

Τ.Ε.Ι. ΣΤΕΡΕΑΣ ΕΛΛΑΔΑΣ
ΤΜΗΜΑ ΗΛΕΚΤΡΟΝΙΚΩΝ ΜΗΧΑΝΙΚΩΝ ΤΕ

ΕΡΓΑΣΤΗΡΙΟ

«ΗΛΕΚΤΡΟΝΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΦΑΣΜΑΤΟΣΚΟΠΙΑΣ»

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*“ΣΥΝΔΕΣΗ - ΕΓΚΑΤΑΣΤΑΣΗ – ΛΕΙΤΟΥΡΓΙΑ-
ΣΥΣΚΕΥΗΣ ΔΙΗΛΕΚΤΡΙΚΗΣ ΦΑΣΜΑΤΟΣΚΟΠΙΑΣ
ΥΨΗΛΩΝ ΣΥΧΝΟΤΗΤΩΝ ΜΕ ΔΙΑΤΑΞΗ ΜΕΤΑΒΟΛΗΣ
ΘΕΡΜΟΚΡΑΣΙΑΣ ”*

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Καθηγητής

ΛΑΜΙΑ 2013

Στην παρούσα εργαστηριακή άσκηση θα μελετηθεί ο τρόπος εγκατάστασης, η υλοποίηση της κατάλληλης συνδεσμολογίας και η λειτουργία της διάταξης Διηλεκτρικής Φασματοσκοπίας *Agilent E 4991 A* σε σύνδεση με διάταξη μεταβολής θερμοκρασίας (φούρνος ESPEC SU).

Παρατίθενται παρακάτω οδηγίες και τεχνικά χαρακτηριστικά απο το εγχειρίδιο χρήσης της διάταξης.

B **Probe Station Connection Kit (Option 010)**

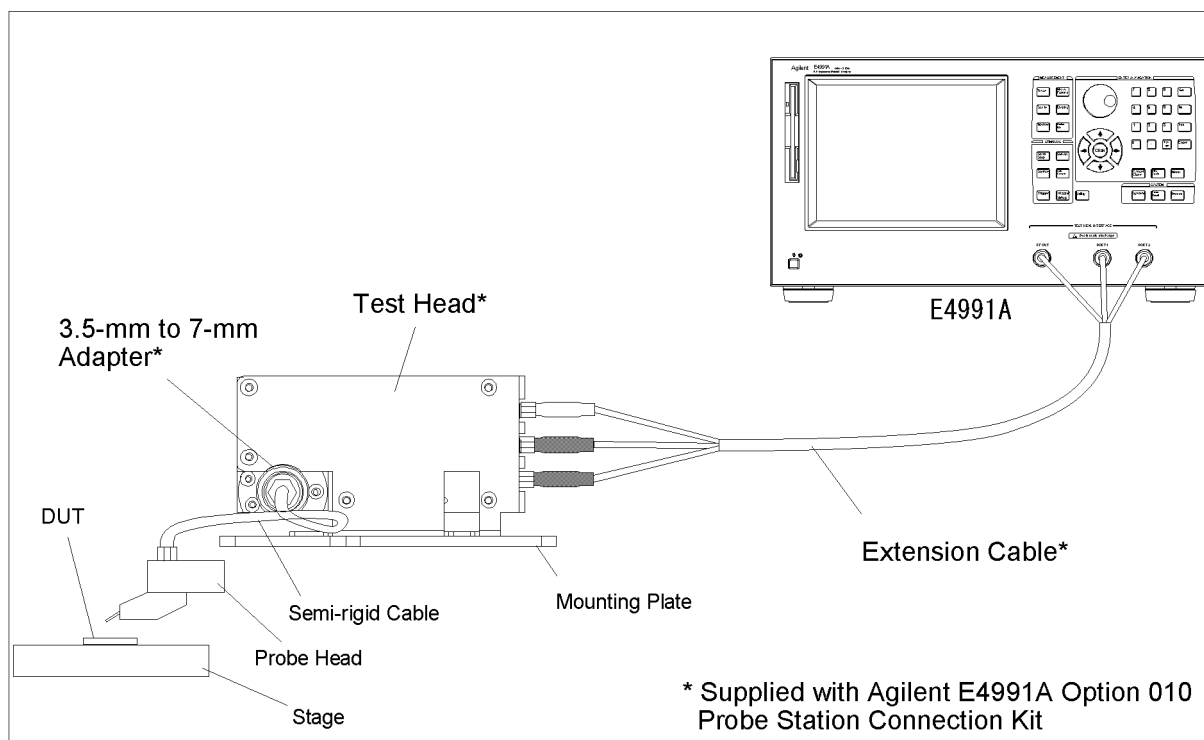
This appendix explains the E4991A Option 010 Probe Station Connection Kit, which is used to connect the instrument to a probe station made by a third-party manufacturer.

Option 010 Overview

The E4991A Option 010 Probe Station Connection Kit permits connection of the E4991A to any manufacturer's probe station. Agilent Technologies recommends that you use the Cascade Microtech Summit 9000, 11000, and 12000 series probe stations. This connection kit consists of a test head and an extension cable. Mount the test head on the probe station with the parts provided by Cascade Microtech before performing measurement.

Use a probe station to measure the impedance of DUTs such as semiconductor devices, components on a substrate, print patterns, and IC packages.

Figure B-1 Overview



e4991a0e213

NOTE



You must not apply either alternate or direct current to the DUT port. Doing this could cause operational failure. Pay particular attention to whether the capacitor is charged. Fully discharge the device under test before connecting it to the test head DUT port or test fixture.

CAUTION

Whenever you connect a DUT to or disconnect it from the DUT port for measurement, you must first turn off the dc bias or set the sweep to the hold state (in sweep hold state, dc bias is not applied to the DUT). If this step is not taken, the dc bias may destroy the DUT.

Recommended Probe Stations

The following probe stations are recommended for use with the Option 010 Probe Station Connection Kit.

- Cascade Microtech Summit 9000 series
- Cascade Microtech Summit 11000 series
- Cascade Microtech Summit 12000 series

Recommended Probe Heads

The following probe heads are recommended for use with the Option 010 Probe Station Connection Kit.

Cascade Microtech ACP series

- ACP40-GS series
- ACP40-SG series
- ACP40-GSG series

Cascade Microtech HPC series

- HPC40-GSG series

NOTE

Except for the oscillator level, the E4991A standard specifications and supplemental information are applied while using the Option 010 Probe Station Connection Kit. For specifications of the oscillator level, refer to “Oscillator Level” on page 239.

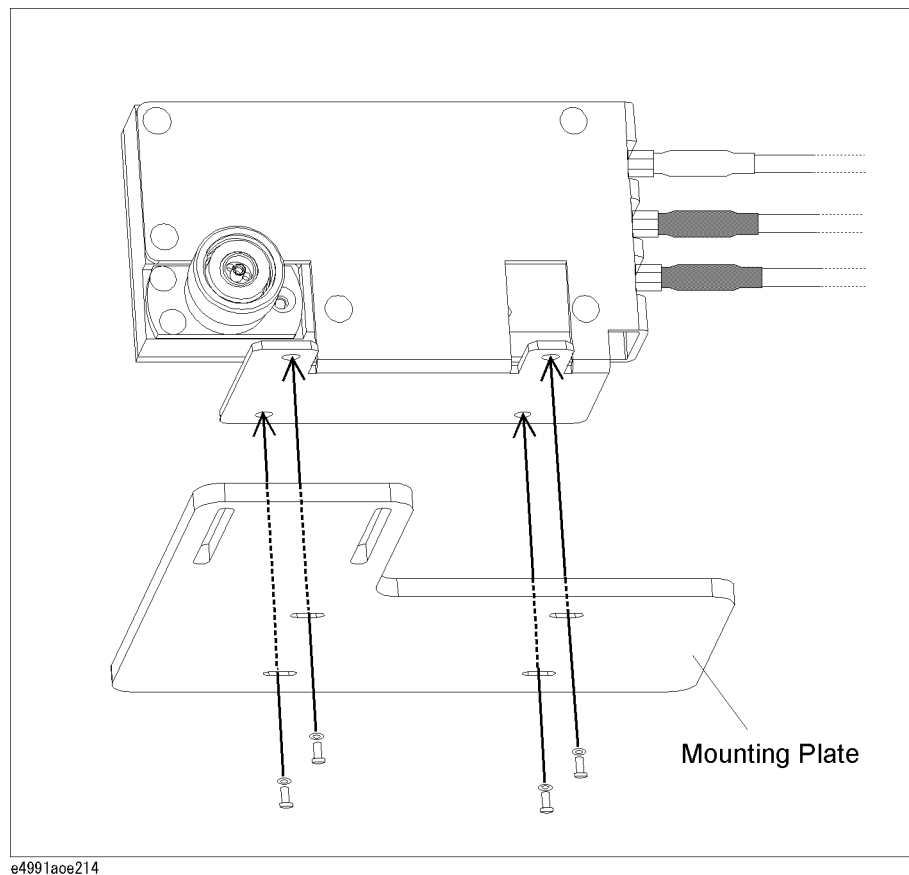
Mounting Test Head and Connecting Cables (using recommended probe station)

To mount the test head, you need the mounting plate and the semi-rigid cable provided by Cascade Microtech in addition to Option 010. The mounting plate is used to connect the test head to the probe arm. The semi-rigid cable is used to connect the test head to the probe head. There are two types of semi-rigid cables: one for the Summit 9000 series and another for the Summit 11000/12000 series. Select the appropriate type for your probe station. To order these parts, please inquire to Cascade Microtech.

Step 1. Fix the test head to the mounting plate supplied by Cascade Microtech.

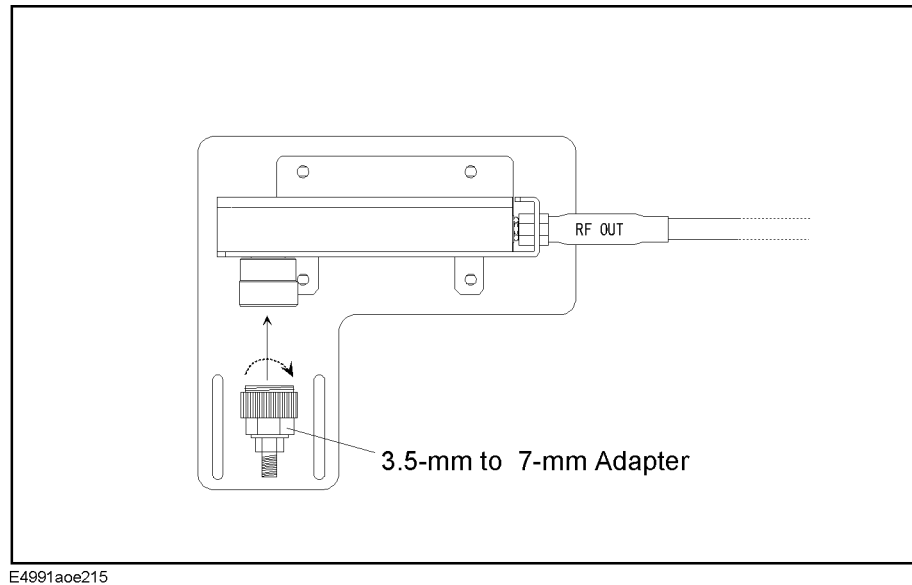
Figure B-2

Fixing Test Head to Mounting Plate



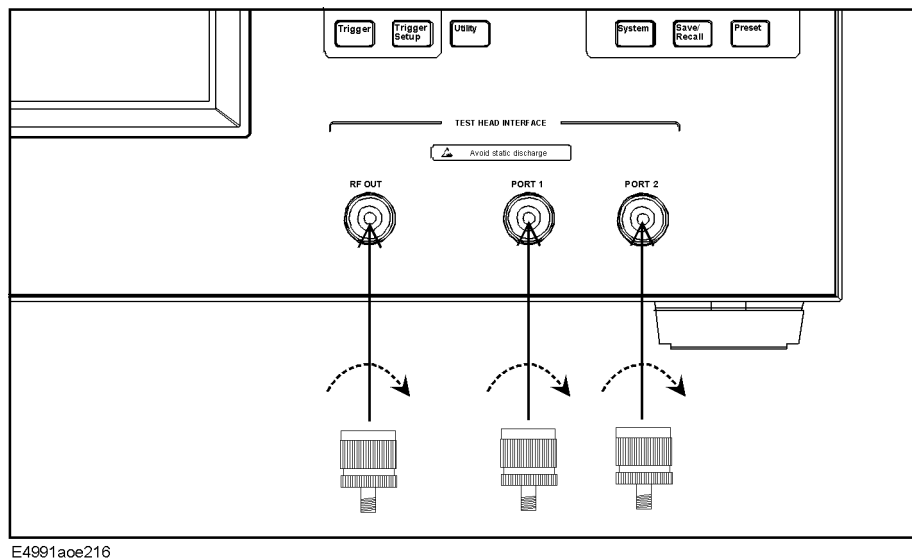
Step 2. Connect the 3.5-mm to 7-mm adapter to the test head's 7-mm connector.

Figure B-3 **Connecting 3.5-mm to 7-mm Adapter**



- Step 3.** Mount the mounting plate with the test head to the probe arm. For more on how to mount the plate, refer to Cascade Microtech's manual.
- Step 4.** Connect the test head's 3.5-mm connector to the probe head with the semi-rigid cable supplied by Cascade Microtech. For more on how to make this connection, refer to Cascade Microtech's manual.
- Step 5.** Connect each N(m) to SMA(f) adapter to the corresponding port on the E4991A test head interface (RF OUT, PORT1, PORT2).

Figure B-4 **Connecting N(m) to SMA(f) Adapter**

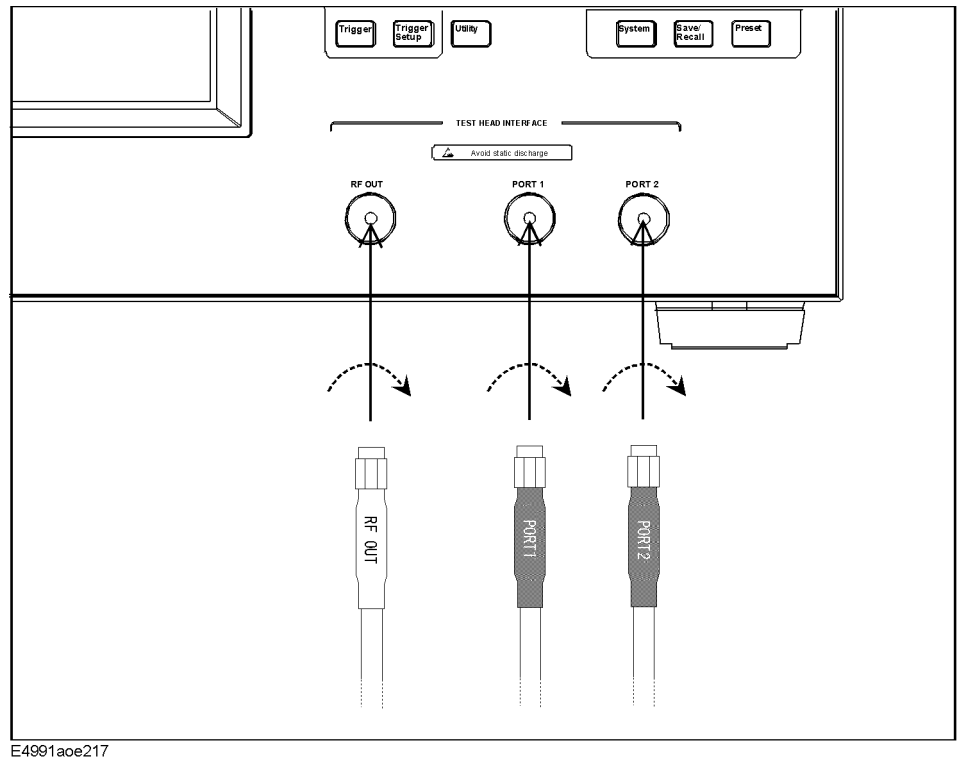


- Step 6.** Connect each of the extension cable's SMA(m) connectors to the corresponding port on the E4991A test head interface (RF OUT, PORT1, PORT2). Use a wrench to tighten the

Probe Station Connection Kit (Option 010)
Mounting Test Head and Connecting Cables (using recommended probe station)

connector nut of the SMA(m) connector.

Figure B-5 Connecting extension cable to E4991A

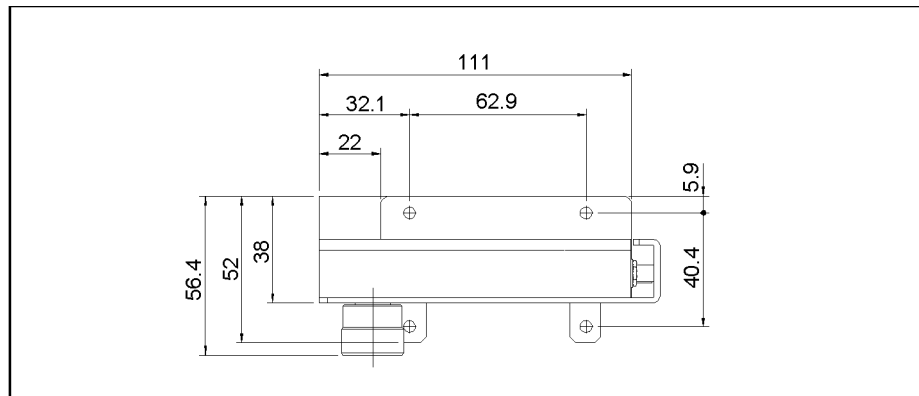


Mounting Test Head and Connecting Cables (using probe stations other than recommended models)

If you use a probe station other than the Cascade Microtech Summit 9000, 11000, or 12000 series, you should prepare a mounting plate that fixes the test head and a cable that connects the test head and probe head. Refer to the test head dimensions (Figure B-6) and customize a mounting plate that connects easily with your probe station. The cable that connects the test head to the probe head should have a 50 Ω characteristic impedance and be as short as possible.

Figure B-6

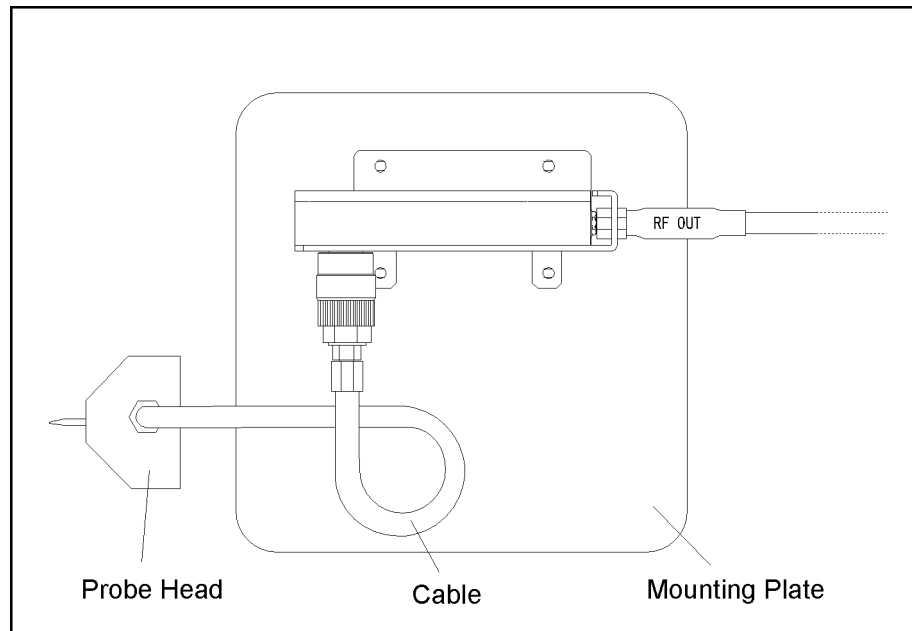
Test Head Dimensions



E4991aoj220

Figure B-7

Example of Mounting Plate and Cable



E4991aoe219

OPEN/SHORT/LOAD Calibration

The OPEN/SHORT/LOAD calibration needs to be performed at the tip of Cascade Microtech's probe head by using the Cascade ISS (Impedance Standard Substrate) to remove residual impedance from the extension cable and probe head.

Set the calibration reference plane to the tip of the probe. Electrical length compensation and fixture compensation (Open compensation and Short compensation) are not executed. Follow the steps below to select fixture type, define calibration kit, select calibration/compensation measurement point mode, and perform OPEN/SHORT/LOAD calibration of the E4991A.

Selecting Fixture Type

Set the fixture type to **none** to turn off the electrical length compensation in the E4991A.

Step 1. Selecting fixture

- a. Right-click to open the shortcut menu and click **Cal/Comp** (or press Cal/ Compen).
- b. Click and open the **Fixture Type** box and then click to select **None**.

Definition of Calibration Kit

The ACP probe head has its own residual parameters such as capacitance (C-Open) at OPEN calibration, inductance (L-Short) at SHORT calibration, and inductance (L-Term) at LOAD calibration. These parameters are defined at each probe pitch and printed inside the probe head's case cover provided by Cascade Microtech. Set the appropriate values in the Cal Kit Menu of the E4991A, depending on the probe head you are using and its pitch.

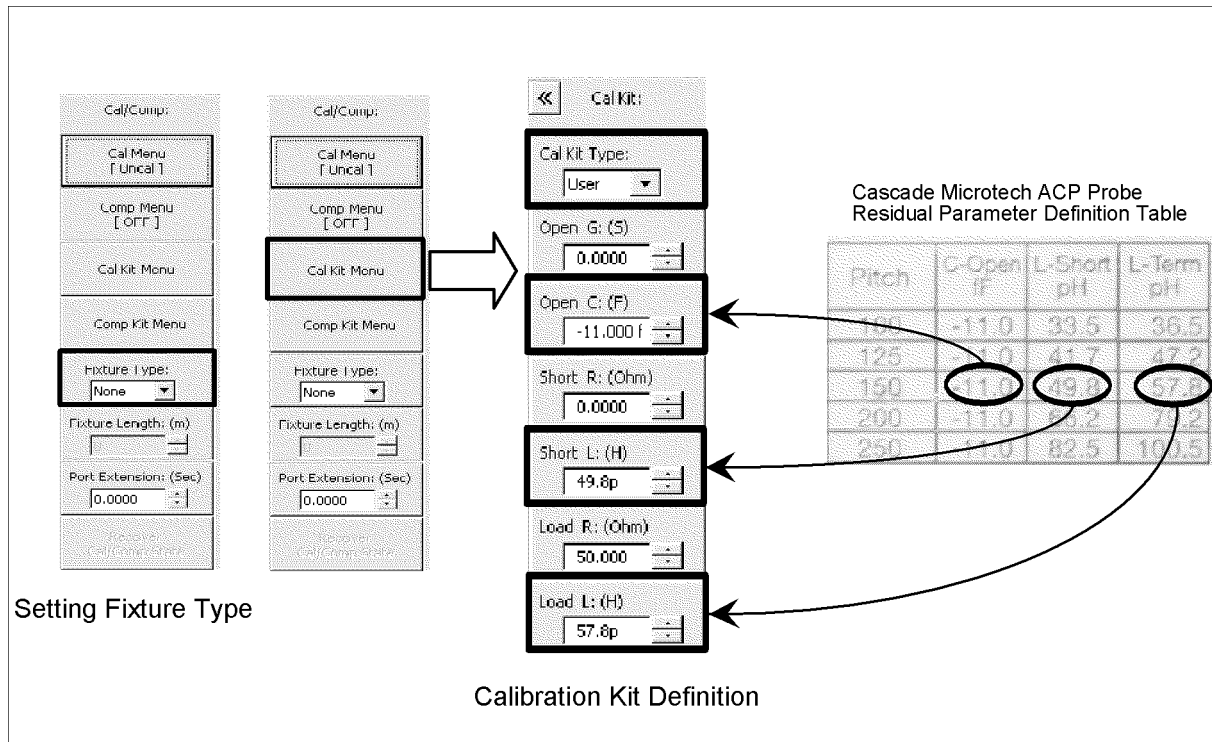
Step 1. Click the **Cal Kit Menu** button

Step 2. Click and open the **Cal Kit Type** box and click to select **User**.

Step 3. Using the numeric entry dialog box that appears by right-clicking inside the calibration kit definition box (or using the **ENTRY/NAVIGATION** block keys on the front panel), enter the definition of the calibration kit:

Calibration Kit Definition Box	Value to be defined
Open C: (F)	Capacitance C at Open Calibration (C-Open)
Short L: (H)	Inductance L at Short Calibration (L-Short)
Load L: (H)	Inductance L at Load Calibration (L-Term)

Figure B-8 Selection of Fixture Type and Definition of Calibration Kit



Calibration/Compensation Measurement Point Mode

The E4991A has three modes for defining the measurement points when the calibration and compensation data are measured. Agilent Technologies recommends performing calibration in User-defined frequency/User-defined power point mode when using a probe station.

Table B-1 Calibration/Compensation Measurement Point Mode

Calibration/Compensation Measurement Point Mode	Calibration/Compensation Measurement Condition			Advantages	Disadvantages
	Frequency	Power	Number of measurement points		
User-defined frequency / User-defined power point mode (User Freq&Pwr)	Frequency points determined by sweep setups	Power points determined by sweep setups	Same as the number of sweep measurement points (NOP)	The most accurate DUT measurement can be performed	Need to retake the calibration/compensation data if measurement points (frequency and/or power) are changed
Fixed frequency / Fixed power point mode (Fixed Freq&Pwr)	372 Preset points	372 Preset points	$372 \times 3 = 1116$ points	Not necessary to retake the calibration/compensation data even if the measurement points are changed	Takes more time to complete calibration/compensation data measurement due to large number of measurement points
Fixed frequency / User-defined power point mode (FixedFreq, UserPwr)	372 Preset points	Power points determined by sweep setups	372 points	Not necessary to retake the calibration/compensation data if the frequency points are changed	

User-defined frequency/User-defined power point mode

This mode obtains calibration/compensation data at the same frequency and power points as those used in actual device measurement, which are determined by the sweep setups. Each set of calibration/compensation data is applied to each measurement at the same points. Accordingly, the most accurate measurement will be performed. If measurement points (frequency and/or power) are changed, calibration should be performed again. User-defined frequency/User-defined power mode is the recommended calibration mode for performing measurement while using a probe station.

Fixed frequency/fixed power point mode

This mode obtains calibration/compensation data in a fixed frequency and power range of the E4991A. In device measurement, calibration or compensation is applied to each measurement point by using interpolation. This causes interpolation error.

Calibration of Open/Short/Load

The calibration data of Open/Short/Load is measured according to the following procedure while using the Cascade ISS (Impedance Standard Substrate). For more information on how to use ISS, refer to the Cascade Microtech's manual.

Step 1. Selection of measurement point for calibration/compensation

- Right-click to open the shortcut menu and select **Cal/Comp** (or press **Cal/ Compen**).
- Click the **Cal Menu** button.
- Click to open the **Cal Type** box and select the desired calibration/compensation measurement point mode. **User Freq&Pwr** (User-defined frequency/User-defined power mode) is recommended for performing calibration.

Cal Type Box	Calibration/Compensation Measurement Point Mode
Fixed Freq&Pwr	Fixed frequency/fixed power point
FixedFreq, UserPwr	Fixed frequency/user-defined power point
User Freq&Pwr	User-defined frequency/user-defined power point

Step 2. Measurement of open calibration data

- Set the probe tip to the open position in the ISS.
- Click the **Meas Open** button and measure the open calibration data.

NOTE

When you want to interrupt measurement of calibration data, click the **Abort Cal Meas** button shown during measurement.

When the measurement of each type of calibration data is finished, a check mark (✓) will appear to the left side of the corresponding calibration execution button. This mark indicates that the calibration data is stored.

Step 3. Measurement of short calibration data.

- Set the probe tip to the short position in the ISS.
- Click the **Meas Short** button and measure short calibration data.

Step 4. Measurement of load calibration data.

- a. Set the probe tip to the load position in the ISS.
- b. Click the **Meas Load** button and measure the load calibration data.

Step 5. Finishing calibration data measurement and confirmation of calibration state.

- a. Click the **Done** button to finish measuring the calibration data.

NOTE

To delete all measured calibration data, click the **Cal Reset** button. At the same time, all stored fixture compensation data are also deleted.

- b. Confirm the calibration state according to the display of the **Cal Menu** button as follows.

Display of Cal Menu button	Calibration State
Cal Menu [Fix]	Calibration is on while in the fixed frequency/fixed power point mode
Cal Menu [FixR]	Calibration is on while in the fixed frequency/user-defined power point mode
Cal Menu [User]	Calibration is on while in the user-defined frequency/user-defined power point mode
Cal Menu [Uncal]	Calibration is off

CAUTION

If you change the probe head or the measurement pitch, you should again perform calibration.

C

Temperature Characteristic Test Kit (Option 007)

This appendix provides information necessary for measuring temperature characteristic using the thermal characteristic test kit (option 007).

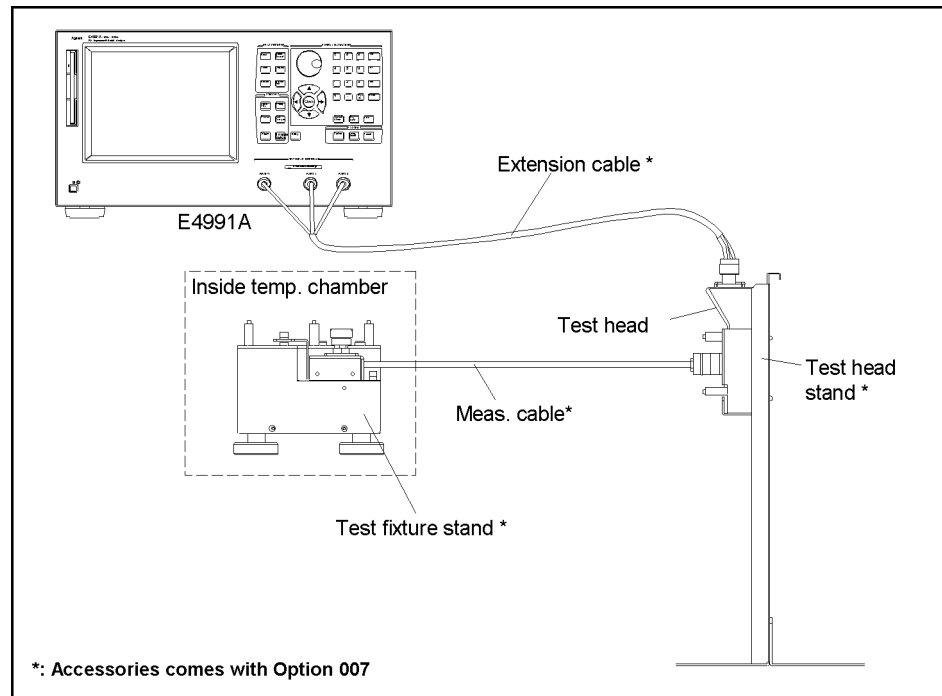
Overview

The E4991A option 007 temperature characteristic test kit extends the measurement terminal to measure the temperature characteristic of the DUT, and is used along with a temperature chamber^{*1}. This kit makes it possible to perform measurement within the range of -55°C to 150°C by extending the test head as close as possible to the temperature chamber, securing it with a stand, and using the heat-resistant measurement cable to connect the 7-mm terminal of the test head and the fixture stand placed in the temperature chamber, as shown in Figure C-1.

The temperature compensation feature using the built-in VBA macro feature is provided to perform temperature compensation for measurement results, decreasing errors due to temperature changes to acquire more accurate temperature characteristics.

Figure C-1

Overview of temperature characteristic test kit



e4991aoe853

*1. To be prepared by the user. The ESPEC SU-261 is recommended, but any other temperature chambers are possibly used.

Installation

To measure temperature characteristics using the temperature characteristic test kit, connect the devices as shown in Figure C-2.

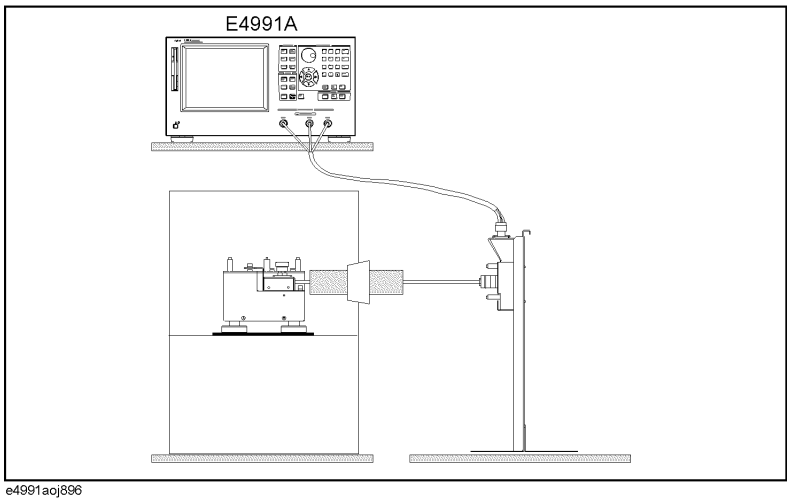
NOTE

Wait for at least 1 hour at the highest and lowest temperatures before starting measurement

In order to obtain stable measurement results, before starting measurement, keep the temperature inside the temperature chamber at the highest temperature of the actual measurement for at least 1 hour and then at the lowest temperature for at least 1 hour. This should be done each time you change the installation.

Figure C-2

Temperature characteristic measurement system

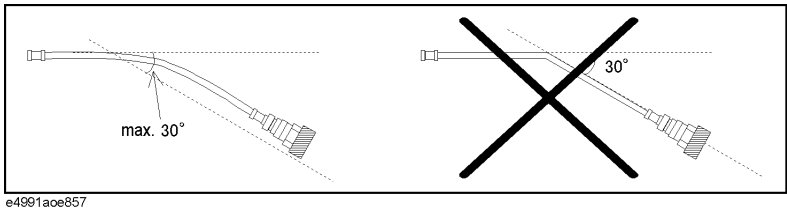


Cautions for protecting cable

- ❑ Use the heat-resistant measurement cable, keeping it straight where possible. If unavoidable, bent it gradually within 30° or less relative to the horizontal as shown in the left figure of Figure C-3.

Figure C-3

Condition for bending measurement cable



- ❑ Connect the extension cable after all the other settings are completed. After connected, the cable should be carefully handled. In particular, when you connect/disconnect the adapter and the N connector with the cable connected to the adapter or when you forcefully move the connected extension cable, the connector part is stressed and may be damaged.

Connection procedure

1. Mount the test head to the stand.

Step 1. Remove the test head from the E4991A.

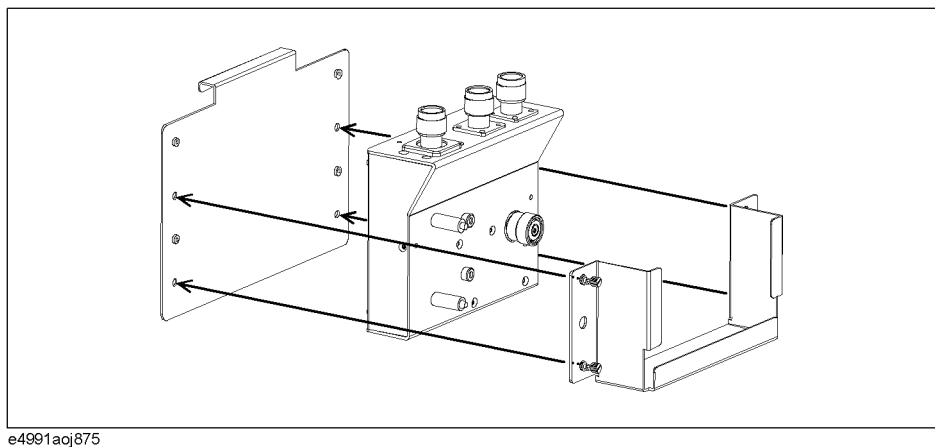
NOTE

First, remove the Type N connector connected to RF OUT. Then, turn both the Type N connectors connected to PORT1 and PORT2 at the same time to remove them.

Step 2. Secure the test head you removed to the test head holder.

Figure C-4

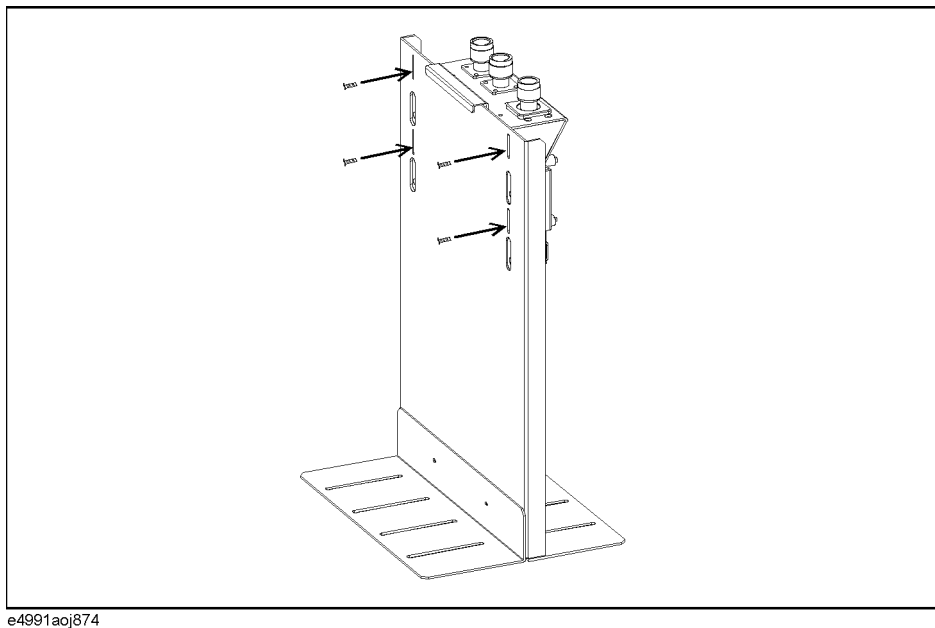
Securing test head



Step 3. Mount the test head holder to the stand. At this time, do not secure it completely for later fine positioning.

Figure C-5

Mounting test head holder

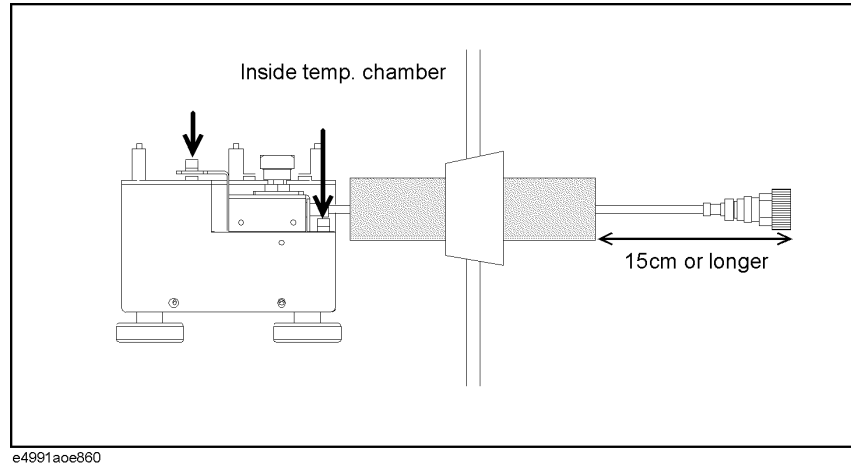


2. Install the measurement cable in the temperature chamber.

- Step 1.** Insert the measurement cable into the hole in the temperature chamber so that the Type L, 7-mm connector side faces the inside of the temperature chamber. Attach heat insulating materials to the cable as necessary.
- Step 2.** Adjust the position of the test fixture stand so that the length of the part of the measurement cable that is exposed to air outside the temperature chamber (refer to Figure C-6) is 15 cm or longer, and install the measurement cable to the stand.

Figure C-6

Installing measurement cable to test fixture stand

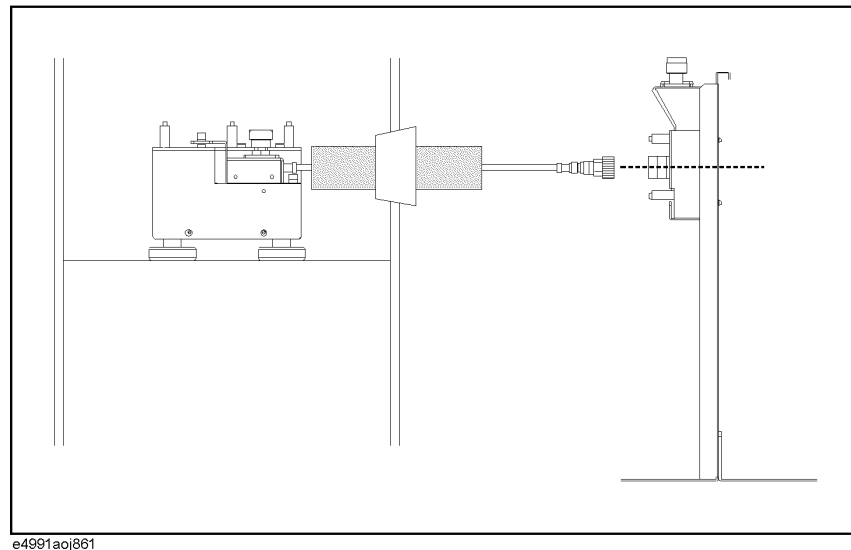


3. Connect the measurement cable to the test head.

- Step 1.** Adjust the position of the stand so that the 7-mm connector of the measurement cable and the 7-mm connector of the test head (DUT port) are located at the same height. In this step, fine adjust the position of the test head holder temporarily mounted and secure it tightly.

Figure C-7

Connecting measurement cable and test head



- Step 2.** Connect the measurement cable and the test head.

4. Connect the extension cable between the E4991A and the test head.

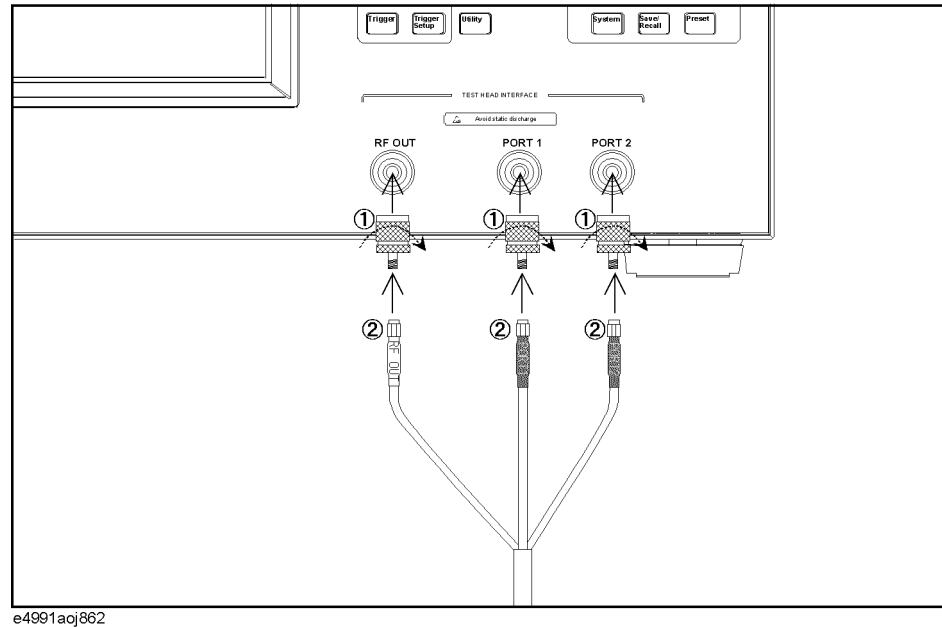
Step 1. Connect the N (male) - 3.5 mm (female) adapters to RF Out, Port 1, and Port 2 on the E4991A and then connect the cables to the corresponding ports whose names are written on the extension cable.

NOTE

To avoid damage to the connectors of the extension cable, be sure to connect the adapters to the E4991A first, and then connect the extension cable to the adapters.

Figure C-8

Connecting extension cable and E4991A

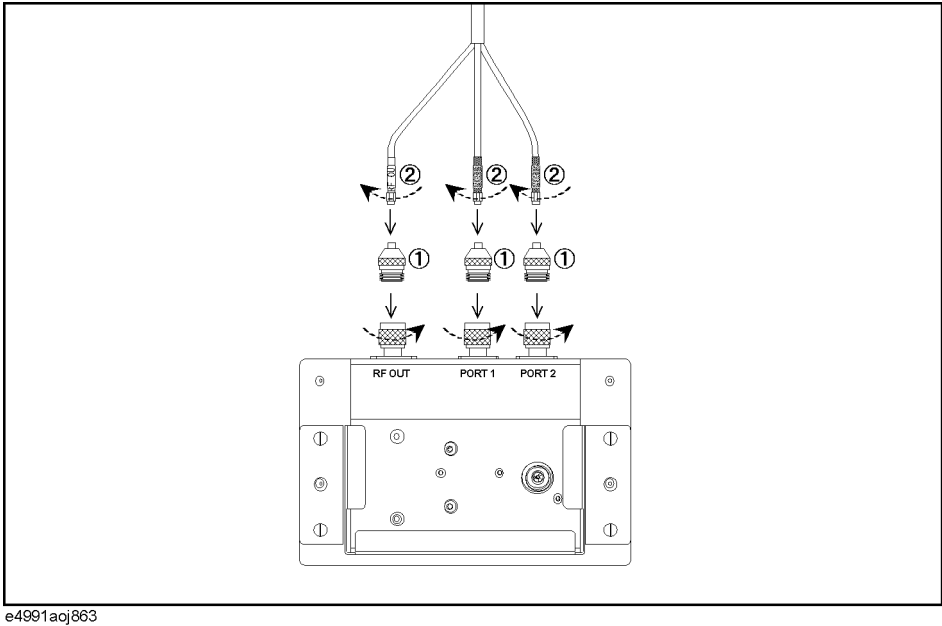


Step 2. Connect the N (female) - 3.5 mm (female) adapters to RF Out, Port 1, and Port 2 on the test head and then connect the cables to the corresponding ports whose names are written on the extension cable.

NOTE

To avoid damage to the connectors of the extension cable, be sure to connect the adapters to the test head first, and then connect the extension cable to the adapters.

Figure C-9 Connecting extension cable and test head



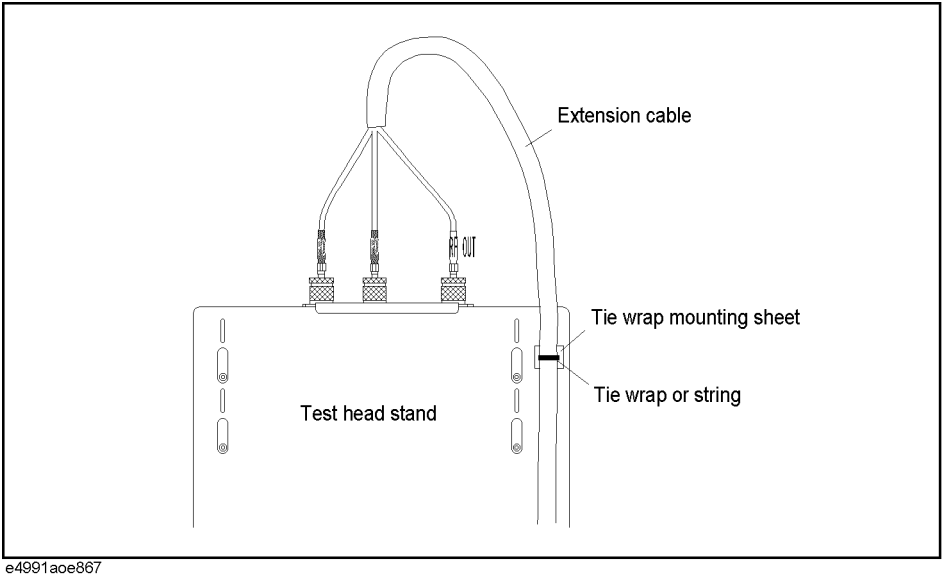
Step 3. To decrease stress on the connector part due to the move of the extension cable, stick the attached mount cable tie (1400-0584) to an appropriate position, and use tie wraps or strings to tie the extension cable to the seat for securing.

NOTE

When routing the extension cable downward, be sure to secure it at an upper part of the stand.

When you need to route the extension cable downward (for example, when placing the E4991A by the test head stand), the weight of the cable itself may stress the connector part. To decrease this overload, secure the extension cable at an upper part of the stand as shown in Figure C-10.

Figure C-10 Securing extension cable



Calibration/compensation

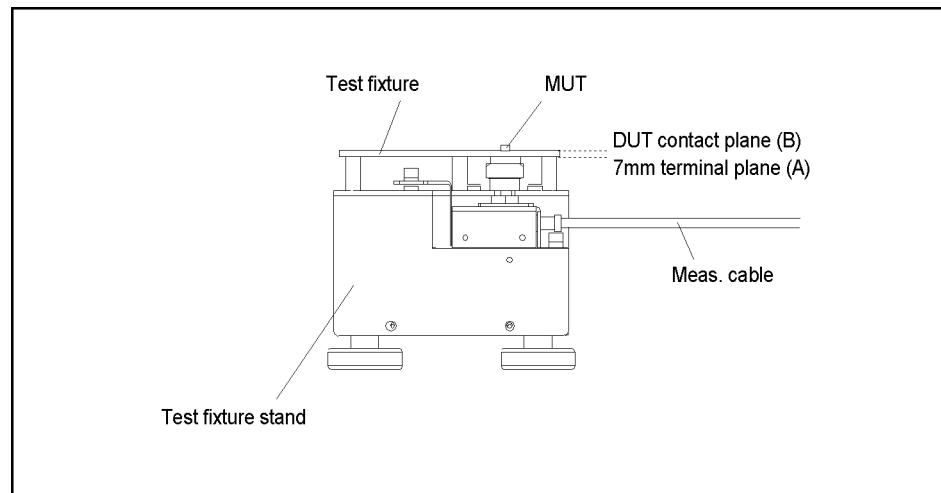
The measurement set with the temperature characteristic test kit connected requires the same calibration/compensation procedures as with usual connection in which the test head is connected directly to the E4991A, except for the calibration reference surface. Perform calibration at room temperature.

While the calibration reference surface is the 7-mm terminal of the test head or the test fixture connected to the 7-mm terminal for the E4991A with the test head is directly connected, it is the 7-mm terminal of the tip of the heat-resistant measurement cable (A in Figure C-11) or the DUT connection terminal of the test fixture connected to the tip of the measurement cable (B in Figure C-11) for the one with the temperature characteristic test kit connected.

For more information about calibration/compensation, see Chapter 4, “Calibration and Compensation.”

Figure C-11

Calibration reference surface



e4991aoe864

F Information on Maintenance

This appendix explains the measures you should take to maintain the Agilent E4991A.

Cleaning this Instrument

This section describes how to clean the instrument.

WARNING

To protect yourself from electrical shock, be sure to unplug the power cable from the outlet before cleaning the instrument.

Never clean the internal components of the instrument.

Cleaning an LCD

Use one of the following methods to clean the display surface regularly.

- For normal cleaning, wipe the surface gently with a soft cloth that is dry or wetted with a small amount of water and wrung tightly.
- When stains are difficult to remove, gently wipe the surface with cloth damped with a small amount of ethanol or isopropyl alcohol.

NOTE

Do not use chemicals other than ethanol and isopropyl alcohol to wet the cleaning cloth.

Maintenance of Connectors/Ports

A 7-mm connector is used for the test head of the E4991A. The N-type connector is used for the front panel. In the RF band, dirt or damage to connectors significantly affects measurement accuracy. Take special care about the following.

- Always keep the connectors free from stains and dust.
- Do not touch the contact surface on the connectors.
- Do not plug damaged or scratched connectors into the test ports.
- Use compressed air for cleaning connectors. Do not use abrasives under any circumstance.

Observe the above instruction for the connectors and ports not on the test head or the front panel.

Procedure to replace center conductor collet of 7-mm connector.

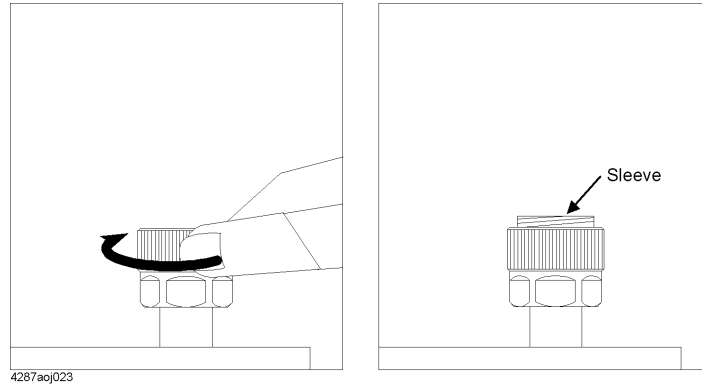
Required tools

	Agilent part number
Collet removal tool	5060-0370
6-slot precision collet	85050-20001

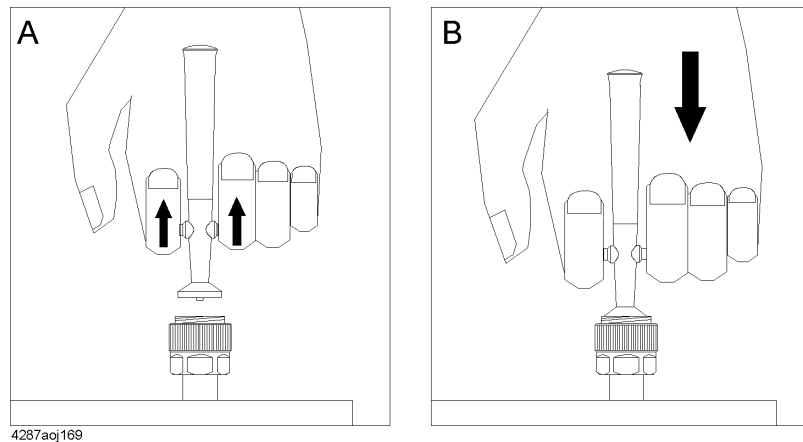
Removing center conductor collet

Follow these steps to remove the center conductor collet of the 7-mm connector.

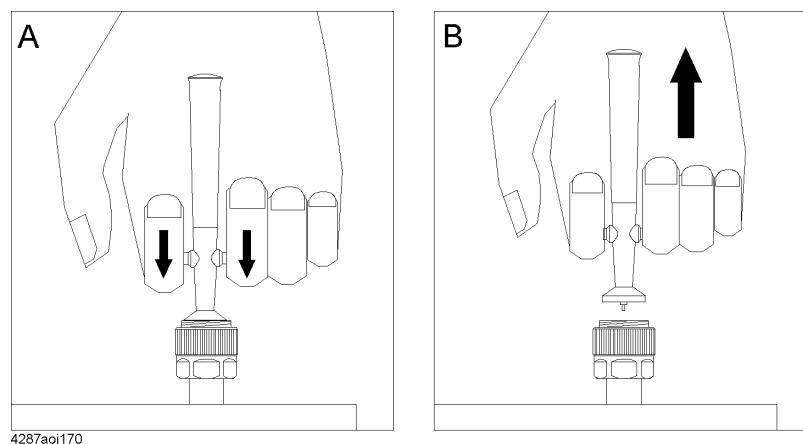
- Step 1.** Turn the outer part of the 7-mm connector clockwise viewed from above to completely expose the connector sleeve.



- Step 2.** Pull up the handle of the collet replacement tool (Figure A below) and, while keeping pulling the handle, insert the replacement tool slowly until it touches the end of the connector (Figure B below).



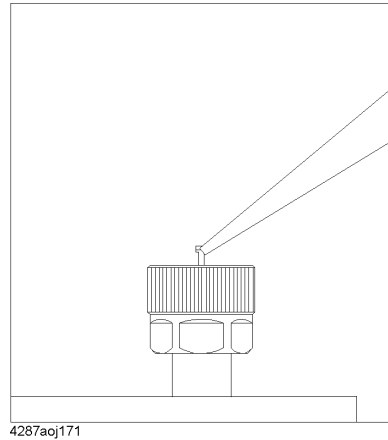
- Step 3.** After releasing the handle (Figure A below), pull up the collet removal tool (Figure B below) to remove the old collet.



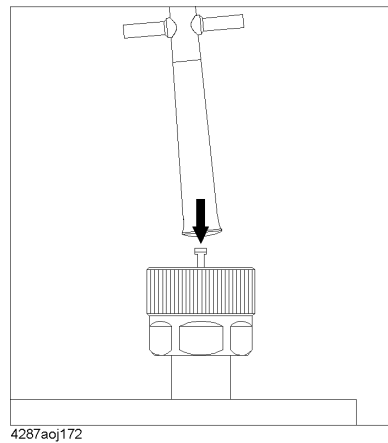
Installing center conductor collet

Follow these steps to install the center conductor collet of the 7-mm connector.

Step 1. Insert the collet into the center conductor of the connector.



Step 2. Push the collet slowly as far as it will go.



Cleaning a Display Other than an LCD

To remove stains on parts other than the LCD, test ports, and other connectors/ports of the instrument, wipe them gently with a soft cloth that is dry or wetted with a small amount of water and wrung tightly.

Cautions Applicable to Requesting Repair, Replacement, Regular Calibration, etc.

Devices to be Sent Back for Repair or Regular Calibration

If it is necessary to send the unit to the Service Center of Agilent Technologies for repair or regular calibration, please follow the instructions below.

Devices you must send

When you ask our service center for repair or periodic calibration of the instrument, send the E4991A with the following accessories attached. No other accessories have to be sent.

- ☐ Test head
- ☐ Calibration kit

For Option 010, send the following accessories in addition to the above.

- ☐ Option 010 test head (with extension cable)
- ☐ N (male) - SMA (female) conversion adapter (x 3)

For Option 007, send the following accessories in addition to the above.

- ☐ Measurement cable (heat-resistant)
- ☐ Extension cable
- ☐ N (male) - SMA (female) conversion adapter (x 3)
- ☐ N (female) - SMA (female) conversion adapter (x 3)

Packing

Use the original package and shock absorbers, or equivalent antistatic packing materials, when sending the unit.

Shipping Address

For the location of the nearest Agilent Technologies Service Center, contact the Customer Contact listed at the end of this brochure.

Recommended Calibration Period

The recommended calibration period for this instrument is one year. The user is recommended to request the Company's Service Center to perform regular calibration every year.

Information on Maintenance

Cautions Applicable to Requesting Repair, Replacement, Regular Calibration, etc.