terminals. Suitable connections are described in the sub-sections detailing the functions' verification procedures.

Verification Points

The accuracy specifications cover the full range of output values which can be generated by 9500B, and its accuracy can therefore be verified against the specification at any number of points in these output ranges.

This section recommends a set of verification points.

Specification Limits

For each chosen verification point it will be necessary to know absolute measurement limits which can be used to judge whether or not the 9500B is performing within its specification. As mentioned earlier, the accuracy specifications detailed in the *9500B Extended Specifications* found online are absolute accuracies which incorporate all the uncertainties involved in calibrating the 9500B up to and including those of National Standards.

Verification Procedure

Suitability

The procedures given in this section to verify the Model 9500B specification are suitable for verification both after receipt from the factory, or when associated with user-calibration.

Traceability

Where, to conform to quality standards, the 9500B is required to be traceable to higher standards; then all equipment used to verify the 9500B specification must also be traceable to those standards.

9500B Mainframe Verification by Functions

Section 9500B Mainframe Verification by Functions is a guide to the process of verifying the Model 9500B functions from the front panel. The following topics are covered:

- DC/Square Function: DC Output
- DC/Square Function: Square Output
- LF Sine Function
- Time Markers Function
- Load Resistance Measurement Function
- Pulse Width Function

The list of topics above are placed in the order in which the 9500B Mainframe functions should be verified. Although it is not essential to verify all the functions at any one time, functions higher in the list should be verified before those lower in the list.

Verifying the DC/Square Function: DC Voltage

Summary

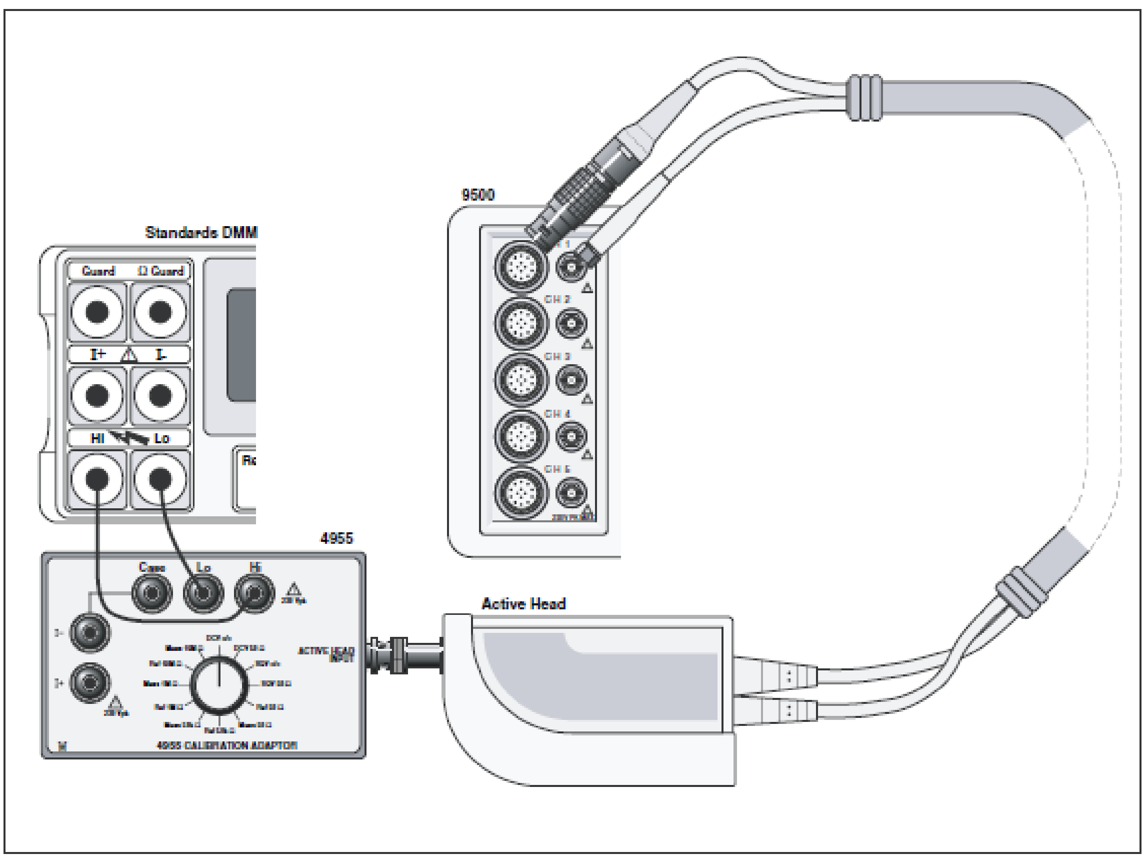
Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections

The DC Function is verified by carrying out measurements of amplitude in the sequence given in Verification Setup, at the verification points shown in Tables 2 and 3.

Equipment Requirements

- The UUT Model 9500B Mainframe, with 9510 or 9530 Active Head.
- A high resolution Standards DMM with DC Voltage accuracy of ±0.005 % or better, from 1 mV to 200 V. Example: Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4 mm leads. Example: Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections



erw201

Figure 3. DC/Square; DC Voltage Verification — Interconnections

Verification Setup

1. Connections: Ensure that the 9500B is connected to the DMM as shown in Figure 3, or via a similar BNC-4mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in MANUAL mode and then select the DC/Square; DC Voltage (Positive) function (from MANUAL mode entry default, press the WAVEFORM soft key and then press the soft key on the right of the screen). Select the required output Signal Channel (1 MΩ Load), trigger channel and Trigger Ratio (if required).

Verification Procedure

Refer to Tables 2 and 3. Follow the correct sequence of verification points as shown on the tables, and carry out the following operations (1) to (6) at each verification point.

1. DMM: Select the correct DCV range for the verification point Output Voltage.
2. 9500B: Set the O/P Volts p-p and polarity as required for the verification point.
3. 4955: If using the Model 4955 Calibration Adaptor, set its switch to DCV o/c. Otherwise ensure that the DMM input is at high impedance.
4. 9500B: Set Output ON and wait for the DMM reading to settle.
5. Amplitude:
   a. Measure the DCV output value.
   b. Record this value in the Measured Value column of the copy of the Table.
   c. Check that the Measured Value is at or between the Absolute Limits.
6. Set Output OFF.

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy.

Table 2. DC/Square DC (+) Verification into 1 Ω Load

Verif. Point	Output Voltage	Absolute Limits (+DCV)		Measured Value
		Lower	Higher	
+DC1	1.0000 mV	0.97475 mV	1.02525 mV	
+DC2	1.9000 mV	1.87453 mV	1.92547 mV	
+DC3	2.3000 mV	2.27443 mV	2.32557 mV	
+DC4	5.0000 mV	4.97375 mV	5.02625 mV	
+DC5	6.0000 mV	5.9735 mV	6.0265 mV	
+DC6	19.000 mV	18.9703 mV	19.0297 mV	
+DC7	23.000 mV	22.9693 mV	23.0307 mV	
+DC8	50.000 mV	49.9625 mV	50.0375 mV	
+DC9	60.000 mV	59.960 mV	60.040 mV	
+DC10	190.00 mV	189.928 mV	190.073 mV	
+DC11	230.00 mV	229.918 mV	230.082 mV	
+DC12	500.00 mV	499.85 mV	500.15 mV	
+DC13	600.00 mV	599.83 mV	600.18 mV	
+DC14	1.9000 V	1.8995 V	1.9005 V	
+DC15	2.3000 V	2.2994 V	2.3006 V	
+DC16	5.0000 V	4.99873 V	5.00127 V	
+DC17	6.0000 V	5.99848 V	6.00152 V	
+DC18	19.000 V	18.99523 V	19.00477 V	
+DC19	23.000 V	22.99423 V	23.00577 V	
+DC20	50.000 V	49.98748 V	50.01252 V	
+DC21	60.000 V	59.98498 V	60.01502 V	
+DC22	190.00 V	189.9525 V	190.0475 V	

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy.

Table 3. DC/Square DC (-) Verification into 1 Ω Load

Verif. Point	Output Voltage	Absolute Limits (-DCV)		Measured Value
		Lower	Higher	
-DC1	1.0000 mV	0.97475 mV	1.02525 mV	
-DC2	1.9000 mV	1.87453 mV	1.92547 mV	
-DC3	2.3000 mV	2.27443 mV	2.32557 mV	
-DC4	5.0000 mV	4.97375 mV	5.02625 mV	
-DC5	6.0000 mV	5.9735 mV	6.0265 mV	
-DC6	19.000 mV	18.9703 mV	19.0297 mV	
-DC7	23.000 mV	22.9693 mV	23.0307 mV	
-DC8	50.000 mV	49.9625 mV	50.0375 mV	
-DC9	60.000 mV	59.960 mV	60.040 mV	
-DC10	190.00 mV	189.928 mV	190.073 mV	
-DC11	230.00 mV	229.918 mV	230.082 mV	
-DC12	500.00 mV	499.85 mV	500.15 mV	
-DC13	600.00 mV	599.83 mV	600.18 mV	
-DC14	1.9000 V	1.8995 V	1.9005 V	
-DC15	2.3000 V	2.2994 V	2.3006 V	
-DC16	5.0000 V	4.99873 V	5.00127 V	
-DC17	6.0000 V	5.99848 V	6.00152 V	
-DC18	19.000 V	18.99523 V	19.00477 V	
-DC19	23.000 V	22.99423 V	23.00577 V	
-DC20	50.000 V	49.98748 V	50.01252 V	
-DC21	60.000 V	59.98498 V	60.01502 V	
-DC22	190.00 V	189.9525 V	190.0475 V	

Verifying the DC/Square Function: Square Voltage

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections.

The Square Function is verified by carrying out measurements of amplitude in the sequence given in Verification Setup, at the verification points shown in Tables 3, 4 and 5.

Equipment Requirements

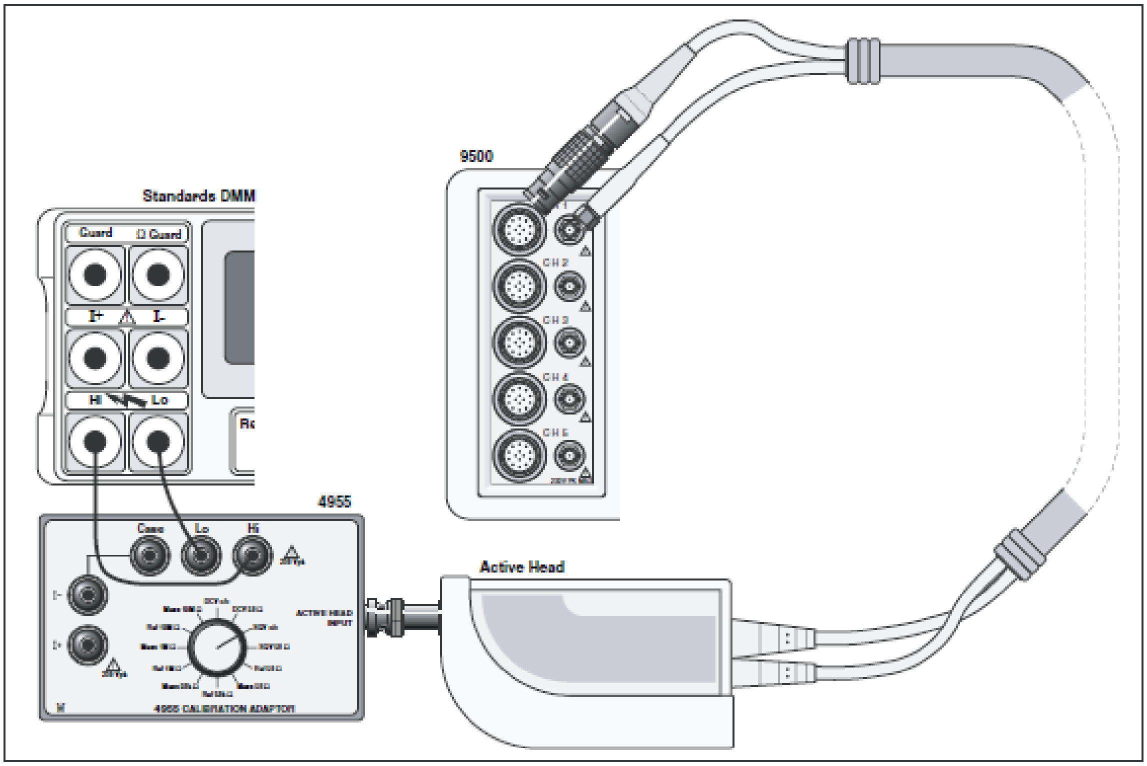
- The UUT Model 9500B Mainframe, with 9510 or 9530 Active Head.
- A high resolution Standards DMM with RMS AC Voltage accuracy of ±0.01 % or better, from 2.5 mV to 35 V, at 1 kHz. Example: Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4mm leads. Example: Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections

Refer to Figure 3 opposite.

Verification Setup

1. Connections: Ensure that the 9500B is connected to the DMM as shown in Figure 4, or via a similar BNC-4mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in MANUAL mode and then select the DC/Square; Square (Positive) function (MANUAL mode entry default or 2 soft key). Select the required output Signal Channel (1 MΩ Load), trigger channel and Trigger Ratio (if required).



erw202

Figure 4. DC/Square; Square Voltage Verification — Interconnections

Verification Procedure

Copy the three tables: 4, 5 and 6. Follow the correct sequence of verification points as shown on the tables, and carry out the following operations at each verification point.

1. Verification Points: Refer to Table 4.
2. DMM: Select the correct RMS Voltage range for the verification point RMS Output Voltage.
3. 9500B: Set the O/P Volts p-p and waveform as required for the verification point.
4. 4955: If using the Model 4955 Calibration Adaptor, set its switch to 'SQV o/c'. If not using the Model 4955, ensure that the DMM input is AC-coupled at high impedance.
5. 9500B: Set Output ON and wait for the DMM reading to settle.

Note

For Operation (6), the RMS Output Voltage values, and RMS Absolute Limits have been derived using the following factor for the output waveform: (at 1 kHz: RMS = 0.5 x 0.999917 x pk-pk).

Note

This factor applies only at 1 kHz and assumes use of model 4955 set to 'SQV o/c'. A compensation of 83 ppm accounts the finite transition time of the Square Wave and the resultant fall in its RMS value.

6. Amplitude:
   a. Measure the RMS Output Voltage value.
   b. Record this value in the Measured Value column of the copy of the Table.
   c. Check that the Measured Value is at or between the Absolute Limits.
7. 9500B: Set Output OFF.
8. Press the WAVEFORM soft key. Select Square (negative) by pressing the key on the right of the screen. Repeat steps (2) to (7), but using Table 5 for each of the verification points.
9. Press the WAVEFORM soft key. Select Square (symmetrical) by pressing the key on the right of the screen. Repeat steps (2) to (7), but using Table 6 for each of the verification points.

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy:

Table 4. DC/Square Square (+) Verification at 1 kHz into 1 MΩ Load

Verif. Point [2]	Frequency	Output Voltage (pk-pk)	Absolute Limits (pk-pk)		Output Voltage (RMS)	Absolute Limits (RMS)		Measured Value (RMS)
			Lower	Higher		Lower	Higher	
+SQ1	1 kHz	600.00 mV	599.39 mV	600.61 mV	299.9979 mV	299.67 mV	300.28 mV	
+SQ2	1 kHz	60.000 mV	59.93 mV	60.07 mV	29.99799 mV	29.96 mV	30.03 mV	
+SQ3	1 kHz	6.0000 mV	5.984 mV	6.016 mV	2.999799 mV	2.992 mV	3.008 mV	
+SQ4	1 kHz	6.0000 V	5.99399 V	6.00601 V	2.999799 V	2.99674 V	3.00275 V	
+SQ5	1 kHz	60.000 V	59.93999 V	60.06001 V	29.99799 V	29.96750 V	30.02751 V	

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy.

Table 5. DC/Square Square (-) Verification at 1 kHz into 1 MΩ Load

Verif. Point	Frequency	Output Voltage (pk-pk)	Absolute Limits (pk-pk)		Output Voltage (RMS)	Absolute Limits (RMS)		Measured Value (RMS)
			Lower	Higher		Lower	Higher	
-SQ1	1 kHz	600.00 mV	599.39 mV	600.61 mV	299.9979 mV	299.67 mV	300.28 mV	
-SQ2	1 kHz	60.000 mV	59.93 mV	60.07 mV	29.99799 mV	29.96 mV	30.03 mV	
-SQ3	1 kHz	6.0000 mV	5.984 mV	6.016 mV	2.999799 mV	2.992 mV	3.008 mV	
-SQ4	1 kHz	6.0000 V	5.99399 V	6.00601 V	2.999799 V	2.99674 V	3.00275 V	
-SQ55	1 kHz	60.000 V	59.93999 V	60.06001 V	29.99799 V	29.96750 V	30.02751 V	

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy.

Table 6. DC/Square Square (Symmetrical) Verification at 1 kHz into 1 MΩ Load

Verif. Point	Frequency	Output Voltage (pk-pk)	Absolute Limits (pk-pk)		Output Voltage (RMS)	Absolute Limits (RMS)		Measured Value (RMS)
			Lower	Higher		Lower	Higher	
±SQ1	1 kHz	600.00 mV	599.39 mV	600.61 mV	299.9979 mV	299.67 mV	300.28 mV	
±SQ2	1 kHz	60.000 mV	59.93 mV	60.07 mV	29.99799 mV	29.96 mV	30.03 mV	
±SQ3	1 kHz	6.0000 mV	5.984 mV	6.016 mV	2.999799 mV	2.992 mV	3.008 mV	
±SQ4	1 kHz	6.0000 V	5.99399 V	6.00601 V	2.999799 V	2.99674 V	3.00275 V	
±SQ55	1 kHz	60.000 V	59.93999 V	60.06001 V	29.99799 V	29.96750 V	30.02751 V	

Verifying the LF Sine Voltage Function

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Equipment Requirements

The LF Sine Voltage Function is verified by carrying out measurements of amplitude in the sequence given in Verification Setup, at the verification points shown in Table 7.

Equipment Requirements

- The UUT Model 9500B Mainframe, with 9510 or 9530 Active Head.
- A high resolution Standards DMM with RMS AC Voltage accuracy of ±0.3 % or better, between 0.5 V and 2 V, at 1 kHz and 45 kHz. Example: Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4mm leads. Example: Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections

Refer to Figure 5 given below.

Verification Setup

1. Connections: Ensure that the 9500B is connected to the DMM as shown in Figure 4, or via a similar BNC-4 mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in MANUAL mode and then select the Sine function (X key). Select the required output Signal Channel (50 Ω Load), trigger channel and Trigger Ratio (if required).

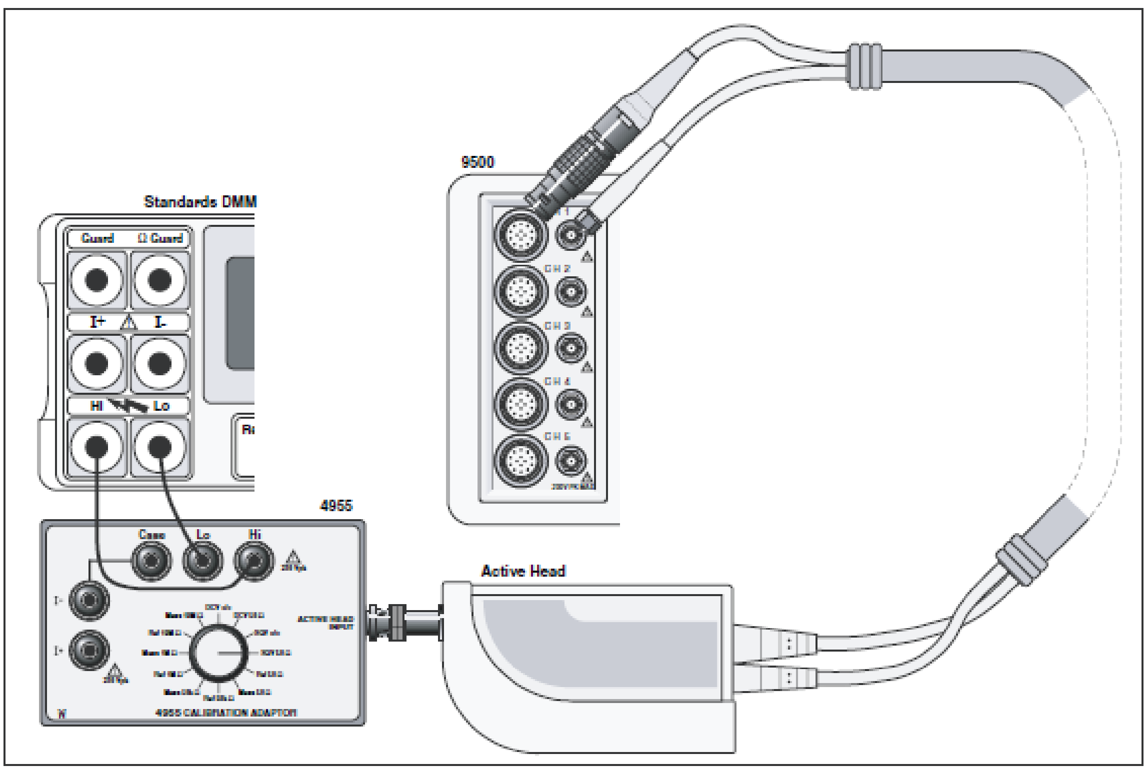


Figure 5. LF Sine Voltage Verification — Interconnections

Verification Procedure

1. Verification Points: Refer to Table 4.
2. DMM: Select the correct RMS Voltage range for the verification point RMS Output Voltage.
3. 9500B: Set the Output Volts p-p as required for the verification point.
4. 4955: If using the Model 4955 Calibration Adaptor, set its switch to 'SQV 50 Ω'. If not using the Model 4955, ensure that the DMM input is AC-coupled at 50 Ω input impedance.
5. 9500B: Set Output ON and wait for the DMM reading to settle.

Note

For Operation (6), the RMS Output Voltage values, and RMS Absolute Limits have been derived using the following factor for the output waveform: (at 1 kHz: RMS = 0.5 x 0.707106781 x pk-pk).

Note

This factor applies only when the Standards DMM input is AC-Coupled through a large capacitance. It is based on the use of a model 4955 set to 'SQV 50 Ω'.

6. Amplitude:
   a. Measure the RMS Output Voltage value.
   b. Record this value in the Measured Value column of the copy of the Table.
   c. Check that the Measured Value is at or between the Absolute Limits.
7. 9500B: Set Output OFF.

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy:

Table 7. Sine Verification into 50 Ω Load

Verif. Point 3	Frequency	Output Voltage (pk-pk)	Absolute Limits (pk-pk)		Output Voltage (RMS)	Absolute Limits (RMS)		Measured Value (RMS)
			Lower	Higher		Lower	Higher	
SIN1	1 kHz	4.8000 V	4.632 V	4.968 V	1.69706 V	1.6377 V	1.7565 V	
SIN2	45 kHz	4.8000 V	4.632 V	4.968 V	1.69706 V	1.6377 V	1.7565 V	
SIN3	1 kHz	1.9000 V	1.8335 V	1.9665 V	0.67175 V	0.6482 V	0.6953V	
SIN4	45 kHz	1.9000 V	1.8335 V	1.9665 V	0.67175 V	0.6482 V	0.6953V	

Verifying the Time Markers Function

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections.

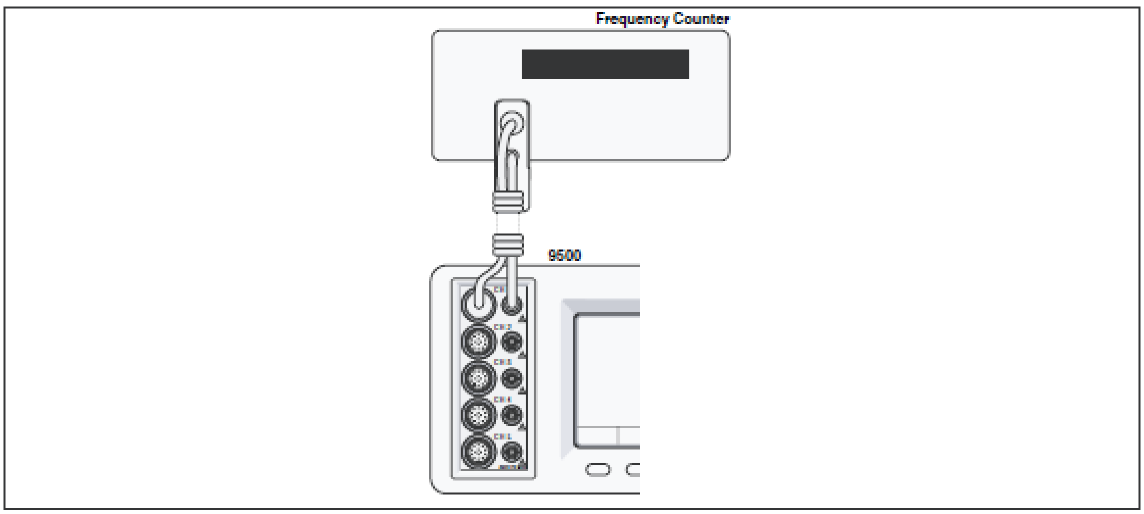
The Time Markers Function is verified by carrying out measurements of Period in the sequence given in Verification Procedure, at the verification points shown in Table 8.

Equipment Requirements

- The UUT Model 9500B Mainframe, with 9510 or 9530 Active Head.
- Digital counter for 0.25 ppm clock accuracy measurements. Example: Hewlett Packard Model HP53131A with Option 012.

Interconnections

Refer to Figure 6.



erw204

Figure 6. Time Marker Verification — Interconnections

Verification Setup

1. Connections: Connect the 9500B to the Counter as shown in Summary, and ensure that both instruments are powered ON and warmed up.
2. Counter: Select the required function to measure period.
3. 9500B:
   a. Ensure that the 9500B is in MANUAL mode and then select the Time Markers function (ζ key).
   b. Use the bottom soft key on the right of the screen, highlighting 1/f (Γ), to view output Period on the screen.
   c. Select the required output Signal Channel (50 Ω or 1 MΩ Load as required), trigger channel and Trigger Ratio (if required).

Verification Procedure

Copy the table 8. Follow the correct sequence of verification points as shown on the table, and carry out the following operations (1) to (5) at each verification point.

1. Verification Points: Refer to Table 8.
2. Counter: Select the correct display time, trigger source and level to measure at the verification point.
3. 9500B: Set the Time Marker period as required for the verification point, and set Output ON.
4. Counter: Adjust the trigger level for a stable display, measure and note the output period.
5. 9500B: Set Output OFF.

Note

Please copy the following table. Enter the measurements in the appropriate Measured Period column on the copy:

Table 8. Time Markers Verification at 1 Vpk-pk Output

Verif. Point	Time Marker Period	Absolute Limits <83 µs, ≥83 µs ±3 ppm		Measured Period
		Lower	Higher	
MKR1	10.000 ns (sqr)	9.9999975 ns	10.0000025 ns	
MKR2	100.00 ns (sqr)	99.999975 ns	100.000025 ns	
MKR3	1.0000 µs (sqr)	0.99999975 µs	1.00000025 µs	
MKR4	1.0000 ms (sqr)	0.999997 ms	1.000003 ms	
MKR5	10.000 ms (sqr)	9.999970 ms	10.000003 ms	

Verifying the Load Resistance Measurement Function

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections.

The Load Resistance Measurement Function is verified by carrying out measurements of Reference Resistors in the sequence given in Verification Procedure, at the verification points shown in Table 9.

Equipment Requirements

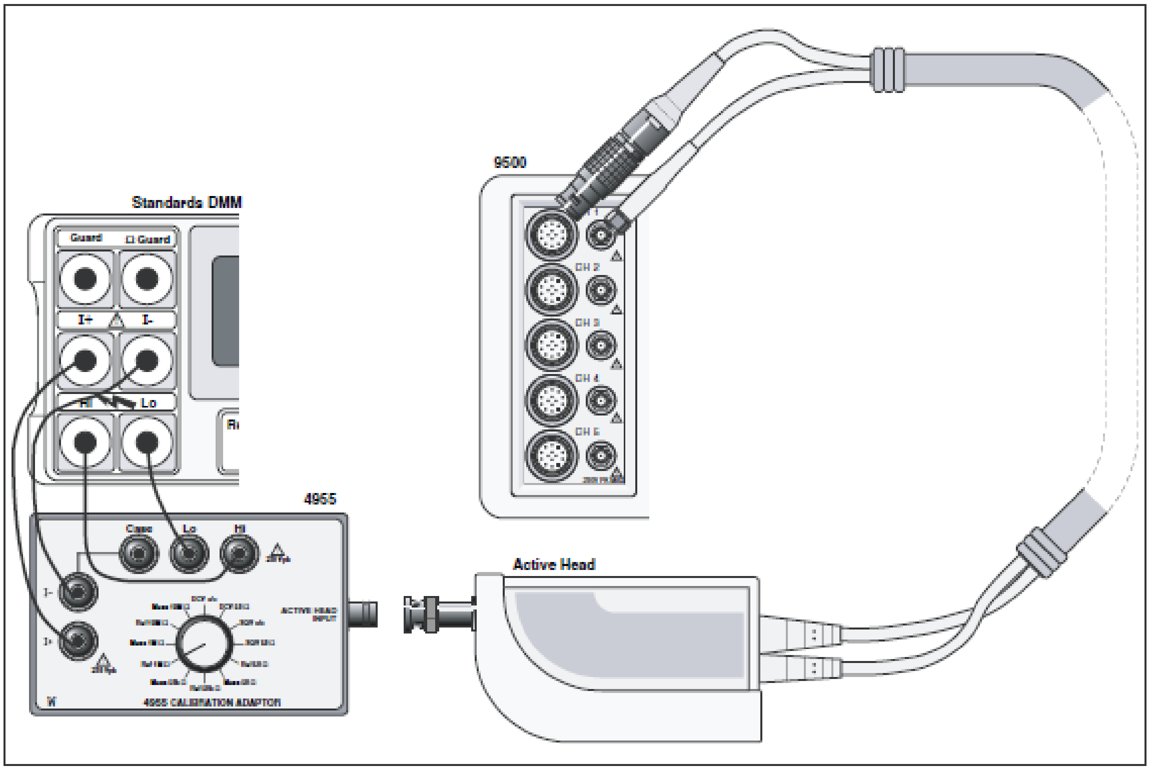
- The UUT Model 9500B with 9510 or 9530 Active Head.
- A traceable, high-resolution Standards DMM, used to measure resistance at 1 MΩ and 50 Ω, with an accuracy of 0.02 % or better. For example, a Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4mm leads, incorporating switchable 50 Ω, and 1 MΩ reference loads. For example, a Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections

Refer to Figure 6.

Verification Setup

1. Connections: Ensure that the 9500B is connected to the Standards DMM as shown in Figure 7, or via a similar BNC-4 mm adaptor and 50 Ω load, and that both instruments are powered on and warmed up.
2. 9500B:
   a. Ensure that the 9500B is in MANUAL mode and then select the Load Resistance Measurement function (From entry default, press the Aux key on the right of the Front Panel, then the Θ soft key at the bottom left of the screen).
   b. In the Θ Menu, select the required output Signal Channel via the Channel Selection screen.



erw205

Figure 7. Load Resistance Measurement Function Verification (1 Ω Ref) — Interconnections

Verification Procedure

Copy the table 9. Follow the correct sequence of verification points as shown on the table, and carry out the following operations (1) to (10) at each verification point.

1. Verification Points: Refer to Table 9.
2. 9500B: Ensure that OUTPUT is OFF.
3. If using the Model 4955 Calibration Adaptor:
    a. Ensure that the Active Head output BNC is disconnected from the Model 4955 input.
    b. Set the Model 4955 Calibration Adaptor switch as shown in Table 9.
4. If not using the Model 4955, set up external circuitry to measure the appropriate load resistor (4-wire connection), with the 9500B Active Head output BNC disconnected.
5. DMM: Set to the appropriate Resistance measurement range, take a Resistance measurement and note the result (R ref) in Table 9.

Note

Make sure to allow for any settling time of the external measuring instrument.

6. Calculate the lower and higher absolute limit values:

   Lower limit: (L lim) = R ref - (R ref x 0.001)

   Higher limit: (H lim) = R ref + (R ref x 0.001)

   Enter L lim and H lim into the appropriate columns in Table 9.
7. If using the Model 4955 Calibration Adaptor:
   a. Set the Model 4955 Calibration Adaptor switch as shown in Table 9.
   b. Reconnect the Active Head output BNC to the Model 4955 input.
8. If not using the Model 4955, disconnect the load resistor from the DMM, and reconnect it to the 9500B Active Head output BNC.
9. Press the ON key to turn the 9500B output on.
10. Using the 9500B, take a Resistance measurement and note the result (R meas) in Table 9.
11. 9500B: Set OUTPUT OFF.

Table 9. Load Resistance Measurement Verification

Verif. Point Θ	4955 Switch Position	Resistance Value Measured by DMM	Calculated Absolute Limits		4955 Switch Position	Resistance Value Measured by 9500B
			Lower	Higher		
	Op. 3(b)	(Rref)	(L lim)	(H lim)	Op. 7(a)	(Rmeas)
RES1	Ref 1 MΩ				Meas 1 MΩ	
RES2	Ref 50 Ω				Meas 50 Ω	

Verifying the Pulse Width Function

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections

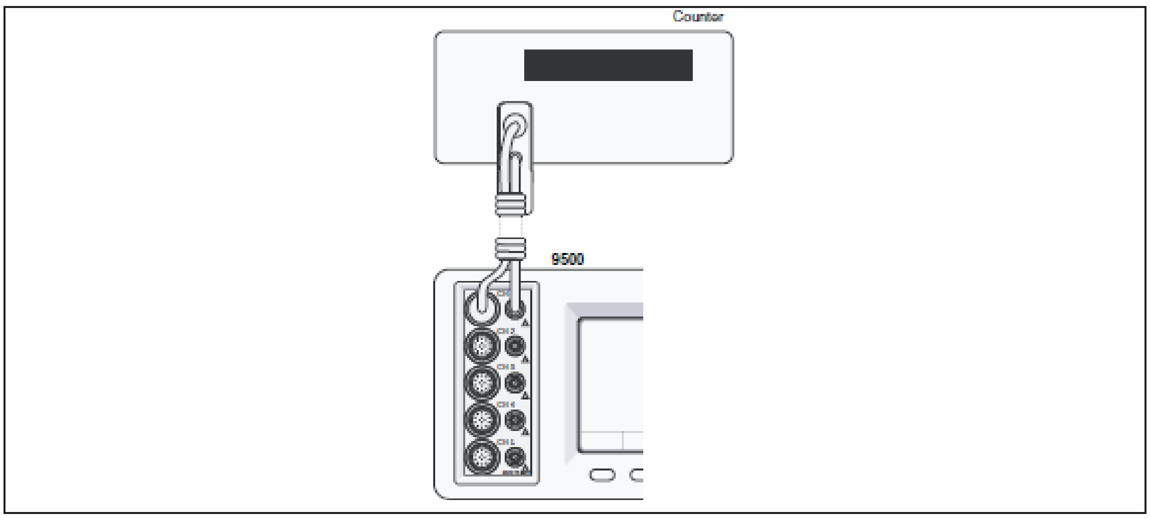
The Pulse Width Function is verified by carrying out measurements of Period in the sequence given in Verification Procedure, at the verification points shown in Table 10.

Equipment Requirements

- The UUT Model 9500B Mainframe, with 9510 or 9530 Active Head.
- Digital counter for 0.25 ppm clock accuracy measurements. Example: Hewlett Packard Model HP53131A with Option 012.

Interconnections

Refer to Figure 8.



erw206

Figure 8. Pulse Width Verification — Interconnections

Verification Setup

1.	Connections:	Connect the 9500B to the Counter as shown in section Verifying the Time Markers Function, Summary, and ensure that both instruments are powered ON and warmed up.
2.	Counter:	Select the required function to measure pulse duration and reading average to enhance measurement resolution.
3.	9500B:	a. Ensure that the 9500B is in MANUAL mode and then select the Pulse Width function.
		b. Select the required output Signal Channel (50 Ω load).

Verification Procedure

Copy the table 10. Follow the correct sequence of verification points as shown on the table, and carry out the following operations (1) to (5) at each verification point.

1. Verification Points: Refer to Table 10.
2. Counter: Select the correct display time, trigger source and level to measure at the verification point.
3. 9500B: Set the Pulse Width Duration as required for the verification point, and set Output ON.
4. Counter: Adjust the trigger level for a stable display, measure and note the output period.
5. 9500B: Set Output OFF.

Table 10. Pulse Width Verification at 1 Vpk-pk Output

Verif. Point	Pulse Width Duration	Absolute Limits (±5 % ±200 ps)		Measured Duration
		Lower	Higher	
PW1	4.0000 ns	3.6000 ns	4.4000 ns	
PW2	20.000 ns	18.800 ns	21.200 ns	
PW3	100.00 ns	95.20 ns	105.20 ns	

9510/9530/9550/9560 Head Verification by Functions

This section is a guide to the process of verifying the Model 9560, 9550, 9530, and 9510 Heads functions from the front panel. The following topics are covered:

- Leveled Sine Function: LF Gain
- Leveled Sine Function: Flatness
- Edge Function
- Load Capacitance Measurement Function

The list of topics above are placed in the order in which the 9500B Head functions should be verified. Although it is not essential to verify all the functions at any one time, functions higher in the list should be verified before those lower in the list. Head verification involves the use of a verified 9500B Mainframe.

Note

Heads can be verified only within the bandwidth of the mainframe. For example, Head Model 9510 with Mainframe Variant 9500B/600 can only be verified to 600 MHz.

Verifying the Leveled Sine Function: LF Gain

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections.

The Leveled Sine Function is verified by carrying out measurements of amplitude at frequencies of 1 kHz, 45 kHz and 50 kHz; in the sequences given in Verification Setup and Verification Procedure, at the verification points shown in Table 11.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe (refer to Verifying the LF Sine Voltage Function).
- A high resolution Standards DMM with RMS ACVoltage accuracy of 0.3 % or better, from 10 mV to 1.5 V, at 1 kHz, 45 kHz and 50 kHz.

  Example: Model 1281 Digital Multimeter.
- An adaptor to convert from PC3.5 or BNC to 4mm leads. Example: Model 4955 Calibration Adaptor and PC3.5 to BNC adaptor.
- Short, high-quality 4 mm leads for connection between the Calibration Adaptor the DMM.

Interconnections

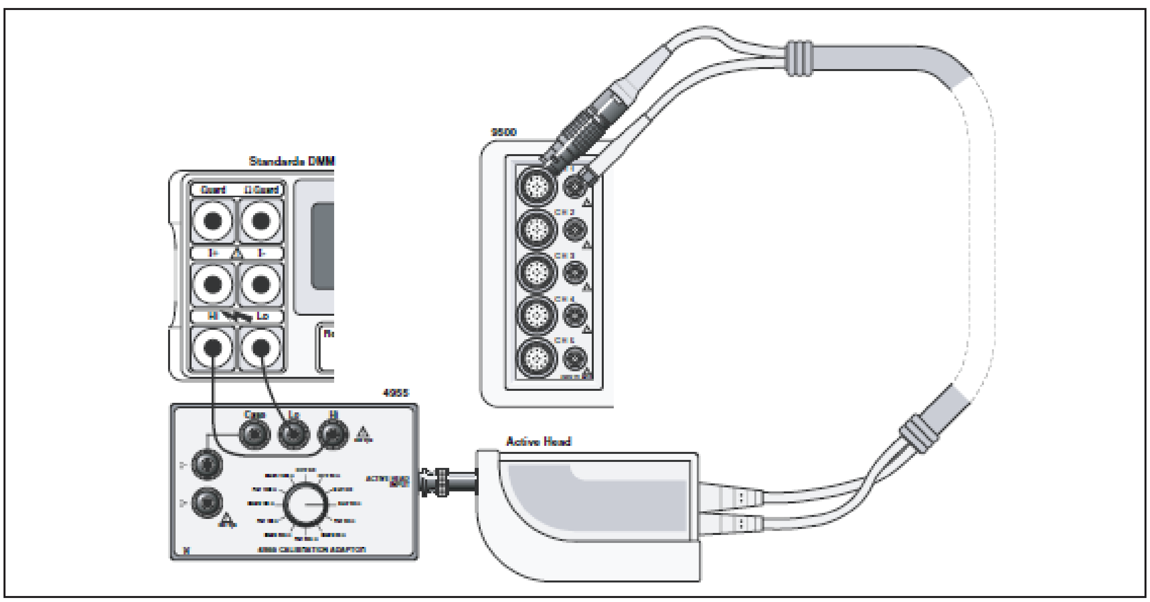


Figure 9. LF Sine Voltage Verification — Interconnections

Verification Setup

1. Connections: Ensure that the 9500B is connected to the DMM as shown in Figure 9, or via a similar PC3.5 or BNC-4 mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in MANUAL mode and then select the Sine function (X key). Select the required output Signal Channel (50 Ω Load).

Verification Procedure

Copy the table 11. Follow the correct sequence of verification points as shown on the table, and carry out the following operations (1) to (7) at each verification point.

1. Verification Points: Refer to Table 11.
2. DMM: Select the correct RMS Voltage range for the verification point RMS Output Voltage.
3. 9500B: Set the Output Volts p-p as required for the verification point:
4. 4955: If using the Model 4955 Calibration Adaptor, set its switch to 'SQV50 Ω'. If not using the Model 4955, ensure that the DMM input is AC-coupled at 50 Ω input impedance.
5. 9500B: Set Output ON and wait for the DMM reading to settle.

Note

For Operation (6), the RMS Output Voltage values, and RMS Limits have been derived using the following factor for the output waveform: (at 1 kHz: RMS = 0.5 x 0.707107 x pk-pk).

Note

This factor applies only when the Standards DMM input is AC-Coupled through a large capacitance. It is based on the use of a model 4955 set to 'SQV 50 Ω'.

6. Amplitude:
   a. Measure the RMS Output Voltage value.
   b. Record this value in the Measured Value column of the copy of the Table.
   c. For SGN1-6 calculate and record the Calculated Values in the copy of the table.
   d. For SGN1-6 check that the Calculated Value is at or between the RMS Limits.
   e. For SGN7-11 check that the Measured Value is at or between the RMS Limits.
7. 9500B: Set Output OFF.

Table 11. Sine Verification into 50 Ω Load

Verif. Point	Freq.	Output Voltage (pk-pk)	Limits (pk-pk)		Output Voltage (RMS)	Limits (RMS)		Measured Value (RMS)	Calculated Value
			Lower	Higher		Lower	Higher		
SGN1	1kHz	1.0000V	-0.020V	0.020V	0.35355V	-7.07mV	7.07mV		SGN8- SGN1
SGN2	1kHz	300.00mV	-6.0mV	6.0mV	106.066mV	-2.12mV	2.12mV		SGN9- SGN2
SGN3	1kHz	100.00mV	-2.0mV	2.0mV	35.3553mV	-0.71mV	0.71mV		SGN10- SGN3
SGN4	45kHz	1.0000V	-0.020V	0.020V	0.35355V	-7.07mV	7.07mV		SGN8- SGN4
SGN5	45kHz	300.00mV	-6.0mV	6.0mV	106.066mV	-2.12mV	2.12mV		SGN9- SGN5
SGN6	45kHz	100.00mV	-2.0mV	2.0mV	35.3553mV	-0.71mV	0.71mV		SGN10- SGN6
SGN7	50kHz	3.0000V	2.955V	3.045V	1.06066V	1.04475V	1.07657V		NA
SGN8	50kHz	1.0000V	0.985V	1.015V	0.35355V	0.34825V	0.35885V		NA
SGN9	50kHz	300.00mV	295.50mV	304.50mV	106.066mV	104.475mV	107.657mV		NA
SGN10	50kHz	100.00mV	98.50mV	101.50mV	35.3553mV	34.8250mV	35.8856mV		NA
SGN11	50kHz	30.000mV	29.55mV	30.45mV	10.6066mV	10.4475mV	10.7657mV		NA

Verifying the Leveled Sine Function: Flatness

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections. Verification Setup shows the Verification Setup.

The Verification Procedure is in Verification Procedure, A short description of Calculating Acceptance Limits is given in Calculation of Acceptance Limits, and the final Uncertainty Calculation and Flatness Check is in Uncertainty Calculations and Flatness Check The Leveled Sine Function is verified by carrying out measurements of amplitude at frequencies between 50 kHz and 6.4 GHz; in the sequences given in Verification Procedure, at the verification points shown in Tables 12, 13, 14 and 15

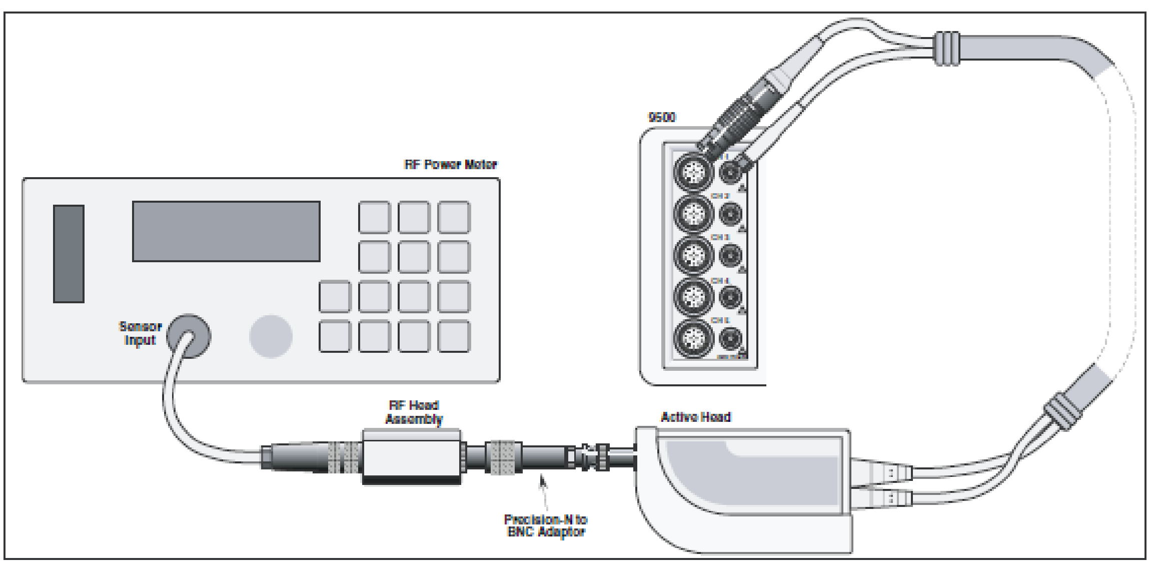
Note

Heads can be verified only within the bandwidth of the mainframe. E.g. Head Model 9510 with Mainframe Variant 9500B/600 can only be verified to 600 MHz.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe (for Mainframe verification, refer to Verifying the LF Sine Voltage Function).
- RF Power Meter for Power measurements from 50 kHz and 6.4 GHz and from 100 mVp-p to 3 Vp-p into 50 Ω. Examples: Marconi Instruments Model 6960B with Model 6912 head up to 1.1 GHz or Rhode and Scwarz NRVS with NRV-Z5 head beyond 1.1 GHz.
- Precision-N to BNC Adapter for signal connection from the UUT Active Head to the input of the RF Power Meter head for Amplitude measurements.
- Example: Huber & Suhner Adapter type no. 31BNC-N-50-51 or 31N-PC3.5-50-1.

Interconnections



erw208

Figure 10. RF Sine Voltage Verification — Interconnections

Verification Setup

1. Connections: Ensure that the 9500B is connected to the RF Power Meter as shown in Figure 10 and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in MANUAL mode and then select the Sine function (X key). Select the required output Signal Channel (50 Ω Load), Trigger Channel and Trigger Ratio (if required).

Verification Procedure

1. Copy the Tables 12, 13, 14 and 15.
2. Starting with Table 12, follow the correct sequence of verification points as shown on the table, and carry out operations (3) to (7) at the verification points on the table.
3. 9500B:
   a. Set the Output Volts p-p as required for the verification points on the table.
   b. Set Frequency to 50 kHz.
   c. Set Output ON.
4. Power Meter: Select a power range which gives an on-scale reading (the example Power Meter auto-ranges to accommodate the input power).
5. 'Ref':
   a. Measure the 9500B output power at 50kHz and calculate the Pk-Pk value of 9500B output voltage into 50 Ω:
      Pk-Pk Voltage = 20√(power into 50 Ω).
   b. Record the result in the 'Measured p-p Voltage at 50 kHz' column on the copy of the Table.
6. Flatness:
   a. Set the 9500B Frequency to the first 'SF' point in the table.
   b. measure the 9500B output power and calculate the Pk-Pk value of 9500B output voltage into 50 Ω:
      Pk-Pk Voltage = 20√(power into 50 Ω)
   c. Record the result in the 'Measured p-p Voltage for Flatness Check' column for the verification point on the copy of the Table.
   d. Set the 9500B Frequency to the next 'SF' point in the table, and repeat operations (b) and (c).
   e. Repeat operation (d) for all other 'SF' points in the table available for the UUT variant type.
7. 9500B: Set Output OFF.
8. Other Tables: Repeat Items (2) to (7), but for Tables 13-15 in turn. The measurements are now complete.

Calculation of Acceptance Limits

1. Introduction

   The first part of the verification procedure in Verifying the Leveled Sine Function: LF Gain deals with verification of amplitude at frequencies below 50 kHz, into input impedance of 50 Ω. A DMM in ACV function is used here as the calibration standard. Unfortunately, the frequency response of DMMs falls off at frequencies which must be used to verify HF flatness above 1 MHz, and so a commonly-used technique employs an RF Power Meter. Flatness is normally expressed as a voltage relative to that at a reference frequency of 50 kHz, and in our procedure, Tables 12, 13, 14 and 15 are used to register the values at this reference frequency.

   For the flatness verification, each output voltage is measured as power into 50 Ω in an RF Power Meter, and converting power to pk-to-pk voltage using a formula given in the procedure. This voltage is compared against the power meter reading at 50 kHz, by checking that it is within Acceptance tolerance limits about the 50 kHz value.

   To calculate the Acceptance tolerance limits at each verification point, we must take into account the Total Measurement Uncertainty and the specified 9500B flatness, with respect to 5 0kHz. These are combined using an RSS calculation.

2. Example: Calculation of Acceptance Limits at 10MHz

   - From the Power Meter Specification, let us say that its Total Measurement Uncertainty (Power) at 10 MHz, including the Sensor uncertainty, is: ±1.4 %.
   - But this is a power uncertainty, and the pk-pk voltage uncertainty will be half: ±0.7 %.
   - With this we must combine (by RSS Method) the 9500B pk-pk voltage flatness specification. At 10 MHz, the 9500B specification relative to 50 kHz is ±2.0 %.

     Acceptance Limits = $\sqrt{[(0.007)^2 + (.020^2)]}$

     $= \pm 0.0212 = \pm 2.12\ \%$

   - We must now multiply this by the Reference value at 50 kHz, and obtain the higher limit at 10 MHz by adding the Acceptance Limits to the 50 kHz Reference value. The lower limit at 10 MHz is found by subtracting the Acceptance Limit from the 50 kHz Reference value.

Uncertainty Calculations and Flatness Check

All Tables

1. Insert the User's Measurement Uncertainty (Um), for each of the verification points in the tables.
2. For each of the verification points: Combine the Total Measurement Uncertainty and the 9500B Sine function accuracy, using the RSS method, to calculate the Flatness Acceptance Limits. For further assistance, refer to Calculation of Acceptance Limits.
3. Enter the limits in the appropriate columns of the copy of the Table.
4. Check that the Measured p-p Voltage is at or between the Flatness Acceptance Limits.

Note

Please copy the following table. Enter the measurements in the Measured Value column on the copy.

Table 12. Sine Flatness Verification at 3 V p-p into 50 Ω Load

Verif Point	Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Acceptance Limits		Measured p-p Voltage for Flatness Check
						Lower	Higher	
Ref 1	3 V	50 kHz						
SF01		10 MHz		±2.0				
SF02		50 MHz		±2.0				
SF03		100 MHz		±2.0				
SF04		250 MHz		±2.0				
SF05		400 MHz		±2.5				
SF06		550 MHz		±2.5				
SF07		600 MHz		±3.5				
SF08†		725 MHz		±3.5				
SF09†		1 GHz		±3.5				
SF10††		1.5 GHz		±4.0				
SF11††		2 GHz		±4.0				
SF12††		2.5 GHz		±4.0				

Additional verification points for: 9500B/1100 and 9500B/3200 (†); and 9500B/3200 (††).

Table 13. Sine Flatness Verification at 1 V p-p into 50 Ω Load

Verif Point	Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz	User's Total Measurement Uncertainty	Flatness Acceptance Limits		Measured p-p Voltage for Flatness Check
				(% of Output)	(Um)	Lower	Higher	
Ref 2	1 V	50 kHz						
SF13		10 MHz		±2.0				
SF14		50 MHz		±2.0				
SF15		100 MHz		±2.0				
SF16		250 MHz		±2.0				
SF17		400 MHz		±2.5				
SF18		550 MHz		±2.5				
SF19		600 MHz		±3.5				
SF20†		725 MHz		±3.5				
SF21†		1 GHz		±3.5				
SF22††		1.5 GHz		±4.0				
SF23††		2 GHz		±4.0				
SF24††		2.5 GHz		±4.0				
SF25††		3 GHz		±4.0				
SF60†††		4 GHz		±4.0				
SF61†††		5 GHz		±4.0				
SF62†††		5.5 GHz		±4.0				
SF63†††		6 GHz		±4.0				

†: Additional verification points for: 9500B/1100 and 9500B/3200 (†); 9500B/3200 only ††) and 9500B/3200 with 9560 (†††).

Table 14. Sine Flatness Verification at 300 mV p-p into 50 Ω Load

Verif Point	Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz	User's Total Measurement Uncertainty	Flatness Acceptance Limits		Measured p-p Voltage for Flatness Check
				(% of Output)	(Um)	Lower	Higher	
Ref 3	300 mV	50 kHz						
SF26		10 MHz		±2.0				
SF27		50 MHz		±2.0				
SF28		100 MHz		±2.0				
SF29		250 MHz		±2.0				
SF30		400 MHz		±2.5				
SF31		550 MHz		±2.5				
SF32		600 MHz		±2.5				
SF33		725 MHz		±3.5				
SF34		1 GHz		±3.5				
SF35		1.5 GHz		±4.0				
SF36		2 GHz		±4.0				
SF37		2.5 GHz		±4.0				
SF38		3 GHz		±4.0				
SF64		4 GHz		±4.0				
SF65†††		5 GHz		±4.0				
SF66†††		5.5 GHz		±4.0				
SF67†††		6 GHz		±4.0				

Additional verification points for: 9500B/1100 and 9500B/3200 (†); 9500B/3200 only (††) and 9500B/3200 with 9560 (†††).

Table 15. Sine Flatness Verification at 100 mV p-p into 50 Ω Load

Verif Point	Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz	User's Total Measurement Uncertainty	Flatness Acceptance Limits		Measured p-p Voltage for Flatness Check
				(% of Output)	(Um)	Lower	Higher	
Ref 4	100 mV	50 kHz						
SF39		10 MHz		±2.0				
SF40		50 MHz		±2.0				
SF41		100 MHz		±2.0				
SF42		250 MHz		±2.0				
SF43		400 MHz		±2.5				
SF44		550 MHz		±2.5				
SF45		600 MHz		±3.5				
SF46†		725 MHz		±3.5				
SF47†		1 GHz		±3.5				
SF48††		1.5 GHz		±4.0				
SF49††		2 GHz		±4.0				
SF50††		2.5 GHz		±4.0				
SF51††		3 GHz		±4.0				
SF68†††		4 GHz		±4.0				
SF69†††		5 GHz		±4.0				
SF70†††		5.5 GHz		±4.0				
SF71†††		6 GHz		±4.0				

Additional verification points for: 9500B/1100 and 9500B/3200 (†); 9500B/3200 only (††) and 9500B/3200 with 9560 (†††).

Verifying the Edge Function

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections. Verification Setup shows the Verification Setup.

The Verification Procedure is in Verification Measurement Procedure, A short description of Calculating Acceptance Limits is given in Calculation of Acceptance Limits, and the final Uncertainty Calculation and Speed Check is in Calculation of Acceptance Limits and Edge Speed Check.

The Edge Function is verified by carrying out measurements of risetime in the sequences given in Verification Setup and Verification Measurement Procedure, at the verification points shown in Table 16.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe.
- High-bandwidth sampling oscilloscope with bandwidth ≥6 GHz for Risetime measurements.
  Examples: Tektronix Model TDS820 (6/20 GHz for 9550/9560) or HP54750 (20/50 GHz)
- 50 Ω SMA - SMA co-axial 'Trigger' cable for trigger inputs to the high-bandwidth oscilloscope.
- High-bandwidth coaxial attenuator may be required if 9500B edge output voltage exceeds oscilloscope input capability.
  Example: HP8493 Copt20 26.5 GHz 3.5 mm 20 dB attenuator.
- 50 Ω SMA - BNC adaptor: Example: Sumner 33 SMA-BNC-50-1.

Interconnections

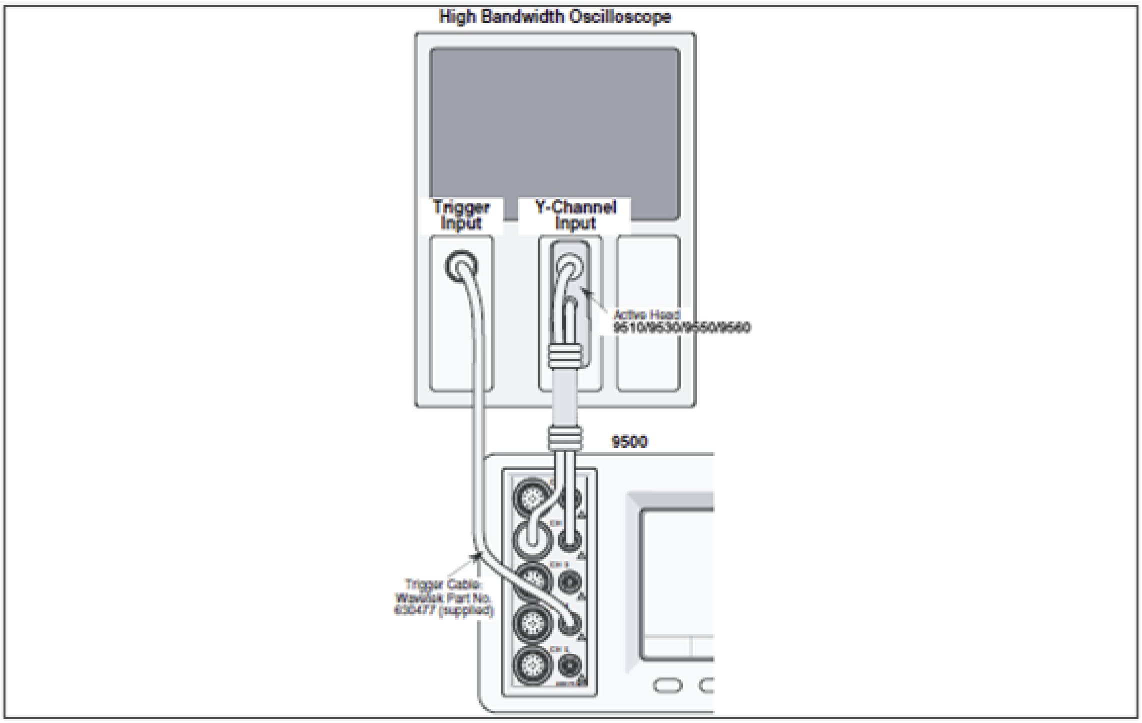


Figure 11. Edge Function Verification — Interconnections

Verification Setup

1. Connections: Ensure that the 9500B is connected to the Oscilloscope as shown in Figure 11 and that both instruments are powered on and warmed up.
2. Oscilloscope: Select the required function to measure edge response.

⚠ Caution

The 9500B Edge function output is capable of generating voltages that may cause damage to sampling oscilloscope inputs with limited input voltage capability. Use of an attenuator is typically required for outputs above 1 V pk-pk.

3. 9500B: Ensure that the 9500B is in MANUAL mode and then select the Edge function (I key). Select the required output Signal Channel (50 Ω Load), Trigger Channel, Cable Select and Trigger Ratio.

Verification Measurement Procedure

1. Copy the Table 16.
2. Using Table 16, follow the correct sequence of verification points as shown on the table, and carry out operations (3) to (8) at the verification points on the table.
3. 9500B: For the verification point:

   Select: Edge type: 6 or 7

   Rise time for Model 9510: $\sqrt{500\,ps}$ only

   for Model 9530: $\sqrt{500\,ps}$ or $\sqrt{150\,ps}$

   for Model 9560: $\sqrt{70\,ps}$

   for Model 9550: $\sqrt{25\,ps}$

   Scope mode or Numeric entry

   Set: O/P Amplitude p-p

   O/P Frequency/Period
4. Oscilloscope:
   a. Select the correct channel.
   b. Select the correct sweep speed, trigger level, trigger edge and channel sensitivity to measure at the verification point.
5. 9500B: Set Output ON.
6. Oscilloscope:
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Check the waveform for correct polarity ('Rise' selected: from a negative potential to ground; 'Fall' selected: from a positive potential to ground).
7. Rise Time:
   a. Measure the (10 % to 90 %) combined pulse rise/fall time.
   b. Calculate the Edge function rise/fall time:

      Edge Function Rise/fall time =

      $$\sqrt{\left(ObservedRiseTime^2 - ScopePulse\,\mathrm{Re}\,sponseTime^2\right)}ps$$
   c. Record the Measured Edge function rise/fall time on the copy of the Table.
   d. Record the 9500B displayed Rise Time on the copy of the Table.
8. 9500B: Set Output OFF.

Calculation of Acceptance Limits

1. Introduction:

   The first part of the verification procedure in section Verification Measurement Procedure deals with measurement of rise/fall times, into an input impedance of 50 Ω. Each rise/fall time is measured on a wide-bandwidth oscilloscope, whose pulse response time is taken into account.

   To calculate the Acceptance limits at each verification point, we must take into account the User's Total Measurement Uncertainty and the specified 9500B Speed Limit. These are combined using an RSS calculation.

2. Example: Calculation of Acceptance Limits (500 ps at 25 mV)

   - From the Oscilloscope Specification, let us say that its Total Measurement Uncertainty (500 ps at 25mV), is: ±20 ps.
   - With this we must combine (by RSS Method) the 9500B Speed specification. At 500 ps, the 9500B specification speed is +50 ps to -150 ps.
   - Considering the upper limit:

     $$\text{Acceptance Limit} = \sqrt{\left[(20\,ps)^2 + (50\,ps)^2\right]}$$

     $$= 53.85 \text{ ps}$$

   - We must now add this Acceptance Limit to the Nominal value of 500 ps, giving the Upper Acceptance Limit of 553.85 ps.
   - Considering the lower limit:

     $$\text{Limit} = \sqrt{\left[(20\,ps)^2 + (150\,ps)^2\right]}$$

     $$= 151.32 \text{ ps}$$

   - We must now subtract this Acceptance Limit from the Nominal value of 500 ps, giving the Lower Acceptance Limit of 348.68 ps.

Calculation of Acceptance Limit and Edge Speed Check

1. Calculate the User's Total Measurement Uncertainty and Acceptance Limits, and enter in the appropriate columns of the copy of the Table. For further assistance, refer to Calculation of Acceptance Limits.
2. Check that the Measured Value is at or between the Upper and Lower Validity Acceptance Limits.
3. Check that the difference between the '9500B Displayed Value' [recorded in Verification Measurement Procedure operation 7(d)] and the 'Measured Value' [recorded in Verification Measurement Procedure operation 7(c)] is within the 9500B displayed value accuracy specification of the Measured Value (see note † below the table).

Note

Please copy the following table. Enter the calculation results and measurements in the appropriate columns on the copy.

Table 16. Edge Function Verification — Rise/Fall Time at 1 MHz (Period 1 μs) into 50 Ω Load

Ver.Pt.	Nominal Rise/Fall Time (10% - 90%)	Edge Type	Output Voltage (pk-pk)	Lower Specification Limit	Upper Specification Limit	User's Total Measurement Uncertainty	Lower Acceptance Limit	Upper Acceptance Limit	Measured Value	9500B Displayed 'Rise Time' Value †
EDG01	γ	Σ	25.000 mV	-150 ps	+50 ps		ps	ps	ps	ps
EDG02		Τ					ps	ps	ps	ps
EDG03	γ	Σ	50.000 mV	-150 ps	+50 ps		ps	ps	ps	ps
EDG04		Τ					ps	ps	ps	ps
EDG05	γ	Σ	250.00 mV	-150 ps	+50 ps		ps	ps	ps	ps
EDG06		Τ					ps	ps	ps	ps
EDG07	γ	Σ	500.00 mV	-150 ps	+50 ps		ps	ps	ps	ps
EDG08		Τ					ps	ps	ps	ps
EDG09	γ	Σ	2.5000 V	-150 ps	+50 ps		ps	ps	ps	ps
EDG10		Τ					ps	ps	ps	ps
EDG11	η*	Σ	25.000 mV	-25 ps	+25 ps		ps	ps	ps	ps
EDG12		Τ					ps	ps	ps	ps
EDG13	η*	Σ	50.000 mV	-25 ps	+25 ps		ps	ps	ps	ps
EDG14		Τ					ps	ps	ps	ps
EDG15	η*	Σ	250.00 mV	-25 ps	+25 ps		ps	ps	ps	ps
EDG16		Τ					ps	ps	ps	ps
EDG17	η*	Σ	500.00 mV	-25 ps	+25 ps		ps	ps	ps	ps
EDG18		Τ					ps	ps	ps	ps
EDG19	η*	Σ	2.5000 V	-25 ps	+25 ps		ps	ps	ps	ps
EDG20		Τ					ps	ps	ps	ps
EDG21	ι**	Σ	33.00 mV	-20 ps	+15 ps		ps	ps	ps	ps
EDG22		Τ	66.00 mV	-20 ps	+15 ps		ps	ps	ps	ps

Table 16. Edge Function Verification — Rise/Fall Time at 1 MHz (Period 1 μs) into 50 Ω Load (cont.)

Ver.Pt.	Nominal Rise/Fall Time (10% - 90%)	Edge Type	Output Voltage (pk-pk)	Lower Specification Limit	Upper Specification Limit	User's Total Measurement Uncertainty	Lower Acceptance Limit	Upper Acceptance Limit	Measured Value	9500B Displayed 'Rise Time' Value †
EDG23	ι**	Σ	100.00 mV	-20 ps	+15 ps		ps	ps	ps	ps
EDG24		Τ	200.00 mV	-20 ps	+15 ps		ps	ps	ps	ps
EDG25	ι**	Σ	330.00 mV	-20 ps	+15 ps		ps	ps	ps	ps
EDG26		Τ	660.00 mV	-20 ps	+15 ps		ps	ps	ps	ps
EDG27	ι**	Σ	1.0 V	-20 ps	+15 ps		ps	ps	ps	ps
EDG28		Τ	2.0 V	-20 ps	+15 ps		ps	ps	ps	ps
EDG29	φ***	Σ	500 mV	-4 ps	+4 ps		ps	ps	ps	ps
EDG30		Τ	500 mV	-4 ps	+4 ps		ps	ps	ps	ps
*: Verification points EDG11 to EDG20 available for Active Head Model 9530 only.										
†: 9500B displayed value accuracy specification: for γs , ±40 ps; for η , ±15 ps; for ι, ±11 ps; for φ, ±4 ps.										
**: Verification points EDG21 to EDG28 available for Active Head Model 9560 only.										
***: Verification points EDG29 to EDG30 available for Active Head Model 9550 only.										

Verifying the Load Capacitance Measurement Function (Ε)

Summary

Equipment requirements are given in Equipment Requirements and test interconnections in Interconnections. Verification Setup shows the Verification Setup.

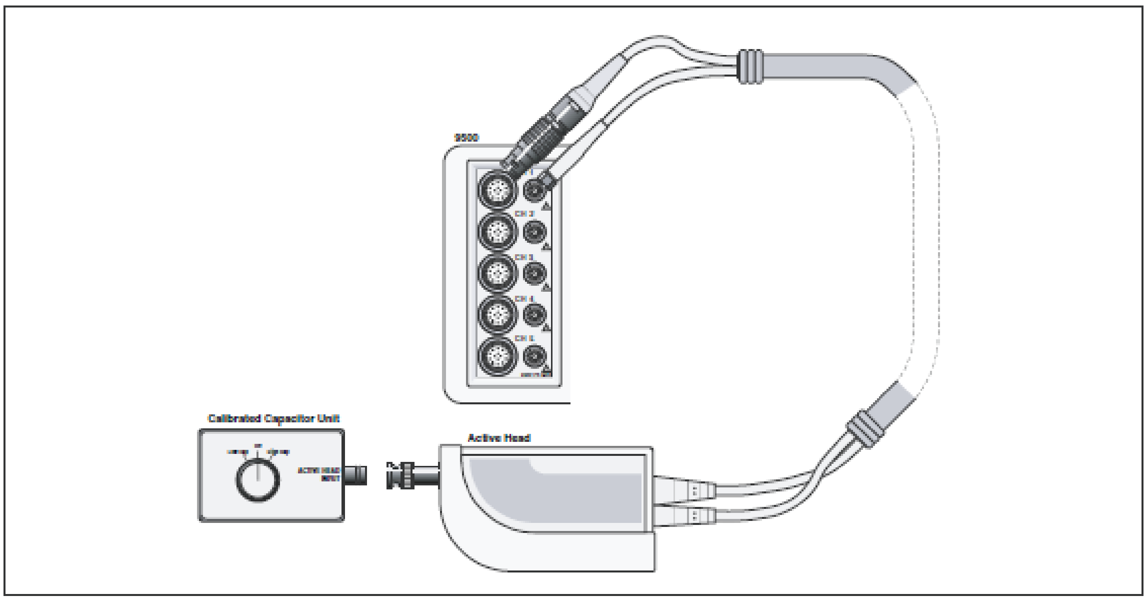
The Verification Procedure is in 9500B Absolute Acceptance Limit. The Load Capacitance Measurement Function is verified by carrying out measurements of the capacitance of a calibrated Capacitance Standard in the sequences given in Verification Setup and 9500B Absolute Acceptance Limit Calculations, at the verification points shown in Table 17.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe.
- Two Calibrated Capacitance Units (BNC-terminated):
  - Calibrated value between 15 pF and 25 pF
  - Calibrated value between 85 pF and 95 pF

Suitable capacitance values can be constructed from a length of coaxial cable fitted with a BNC connector at one end and open circuit at the other. Measure the capacitance value with a capacitance bridge. If the cable is fitted with a female connector, a BNC male/male adapter is required to interface with the Active Head and must be included in the capacitance value.

Interconnections



erw210

Figure 12. Load Capacitance Measurement Function Verification — Interconnections

Verification Setup

1. Copy the Table 17.
2. Test Capacitor Values:
   a. Ensure that the two Capacitors have been calibrated.
   b. Enter the low and high calibrated values in the 'Capacitance Calibrated Value' column of Table 17.
3. Connections: Ensure that the 9500B is connected to the Capacitance unit (or individual capacitors in turn) as shown in Figure 12, and that both instruments are powered on and warmed up.
4. 9500B:
   a. Select the Aux functions (Aux key on the right of the front panel). Press the E soft key on the bottom row.
   b. Select the required output Signal Channel.

9500B Absolute Limit Calculations

1. Refer to Table 17. Ensure that the Test Capacitance Calibrated Values have been entered for the two Test Capacitors (High and Low).
2. Use the specification figures to calculate the 9500B Absolute Limits.

   Example: Let us say that the Test Capacitor value has been calibrated at 20 pF:

   The specification for this value is: ±2 % ± 0.25 pF.

   $$\pm[(2\ \%\ \text{x}\ 20\ \text{pF}) + 0.25\ \text{pF}] = \pm[0.4\ \text{pF} + 0.25\ \text{pF}] = 0.65\ \text{pF}$$

   We must now subtract this value from 20pF for the lower limit (19.35 pF), and add it to 20 pF for the higher limit (20.65 pF).
3. Enter the 9500B Absolute Limits into their respective columns on Table 17.

Verification Procedure

Refer to Table 17. At each verification point shown on the table, carry out the following operations (1) to (6).

2. Test Cap: Select the correct Test Capacitance for the verification point range.
3. 9500B: Set Output ON and wait for the Load Capacitance reading to settle.
4. Reading:
   a. Record the 9500B reading in the Measured Value column of the copy of the Table.
   b. Check that the Measured Value is at or between the Absolute Limits.
5. 9500B: Set Output OFF.

Table 17. Load Capacitance Measurement Verification

Verif. Point E	Capacitance Test Range	Test Capacitance Calibrated Value	9500B Measurement Spec	9500B Absolute Limits		9500B Measured Value
				Lower	Higher	
CAP1	Low: 15-25 pF	pF	±2 % ± 0.25 pF	pF	pF	pF
CAP2	High: 85-95 pF	pF	±3 % ± 0.25 pF	pF	pF	pF

Calibration

This section outlines general procedures for calibrating the Model 9500B. In it you will find the recommended calibration methods, details of the parameters that require calibration and the procedures needed to calibrate them.

This section is divided into the following sub-sections:

- 9500B Mainframe Calibration and Active Head™
  Calibration Functions and Methods.
- The Model 9500B Calibration Mode
  Selection of Calibration Mode, Special Calibration and Standard Calibration.
- Standard Calibration — Basic Sequences
  Using the Target Selection and Adjustment screens.
- Front-panel Calibration by Functions
  General procedure, sequencing, equipment requirements, interconnections, procedures and lists of calibration points for all functions requiring calibration.
- Head Calibration Procedures
  Calibrating sine, edge, timing markers, load capacitance and 50 Ω/1 MΩ ratio functions.

9500B Mainframe Calibration and Active Head™ Calibration

The Model 9500B has been designed around a 1-year recalibration interval. When they do need recalibration, it is not necessary to lose the entire system while it is being performed.

In addition to being supported by traditional scope calibration standards, the 9500B's mainframe and its Active Heads are calibrated separately. The mainframe unit defines the DC and LF traceability, and is easily calibrated on-site.

All high frequency calibrations (such as the leveled sinewave and pulse outputs) are confined to the Active Heads, which can therefore be calibrated independently. They are small enough and light enough to be sent by regular mail services to a calibration laboratory. Our global network of Service Centers provides a fast turnaround Active Head recalibration service. By substituting a spare head for the one that is being calibrated, the benefits of near-zero downtime become attainable.

Mainframe Unit Calibration

Mainframe Unit calibration correction factors are stored in non-volatile calibration memory in the Mainframe Unit. The following calibrations are available:

- 'DC' voltage, positive and negative outputs, selected using the WAVEFORM soft key on the DC/Square 'Target Selection' screen when in Calibration mode.
- 'Square' voltage waveforms, positive, negative and symmetrical outputs, selected using the WAVEFORM soft key on the DC/ Square 'Target Selection' screen when in Calibration mode.

- 'LF Sine' function, selected simply by pressing the X front-panel push-button when in Calibration mode.
- 'Resistance Measurement', selected by pressing the Aux front panel push-button when in Calibration mode.

Active Head Calibration

Active Head calibration correction factors are stored in non-volatile calibration memory in the Active Head itself. The following calibrations are required:

- 'Sine' flatness above 50 kHz
- 'Low Edge' and 'Fast Edge' functions
- 'Load Capacitance' measurement functions
- 'Termination Compensation' functions

Head calibration involves the use of a verified 9500B Mainframe.

Note

Heads can be calibrated only within the bandwidth of the mainframe. For example, Head Model 9510 with Mainframe Variant 9500B/400 can only be calibrated to 400 MHz.

Other Functions

Other 9500B functions are either derived directly from functions that are calibrated, or are calibrated 'for life' during manufacture:

- Dual-Sine
- Current
- Composite Video
- Linear Ramp
- Overload Pulse
- Zero Skew
- Auxiliary Input
- Input Leakage

Attempting to select these functions during Mainframe calibration, (or those in Active Head Calibration) while the Model 9500B is in CAL mode, will result in an error message being displayed:

No calibration for this function

Mainframe Unit Manual Calibration

Mainframe Unit Calibration can be performed manually from the front panel and this is the main subject of this section:

1. The Model 9500B Calibration Mode section covers general access to the processes via Calibration Mode
2. Standard Calibration — Basic Sequences section deals with the general processes of selecting:
    a. Hardware configurations (Cal Ranges).
    b. Target Values within Cal Ranges.
    c. Modifying and saving modified Target Values for individual calibration environments.
    d. Adjusting the 9500B output values to calibrate Cal Ranges (thereby storing correction factors in non-volatile Calibration Memory).
3. Front Panel Base Calibration by Functions section details front panel operation to calibrate functions, providing connection diagrams and sequenced procedures.

The Model 9500B Calibration Mode

This section is a guide to the use of the Model 9500B's Calibration Mode, for manual calibration of the 9500B Mainframe.

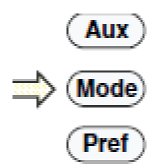
- Mode Selection
    - 'Mode' Key
    - 'Mode Selection' Screen
- Selection of Calibration Mode
    - Calibration Enable Switch
    - Password
    - Calibration Mode Display
    - Calibration Mode Screen Softkeys
- Special Calibration
    - Selecting Special Calibration
    - When to Characterize
    - How to Characterize
    - Form of Characterization

- Special Cal: 'Adjust FREQ'
  - When to Adjust
  - Equipment Requirements
  - Interconnections
  - 9500B and Counter Setup
  - Sequence of Operations
- Mainframe Standard Calibration (STD CAL)
  - Function Selection
  - Cal Mode Function Screens
  - 'Hardware Configurations'
  - 'Target Calibration Values'
- Overview of Calibration Operations

Mode Selection

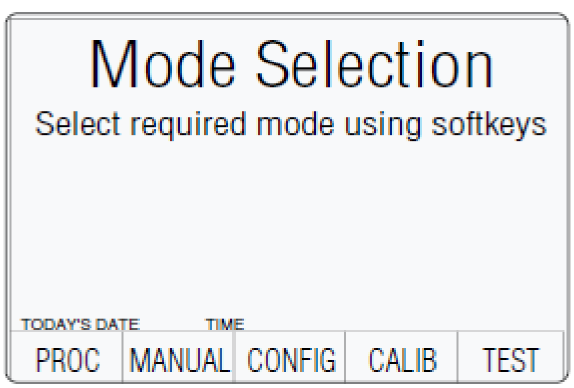
'Mode' Key

Selection of any one of the Model 9500B's five operating 'Modes' is enabled by pressing the 'Mode' key at the bottom right of the 'CALIBRATION SYSTEM' key panel.



erw211

This results in display of the mode selection screen:



erw212

'Mode Selection' Screen

The Mode Selection menu screen allows you to select any one of the following operating modes:

PROC	Procedure mode
MANUAL	Manual mode
CONFIG	Configure mode
CALIB	Calibration mode
TEST	Selftest mode

Each mode is selected by pressing the appropriate screen softkey, after which a new menu screen relating specifically to that mode will be displayed.

Note

For the calibration menu screen to appear, certain other conditions must be satisfied — see Selection of Calibration Mode.

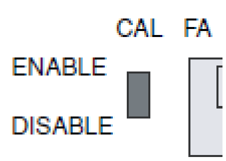
Selection of Calibration Mode

The following two conditions must be satisfied before the Calibration mode menu screen can be accessed:

1. The rear-panel Calibration Enable switch must be in the 'ENABLE' position.
2. A valid password must have been entered via the front panel keypad.

Calibration Enable Switch

The Calibration Enable DIP-switch is accessible, using a small screwdriver, through a recess on the Model 9500B's rear panel.



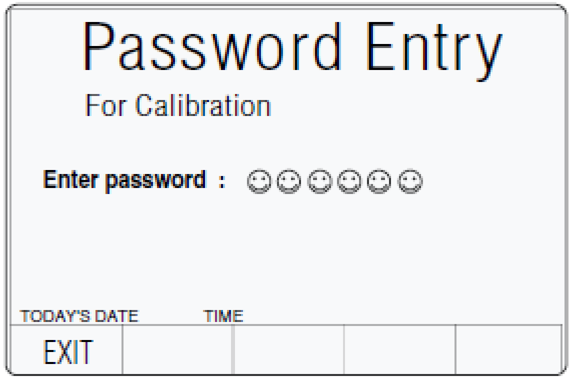
erw213

DISABLE

With the Calibration Enable switch in the 'DISABLE' position, any attempt to select Calibration mode by pressing the 'CALIB' screen softkey will result in the screen prompt "**Calibration switch not enabled!**" being displayed, and access to Calibration mode will be denied.

ENABLE

With the Calibration Enable switch in the 'ENABLE' position, pressing the 'CALIB' screen key will result in the 'Password Entry for Calibration' user prompt screen being displayed:



erw214

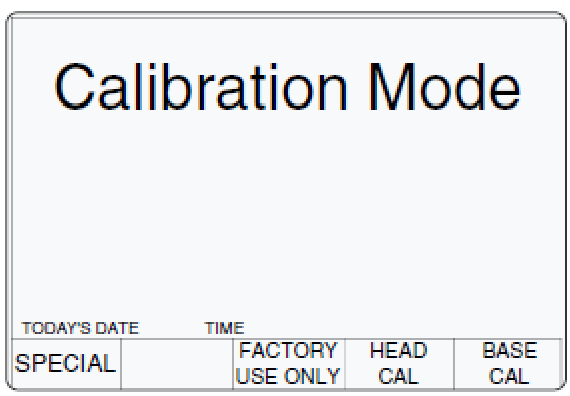
Password

Before the Calibration mode menu screen can be displayed you must now enter a valid password using the Model 9500B's alpha-numeric keyboard. For information about the initial 'shipment' password, and about the method of changing this to a custom password, refer to Passwords and Access in the *9500B Users Guide*.

As each character in the password is entered, security code icons will appear on the screen as shown above. Once the correct password has been entered, pressing the 'ξ' (Enter) key will result in the Calibration Mode menu screen being displayed. If the wrong password is used, the error message "PASSWORD INCORRECT" will be displayed and the security code character icons will disappear, enabling you to attempt correct password entry again. The 'EXIT' screen softkey will take you back to the Mode Selection screen

Calibration Mode Display

When Calibration mode has been successfully entered by setting the CAL ENABLE switch to the ENABLE position and entering the correct Password, the 'Calibration Mode' menu screen shown below will be displayed:



erw215

Calibration Mode Screen Softkeys

The following screen softkeys are active:

SPECIAL

Accesses the Special Calibration menu so that you can perform several 'Chse' (Characterize) calibration operations, which must be done immediately before carrying out routine recalibration of the Model 9500B.

FACTORY USE ONLY

Accesses 'factory-set' calibration operations which can only be entered by a special password. These calibration operations only need to be performed when the instrument is manufactured, or after certain types of repair have been carried out on it. The password is not given in this manual; any user who suspects that such calibration may be needed should contact their Fluke Calibration Service Center.

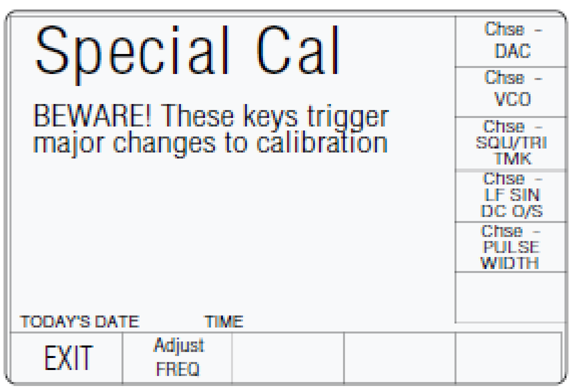
STD CAL

Accesses the user control screens for routine external Mainframe calibration of each Model 9500B function able to be calibrated.

Special Calibration

Selecting Special Calibration

Pressing the SPECIAL softkey in the Calibration Mode screen transfers to the Special Calibration screen:



erw216

When to Characterize

Characterizations are adjustments which calibrate basic digital sources of output. These adjustments are only required immediately prior to routine Standard Calibration of the Model 9500B, (detailed in subsequent sections).

Note

Do not characterize unless you are doing so as part of an authorized recalibration of the Model 9500B. Although the internal adjustment operations which it initiates will not dramatically change the overall calibration of the instrument, they will introduce a very small 'artificial' step into its apparent drift performance. If your company maintains historical records on each calibrator's drift performance between calibrations (for example, for the purposes of statistical process control in a total quality management system), this artificial step would need to be determined and suitably recorded in these records. There are no performance advantages to be gained by characterizing at any time other than immediately before Standard Calibration of the Model 9500B's functions.

How to Characterize

Characterization is performed merely by pressing the appropriate 'Chse - ...' soft key. When characterizing, do so in the following sequence:

1. Chse - DAC
2. Chse - VCO
3. Chse - SQU/TRI TMK
4. Chse - LF SIN DC O/S
5. Chse - PULSE WIDTH

Note

Selected characterization has completed when single highlighted softkey selected is replaced by complete softkey menu display.

Form of Characterization

The Characterize operations comprise sets of fully automatic internal adjustments, such as (in the case of Chse - DAC) checking and calibrating the linearity of the 9500B D-A converter, which is used to set the amplitude of its analog output functions.

Press EXIT to return to the calibration mode menu screen on completion of all characterizations.

Special Cal: 'Adjust FREQ'

This is really a calibration of the internal frequency source, to an external frequency standard. The 9500B generates a stream of square timing markers (as in Time Markers Function — refer to the *9500B Users Guide, Time Markers Function* section) at 100 MHz. This is applied to the external frequency standard, and the internal frequency DAC factor is adjusted until the external counter registers 100 MHz.

When to Adjust

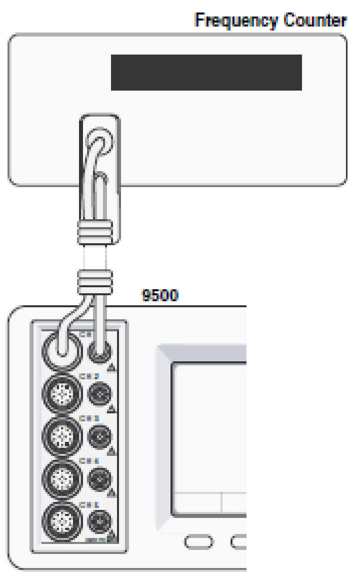
The 9500B Frequency Uncertainty (5 years) is specified at 100 MHz as: ±0.25 ppm.

In either case, it is normally unnecessary to adjust the frequency at less than 5 year intervals.

Equipment Requirements

Digital counter for 0.25 ppm clock accuracy measurements.

Example: Hewlett Packard Model HP53131A with Option 012.



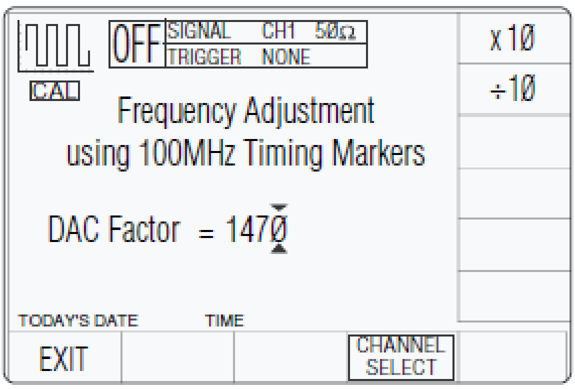
erw217

Interconnections

9500B and Counter Setup

1. Connections: Connect the 9500B to the Counter and ensure that both instruments are powered ON and warmed up. Any model number head may be used (except 9550).
2. Counter: Select the required function to measure frequency.
3. 9500B: In the Calibration Mode screen, press the SPECIAL soft key on the left of the bottom row. This transfers to the Special Cal screen shown in Selecting Special Calibration.

Sequence of Operations



erw218

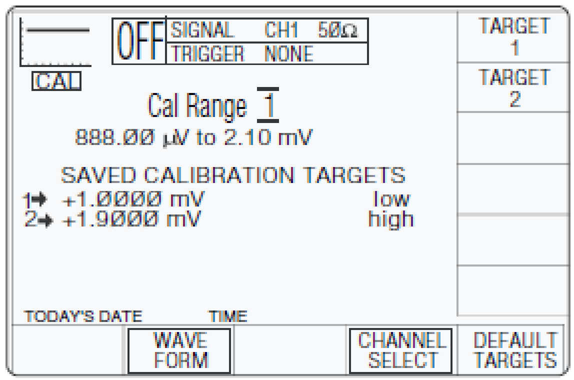
1. 9500B: In the Special Cal screen, press the Adjust FREQ soft key on the bottom row. This transfers to the Frequency Adjustment screen.
2. Counter: Select the correct display time, trigger source and level to measure at the calibration point.
3. 9500B: Set Output ON.
4. Counter: Adjust the trigger level for a stable display and note the measured frequency.
5. 9500B:
   a. Use the cursor keys to increment or decrement the DAC Factor value until the Counter registers a frequency of 100 MHz.
   b. Set Output OFF.
   c. Press the EXIT soft key on the bottom row to return to the Special Cal screen.

Frequency calibration is now complete.

Mainframe Standard Calibration (BASE CAL)

Function Selection

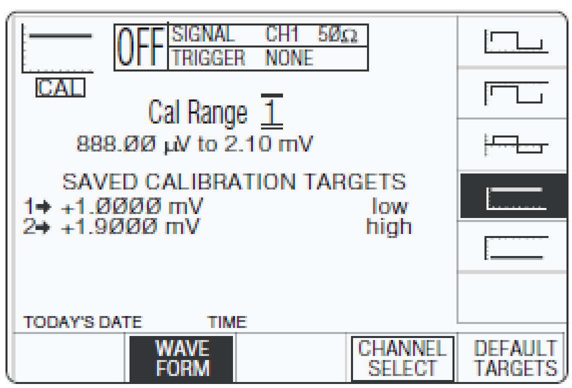
Pressing the 'BASE CAL' screen softkey displays a DC/Square'DC CAL' function screen (the 'Target Selection' screen) shown below, which appears on entry to Standard Calibration.



erw219

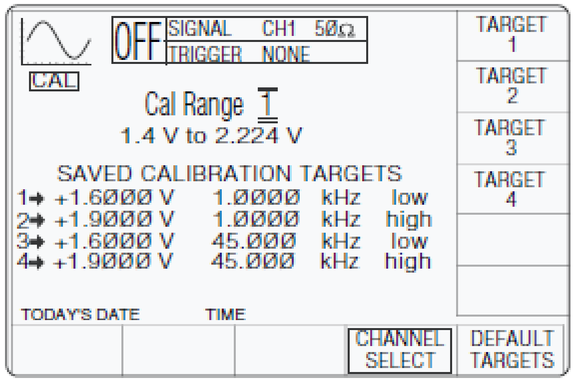
Other available Mainframe calibrations are:

- DC/Square Function: 'DC Negative' and 'Square' waveforms, selected using the WAVEFORM soft key:



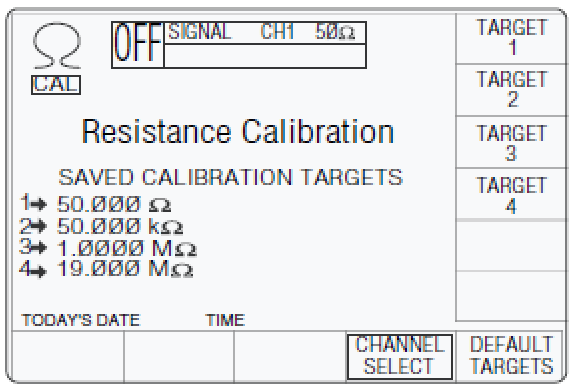
erw220

- Sine Function, selected simply by pressing the X front-panel push-button.



erw221

- Resistance Measurement, selected by pressing the Aux front-panel push-button.



erw222

Note that the other 9500B functions, listed in Active Head Calibration and Other Functions cannot be externally adjusted during Mainframe calibration (they are either derived directly from functions that can be calibrated, or are calibrated 'for life' during manufacture, or are adjusted during 'Head' calibration). Attempting to select these functions during Mainframe calibration, while the Model 9500B is in CAL mode, will result in an error message being displayed:

No calibration for this function

Cal Mode Function Screens

Generally, two special screens are provided to adjust each of the functions' calibration points. In CAL mode, the purpose of these screens is to allow you to set the 9500B into the various hardware configurations (also known as 'Cal Ranges') required during calibration, and initiate the necessary sequences of operations.

Each Function/Waveform is identified by the usual symbol in the top left corner.

'Hardware Configurations'

Although all functions in the 9500B appear to the operator to have a single continuous range which covers the entire span of output values from the lowest to the highest (for example, for DC Voltage from 888.00 μV to 222.4 V), internal devices such as voltage dividers and power amplifiers must be switched to achieve this total span. With this switching, the hardware configuration changes.

Because each of these configurations introduces slight offset and gain errors into the 9500B output, they must be compensated by calibration in order to maintain the 9500B's very high level of performance. Calibration of the 9500B determines and stores the offset and gain errors associated with each hardware configuration, so that they can be digitally compensated by the instrument's control processor. The processor applies digital correction factors to the selected output value, so that the analog output accurately matches the selected value (within its specification). This results in an accurate and linear output response across each function's entire output span.

'Target Calibration Values'

Individual hardware configurations are calibrated by accurately measuring their analog outputs at (usually) two or more points using a higher order calibration standard. In most cases these 'target calibration values' are values close to the lower and upper extremes of the hardware configuration's output capability.

Overview of Calibration Operations

In general, calibration of each of the 9500B's hardware configurations can be broken down into three distinct stages as follows:

1. Selection of the required hardware configuration (Target Selection screen).
2. Selection of 'target' values at which this hardware configuration will be calibrated (Target Selection screen).
3. Modification of the target values and determination of the 9500B's output error at each of these values (Adjustment screen).

The Target Selection screen is used to select the correct hardware configuration, expressed as 'Cal Range', and permits you to opt to use Fluke Calibration Calibration's recommended 'default' target calibration values or custom target values (close to the default values) more appropriate to the equipment being used for calibration purposes.

Selecting one of the target values displayed in the target selection screen (by pressing its corresponding Target softkey) transfers you to the 'Adjustment' screen, where you can optionally alter and save the target value before measuring the output error and generating a compensating correction.

These three stages are described in more detail in *Standard Calibration — Basic Sequences*, while descriptions of the calibration sequences for each individual function are provided in *Front Panel Base Calibration by Functions*.

The flow chart in Figure 13 summarizes the operator actions needed to enter Calibration mode, and to then select an appropriate function for calibration.

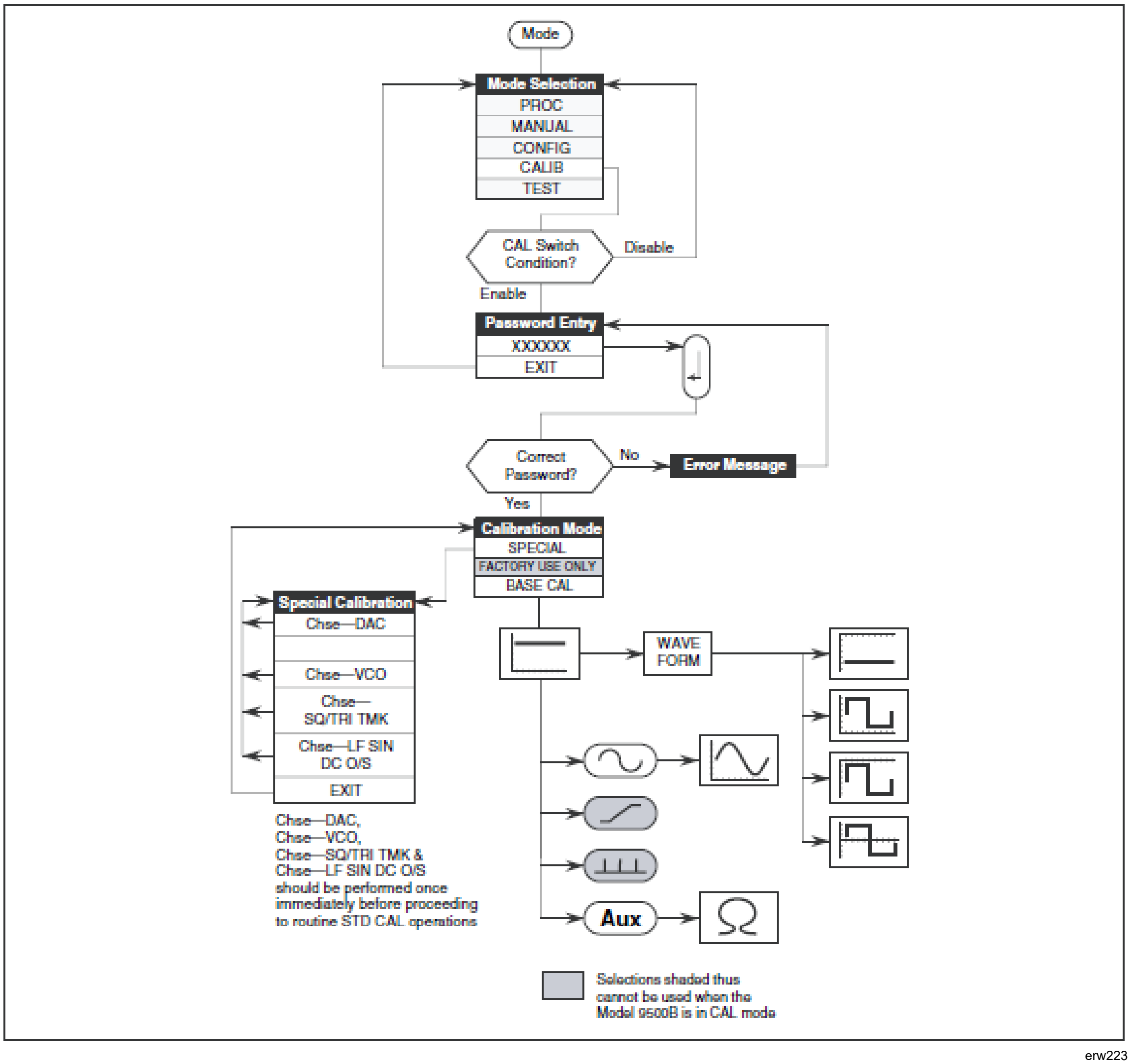


Figure 13. Access to Functions in Calibration Mode

Standard Calibration — Basic Sequences

This section describes in more detail the main processes involved when calibrating each of the Model 9500B's 'hardware configurations' from the instrument's front panel.

- Introduction
  - Aim of Calibration
  - General Calibration Process
- Target Selection Screen — Selecting Hardware Configurations
  - Waveform Selection
  - Hardware Configurations
  - Channel Selections
  - Retained Channel Memory
  - 'Default' or 'Saved' Targets
- The Adjustment Screen
  - Setting Target Values
  - Selecting Default Calibration Targets
  - Modifying a Calibration Target
- Calibrating the Model 9500B at Target Values
  - Adjust Output Amplitude
  - Target Selection
  - 'RESET CAL POINT'
- Standard Calibration of AC Functions
  - Output Frequency Synthesis
  - Changing the Output Frequency of Target Calibration Points
- Exit from Calibration - Cal Date and Cal Due Date
  - Exit: Mode Key — Warning Screen
  - Exit Only
  - Update the Date Stamp on a Certificate
  - Setting the Cal Due Date and Advance Warning Period

Aim of Calibration

The aim of calibrating the Model 9500B Oscilloscope calibrator is to determine the accuracy of its outputs, and if necessary adjust them so that they are within specification. If this calibration is to be traceable, then the 9500B's outputs must be compared with Traceable calibration standards of suitable 'Test Uncertainty Ratio'.

General Calibration Process

As mentioned earlier in section, The Model 9500B Calibration Mode, calibrating each of the 9500B's functions can be broken down into three distinct stages as follows:

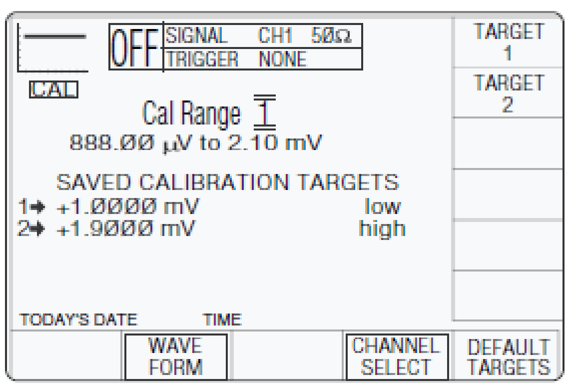
1. Select the required 'hardware configuration' by selecting the correct 'Cal Range'.
2. Select 'target' values at which this hardware configuration will be calibrated.
3. Determine the 9500B's output error at each of these target values, and generate a suitable compensating correction factor.

This section Standard Calibration — Basic Sequences describes the general process of calibrating the 9500B using front panel controls.

The following description uses, as an example, the DC/Square function, which has eleven positive-DC hardware configurations (called 'Cal Ranges') to generate output voltages between +888.00 mV and +222.40 V. Each Cal Range requires two target-value calibration points, generating two associated correction factors. The factors are stored in non-volatile memory, and are subsequently used to correct all outputs which employ the hardware configuration.

We will start by assuming that the 'Cal' mode of the DC Voltage function has been selected as described in section The Model 9500B Calibration Mode of this manual. This presents the 'Target Selection' screen, similar to that illustrated in the figure below.

Target Selection Screen — Selecting Hardware Configurations



erw224

Waveform Selection

Refer to *Function Selection*.

Hardware Configurations

For a given function, selecting a particular 'Cal Range' switches in the relevant hardware configuration which will generate the required span from the function's total output range. The span of the hardware configuration appears under the 'Cal Range' selection on the screen.

For example, the total output range in DC/Square function (DC positive output) consists of eleven separate hardware configurations numbered as Cal Ranges:

1. 888.00 mV to 2.10 mV
2. 2.10 mV to 5.56 mV
3. 5.56 mV to 21.00 mV
4. 21.00 mV to 55.60 mV
5. 55.60 mV to 210.00 mV
6. 210.00 mV to 556.00 mV
7. 556.00 mV to 21.0 V
8. 21.0 V to 5.56 V
9. 5.56 V to 22.24 V
10. 22.24 V to 55.60 V
11. 55.60 V to 222.40 V

Hence hardware configuration (1) can be selected by setting the Cal Range to '1'. Hardware configuration (2) can be selected by setting the Cal Range to '2' etc., using the ϑ and K cursor keys or spinwheel.

The full list of Cal Ranges used to establish all the required hardware configurations for each function are given in the detailed calibration procedures contained in section Front Panel Base Calibration by Functions of this manual.

Note that in this instance, by selecting Cal Range 1, two 'Saved Calibration targets' appear:

1. ψ +1.0000 mV (Low)
2. ψ +1.9000 mV (High)

Channel Selections

Connection of the Mainframe to the standards equipment must be routed through a signal channel head, with a trigger channel/cable if necessary. Signal Channel selection, Trigger Channel selection, Cable selection and Trigger Ratio operate in the same way as in normal DC/Square function. Refer to *9500B Users Guide*, Menu Selections.

Retained Channel Memory

Refer to *9500B Users Guide*, Retained Channel Memory.

Default' or 'Saved' Targets

For each function and Cal Range, users can choose 'Default' or 'Saved' calibration targets.

Pre-programmed Default Targets, selected by pressing the 'DEFAULT TARGETS' softkey (which becomes highlighted), are those considered by Fluke Calibration Calibration to be generally appropriate for use unless a user decides otherwise (shown in the list for DC Positive in Target Selection).

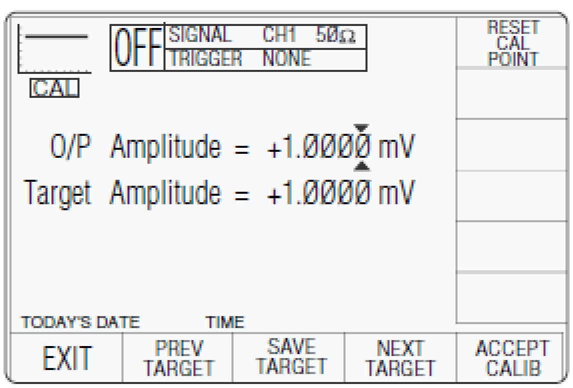
Saved Targets are those previously set and saved in earlier calibrations, available when the 'DEFAULT TARGETS' softkey is not highlighted. The former user has deemed that, for the calibration environment being employed at the time, the saved value of a target is more appropriate than the default target. The 'save' action is described later in The Adjustment Screen.

The Adjustment Screen

Using this screen, action is taken to perform the adjustment at or close to the selected calibration target, having already selected the hardware configuration and committed to 'default' or 'saved' targets, on the Target Selection screen (refer to Target Selection Screen — Selecting Hardware Configurations).

Setting Target Values

Once the correct hardware configuration has been chosen on the Target Selection screen by selecting the Cal Range; pressing one of the TARGET softkeys will Transfer to the 'Adjustment' screen — similar to the following:



erw225

This screen initially shows the value to which the 9500B output is presently set, and the value of the selected target amplitude (whether 'default' or 'saved'). Note that on these values, triangular cursors indicate which digit will change when using the cursor keys or spinwheel. When transferring, using the 'tab' Δ key, the cursor always moves to the least significant digit on the other value.

Output and Target Amplitude control on this screen is similar to normal operation of the 9500B, either by digit edit method (cursor controls/spinwheel operating on one digit at a time), or direct edit method (numeric keypad). At this point you have already chosen to use either the default or saved value which is now shown on the screen.

At any time you can return to the Target Selection screen by pressing the EXIT softkey.

Selecting Default Calibration Targets

As mentioned earlier, the Model 9500B's firmware contains a complete set of recommended target calibration values, for every hardware configuration of every function that can be directly calibrated.

Before changing from 'Saved' calibration target values back to 'Default' target values, consider that there may have been good reasons for choosing values other than default values at the previous calibration. Your calibration standards may be uniquely characterized at particular target values (for example, standard cells may provide a calibration point voltage different from the default value). Using default target values may therefore reduce the usefulness of historical calibration records.

- If you decide to use default values, rather than the values at which your 9500B was previously calibrated (assuming that the 'saved' and 'default' values are different), simply press the DEFAULT TARGETS softkey on the Target Selection screen.
- The targets on the screen will have a new title: DEFAULT CALIBRATION TARGETS, and the DEFAULT TARGETS soft key will be highlighted.
- When passing to the Adjustment screen by selecting a target, the default target value will be shown, and from this point, all targets will be default targets until you change back to saved targets again, or decide to change the selected target value.
- Back on the Target Selection screen, pressing the DEFAULT TARGETS soft key again will restore the title SAVED CALIBRATION TARGETS, and the target values will revert to the saved values — i.e. the DEFAULT TARGETS key toggles between the 'Saved' and 'Default' sets of target values.

Modifying a Calibration Target

Once the Adjustment screen is displayed, the existing target value can be changed to a new value, if this is preferable to using either the default target value or a target value 'saved' from a previous calibration. The target value can be changed whether it starts as a default or a saved target, but will always become a new saved target. The default target values will not change.

To change the existing Target Amplitude:

- Use the 'tab' Δ key to place the cursor on its value, then use the ϑ, K, Λ and M keys to set the required target amplitude.

Note

The extent to which the target value can be changed from the default value is limited. In our example at 1.0000 mV, the target cannot be set above 1.0700 mV, nor below 0.9300 mV. Beyond these limits the error message 'Outside amplitude range' is given.

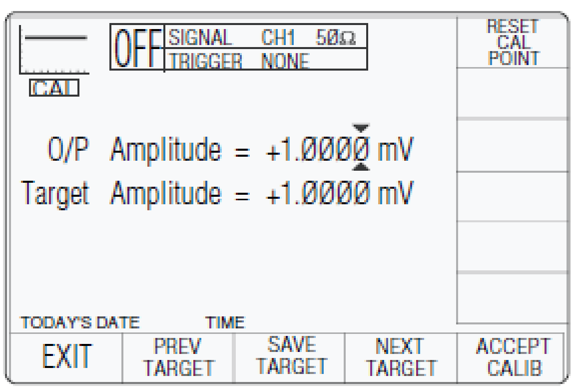
- Press the SAVE TARGET soft key to record the change. A message will appear 'TARGET SAVED'.
- You can check that the change has been recorded by pressing EXIT to return to the Target Selection screen, where the different value will have appeared against that saved target (unless the DEFAULT TARGETS key is highlighted). If default targets remain selected, then they will not have changed, merely press the DEFAULT TARGETS key to return to saved targets to note the change in saved target value.
- Returning to the Adjustment screen by pressing the same target soft key, it can be seen that the 9500B O/P Amplitude has also changed to the saved value in preparation for adjustment.

Calibrating the Model 9500B at Target Values

Adjust Output Amplitude

Once the target value is as required, the next step is to set up the external circuit so that the output can be measured by a suitable external Standard.

To calibrate at the target value, use the Adjustment screen:



erw226

- Ensure that the Output is OFF.

Note

Do not press the ACCEPT CALIB softkey while using the Adjustment screen unless you are sure that you wish to perform an authorized recalibration of the selected hardware configuration at the selected target value. To prevent accidental calibrations due to inadvertent use of the CALIB key, initial use of the Adjustment screen takes place with the 9500B output OFF. If you accidentally press the ACCEPT CALIB key, or attempt a calibration without first turning the 9500B output on, the following error message will be shown:

Output must be ON for CAL

Under output-off conditions, the existing, stored calibration corrections will remain unchanged.

- Ensure that the Adjustment screen is displayed, with the cursor on the O/P Amplitude value.
- Set the Output ON. The displayed output value has already followed to match the target value, so the external Standard measurement will include the error between the output value and the target value.
- With the cursor on the O/P Amplitude value, use the ϑ, K, Λ and M keys to adjust the output amplitude until the external Standard measurement is the same as the target value. Note that the O/P Amplitude display will now include the error.

Note

Limits are placed on the extent to which the Output Amplitude value can be changed. In our example at 1.0000 mV, the amplitude cannot be set above 1.4500 mV, nor below 0.8880 mV. Beyond these limits the error message 'Outside amplitude range' is given.

- Once you are satisfied that the external measurement matches the Target value, perform the adjustment by pressing the ACCEPT CALIB soft key. The displayed O/P Amplitude value returns to the Target value, the external Standard measurement remains the same as the Target value and the adjustment at this target is complete.

Target Selection

On the Adjustment screen, using the NEXT TARGET and PREV TARGET soft keys, it is possible to move backwards and forwards along the current target list for the selected function without returning to the Target Selection screen. The lists are in *Front Panel Base Calibration by Functions*.

For example: if the present Cal Range in DC/Square function DC Positive target is Cal Range 2, and the Target 1 (low — +2.3000 mV) is selected, then pressing the NEXT TARGET soft key transfers to Cal Range 2, Target 2 (high — +5.0000 mV).

On the other hand: from the same target, then pressing the PREV TARGET soft key transfers to Cal Range 1, Target 2 (high — +1.9000 mV).

'RESET CAL POINT'

Over a series of recalibration periods, a condition may be reached when the Calibration memory for a particular Cal Point is heavily biased in one direction. A conflict can arise between the limits on the O/P Amplitude value and the target value. In response to successive attempts at adjustment, the 9500B will keep repeating the error message 'Outside amplitude range' and calibration is not accepted.

This conflict can often be resolved by pressing the 'RESET CAL POINT' soft key to clear the cal memory to zero, then recalibrating.

If this does not work, then it could indicate one of two causes:

1. The Model 9500B has developed a fault.
2. The measuring instrument has developed a fault, is incorrectly set up, or is incorrectly connected to the Model 9500B's terminals.

The cause should be determined and rectified before proceeding. If this is not possible, then you should contact your Fluke Calibration Calibration Service Center.

Standard Calibration of AC Functions

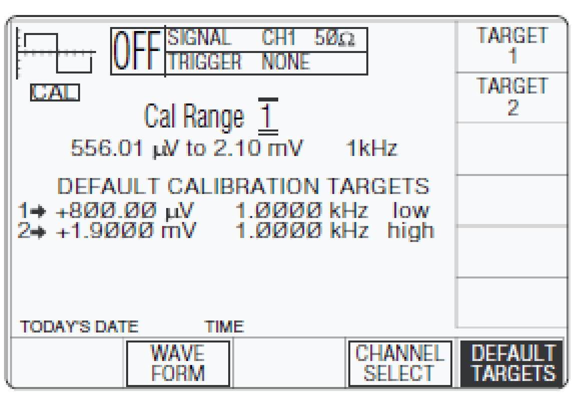
Standard calibration of the Square Voltage and Sine Voltage functions in the 9500B uses the same procedure as that described in sections, Introduction, Target Selection Screen — Selecting Hardware Configurations, The Adjustment Screen and Calibrating the Model 9500B at Target Values of this section except that the frequency of the target calibration points must also be set.

Output Frequency Synthesis

The frequency of the Model 9500B's Square Voltage and Sine Voltage output is derived digitally from an internal reference frequency crystal, which is sufficiently stable for the output frequencies of these functions not to require any routine calibration for at least 5 years (Refer to Special Cal: 'Adjust FREQ').

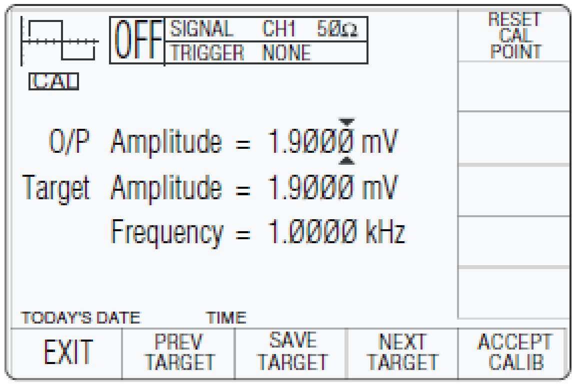
Changing the Output Frequency of Target Calibration Points

When you display target selection screens for AC functions on the Target Selection screen, you will notice that the Saved Calibration Targets and Default Calibration Targets all include a target calibration point frequency. As an example, the default calibration targets for the Symmetrical Square Voltage, Cal Range 1 — Target 2 are illustrated in the following screen:



erw227

When you select target 2 by pressing its soft key, the Target Amplitude and Frequency will be displayed below the current Output Amplitude as shown in the following Adjustment screen illustration:



erw228

If you now wish to change the calibration point frequency, this must be done by editing the Frequency setting.

To do this, first transfer cursor control to the Frequency setting via the Tab Δ key. Then alter the frequency setting using the same digit edit (cursor controls/spinwheel) method or direct edit (numeric keypad) method used to change Output and Target Amplitude.

Note

Limits are placed on the extent to which the Frequency value can be changed. In our example at 1.0000 kHz, the frequency cannot be set above 1.0500 kHz, nor below 0.9500 kHz. Beyond these limits the error message 'Outside frequency range' is given.

Once the target has been saved, the new saved Frequency will be shown as well as any new saved Target Amplitude on the Target Selection screen, when the 'DEFAULT TARGETS' soft key label is not highlighted. Calibration can now continue as detailed in Calibrating the Model 9500B at Target Values.

Exit from Base Calibration - Cal Date and Cal Due Date

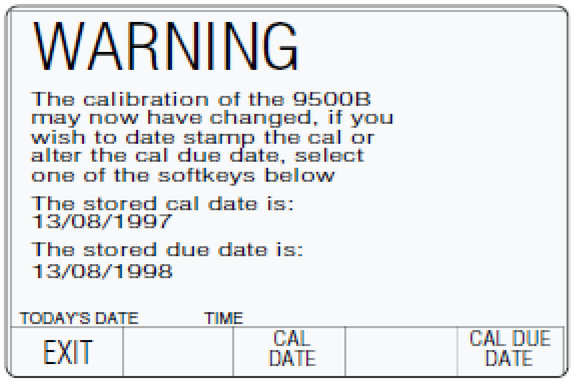
Once all calibration has been completed, you will wish to return to normal operation, which requires a short 'exit' process. The normal means of exit from Calibration mode is to press the Mode key on the right of the front panel. When you do this, the 9500B will present a Warning screen to indicate that the 9500B calibration may have changed, and to offer you the following options:

- Altering the date-stamp on any directly printed results certificate (or not)
- Entering or altering the calibration due date
- Indicate the advance warning period required before the cal due date

The following paragraphs show the screens, required actions and consequences.

Exit: Mode Key — Warning Screen

To exit from Calibration, press the Mode key on the right of the front panel. The 9500B will present a 'Warning' display on the screen:



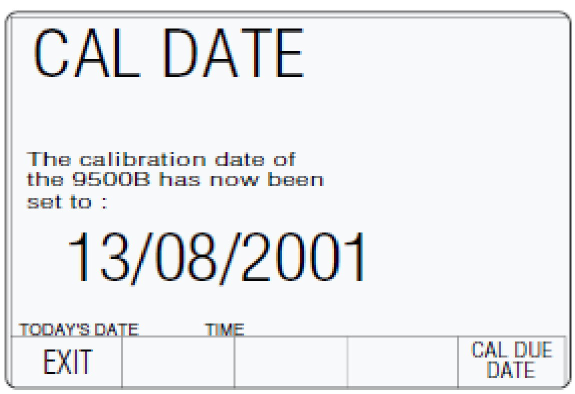
erw229

Exit Only

If you do not wish to alter the date-stamp, and do not wish to alter the cal due date or its advance warning period, press the EXIT key. This terminates the calibration session, and you will be returned to the Mode Selection screen to select another mode.

Update the Date Stamp on a Certificate

If you wish to update the date stamp to today's date, press the CAL DATE key. The 9500B presents the Cal Date screen:



erw230

The alpha-numeric keypad is locked out.

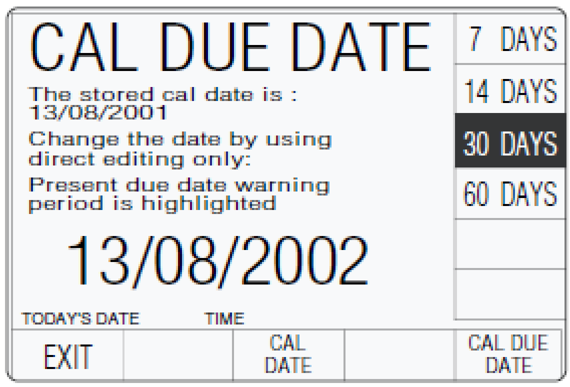
If updating the date-stamp is all that is required, without altering the due date, press the EXIT screen key to return to the Mode Selection screen.

Setting the Cal Due Date and Advance Warning Period

Note

If these parameters are not altered, then those which are already stored will be presented on any directly-printed certificate.

To alter the CAL DUE date, press the CAL DUE DATE key. The 9500B will present the CAL DUE DATE screen:



erw231

This screen also displays a stored CAL DATE reminder for calculating the cal due date.

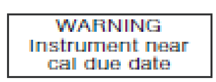
If you do not wish to update the CAL DUE DATE, press the EXIT screen key.

Setting the Cal Due Date

To set a new CAL DUE DATE, use the alphanumeric keypad to type in the required due date, then press the Enter (ξ) key. Note that the screen presentation uses the 'DATE TIME' format set in Configuration mode, and should be observed, otherwise the advance warning period could be calculated from an incorrect date! — refer to the *9500B Users Guide* - 'DATE TIME'.

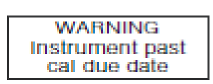
Advance Warning Period

In order to inform a user that the future due date for calibration is approaching, the 9500B will place a warning on the screen, starting at the nominated period of time before the due date, every time the 9500B is powered on:



erw232

After the Cal due date, the message changes to:



erw233

Setting the Advance Warning Period

On the CAL DUE DATE screen, the present setting of the advance warning period is shown highlighted against one of the right screen keys. This period is altered by pressing the appropriate right screen key.

Final Exit from Calibration Mode

When satisfied that the CAL DUE DATE and advance warning period are correct, press the EXIT screen key to terminate calibration and return to the Mode Selection screen.

The stored Cal Date and Cal Due Date will appear on any directly-printed certificate for this calibration.

Front Panel Base Calibration by Functions

Introduction

This section is a guide to the process of calibrating the Model 9500B's functions from the front panel.

Other Functions

No calibration is required for the following functions, as they are either calibrated for life at manufacture, or calibrated automatically as a result of calibrating the functions listed above, as shown in the table:

Function	Calibration Performed
HF Sine flatness above 50 kHz	Head Calibration
500 ps, High and Fast Edge	Head Calibration
Load Capacitance	Head Calibration
Termination Compensation	Head Calibration
Dual Sine	Via Sine (LF and Flatness)
Frequency	Special Calibration
Current	Via DC/Square
Linear Ramp	N/A
Overload Pulse	N/A
Function	**Calibration Performed**
Zero Skew	N/A
Auxiliary Input	N/A
Input Leakage	N/A
Pulse Width	N/A

There are therefore no manual calibration procedures for functions listed in the table, although confidence checks for them can be performed (e.g. the Full Selftest procedure detailed in, *Model 9500B Test and Selftest*).

Summary of Calibration Process

General Procedure

The Model 9500B Calibration Mode and Standard Calibration — Basic Sequences sections introduced the general calibration process for the Model 9500B. They also outlined the methods used to select functions, hardware configurations and target calibration points, and how to calibrate the 9500B at these target points.

This entire process is outlined again here as a sequence of simple steps:

1. Ensure that the 9500B output is OFF.
2. Connect the necessary measuring equipment to the 9500B's output terminals, and set it to the required measurement function and range.
3. Ensure that the rear-panel CAL (Calibration) switch is set to the ENABLE position.
4. Press the front panel Mode key to display the Mode Selection screen.
5. Press the CALIB screen key to display the Password Entry for Calibration screen.
6. Enter the correct password and press the ξ key to display the Calibration Mode screen.
7. Press the Special screen key to display the Special Calibration screen.

Note

The Characterize operations 8-12 below should be performed once only, immediately before performing Standard Calibration of the 9500B. It is not necessary to repeat them before calibrating each individual function of the 9500B.

8. Press the Chse-DAC screen key to initiate the Characterize DAC operations and wait until these automatic internal adjustments have been successfully completed.
9. Press the Chse-VCO screen key to initiate the Characterize VCO operations and wait until these automatic internal adjustments have been successfully completed.
10. Press the Chse-SQU/TRI TMK screen key to initiate the Characterize Timing Marker operations and wait until these automatic internal adjustments have been successfully completed.
11. Press the Chse-LF SIN DC O/S screen key to initiate the Characterize LF Sine DC Offset operations and wait until these automatic internal adjustments have been successfully completed.
12. Press the Chse-PULSE WIDTH screen key to initiate the Characterize Pulse Width operations and wait until these automatic internal adjustments have been successfully completed.
13. Press the EXIT soft key to display the Calibration Mode screen.

14. Press the BASE CAL screen key to see the Standard Calibration initial default screen — the DC/Square; DC+ Voltage function; Target Selection screen.
15. Select the function to be calibrated. Standard Calibration can only be carried out for the following functions. DC/Square (Select waveforms via the WAVEFORM soft key); Sine (Select by pressing the front panel Xl key); Resistance Measurement (Select by pressing the front panel Aux key).

Note

Because in calibrating Resistance Measurement, the 9500B does not produce an output, it does not conform exactly to the following sequence. Instead, refer Load Resistance Measurement Calibration.

16. Select the required output signal channel, trigger channel and Trigger Ratio (if required) via the Target Selection screen. Any channel may be used for mainframe calibration.
17. Select the required 9500B hardware configuration by choosing the appropriate Cal Range. (Details of each function's hardware configurations and suitable output values to select them can be found in the detailed procedures provided later in this section).
18.
    a. If you wish to use the 'saved' target calibration points used during the previous calibration of the 9500B, do not press the DEFAULT TARGETS screen key.
    b. If you wish to use the default target calibration points defined for this hardware configuration, press the DEFAULT TARGETS screen key.
19. Press the TARGET 1 or TARGET 2 screen key to display the target's Adjustment screen.
20.
    a. If you wish to change the amplitude of the target calibration point, press the TAB Δ key one or more times until the cursor is positioned on the target amplitude value. Now use any editing mode to change this value (note that the new value must lie within the limits specified in the detailed procedures provided later in this section).
    b. (For Square or Sine functions only) If you wish to change the frequency of the target calibration point, press the TAB Δ key one or more times until the cursor is positioned on the Frequency value. Now use any editing mode to change this value (note that the new value must lie within the limits specified in the detailed procedures provided later in this section).
    c. Press the SAVE TARGET soft key.
21. Press the SAVE TARGET soft key.

22. Ensure that cursor control is returned to the 9500B output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel until the reading on the measuring instrument (connected to the 9500B's front-panel active head channel) is the same as the displayed target value.

Note

Make sure to allow for any settling time required by the external measuring instrument.

23. When you are satisfied with the measurement, press the ACCEPT CALIB key to generate and implement the correction factor required by the 9500B, to ensure that its displayed output value and actual output value coincide.

Note

In Operations (23) to (25), the 'NEXT TARGET' and 'PREV TARGET' keys provide a shortcut to avoid returning to the Target Selection screen.

24. Press EXIT to return to the Target Selection screen.
25. Repeat steps (17) to (23) for each of the target values displayed in the Target Selection screen.
26. Repeat steps (16) to (24) for each of the Cal Ranges associated with the 9500B function that is being calibrated.
27. Repeat steps (14) to (25) for each function of the 9500B which is to be calibrated.
28. Press the Mode key to exit from Calibration mode (refer to section Standard Calibration — Basic Sequences, Exit from Calibration - Cal Date and Cal Due Date for the processes of date-stamping, altering Cal Due date and setting the advance warning period).
29. Press either the PROC or MANUAL screen keys to return the 9500B to normal Procedure Mode or Manual Mode respectively.

Sequencing Calibrations

The table below indicates the order in which the various Model 9500B functions should be calibrated. Although it is not essential to calibrate all the functions indicated below at any one time, functions higher in the list should be calibrated before those lower in the list.

Table 18. Recommended Sequence of Calibrations

Sequence	Function
1	DC/Square: DC Voltage (Positive)
2	DC/Square: DC Voltage (Negative)
3	DC/Square: Square Voltage (Positive)
4	DC/Square: Square Voltage (Negative)

Table 18. Recommended Sequence of Calibrations (cont.)

Sequence	Function
5	DC/Square: Square Voltage (Symmetrical)
6	LF Sine
7	Load Resistance Measurement

DC/Square — DC Voltage Calibration

Introduction

This section is a guide to calibrating the Model 9500B's DC/Square Function, DC Voltage; using its front panel controls.

- Calibration Equipment Requirements
- Interconnections
- Calibration Setup
- Calibration Procedure

Calibration Equipment Requirements

- The UUT Model 9500B with 9510 or 9530 Active Head.
- A high resolution Standards DMM with DC Voltage accuracy of ±0.005 % or better, from 1 mV to 200 V.

  For example, a Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4 mm leads.

  For example, a Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections

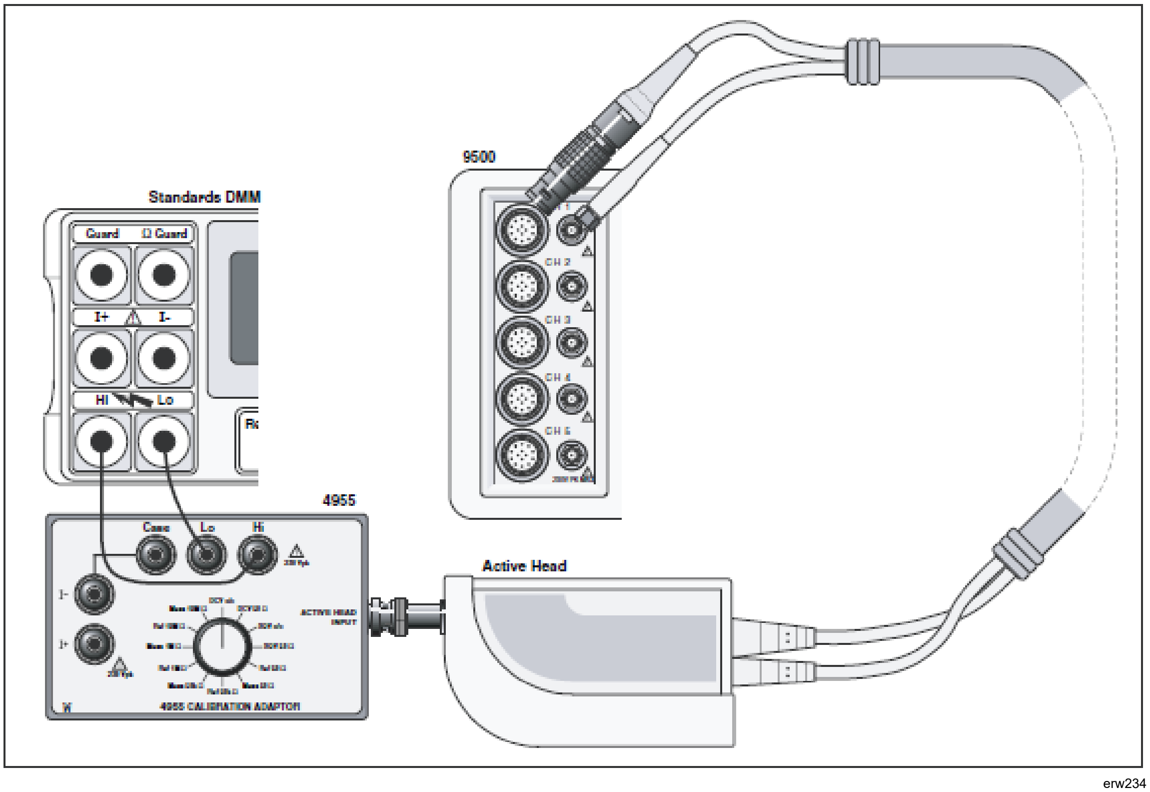


Figure 14. DC/Square; DC Voltage Calibration — Interconnections

Calibration Setup

1. Connections: Ensure that the 9500B is connected to the Standards DMM as shown in Figure 14, or via a similar BNC-4 mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in BASE CAL mode and then select the DC/Square; DC Voltage (Positive) function (default selection when entering STD CAL). Select the required output Signal Channel (1 MΩ Load), trigger channel and Trigger Ratio (if required) via the Target Selection screen.

Calibration Procedure

1. Starting at Cal Range 1, calibrate at all calibration points listed in Table 19 by performing operations (2) to (13) below.
2. Select the required 9500B hardware configuration by choosing the appropriate Cal Range.
3. For this Cal Range, use (a) or (b):
   a. If you wish to use the 'saved' target calibration points used during the previous calibration of the 9500B, do not press the DEFAULT TARGETS screen key.
   b. If you wish to use the default target calibration points defined for this hardware configuration, press the DEFAULT TARGETS screen key.
4. Press the TARGET 1 or TARGET 2 screen key to display the target's Adjustment screen.

Note

Omit operation 5 if you do not wish to change the amplitude of this target calibration point.

5.

   a. If you wish to change the target calibration point amplitude, use theTAB Δ key to position the cursor on the Target Amplitude value. Now use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 19).

   b. Press the SAVE TARGET soft key.

6. If using the Model 4955 Calibration Adaptor, set its switch to 'DCV o/c'. Otherwise ensure that the DMM input is at high impedance.
7. Set the Standards DMM to the appropriate measurement range.
8. Press the ON key to turn the 9500B output on.
9. Press the TAB Δ key to return the cursor to the 9500B O/P Amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel until the reading on the Standards DMM is the same as the displayed Target Amplitude value.

Note

Make sure to allow for any settling time required by the external measuring instrument.

10. When you are satisfied with the measurement, press the ACCEPT CALIB key to generate and implement the correction factor required by the 9500B, to ensure that its displayed O/P Amplitude value and measured output value coincide. The O/P Amplitude value will change to the Target Amplitude value, and the adjustment of the output amplitude at this target is complete.
11. Press the EXIT key to turn the 9500B output off and return to the Target Selection screen.
12. Repeat steps (3) to (11) for each of the target values displayed in the Target Selection screen.
13. Repeat steps (2) to (12) for each of the Cal Ranges detailed in the Table 19.
14. On the Target Selection screen, press the WAVEFORM soft key. Select DCV (negative) by pressing the key on the right of the screen. Repeat steps (2) to (12) for each of the Cal Ranges detailed in the Table 20.

Note

If other functions are being calibrated in addition to DC Voltage, refer to Table 18 for information on sequencing calibrations.

Table 19. DC/Square; DC Voltage (Positive) Hardware Configurations and Calibration Targets

Function/ Waveshape	Cal Range	Hardware Configuration Span	Target 1 (low)			Target 2 (high)		
			Default	Minimum	Maximum	Default	Minimum	Maximum
	1	888.00 µV - 2.10 mV	+1.0000 mV	+0.9300 mV	+1.0700 mV	+1.9000 mV	+1.7670 mV	+2.0330 mV
	2	2.10 mV - 5.56 mV	+2.3000 mV	+2.1390 mV	+2.4610 mV	+5.0000 mV	+4.6500 mV	+5.3500 mV
	3	5.56 mV - 21.00 mV	+6.0000 mV	+5.5800 mV	+6.4200 mV	+19.000 mV	+17.670 mV	+20.330 mV
	4	21.00 mV - 55.60 mV	+23.000 mV	+21.390 mV	+24.610 mV	+50.000 mV	+46.500 mV	+53.500 mV
	5	55.60 mV - 210.00 mV	+60.000 mV	+55.800 mV	+64.200 mV	+190.00 mV	+176.70 mV	+203.30 mV
	6	210.00 mV - 556.00 mV	+230.00 mV	+213.90 mV	+246.10 mV	+500.00 mV	+465.00 mV	+535.00 mV
	7	556.00 mV - 2.10 V	+600.00 mV	+558.00 mV	+642.00 mV	+1.9000 V	+1.7670 V	+2.0330 V
	8	2.10 V - 5.56 V	+2.3000 V	+2.1390 V	+2.4610 V	+5.0000 V	+4.6500 V	+5.3500 V
	9	5.56 V - 22.24 V	+6.0000 V	+5.5800 V	+6.4200 V	+19.000 V	+17.670 V	+20.330 V
	10	22.24 V - 55.60 V	+23.000 V	+21.390 V	+24.610 V	+50.000 V	+46.500 V	+53.500 V
	11	55.60 V - 222.40 V	+60.000 V	+55.800 V	+64.200 V	+190.00 V	+176.70 V	+203.30 V

Table 20. DC/Square; DC Voltage (Negative) Hardware Configurations and Calibration Targets

Function/ Waveshape	Cal Range	Hardware Configuration Span	Target 1 (low)			Target 2 (high)		
			Default	Minimum	Maximum	Default	Minimum	Maximum
	1	888.00 µV - 2.10 mV	-1.0000 mV	-0.9300 mV	-1.0700 mV	-1.9000 mV	-1.7670 mV	-2.0330 mV
	2	2.10 mV - 5.56 mV	-2.3000 mV	-2.1390 mV	-2.4610 mV	-5.0000 mV	-4.6500 mV	-5.3500 mV
	3	5.56 mV - 21.00 mV	-6.0000 mV	-5.5800 mV	-6.4200 mV	-19.000 mV	-17.670 mV	-20.330 mV
	4	21.00 mV - 55.60 mV	-23.000 mV	-21.390 mV	-24.610 mV	-50.000 mV	-46.500 mV	-53.500 mV
	5	55.60 mV - 210.00 mV	-60.000 mV	-55.800 mV	-64.200 mV	-190.00 mV	-176.70 mV	-203.30 mV
	6	210.00 mV - 556.00 mV	-230.00 mV	-213.90 mV	-246.10 mV	-500.00 mV	-465.00 mV	-535.00 mV
	7	556.00 mV - 2.10 V	-600.00 mV	+558.00 mV	-642.00 mV	-1.9000 V	-1.7670 V	-2.0330 V
	8	2.10 V - 5.56 V	-2.3000 V	-2.1390 V	-2.4610 V	-5.0000 V	-4.6500 V	-5.3500 V
	9	5.56 V - 22.24 V	-6.0000 V	-5.5800 V	-6.4200 V	-19.000 V	-17.670 V	-20.330 V
	10	22.24 V - 55.60 V	-23.000 V	-21.390 V	-24.610 V	-50.000 V	-46.500 V	-53.500 V
	11	55.60 V - 222.40 V	-60.000 V	-55.800 V	-64.200 V	-190.00 V	-176.70 V	-203.30 V

DC/Square — Square Calibration

Introduction

This section is a guide to calibrating the Model 9500B's DC/Square Function, Square Waveform; using its front panel controls. The following topics are covered:

- Calibration Equipment Requirements
- Interconnections
- Calibration Setup
- Calibration Procedure

Calibration Equipment Requirements

- The UUT Model 9500B with 9510 or 9530 Active Head.
- A high resolution Standards DMM with RMS AC Voltage accuracy of ±0.01 % or better, from 2.5 mV to 35 V, at 1 kHz.

  For example: Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4 mm leads.

  For example, a Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections

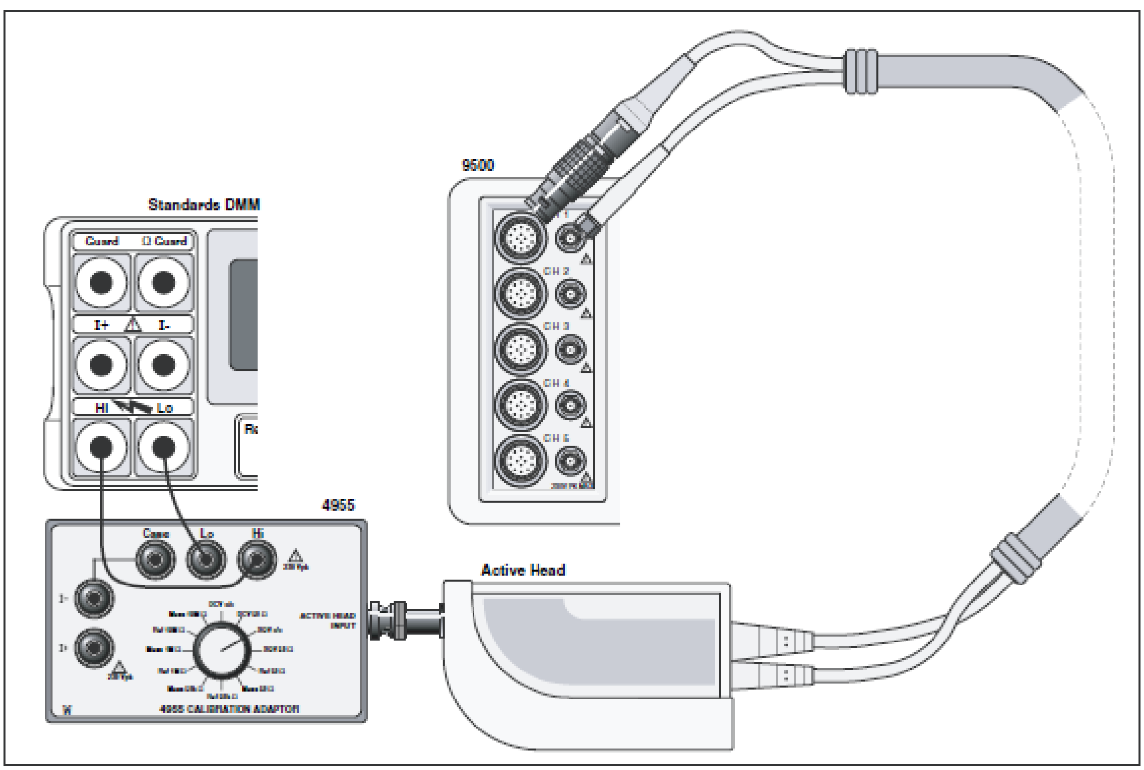


Figure 15. DC/Square; Square Waveform Calibration — Interconnections

Calibration Setup

1. Connections: Ensure that the 9500B is connected to the Standards DMM as shown in Figure 15, or via a similar BNC-4 mm adaptor, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in BASE CAL mode and then select the DC/Square; Square Waveform (Positive) function (From entry default, in the Target Selection screen, press the WAVEFORM soft key and then press the 2 soft key on the right of the screen). Select the required output Signal Channel (1 MΩ Load), trigger channel and Trigger Ratio (if required) via the Target Selection screen.

Calibration Procedure

1. Starting at Cal Range 1, calibrate at all calibration points listed in Table 21 by performing operations (2) to (13) below.
2. Select the required 9500B hardware configuration by choosing the appropriate Cal Range.
3. For this Cal Range, use (a) or (b):
   a. If you wish to use the 'saved' target calibration points used during the previous calibration of the 9500B, do not press the DEFAULT TARGETS screen key.
   b. If you wish to use the default target calibration points defined for this hardware configuration, press the DEFAULT TARGETS screen key.
4. Press the TARGET 1 or TARGET 2 screen key to display the target's Adjustment screen.

Note

Omit operation 5 if you do not wish to change the amplitude of this target calibration point. The frequency is fixed and cannot be changed.

5.
   a. If you wish to change the target calibration point frequency, use the TAB Δ key to position the cursor on the Frequency value. Now use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 21).
   b. If you wish to change the target calibration point amplitude, use the TAB Δ key to position the cursor on the Target Amplitude value. Now use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 21).
   c. Press the SAVE TARGET soft key.
6. If using the Model 4955 Calibration Adaptor, set its switch to 'SQV o/c'. If not using the Model 4955, ensure that the DMM input is AC coupled at high impedance.

7. Set the Standards DMM to the appropriate RMS voltage measurement range.
8. Calculate the RMS value of the 9500B output pk-pk voltage from the following factor:

   (at 1 kHz, RMS = 0.5 x 0.999917 x pk-pk)

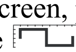
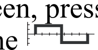
Note

This factor applies only at 1 kHz and assumes use of model 4955 set to 'SQV o/c'. A compensation of 83 ppm accounts the finite transition time of the Square Wave and the resultant fall in its RMS value.

9. Press the ON key to turn the 9500B output on.
10. Press the TAB Δ key to return the cursor to the 9500B O/P Amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel until the reading on the Standards DMM is the RMS equivalent of the displayed Target Amplitude pk-pk value calculated in operation (8).

Note

Make sure to allow for any settling time of the external measuring instrument - approx 30-40 secs.

11. When you are satisfied with the measurement, press the ACCEPT CALIB key to generate and implement the correction factor required by the 9500B, to ensure that its displayed O/P Amplitude value and measured output value coincide. The O/P Amplitude value will change to the Target Amplitude value, and the adjustment of the output amplitude at this target is complete.
12. Press the EXIT key to turn the 9500B output off and return to the Target Selection screen.
13. Repeat steps (3) to (12) for each of the target values displayed in the Target Selection screen.
14. Repeat steps (2) to (13) for each of the Cal Ranges detailed in the Table 21.
15. On the Target Selection screen, press the WAVEFORM soft key. Select Square (negative) by pressing the  key on the right of the screen. Repeat steps (1) to (14), but using Table 22 for each of the Cal Ranges, Targets and Limits.
16. On the Target Selection screen, press the WAVEFORM soft key. Select Square (symmetrical) by pressing the  key on the right of the screen. Repeat steps (1) to (14), but using Table 23 for each of the Cal Ranges, Targets and Limits.

Note

If other functions are being calibrated in addition to Square Waveform, refer to Table 18 for information on sequencing calibrations.

Table 21. DC/Square; Square Waveform (Positive) Hardware Configurations and Calibration Targets

Function/ Waveshape	Cal Range	Frequency Target			Hardware Configuration Span	Target 1 (low) pk-pk			Target 2 (high) pk-pk		
		Default	Minimum	Maximum		Default	Minimum	Maximum	Default	Minimum	Maximum
2	1	1 kHz	0.9500 kHz	1.0500 kHz	556.01 µV - 2.10 mV	800.00 µV	744.00 µV	856.00 µV	1.9000 mV	1.7670 mV	2.0330 mV
	2	1 kHz	0.9500 kHz	1.0500 kHz	2.10 mV - 5.56 mV	2.3000 mV	2.1390 mV	2.4610 mV	5.0000 mV	4.6500 mV	5.3500 mV
	3	1 kHz	0.9500 kHz	1.0500 kHz	5.56 mV - 21.00 mV	6.0000 mV	5.5800 mV	6.4200 mV	19.000 mV	17.670 mV	20.330 mV
	4	1 kHz	0.9500 kHz	1.0500 kHz	21.00 mV - 55.60 mV	23.000 mV	21.390 mV	24.610 mV	50.000 mV	46.500 mV	53.500 mV
	5	1 kHz	0.9500 kHz	1.0500 kHz	55.60 mV - 210.00 mV	60.000 mV	55.800 mV	64.200 mV	190.00 mV	176.70 mV	203.30 mV
	6	1 kHz	0.9500 kHz	1.0500 kHz	210.00 mV - 556.00 mV	230.00 mV	213.90 mV	246.10 mV	500.00 mV	465.00 mV	535.00 mV
	7	1 kHz	0.9500 kHz	1.0500 kHz	556.00 mV - 2.10 V	600.00 mV	558.00 mV	642.00 mV	1.9000 V	1.7670 V	2.0330 V
	8	1 kHz	0.9500 kHz	1.0500 kHz	2.10 V - 5.56 V	2.3000 V	2.1390 V	2.4610 V	5.0000 V	4.6500 V	5.3500 V
	9	1 kHz	0.9500 kHz	1.0500 kHz	5.56 V - 22.24 V	6.0000 V	5.5800 V	6.4200 V	19.000 V	17.670 V	20.330 V
	10	1 kHz	0.9500 kHz	1.0500 kHz	22.24 V - 55.60 V	23.000 V	21.390 V	24.610 V	50.000 V	46.500 V	53.500 V
	11	1 kHz	0.9500 kHz	1.0500 kHz	55.60 V - 222.40 V	60.000 V	55.800 V	64.200 V	190.00 V	176.70 V	203.30 V

Table 22. DC/Square; Square Waveform (Negative) Hardware Configurations and Calibration Targets

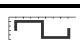
Function/ Waveshape	Cal Range	Frequency Target			Hardware Configuration span	Target 1 (low)			Target 2 (high)		
		Default	Minimum	Maximum		Default	Minimum	Maximum	Default	Minimum	Maximum
	1	1 kHz	0.9500 kHz	1.0500 kHz	556.01 µV - 2.10 mV	800.00 µV	744.00 µV	856.00 µV	1.9000 mV	1.7670 mV	2.0330 mV
	2	1 kHz	0.9500 kHz	1.0500 kHz	2.10 mV - 5.56 mV	2.3000 mV	2.1390 mV	2.4610 mV	5.0000 mV	4.6500 mV	5.3500 mV
	3	1 kHz	0.9500 kHz	1.0500 kHz	5.56 mV - 21.00 mV	6.0000 mV	5.5800 mV	6.4200 mV	19.000 mV	17.670 mV	20.330 mV
	4	1 kHz	0.9500 kHz	1.0500 kHz	21.00 mV - 55.60 mV	23.000 mV	21.390 mV	24.610 mV	50.000 mV	46.500 mV	53.500 mV
	5	1 kHz	0.9500 kHz	1.0500 kHz	55.60 mV - 210.00 mV	60.000 mV	55.800 mV	64.200 mV	190.00 mV	176.70 mV	203.30 mV
	6	1 kHz	0.9500 kHz	1.0500 kHz	210.00 mV - 556.00 mV	230.00 mV	213.90 mV	246.10 mV	500.00 mV	465.00 mV	535.00 mV
	7	1 kHz	0.9500 kHz	1.0500 kHz	556.00 mV - 2.10 V	600.00 mV	558.00 mV	642.00 mV	1.9000 V	1.7670 V	2.0330 V
	8	1 kHz	0.9500 kHz	1.0500 kHz	2.10 V - 5.56 V	2.3000 V	2.1390 V	2.4610 V	5.0000 V	4.6500 V	5.3500 V
	9	1 kHz	0.9500 kHz	1.0500 kHz	5.56 V - 22.24 V	6.0000 V	5.5800 V	6.4200 V	19.000 V	17.670 V	20.330 V
	10	1 kHz	0.9500 kHz	1.0500 kHz	22.24 V - 55.60 V	23.000 V	21.390 V	24.610 V	50.000 V	46.500 V	53.500 V
	11	1 kHz	0.9500 kHz	1.0500 kHz	55.60 V - 222.40 V	60.000 V	55.800 V	64.200 V	190.00 V	176.70 V	203.30 V

Table 23. DC/Square; Square Waveform (Symmetrical) Hardware Configurations and Calibration Targets

Function/ Waveshape	Cal Range	Frequency Target			Hardware Configuration Span	Target 1 (low)			Target 2 (high)		
		Default	Minimum	Maximum		Default	Minimum	Maximum	Deafult	Minimum	Maximum
	1	1 kHz	0.9500 kHz	1.0500 kHz	556.01 µV - 2.10 mV	800.00 µV	744.00 µV	856.00 µV	1.9000 mV	1.7670 mV	2.0330 mV
	2	1 kHz	0.9500 kHz	1.0500 kHz	2.10 mV - 5.56 mV	2.3000 mV	2.1390 mV	2.4610 mV	5.0000 mV	4.6500 mV	5.3500 mV
	3	1 kHz	0.9500 kHz	1.0500 kHz	5.56 mV - 21.00 mV	6.0000 mV	5.5800 mV	6.4200 mV	19.000 mV	17.670 mV	20.330 mV
	4	1 kHz	0.9500 kHz	1.0500 kHz	21.00 mV - 55.60 mV	23.000 mV	21.390 mV	24.610 mV	50.000 mV	46.500 mV	53.500 mV
	5	1 kHz	0.9500 kHz	1.0500 kHz	55.60 mV - 210.00 mV	60.000 mV	55.800 mV	64.200 mV	190.00 mV	176.70 mV	203.30 mV
	6	1 kHz	0.9500 kHz	1.0500 kHz	210.00 mV - 556.00 mV	230.00 mV	213.90 mV	246.10 mV	500.00 mV	465.00 mV	535.00 mV
	7	1 kHz	0.9500 kHz	1.0500 kHz	556.00 mV - 2.10 V	600.00 mV	558.00 mV	642.00 mV	1.9000 V	1.7670 V	2.0330 V
	8	1 kHz	0.9500 kHz	1.0500 kHz	2.10 V - 5.56 V	2.3000 V	2.1390 V	2.4610 V	5.0000 V	4.6500 V	5.3500 V
	9	1 kHz	0.9500 kHz	1.0500 kHz	5.56 V - 22.24 V	6.0000 V	5.5800 V	6.4200 V	19.000 V	17.670 V	20.330 V
	10	1 kHz	0.9500 kHz	1.0500 kHz	22.24 V - 55.60 V	23.000 V	21.390 V	24.610 V	50.000 V	46.500 V	53.500 V
	11	1 kHz	0.9500 kHz	1.0500 kHz	55.60 V - 222.40 V	60.000 V	55.800 V	64.200 V	190.00V	176.70 V	203.30 V

LF Sine Voltage Calibration

Introduction

This section is a guide to calibrating the Model 9500B's LF Sine Function; using its front panel controls.

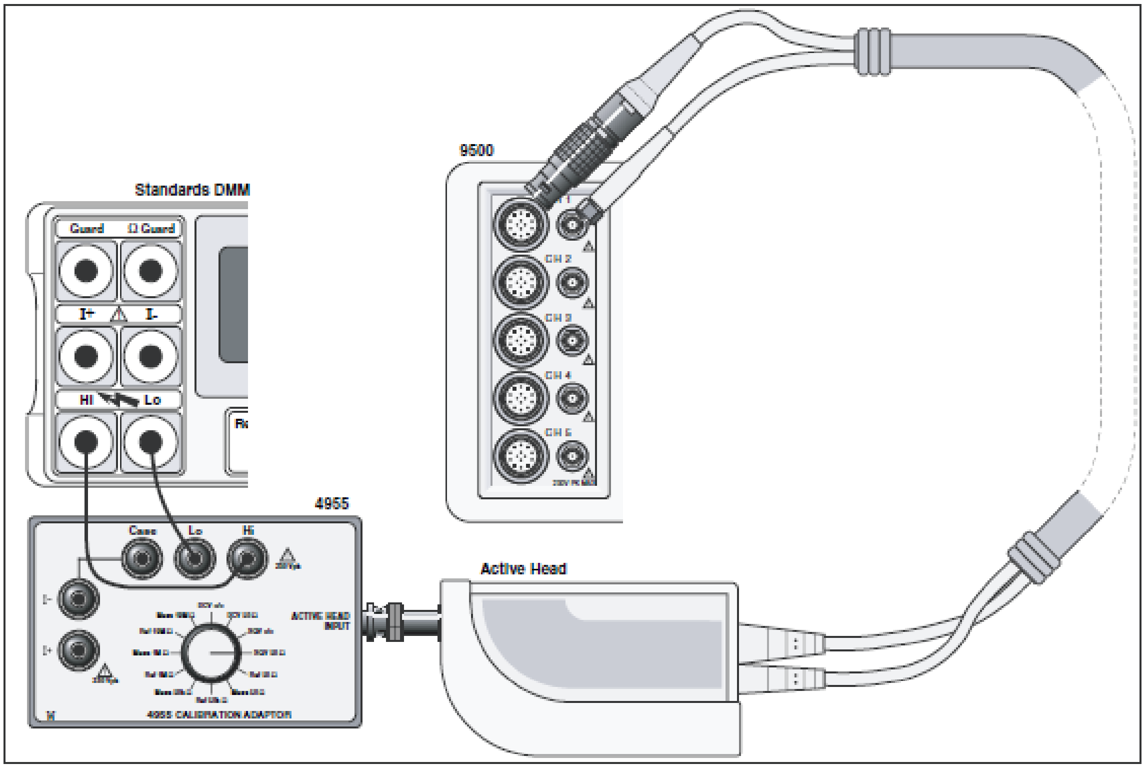
The following topics are covered:

- Calibration Equipment Requirements
- Interconnections
- Calibration Setup
- Calibration Procedure

Calibration Equipment Requirements

- The UUT Model 9500B with Active Head.
- A high resolution Standards DMM with RMS AC Voltage accuracy of ±0.3 % or better, between 0.5 V and 2 V, at 1 kHz and 45 kHz. For example, a Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4 mm leads, incorporating a 50 Ω load. For example, a Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections



erw236

Figure 16. LF Sine Function Calibration — Interconnections

Calibration Setup

1. Connections: Ensure that the 9500B is connected to the Standards DMM as shown in Figure 16, or via a similar BNC-4 mm adaptor and 50 Ω load, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in BASE CAL mode and then select the LF Sine function (From entry default, in the Target Selection screen, press the X key on the right of the Front Panel). Select the required output Signal Channel (50 Ω Load), trigger channel and Trigger Ratio (if required) via the Target Selection screen.

Calibration Procedure

1. Starting at Cal Range 1, calibrate at all calibration points listed in Table 21 by performing operations (2) to (13) below.
2. Select the required 9500B hardware configuration by choosing the appropriate Cal Range.

3. For this Cal Range, use (a) or (b):
   a. If you wish to use the 'saved' target calibration points used during the previous calibration of the 9500B, do not press the DEFAULT TARGETS screen key.
   b. If you wish to use the default target calibration points defined for this hardware configuration, press the DEFAULT TARGETS screen key.
4. Press the TARGET 1, TARGET 2, TARGET 3 or TARGET 4 screen key to display the target's Adjustment screen.

Note

Omit operation 5 if you do not wish to change the frequency or amplitude of this target calibration point.

5.
   a. If you wish to change the target calibration point frequency, use the TAB Δ key to position the cursor on the Frequency value. Now use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 24).
   b. If you wish to change the target calibration point amplitude, use the TAB Δ key to position the cursor on the Target Amplitude value. Now use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 24).
   c. Press the SAVE TARGET soft key.
6. If using the Model 4955 Calibration Adaptor, set its switch to 'SQV 50 Ω'. If not using the Model 4955, ensure that the DMM input is AC-coupled using an external 50 Ω load impedance.
7. Set the Standards DMM to the appropriate RMS voltage measurement range.
8. Calculate the RMS value of the 9500B output pk-pk voltage from the following factor:

   (RMS = 0.5 x 0.70710 x pk-pk)

Note

The above figure applies only when the Standards DMM input is AC-Coupled.

9. Press the ON key to turn the 9500B output on.
10. Press the TAB Δ key to return the cursor to the 9500B O/P Amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel until the reading on the Standards DMM is the RMS equivalent of the displayed Target Amplitude pk-pk value calculated in operation (8).

Note

Make sure to allow for any settling time of the external measuring instrument - approx 60 secs.)

11. When you are satisfied with the measurement, press the ACCEPT CALIB key to generate and implement the correction factor required by the 9500B, to ensure that its displayed O/P Amplitude value and measured output value coincide. The O/P Amplitude value will change to the Target Amplitude value, and the adjustment of the output amplitude at this target is complete.
12. Press the EXIT key to turn the 9500B output off and return to the Target Selection screen.
13. Repeat steps (3) to (12) for each of the target values displayed in the Target Selection screen.
14. Repeat steps (2) to (13) for each of the Cal Ranges detailed in the Table 24.

Note

If other functions are being calibrated in addition to Square Waveform, refer to Table 15 for information on sequencing calibrations.

Table 24. LF Sine Function; Hardware Configurations and Calibration Targets

Function/ Waveshape	Cal Range	Target No	Target Frequency			Hardware Configuration Span	Target Amplitude		
			Default	Minimum	Maximum		Default	Minimum	Maximum
3	1	1	1.0000 kHz	0.9000 kHz	1.1000 kHz	1.400 V - 2.224 V	1.6000 V	1.5500 V	1.7000 V
		2	1.0000 kHz	0.9000 kHz	1.1000 kHz	1.400 V - 2.224 V	1.9000 V	1.8000 V	2.0000 V
		3	45.000 kHz	44.000 kHz	46.000 kHz	1.400 V - 2.224 V	1.6000 V	1.5500 V	1.7000 V
		4	45.000 kHz	44.000 kHz	46.000 kHz	1.400 V - 2.224 V	1.9000 V	1.8000 V	2.0000 V
	2	1	1.0000 kHz	0.9000 kHz	1.1000 kHz	2.224 V - 5.56 V	2.6000 V	2.5500 V	3.0000 V
		2	1.0000 kHz	0.9000 kHz	1.1000 kHz	2.224 V - 5.56 V	4.8000 V	4.2000 V	5.0000 V
		3	45.000 kHz	44.000 kHz	46.000 kHz	2.224 V - 5.56 V	2.6000 V	2.5500 V	3.0000 V
		4	45.000 kHz	44.000 kHz	46.000 kHz	2.224 V - 5.56 V	4.8000 V	4.2000 V	5.0000 V

Load Resistance Measurement Calibration

Introduction

This section is a guide to calibrating the Model 9500B's Load Resistance Measurement Function; using its front panel controls. The following topics are covered:

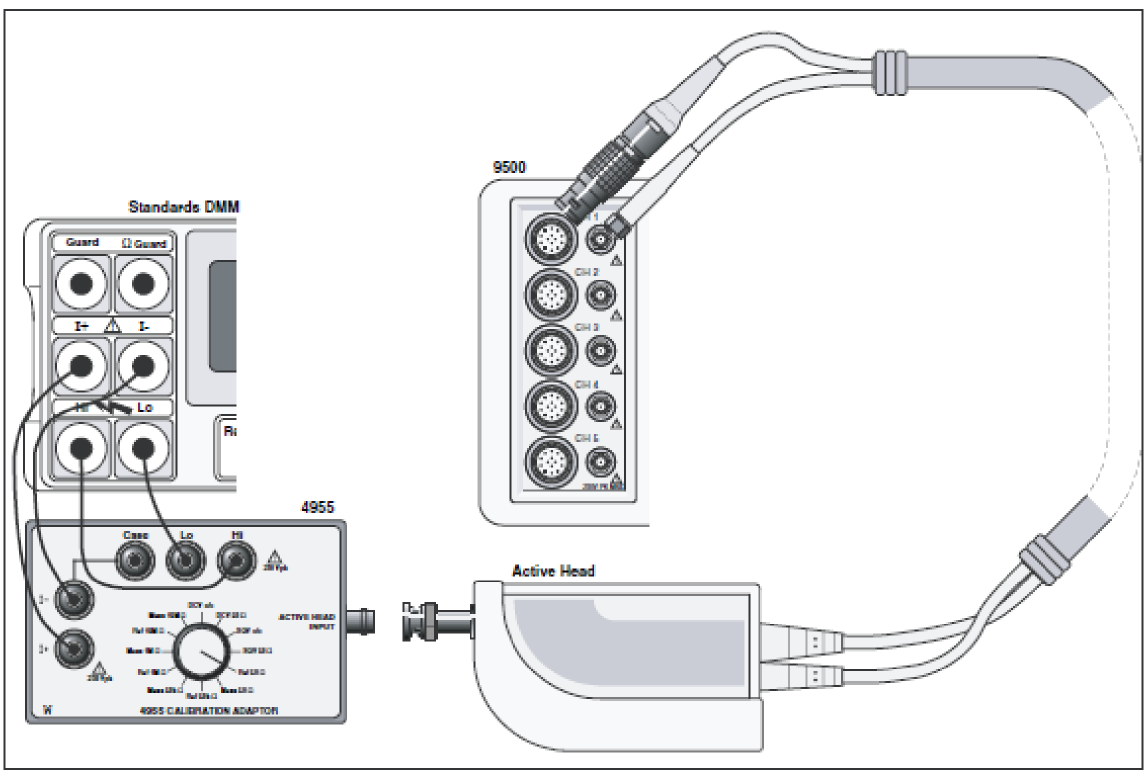
- Calibration Equipment Requirements
- Interconnections
- Calibration Setup
- Calibration Procedure

Calibration Equipment Requirements

- The UUT Model 9500B with 9510 or 9530 Active Head.
- A traceable, high-resolution Standards DMM, used to measure resistance at 50 Ω, 50 kΩ, 1 MΩ and 19 MΩ, with an accuracy of 0.02 % or better. For example, a Model 1281 Digital Multimeter.
- An adaptor to convert from BNC to 4mm leads, incorporating switchable 50 Ω, 50 kΩ, 1 MΩ and 19 MΩ loads.

  For example, a Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads.

Interconnections



erw237

Figure 17. Load Resistance Measurement Function Calibration (50 Ω Ref) — Interconnections

Calibration Setup

1. Connections: Ensure that the 9500B is connected to the Standards DMM as shown in Figure 17, or via a similar BNC-4 mm adaptor and 50 Ω load, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in BASE CAL mode and then select the Load Resistance Measurement function (From entry default, in the Target Selection screen, press the Aux key on the right of the Front Panel). Select the required output Signal Channel via the Target Selection screen.

Calibration Procedure

1. Starting at Target 1, calibrate at all calibration points listed in Table 22 by performing operations (2) to (15) below.
2. Use (a) or (b):
   a. If you wish to use the 'saved' target calibration points used during the previous calibration of the 9500B, do not press the DEFAULT TARGETS screen key.
   b. If you wish to use the default target calibration points, press the DEFAULT TARGETS screen key.
   c. Saved/default targets should be considered as nominal values, with the actual value being used during calibration, which is typically not saved at step 13.
3. Select the required load resistance by choosing the appropriate TARGET 1, TARGET 2, TARGET 3 or TARGET 4 screen key to display the target's Adjustment screen.

Note

Omit operation (4) if you do not wish to change the resistance value of this target calibration point.

4.
   a. If you wish to alter the target resistance, use any editing mode to change this value (note that the new value must lie within the Max and Min limits specified in Table 25).
   b. Press the SAVE TARGET soft key.
5. If using the Model 4955 Calibration Adaptor:
   a. Ensure that the Active Head output BNC is disconnected from the Model 4955 input.
   b. Set the Model 4955 Calibration Adaptor switch as shown in Table 25.

6. If not using the Model 4955, set up external circuitry to measure the appropriate load resistor (4-wire connection), with the 9500B Active Head output BNC disconnected.
7. Set the Standards DMM to the appropriate Resistance measurement range, take a Resistance measurement and note the result.

Note

Make sure to allow for any settling time of the external measuring instrument.

8. If using the Model 4955 Calibration Adaptor:
   a. Set the Model 4955 Calibration Adaptor switch as shown in Table 25.
   b. Reconnect the Active Head output BNC to the Model 4955 input.
9. If not using the Model 4955, disconnect the load resistor from the DMM, and reconnect it to the 9500B Active Head output BNC.
10. Press the ON key to turn the 9500B output on.
11. Set the Target Res to the value measured in operation (7), using the cursor controls and/or spinwheel.
12. Press the ACCEPT CALIB key to generate and implement the correction factor. The Measured Res value will change to the Target Res value, and the adjustment of the output amplitude at this target is complete.

Note

Omit operation (13) if you do not wish to save the resistance value of this target calibration point.

13. Press the SAVE TARGET soft key.
14. Press the EXIT key to turn the 9500B output off and return to the Target Selection screen.
15. Repeat steps (2) to (14) for each of the target values displayed on the Target Selection screen (also see Table 25 below).

Note

If other functions are being calibrated in addition to Square Waveform, refer to Table 18 for information on sequencing calibrations.

Table 25. Load Resistance Measurement Function; Calibration Targets

Function	Target No	Target Resistance			4955 Switch Positions	
		Default	Minimum	Maximum	Op. 5 (b)	Op. 8 (a)
Θ	1	50.000 Ω	45.000 Ω	55.000 Ω	Ref 50 Ω	Meas 50 Ω
	2	50.000 kΩ	45.000 kΩ	55.000 kΩ	Ref 50 kΩ	Meas 50 kΩ
	3	1.0000 MΩ	0.9000 MΩ	1.1000 MΩ	Ref 1 MΩ	Meas 1 MΩ
	4	19.000 MΩ	18.000 MΩ	19.900 MΩ	Ref 19 MΩ	Meas 19 MΩ

9510/9530/9550/9560 Head Calibration Procedures

Section 9510/9530/9550/9560 Head Calibration Procedures is a guide to the process of calibrating the Model 9510, 9530, 9550 and 9560 Head functions from the front panel.

- Levelled Sine Function: LF Gain Calibration
- Levelled Sine Function: HF Calibration
- Edge Function Calibration
- Calibrating the Timing Markers
- Load Capacitance Calibration
- 50 Ω/1 MΩ Ratio Calibration
- Exit from Head Calibration

The list of topics above are placed in the order in which the 9500B Head functions should be calibrated. Head calibration requires the use of a verified 9500B Mainframe.

Note

Heads can be calibrated only within the bandwidth of the mainframe (see Table 26) e.g. Head Model 9510 with Mainframe Variant 9500B/600 can only be verified to 600 MHz.

Table 26. Head Calibration and Base Compatibility

Model	9510	9530	9550	9560
400 MHz base	No	No	Yes	No
600 MHz base	No	No	Yes	No
1.1 GHz base	Yes	No	Yes	No
3.2 GHz base	Yes	Yes	Yes	Yes

Levelled Sine Function: LF Gain

Summary

The Levelled Sine Function LF Gain is calibrated by carrying out the sequences given in Calibration Procedure: LF Gain.

Equipment requirements are for LF Gain calibration are given in Equipment Requirements and calibration setup in Calibration Setup.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe.
- A high resolution Standards DMM with RMS AC Voltage accuracy of ±0.3 % or better, from 10 mV to 3 V at 1 kHz.

  Example: Model 1281 Digital Multimeter.
- An adaptor to convert from BNC or PC3.5 to 4 mm leads.

  Example: Model 4955 Calibration Adaptor.
- Short, high-quality 4 mm leads for connection between the Calibration Adaptor the DMM.

Calibration Setup

Connections: Ensure that the 9500B is connected to the DMM as shown in Figure 18, or via a similar BNC or PC3.5 to 4 mm adaptor, and that both instruments are powered on and warmed up.

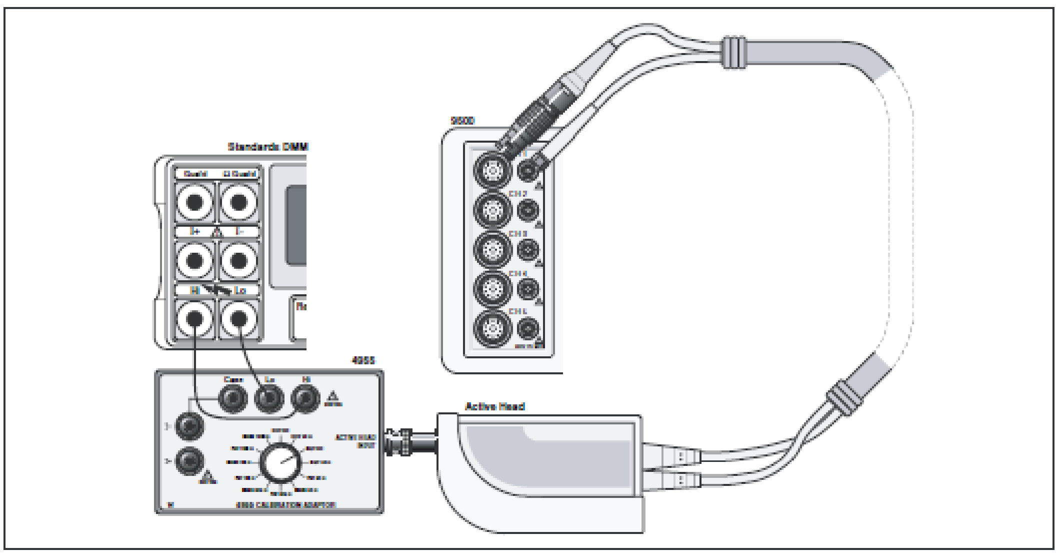


Figure 18. LF Sine Voltage Calibration — Interconnections

Calibration Procedure: LF Gain

1. Ensure that the 9500B is in HEAD CAL mode, then select Sine, Lo Frq Sine function.
2. Select TARGET 1.
3. Set output ON and wait for DMM reading to settle.
4. If using the Model 4955 Calibration Adapter, set its switch to 'SQV o/c' according to Table 27. If not using the Model 4955, ensure that the DMM input is AC-coupled at 50 Ω or 1 MΩ input impedance as shown in Table 27.
5. Select the correct RMS Voltage range for the calibration point RMS Output Voltage.
6. Adjust the 9500B's output amplitude until the DMM reads the same as the Target Amplitude on the 9500B:

   pk-pk Voltage = 2 * √ (2) * RMS Voltage.
7. Press ACCEPT CALIB.
8. Select next TARGET and return to step 4; repeat until no TARGETs remain.

Table 27. Levelled Sine Function: LF Gain

Cal. Point	Frequency	O/P Volts	O/P Loads
Target 1	1 kHz	1 3.0000 V	50 Ω
Target 2	1 kHz	1.0072 V	50 Ω
Target 3	1 kHz	316.49 mV	50 Ω
Target 4	1 kHz	316.49 mV	50 Ω
Target 5	1 kHz	3.0000 V	1 MΩ

Levelled Sine Function: HF Calibration

Summary

The Levelled Sine Function HF calibration is calibrated by carrying out the sequences given in sections Calibration Procedure: HF Linearity through Calibration Procedure: 3 GHz Levelled Sine Function: HF Flatness (9530 only). The 3 GHz calibrations described in Sections Calibration Procedure: 3 GHz Levelled Sine Function: HF Linearity (9530 only) and Calibration Procedure: 3 GHz Levelled Sine Function: HF Flatness (9530 only) only apply to model 9530 Heads and the 6 GHz only applies to model 9560 heads.

Equipment requirements are for LF Gain calibration are given in Equipment Requirements and calibration setup in Calibration Setup.

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe.
- RF Power Meter for Power measurements from 50 kHz to 6 GHz and from 20 mVp-p to 5.5 Vp-p into 50 Ω.

  Example: Marconi RF Power Meter model 6960B

  Rhode and Swartz NRVZ with NRV-25 Head
- Precision-N to BNC or PC3.5 Adapter for signal connection from the UUT Active Head to the input of the RF Power Meter head for Amplitude measurements.

  Example: Huber & Suhner Adapter type no. 31BNC-N-50-51 or 31N-PC3.5-50-1.

Calibration Setup

Connections: Ensure that the 9500B is connected to the RF Power Meter as shown in Figure 19, and that both instruments are powered on and warmed up.

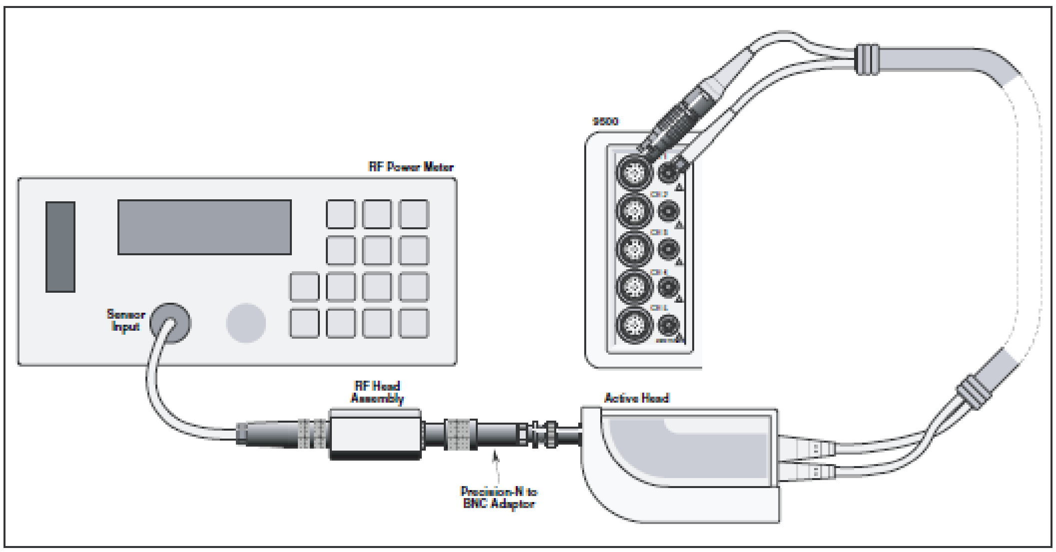


Figure 19. RF Sine Voltage Calibration — Interconnections

Calibration Procedure: HF Linearity

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, Hi Frq Sine mode, LIN.
2. The following process takes you through all TARGETs in Table 28.
3. 9500B: Set Output ON.
4. Power Meter: Select a range that gives an on-scale reading.
5. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{(power)}{}^{*}20$.
6. Press ACCEPT CALIB.
7. Select the next TARGET and return to step 4; repeat until no TARGETs remain.

Table 28. Levelled Sine Function: HF Linearity

Cal. Point	Voltage	Frequency
Target 1	1.0000 V	250 MHz
Target 2	1.5000 V	250 MHz
Target 3	2.0000 V	250 MHz
Target 4	3.0000 V	250 MHz
Target 5	5.5000 V	250 MHz

Calibration Procedure: Levelled Sine Function: HF Flatness

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, Hi Frq Sine mode, FLAT.
2. The following process takes you through all TARGETs in Table 29. The process sequentially calibrates all amplitudes at one frequency before repeating the same amplitude calibration points at the next frequency step.
3. 9500B: Set Output ON.
4. Power Meter: Select a range that gives an on-scale reading.
5. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{(power)}{}^{*}20$.
6. Press ACCEPT CALIB.
7. Select the next TARGET and return to step 4; repeat until no TARGETs remain.
8. Press NEXT FREQ then select TARGET 1 and return to step 4; repeat until no TARGETs remain.

Table 29. Levelled Sine Function: HF Flatness

Cal. Point	Voltage	Frequency
Target 1	3.0000 V	50 kHz
Target 2	1.0072 V	50 kHz
Target 3	316.49 mV	50 kHz
Target 4	316.49 mV	50 kHz

Repeat the process using the Cal. Point voltage levels in the Targets 1 - 4 sequence for each of these frequency points, for a total of 28 calibration steps:

Targets 05 - 08: 10 MHz	Targets 17 - 20: 550 MHz
Targets 09 - 12: 50 MHz	Targets 21 - 24: 800 MHz
Targets 13 - 16: 250 MHz	Targets 25 - 28: 1.0 GHz

Calibration Procedure: 3 GHz Levelled Sine Function: HF Linearity (9530 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 3 GHz Sine mode, LIN.
2. The following process takes you through all TARGETs in Table 30.
3. 9500B: Set Output ON.
4. Power Meter: Select a range that gives an on-scale reading.
5. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{}$ (power)*20.
6. Press ACCEPT CALIB.
7. Select the next TARGET and return to step 4; repeat until no TARGETs remain.

Table 30. 3-GHz Levelled Sine Function: HF Linearity

Cal. Point	Voltage	Frequency
Target 1	450.00 mV	1.2 GHz
Target 2	800.00 mV	1.2 GHz
Target 3	1.2000 V	1.2 GHz
Target 4	2.0000 V	1.2 GHz
Target 5	2.8000 V	1.2 GHz
Target 6	3.7000 V	1.2 GHz

Calibration Procedure: 3 GHz Levelled Sine Function: HF Flatness (9530 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 3 GHz Sine mode, FLAT.
2. The following process takes you through all TARGETs in Table 31. The process sequentially calibrates all amplitudes at one frequency before repeating the same amplitude calibration points at the next frequency step.
3. 9500B: Set Output ON.
4. Power Meter: Select a range that gives an on-scale reading.
5. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{}$ (power)*20.
6. Press ACCEPT CALIB.
7. Select the next TARGET and return to step 4; repeat until no TARGETs remain.
8. Press NEXT FREQ then select TARGET 1 and return to step 4; repeat until no TARGETs remain.

Table 31. 3-GHz Levelled Sine Function: HF Flatness

Cal. Point	Voltage	Frequency
Target 1	2.0000 V	1.2 GHz
Target 2	671.48 mV	1.2 GHz
Target 3	210.99 mV	1.2 GHz
Target 4	70.839 mV	1.2 GHz
Target 5	22.259 mV	1.2 GHz

Repeat the process using the Cal. Point voltage levels in the Targets 1 - 5 sequence for each of these frequency points, for a total of 75 calibration steps:

Targets 06 - 10: 1.50 GHz	Targets 41 - 45: 2.55 GHz
Targets 11 - 15: 1.75 GHz	Targets 46 - 50: 2.65 GHz
Targets 16 - 20: 1.95 GHz	Targets 51 - 55: 2.80 GHz
Targets 21 - 25: 2.05 GHz	Targets 56 - 60: 2.90 GHz
Targets 26 - 30: 2.20 GHz	Targets 61 - 65: 3.00 GHz
Targets 36 - 40: 2.45 GHz	Targets 71 - 75: 3.20 GHz

Calibration Procedure: 6 GHz Levelled Sine Function: HF Linearity up to 3.2 GHz (9560 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 3 GHz Sine mode, LIN.

   The following process takes you through all TARGETs in Table 32.
2. 9500B: Set Output ON.
3. Power Meter: Select a range that gives an on-scale reading.
4. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = √ (power)*20.
5. Press ACCEPT CALIB.
6. Select the next TARGET and return to step 4; repeat until no TARGETs remain.

Table 32. 6-GHz Levelled Sine Function: HF Linearity

Cal. Point	Voltage	Frequency
Target 1	450.00 mV	1.2 GHz
Target 2	700.00 mV	1.2 GHz
Target 3	1.0000 V	1.2 GHz
Target 4	1.6000 V	1.2 GHz
Target 5	2.4000 V	1.2 GHz
Target 6	3.5000 V	1.2 GHz

Calibration Procedure: 6 GHz Levelled Sine Function: HF Flatness up to 3.2 GHZ (9560 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 3 GHz Sine mode, FLAT.

   The following process takes you through all TARGETs in Table 33. The process sequentially calibrates all amplitudes at one frequency before repeating the same amplitude calibration points at the next frequency step.
2. 9500B: Set Output ON.
3. Power Meter: Select a range that gives an on-scale reading.
4. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device.

   The conversion from power to pk-pk voltage is pk-pk Voltage = √ (power)*20.
5. Press ACCEPT CALIB.
6. Select the next TARGET and return to step 4; repeat until no TARGETs remain.
7. Press NEXT FREQ then select TARGET 1 and return to step 4; repeat until no TARGETs remain.

Table 33. 6-GHz Levelled Sine Function: HF Flatness

Cal. Point	Voltage	Freq
Target 1	1.6000 V	1.2 GHz
Target 2	526.30 mV	1.2 GHz
Target 3	155.30 mV	1.2 GHz
Target 4	51.300 mV	1.2 GHz
Target 5	15.240 mV	1.2 GHz

Repeat the process using the Cal. Point voltage levels in the Targets 1 - 5 sequence for each of these frequency points, for a total of 75 calibration steps:

Targets 06 - 10: 1.50 GHz	Targets 41 - 45: 2.55 GHz
Targets 11 - 15: 1.75 GHz	Targets 46 - 50: 2.65 GHz
Targets 16 - 20: 1.95 GHz	Targets 51 - 55: 2.80 GHz
Targets 21 - 25: 2.05 GHz	Targets 56 - 60: 2.90 GHz
Targets 26 - 30: 2.20 GHz	Targets 61 - 65: 3.00 GHz
Targets 31 - 35: 2.30 GHz	Targets 66 - 70: 3.10 GHz
Targets 36 - 40: 2.45 GHz	Targets 71 - 75: 3.20 GHz

Calibration Procedure: 6 GHz Levelled Sine Function: HF Linearity Above 3.2 GHz (9560 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 6.4 GHz Sine mode, LIN.

   The following process takes you through all TARGETs in Table 34.
2. 9500B: Set Output ON.
3. Power Meter: Select a range that gives an on-scale reading.
4. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{}$ (power)*20.
5. Press ACCEPT CALIB.
6. Select the next TARGET and return to step 4; repeat until no TARGETs remain.

Table 34. 6-GHz Levelled Sine Function: HF Linearity

Cal. Point	Voltage	Frequency
Target 1	400.00 mV	3.3 GHz
Target 2	700.00 mV	3.3 GHz
Target 3	1.0000 V	3.3 GHz
Target 4	1.6000 V	3.3 GHz
Target 5	2.0000 V	3.3 GHz
Target 6	2.5000 V	3.3 GHz

Calibration Procedure: 6 GHz Levelled Sine Function: HF Flatness Above 3.2 GHz (9560 only)

1. 9500B: Ensure that the 9500B is in HEAD CAL, Sine, 6.4 GHz Sine mode, FLAT.

   The following process takes you through all TARGETs in Table 35. The process sequentially calibrates all amplitudes at one frequency before repeating the same amplitude calibration points at the next frequency step.
2. 9500B: Set Output ON.
3. Power Meter: Select a range that gives an on-scale reading.
4. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = √ (power)*20.
5. Press ACCEPT CALIB.
6. Select the next TARGET and return to step 4; repeat until no TARGETs remain.
7. Press NEXT FREQ then select TARGET 1 and return to step 4;repeat until no TARGETs remain.

Table 35. 6-GHz Levelled Sine Function: HF Flatness

Cal. Point	Voltage	Freq.
Target 1	1.6000 V	3.3 GHz
Target 2	500.00 mV	3.3 GHz
Target 3	152.00 mV	3.3 GHz
Target 4	48.500 mV	3.3 GHz

Repeat the process using the Cal. Point voltage levels in the Targets 1- 4 sequence for each of these frequency points, for a total of 60 calibration steps:

Cal. Point	Freq.
Targets 05 - 08	3.50 GHz
Targets 09 - 12	3.70 GHz
Targets 13 - 1	3.90 GHz
Targets 17 - 2	4.10 GHz
Targets 21 - 24	4.30 GHz
Targets 25 - 28	4.50 GHz
Targets 29 - 32	4.70 GHz
Targets 33 - 36	5.00 GHz
Targets 37 - 40	5.30 GHz
Targets 41 - 44	5.50 GHz
Targets 45 - 48	5.80 GHz
Targets 49 - 52	6.00 GHz
Targets 53 - 56	6.20 GHz
Targets 57 - 60	6.40 GHz

Calibrating the Edge Function

Summary

The Edge Function is calibrated by applying risetime corrections in the sequences given in *Calibration Procedure: 500ps Edge: Linearity* through *Calibration Procedure: 25ps Edge: Speed*. Equipment requirements are given in *Equipment Requirements*; *Calibration Setup* describes the Calibration Setup

Equipment Requirements

- The UUT Active Head, connected to a verified Model 9500B Mainframe.
- High-bandwidth sampling oscilloscope with bandwidth ≥6 GHz for Risetime measurements.(≥20 GHz for 9550 and 9560)
- Example: Tektronix Model TDS820 with an 80E01 series plug or Agilent 86100 Digitizing Oscilloscope with a HP83489A or 54752A 50 GHz Sample Head.
- 50 Ω SMA – SMA co-axial 'Trigger' cable for trigger inputs to the high-bandwidth oscilloscope

Note

Calibrating the 25 ps edge risetime of the 9550 requires the use of a short (no longer than 19.5 inches or 0.5 m), high quality, trigger cable fitted with SMA connectors. This insures a trigger signal with timing that is compatible with certain models of high speed sampling oscilloscopes.

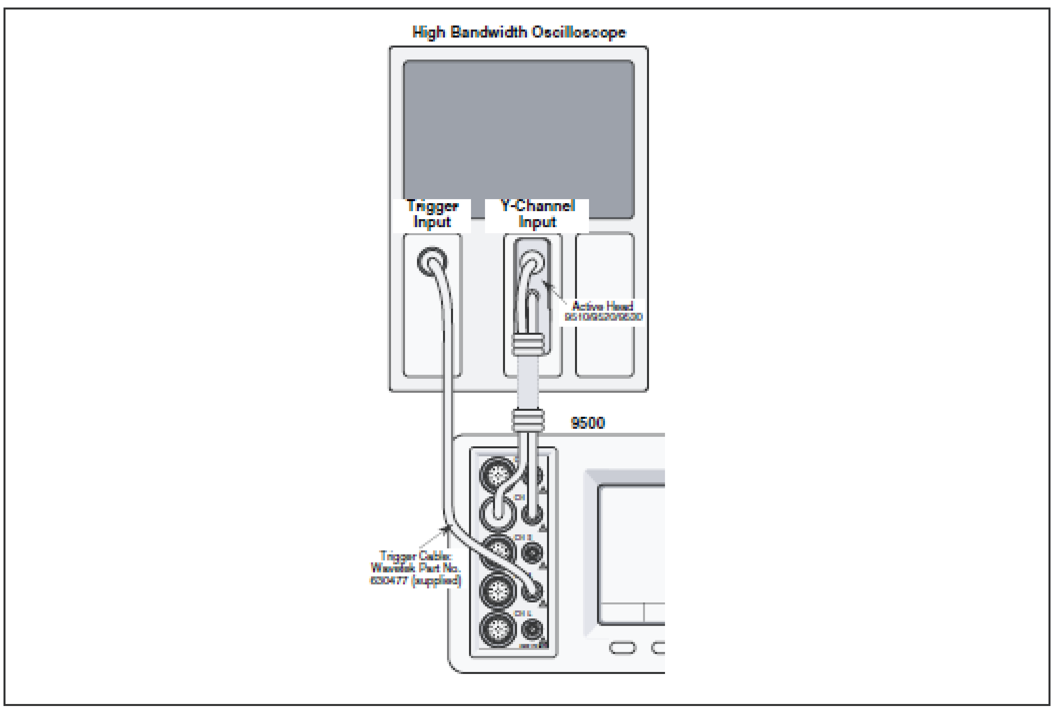
Example: Fluke Calibration Calibration part number 2636395 (supplied with 9550 or available as a spare part)

- High-bandwidth coaxial attenuator may be required if 9500B edge output voltage exceeds oscilloscope input capability.

Example: HP8493C opt 20 26.5 GHz 3.5mm 20 dB attenuator.

Calibration Setup

1.	Connections:	Ensure that the 9500B is connected to the Oscilloscope as shown in Figure 20, and that both instruments are powered on and warmed up.
2.	Oscilloscope:	Select the required function to measure edge response. Caution: The 9500B Edge function output is capable of generating voltages that may cause damage to sampling oscilloscope inputs with limited input voltage capability. Use of an attenuator is typically required for outputs above 1 V pk-pk.



erw240

Figure 20. Edge Function Calibration — Interconnections

Calibration Procedure: 500 ps Edge: Linearity

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20. and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 500 ps Edge, LIN mode.
5. Set the 9500B's output ON.
6. Select a measurement device range that gives an on-scale reading.
7. Adjust the 9500B's output amplitude to give a measurement device reading equal to TARGET 1 amplitude in Table 36.
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 36 and return to step 4; repeat until no TARGETs remain.

Table 36. Edge Function: 500 ps Edge: Linearity

Cal. Point	Voltage	Frequency	Edge
Target 1	1.0000 V	100 kHz	Rising
Target 2	2.0000 V	100 kHz	Rising
Target 3	2.5000 V	100 kHz	Rising
Target 4	1.0000 V	100 kHz	Falling
Target 5	2.0000 V	100 kHz	Falling
Target 6	2.5000 V	100 kHz	Falling

Calibration Procedure: 500 ps Edge: Gain

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20. and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 500 ps Edge, GAIN mode.
5. Set the 9500B's output ON.
6. Select a measurement device range that gives an on-scale reading.
7. Adjust the 9500B's output amplitude to give a measurement device reading equal to TARGET 1 amplitude in Table 37.
8. Press ACCEPT CALIB.

Table 37. Edge Function: 500 ps Edge: Gain

Cal. Point	Voltage	Frequency	Edge
Target 1	2.5000 V	100 kHz	Rising

Calibration Procedure: 500 ps Edge: Speed

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20, and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 500 ps Edge, SPEED mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 38.
6. Select a measurement device range that gives an on-scale reading.
7. Note the rise or fall time of the edge and enter it into the Edge Speed field on the 9500B. Make sure allowance is made for the rise time of the oscilloscope:

   Edge Rise Time = √((Measured Rise Time)2 - (Scope Rise Time)2).
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 38 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 38. Edge Function: 500 ps Edge: Speed

Cal. Point	Voltage	Frequency	Edge
Target 1	3.0000 V	1 MHz	Rising
Target 2	2.0000 V	1 MHz	Rising
Target 3	1.0000 V	1 MHz	Rising
Target 4	1.0072 V	1 MHz	Rising
Target 5	316.49 mV	1 MHz	Rising
Target 6	316.49 mV	1 MHz	Rising
Target 7	3.0000 V	1 MHz	Falling
Target 8	20000 V	1 MHz	Falling
Target 9	1.0000 V	1 MHz	Falling
Target 10	1.0072 V	1 MHz	Falling
Target 11	316.49 mV	1 MHz	Falling
Target 12	316.49 mV	1 MHz	Falling

Calibration Procedure: 150 ps Edge: Linearity

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20. and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 150 ps Edge, LIN mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 39.
6. Select a measurement device range that gives an on-scale reading.
7. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the oscilloscope.
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 39 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 39. Edge Function: 150 ps Edge: Linearity

Cal. Point	Voltage	Frequency	Edge
Target 1	1.0000 V	100 kHz	Rising
Target 2	2.0000 V	100 kHz	Rising
Target 3	2.5000 V	100 kHz	Rising
Target 4	1.0000 V	100 kHz	Falling
Target 5	2.0000 V	100 kHz	Falling
Target 6	2.5000 V	100 kHz	Falling

Calibration Procedure: 150 ps Edge: Gain

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20, and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 150 ps Edge, GAIN mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 40.
6. Select a measurement device range that gives an on-scale reading.

7. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the oscilloscope.
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 40 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 40. LS Function: 150 ps Edge: Gain

Cal. Point	Voltage	Frequency	Edge
Target 1	2.5000 V	100 kHz	Rising
Target 2	839.39 mV	100 kHz	Rising
Target 3	263.74 mV	100 kHz	Rising
Target 4	263.74 mV	100 kHz	Rising

Calibration Procedure: 150 ps Edge: Speed

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20, and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 150 ps Edge, SPEED mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 41.
6. Select a measurement device range that gives an on-scale reading.
7. Note the rise or fall time of the edge and enter it into the Edge Speed Field on the 9500B. Make sure allowance is made for the rise time of the oscilloscope:

   Edge Rise Time = √((Measured Rise Time)2 - (Scope Rise Time)2).
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 41 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 41. Edge Function: 150 ps Edge: Speed

Cal. Point	Voltage	Frequency	Edge
Target 1	3.0000 V	1 MHz	Rising
Target 2	2.0000 V	1 MHz	Rising
Target 3	1.0000 V	1 MHz	Rising
Target 4	1.0072 V	1 MHz	Rising
Target 5	316.49 mV	1 MHz	Rising
Target 6	316.49 mV	1 MHz	Rising
Target 7	3.0000 V	1 MHz	Falling
Target 8	2.0000 V	1 MHz	Falling
Target 9	1.0000 V	1 MHz	Falling
Target 10	1.0072 V	1 MHz	Falling
Target 11	316.49 mV	1 MHz	Falling
Target 12	316.49 mV	1 MHz	Falling

Calibration Procedure: 70 ps Edge: Linearity

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20. and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 70 ps Edge, LIN mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 42.
6. Select a measurement device range that gives an on-scale reading.
7. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the oscilloscope.
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 42 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 42. Edge Function: 70 ps Edge: Linearity

Cal. Point	Voltage	Frequency	Edge
Target 1	25 mV	100 kHz	Rising
Target 2	40 mV	100 kHz	Rising
Target 3	70 mV	100 kHz	Rising
Target 4	75 mV	100 kHz	Rising
Target 5	120 mV	100 kHz	Rising
Target 6	220 mV	100 kHz	Rising
Target 7	250 mV	100 kHz	Rising
Target 8	400 mV	100 kHz	Rising
Target 9	700 mV	100 kHz	Rising
Target 10	750 mV	100 kHz	Rising
Target 11	1.2 V	100 kHz	Rising
Target 12	2.2 V	100 kHz	Rising

Calibration Procedure: 70 ps Edge: Speed

1. Ensure that the 9500B is connected to the oscilloscope as shown in Figure 20, and that both instruments are powered on and warmed up.
2. Select the required 9500B Trigger Channel, Cable Select, and Trigger Ratio settings.
3. Select the required measurement device function to measure edge response.
4. Ensure that the 9500B is in HEAD CAL, Edge, 150 ps Edge, SPEED mode.
5. Set 9500B's output ON, selecting TARGET 1 from Table 43.
6. Select a measurement device range that gives an on-scale reading.
7. Note the rise or fall time of the edge and enter it into the Edge Speed Field on the 9500B. Make sure allowance is made for the rise time of the oscilloscope:

   Edge Rise Time = √((Measured Rise Time)2 - (Scope Rise Time)2).
8. Press ACCEPT CALIB.
9. Select the next TARGET in Table 43 by pressing NEXT TARGET and return to step 4; repeat until no TARGETs remain.

Table 43. Edge Function: 70 ps Edge: Speed

Cal. Point	Voltage	Frequency	Edge
Target 1	2.2000 V	1 MHz	Rising
Target 2	1.2000 V	1 MHz	Rising
Target 3	750 mV	1 MHz	Rising
Target 4	700 mV	1 MHz	Rising
Target 5	400 mV	1 MHz	Rising
Target 6	250 mV	1 MHz	Rising
Target 7	220 mV	1 MHz	Rising
Target 8	120 mV	1 MHz	Rising
Target 9	75 mV	1 MHz	Rising
Target 10	70 mV	1 MHz	Rising
Target 11	40 mV	1 MHz	Rising
Target 12	25 mV	1 MHz	Rising

Calibration Procedure: 25 ps Edge: Speed

Ensure that the 9500B is connected to the oscilloscope as shown in Figure 21 and that both instruments are powered on and warmed up. (Be sure to use the appropriate connector adapter as necessary to connect the 9550's SMA output connector to the input connector of the oscilloscope.)

Basic Setup

Recommended Settings for the Sampling Oscilloscope:

Channel Setup	Timebase
Scale 100 mV/div	Scale 50pS/div
External Scale 0dB	Reference Center
Units Volts	Windowing Disabled
Bandwidth >20 GHz	Position 25 ns
Offset -220 mV	
Trigger	**Acquisition**
Source Channel 2	Averaging Off
Slope Positive Edge	

Fast Edge Rise time & Fall time Measurement Procedure

1. Press the MODE function key to access the main menu screen.
2. From the main menu screen selection, select the MANUAL Mode of operation.
3. Using the major function keys, select the Edge function.
4. From the screen menu, select FAST edge, followed by the 25 ps pulse function.

Note

On the earlier 9500 models the 25 ps function is accessible through AUX key on the front panel.

5. To ensure the 9500B is properly configured for calibration, the TRIGGER CHANNEL and CABLE SELECT must match and be different from the SIGNAL CHANNEL settings. Use the following key sequence:
   a) Press the CHANNEL SELECT selection.
   b) Select the proper SIGNAL CH setting as connected to the 9550 Head being calibrated – (select among CH1 to CH5 alternatives).
   c) Press the TRIGGER CHANNEL selection.
   d) Select the proper TRIGGER CH setting as connected with the external trigger cable – (select among CH1 to CH5 alternatives).
   e) Confirm the wording Trigger Cable is displayed on the same channel as connected with external trigger cable. If not, then push the CABLE SELECT soft key and then match the CABLE CH setting to the correct trigger channel, and push EXIT.
   f) Press the TRIGGER RATIO selection.
   g) Select the desired signal to trigger ratio (typically divide by 10).
6. Return to the 25 ps FAST Edge screen by pressing EXIT twice.
7. Prepare to measure the 9550's rising edge transition time. On the 9500B confirm operation with the settings at an Amplitude of 500 mV, Frequency at 1 MHz, Rising Edge, and OUTPUT ON.
8. Adjust Oscilloscope Channel Offset and Timebase Position to center the displayed waveform.
9. Set the oscilloscope to average 256 samples.
10. Select on the oscilloscope the appropriate edge transition (rising or falling) corresponding to what is being measured.
11. Record the measured edge speed as observed on the oscilloscope.

12. The measured edge rise time value is the average of 8 separate measurements. Use the following sequence for measuring the remaining measurement values.
    a) Press the calibrator OUTPUT OFF button.
    b) Press the calibrator OUTPUT ON button.
    c) Repeat the measurement and record the measured rise time.
    d) Repeat this sequence of steps until you have recorded a total of 8 measurements.
13. Calculate the average of these 8 measurements to a precision of 2 decimal places. This is the calculated average rise time of the combined 9550 signal rise time and the oscilloscope response rise time.
14. Using the following formula, determine the 9550's calibrated edge rise time by subtracting the measured (or calibrated) oscilloscope measurement response rise time from your calculated average.

$$\text{Edge Rise Time} = \sqrt{(\text{Calculated Average Rise Time})^2 - (\text{Scope Rise Time})^2}$$

15. Save this calculated edge rise time value for later use in calibrating the head.
16. Prepare to measure the 9550's falling edge transition time by selecting the falling edge with the soft key. On the 9500B confirm operation with the settings at an Amplitude of 500 mV, Frequency at 1MHz, Falling Edge, and OUTPUT ON.
17. Repeat steps 8 to 15 for the 9550's falling edge time measurement.
18. Turn the OUTPUT OFF.

Save Calibration Data to Active Head

1. Insure the rear-panel Calibration Enable switch is in the "ENABLE" position.
2. Press the MODE function key to access the main menu screen.
3. Press the CALB Key on the main menu.
4. Enable changing calibration constants by entering a valid password to access the Calibration Mode display screen.
5. From the main menu screen selection, select the HEAD CAL Mode of operation.
6. Confirm the CHANNEL SELECT settings are appropriate, then select EDGE and 25 ps.
7. Select TARGET 1.
8. Refer to the Rising Edge speed as calculated in the previous section and enter this value into the edge speed field on the display screen. Press ACCEPT CAL.

9. Select TARGET 2 and similarly enter calculated Falling Edge speed value. Press ACCEPT CAL followed by EXIT.
10. Select STORE HEAD CAL and follow on screen instructions to:
    - Select the warning period before recalibration is due (leave at default 30 days unless otherwise requested).
    - Modify the calibration due date (default 1 year from calibration date)
11. Select STORE. Use the CHANNEL SELECT softkey to change to the appropriate Active Head to save any unsaved data until the NONE indicator is displayed.
12. Select EXIT to step back through the menus to the main Calibration Mode menu, then press the MODE key to exit calibration mode.
13. Disconnect 9550 from 9500B Base Unit.

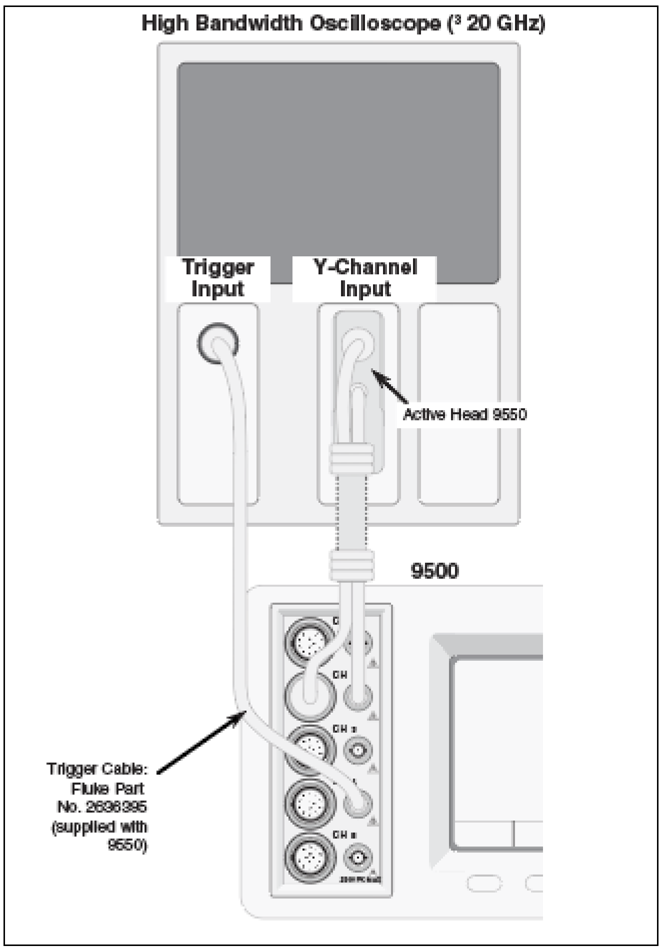


Figure 21. 25 ps Edge Function Calibration — Interconnections

Calibrating the Timing Markers (9510 only)

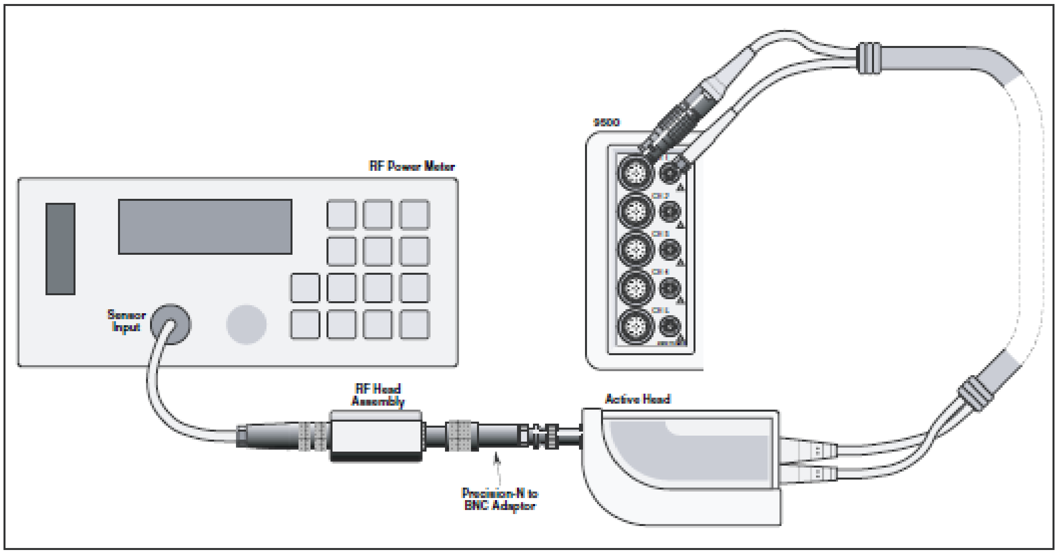
1. Ensure that the 9500B is connected to the Power Meter as shown in Figure 22, satisfies the equipment requirements in Equipment Requirements, and that both instruments are powered on and warmed up.
2. 9500B: Ensure that the 9500B is in HEAD CAL, Other, Timing Marker.
3. The following process takes you through TARGETs 1 - 3 in Table 44, repeating amplitude calibrations for frequency points in TARGETs 4 - 9.
4. 9500B: Set Output ON.
5. Power Meter: Select a range that gives an on-scale reading.
6. Adjust the 9500B's output amplitude to give a reading equal to Target Amplitude on the measuring device. The conversion from power to pk-pk voltage is pk-pk Voltage = $\sqrt{}$ (power)*20.
7. Press ACCEPT CALIB.
8. Select the next TARGET and return to step 4; repeat until no TARGETs remain.
9. Press NEXT FREQ then select TARGET 1 and return to step 4; repeat until no TARGETs remain.

Table 44. Timing Marker Calibration Points

Cal. Point	Voltage	Frequency
Target 1	100.00 mV	1.11 GHz
Target 2	250.00 mV	1.11 GHz
Target 3	500.00 mV	1.11 GHz

Repeat the sequence using the Cal. Point voltage levels in TARGETs 1 - 3 for each of these frequency points, for a total of 9 calibration steps:

Targets 4 - 6:	1.6 GHz
Targets 7 - 9:	2.0 GHz



erw241

Figure 22. Timing Marker Amplitude Calibration — Interconnections

Load Capacitance Function Calibration (9510 and 9530 only)

Equipment required - two calibrated capacitance standards:

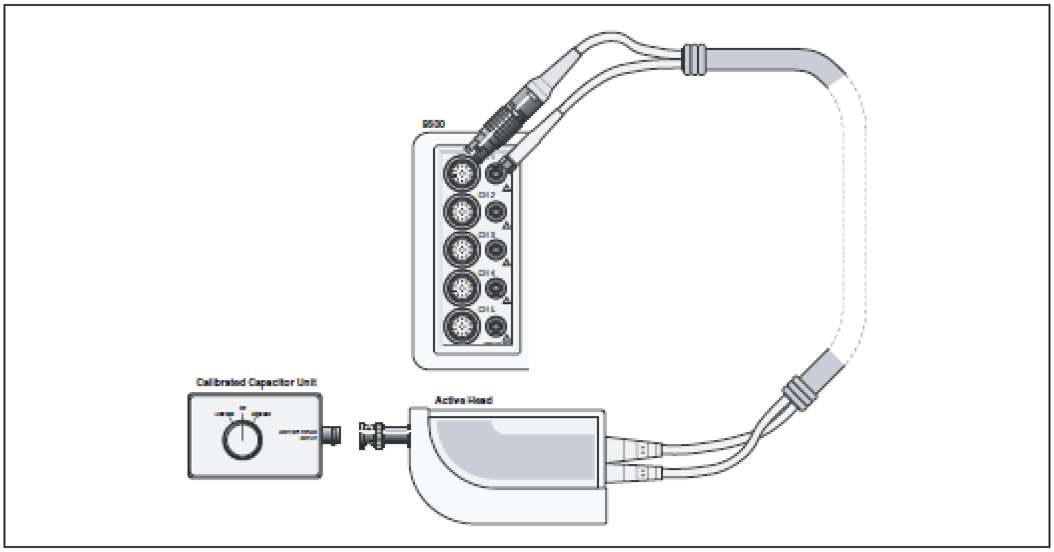
1. Calibrated value between 15 pF and 25 pF
2. Calibrated value between 85 pF and 95 pF.

These values may be recorded in Table 45 for use during the calibration and for future reference.

1. Make connections as shown in Figure 23.
2. 9500B: Ensure that the 9500B is in HEAD CAL, Other, Load Cap.
3. The following process takes you through all TARGETs in Table 45.
4. 9500B: Set Output ON.
5. Connect the appropriate standards capacitors with nominal values as shown in Table 45.
6. Enter the calibrated value of the standard capacitor (recorded in Table 45) into the 9500B's Target Cap. field and press Enter.
7. Press ACCEPT CALIB.
8. Select the next TARGET and return to step 4; repeat until no TARGETs remain.

Table 45. Load Capacitor Calibration Points

Cal. Point	Voltage	Frequency
Target 1	0 pF	
Target 2	15 pF	
Target 3	82 pF	



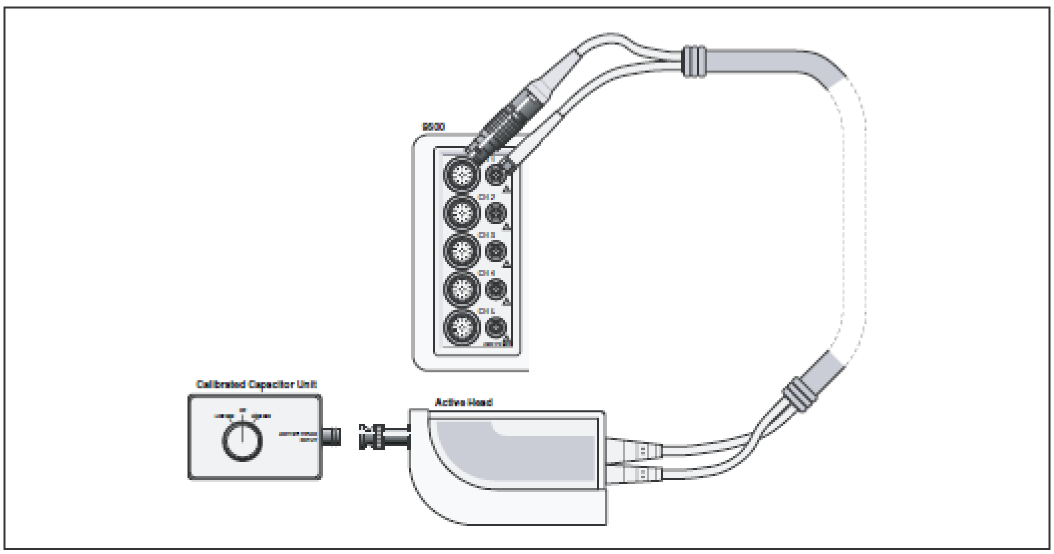
erw242

Figure 23. Load Capacitance Function Calibration — Interconnections

50 Ω / 1 MΩ Ratio Calibration

1. Ensure that the 9500B is connected to the DMM as shown in Figure 24, and that both instruments are powered and warmed up.
2. 9500B: It is necessary to temporarily exit the Head Calibration Mode to make and note the result of four measurements. Using the Mode key return the instrument to Manual Mode and select the DC/ Square Function.
3. 9500B: Select DC Positive waveform at 5.0000 V configured to drive 1 MΩ.
4. On the 4955 Select “DCV o/c” (or simply connect the Head directly to the DMM). Turn the 9500B Output ON, allow the DMM to settle and note the measurement in Table 46.
5. 9500B: Select DC Positive waveform at 5.0000 V configured to drive 50 Ω.
6. On the 4955 Select “DCV 50 Ω” (or use an alternative shunt resistor). Turn the 9500B Output ON, allow the DMM to settle and note the measurement in Table 46.

7. 9500B: Select Square waveform with positive bias at 5.0000 V pk - pk configured to drive 1 MΩ.
8. On the 4955 Select “SQR o/c” (or connect the Head directly to the DMM, configured to measure DC voltage). Turn the 9500B Output ON, allow the DMM to settle and note the measurement in Table 46. Please note that the DMM reading (average DC level) should be multiplied by two (pk-pk level).
9. 9500B: Select Square waveform with positive bias at 5.0000 V pk - pk configured to drive 50 Ω.
10. On the 4955 Select “SQR 50 Ω” (or use an alternative shunt resistor). Turn the 9500B Output ON, allow the DMM to settle and note the measurement in Table 46. Please note that the DMM reading (average DC level) should be multiplied by two (pk-pk level). Having made the necessary measurements, re-enter the Head Calibration mode using the Mode and Cal keys.
11. 9500B: Select HEAD CAL, Other, 50 Ω/1 MΩ Ratio. For Target 1, this screen requires entry of two Measurement values for the DC function - Target 1.1 and Target 1.2. Repeat this process for Target 2 and the values Target 2.1 and 2.2.



erw242.eps

Figure 24. 50-Ω/1 MΩ Ratio Calibration — Interconnections

Table 46. 50-Ω/1 MΩ Ratio Calibration Points

Meas. Point	Target Voltage	Waveshape	DC Voltage Measurement	Target Name
Target 1.1	5.0000 V	DC		Amp @ 1 MΩ
Target 1.2	5.0000 V	DC		Amp @ 50 Ω
Target 2.1	5.0000 Vpk-pk	Square		Amp @ 1 MΩ
Target 2.2	5.0000 Vpk-pk	Square		Amp @ 50 Ω

Exit from Head Calibration

When the necessary calibration operations are complete, return to the Calibration screen that contains the Exit and Store Head Cal softkeys. Selecting Exit produces the reminder message:

WARNING: Cal data not stored:
Exit again to abandon data

Select Exit to abandon head cal data.

To store head cal data, select the Store Head Cal softkey, which produces a new screen labelled:

Head Calibration: CHx (where x is the head number)

Follow the on-screen instructions to:

- Select the warning period before recalibration is due
- Modify the cal due date

Below the displayed dates is a message that reads:

These heads have unsaved data

followed by a line that identifies the heads e.g. CH1, CH4. If there is no cal data to store, or if all head cal data storage is complete, the NONE indicator appears.

Selecting the Store softkey displays the message:

Saving cal factors to head x (where x is the head number)

The save operation may take up to 30 seconds to complete. To save any remaining unsaved head data, use the Channel Select softkey to change to the appropriate head, then select Store. Repeat for each unsaved head until the NONE indicator is displayed.

Select Exit to step back through the menus to the required instrument setting.