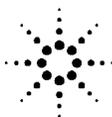


Agilent 4286A RF LCR meter
User's Guide

SERIAL NUMBERS

This manual applies directly to instruments with serial number prefix JP3KC and above, or whose firmware is version 2.0. For additional important information about serial numbers, read "Serial Number" in Appendix A of this manual.



Agilent Technologies
Innovating the HP Way

Agilent Part No. 04286-90031
Printed in JAPAN December 1999

Fifth Edition

Notice

The information contained in this document is subject to change without notice.

This document contains proprietary information that is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of the Agilent Technologies.

Agilent Technologies Japan, Ltd.
Component Test PGU-Kobe
1-3-2, Murotani, Nishi-ku, Kobe-shi,
Hyogo, 651-2241 Japan

MS-DOS[®] is a U.S. registered trademark of Microsoft Corporation.
APC-7[®] is a U.S. registered trademark of Bunker Ramo Corporation.

Manual Printing History

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

June 1995	First Edition (part number: 04286-90001)
July 1995	Second Edition (part number: 04286-90011)
September 1998	Third Edition (part number: 04286-90021)
April 1999	Fourth Edition (part number: 04286-90031)
December 1999	Fifth Edition (part number: 04286-90031)

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific **WARNINGS** elsewhere in this manual may impair the protection provided by the equipment. In addition it violates safety standards of design, manufacture, and intended use of the instrument.

The Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

Note



4286A is designed for use in INSTALLATION CATEGORY II according to IEC 61010-1 and POLLUTION DEGREE 1 according to IEC 61010-1 and IEC 60664-1. 4286A is an INDOOR USE product.

Note



LEDs in 4286A are Class 1 in accordance with IEC60825-1.
CLASS 1 LED PRODUCT

Ground The Instrument

To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Dangerous Procedure Warnings

Warnings , such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning



Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: icons are symbols.
<i>Italics</i>	Italic type is used for emphasis and for titles of manuals and other publications. Italic type is also used for keyboard entries when a name or a variable must be typed in place of the words in italics. For example: copy <i>filename</i> means to type the word <i>copy</i> , to type a space, and then to type the name of a file such as <i>file1</i> .
Computer	Computer font is used for on-screen prompts and messages.
	Labeled keys on the instrument front panel are enclosed in  .
	Softkeys located to the right of the CRT are enclosed in  .

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

For any assistance, contact your nearest Agilent Technologies Sales and Service Office. Addresses are provided at the back of this manual.

Safety Symbols

General definitions of safety symbols used on equipment or in manuals are listed below.



Instruction manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.



Alternating current.



Direct current.



On (Supply).



Off (Supply).

Warning



This **Warning** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

Caution



This **Caution** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Note



Note denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.



Affixed to product containing static sensitive devices use anti-static handling procedures to prevent electrostatic discharge damage to component.

Contents

1. Brief Description of the 4286A	
Front and Rear Panels	1-2
2. Installation and Set Up Guide	
Incoming Inspection	2-1
Rack Mounting	2-3
Power Cable	2-5
Power Requirements	2-7
Ventilation Requirements	2-7
Instruction for Cleaning	2-7
Connecting the Connector Box	2-7
 Connecting the Test Head	2-9
 Connecting the Test Head with L-type Coaxial Adapter (Option 022 only)	2-9
Connecting the APC-3.5 to 7mm Adapter	2-10
Connecting a Keyboard (Option 1C2 Only)	2-11
3. Basic Measurement Procedures	
Measurement Outline	3-2
Basic Measurement Flow	3-2
Required Equipment	3-3
1. Power ON	3-4
Line Input Receptacle	3-4
 Fuse	3-4
Steps to turn on the power	3-4
2. Setting up the 4286A	3-5
2-1. Setting up for L _s -Q Frequency Characteristics Measurements	3-5
2-2. Creating a sweep table	3-5
2-3. Setting the OSC level	3-5
3. Calibration	3-7
Calibration Procedure	3-7
4. Connecting the Test Fixture	3-12
Selecting a Test Fixture	3-12
Connecting the Test Fixture to the Test Head	3-12
5. Setting the Electrical Length of the Test Fixture	3-14
6. Fixture Compensation	3-15
Performing SHORT Compensation	3-15
SHORT Compensation Key Sequence	3-17
Performing OPEN Compensation	3-18
OPEN Compensation Key Sequence	3-18
7. Connecting the DUT to the Test Fixture	3-19
8. Measuring the DUT	3-20

4. 4286A with Chip Handler	
Differentiation of DUTs through BIN Sorting	4-2
Editing BIN Table	4-2
Setting up Handler Interface	4-3
BIN Sorting	4-3
GO/NO-GO Test with Limit Test Function	4-4
Editing Limit Table	4-4
Setting up Handler Interface	4-5
Limit Test	4-6
Contact Check	4-7
Setting up Beeper	4-8
Display Updating ON/OFF	4-9
Setup Linking 4286A and Chip Handler	4-10
Setting up Handler Interface Board	4-11
Checking Default Settings	4-11
Selecting Settings	4-12
Changing Settings	4-13
Removing the Top Cover	4-13
Setting up Control Output Signal and DC Isolated Input Signal	4-13
Using External Power Source	4-13
Using Internal Power Source	4-14
Setting up the Internal Power Source	4-14
Mounting the Top Cover	4-14
Mounting a Pull-up Resistor	4-15
Pull-up Resistor for Comparator Signals	4-15
Pull-up Resistor for Control Output Signal	4-15
Setting up Output Signal Pattern	4-16
4286A Measurement Time	4-19
Electrical Specification of Handler Interface	4-21
Signal Output Mode	4-22
Signal Lines	4-22
Pin Assignment and Signal Definitions (Mode 1)	4-23
Pin Assignment and Signal Definitions (Mode 2)	4-27
Electrical Characteristics of Signals	4-33
DC Isolated Output Signals	4-33
DC Isolated Input Signals	4-35
Handler Interface Board Switches	4-37
Top Cover Removal	4-37
Tools Required	4-37
Procedure	4-37
Top Cover Attachment	4-37
Procedure	4-37
Performing Calibration with Working Standard (only with option 004)	4-39
Measuring the Working Standard Value	4-39
Calibration with Working Standard	4-39
Restoring Settings After Power Interruption	4-41

5. Typical Functions	
Point Delay and Sweep Delay	5-2
Making a Point Delay Measurement	5-2
Making a Sweep Delay Measurement	5-2
Delay Description	5-2
Averaging	5-3
Further Discussion	5-3
OSC Level Monitor	5-4
Entering Titles on the Screen	5-5
Title Entry Procedure	5-5
Saving and Recalling	5-6
Saving 4286A Setting and Measurement Trace	5-6
Recalling a Saved 4286A Setting and Measurement Trace	5-6
Saving a Display Image to an HP-GL File	5-7
Saving Measured Data for a Spreadsheet	5-7
Purging a File	5-7
Initializing a Disk/RAM Disk for Use	5-7
Printing or Plotting	5-9
Printing or Plotting a Display Image	5-9
Using a Different GPIB Address for the Printer/Plotter	5-9
Logging the Key Sequence into a Program (Option 1C2 Only)	5-10
Resetting the 4286A	5-11
A. Manual Changes	
Introduction	A-1
Manual Changes	A-1
Serial Number	A-2
B. Maintenance	
Performance Verification	B-1
Repair	B-1
Possible Problems and Their Solution	B-1
Replacement of Center Conductor Collet	B-2
Changing the Line Voltage Setting	B-4
 Replacing the Fuse	B-6
C. Fixture Compensation Procedures for the 16191A and 16193A	
16191A	C-1
SHORT Compensation	C-1
SHORT Compensation Key Sequence	C-3
OPEN Compensation	C-3
OPEN Compensation Key Sequence	C-4
Connecting DUT	C-4
16193A	C-6
SHORT Compensation	C-6
SHORT Compensation Key Sequence	C-7
OPEN Compensation	C-7
OPEN Compensation Key Sequence	C-8
Connecting DUT	C-8

Index

Figures

1-1. 4286A Front Panel	1-2
1-2. 4286A Rear Panel	1-2
2-1. Contents of Package	2-4
2-2. Power Cable Supplied	2-6
2-3. Connecting the Connector Box to the Mainframe	2-8
2-4. Connecting a Keyboard	2-11
3-1. Basic Flow for Impedance Measurements	3-2
3-2. Required Equipment	3-3
3-3. Line Input Receptacle and Fuse	3-4
3-4. Calibration	3-7
3-5.	3-8
3-6.	3-8
3-7.	3-8
3-8.	3-9
3-9.	3-9
3-10.	3-9
3-11.	3-10
3-12.	3-10
3-13.	3-13
3-14.	3-13
3-15. Connecting the Test Fixtures (16192A)	3-13
3-16. Fixture Compensation	3-15
4-1. Example of BIN Table	4-2
4-2. Basic Flow of Handler Interface Setting	4-17
4-3. BIN Sorting	4-23
4-4. Limit Test	4-23
4-5. Timing Diagram (Mode 1)	4-26
4-6. BIN Sorting	4-28
4-7. Limit Test	4-28
4-8. Timing Diagram (mode 2: On Sweep Mode)	4-32
4-9. Timing Diagram (mode 2: On Point Mode)	4-32
4-10. Circuit Configuration of Comparator Output Signals	4-34
4-11. Circuit Configuration of Control Output Signals	4-35
4-12. Circuit Configuration of Handler Interface Input Signals	4-36
4-13. Handler Interface Board Switches	4-37
5-1. Point Delay and Sweep Delay	5-2
5-2. Point Averaging	5-3
5-3. Level Monitor Function	5-4
5-4. Label Function	5-5
A-1. Serial Number Plate	A-2

Tables

2-1. Contents	2-2
2-2. Rack Mount Kits	2-3
3-1. Example of Measurement Conditions	3-5
3-2. Test Fixture Specification	3-12
3-3. Dimension of Shorting Devices	3-15
3-4. Dimension of Shorting Devices	3-16
4-1. Example of limit setting	4-4
4-2. Handler Interface Board Setup Worksheet	4-12
4-3. SW1 Setting	4-13
4-4. SW2 Setting (External power source:1)	4-14
4-5. SW2 Setting (External Power Source:2)	4-14
4-6. SW2 Setting(Internal Power Source)	4-14
4-7. Typical Pull-up Resistance for Comparator Signals	4-15
4-8. Typical Pull-up Resistance for DC Isolated Input Signal	4-15
4-9. Pin Assignment of Handler Interface Connector (Mode 1)	4-24
4-10. Signal Definition (Mode 1)	4-25
4-11. Handler Interface Connector Pin Assignment (Mode 2)	4-29
4-12. Signal Definition (Mode 2)	4-30
4-13. Electrical Characteristics of DC Isolated Output Signals	4-33
4-14. Electrical Characteristics of DC Isolated Input Signals	4-36
4-15. Typical Values of Working Standard (with option 004)	4-40
A-1. Manual Changes by Serial Number	A-1
A-2. Manual Changes by Firmware Version	A-1
B-1. Line Voltage Ranges	B-4

Brief Description of the 4286A

- Key specification assuring high accuracy impedance measurement in the RF region
 - Measurement frequency: 1 MHz to 1 GHz
 - Basic measurement accuracy: 1%
 - Impedance measurement range: 200 m Ω to 3 k Ω
 - High accuracy Q factor measurement(6%, @Q=100, 100 Mhz)
- Features simplifying integration to your system
 - GPIB, Handler Interface
 - HP Instrument BASIC(Option 1C2)
 - 1 m / 3 m selectable measurement cable
 - Test head with APC 3.5 connector
- Capabilities allowing high throughput testing
 - High-speed measurement(15 ms)
 - Comparator function
 - Contact checking function
 - List sweep

Front and Rear Panels

This section outlines the 4286A front and rear panels. See the *Function Reference* for functions available with key blocks and connectors as well as operation procedures of these blocks.

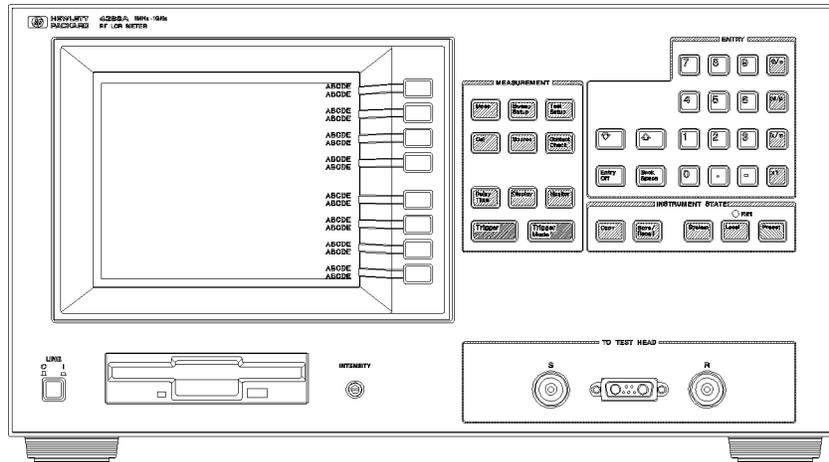


Figure 1-1. 4286A Front Panel

Each of the functions available with the 4286A becomes active when you press the corresponding hardkey or softkey on the front panel. When a function is active, you can enter a new setting or change the current setting. Measurement results and conditions as well as the 4286A settings are displayed on the CRT. I/O ports to connect to the connector box and a floppy disk drive to store data and 4286A settings are also provided on the front panel.

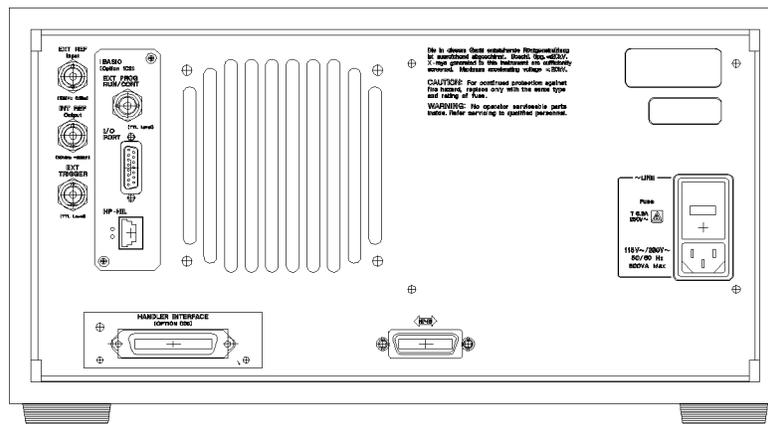


Figure 1-2. 4286A Rear Panel

An I/O port is provided on the rear panel. Connecting to external equipment through this port allows the 4286A to be controlled by external equipment or allows it to control external equipment. When you install the optional option 1C2, the BASIC program control connector, external keyboard control connector, and parallel I/O port controlled by BASIC programs will be also available for use.

Installation and Set Up Guide

This chapter provides the information necessary for performing an incoming inspection and setting up your 4286A.

Incoming Inspection

Warning

To avoid hazardous electrical shock, do not turn on the 4286A when there are signs of shipping damage to any portion of the outer enclosure (for example, covers, panel, or display)

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the 4286A has been checked mechanically and electrically. The contents of the shipment should be as listed in Table 2-1. If the contents are incomplete, if there is mechanical damage or defect, or if the 4286A does not pass the power-on selftests, notify the nearest Agilent Technologies office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Agilent Technologies office. Keep the shipping materials for the carrier's inspection.

The line voltage selector is set at the factory to correspond to the most commonly used line voltage of the country of destination. If you want to change the line voltage, see "Changing the Line Voltage Setting" in Appendix B.

Table 2-1. Contents

Description	Agilent Part Number
RF LCR meter	4286A
Mainframe	
Fixture Stand ¹	
Right Angle Type Test Head with 1-m cable ²	
Documents ³	
User's Guide ⁴	04286-90001
Function Reference ⁴	04286-90002
Programming Manual ⁴	04291-90007
APC-3.5 to 7mm Adapter	1250-1746
Power Cable ⁴	8120-4753 (See Fig in Spec.)
Calibration Kit ⁵	
0 S Termination	04186-85302
0 Ω Termination	04186-85300
50 Ω Termination	04286-65006
LOW-LOSS Capacitor	04291-60042
Carrying Case ⁴	04291-60041
Option 021 only	
Straight Angle Type Test Head with 1-m cable	04286-60121
L-type Coaxial Adapter	1250-1249
Option 022 only	
Straight Angle Type Test Head with 3-m cable	04286-60122
L-type Coaxial Adapter	1250-1249
Option 032 only	
Right Angle Type Test Head with 3-m cable	04286-60132

1 Not included when Option 002 is ordered.

2 Not included when Option 031 is ordered.

3 Not included when Option 0B0 is ordered.

4 Accessories are not shown in Figure 2-1.

5 Not included when Option 001 is ordered.

Table 2-1. Contents (continued)

Description	Agilent Part Number
Option 004 only	
Shorting Device	
1.0×0.5 mm	16191-29005
1.6×0.8 mm	16191-29006
2.0×1.25 mm	16191-29007
3.2×1.6	16191-29008
51Ω Chip Resistor	
1.0×0.5 mm	5182-0433
1.6×0.8 mm	5182-0434
2.0×1.25 mm	5182-0435
3.2×1.6 mm	5182-0436
Device Case	1540-0692
Option 0BW only	
Service Manual ¹	04291-90101
Option 1C2 only	
Keyboard Template ¹	08751-87111
HP-HIL Keyboard ¹	HP 46021C Option ABA
Keyboard Cable ¹	46020-60001
HP Instrument BASIC User's Handbook ¹	E2083-90000
HP Instrument BASIC User's Handbook Supplement	04286-90005

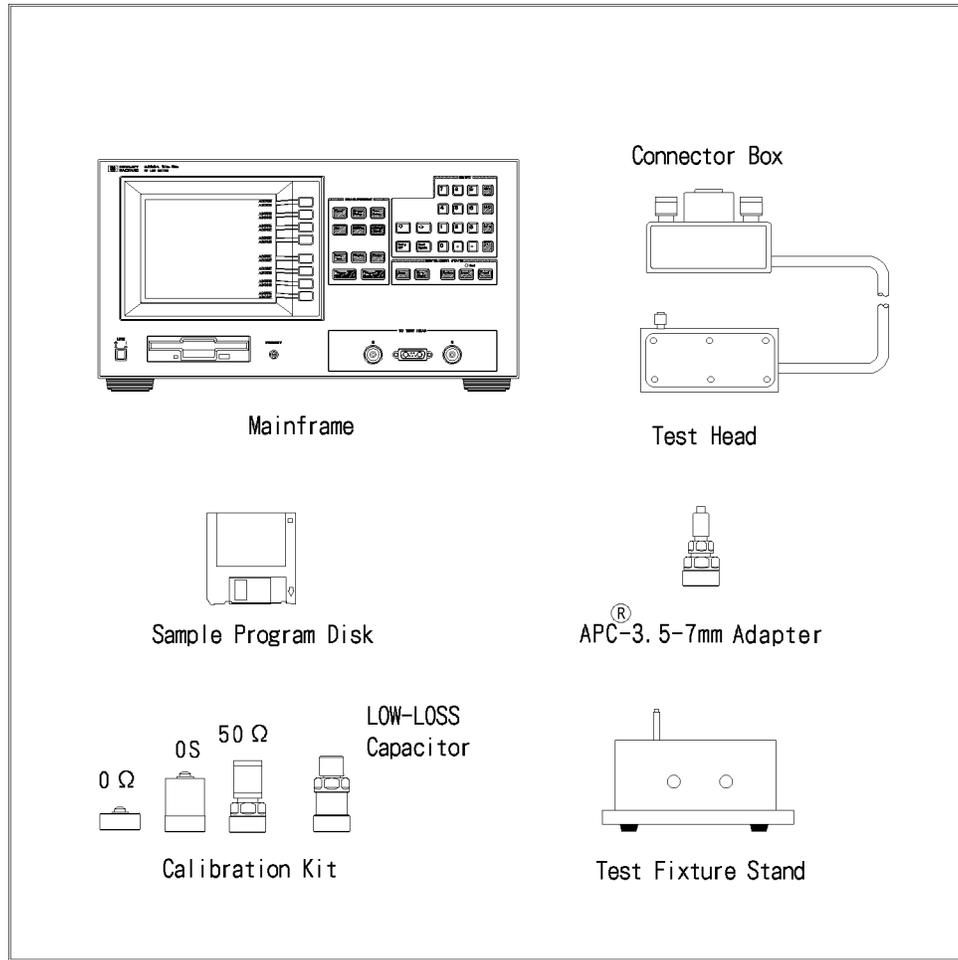
¹ This item is not shown in Figure 2-1.

Rack Mounting

Rack mounting information is provided with the rack mount kit. If the kit was not ordered with the 4286A as an option, it may be ordered through the nearest Agilent Technologies office. The part numbers of the rack mount kit are shown in Table 2-2.

Table 2-2. Rack Mount Kits

Option	Description	Agilent Part Number
1CN	Handle Kit	5062-3991
1CM	Rack Flange Kit	5062-3979
1CP	Rack Mount & Handle Kit	5062-3985



C9102J04

Figure 2-1. Contents of Package

Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of the power cables available.

Warning



For protection from electrical shock, the power cable ground must not be defeated.

The power plug must be plugged into an outlet that provides a protective earth ground connection.

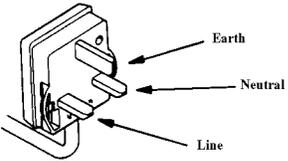
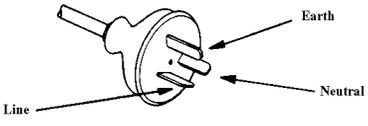
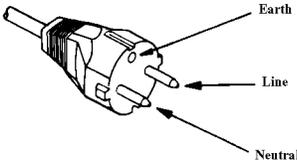
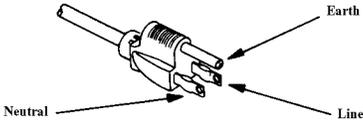
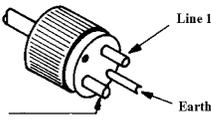
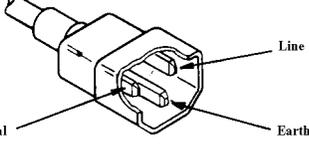
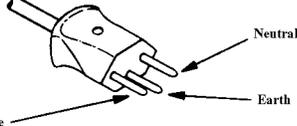
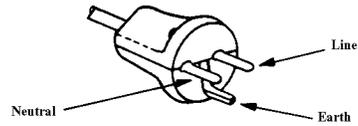
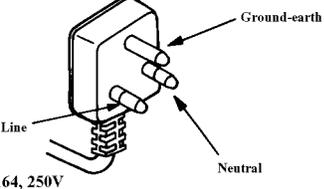
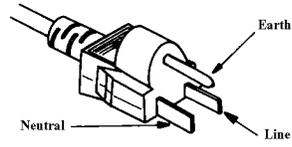
<p>OPTION 900 United Kingdom</p>  <p>Plug : BS 1363A, 250V Cable : HP 8120-1351</p>	<p>OPTION 901 Australia / New Zealand</p>  <p>Plug : NZSS 198/AS C112, 250V Cable : HP 8120-1369</p>
<p>OPTION 902 European Continent</p>  <p>Plug : CEE-VII, 250V Cable : HP 8120-1689</p>	<p>OPTION 903 U.S. / Canada</p>  <p>Plug : NEMA 5-15P, 125V, 15A Cable : HP 8120-1378</p>
<p>OPTION 904 U.S. / Canada</p>  <p>Plug : NEMA 6-15P, 250V, 15A Cable : HP 8120-0698</p>	<p>OPTION 905* Any country</p>  <p>Plug : CEE 22-VI, 250V Cable : HP 8123-1396</p>
<p>OPTION 906 Switzerland</p>  <p>Plug : SEV 1011.1959-24507 Type 12, 250V Cable : HP 8120-2104</p>	<p>OPTION 912 Denmark</p>  <p>Plug : DHCR 107, 220V Cable : HP 8120-2956</p>
<p>OPTION 917 India / Republic of S.Africa</p>  <p>Plug : SABS 164, 250V Cable : HP 8120-4211</p>	<p>OPTION 918 Japan</p>  <p>Plug : JIS C 8303, 125V, 15A Cable : HP 8120-4753</p>
<p>NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).</p> <p>* Plug option 905 is frequently used for interconnecting system components and peripherals.</p>	

Figure 2-2. Power Cable Supplied

Power Requirements

4286A requires a following power source:

Voltage : 90 to 132 Vac, 198 to 264 Vac

Frequency : 47 to 66 Hz

Power : 500 VA maximum

Ventilation Requirements

To ensure adequate ventilation, make sure that there is adequate clearance of at least 180 mm behind, 60 mm sides and 15 mm above and below.

Instruction for Cleaning

For cleaning, wipe with soft cloth that is soaked with water and wrung tightly without undue pressure.

Connecting the Connector Box

The 4286A consists of the mainframe, the test head, and the test fixture stand. The test head has a connector box that connects to the mainframe. This connection is shown in Figure 2-3. While you connect the connector box to the mainframe, turn off the 4286A.

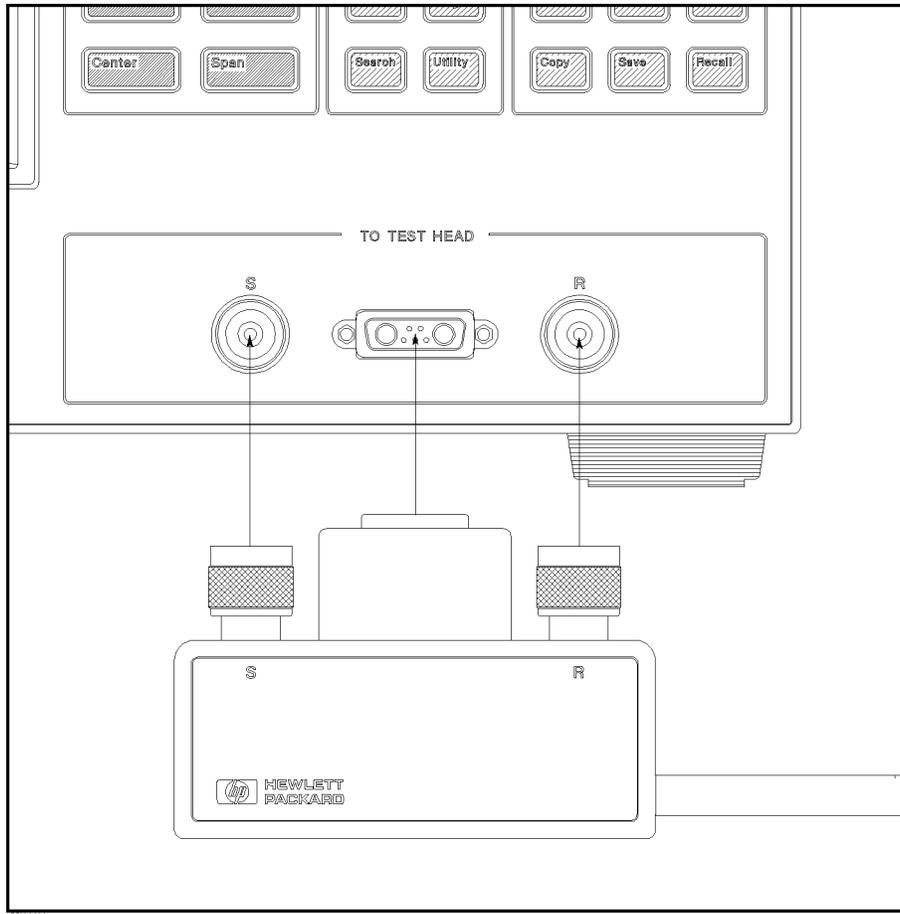


Figure 2-3. Connecting the Connector Box to the Mainframe

1. Engage the two type-N connectors (labeled S and R, respectively) and the center connector.
2. Turn the two type-N connectors to tighten the connection.

Connecting the Test Head

When you connect or replace the test head, turn off the 4286A.

1.  Place the test fixture stand on a level surface. At this time, make sure that the hexagonal hole on top of the stand is located in front of the two mounting posts as you look at the stand. Then, lay the stand on its side.
2.  Allow the test head to pass under the fixture stand from the side opposite to yours.
3.  Position the test head such that the connectors of the test head and holes on top of the fixture stand are aligned.
4.  Slightly tighten the two screws on the bottom surface of the fixture stand to ensure that the test head is sufficiently stable. Press screws to check for correct engagement of their thread.
5.  Further tighten the screws while holding the test head with your hand to completely secure the head in place.
6.  Place the fixture stand with its bottom surface down.

Connecting the Test Head with L-type Coaxial Adapter (Option 022 only)

When you connect or replace the test head, turn off the 4286A.

1.  Connect Connecting L-type Coaxial Adapter to the Test Head.
2.  Place the test fixture stand on a level surface. At this time, make sure that the hexagonal hole on top of the stand is located in front of the two mounting posts as you look at the stand. Then, lay the stand on its side.
3.  Allow the test head to pass under the fixture stand from the side opposite to yours.
4.  Position the test head such that the connectors of the L-type Coaxial adapter and holes on top of the fixture stand are aligned.
5.  Slightly tighten the two screws on the bottom surface of the fixture stand to ensure that the test head is sufficiently stable. Press screws to check for correct engagement of their thread.

6.  Further tighten the screws while holding the test head with your hand to completely secure the head in place.
7.  Place the fixture stand with its bottom surface down.

Connecting the APC-3.5 to 7mm Adapter

1. Check that the connector sleeve is fully extended.
2. Connect APC-3.5 to 7mm adapter to the test head connector through the hole on top of the fixture stand.
3. Tighten the adapter nut to secure this adapter in place.

Connecting a Keyboard (Option 1C2 Only)

When Option 1C2 is installed, an HP-HIL keyboard can be connected to the HP-HIL connector on the rear panel of the 4286A. The HP-HIL keyboard provides an easier way to enter characters for the file names, display titles, and Instrument BASIC programs. It can also access the 4286A softkey functions by using keyboard function keys. For more information on the HP-HIL keyboard, see the *HP Instrument BASIC User's Handbook Supplement* that is included in Option 1C2.

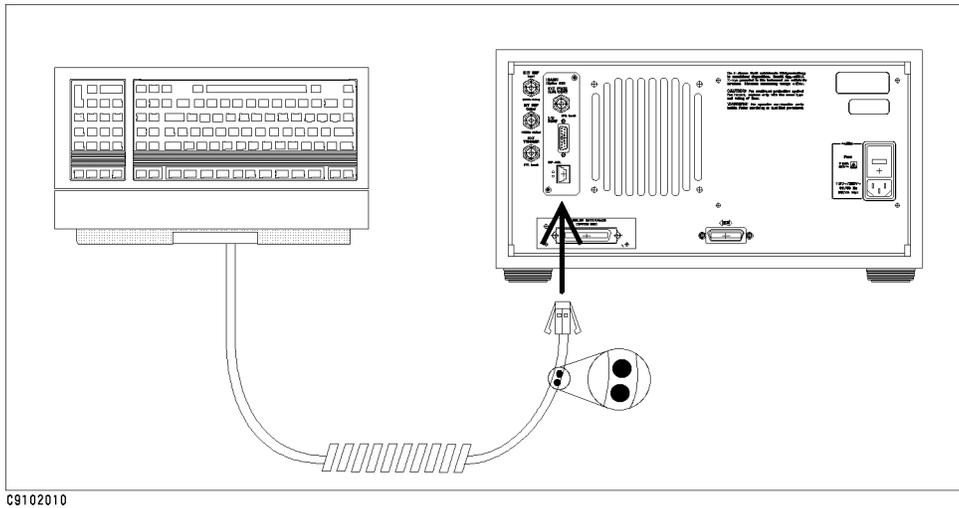


Figure 2-4. Connecting a Keyboard

Basic Measurement Procedures

This chapter provides a quick start guide of the 4286A. New users can quickly become familiar with the 4286A by following these procedures. In this chapter, to help you learn how to use the 4286A, impedance of inductors are measured as examples.

At the end of the quick start procedures, you will have learned how to get the following measurement results:

- Calibration
- Setting electrical length of test fixture
- Correction of test fixture
- List sweep

Measurement Outline

This chapter describes how to measure the impedance of a 100 nH inductor as an example. Measurement items and conditions are shown below.

Parameter	L_s - Q
Frequency	1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 MHz
OSC level	10 mA

Basic Measurement Flow

Figure 3-1 shows the basic flow for an impedance measurement.

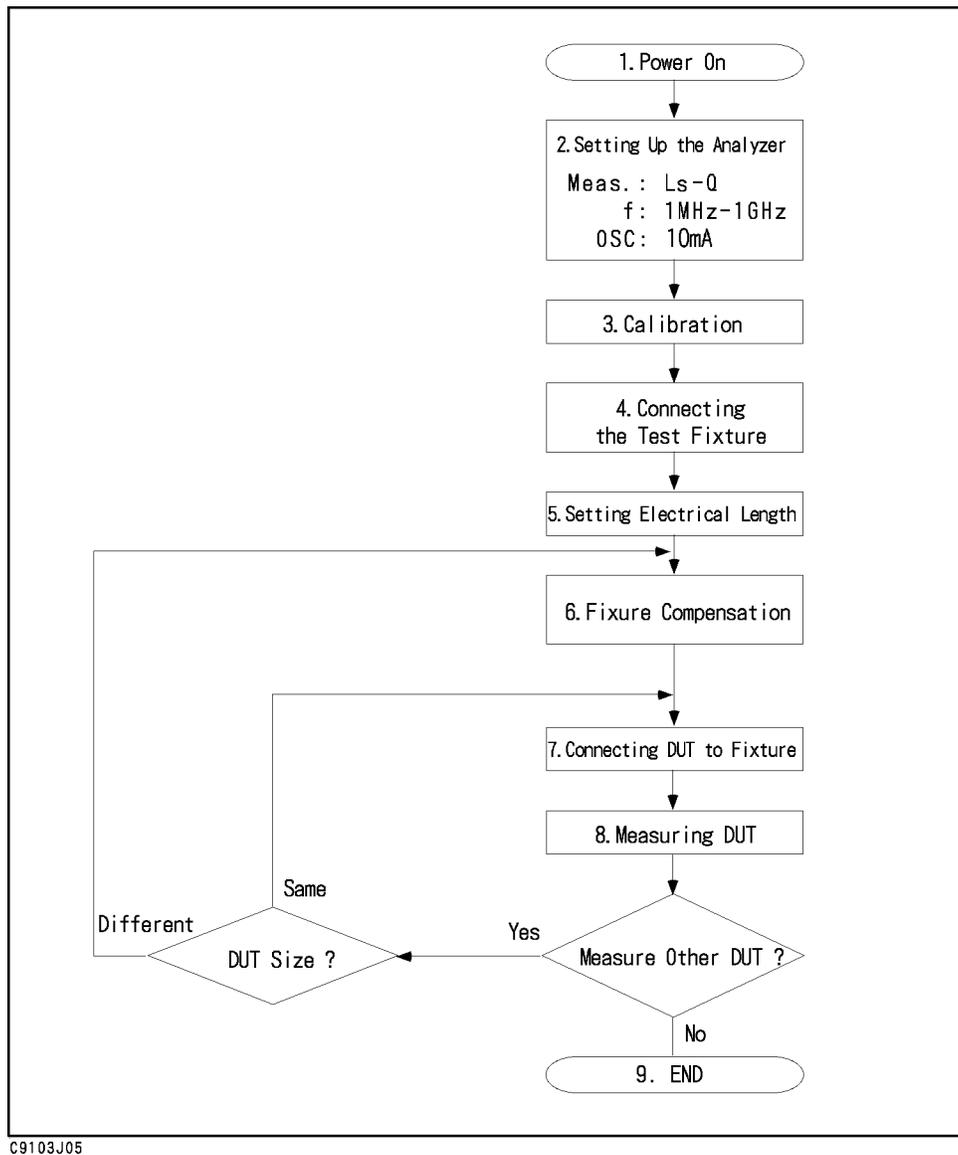


Figure 3-1. Basic Flow for Impedance Measurements

Required Equipment

To perform all the steps in this quick start, the following equipment is required:

- 4286A RF LCR meter
- Test Head
- Fixture Stand
- Calibration Kit
- Test Fixture
 - 16191A Side Electrode SMD Test Fixture, or
 - 16192A Parallel Electrode SMD Test Fixture, or
 - 16193A Small Side Electrode SMD Test Fixture
- Shorting Device Set (Included with 16191A, 16192A, 16193A, and Option 004 Working Standard Set)
- Tweezers (Included with 16191A, 16192A, and 16193A)
- Device Under Test (DUT) (A chip inductor is used in this guide.)

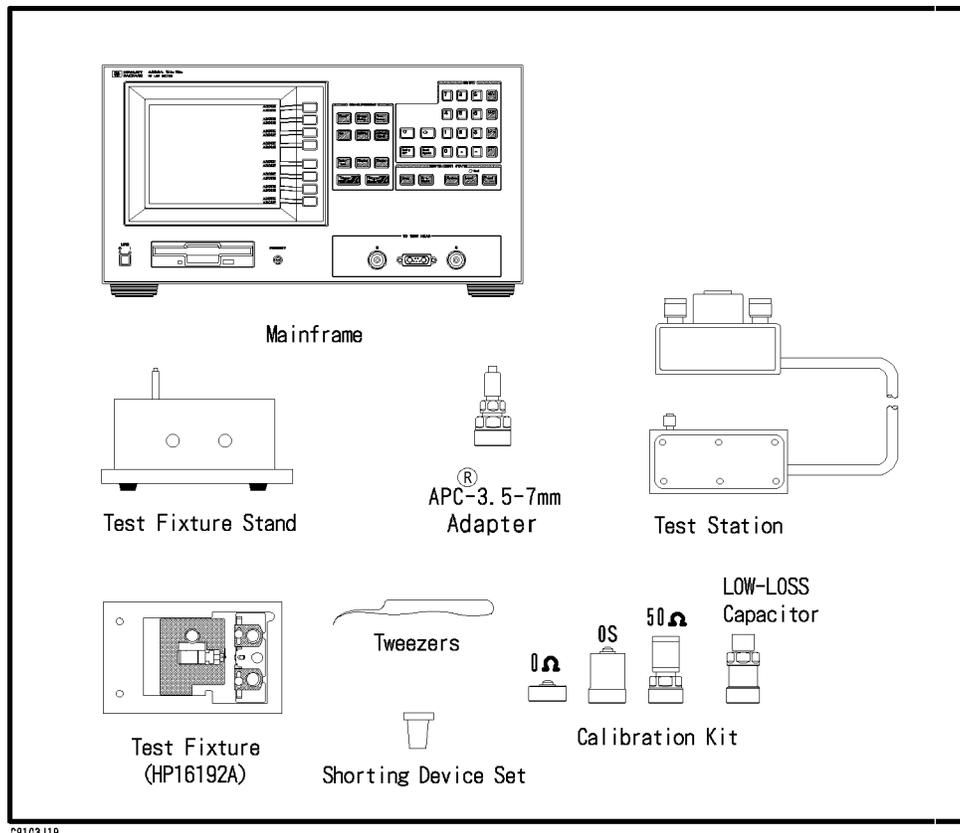


Figure 3-2. Required Equipment

1. Power ON

Verify the connector box and the test head are correctly set up before turning ON the 4286A. If they have not been set up, see Chapter 2.

Line Input Receptacle

AC Power cable is connected to this receptacle.

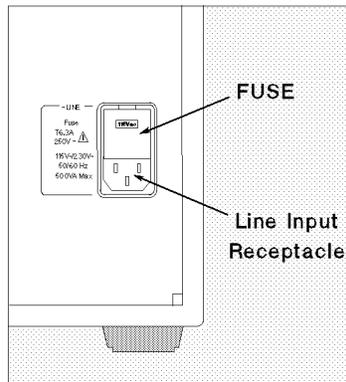


Figure 3-3. Line Input Receptacle and Fuse

Fuse

Use the following fuse:

Agilent Part Number : 2110-0917

(UL/CSA type, Semi Time Lag, 6.3 A 250 V)

If you need this fuse, contact your nearest Agilent Technologies Sales and Service Office.

Steps to turn on the power

1. Verify the power line setting is correct before you turning ON the meter. If necessary, see “Changing the Line Voltage Setting” in Appendix B.
2. Connect AC power cable to the line input receptacle.
3. Press the LINE switch.

After the power-on self-test (approximately 10 seconds), the installed options and the connected test head information are displayed.

Note

Only option numbers 1C2 and 001 are displayed at power-on (if they are installed). Other installed option numbers are listed on the rear panel.



A 30 minute-warm-up period is required to stabilize the 4286A after it has been turned ON. This ensures the 4286A its specified measurement accuracy.

2. Setting up the 4286A

Before you start the measurement, you must set up the 4286A to fit your measurement requirements. This section provides the set up procedures for L_S -Q frequency characteristics measurements.

To set up the 4286A, press the front panel keys as shown below. All keys necessary for this set up procedures are available on the MEASUREMENT Block.

2-1. Setting up for L_S -Q Frequency Characteristics Measurements

Table 3-1. Example of Measurement Conditions

Range	1MHz, 2MHz, 5MHz, 10MHz, 20MHz, 50MHz, 100MHz, 200MHz, 500MHz, 1GHz
OSC Level	10 mA

Select parameters to satisfy the conditions above. Follow the procedures below.

1. Press **Meas**.
2. Press **L_S -Q**. The **L_S -Q** softkey label becomes underlined, showing that **L_S -Q** has been selected.

2-2. Creating a sweep table

Create a sweep table to set list sweep conditions. Follow the procedures below.

1. Press **Sweep Setup**.
2. Press **EDIT LIST ADD** to create an additional segment.
3. Press **2**, then **M/ μ** to set the measurement frequency of the additional segment to 2 MHz.
4. Press **SEGMENT DONE** to complete the segment setting.
5. Repeat steps 2 through 4 to create 8 additional segments. Set the frequency of each of these segments to 5, 10, 20, 50, 100, 200, 500, and 1000 (= 1G) MHz, respectively. (The frequency of a segment available at power-on has automatically been set to 1 MHz.)
6. Press **LIST DONE** to complete the table creation step.

2-3. Setting the OSC level

Set the OSC signal level applied to the DUT. Follow the procedures below.

Press **Source**.

Press **AMPERE** to set the OSC level as current.

Press **1**, **0**, and then **k/m** to set the OSC level to 10 mA.

Hints



- Use **↑** or **↓** to quickly increase or decrease the value to be entered. The value changes in steps of 1, 2, 5, and 10 with these keys.

- To delete the value you have entered, simply press **Back Space** if you have not pressed **(M/μ)**, or enter a new value if you have already pressed **(M/μ)** but not **SEGMENT DONE**.
 - To start the segment condition setting all over again, first press **SEGMENT QUIT** and then **SEGMENT**. Next, specify the desired segment number using numeric keys and **(x1)**. Finally, press **EDIT** and then **SEGMENT**. You are now ready to specify the frequency for the selected segment.
-

3. Calibration

Calibration defines the measurement accuracy for the contact surface of the APC-7[®] on the APC-3.5 to 7mm adapter which is connected to the test head. The calibration must be performed when the 4286A is turned ON. After the calibration, the 4286A can measure within its specified measurement accuracy.

The 0 S, 0 Ω , and 50 Ω terminations and low-loss capacitor in the calibration kit are required.

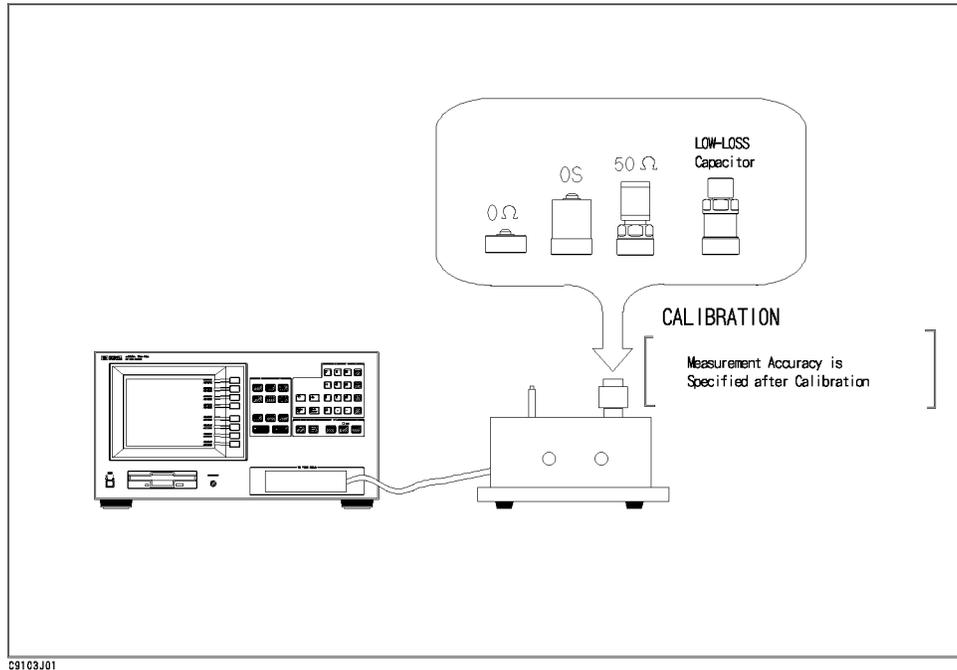


Figure 3-4. Calibration

Calibration Procedure

1. Press **[Cal]**.
2. Press **CALIBRATE MENU**.
3. Press **CAL POINTS** to set the frequency for the Calibration

When you modify the measurement frequency, select **FIXED**.

When you do not modify the measurement frequency, select **USER**.

See *Function Reference* for details on **FIXED** (fixed point calibration) and **USER** (user-defined point calibration).

4. Turn the APC-7[®] connector on the test head as shown in Figure 3-5.
5. Verify that the connector sleeve is extended fully as shown in Figure 3-6.

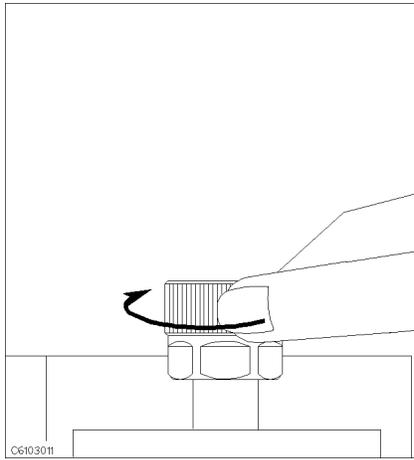


Figure 3-5.

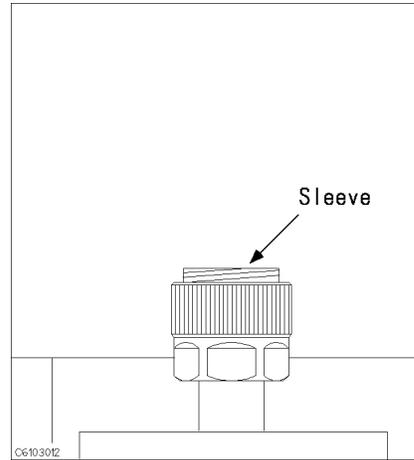


Figure 3-6.

6. Connect the 0 S termination to the APC-7[®] connector as shown in Figure 3-7.

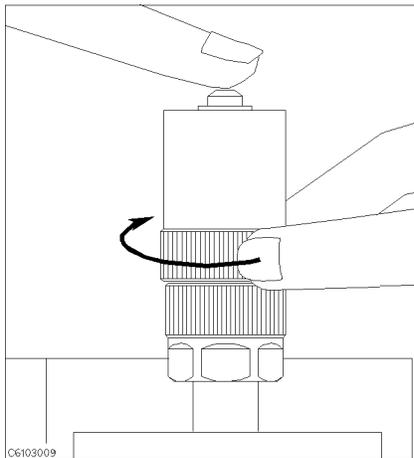


Figure 3-7.

7. Press **OPEN**.

After an OPEN calibration sequence of about 20 seconds, the **OPEN** softkey label is underlined.

8. Disconnect the 0 S termination.

9. Connect the 0 Ω termination on the APC-7[®] connector as shown in Figure 3-8.

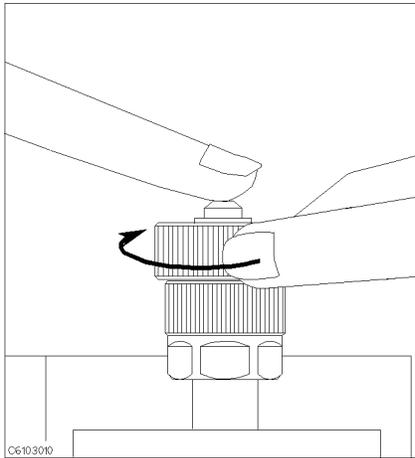


Figure 3-8.

10. Press **SHORT**.

After a SHORT calibration sequence of about 20 seconds, the **SHORT** softkey label is underlined.

11. Disconnect the $0\ \Omega$ termination.
12. Turn only the APC-7[®] connector nut of the $50\ \Omega$ termination as shown in Figure 3-9.
13. Verify that the connector sleeve is retracted fully as shown in Figure 3-10.

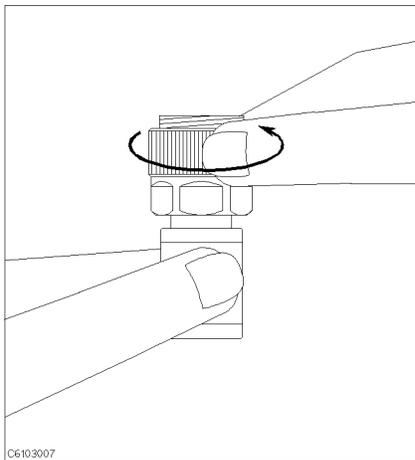


Figure 3-9.

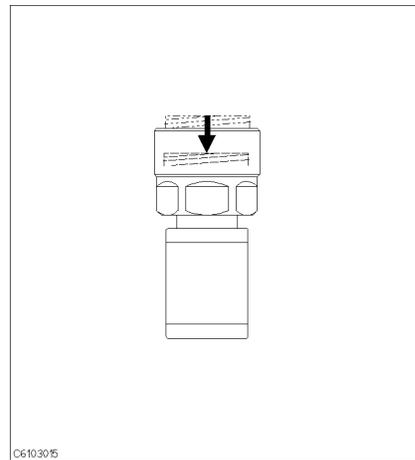


Figure 3-10.

14. Connect the $50\ \Omega$ termination on the APC-7[®] connector as shown in Figure 3-11.

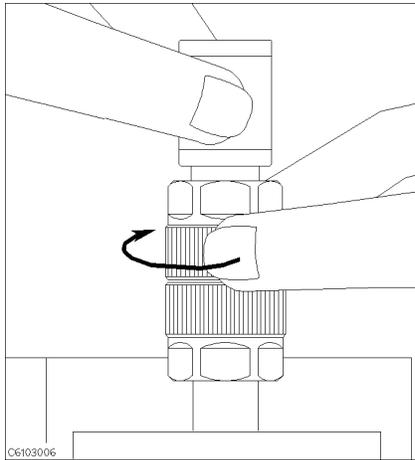


Figure 3-11.

15. Press **LOAD**.

After a LOAD calibration sequence of about 20 seconds, the **LOAD** softkey label is underlined.

16. Disconnect the 50 Ω termination.

17. Connect the low-loss capacitor to the APC-7[®] connector as shown in Figure 3-12.

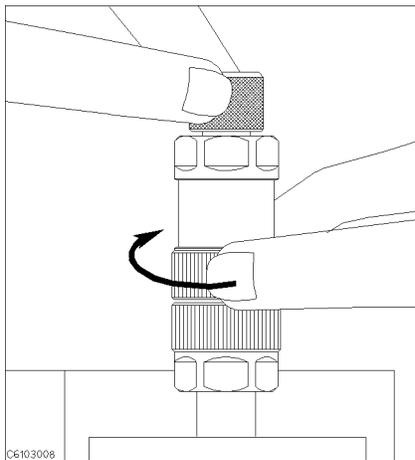


Figure 3-12.

18. Press **LOW-LOSS CAPACITOR**.

After a low-loss capacitor calibration sequence of about 20 seconds, the **LOW-LOSS CAPACITOR** softkey label is underlined.

19. Disconnect low-loss capacitor.

20. Press **DONE:CAL**.

21. Verify that “C0+” (when you have selected **FIXED**) or “Co+” (when you have selected **USER**) is displayed on the left of the screen.

The calibration data is erased when the 4286A is turned off.

Note

Handling and Storage of the APC-7[®] Connector:

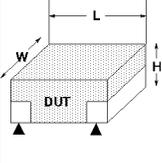
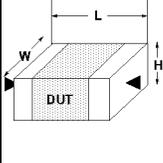
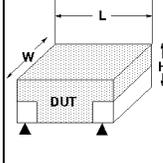
- Keep connectors clean.
 - Do not touch the mating plane surfaces.
 - Do not set connectors contact-end down.
 - Before storing, extend the sleeve or connector nut.
 - Use end caps over the mating plane surfaces.
 - Never store connectors loose in a box or a drawer.
-

4. Connecting the Test Fixture

Selecting a Test Fixture

Agilent Technologies provides the test fixtures listed in Table 3-2 for different sizes of surface mounted device (SMD) measurements. These fixtures provide high stability and repeatability measurements.

Table 3-2. Test Fixture Specification

		16191A	16192A	16193A
Mountable DUT size	Length (mm)	2.0 to 12.0	1.0 to 20.0 ¹	0.5 to 3.2
	Width (mm)	0.5 to 5	0.5 to 5	3 or less
	Height (mm)	0.5 to 5	0.5 to 5	3 or less
Electrodes in contact with DUT (shown with ▲)				

¹ See chapter 2 of the &161920PMNL; for the electrodes' configuration when measuring a DUT of more than 5 mm long.

This user's guide explains how to use these test fixtures.

Connecting the Test Fixture to the Test Head

To connect your fixture to the Test Head, perform the steps listed below. (Figure 3-15 shows the connection for 16192A as an example.)

1. Turn the APC-7[®] connector on the test head as shown in Figure 3-13.
2. Verify that the connector sleeve is retracted fully as shown in Figure 3-14.

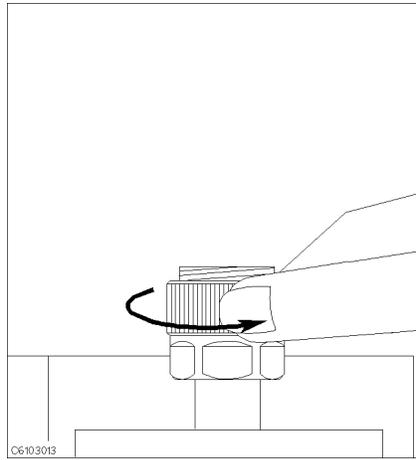


Figure 3-13.

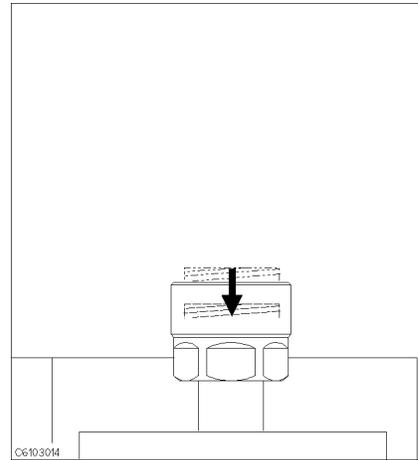


Figure 3-14.

3. Set the mounting posts of the test station into the twin locating holes at the corner of the test fixture.
4. Connect the connector on the underside of the test fixture to the APC-7[®] connector on the test head.

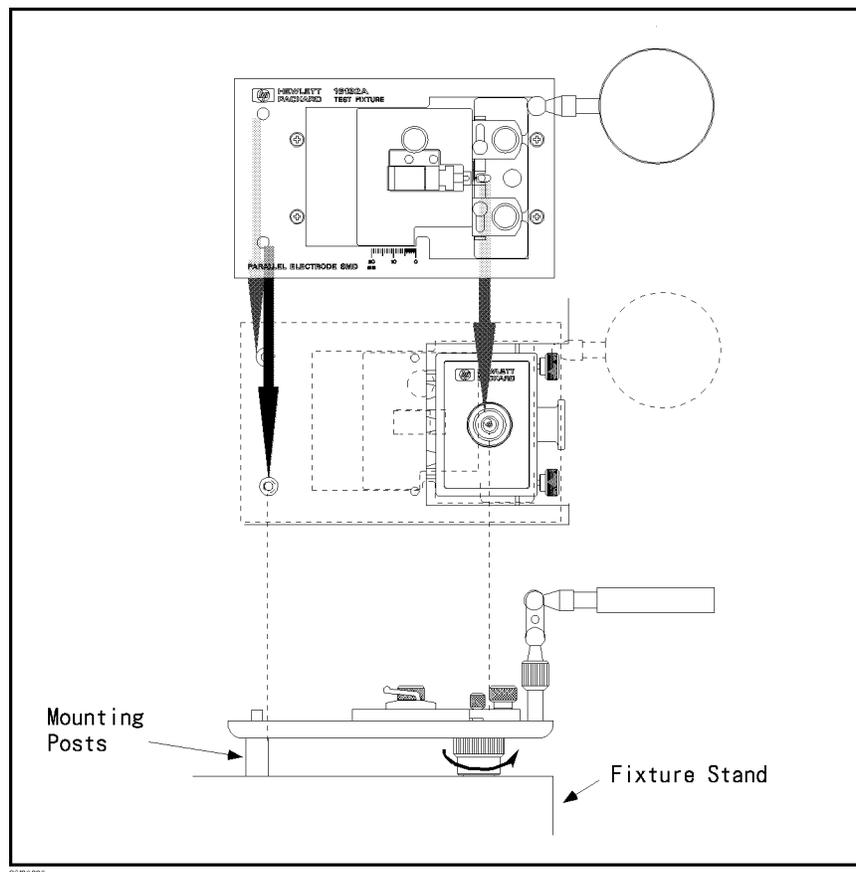


Figure 3-15. Connecting the Test Fixtures (16192A)

5. Setting the Electrical Length of the Test Fixture

In the RF region, the wavelengths are short and are not negligible compared to the physical transmission line length of the test fixture. This causes a phase shift error. The phase shift error is compensated by the electrical length parameter for the test fixture. Because the electrical length values for the Agilent Technologies test fixtures are stored in the 4286A, you can set the electrical length parameter by selecting the fixture model number.

Setting Procedure

1. Press **Cal**.
2. Press **FIXTURE []** and then **SELECT FIXTURE**.
3. Select the fixture model number that you are using.
4. Press **RETURN**.
5. Verify that “Del” appears on the left of the display.

6. Fixture Compensation

Fixture compensation reduces the parasitic error existing between the test fixture electrode and the test head APC-7[®] connector (where the measurement accuracy is specified). Fixture compensation consists of OPEN, SHORT and LOAD compensations. For basic measurements, the OPEN and SHORT compensations are required.

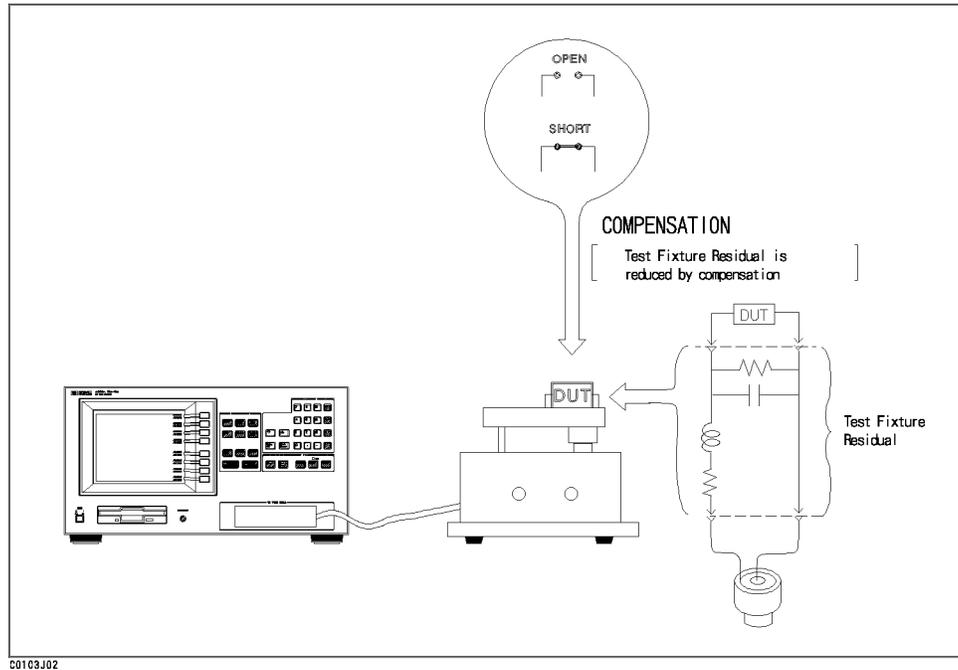


Figure 3-16. Fixture Compensation

Performing SHORT Compensation

SHORT Compensation compensates for the residual impedance due to the test fixture.

When you use a shorting device supplied with the 4286A (with option 004) or fixture (with option option 010), be sure to select the device of the same size as or at least closest to that of the DUT. The dimensions for each shorting device are shown in Table 3-3.

Table 3-3. Dimension of Shorting Devices

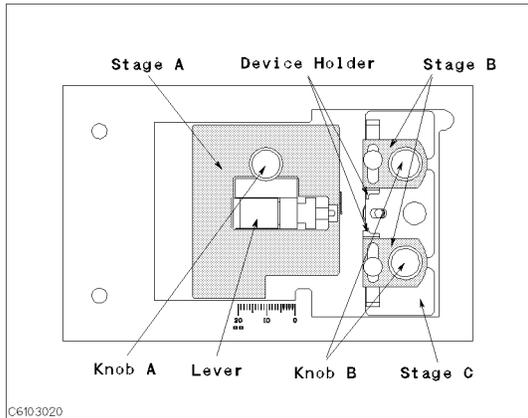
Dimension (mm)	Agilent Part Number
1.0 × 0.5 × 0.5	16191-29005
1.6 × 0.8 × 0.8	16191-29006
2.0 × 1.25 × 0.8	16191-29007
3.2 × 1.6 × 0.8	16191-29008

Four shorting devices of different dimensions are supplied with each fixture. The shorting device that is closest to the size of the DUT should be used. The dimensions for each shorting device are shown in Table 3-4.

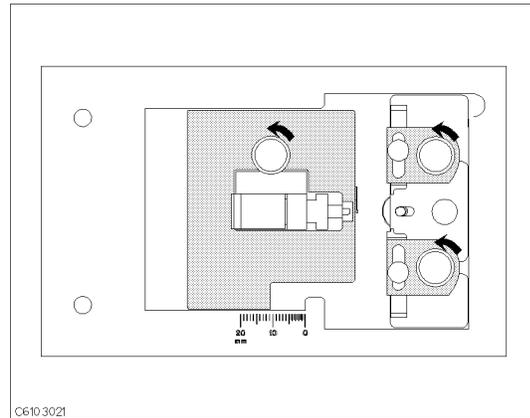
Table 3-4. Dimension of Shorting Devices

Dimension (mm)	Agilent Part Number
1 × 1 × 2.4	16191-29001
1.6 × 2.4 × 2	16191-29002
2.4 × 2.4 × 3.2	16191-29003
2.4 × 2.4 × 4.5	16191-29004

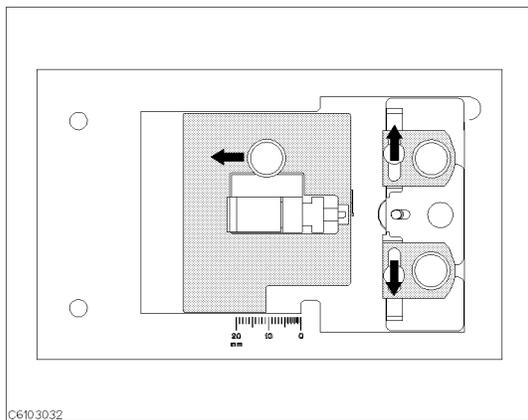
How to perform SHORT compensation for the 16192A is shown below as an example. The procedures for the 16191A and 16193A are shown in Appendix C.



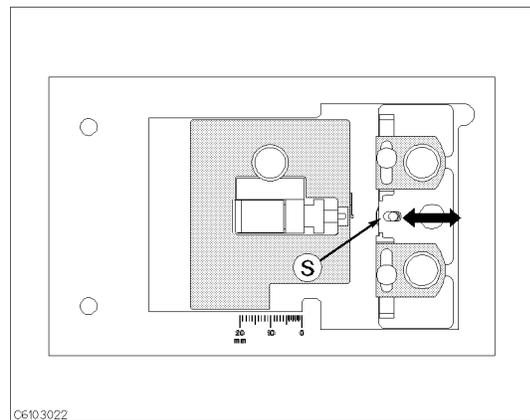
The names of each part are listed above.



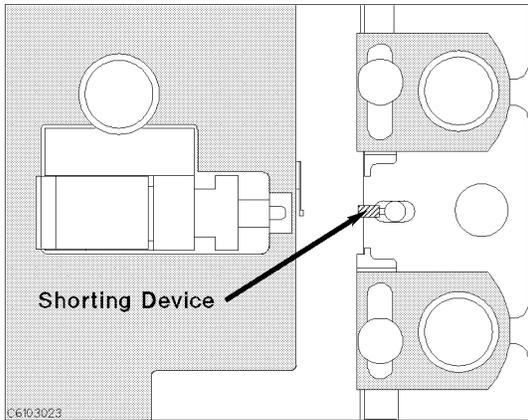
1. Loosen the three knobs.



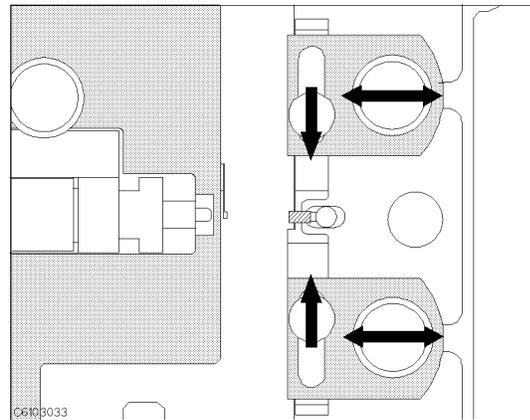
2. Move stage A and two device holders as shown by the arrows.



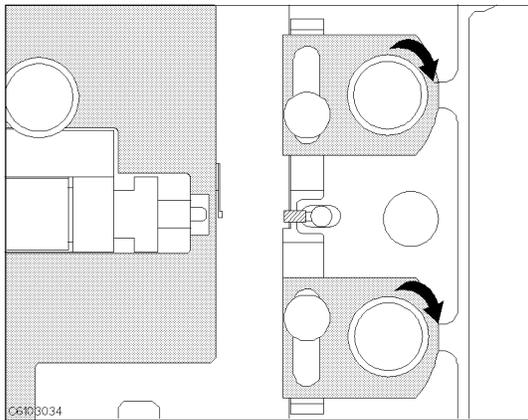
3. Adjust stage C so that the shorting device is placed on position S.



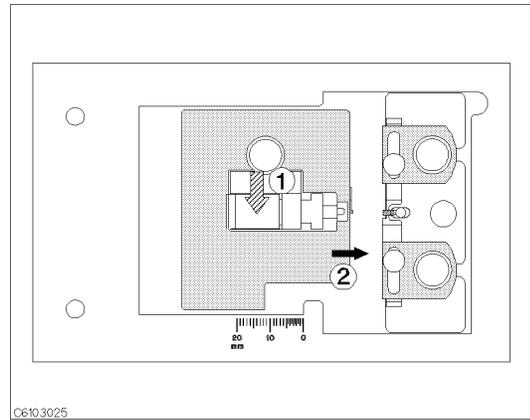
4. Place the shorting device so that it contacts the electrode.



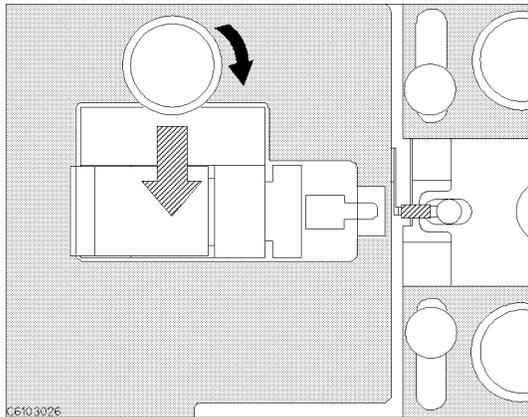
5. Adjust the two B stages and the two device holders to hold the shorting device.



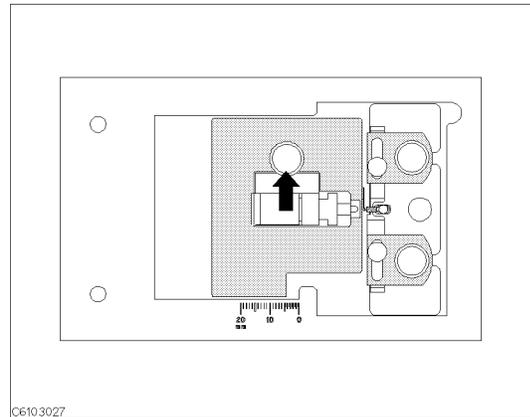
6. Tighten the two B knobs to fix the B stages and the device holders.



7. ① Push the lever. ② Slide stage A while pushing the lever until the electrode on the stage A slightly contacts the shorting device.



8. Tighten knob A while pushing the lever.



9. Release the lever to hold the shorting device.

SHORT Compensation Key Sequence

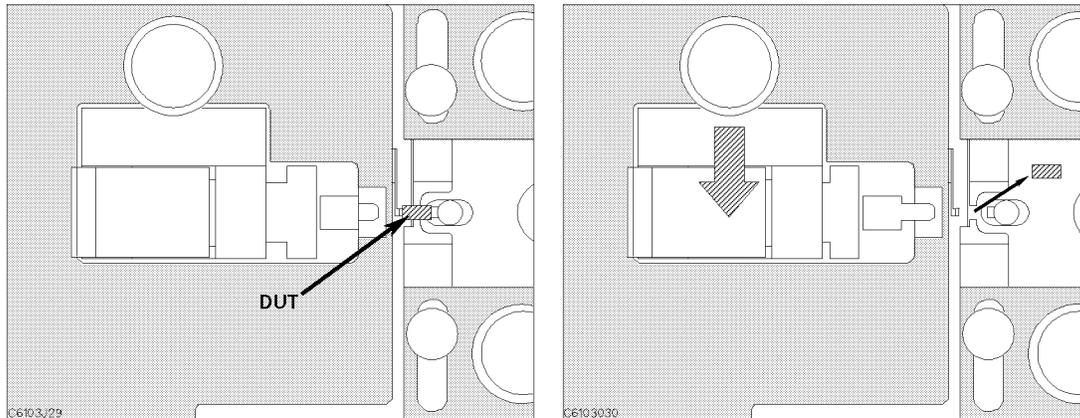
When the test fixture is ready for the SHORT compensation sequence, press the following front panel keys:

1. Press **Cal** **FIXTURE COMPEN** **COMPEN MENU** **SHORT**.

After the SHORT compensation sequence is done, the **SHORT** softkey label is underlined.

Performing OPEN Compensation

OPEN Compensation corrects for stray admittance due to the test fixture. How to perform an OPEN compensation sequence for the 16192A is described as an example. The procedures for the 16191A and 16193A are shown in Appendix C.



1. Set the DUT on the test fixture just as you set the shorting device in the SHORT compensation.
2. Push the black lever and remove the DUT.

OPEN Compensation Key Sequence

When the test fixture is ready for the OPEN compensation sequence, perform the following procedure:

1. Press **OPEN**.
- After the OPEN compensation sequence is done, the **OPEN** softkey label is underlined.
2. Press **DONE: COMPEN**.
 3. Verify that “Cmp” appears on the left of the display.

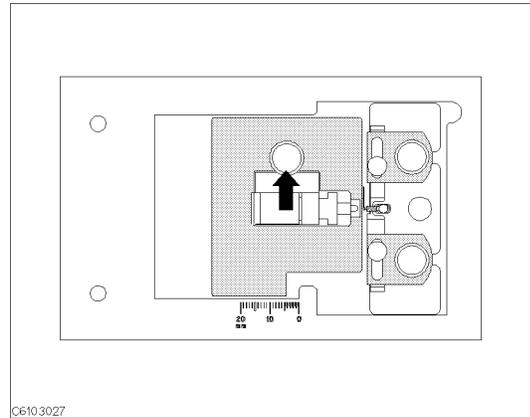
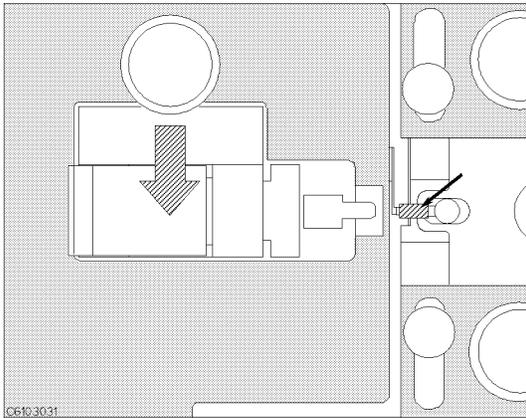
Note



You can perform the desired fixture compensation individually. To do this, press **Cal** **FIXTURE COMPEN** **RESUME CAL SEQUENCE** and then the key for the desired compensation.

7. Connecting the DUT to the Test Fixture

How to connect the DUT to the 16192A is shown in below as an example. The procedures for the 16191A and 16193A are shown in Appendix C.



1. Push the lever and place the DUT on the electrode.
2. Release the lever to hold the DUT.

Caution



Protect the instrument from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any static charge built-up by touching the outer shell of any grounded instrument chassis before touching the test port connectors.

8. Measuring the DUT

After you place the DUT on the test fixture, the measured result is displayed.

4286A with Chip Handler

This chapter describes the functions available with the 4286A and operation procedures for each of those functions when the 4286A is used with a chip handler.

- Differentiation of DUTs through BIN Sorting
- GO/NO-GO Test with Limit Test Function
- Contact Check
- Enabling Beeper
- Display Updating ON/OFF
- Setup Linking 4286A and Chip Handler
- Setting up Handler Interface Board

This chapter also includes the technical information for using 4286A with automatic selection system in the production line.

- 4286A Measurement Time
- Electrical Specification of Handler Interface
- Performing Calibration with Working Standard
- Restoring Settings After Power Interruption

Note

When you use the 4286A together with a chip handler, be sure to set up the interface board before performing limit test or BIN sorting. See “Setting up Handler Interface Board” for details.

Differentiation of DUTs through BIN Sorting

You can differentiate DUTs by checking which BINs DUTs are classified into. To do this, you need to set several combinations of upper and lower limits for a specific frequency as measurement parameters.

Editing BIN Table

This section describes how to edit a BIN table as shown in Figure 4-1.

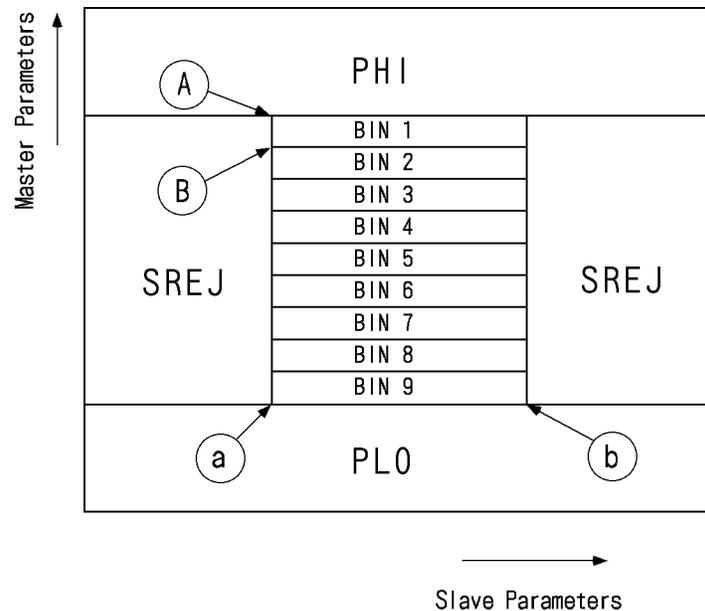


Figure 4-1. Example of BIN Table

1. Press **(Test Setup)**, and then **BIN SORT MENU**.
2. Set desired frequency points for BIN sorting. Select frequency points for BIN sorting from the segment of list table which is set by **(Sweep Setup)**. (The 4286A has been initially set to segment 1 of the frequency point for BIN sorting.)

Press **TEST SEG**.

Enter the desired segment number for BIN sorting, then press **(x1)**.

3. Primary Parameters

Press **EDIT BIN SORT**.

Press **ADD** to create BIN1.

Press **UPPER LIMIT**.

Enter value **Ⓐ**.

Press **LOWER LIMIT**.

Enter value **Ⓑ**.

Press **DONE** to complete the creation of BIN1.

Repeat the steps above to create BIN2 through BIN9.

4. Secondary Parameters

Press **SEC REJECT MENU**.

Press **UPPER LIMIT**.

Enter value **Ⓐ**.

Press **LOWER LIMIT**.

Enter value **Ⓑ**.

Press **SEC REJECT on OFF** to toggle it **ON off**.

Press **RETURN** to complete the secondary parameter setting.

5. Press **DONE** to complete the creation of BIN table.

Setting up Handler Interface

1. Set up the handler interface board. See “Setting up Handler Interface Board” for details about the mode.
2. Press **(Test Setup)**, and then **HANDLER IF**.
3. Select **MODE 1** or **MODE 2**.
The pattern of output signals for BIN sorting can be selected from either Mode 1 or Mode 2. Definitions in output signals for handler interface vary depending on the mode used. See “Setting up Handler Interface Board” for details about the mode.
4. Press **RETURN**.

BIN Sorting

1. Press **(Test Setup)** and then, **BIN SORT MENU**.
2. Press **BIN SORT on OFF** to toggle it **ON off**.

When the BIN sort key is ON, measured data outside the limits are output and displayed as follows:

- On-screen Message Showing Corresponding BIN or BIN OUT (if outside preset limits)
- Beeper (ON/OFF selectable)
- GPIB Command :DATA? BIN
- Handler Interface Output

GO/NO-GO Test with Limit Test Function

Use the limit test function to perform GO/NO-GO test. This function sets the upper and lower limits to determine whether DUTs are acceptable. The limit differentiation function compares the measured data with preset limits and shows through its output and on-screen message whether the DUT is within the limits.

Editing Limit Table

This section describes how to edit the limit table of primary parameters and secondary parameters, as shown in Table 4-1.

Table 4-1. Example of limit setting

Segment	Stimulus Value	Primary Parameter		Secondary Parameter	
		Lower limit	Upper limit	Lower limit	Upper limit
1	1MHz	10nH	12nH	100.0	1G ¹
2	10MHz	12nH	14nH	100.0	1G ¹
3	100MHz	10nH	14nH	100.0	1G ¹

¹ Testing function is not actually performed.

Note



If you do not want to perform testing function for upper or lower limits of secondary parameters, specify sufficiently large value for upper limit or sufficiently small value for lower limit.

1. Press **Test Setup** , and then **LIMIT TEST MENU** .
2. Press **EDIT PRI LIMIT** .
3. Segment 1
 - Press **EDIT** and **STIMULUS VALUE** .
 - Enter Stimulus (1MHz).
 - Press **LOWER LIMIT** .
 - Enter lower limit value (10nH).
 - Press **UPPER LIMIT** .
 - Enter upper limit value (12nH).
 - Press **DONE** to complete the editing of this segment.
4. Segment 2
 - Press **ADD** to edit the new segment.
 - Press **STIMULUS VALUE** .
 - Enter Stimulus (10MHz).
 - Press **LOWER LIMIT** .
 - Enter lower limit value (12nH).

Press **UPPER LIMIT**.

Enter upper limit value (14nH).

Press **DONE** to complete the editing of this segment.

5. Segment 3

Press **ADD** to edit the new segment.

Enter stimulus, lower limit, and upper limit values in the same manner above.

Press **DONE** to complete the editing of this segment.

6. Press **DONE** to complete the editing of the primary parameter limit table.

Then, press **EDIT SEC LIMIT** to edit the secondary parameter limit table.

1. Segment 1

Press **LOWER LIMIT**.

Enter lower limit value (100.0).

Press **UPPER LIMIT**.

Enter upper limit value (1G).

Press **DONE** to complete the editing of this segment.

2. Segment 2,3

Enter lower and upper limit values and press **DONE** to complete the editing of this segment in the same manner as segment 1.

Setting up Handler Interface

1. Set up the handler interface board. See “Setting up Handler Interface Board” for the set up procedure.

2. Press **(Test Setup)**, and then **HANDLER IF**.

3. Press **MODE 1** or **MODE 2**.

When you perform limit test, select the signal pattern from either Mode 1 or Mode 2. The output for the interface varies depending the mode used as follows.

MODE 1 Outputs overall results of comparison for limit test.

MODE 2 Outputs results for each segment.

See “Setting up Handler Interface Board” for details about the mode.

4. Press **RETURN**.

Limit Test

You can perform limit test for only primary or secondary parameters.

1. Press **Test Setup**, and then **LIMIT TEST MENU**.
2. Press **PRI LIMIT on OFF** (primary parameters) or **SEC LIMIT on OFF** (secondary parameters) to toggle it **ON off**.

When either of the limit test keys is ON, measured data outside the limits are output and displayed as follows:

- On-screen FAIL Message
- Beeper (ON/OFF selectable)
- GPIB Command :DATA? LFA, :DATA? LLIS, :DATA? LMAR

Note



The frequency (stimulus value) of limit table for setting limits can be set independently of the frequency set in the list table.

If the frequency of the limit table does not equal to the measurement frequency of list table, limit tests for all measurements can be performed using interpolation of the limit values.

For example, if only one point is defined in limit table, limit test is performed with the constant upper limit and lower limit for all measurements.

Contact Check

Contact check is used to check the electrical contact between the test head and DUT. This check consists of measuring dc resistance between the two and determining whether the resistance is within the preset limits.

Follow the procedure below.

1. Press **Contact Check**.
2. Set the upper and lower limits for dc resistance between the test head and DUT.
Press **RDC UPPER LIMIT** and enter the upper limit.
Press **RDC LOWER LIMIT** and enter the lower limit.
3. Press **RDC MEAS on OFF** to toggle it **RDC MEAS ON off**.
Then, the measured dc resistance will be displayed on the screen.
4. Press **RDC LIMIT on OFF** to toggle it **RDC LIMIT ON off**.
Whether the measured resistance is within the limits will be displayed on the screen.

Contact check results will be output and displayed as follows:

- On-screen FAIL Message
- Handler Interface
- GPIB Command

Setting up Beeper

Beeper can be used to announce results of limit test and BIN sorting.

The beeper can be set to sound when both of BIN sorting and limit test passed or both of them failed.

Follow the procedure below.

1. Press **Test Setup**, and then **BEEP**.
2. If you wish to sound the beeper when both of BIN sorting and limit test passed, press **PASS**.
If you wish to sound it when both of BIN sorting and limit test failed, press **FAIL**. Press **OFF** when you do not wish to sound the beeper regardless of test results. In other words, if either of BIN sorting or limit test failed, the beeper does not sound for any settings.
3. Press **RETURN**.

Display Updating ON/OFF

You can select whether to display new measurement results on the screen by switching the display updating function ON and OFF. Switch this function OFF to more quickly determine whether the DUT is acceptable or not.

Switching display updating OFF gains 3ms + 6ms/point.

This updating function can be switched ON and OFF at any time.

Follow the procedure below.

1. Press **Display**.
2. Press **MEAS DISP ON off** to switch the updating function ON and OFF.

Setup Linking 4286A and Chip Handler

The 4286A can be set up to read initial settings from flexible disk during startup. This setup allows the 4286A to run exclusively for your particular purpose, the chip handler for instance, from the moment of startup.

Follow the procedure below.

1. Set up the 4286A for use with the handler.
2. Insert a 3.5-inch LIF or DOS-formatted disk into the built-in disk drive.
3. Press **Save/Recall** .
4. Press **STOR DEV** to switch it to **[DISK]** . This specifies the built-in disk drive as the storage destination.
5. Press **STATE** .
6. Enter **AUTOREC** as the filename and press **DONE** .

Before turning on the 4286A, insert the disk containing the “AUTOREC” file into the built-in disk drive. Each time you turn on 4286A, it recalls settings in the file to operate exclusively for the handler from the moment of startup.

Setting up Handler Interface Board

This section describes the steps necessary to use the handler interface board. There are 3 major steps as follows:

- **Mounting Pull-up Resistor**

Mount a pull-up resistor to the handler. Where to mount a resistor and what resistance the resistor needs to have depends on the signal I/O format.

Note A pull-up resistor must be mounted to the handler for comparator signals.



- **Setting up Handler Interface**

Set up the handler interface signal pattern that suits the 4286A operation mode. Set it up on the 4286A.

The following step is required when the power supplies for I/O or COMMON setting should be modified.

- **Changing Signal I/O Format**

Change the switch setting on the handler interface board to change its signal I/O format. This is necessary when you need the I/O format that requires the switch settings different from the default settings.

Checking Default Settings

The handler interface board has been set as follows before shipment.

Signals	Settings
Comparator Signal	This signal is opto-isolated and is output through open-collector. COM1 is used as COMMON that is isolated from 4286A's chassis ground. Pull-up resistors are mounted to the handler. Output voltage is supplied from an external power source (5 to 24V) on the handler.
Control Output Signal	This signal is opto-isolated and is output through open-collector. COM2 is used as COMMON that is isolated from 4286A's chassis ground. Pull-up resistors are mounted to the handler. Output voltage is supplied from an external power source (5 to 15V) on the handler.
DC isolated Input Signal	This signal is opto-isolated from the internal circuits of 4286A. Driving voltage is supplied from an external power source (5 to 7V) through EXT.DCV2. This signal turns "TRUE" if input signal is connected to the COMMON of the external power source.
Internal power source (5V)	Not used.

See "Handler Interface Board Switches" for default switch settings.

Warning **Be sure to check the procedures in "Removing the Top Cover" before removing the 4286A top cover.**



Selecting Settings

Select the desired settings according to the table below.

Table 4-2. Handler Interface Board Setup Worksheet

Item	Selection	Default	Power Source	Pull-up Resistor	Opt-isolation	Modification to Default
Comparator Signal	A	Default Setting	External(COM1)	Mount to the handler	Isolated	
	B		Internal(+5V) ¹		Not isolated	Supply an internal power source(+5V) to pull-up resistors on the handler. Set SW2(5) ON.
Control Output Signal	C	Default Setting	External ²	Mount to the handler	Isolated	
	D		External ²	Use internal pull-up resistors(4.64kΩ).	Isolated	Set SW2(1) through SW2(3) ON.
	E		Internal ³	Mount to the handler	Not isolated	Turn SW1 Internal(+5V) side.
	F		Internal ³	Use internal pull-up resistors(4.64kΩ).	Not isolated	Set SW2(1) through SW2(3) and SW2(4) ON.
DC Isolated Input Signal	G	Default Setting	External ²	Use internal pull-up resistors.	Isolated	
	H		External ²		Isolated	Set SW2(6) and SW2(8) OFF.
	I		Internal ³		Not isolated	Turn SW1 Internal(+5V) side.

1 Chassis grounding is used.

2 Supply through EXT.DCV2. COM2 is used as COMMON.

3 Set voltage +5V.

Follow the combination logic shown below according to power sources.

Comparator Signal	Control Output Signal	DC Isolated Input Signal
Select A or B.	For external power source ... Select C or D. For internal power source ... Select E or F.	For C or D ... Select G or H. For E or F ... Select I.

Note



Review the check items below before selecting your settings.

- You must use the same power source for control output signal and DC isolated input signal.
- If you select COM1 for COMMON and use internal power source output, comparator signals will not be opto-isolated.
- If you select COM2 for COMMON and choose to use internal power source output, comparator signals will not be opto-isolated.

- When you use the internal pull-up resistor and apply voltage to the control output signal from an external power source, the permissible voltage range is between 5 and 15V.

If your current settings are default settings or if you wish to change your settings, follow the steps below.

Changing Settings

You need to change your settings depending on the signal output format (open-collector, internal voltage output, or external voltage output) of your handler interface. Two switches are provided for changing settings. The setting of both switches can be changed on the top shield. (See “Handler Interface Board Switches”.)

See “Electrical Specification of Handler Interface” first to become familiar with electrical characteristics of each signal and operations of the interface board and I/O circuits before changing your settings.

Also, check the default settings in “Checking Default Settings”. If you need to change the default setting, follow the steps below.

Removing the Top Cover

1. Turn OFF the 4286A, disconnect the power cable, and wait for a few minutes to allow capacitors in the 4286A to discharge.

Warning



The 4286A internal circuits carry high voltage during operation and immediately after it has been turned OFF. To prevent injuries due to electrical shocks, be sure to wait for at least few minutes before removing the cover to make sure that capacitors in the 4286A discharge completely

2. Remove 4 back legs that hold the top cover and rear panel together.
3. Fully loosen the screw behind the top cover.
4. Slide the top cover backward and lift it up to remove it. Find the top shield, which shows the locations and default settings of SW1 and SW2.

Setting up Control Output Signal and DC Isolated Input Signal

Select either external or internal power source for supplying voltage to the control output and DC isolated input signals.

Set SW1 as follows:

Table 4-3. SW1 Setting

Power Source	SW1
External Source	Switch it over toward the rear panel.
Internal Source	Switch it over toward the front panel.

Using External Power Source. Set SW2(1) through SW2(3) and SW2(6) and SW2(8) as follows:

1. Select whether to use the internal pull-up resistor or to mount a pull-up resistor at the handler side of the board.

Table 4-4. SW2 Setting (External power source:1)

Setting	SW2		
	(1)	(2)	(3)
Internal pull-up resistor	ON	ON	ON
Pull-up resistor at handler side	OFF	OFF	OFF

- Set up pull-up resistor (for DC isolated input signal) according to voltage level of external power source.

Table 4-5. SW2 Setting (External Power Source:2)

External Source Voltage	SW2		
	(6)	(7)	(8)
5 to 7V	ON	ON	ON
7 to 12V	OFF	ON	OFF

Using Internal Power Source. Set SW2(1) through SW2(4) and SW2(6) and SW2(8) as follows:

Table 4-6. SW2 Setting(Internal Power Source)

SW2						
(1)	(2)	(3)	(4)	(6)	(7)	(8)
ON	ON	ON	ON ¹	ON	ON	ON

¹ This switch settings specifies the 4286A COMMON as the control output COMMON.

Setting up the Internal Power Source

When you use the internal power source (5V), set either SW2(4) or SW2(5) or both to ON position. Check the following to make sure that other setting are correct.

- SW2(4) set to ON
COM2 is connected to the 4286A COMMON. A 5V COMMON is available from COM2.
Note that the control output signal is not opto-isolated.
- SW2(5) set to ON
COM1 is connected to the 4286A COMMON. A 5V COMMON is available from COM1.
Note that the control output signal is not opto-isolated.

Mounting the Top Cover

Reverse the order of steps mentioned in “Removing the Top Cover” to mount the top cover and back legs in position.

Mounting a Pull-up Resistor

Mount a pull-up resistor at the handler when you wish to use an external power source for I/O signals.

Note You must mount a pull-up resistor for comparator signals.



Pull-up Resistor for Comparator Signals

Be sure to use a pull-up resistor that meets the requirement of the equation below.

$$R \simeq \frac{V_p}{3} [k\Omega]$$

where

R Pull-up Resistance [k Ω]
 V_p Pull-up Voltage [V]

Typical pull-up resistance is given below.

Table 4-7. Typical Pull-up Resistance for Comparator Signals

Pull-up Voltage [V]	Pull-up Resistance [k Ω]
5	1.78
12	3.16
24	8.25

Pull-up Resistor for Control Output Signal

Be sure to use a pull-up resistor that meets the requirement of the equation below when you mount it at the handler side of the board.

$$R \simeq \frac{V_p}{2.5} [k\Omega]$$

where

R Pull-up Resistance [k Ω]
 V_p Pull-up Voltage [V]

Typical pull-up resistance is given below.

Table 4-8. Typical Pull-up Resistance for DC Isolated Input Signal

Pull-up Voltage [V]	Pull-up Resistance [k Ω]
5	1.78
9	3.16
12	4.22

Setting up Output Signal Pattern

Set up the signal pattern for the handler interface. Settings vary depending on the 4286A operation mode.

■ Mode 1(MODE 1)

BIN sorting is performed on one of the segments defined in the frequency list table. DUTs are classified into 9 BINs maximum based on the results for the specified segment. For the other segments, limit test is performed.

Output signal appears on the corresponding connector pin, indicating the BIN which DUT falls into. The limit test result is output as overall results of comparison for all specified segments.

■ Mode 2(MODE 2)

Outputs overall results of comparison for all specified segments. Also, outputs results of comparison and BIN sorting for each segment. The BIN sorting results are output as 4 bit code.

Mode 2 can be further divided into **On Sweep Mode** and **On Point Mode**, depending on the type of triggering used. Definitions of some output signals are different between the two modes. See “Electrical Specification of Handler Interface” for details.

Follow the steps shown in the flowchart below to set your handler interface.

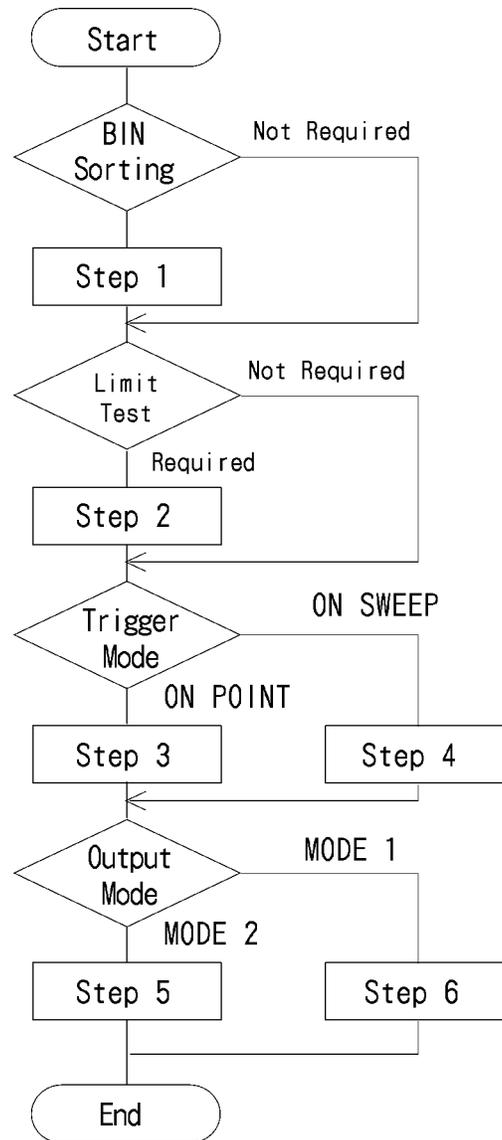


Figure 4-2. Basic Flow of Handler Interface Setting

Step 1: Setting up for BIN Sorting

1. Press **Test Setup**, and then **BIN SORT MENU**.
2. Press **BIN SORT** on **OFF** to toggle it **ON off**.
3. Define a BIN table. See “Editing BIN Table” for details.

Step 2: Setting up for Limit Test

1. Press **Test Setup**, and then **LIMIT TEST MENU**.
2. Press **LIMIT TEST** on **OFF** to toggle it **ON off**.
3. Define a limit table. See “Editing Limit Table” for details.

Step 3: Setting up for On Point Trigger

1. Press **Trigger Mode**.
2. Press **TRIG EVENT** to toggle it **ON POINT**.

Step 4: Setting up for On Sweep Trigger

1. Press **Trigger Mode**.
2. Press **TRIG EVENT** to toggle it **ON SWEEP**.

Step 5: Setting Mode 2

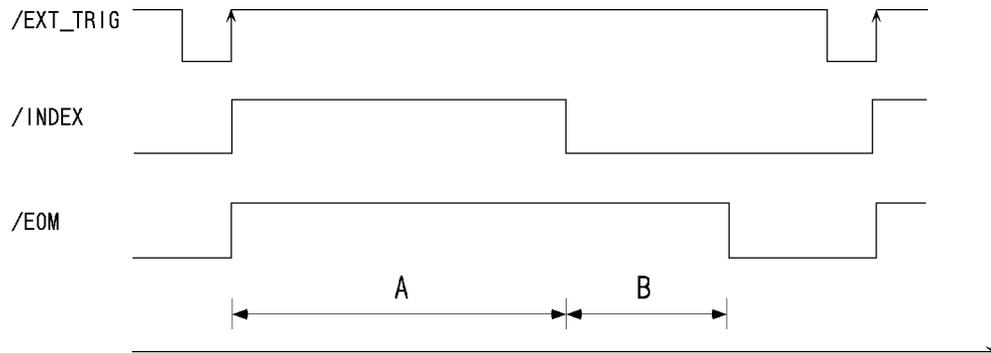
1. Press **Test Setup**, and then **HANDLER IF**.
2. Press **MODE 2**. Press **OFF** when you do not wish to send signals to the handler interface.
3. Press **RETURN** to confirm the entry of settings.

Step 6: Setting Mode 1

1. Press **Test Setup**, and then **HANDLER IF**.
2. Press **MODE 1**. Press **OFF** when you do not wish to send signals to the handler interface.
3. Press **RETURN** to confirm the entry of settings.

4286A Measurement Time

Total measurement time of the LCR meter is calculated as follows:



Event		Time
/EXT_TRIG		
A ↓	Contact check	15ms
	Analog measurement	15ms/point ¹
/INDEX(until the end of list sweep)		
B ↓	Comparator	
	BIN sorting	2ms
	Limit test	500 μ s/point
	Measured value display	3ms + 6ms/point
	Handler signal output	0.1ms
/EOM		
Data transfer through GPIB		20ms/ (contact check + 2 measurement points)

¹ By incrementing the averaging factor by 1, total measurement time becomes 5ms longer. For example, analog measurement time is 30ms (= 15ms + 5ms \times 3) when you select 4 for the averaging factor.

- You can turn the measured value display ON/OFF on the front panel. When you set this function to OFF, the duration of time between EOM(End of Measurement) and next trigger becomes shorter.
- The data transfer time through GPIB shown above includes the time required to input a contact check comparator signal and 2-point measurement results at the same time using the HP 9000 Series 360.

Example

The following shows the approximate duration of time required to make a 2-point measurement by list sweep. We assume that the measured value display, comparator, and handler signal output are respectively OFF, ON, and ON.

Calculating the time for each operation from the above, we obtain the following:

Contact check 15ms

Analog measurement 30ms (= 15ms × 2)

Comparator 7ms (= 6ms + 1ms)

Handler signal output 1ms

Total time from assertion of external trigger to output of handler signal amounts to 53 ms.

Electrical Specification of Handler Interface

The handler interface sends results of comparison from the 4286A to the handler interface and allows timing control signals for measurements and handler operation to be exchanged between the 4286A and handler interface.

Using these signals you can configure a highly efficient chip handling system.

This section provides the pin assignment of the handler interface connector, description of each signal, and timing diagram of these signals.

Signal Output Mode

The handler interface has 2 signal output modes. Signals in each mode carry different information.

- Mode 1** Outputs overall results of comparison for all specified segments. Also, outputs BIN sorting results for segments specified using `TEST_SEG[]`.
- Mode 2** Outputs overall results of comparison for all specified segments. Also, outputs results of comparison and BIN sorting for each segment. Results of BIN sorting are represented in 4-bit code.
- Mode 2 can be further divided into **On Sweep Mode** and **On Point Mode** depending on the type of triggering used. Definitions in output signals are different in these mode. See Table 4-12 for details.

Signal Lines

Signals sent from and received by the handler interface can be classified into 3 groups as follows:

Definitions of signals in each line vary depending on the mode (mode 1 or mode 2) used. See Table 4-10 and Table 4-12 for details.

- Comparator Output Signals
 - /BIN1 to /BIN9, /AUX_BIN, /OUT_OF_BIN, /PHI, /PHO, /SREJ (comparator signal for mode 1)
 - /F1REJ to /F10REJ, DBIN0 to DBIN3 (comparator signals for mode 2)
 - /FAIL (overall comparator signal)
 - /NO_CONTACT (contact check fail signal)
- Control Output Signals
 - /INDEX (analog measurement end signal)
 - /EOM (measurement cycle end or comparator data enable signal)
- Control Input Signals
 - /EXT_TRIG (external trigger)
 - /KEY_LOCK (key lock signal)

Note “/” before some signal names means those signals are negative logic (low-asserted) signals.



Pin Assignment and Signal Definitions (Mode 1)

The relationship between the primary/secondary parameter values and signals /BIN1 to /BIN9, /OUT_OF_BINS, /AUX_BIN, /PHI, /PHO, /SREJ is as follows:

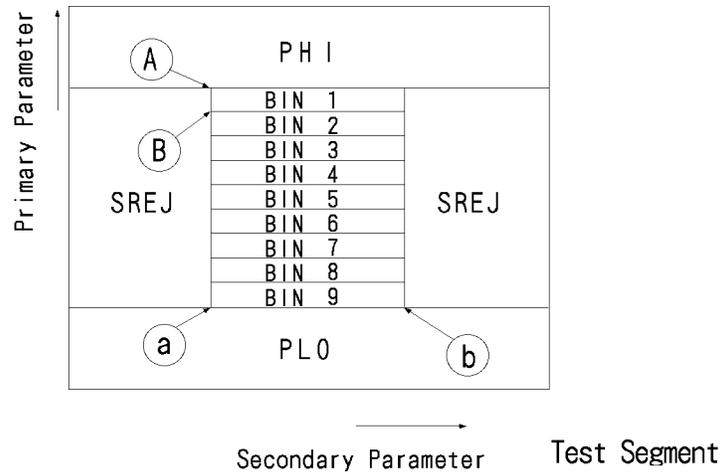


Figure 4-3. BIN Sorting

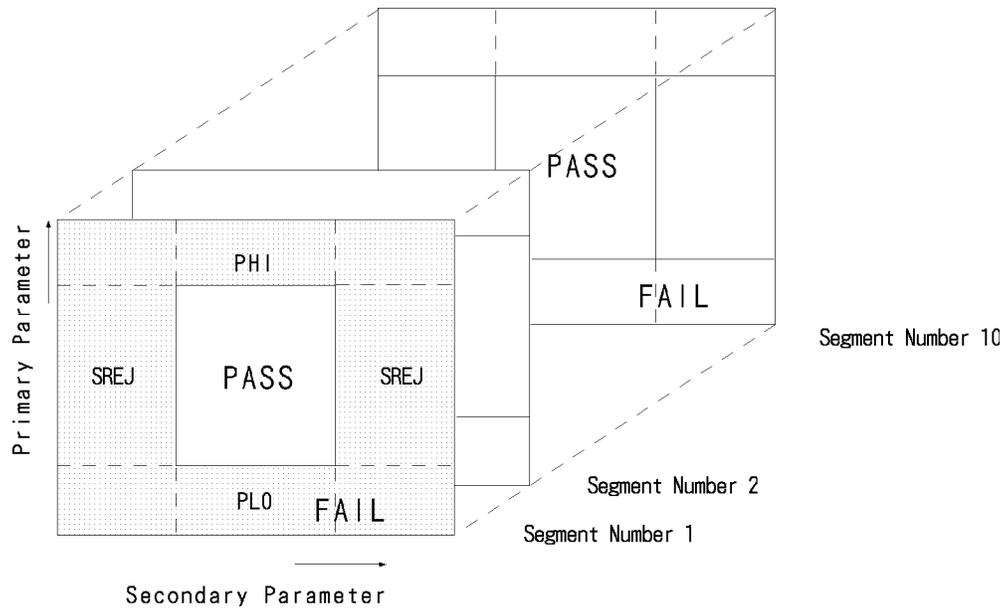


Figure 4-4. Limit Test

Signals are assigned to the connector pins as follows:

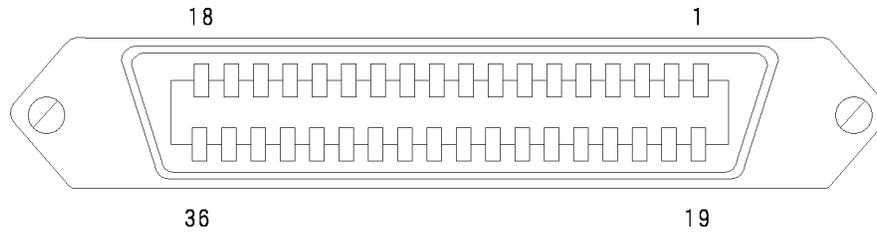


Table 4-9. Pin Assignment of Handler Interface Connector (Mode 1)

Pin No.	Signal	Pin No.	Signal
1	/BIN1	19	/PHI
2	/BIN2	20	/PLO
3	/BIN3	21	/SREJ
4	/BIN4	22	/FAIL
5	/BIN5	23	N.C.
6	/BIN6	24	/NO_CONTACT
7	/BIN7	25	/KEY_LOCK
8	/BIN8	26	N.C.
9	/BIN9	27	N.C.
10	/OUT_OF_BIN	28	N.C.
11	/AUX_BIN	29	/ALARM
12	/EXT_TRIG	30	/INDEX
13	/EXT_TRIG	31	/EOM
14	EXT.DCV2	32	COM2
15	EXT.DCV2	33	COM2
16	+5V	34	COM1
17	+5V	35	COM1
18	+5V	36	COM1

Table 4-10. Signal Definition (Mode 1)

Pin No.	Signal	Input /Output	Definition and Description
1	/BIN1	Output	Comparator signal for DUT classification. Informs which BIN the DUT has been classified into. All signals are output through open-collector.
2	/BIN2		
3	/BIN3		
4	/BIN4		
5	/BIN5		
6	/BIN6		
7	/BIN7		
8	/BIN8		
9	/BIN9		
10	/OUT_OF_BINS	Output	Is output if the primary parameter has no been classified into any BIN.
11	/AUX_BIN	Output	Is output if the primary parameter has been classified into a BIN and the secondary parameter has not been classified into any BIN.
12	/EXT_TRIG	Input	External trigger. Used in the external trigger mode. Triggers the handler at the falling edge or rising edge of pulse, which can be selected through 4286A's softkey setting.
13	/EXT_TRIG		
14	EXT.DCV2	Input	External DC voltage. This voltage is supplied to the DC isolated input signal (/EXT_TRIG, /KEY_LOCK) and DC isolated output signal (/ALARM, /INDEX, /EOM). Change the switch settings on the top shield when using the internal DC voltage.
15	EXT.DCV2		
16	+5V	Output	Internal DC voltage. Max. permissible current is 0.5A. If current above this limit flows, the overcurrent detection circuit is activated to stop voltage output.
17	+5V		
18	+5V		
19	/PHI	Output	Primary parameter upper limit OVER signal. Is output together with /OUT_OF_BIN if the measured value exceeds the upper limit for BIN1 to 9. (See Figure 4-3.)
20	/PHO	Output	Primary parameter lower limit UNDER signal. Is output together with /OUT_OF_BIN if the measured value falls below the lower limit for BIN1 to 9. (See Figure 4-3.)
21	/SREJ	Output	Secondary parameter limit OUT signal. Is output when the measured value is outside the preset limits. (See Figure 4-3.)
22	/FAIL	Output	Overall comparator output signal. Is output at the end of measurement cycle if one of the conditions below is met. <ul style="list-style-type: none"> ■ /NO_CONTACT is output. ■ /OUT_OF_BINS or /AUX_BIN is output for the segment currently under BIN sorting. ■ Limit line test fails for segments other than the above.

Table 4-10. Signal Definition (Mode 1) (continued)

Pin No.	Signal	Input /Output	Definition and Description
23	N.C.	—	Not used.
24	/NO_CONTACT	Output	Contact check fail signal. Is output if the measured DC resistance is outside the preset limits for contact check.
25	/KEY_LOCK	Input	Key lock signal. All key operations on the 4286A front panel are disabled if this signal is received.
26	N.C.	—	Not used.
27			
28			
29	/ALARM	Output	Failure signal. Is output if self-test results are faulty, if power is instantaneously interrupted, or if a specific circuit malfunctions. During power interruption, this signal remain ON only during loss of power.
30	/INDEX	Output	Analog measurement end signal. You can connect the handler to a new DUT when this signal is received by the handler. Note that measured data will be available only when /EOM is output.
31	/EOM	Output	Measurement cycle end signal. Measured data and comparator signals are valid when this signal is output.
32	COM2	—	External DC voltage COMMON for EXT.DCV2
33	COM2		
34	COM1	—	External DC voltage COMMON. This COMMON supplies DC voltage to DC isolated output signals (/BIN1 to /BIN9, /OUT_OF_BIN, /AUX_BIN, /PHI, /PLO, /SREJ, /FAIL, /NO_CONTACT).
35	COM1		
36	COM1		

Figure 4-5 shows timing diagram for mode 1.

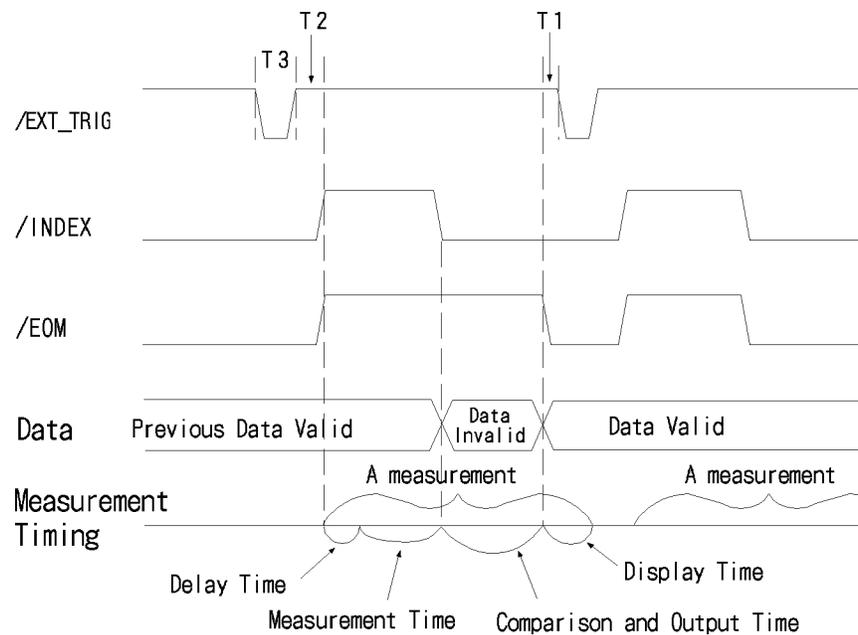


Figure 4-5. Timing Diagram (Mode 1)

Time		Min.	Max.
T1	Trigger pulse width	1 μ s	—
T2	Measurement start delay	—	600 μ s
T3	Wait time from /EOM output to triggering ¹	5ms	600ms

¹ T3 represents the *minimum duration of time* required for the 4286A to function properly. Min. and Max. represents the time required respectively when the most simple and most complex measurement conditions are set. Note that when you specify excessively short time, /EXT_TRIG may be ignored, causing the 4286A to malfunction.

The items which can affect on T3 are listed below. T3 gets *longer* if the items are ON and/or the number of frequency points increases.

- a. Number of measurement points
- b. Setting the beeper ON/OFF
- c. Setting limit test ON/OFF, and number of frequency points
- d. Setting BIN sorting ON/OFF, and number of frequency points

The beeper significantly affects T3, adding 100ms when it is ON.

Note



- See *Function Reference* for detailed description of measurement time.
 - Comparison and output require about 0.5ms
 - The display time is about 3ms+6ms/points.
-

Pin Assignment and Signal Definitions (Mode 2)

The relationship between the primary/secondary parameter values and signals /F1REJ to /F10REJ and /DBIN0 to /DBIN3 is as follows:

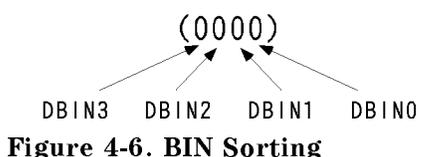
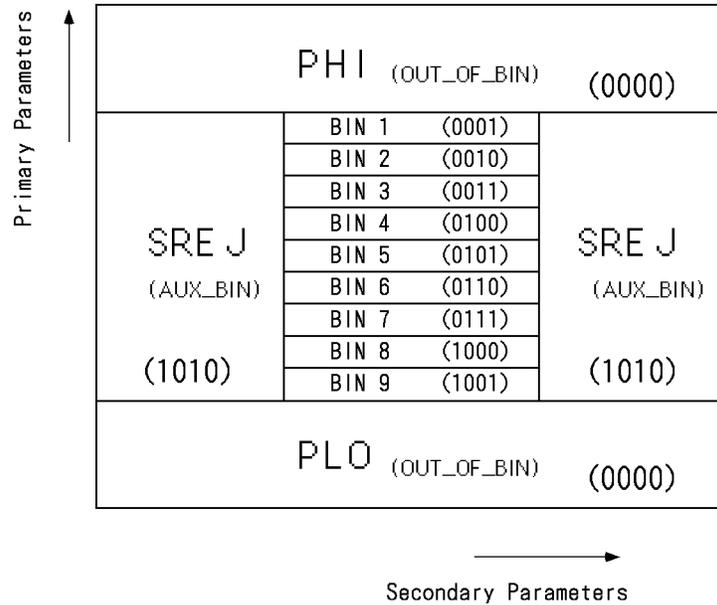


Figure 4-6. BIN Sorting

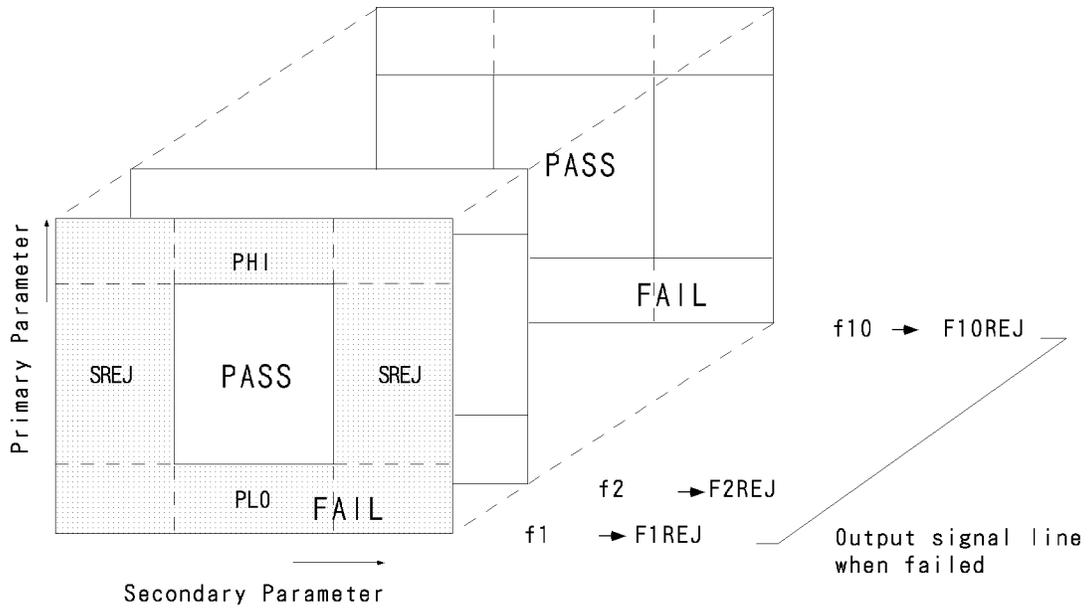


Figure 4-7. Limit Test

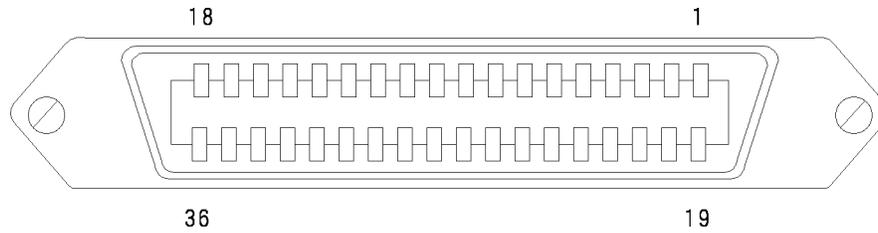


Table 4-11. Handler Interface Connector Pin Assignment (Mode 2)

Pin No.	Signal	Pin No.	Signal
1	/F1REJ	19	DBIN0
2	/F2REJ	20	DBIN1
3	/F3REJ	21	DBIN2
4	/F4REJ	22	DBIN3
5	/F5REJ	23	N.C.
6	/F6REJ	24	/NO_CONTACT
7	/F7REJ	25	/KEY_LOCK
8	/FSREJ	26	N.C.
9	/F9REJ	27	N.C.
10	/F10REJ	28	N.C.
11	/FAIL	29	/ALARM
12	/EXT_TRIG	30	/INDEX
13	/EXT_TRIG	31	/EOM
14	EXT.DCV2	32	COM2
15	EXT.DCV2	33	COM2
16	+5V	34	COM1
17	+5V	35	COM1
18	+5V	36	COM1

Table 4-12. Signal Definition (Mode 2)

Pin No.	Signal	Input/ Output	Definition and Description
1	/F1REJ ¹	Output	Output if the DUT is rejected at sweep point 1.
2	/F2REJ ¹		Output if the DUT is rejected at sweep point 2.
3	/F3REJ ¹		Output if the DUT is rejected at sweep point 3.
4	/F4REJ ¹		Output if the DUT is rejected at sweep point 4.
5	/F5REJ ¹		Output if the DUT is rejected at sweep point 5.
6	/F6REJ ¹		Output if the DUT is rejected at sweep point 6.
7	/F7REJ ¹		Output if the DUT is rejected at sweep point 7.
8	/F8REJ ¹		Output if the DUT is rejected at sweep point 8.
9	/F9REJ ¹		Output if the DUT is rejected at sweep point 9.
10	/F10REJ ¹		Output if the DUT is rejected at sweep point 10.
11	/FAIL ¹	Output	<p>Test-failed or no-contact signal. This signal is output at the end of measurement cycle if one of the conditions below is met.</p> <ul style="list-style-type: none"> ■ /NO_CONTACT is output. ■ /OUT_OF_BINS is output for the segment currently under BIN sorting. ■ Limit line test fails for segments other than the above.
12 to 18	See Table 4-9.	Same as with mode 1. (See Table 4-9.)	
19	DBIN0	Output	Comparator output for DUT classification. The range of acceptable measurements for comparator output is the same as for mode1. A 4-bit binary signal of DBIN0 to DBIN3 is output as comparator signal. See Figure 4-6 for details.
20	DBIN1		
21	DBIN2		
22	DBIN3		
23 to 29	See Table 4-9.	—	Same as with mode 1. (See Table 4-9.)

¹ This signal is output at the end of sweep measurement.

Table 4-12. Signal Definition (Mode 2) (continued)

Pin No.	Signal	Input/ Output	Definition and Description
30	/INDEX	Output	<p>Analog measurement end signal. Signal definition varies depending on the sweep mode used, as shown below.</p> <ul style="list-style-type: none"> ■ On Sweep Mode Is output at the end of analog measurement of the last sweep point. You can connect the handler to a new DUT when this signal is received by the handler. ■ On Point Mode Is output at the end of analog measurement of each sweep point. You can start measurement of the next sweep point when this signal is received by the handler. <p>Note that measured data will be available only when /EOM is output, regardless of the sweep mode used.</p>
31	/EOM	Output	<p>Measurement cycle end signal. Signal definition varies depending on the sweep mode used, as shown below.</p> <ul style="list-style-type: none"> ■ On Sweep Mode Is output at the end of sweep measurement. Measured data and comparator signals are valid when this signal is output. ■ On Point Mode Is output when valid data are obtained after measurement (including time required for the comparator to make comparisons) of each sweep point. Comparator signals are valid when /EOM is output at the end of measurement of the last sweep point.
32 to 36	See Table 4-9.	—	Same as with mode 1. (See Table 4-9.)

Figure 4-8 and Figure 4-9 shows timing diagram for mode 2.

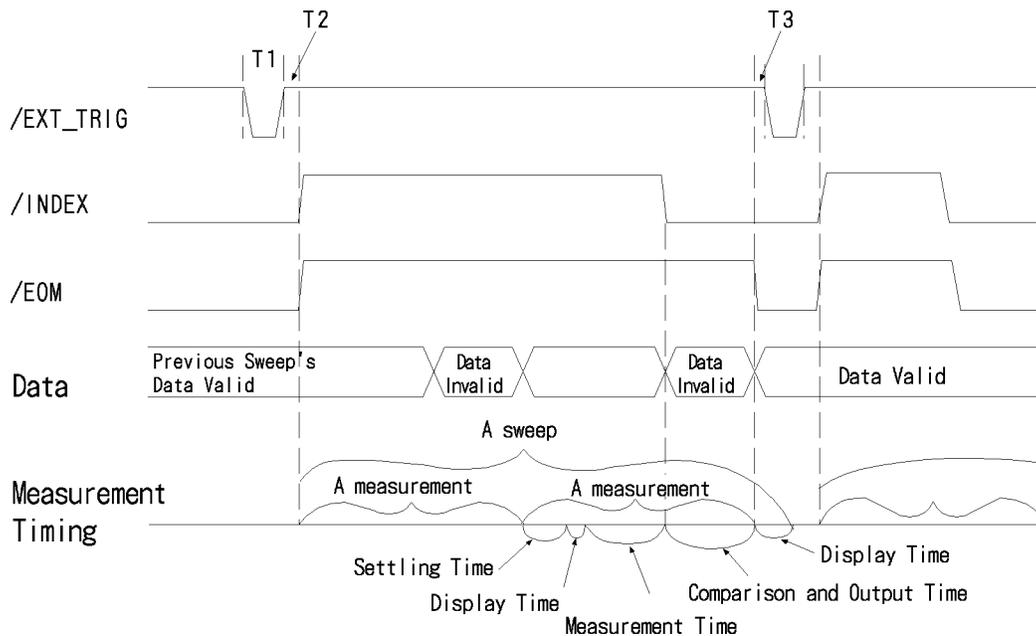


Figure 4-8. Timing Diagram (mode 2: On Sweep Mode)

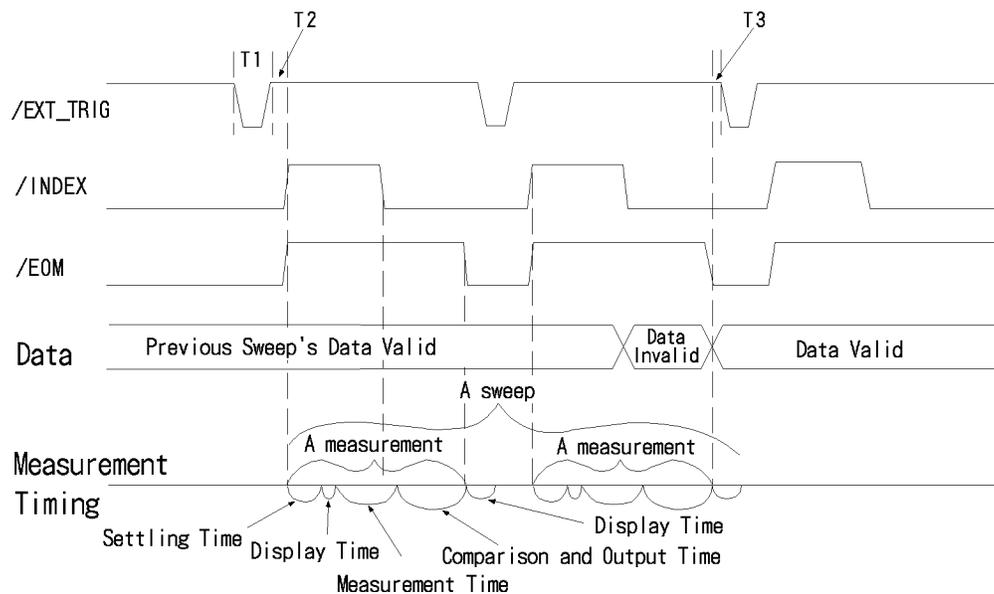


Figure 4-9. Timing Diagram (mode 2: On Point Mode)

Note



- Settling time includes switching time of correction data.
- See *Function Reference* for detailed description of measurement time.
- Comparison and output require about $1\text{ms} + 0.1\text{ms/point}$, display about $3\text{ms} + 6\text{ms/point}$.
- See Figure 4-5 for description of T1, T2, and T3.

Electrical Characteristics of Signals

This section provides description of electrical characteristics of each signal and configuration of I/O circuits.

Electrical characteristics of each signal do not change regardless of the function (comparator function and list sweep comparator function) used.

DC Isolated Output Signals

Each of the DC isolated signals (pins 1 to 11, 19 to 24, 29 to 31) is output through an open-collector and photocoupler.

You can use switches on the handler interface board to select the desired power source. The internal source (5V) or an external power source (5 to 24V for comparator output signals or 5 to 15V for control output signals) can be selected. Note that you usually use an external power source to supply voltage to control output signals.

You can connect the internal pull-up resistor of 4.7k Ω to control signals by simply changing switch settings. Note that you must mount a pull-up resistor to the handler side of the board for comparator output signals.

Table 4-13. Electrical Characteristics of DC Isolated Output Signals

Output	Rated Voltage Output		Max. Current	COMMON
	LOW	HIGH		
Comparator Output Signal	$\leq 0.5V$	5V to 24V	5mA	COM1
Control Output Signal	$\leq 0.5V$	5V to 15V	5mA	COM2

Figure 4-10 and Figure 4-11 show the circuit configuration of comparator and control output signals, respectively.

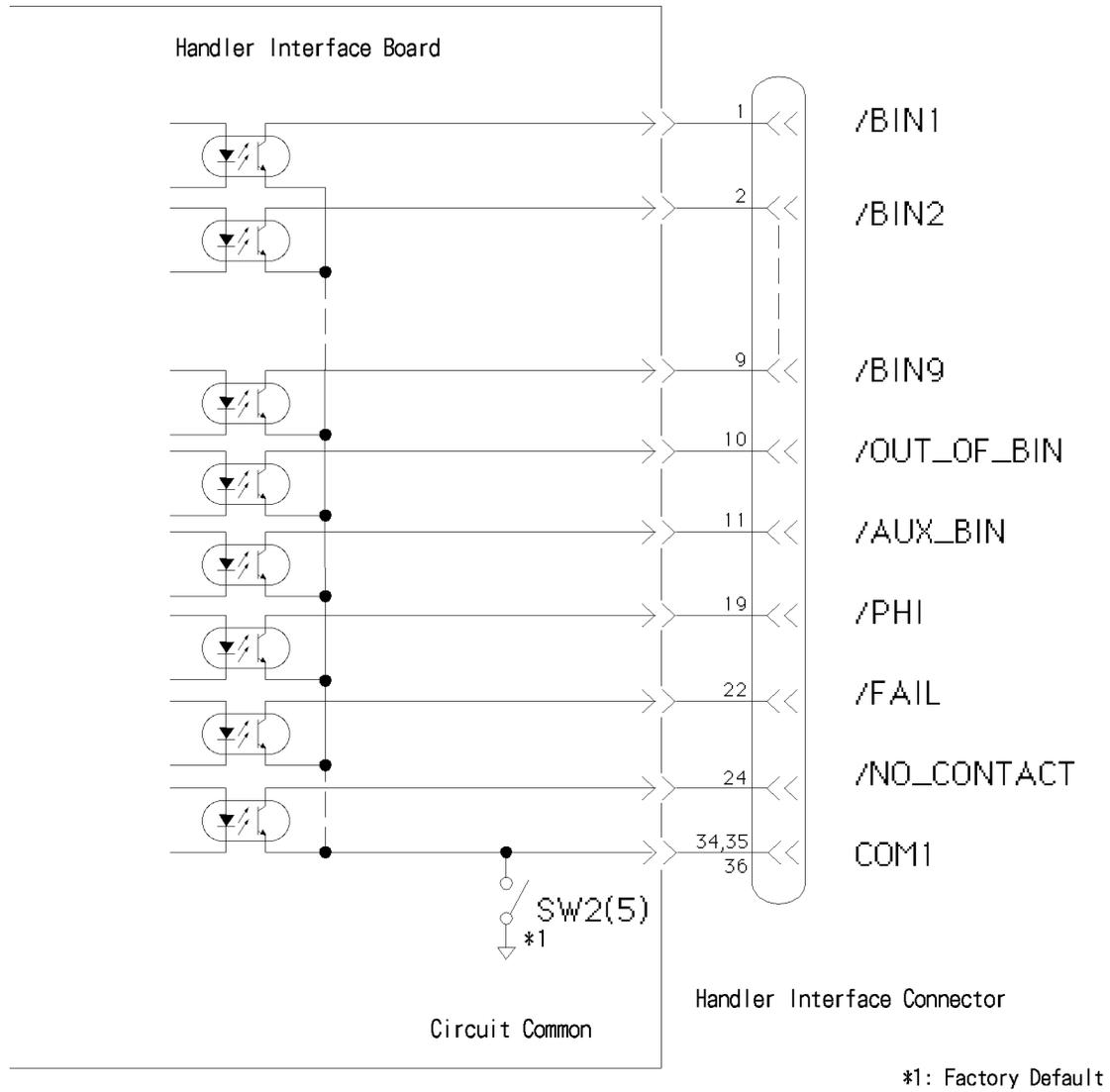


Figure 4-10. Circuit Configuration of Comparator Output Signals

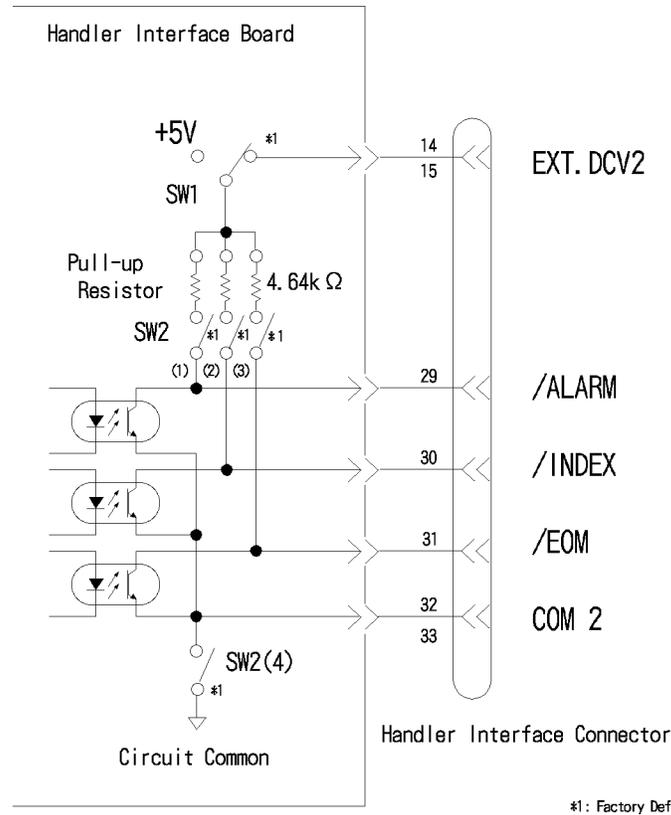


Figure 4-11. Circuit Configuration of Control Output Signals

DC Isolated Input Signals

DC isolated input signals can be divided into /EXT_TRIG and /KEY_LOCK.

■ /EXT_TRIG

/EXT_TRIG (pins 12 and 13) is input to the cathode of photocoupler LED. The 4286A is triggered at the falling edge or rising edge of pulse, which can be selected through 4286A's softkey setting. Drive voltage is applied to the anode of photocoupler LED by the internal (5V) or external (EXT.DCV2) power source. (Use switches on the handler interface board to select the desired source.)

Note



Use SW2 to select the proper resistor according to the level of anode voltage applied. This resistor is used to limit the trigger voltage to the specified level. See Table 4-5 for details.

■ /KEY_LOCK

/KEY_LOCK (pin 25) is input to the cathode of photocoupler LED. All keys on the 4286A front panel are disabled when this signal is low. Drive voltage is applied to the anode of photocoupler LED through pins 14 and 15 by the internal (5V) or external (EXT.DCV2) power source. (Use switches on the handler interface board to select the desired source.)

Table 4-14. Electrical Characteristics of DC Isolated Input Signals

Input Signal	Input Voltage		Input Current (at LOW)			COMMON
	LOW	HIGH	5V	12V	15V	
/EXT_TRIG	≤1V	Voltage – 1V ≤HIGH≤Voltage	10.0mA	12.0mA	15.0mA	<ul style="list-style-type: none"> ■ Internal Power Source 4286A COMMON ■ External Power Source COM2
/KEY_LOCK	≤1V	Voltage – 1V ≤HIGH≤Voltage	12.5mA	12.0mA	15.0mA	<ul style="list-style-type: none"> ■ Internal Power Source 4286A COMMON ■ External Power Source COM2

Figure 4-12 shows the circuit configuration of input signals.

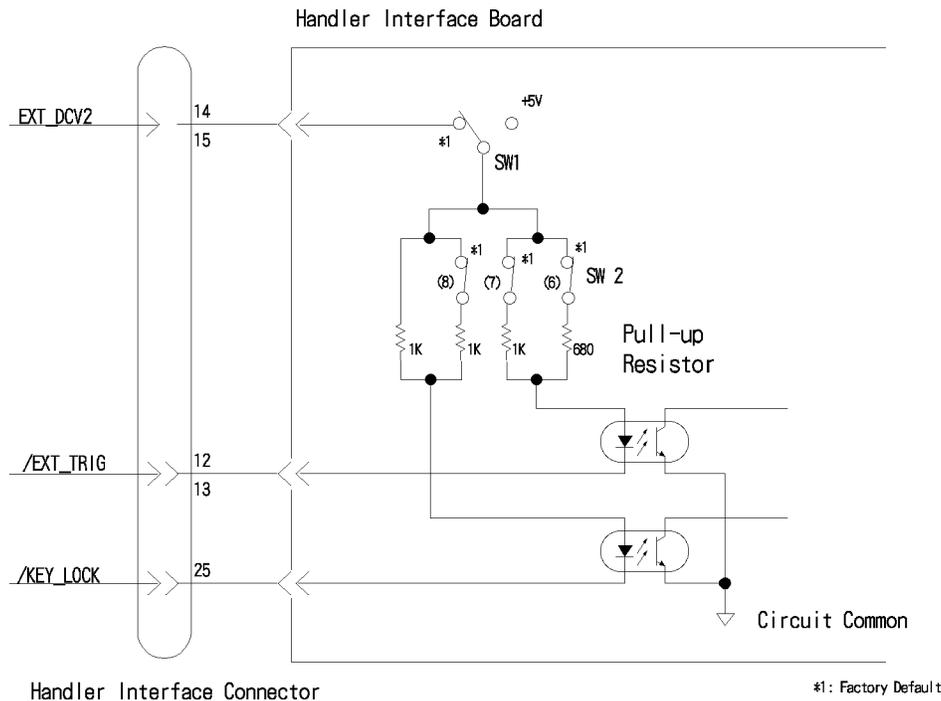


Figure 4-12. Circuit Configuration of Handler Interface Input Signals

Note



When you use the internal power source, use COM2 as COMMON. To do this, set SW2(4) to ON position to connect the 4286A COMMON to COM2.

Handler Interface Board Switches

You can select the desired signal I/O format for the handler interface by changing settings of switches on the interface board. Two switches are provided for signal I/O interface and their settings can be changed on the top shield.

Top Cover Removal

Tools Required

- Torx screwdriver, T15
- Pozidriv screwdriver, pt size #2 (medium)

Procedure

1. Disconnect the power cable from the analyzer.
2. Remove the two rear feet behind the top cover.
3. Loosen the top cover rear screw.
4. Slide the top cover toward the rear and lift it off.

Figure 4-13 illustrates the locations and default settings of the switches.

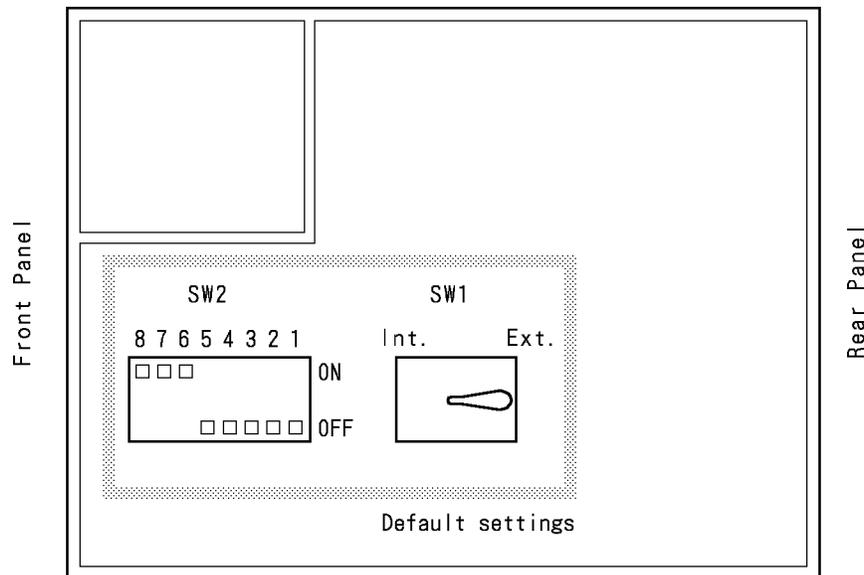


Figure 4-13. Handler Interface Board Switches

Top Cover Attachment

Procedure

1. Put the top cover and slide it toward the front.
2. Tighten the top cover rear screw.
3. Attach the two rear feet behind the top cover.

Warning

Do not connect the power cable to the meter during the top cover is removed.



Performing Calibration with Working Standard (only with option 004)

Note This procedure is necessary when you use 4286A with option 004.



Measuring the Working Standard Value

Measure the working standard to obtain L_s required for LOAD compensation. Specify 51Ω for resistor.

1. Prepare the test head and perform OPEN/SHORT/LOAD calibrations for the contact surface of APC-7[®] connector.
2. Connect fixture to the test head and perform OPEN/SHORT compensations. Make sure that you performed the fixture compensation with shorting device for the working standard.
3. Connect the chip resistor for working standard to the fixture.
4. Measure L_s of the connected chip resistor. We recommend the following conditions for accurate and robust measurement.

Frequency	100 MHz
Measurement parameter	L_s - R_s
Averaging factor	32
OSC level	0.5 V

5. Record the measurements.

Calibration with Working Standard

Follow the procedure below.

1. Make sure that you complete the procedure shown above.
2. Set up calibration kit.

Press **CAL KIT**, **USER KIT** to toggle it **USER**.

Press **MODIFY**.

Press **DEFINE STANDARD**.

Press **LOAD RESIST. (R)**.

Press **5**, **1**, **x1** consequently to set R to 51Ω .

Press **LOAD INDUCT. (L)**.

Set the value which is given by the procedure in “Measuring the Working Standard Value” to L_s .

3. Perform OPEN/LOAD/SHORT calibration procedures.

The table below lists typical values of the working standards with option 004. The values serves as reference: use actually obtained results for calibration kit.

Table 4-15. Typical Values of Working Standard (with option 004)

P/N	Size	R_s	L_s
5182-0433	1.0×0.5 mm	≈51Ω	≈ 200 pF
5182-0434	1.6×0.8 mm	≈51Ω	≈ 300 pF
5182-0435	2.0×1.25 mm	≈51Ω	≈ 500 pF
5182-0436	3.2×1.6 mm	≈51Ω	≈ 700 pF

Restoring Settings After Power Interruption

Instantaneous power interruption resets the 4286A to default settings. The 4286A must, therefore, be set to your own settings again after power interruption. To do this, you can use the backup SRAM disk memory or built-in flexible disk drive to automatically restore your settings.

When you wish to use the flexible disk drive, first save your settings in the file named `AUTOREC` on a flexible disk. Then, insert this disk in the disk drive and keep it inserted while the 4286A is running. When you wish to use the SRAM disk memory, save the `AUTOREC` file on the disk memory. In either case, the 4286A will read the contents of this file to recall its settings and calibration data if the power is interrupted. AutoRecall provides a fast way to recover your 4286A settings after power interruption.

Note



When you have the `AUTOREC` file stored in both the flexible disk and RAM disk memory, the contents of the file in the flexible disk will be read into the 4286A.

All data in the disk memory will be lost in 3 days after power interruption. Backup batteries can be automatically recharged when the 4286A is ON.

Typical Functions

The 4286A has a number of functions other than those explained in the previous chapters. This chapter describes the major features of and operation procedures associated with these functions.

Functions available with the 4286A are listed below. If you find a function that suits your task, become familiar with the description of that function and its key operation sequence in the associated section.

- Key Features:
 - Measurement-related Functions:
 - Point Delay and Sweep Delay
 - Point Averaging
 - OSC Level Monitor
 - Display-related Function:
 - Entering Titles on the Screen
 - Other Functions
 - Saving and Recalling
 - Printing or Plotting
 - Logging Key Sequence into a Program (Option 1C2 Only)

Point Delay and Sweep Delay

Delay functions stabilize the measurements by delaying the measurement start for a specified time after the stimulus is set.

Making a Point Delay Measurement

1. Press **Delay Time** .
2. Press **POINT DELAY TIME** .
3. Enter the point delay time and press one of the unit keys such as **x1**.

Making a Sweep Delay Measurement

1. Press **Delay Time**.
2. Press **SWEEP DELAY TIME** .
3. Enter the sweep delay time and press one of the unit keys such as **x1**.

Delay Description

■ Point Delay

The measurement start for each point is delayed for a user-specified time after the stimulus is set at each point.

■ Sweep Delay

The sweep start is delayed for a user-specified delay time after the trigger.

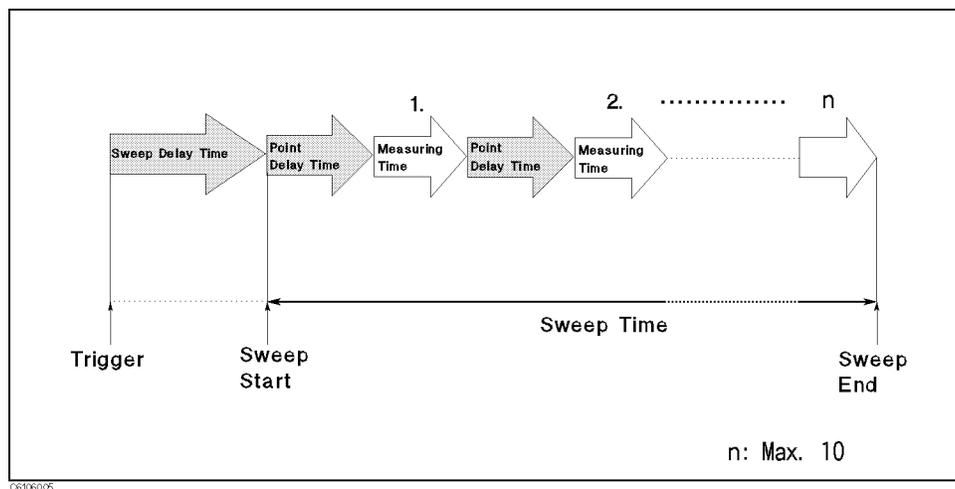


Figure 5-1. Point Delay and Sweep Delay

Averaging

4286A employs point averaging method, which allows data measured at the same frequency to be averaged. This function reduces non-repeatable variations contained in measured values.

1. Press **Sweep Setup**.
2. Press **SEGMENT** to select the desired segment for averaging.
3. Press **EDIT AVERAGING ON POINT**.
4. Enter the averaging factor (number of measurements) and press **x1**.
5. Press **SEGMENT DONE**.
6. Repeat list item 2 through list item 5 for the segment selected.
7. Press **LIST DONE**.

Further Discussion

Point Averaging averages each data point by a user-specified averaging factor. The 4286A repeats measuring the same point until the averaging factor is reached. It then divides the vector summation of measurement values by the averaging factor and starts measuring the next point.

For some other impedance analyzers, 2 types of averaging methods are available, which is sweep averaging method and point averaging method. When you compare results with those obtained by other impedance meter or analyzer, be sure that the both measurement are based on point averaging method.

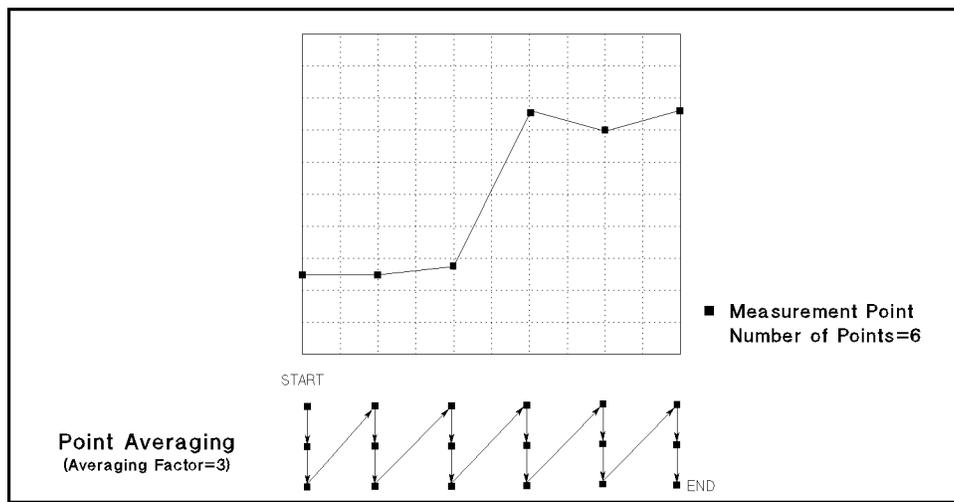


Figure 5-2. Point Averaging

OSC Level Monitor

Level Monitor allows monitoring of voltage applied to or current flowing through the DUT.

1. Press **Monitor**.
2. Select the desired parameter you wish to monitor. Press **OFF** when you do not wish to monitor the OSC level.
 - Press **AC-V** to monitor the voltage.
 - Press **AC-I** to monitor the current.

Signal level is displayed on the screen.

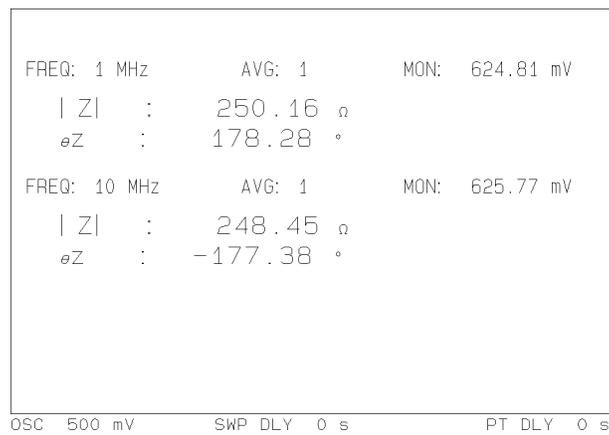


Figure 5-3. Level Monitor Function

Entering Titles on the Screen

The label function allows you to enter the desired characters on the screen as titles as long as those characters can be used on the 4286A.

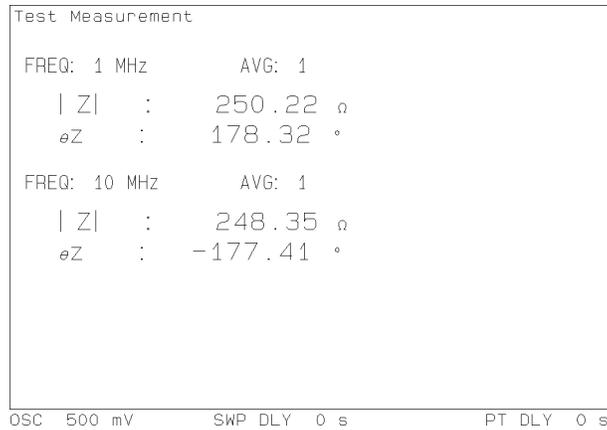


Figure 5-4. Label Function

Title Entry Procedure

1. Press **Display**, and then **TITLE**.
2. Press **LETTER MENU**.
3. Enter the desired characters.
 - Use any of **<upper>**, **<lower>**, **<digit>**, and **<other>** as necessary to enter upper or lower characters, or numbers.
 - Press **MORE** repeatedly until the desired character appears on the screen
 - Press the key that corresponds to the character to be entered. Press **BACK SPACE** to delete characters on the screen.
4. Continue to enter all characters as described above.
5. When you finish, press **DONE**.

Note

You can enter characters on your keyboard when your 4286A is equipped with option 1C2.



Saving and Recalling

The save/recall functions allow you to save and recall a 4286A setting, measurement data, or display image.

The 4286A has two kinds of mass storage, a built-in flexible drive and a RAM disk memory. Each mass storage supports two kinds of format, LIF (Logical Interchange Format) and MS-DOS®. The 4286A automatically detects the disk format as either LIF or MS-DOS®.

Caution



The files on the RAM disk are kept until the 4286A is turned off. When the 4286A is turned off, the data on the RAM disk is lost.

Saving 4286A Setting and Measurement Trace

1. Insert a LIF or MS-DOS® formatted 3.5 inch disk into the built-in disk drive. When you are saving an instrument state file to the RAM disk, skip this step. See “Initializing a Disk/RAM Disk for Use” in the following section for how to initialize your disk.
2. Press **Save/Recall**.
3. Select where to store the file by pressing either **STOR DEV [DISK]** (built-in disk drive) or **STOR DEV [MEMORY]** (RAM disk). Press **STOR DEV [DISK]** to display the desired storage in [].
4. Press **STATE**.
5. Follow the procedure in “Title Entry Procedure” to enter a filename. Then press **DONE**.

Recalling a Saved 4286A Setting and Measurement Trace

1. Insert the appropriate disk (if you are recalling an instrument state file from the RAM disk, skip this step).
2. Press **Save/Recall**.
3. Select where to store the file pressing either **STOR DEV [DISK]** (built-in disk drive) or **STOR DEV [MEMORY]** (RAM disk).
4. Search for the filename you want to recall (the files are listed as softkey labels).
5. Press **RECALL FILE**, and the name of each stored file is listed as a softkey label. Press the softkey that corresponds to the target file.
6. If the target file is not found on any softkey label, scroll other labels by pressing **PREV FILES** or **NEXT FILES**.
7. Press the softkey corresponding to the target file.

Note



You can automatically recall the instrument state every time the 4286A is turned ON. Use “AUTOREC” as a filename. The 4286A recalls this file from a disk that is in the built-in disk drive when it is turned ON.

Saving a Display Image to an HP-GL File

1. Press **(Save/Recall)**, then **SAVE FILE** and **ASCII SAVE**.
2. Press **GRAPHICS**.
3. Select where to store the file by pressing either **STOR DEV [DISK]** (built-in disk drive) or **STOR DEV [MEMORY]** (RAM disk).
4. Enter filename. Then press **DONE**.

The 4286A saves an HP-GL file with an “.HPG” extension for a DOS format, or a “_G” suffix for a LIF format. If you want to change the extension for a DOS format, press **(Save/Recall)**, then **SAVE FILE**, **ASCII SAVE**, **DEFINE EXTENSION**, and **GRAPHICS [.HPG]** to call the extension defining menu. Then enter a new extension. This feature is only available for a DOS format disk.

Saving Measured Data for a Spreadsheet

1. Insert a DOS format disk into the built-in disk drive.
2. Press **(Save/Recall)**, then **SAVE FILE** and **ASCII SAVE**.
3. Press **DATA ONLY (ASCII)**.
4. Select the built-in disk drive as the storage device by toggling to **STOR DEV [DISK]**.
5. Enter a filename. Then press **DONE**.

The 4286A saves an ASCII file with a “.TXT” extension. If you want to change the extension, press **(Save/Recall)**, then **SAVE FILE**, **ASCII SAVE**, **DEFINE EXTENSION**, and **ASCII DATA [.TXT]** to call the extension defining menu.

Then enter a new extension. The measured data is saved as ASCII text. Each value is separated by a tab. When you open this file from the spreadsheet software, specify the file format as the “TEXT with TAB delimiter”.

Purging a File

If there is a file on the disk that has the same name you entered when saving a file, the error message, “filename error” is displayed. To save the file, you must use another filename or purge the old file. To purge a file, press **(Save/Recall)**, then **FILE UTILITIES** and **PURGE FILE** then select the displayed filename by pressing the associated softkey.

Initializing a Disk/RAM Disk for Use

1. Insert a disk that is not write protected (if you are initializing the RAM disk, skip this step).
2. Press **(Save/Recall)**, and then **FILE UTILITIES**.
3. Select the disk format (either DOS or LIF) by toggling **FORMAT [DOS]** or **[LIF]**.
4. Select the initialized storage device by toggling **STOR DEV [DISK]** or **[MEMORY]**.
5. Press **INITIALIZE**.

6. Press `INITIALIZE DISK: YES` to initialize the RAM disk or the disk.

Printing or Plotting

Printing or Plotting a Display Image

1. Connect a printer or a plotter to the 4286A with an GPIB cable.
2. Set the GPIB address as follows:
Printer : 1 (verify that the printer is NOT set to “Listen Always”).
Plotter : 5
3. Press **(Local)**. Then press **SYSTEM CONTROLLER**.
4. Press **(Copy)** **PRINT [STANDARD]** to print or **(Copy)** **PLOT** to plot.

To stop printing or plotting in progress, press **(Copy)** **COPY ABORT**.

Using a Different GPIB Address for the Printer/Plotter

1. Press **(Local)** **SET ADDRESSES**.
2. Press **ADDRESS: PLOTTER** or **ADDRESS: PRINTER**. Then enter a new GPIB address.
3. Press **RETURN** to return to the top menu.

Logging the Key Sequence into a Program (Option 1C2 Only)

When Option 1C2 is installed, the logging function allows you to log your key sequence into an instrument BASIC program. This function allows you to create a program without referring to the *GPIB Command Reference*.

1. Press **(System) IBASIC**.
2. Toggle **LOGGING on OFF** to **ON off**.
3. Press the front panel keys according to your required setting.
4. Press **(System) IBASIC**.
5. Toggle **LOGGING ON off** to **on OFF**.
6. Press **EDIT** to enter the edit mode.
7. Verify that the program was created according to your key sequence.

Note



When you log the calibration and the fixture compensation procedure, you must modify the program to wait for completion of the calibration or the fixture compensation.

Resetting the 4286A

Press **Preset** to reset all function parameters to the preset values.

See *Function Reference* for preset values.

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the meter than the current printing date of this manual. The information in this manual applies directly to the 4286A RF LCR meter serial number prefix listed on the title page of this manual.

Manual Changes

To adapt this manual to your 4286A, see Table A-1 and Table A-2, and make all the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument's serial number is not listed on the title page of this manual or in Table A-1, it may be documented in a *yellow MANUAL CHANGES* supplement.

In additions to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Agilent Technologies recommends that you periodically request the latest *MANUAL CHANGES* supplement.

For information concerning serial number prefixes not listed on the title page or in the *MANUAL CHANGE* supplement, contact the nearest Agilent Technologies office.

Turn on the line switch or execute the *IDN? command by GPIB to confirm the firmware version. See the *GPIB Command Reference* manual for information on the *IDN? command.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes

Table A-2. Manual Changes by Firmware Version

Version	Make Manual Changes

Serial Number

Agilent Technologies uses a two-part, ten-character serial number that is stamped on the serial number plate (see Figure A-1) attached to the rear panel. The first five characters are the serial prefix and the last five digits are the suffix.



Figure A-1. Serial Number Plate

Maintenance

This appendix provides information on performance verification, repair, replacement of Center Conductor Collet, line voltage setting changes, and fuse replacement.

Performance Verification

The 4286A requires periodic performance verification. How often you verify performance depends on the operating and environmental conditions. The recommended cycle is at least once a year. The performance verification procedure is described in the *Service Manual*. For the customer who does not have the test instruments required for performance verification or who wants to save time, Agilent Technologies provides calibration service. For detailed information, contact the nearest Agilent Technologies office.

Repair

When your meter seems defective, the following section of “Possible Problems and Their Solution” will help you to determine what to do. If you can not find a solution, contact the nearest Agilent Technologies office. If you send the instrument to Agilent, include information about the trouble symptom. Send all of your meter, including the mainframe, test station, test head and calibration kit (0 Ω , 0 S, 50 Ω terminations and low-loss capacitor).

Possible Problems and Their Solution

■ meter does not turn on:

Check the fuse and the voltage selected.

■ Measurement trace is not stable:

1. Check the test station, the test head, and the fixture connection.
2. Check the center conductor collet of the APC-7 connector on the test head, the 50 Ω termination, and the low-loss capacitor. If a collet is defective, replace it (see “Replacement of Center Conductor Collet”).

■ Measurement trace is displayed as a line or is not smooth:

The number of measurement points may be too small.

- Nothing is displayed on the screen or only the softkey labels are displayed.
If Option 1C2 is installed, the display allocation may set to all BASIC.
- Recalling a status file, but the calibration data isn't recalled (COR is not displayed.)
The different kind of test head may be connected.

Replacement of Center Conductor Collet

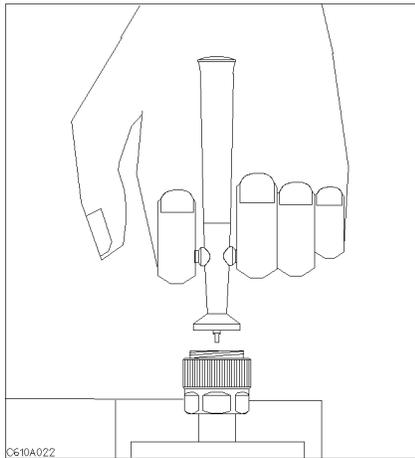
The replacement procedure for the center conductor collet on the APC-7® is described in below:

Required Item	Agilent Part Number
Collet Removal Tool	5060-0236
6-Slot Precision Collet	85050-20001
Removing Tool Guide (for low-loss capacitor)	04291-21002

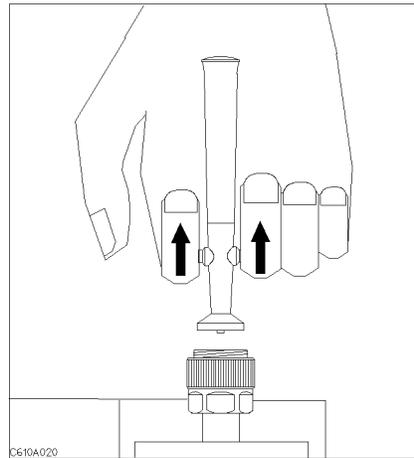
Note Removing Tool Guide (Agilent P/N 04291-21002) is furnished with the low-loss capacitor as the end cap.



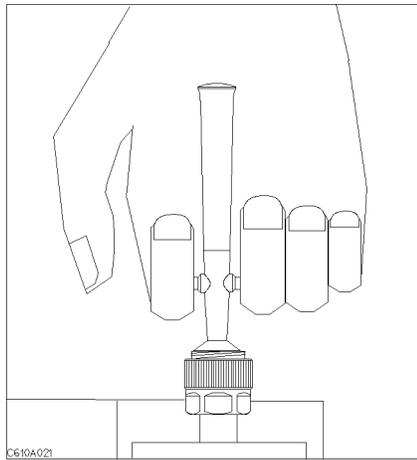
Removing Center Conductor Collets



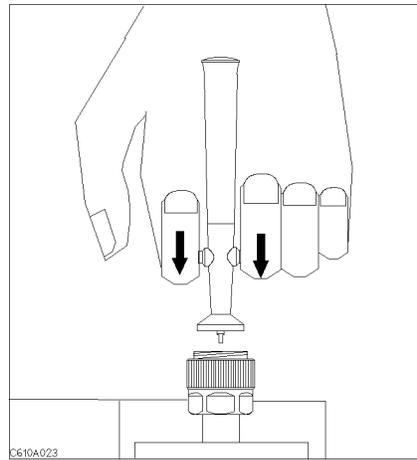
1. Verify that the connector sleeve is extended fully.



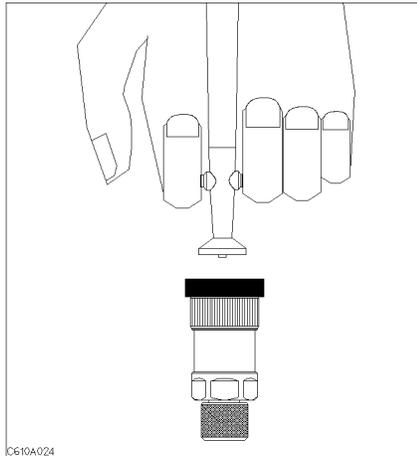
2. Pull back the handle of the collet removing tool.



3. Keep the handle pulled back and insert the tool into the connector until it comes to rest lightly on the interior support bead.

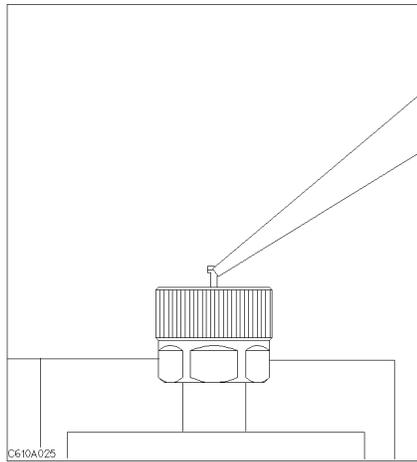


4. Release the handle and remove the old collet and the tool.

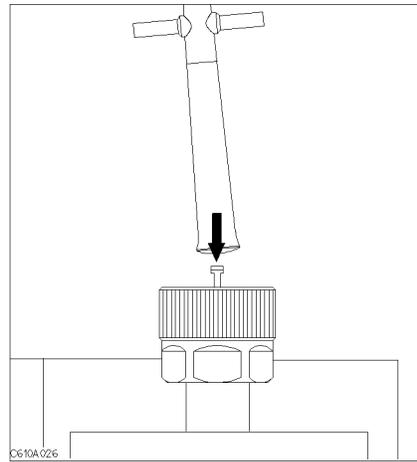


The low-loss capacitor has no extending connector sleeve. Use the Removing Tool Guide instead of extending connector sleeve.

Insert Center Conductor Collets



1. Place the collet on the center conductor of the connector.



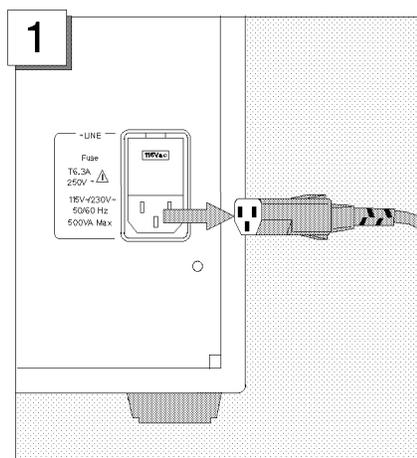
2. Press the collet gently until it snaps into place.

Changing the Line Voltage Setting

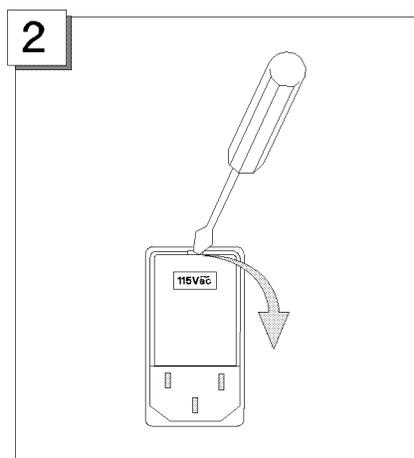
Table B-1. Line Voltage Ranges

AC Voltage Range	Selector Voltage
90 V to 132 V	115 V
198 V to 264 V	230 V

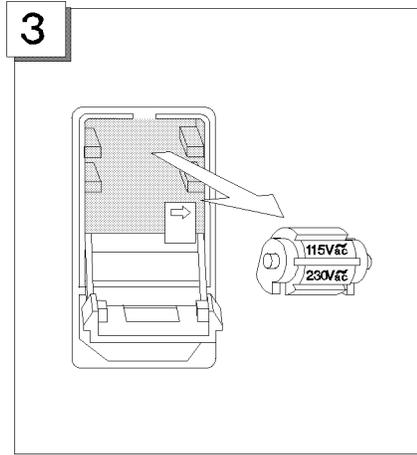
The line voltage selector is set at the factory to correspond to the most commonly used line voltage of the country of destination. The line voltage selected for the meter is indicated on the line voltage selector. Refer to table Table B-1 for the line voltage ranges. Perform the following steps to change the line voltage:



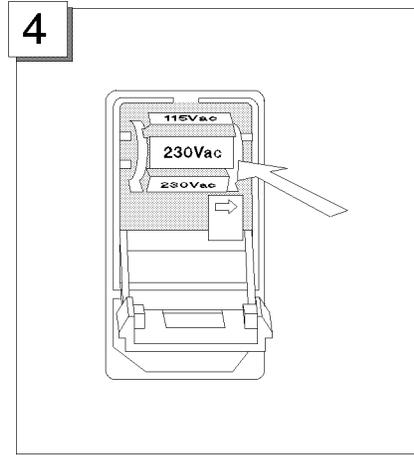
1. Remove the power cord if it is connected.



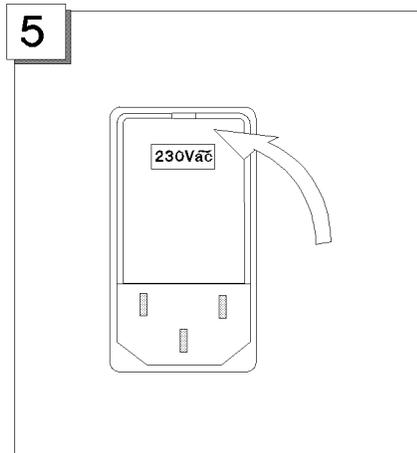
2. Open the cover of AC line receptacle on the rear panel using a small, flat-blade screwdriver.



3. Pull out the Line-Voltage Drum.



4. Insert the Line-Voltage Drum so that the required voltage is displayed at the front.



Close the cover by pushing it until it clicks. Verify that the correct line voltage appears in the window of the power selector cover.

Replacing the Fuse

Use the following fuse:

Agilent Part Number : 2110-0917

(UL/CSA type, semi time delay 6.3A 250V)

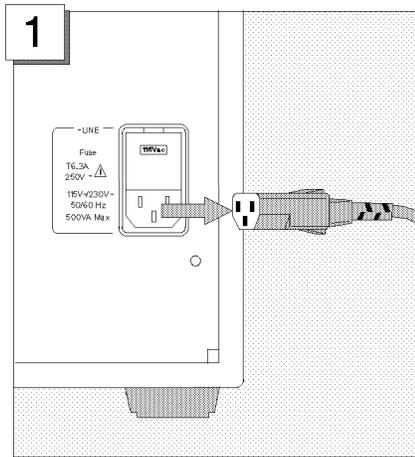
If you need this fuse, contact your nearest Agilent Technologies Sales and Service Office.

Note

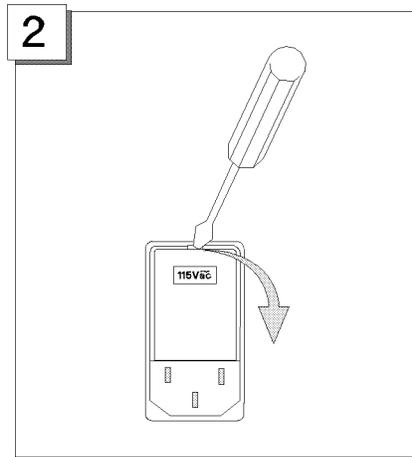


The same fuse can be used for both line voltage settings. You do not have to change the fuse when changing the line voltage.

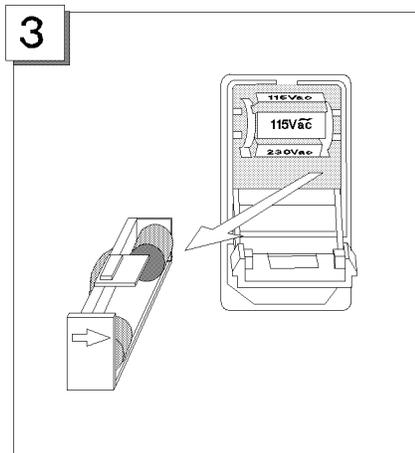
Perform the following steps to exchange the fuse:



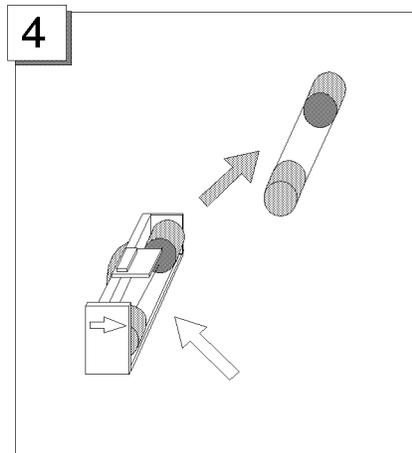
1 Remove the power cord if it is connected.



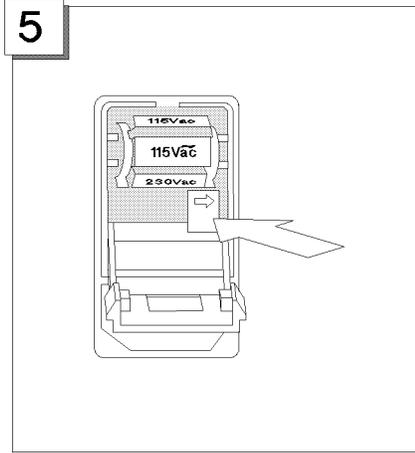
2 Open the cover of AC line receptacle on the rear panel using a small, flat-blade screwdriver.



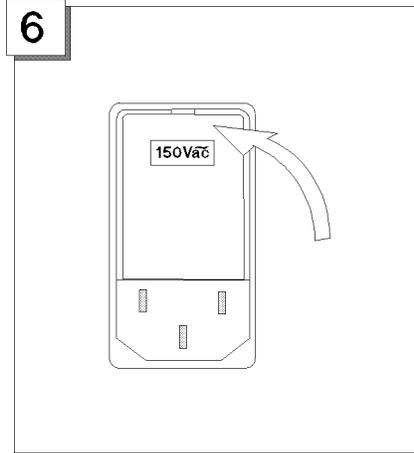
3 To check or replace the fuse, pull the fuse holder out of the power selector and remove the fuse from the fuse holder.



4 To reinstall the fuse, insert a fuse into the fuse holder.



Push the fuse holder into the power selector.



Close the cover by pushing it until it clicks.

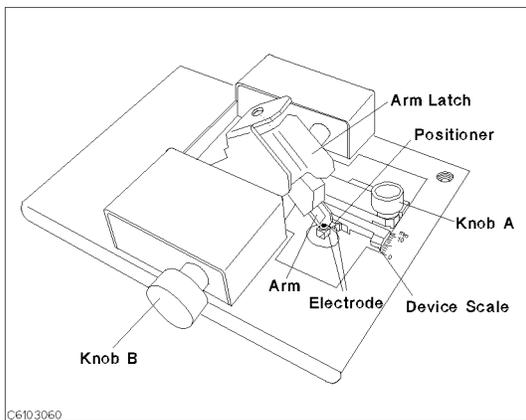
C

Fixture Compensation Procedures for the 16191A and 16193A

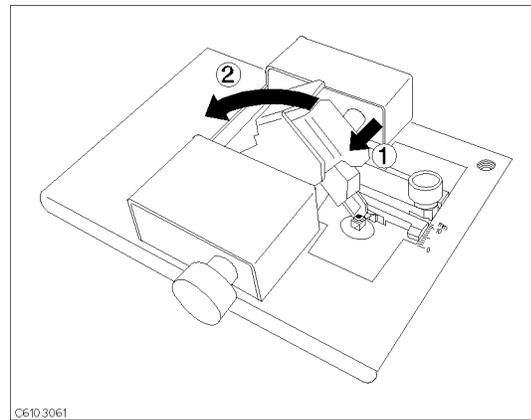
This appendix provides fixture compensation procedures for the 16191A and 16193A. A fixture compensation procedure for the 16192A is described in the “6. Fixture Compensation” in Chapter 3.

16191A

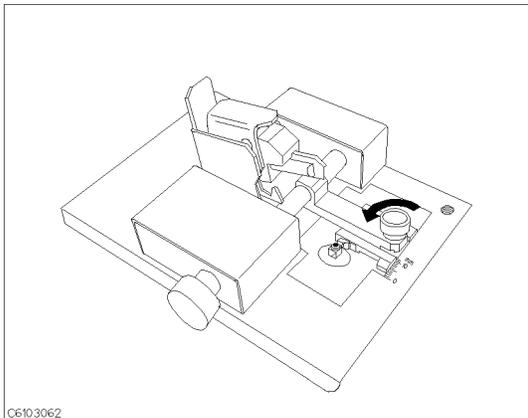
SHORT Compensation



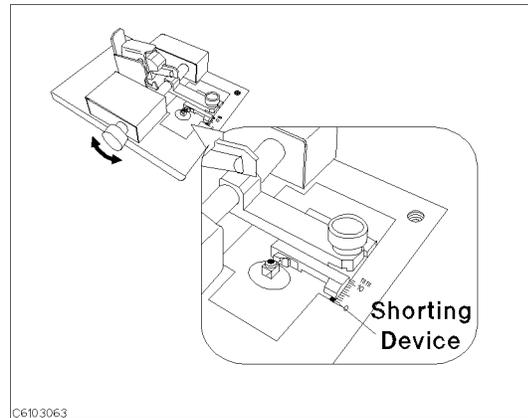
The names of each part are listed above.



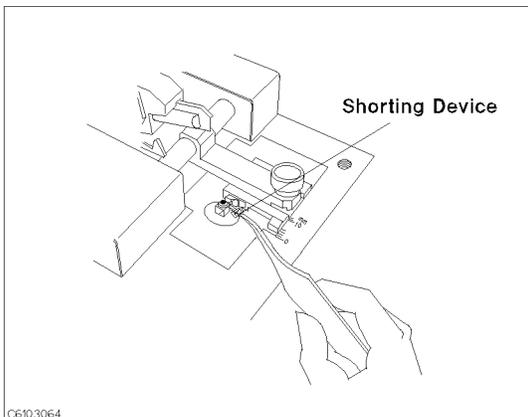
1. ① Latch off the arm latch. ② Hold up the pressure arm.



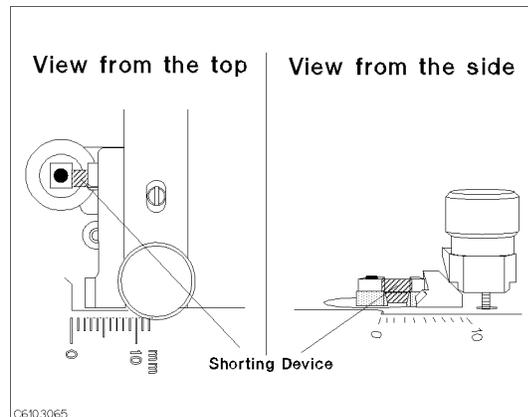
2. Loosen knob A



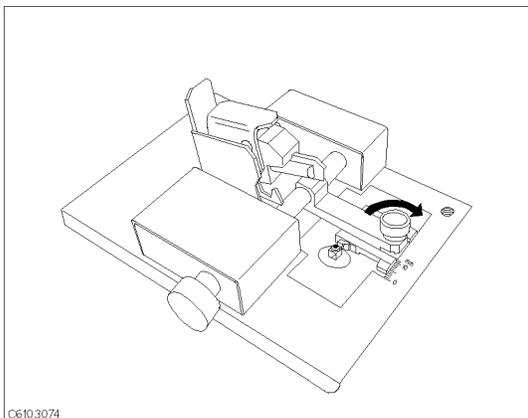
3. Adjust knob B to fit the shorting device to the device scale.



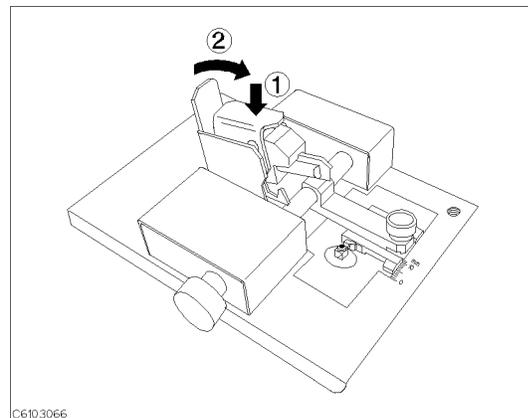
4. Place the shorting device on the electrode and turn knob B for fine adjustment.



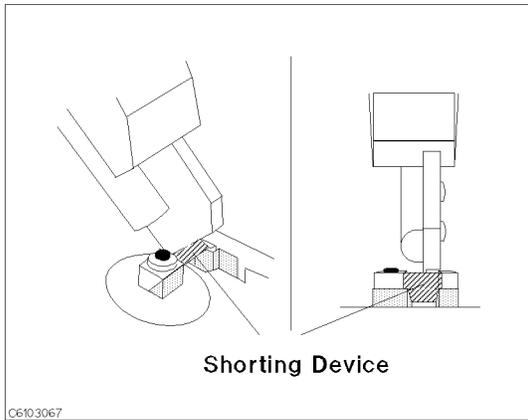
5. Verify that the shorting device contacts the electrodes securely.



6. Tighten knob A.



7. ① Press the arm latch. ② Turn down the pressure arm.

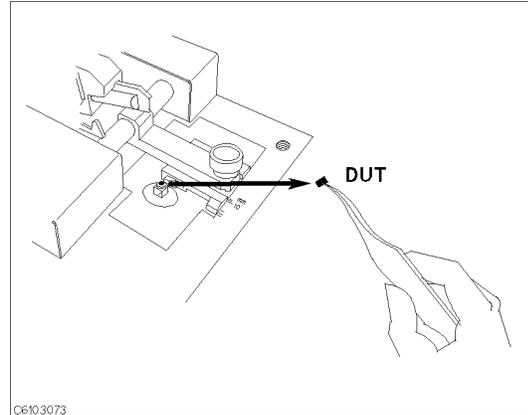
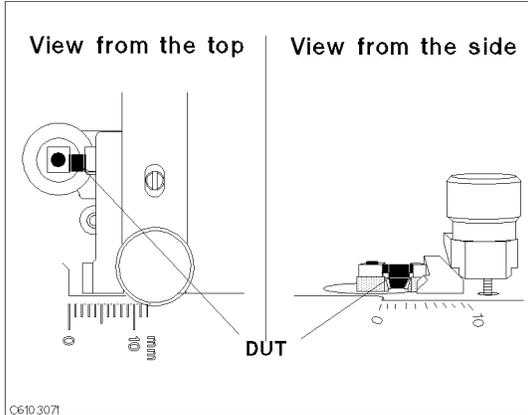


8. Verify that pressure arm presses the shorting device.

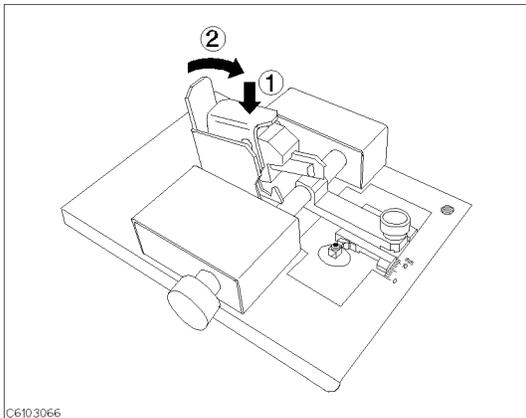
SHORT Compensation Key Sequence

1. Press **Cal** **FIXTURE COMPEN** **COMPEN MENU** **SHORT**.
2. After the short compensation sequence is completed, the **SHORT** softkey label is underlined.

OPEN Compensation



1. Place the DUT on the electrode just as you set the shorting device in the short compensation.
2. Remove the DUT from the electrodes.

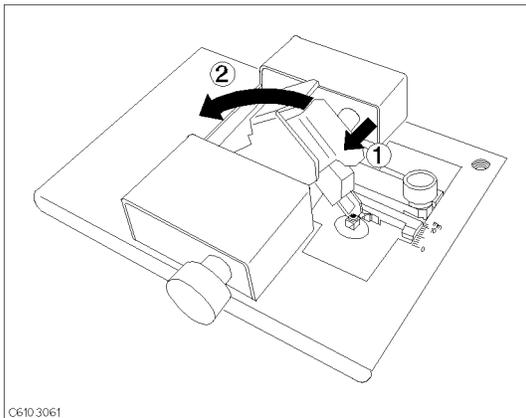


9. ① Press the arm latch. ② Turn down the pressure arm.

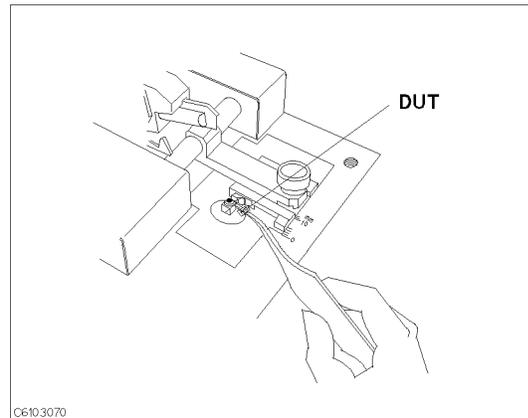
OPEN Compensation Key Sequence

1. Press **OPEN**.
2. After the open compensation sequence is completed, the **OPEN** softkey label is underlined.
3. Press **DONE: COMPEN**.
4. Verify that two **CMP** notations appear on the left side of the display.

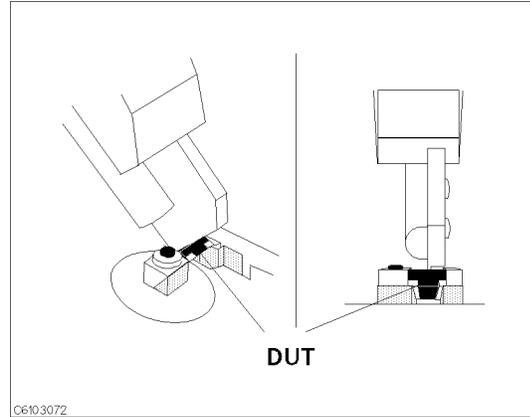
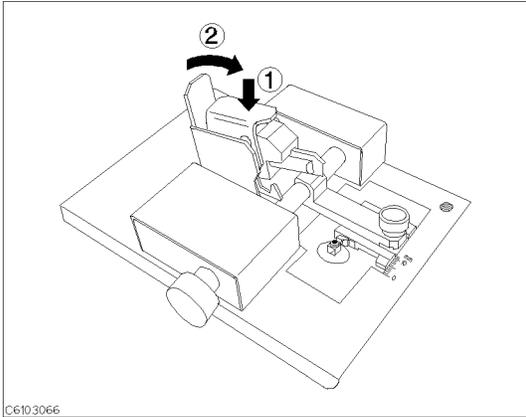
Connecting DUT



1. ① Latch off the arm latch. ② Hold up the pressure arm.



2. Place the DUT on the electrodes.

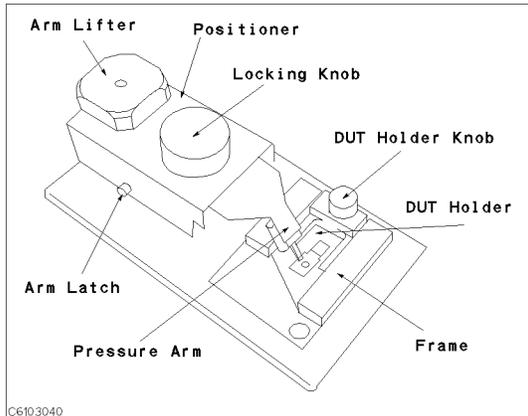


3. ① Press the arm latch. ② Turn down the pressure arm.

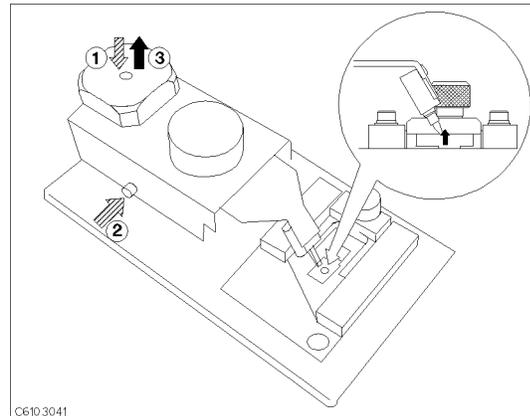
4. Verify that pressure arm presses the DUT.

16193A

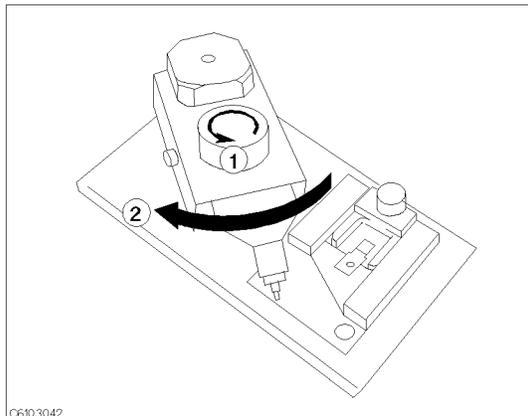
SHORT Compensation



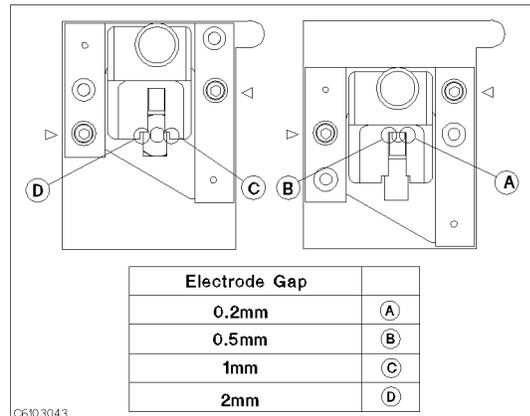
The names of each part are listed above.



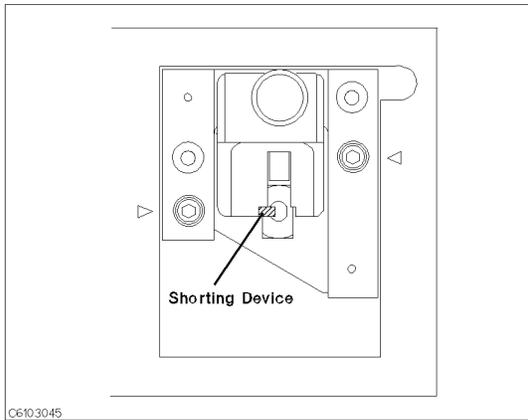
1. ① Push the arm lifter. ② Push the arm latch button. ③ Release the arm lifter while pushing the arm latch button so that the pressure arm is held.



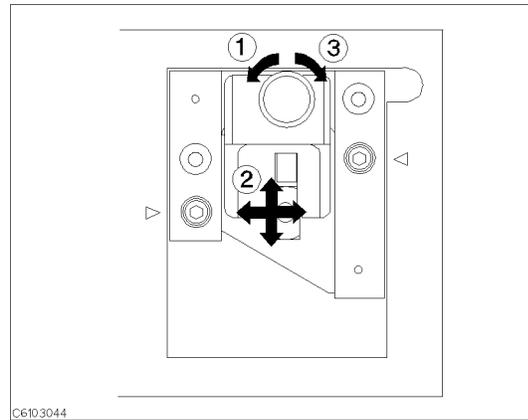
2. ① Loosen the locking knob. ② Rotate the positioner until the nose of the pressure arm is located outside the stage.



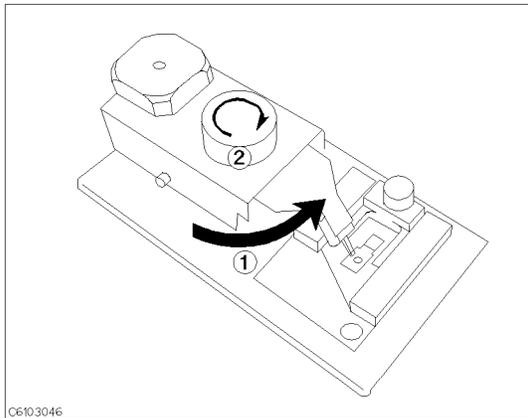
3. Position the size selection frame depending on the size of the DUT. (This procedure shows the case for D as an example.)



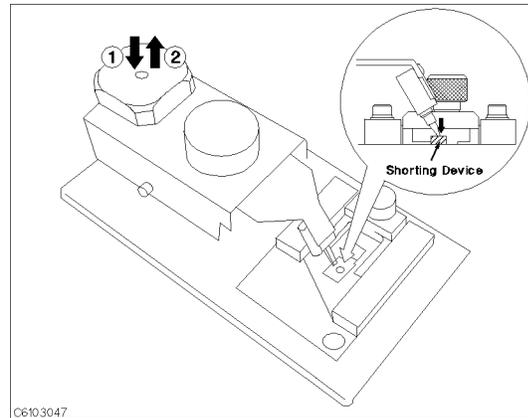
4. Place the shorting device on the electrode.



5. ① Loosen the knob. ② Position the DUT holder so that the short bar contacts both electrodes. ③ Tighten the knob to fix the DUT holder.



6. ① Reposition the positioner so that the nose of the pressure arm is just above the shorting device. ② Tighten the locking knob.



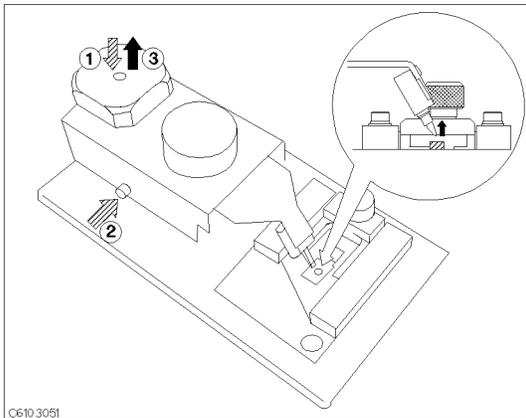
7. ① Push the arm lifter so that the arm latch is released. ② Let down the pressure arm to press down the shorting device.

SHORT Compensation Key Sequence

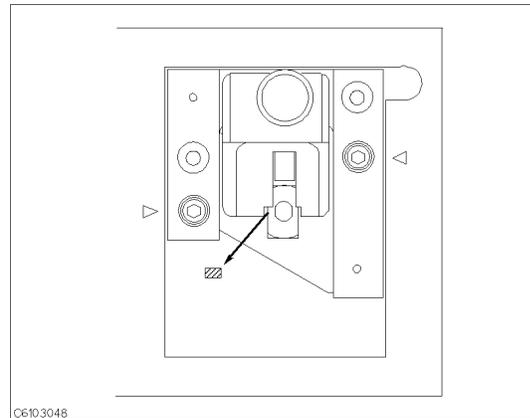
1. Press **Cal** **FIXTURE COMPEN** **COMPEN MENU** **SHORT**.

After the short compensation sequence is completed, the **SHORT** softkey label is underlined.

OPEN Compensation



1. ① Push the arm lifter. ② Push the arm latch button. ③ Release the arm lifter while pushing the arm latch button so that the pressure arm is held.

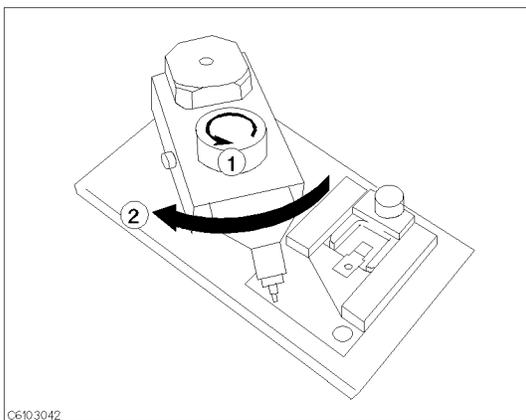


2. Remove the shorting device.

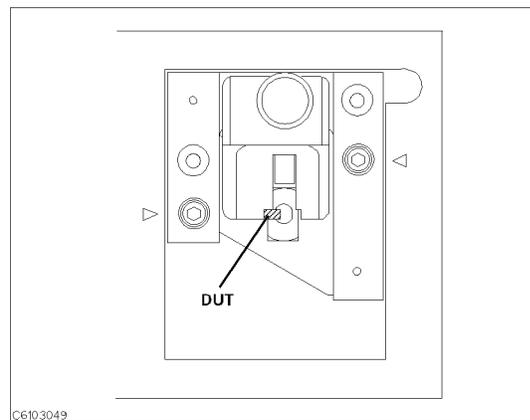
OPEN Compensation Key Sequence

1. Press **OPEN**.
2. After the open compensation sequence is completed, the **OPEN** softkey label is underlined.
3. Press **DONE: COMPEN**.
4. Verify that two **CMP** notations appear on the left side of the display.

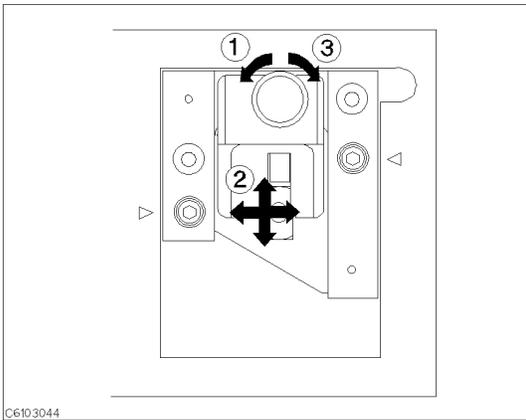
Connecting DUT



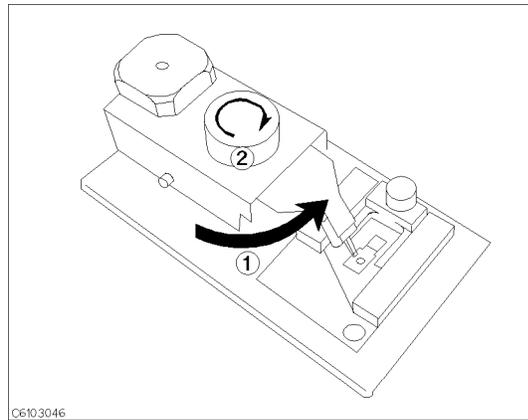
1. ① Loosen the locking knob. ② Rotate the positioner until the nose of the pressure arm is located outside the frame.



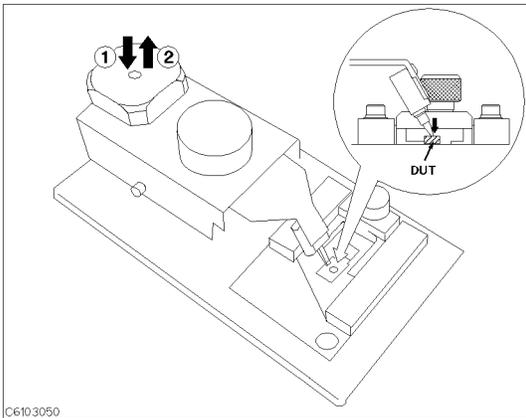
2. Place the DUT on the electrode.



3. ① Loosen the knob. ② Position the DUT holder so that the DUT contacts both electrodes. ③ Tighten the knob.



① Reposition the positioner so that the nose of the pressure arm is just above the DUT. ② Tighten the locking knob.



3. ① Push the arm lifter so that the arm latch is released. ② Let down the pressure arm to press down the DUT.

Index

A

ADDRESS , 5-9
ASCII save , 5-7
AUTOREC , 5-6
Averaging , 5-3

C

cleaning , 2-7

D

delay , 5-2
delay function , 5-2

F

file
 purge , 5-7
file format
 DOS , 5-7
 LIF , 5-7
fuse, 3-4, B-6

G

go/no-go test , 4-5
GPIB address , 5-9

H

HP-GL , 5-7

I

initialize , 5-7

L

label function , 5-5
LABEL MENU , 5-5
level monitor , 5-4
list sweep comparator function , 4-5

log
 program , 5-10

M

manual changes, A-1

O

OSC level monitor , 5-4

P

plot
 display image , 5-9
point delay , 5-2
POINT DELAY TIME , 5-2
power cable , 2-5
power requirement, 2-7
print
 display image , 5-9
PRINT , 5-9
program
 log , 5-10

R

recall
 setting , 5-6

S

save
 display image , 5-7
 setting , 5-6
serial number, A-2
sweep delay , 5-2
SWEEP DELAY TIME , 5-2

V

ventilation requirement, 2-7

