Agilent 16196A/B/C Parallel Electrode SMD Test Fixture

Operation and Service Manual

Third Edition

Agilent Technologies
Innovating the HP Way

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Notices

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

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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.

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

NOTE

16196A/B/C comply with INSTALLATION CATEGORY I and POLLUTION DEGREE 2 in IEC61010-1. 16196A/B/C are INDOOR USE 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.

- 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.

Safety Symbol

General definitions of safety symbols used on the instrument 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 instrument manual.

Alternating current.

Direct current.

On (Supply).


Off (Supply).


In position of push-button switch.


Out position of push-button switch.


Frame (or chassis) terminal. A connection to the frame (chassis) of the equipment which normally include all exposed metal structure.

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.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

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This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. Fixtures and adapters are warranted for a period of 90 days. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that prove to be defective.

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Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instruction when property installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: **icons** are symbols.
Italic	Italic type is used for emphasis and for titles of manuals and other publications.
[Hardkey]	Indicates a hardkey labeled “Hardkey.”
Softkey	Indicates a softkey labeled “Softkey.”
[Hardkey] - **Softkey1** - **Softkey2**	Indicates keystrokes **[Hardkey]** - **Softkey1** - **Softkey2**.

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1 Installation Guide

In this chapter, the procedures required from the time the 16196A/B/C Parallel Electrode SMD Test Fixture arrives until its use begins are described.

Incoming Inspection

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 16196A/B/C has been checked mechanically and electrically.

The shipment should contain everything listed in Table 1-1 to Table 1-3. If the contents are incomplete or if there is mechanical damage or defect, 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.

NOTE

When the equipment is used for the first time following purchase, “Wear Check” should be conducted. This “Wear Check” is required for keeping the measurement accuracy. Refer to “Reference Value Acquisition” on page 45 in “Wear Check” for details.

Figure 1-1 **16196A/B/C** Contents

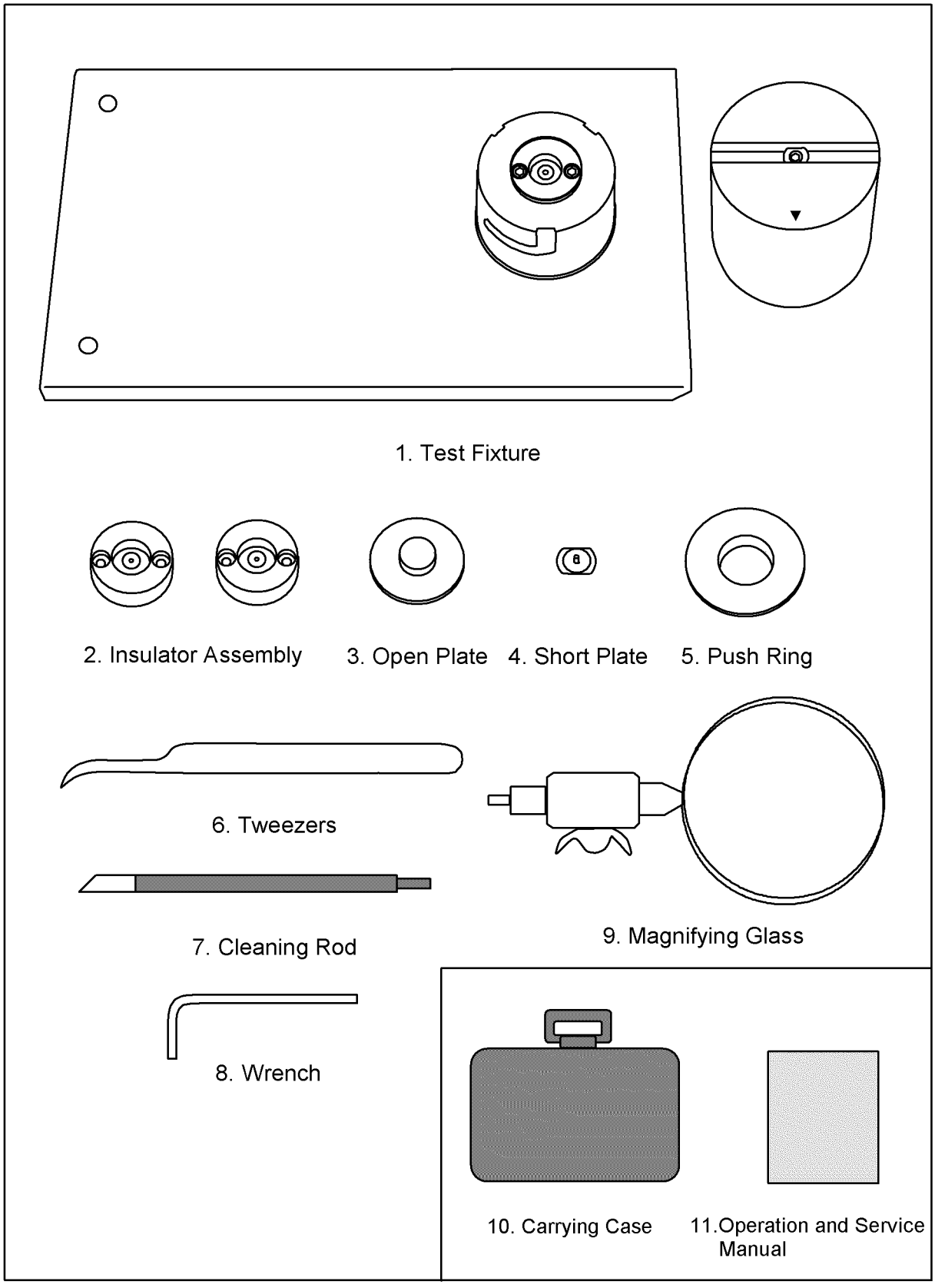


Table 1-1 16196A Package Contents

No.	Description	Agilent Part No.	Qty.
1	16196A Parallel Electrode SMD Test Fixture	-	1
-	Insulator Assembly ϕ1.34 *1	16196-60112	1
2	Insulator Assembly ϕ1.14	16196-60113	1
2	Insulator Assembly ϕ1.08	16196-60114	1
3	Open Plate *2	16196-29002	1
4	Short Plate *2	16196-29026	1
5	Push Ring	16196-24004	1
6	Tweezers*3	8710-2081	1
7	Cleaning Rod	5182-7586	1
8	Wrench	8710-0909	1
9	Magnifying Glass*3	16193-60002	1
10	Carrying Case	16196-60150	1
11	Operation and Service Manual (This manual)	16196-90020	1

*1. Mounted in the Test Fixture when shipped from the factory.
*2. The Open Plate and Short Plate are packed in a single case and shipped.
*3. Furnished with Option 710.

Table 1-2 16196B Package Contents

No.	Description	Agilent Part No.	Qty.
1	16196B Parallel Electrode SMD Test Fixture	-	1
-	Insulator Assembly ϕ0.85 *1	16196-60212	1
2	Insulator Assembly ϕ0.75	16196-60213	1
2	Insulator Assembly ϕ0.68	16196-60214	1
3	Open Plate *2	16196-29002	1
4	Short Plate *2	16196-29027	1
5	Push Ring	16196-24004	1
6	Tweezers*3	8710-2081	1
7	Cleaning Rod	5182-7586	1
8	Wrench	8710-0909	1

Table 1-2 16196B Package Contents

No.	Description	Agilent Part No.	Qty.
9	Magnifying Glass*3	16193-60002	1
10	Carrying Case	16196-60250	1
11	Operation and Service Manual (This manual)	16196-90020	1

*1. Mounted in the Test Fixture when shipped from the factory.
*2. The Open Plate and Short Plate are packed in a single case and shipped.
*3. Furnished with Option 710.

Table 1-3 16196C Package Contents

No.	Description	Agilent Part No.	Qty.
1	16196C Parallel Electrode SMD Test Fixture	-	1
-	Insulator Assembly ϕ0.48 *1	16196-60312	1
3	Open Plate *2	16196-29002	1
4	Short Plate*2	16196-29028	1
5	Push Ring	16196-24004	1
6	Tweezers*3	8710-2081	1
7	Cleaning Rod	5182-7586	1
8	Wrench	8710-0909	1
9	Magnifying Glass*3	16193-60002	1
10	Carrying Case	16196-60350	1
11	Operation and Service Manual (This manual)	16196-90020	1

*1. Mounted on the Test Fixture when shipped from the factory.
*2. The Open Plate and Short Plate are packed in a single case and shipped.
*3. Furnished with Option 710.

Connecting the 16196A/B/C to a Measuring Instrument

To connect the 16196A/B/C Test Fixture to a measuring instrument, it is necessary to use an adapter that fits the measuring instrument.

The 16196A/B/C Test Fixture is suitable for use with a high frequency LCR Meter or Impedance Analyzer. Table 1-4 lists the appropriate combination of measuring instrument and adapter.

Table 1-4 Measuring Instruments and Adapters

Instrument	Adapter
4287A	Test Head + Test Fixture Stand (Furnished with the 4287A)
4291A/B	Test Station + Test Head (Furnished with the 4291A/B)
4286A	Test Head + Test Fixture Stand (Furnished with the 4286A)
4395A*1	43961A Impedance Test Adapter
4396B*1	43961A Impedance Test Adapter

*1. "Option 010 Impedance Measuring Function" is required.

16196A/B/C Test Fixture can be connected to instruments with the 4-terminal pair configuration.

Table 1-5 Measuring Instruments and Adapters

Instrument	Adapter
4294A	42942A Terminal Adapter
4194A	41941A + 16099A or 41941B + 16099A
4192A, 4194A, 4263B, 4268A, 4278A, 4279A, 4284A, 4285A	16085B Terminal Adapter

Refer to the adapter's manual about the procedure for connecting to the measuring instrument.

NOTE Some instruments require calibration at the 7-mm connector. Perform calibration at the 7-mm connector before connecting a test fixture. See the operation manual of the instrument for more details.

The general procedure for mounting the Test Fixture on the adapter is as shown below. (For details, see the Manual supplied with each adapter.)

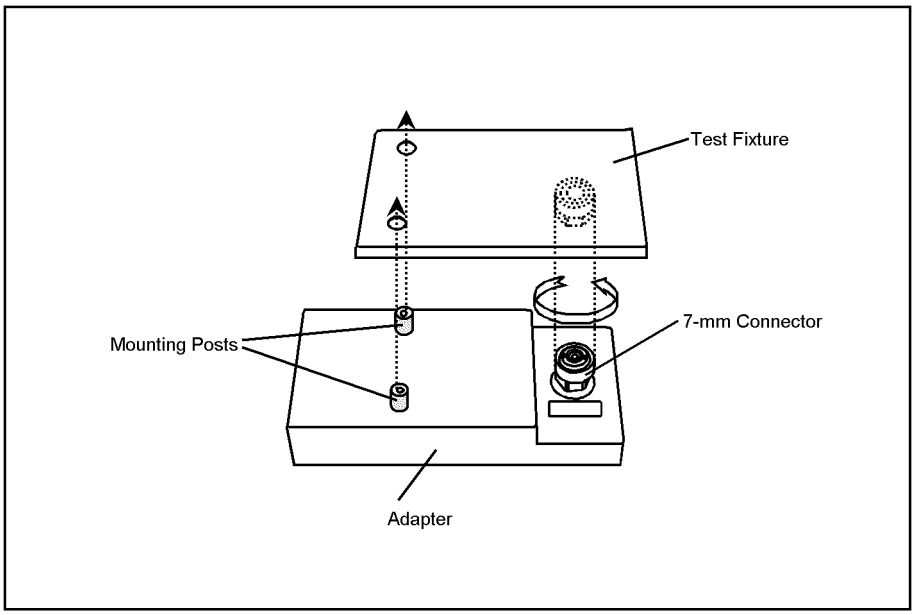
Step 1. Turn the adapter's 7-mm connector in the counterclockwise direction when viewed from above and screw the connection sleeve in fully.

Step 2. Align the text fixture with the adapter's mount post and 7-mm connector and set it gently in place.

Step 3. Turn the adapter's 7-mm connector counterclockwise, connecting the bottom of the test fixture with the connector.

NOTE To make a firm connection with the test fixture, use the torque wrench (size: 3/4 inch, torque: 12 lb-in, Agilent part number: 8710-1766) to fasten the adapter's 7-mm connector.

Figure 1-2 Installing the Test Fixture



16196abcoj0101

2 Product Overview

Product Overview

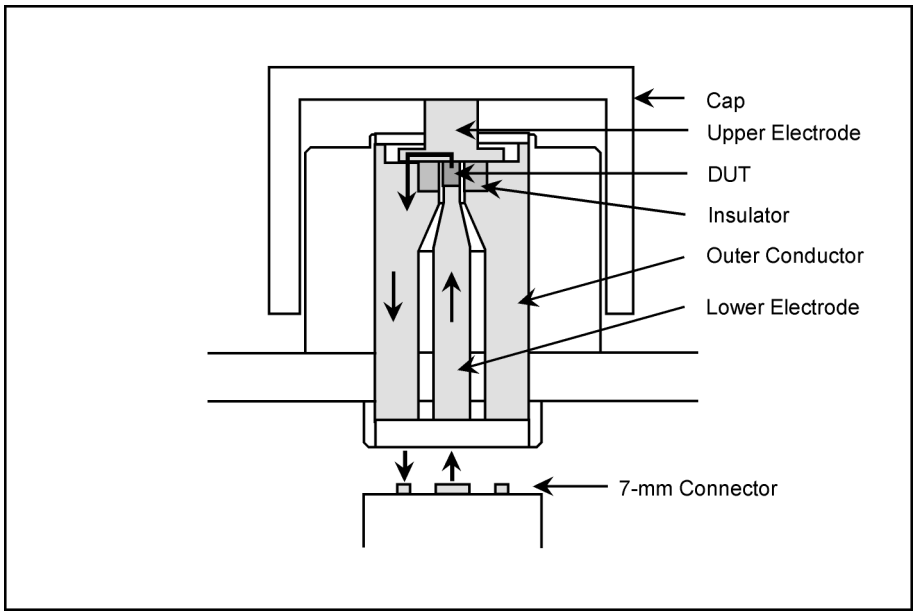
The 16196A, 16196B and 16196C are test fixtures for measuring chip components. They enable chip type capacitors, inductors and other components to be measured with high precision and measurement repeatability. The 16196A/B/C also is compatible with measuring frequencies up to 3 GHz. The 16196A is for size 1608 parts [*1], the 16196B is for size 1005 parts [*1] and the 16196C is for size 0603parts [*1].

Figure 2-1 **Product Overview (The photograph shows the 16196B.)**

The product appearance is the same for the 16196A, 16196B and 16196C.

*1. These sizes, 1608, 1005 and 0603, are all nominal sizes in millimeters.

Figure 2-2 **Electrode Structure**



After passing through the DUT (Device Under Test), the current flows to the outer conductor via the cap electrode and returns to the outer conductor of the 7-mm connector. Through this structure, the ideal shield structure is formed.

Functions

The names of each part of the 16196A/B/C are shown in Figure 2-3.

Figure 2-3 **Names of Parts**

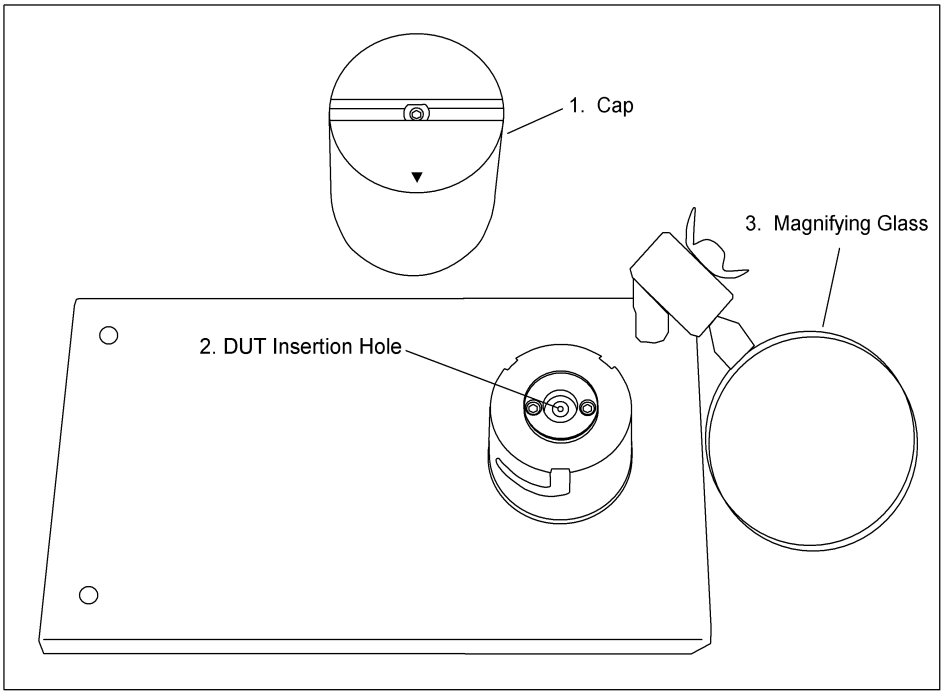


Table 2-1 Names of Parts and Functions

No.	Name	Function
1	Cap	This is the LOW side electrode.
2	DUT Insertion Hole	Forms a cylindrical structure made with an insulator and holds the DUT from the sides.
3	Magnifying Glass*1*2	Enlarges the DUT and the insulator hole area.

*1. Furnished with Option 710.
*2. The magnifying glass is packed separately from the 16196A/B/C body. Connect it as shown in Figure 2-3.

Names of Accessories and Functions

Figure 2-4 **Accessories**

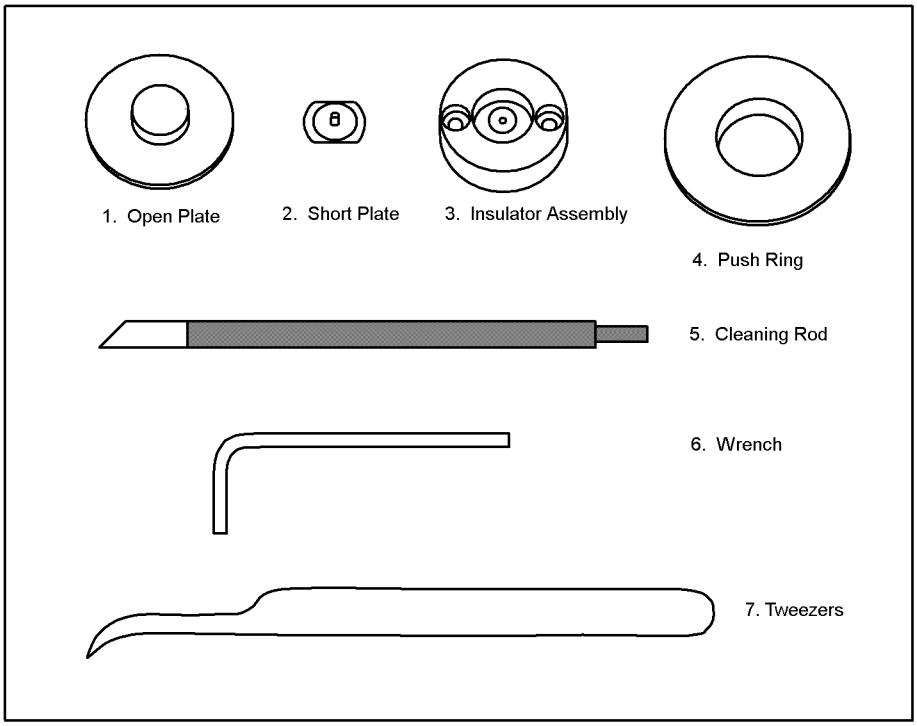


Table 2-2 **Names of Accessories and Functions**

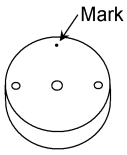
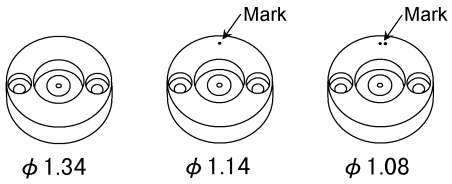
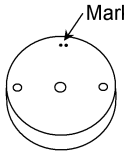
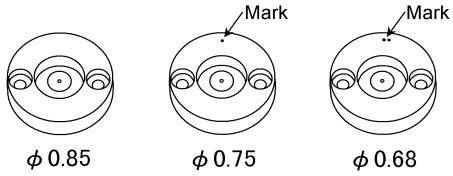
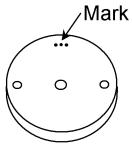
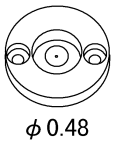
No.	Name	Function
1	Open Plate	Used when correcting for an open circuit.
2	Short Plate	Used when correcting for a short circuit.
3	Insulator Assembly	Used to change assemblies when measuring DUTs with different shapes.
4	Push Ring	Supplementary tool used when removing DUTs.
5	Cleaning Rod	Cleans the electrodes.
6	Wrench	For removing hex nuts.
7	Tweezers*1	Used to handle the open plate, short plate, and DUTs, etc.

*1. Frnished with Option 710.

Insulator Assembly

In order to handle DUTs with differing shapes, the 16196A and 16196B each come with 3 types of insulator assembly and the 16196C comes with 1 insulator assembly. Each of these insulator assemblies has little marks engraved in them to enable identification of each model and hole diameter. There are marks on the back of the insulator assemblies to identify the model and there are marks on the front to identify the hole diameter.

Insulator Assembly identifications

Agilent Model No.	Back	Front
16196A		
16196B		
16196C		

3 Operation

This chapter describes preparations and fixture compensation when using the 16196A/B/C to take measurements as well as DUT connection and measuring methods.

Flow of Measurements

Follow the steps below when performing measurements of DUTs with the 16196A/B/C.

1. Selecting and Changing the Insulator Assembly
   Select an insulator assembly that is appropriate for the shape of the measured DUT and replace the insulator assembly in the fixture.
2. Setting the Electrical Length
   Set the fixture's electrical length in the measuring instrument you will be using.
3. Perfoming Fixture Compensation
   Measure the data for open compensation and measure the data for short compensation. When performing measurements with higher precision, carry out "Fixture compensation for higher precision measurements".
4. Connecting and Measuring the DUT
   Connect the DUT and perform measurements.

Settings of the electrical length and fixture compensation differ depending on the measuring instrument used. Refer to the Operation Manual for the measuring instrument that you are using.

NOTE The 16196A/B/C requires frequent wear checks to keep the best measurement accuracy. Refer to “Wear Check” on page 42 for details.

Selecting and Changing the Insulator Assembly

Select an insulator assembly that corresponds to the shape of the DUT being measured and replace the insulator assembly in the fixture..

Step 1. Select an insulator assembly that is appropriate for the shape of the DUT to be measured.

To take accurate and repeatable measurements, it is necessary for the DUT to be placed in the DUT insertion hole and be stable. For that reason, the 16196A and 16196B each are provided with 3 types of insulator assembly which have DUT insertion holes with different diameters (the 16196C has only one type of insulator assembly). Select an insulator assembly that will create the narrowest gap between the DUT and the DUT insertion hole.

Figure 3-1 DUT and DUT Insertion Hole Diameter

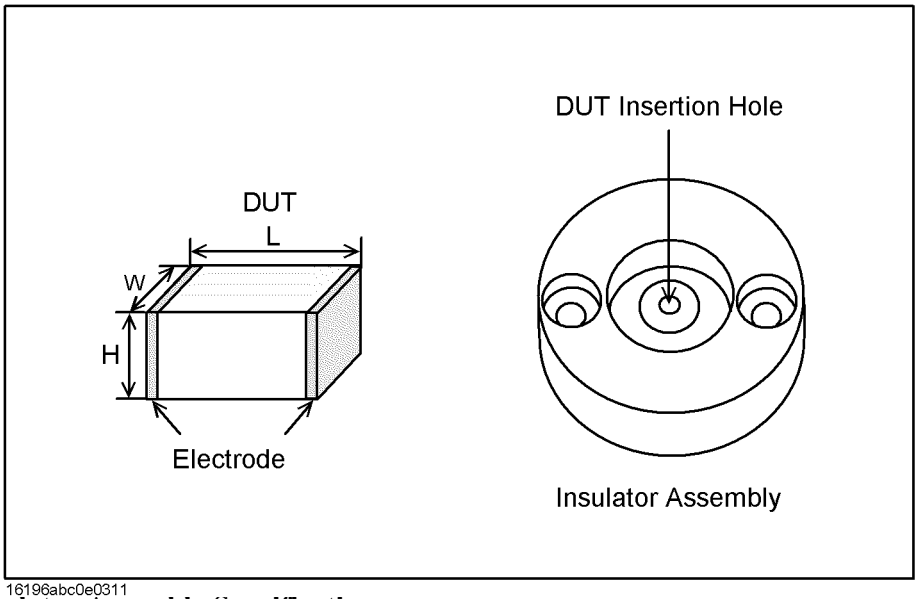


Table 3-1 Insulator Assembly Specifications

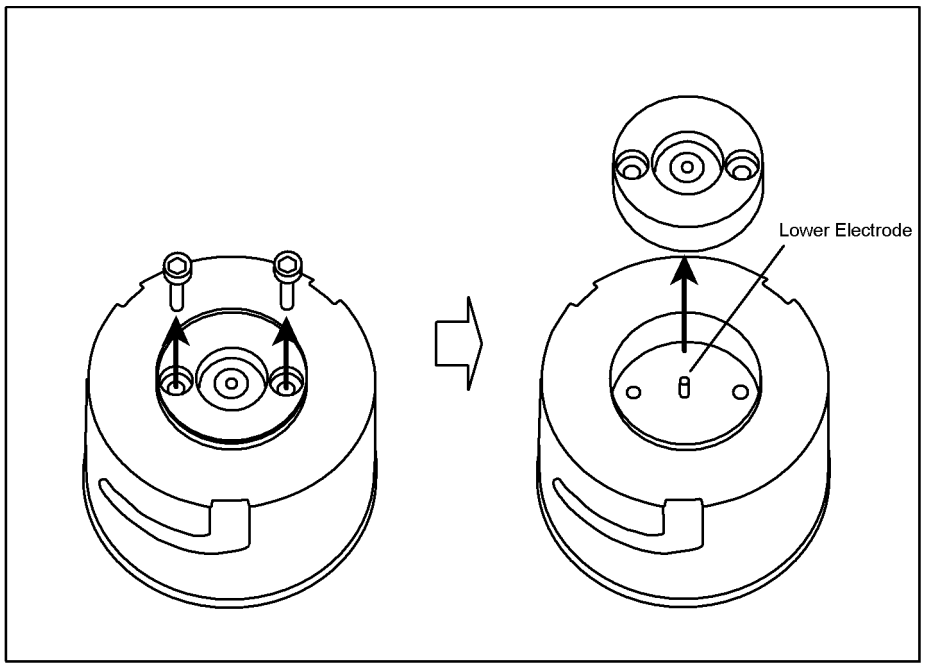
	Insulator Assembly	Example of Corresponding Chip (mm)		
		Length (L)	Width (W)	Height (H)
16196A	ϕ1.34	1.6	0.8	0.8
	ϕ1.14	1.6	0.8	0.6
	ϕ1.08	1.6	0.8	0.5
16196B	ϕ0.85	1.0	0.5	0.5
	ϕ0.75	1.0	0.5	0.35
	ϕ0.68	1.0	0.5	0.35
16196C	ϕ0.48	0.6	0.3	0.3

NOTE The number of the insulator assembly doesn't indicate the maximum diameter of the DUT insertion hole that can insert the cylindrical device.

NOTE If the gap between the DUT and the insulator is large, the measurement accuracy and repeatability decrease. Select an insulator assembly that is appropriate for the shape of the DUT to be measured.

Step 2. Replace the insulator assembly in the fixture with the selected insulator assembly. Loosen the 2 screws used to fasten the insulator assembly with the hex wrench and take them out, then remove the insulator assembly.

Figure 3-2 Removing the Insulator Assembly

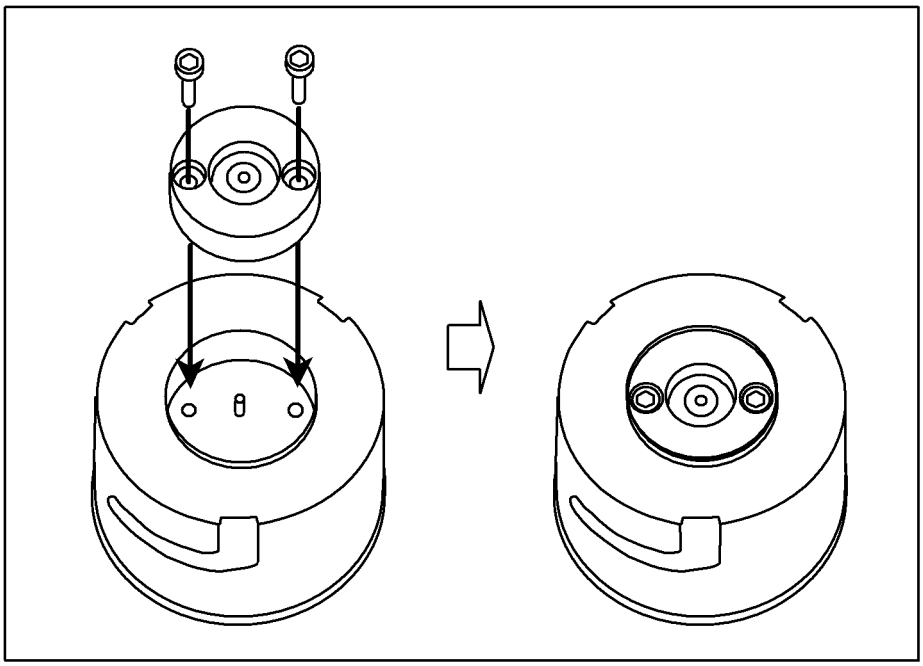


NOTE If the insulator assembly is difficult to remove, turn the fixture over and remove the insulator assembly by letting it fall out.

CAUTION There is danger of the measuring precision and repeatability being adversely affected, and thus do not touch the lower electrode with your hands or damage it in any way.

Install the selected insulator assembly and tighten the screws to fasten it in place.

Figure 3-3 **Installing the Insulator Assembly**



Step 3. Connect the test fixture to the measuring instrument.
Connect the test fixture to the instrument in accordance with “Connecting the 16196A/B/C to a Measuring Instrument” on page 14 in Chapter 1.

Setting the Electrical Length

Set the electrical length in the measuring instrument. For the electrical length setting method, see the Operation Manual for the measuring instrument you are using. The electrical lengths for the 16196A/B/C are as shown below.

Table 3-2 Electrical Length

Model	Electrical Length [mm]
16196A	26.2
16196B	26.9
16196C	27.1

Performing Fixture Compensation

In order to perform more accurate measurements, before beginning the measurement procedure, it is necessary to compensate the fixture. For the 16196A/B/C, perform measurements of the data for open compensation and of the data for short compensation.

NOTE If there are temperature fluctuations which exceed a temperature range of ±5°C after fixture compensation has been carried out, then perform fixture compensation again.

Measuring Open Compensation Data

Set the fixture in the open state using the open plate supplied.

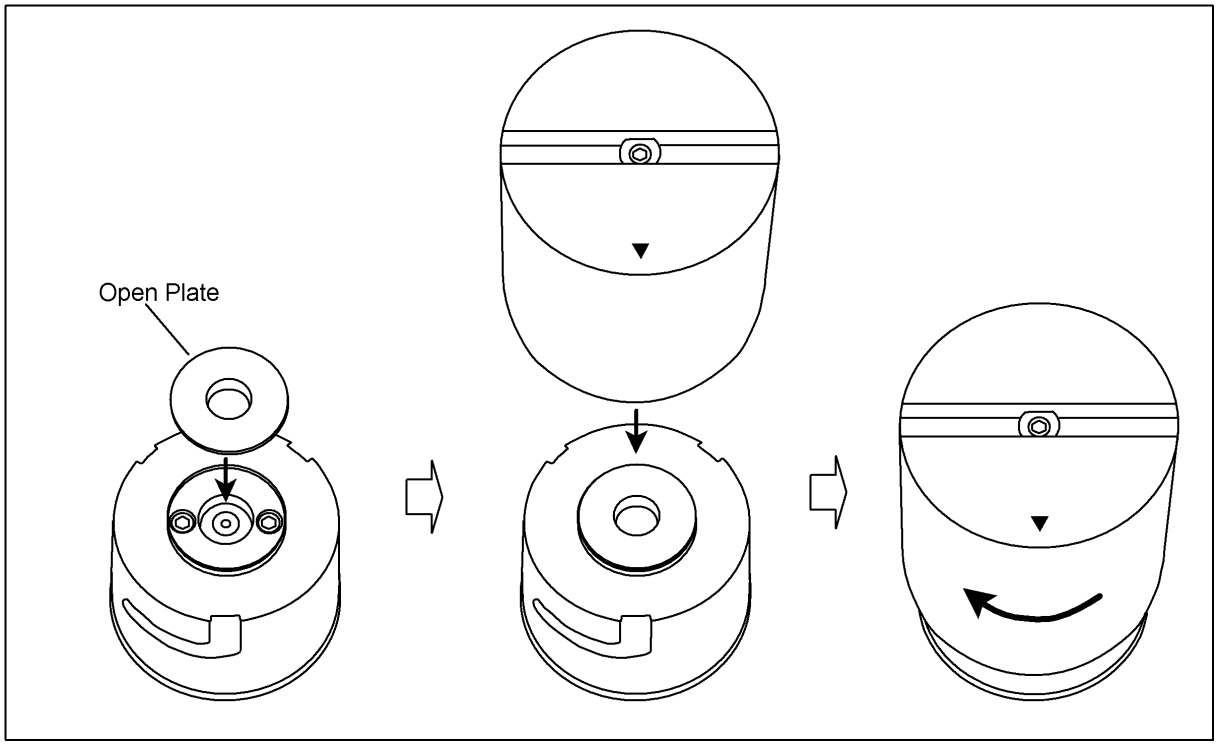
Step 1. Remove the cap.

CAUTION Make sure there is no dirt or other foreign matter in the DUT insertion hole.

Step 2. Using the Tweezers, place the open plate on top of the insulator assembly. Set the open plate with the protruding surface down.

CAUTION Handle the open plate with Tweezers. If dirt, etc. gets on it, measuring precision and repeatability may be adversely affected.

Figure 3-4 Setting the Open State Using the Open Plate



Step 3. Fit the cap in place with the mark toward the front, and turn it to the right until it is locked.

Step 4. Take measurements of the data for open compensation in accordance with the Operation Manual for the measuring instrument you are using.

Measuring Short Compensation Data

Set the fixture in the short state using the short plate supplied.

Step 1. Remove the cap. Take out the open plate used to measure the open compensation data.

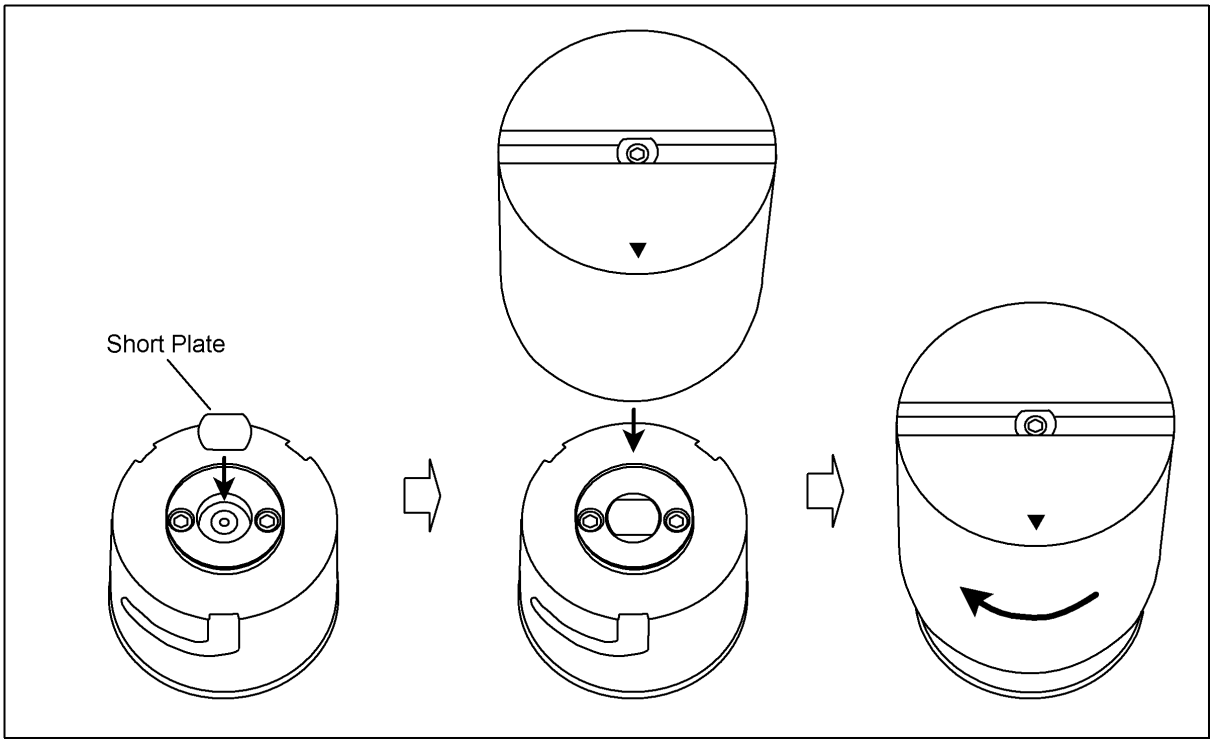
CAUTION Make sure there is no dirt or other foreign matter in the DUT insertion hole.

CAUTION An exclusive type of short plate is supplied with each model. Do not use a short plate from a different model.

Step 2. Using the Tweezers, place the short plate on top of the insulator assembly. Set the short plate with the protrusion down, and insert it in the DUT insertion hole.

CAUTION Handle the short plate with Tweezers. If dirt, etc. gets on it, measuring precision and repeatability may be adversely affected.

Figure 3-5 Setting the Short State Using the Short Plate



Step 3. Fit the cap in place with the mark toward the front, and turn it to the right until it is locked.

Step 4. Take measurements of the data for short compensation in accordance with the Operation Manual for the measuring instrument you are using.

NOTE

Residual inductance (typical data) for the Short Plate is as follows.

Model	Residual Inductance [nH] (typical)
16196A	0.43
16196B	0.27
16196C	0.16

Connecting and Measuring DUTs

Connect DUTs to the electrodes and take measurements.

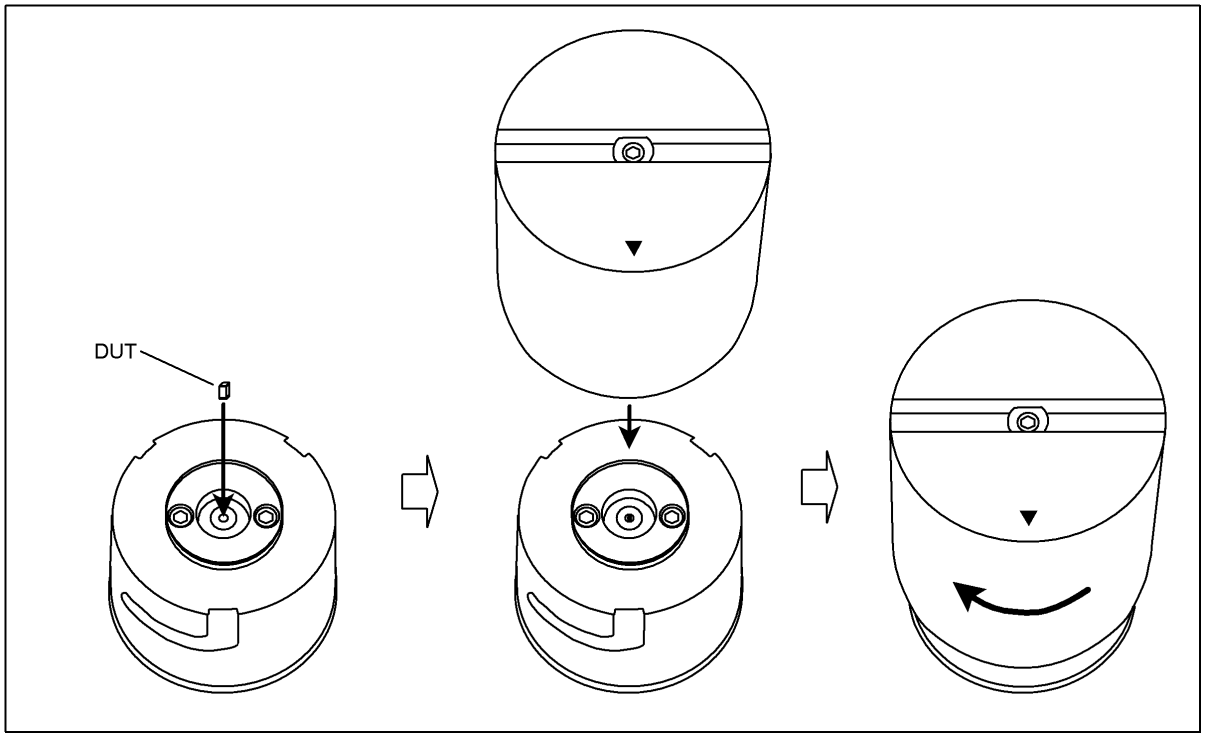
CAUTION Do not connect a DUT, which has an incompatible size.

Step 1. Remove the cap.

CAUTION Make sure there is no dirt or other foreign matter in the DUT insertion hole.

Step 2. Insert the DUT in the insulator hole using Tweezers. Check if the DUT is inserted correctly in the insulator hole using the magnifying glass.

Figure 3-6 Connecting a DUT



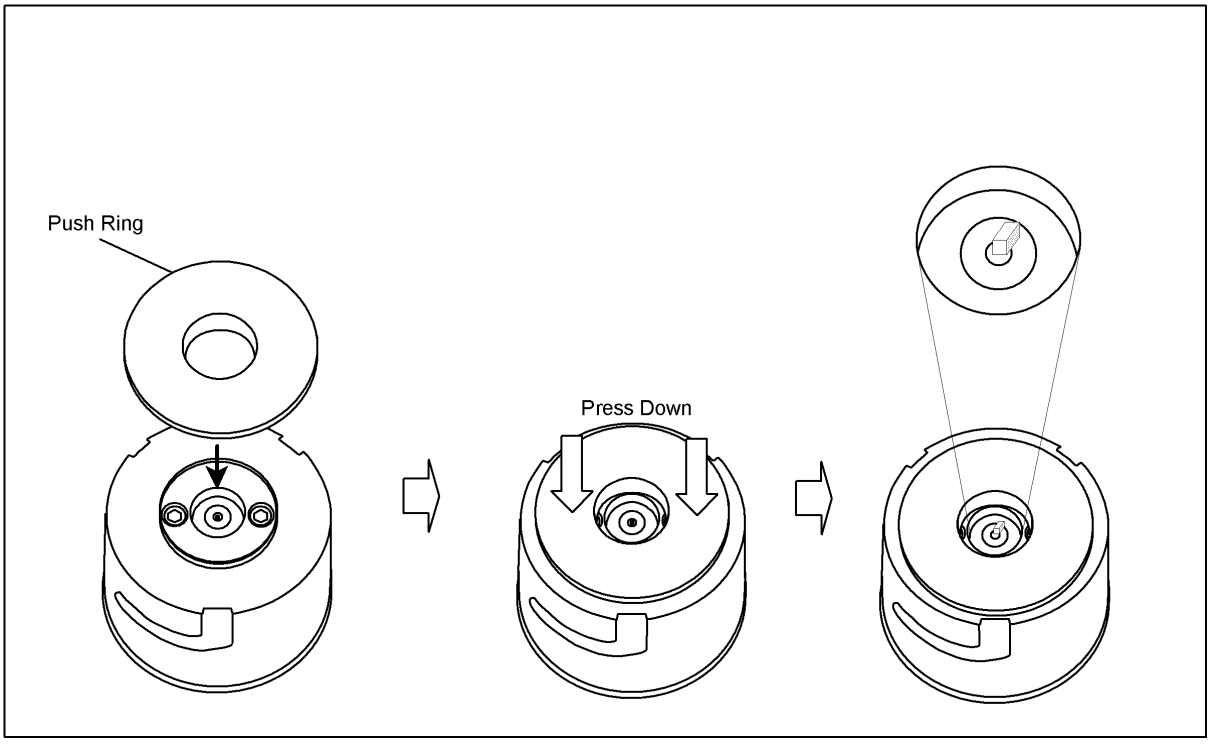
Step 3. Fit the cap in place with the mark toward the front, and turn it to the right until it is locked.

Step 4. Take measurements in accordance with the Operation Manual for the measuring instrument you are using.

Removing the DUT

Use the push ring when removing the DUT.

Figure 3-7 Removing the DUT Using the Push Ring



Press the insulator assembly down using the push ring. When this is done, the lower electrode will push up the DUT and you will be able to remove it. Measurements can also be taken with the push ring placed as is on the insulator assembly.

4 User Maintenance

Overview

The Necessity of User Maintenance

The measurement performance of the fixture decreases slightly each time measurement is repeated. This is due to contamination of the contacting sections by solder, etc. and mechanical wear and distortion caused by repeated use. Consequently, to maintain satisfactory measurement results, it is important to maintain the contacting sections in good condition and take appropriate measures before wear or distortion occurs. To accomplish this it is necessary to monitor the fixture and perform maintenance of the various items as described in “User Maintenance Flow” on page 37.

Because deterioration of the fixture seriously affects the measurement results when measuring minute values or performing measurements with a high accuracy, proper maintenance of the fixture is particularly important in these cases. Depending on the required measurement performance, it may be necessary to take measures such as establishing more rigorous evaluation standards and perform maintenance more frequently.

The upper and lower electrodes and the short plate are consumable products. These are the fixture construction parts that tend to have the greatest effect on the measurement results. During measurement, solder from the DUT tends to adhere to the upper and lower electrodes, causing gradual deterioration of the electrodes. The short plate part is used for creating a zero-standard during fixture compensation and distortion or contamination of the short plate therefore directly affects the measurement result. Focusing on the upper and lower electrodes and the short plate, this chapter explains the general aspects of user maintenance.

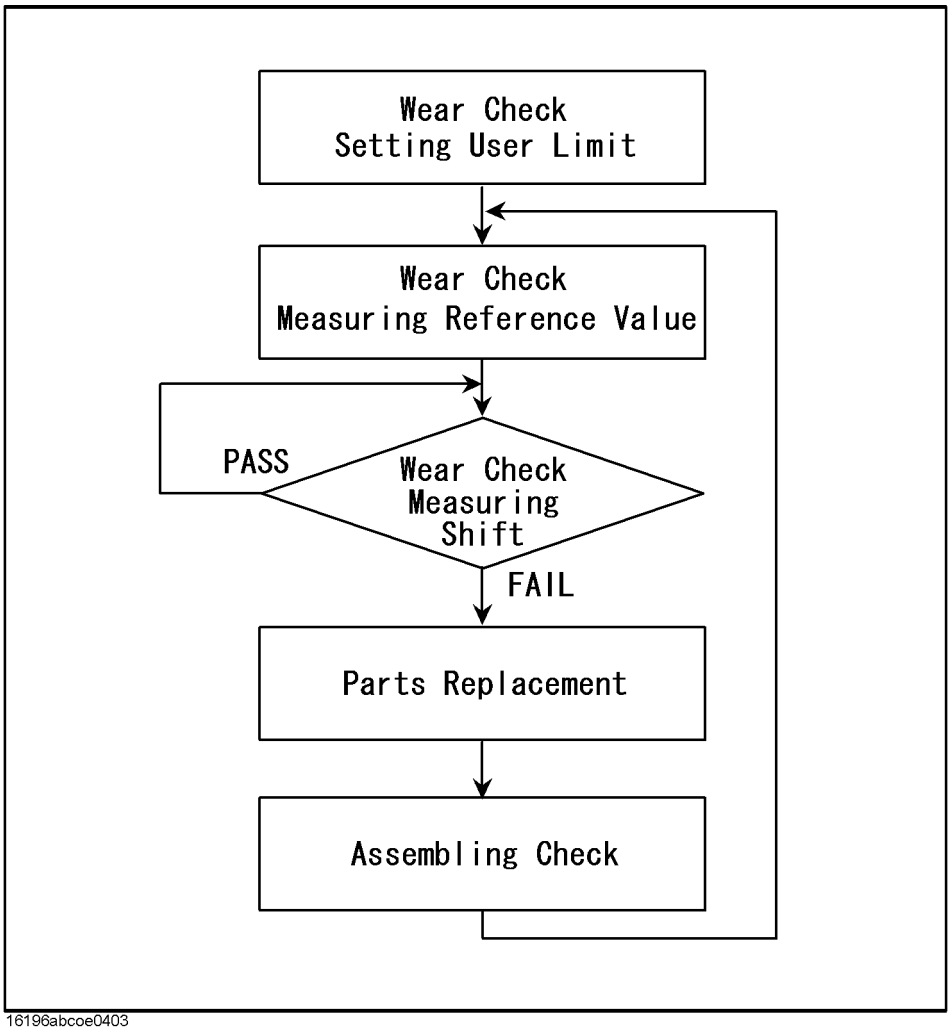
User Maintenance Flow

Figure 4-1 shows the flowchart of the user maintenance. The overview of the each maintenance item is explained below.

Table 4-1 **Maintenance Items**

Item		Frequency	Item
Cleaning		Several times daily	Cleaning of fixture
Wear Check	Setting the user limit	When the product is received and when you need	Set the user limit to the required measurement accuracy and the measurement condition.
	Measuring reference value	When the product is received and after parts replacement	Measure Ls and Rs of the fixture and set it the reference value
	Measuring impedance shift	daily and before fixture compensation	Measure Ls and Rs of the fixture and calculate the shift from the reference value.
Parts Replacement		When the wear check is failed.	Replacement of worn parts
Assembling Check		After parts replacement	Measure Ls and Rs to confirm that the fixture is assembled correctly.

Figure 4-1 **Flowchart of User Maintenance**



Cleaning

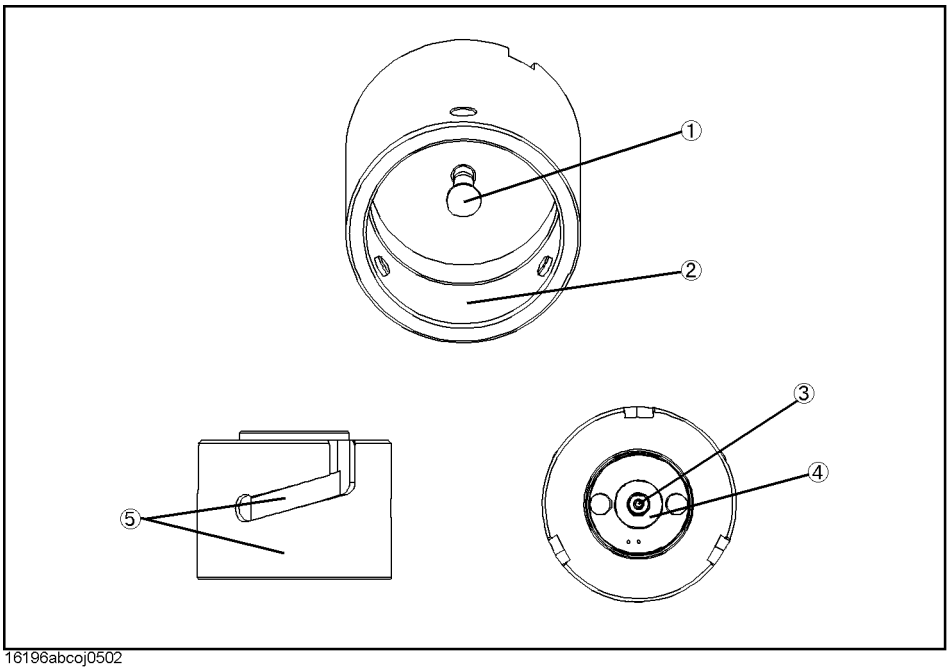
If the electrodes and insulator assembly become dirty, measuring accuracy and repeatability will decrease. Also, if dirt adheres to the surfaces of the body, it will become impossible to remove the cap smoothly. In order to ensure measurement with high accuracy, be sure to perform cleaning periodically.

Places Requiring Cleaned

Place, which need to be cleaned, are as follows.

- Upper Electrode (Figure 4-2 (1))
- Cap Inside (Figure 4-2 (2))
- Lower Electrode (Figure 4-2 (3))
- Insulator Assembly recessed part (Figure 4-2 (4))
- Body side surfaces (Figure 4-2 (5))
- Short Plate
- Open Plate

Figure 4-2 **Places to be Cleaned**



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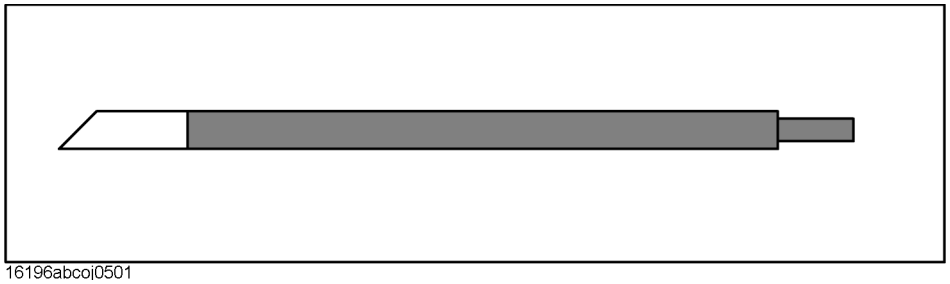
Cleaning Methods

Upper Electrode (Figure 4-2 (1)), Insulator Assembly (Figure 4-2 (4)), Open Plate, Short Plate

Use the Cleaning Rod (Agilent parts number 5182-7586) for the cleaning.Use the white rubber part of the cleaning rod to remove dirt from all contacting surfaces of the above-mentioned parts. Be careful not to scratch or damage the parts when removing the dirt.

Figure 4-3 **Cleaning Rod**



Dirt tends to adhere to the upper electrode and short plate parts in particular. Meticulous cleaning of these parts is recommended.

CAUTION The front of the short plate has a sharp edge, so take adequate precautions when cleaning it.

CAUTION Do not use a file or similar object to remove dirt, as this will affect measurement accuracy and repeatability.

NOTE If the dirt cannot be removed, replace the part. For replacement method, see the sections "Replaceable Parts" and "Replacement Procedure".

Lower Electrode (Figure 4-2 (3))

Use the Cleaning Rod (Agilent parts number 5182-7586) for the cleaning.First use the push ring to press down the insulator assembly. While maintaining this condition, use the white rubber part of the cleaning rod to remove dirt from the contacting parts of the lower electrode. Be careful not to scratch or damage the parts when removing the dirt.

Dirt tends to adhere to the lower electrode parts in particular. Meticulous cleaning of these parts is recommended.

CAUTION Do not use a file or similar object to remove dirt, as this will affect measurement accuracy and repeatability.

NOTE If the dirt cannot be removed, replace the part. For replacement method, see the sections "Replaceable Parts" and "Replacement Procedure".

Cap Inside (Figure 4-2 (2)), Body Side Surfaces (Figure 4-2 (5))

Wipe dirt off using a soft cloth, etc.

NOTE When removing dirt, always be careful to clean so that the electrodes and insulator assembly are not damaged.

Wear Check

The wear check allows you to obtain an idea about the deterioration of the fixture in order to ensure that the desired measurement accuracy is obtained. This check comprises “User Limit Setting”, “Reference Value Acquisition” and “Measuring Impedance Shift”. Using a desired frequency, the impedance (Rs, Ls) of the fixture itself is measured. It is recommended to use a frequency that is also used under the conditions where the fixture is normally used.

Normally, “User Limit Setting” should be conducted under the following circumstances.

- When the equipment is used for the first time following purchase.
- When the required measurement accuracy is changed.

Normally, “Reference Value Acquisition” should be conducted under the following circumstances.

- When the equipment is used for the first time following purchase.
- Following replacement of parts.

Normally, “Measuring Impedance Shift” should be conducted under the following circumstances.

- Once daily and before fixture compensation is performed.

Example of User Limit Values Setting

It is necessary to decide wear check user limit values suitable for the DUT and the demanded measurement accuracy. An example follows below.

To measure the inductors L: 10 nH and Q: 10 at a frequency (f) of 100 MHz with a measurement accuracy degree of 20%;

L:	10 nH
Q:	10
Frequency:	100 MHz
Demanded Accuracy:	20% for both L and Q

Using the above conditions, the inductor’s reactance X and resistance R are determined in the following manner.

$$X = 2\pi fL = 6\ \Omega$$
$$R = X/Q = 0.6\ \Omega$$

From $Q = X/R = 2\pi fL/R$ we understand that when R changes 20% (100 mΩ) Q should be approximately 20%, and when L changes 20% (2 nH), L and Q both change 20%. Accordingly, in order to measure both L and Q with a measurement accuracy of 20% or less, at least the error of L and R must be less than 2 nH and 120 mΩ, respectively. While remembering that L and R change together and keeping in mind other error factors than the deterioration of the fixture, the respective values should be set to 25% in this example, i.e., 500 pH and 30 mΩ.

CAUTION Use the same user limit values for “Measuring Impedance Shift”.

NOTE The above is just an example. The methods to determine the user limit vary with the measurement conditions and the DUT, etc.

NOTE In actually testing, a part of the effect of electrode wear is cancelled by the SHORT compensation. It is recommended, however, to set the user limit as shown in this example as the deviation from the reference value can be used to deal with all the things affecting the measured values.

Please enter the user limit values in the “Check Sheet” (page 48, page 49). See “Check Sheet Fill-Out Example” on page 47 for an example of how this is done.

Reference Value Acquisition

The impedance (Rs, Ls) of the fixture itself should be measured before deterioration sets in. It is recommended to use a measurement frequency that is used under the conditions where the fixture is normally used.

Normally, the reference value should be measured under the following circumstances.

- When the product is introduced.
- Following replacement of parts.

Required Tools

- 1.5-mm hex wrench (provided accessory)
- Short plate (provided accessory)
- Impedance measuring instrument (with 7-mm connector and calibrated)

CAUTION The measuring instrument's fixture compensation function should be set to OFF.

Acquisition Procedure (Electrode Wear Check Reference Value)

Step 1. Remove the cap and ensure that nothing is inserted into the fixture.

Step 2. Clean the fixture's upper and lower electrodes as described in "Cleaning" on page 39.

Step 3. Connect the fixture to the 7-mm connector.

Step 4. Place the cap on the fixture body.

Step 5. In order to contact the upper electrode and the lower electrode, use the provided hex wrench to turn the screw at the top of the cap approximately 6 turns to the left.

Step 6. Measure Rs and Ls as described in the Operation Manual for the measuring instrument.

Step 7. Record the read values as the reference values in the "Check Sheet" (page 48).

Step 8. Calculate the upper limit value and the lower limit value from the previously set user limits and the reference values obtained here. Record these in the "Check Sheet".

Step 9. Tighten the screw on top of the cap loosened in Step 5.

Acquisition Procedure (Short Plate Wear Check Reference Value)

Step 1. Clean the short plate as described in "Cleaning" on page 39.

Step 2. Remove the cap and place the short plate with the protruding surface down on the insulator assembly.

Step 3. Place the cap on the fixture body.

Step 4. Measure Rs and Ls as described in the Operation Manual for the measuring instrument.

Step 5. Record the read values as the reference values in the "Check Sheet" (page 49).

Step 6. Calculate the upper limit value and the lower limit value from the previously set user limits and the reference values obtained here. Record these in the "Check Sheet".

Measuring Impedance Shift

Measuring the impedance of the fixture with the upper and lower electrodes in contact should check the electrode wear.

Normally, this check should be conducted under the following circumstances.

- Once daily and before fixture compensation.

Required Tools

- 1.5-mm hex wrench (provided accessory)
- Impedance measuring instrument (with 7-mm connector and calibrated)

CAUTION The measuring instrument's fixture compensation function should be set to OFF. Also, other settings should be the same as those used for "Reference Value Acquisition".

Procedure (Electrode Wear Check)

Step 1. Clean the electrodes as described in "Cleaning" on page 39.

Step 2. Set the measuring instrument and measure in the same way as for "Acquisition Procedure (Electrode Wear Check Reference Value)" on page 45.

Step 3. Record the Rs and Ls measured values as pass-fail in the "Check Sheet" (page 48).

Step 4. If the result is unacceptable, replace both the upper and the lower electrode.

Procedure (Short Plate Wear Check)

Step 1. Clean the short plate as described in "Cleaning" on page 39.

Step 2. Set the measuring instrument and measure in the same way as for "Acquisition Procedure (Short Plate Wear Check Reference Value)" on page 45.

Step 3. Enter the Rs and Ls measured values as pass-fail in the "Check Sheet" (page 49).

Step 4. If the result is unacceptable, replace the short plate.

Check Sheet

Check Sheet Fill-Out Example

The following example shows how the check sheet is filled out following electrode wear check. Fill out the sheet in the same manner for short plate wear check.

Electrode Wear Check Fill-Out Example

Table 4-2 Reference Value and User Limit Values Fill-Out Example

Frequency*1	Measurement Parameter	Reference Value*2 [a]	User Limit Value*3 [b]	Lower Limit [a-b]	Upper Limit [a+b]
100 MHz	Rs	*90* mΩ	*30* mΩ	*60* mΩ	*120* mΩ
	Ls	*–290* pH	*500* pH	*–790* pH	*210* pH
800 MHz	Rs	*310* mΩ	*40* mΩ	*270* mΩ	*350* mΩ
	Ls	*–260* pH	*400* pH	*–660* pH	*140* pH

*1. Set by the user as desired.
*2. Record values obtained at the time of "Reference Value Acquisition" on page 45.
*3. See also "Example of User Limit Values Setting" on page 42.

Table 4-3 Check History Fill-Out Example

Date	Frequency	Measurement parameter	Measured Value	Pass/Fail
Oct./11/1999 9:30	*100 MHz*	Rs	*100* mΩ	Pass
		Ls	*–320* pH	Pass
Oct./11/1999 9:35	*800 MHz*	Rs	*345* mΩ	Pass
		Ls	*–360* pH	Pass
Oct./12/1999 9:30	*100 MHz*	Rs	*105* mΩ	Pass
		Ls	*–340* pH	Pass
Oct./12/1999 9:35	*800 MHz*	Rs	*355* mΩ	Fail*1
		Ls	*–320* pH	Pass

*1. When the result is unacceptable, replace the part.

Electrode Wear Check

Table 4-4 Reference Value and User Limit Values

Frequency	Measurement Parameter	Reference Value [a]	User Limit Value [b]	Lower Limit [a - b]	Upper Limit [a + b]
	Rs	mΩ	mΩ	mΩ	mΩ
	Ls	pH	pH	pH	pH
	Rs	mΩ	mΩ	mΩ	mΩ
	Ls	pH	pH	pH	pH

Table 4-5 Check History

Date	Frequency	Measurement Parameter	Measured Value	Pass/Fail
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	

Short Plate Wear Check

Table 4-6 Reference Value and User Limit Values

Frequency	Measurement Parameter	Reference Value [a]	User Limit Value [b]	Lower Limit [a - b]	Upper Limit [a + b]
	Rs	mΩ	mΩ	mΩ	mΩ
	Ls	pH	pH	pH	pH
	Rs	mΩ	mΩ	mΩ	mΩ
	Ls	pH	pH	pH	pH

Table 4-7 Check History

Date	Frequency	Measurement Parameter	Measured Value	Pass/Fail
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	
		Rs	mΩ	
		Ls	pH	

Parts Replacement

The replacement of parts is explained in the following.

Procedure for Replacement

Refer to “Replaceable Parts” on page 60 and “Replacement Procedure” on page 65 when replacing parts.

A maintenance kit containing 5 pieces is available for replacement of upper and lower electrodes and the short plate. For details, see “Maintenance Kit” on page 64.

Check Following Replacement

Following replacement of parts, it is necessary to confirm that the fixture has been correctly assembled. Please conduct the “Assembling Check” on page 51.

Assembling Check

Following replacement of parts, confirm that the fixture has been correctly assembled. The assembling check consists of “Electrode Check” and “Short Plate Check”, Measure the impedance (Rs, Ls) of both at 100 MHz and 1 GHz.

Normally, this check should be conducted under the following circumstances.

- Following replacement of parts.

Electrode Check

It should be checked whether the fixture is correctly assembled by measuring the impedance (Rs, Ls) of the fixture itself with the upper and lower electrodes in contact.

Required Tools

- 1.5-mm hex wrench (provided accessory)
- Impedance measuring instrument (with 7-mm connector and calibrated)

Table 4-8 Setting of Measuring Instrument (4291B)

Measurement Condition	Set Value
Electrical Length	16196A: 26.2 mm 16196B: 26.9 mm 16196C: 27.1 mm
Measurement Parameter	Ls, Rs
OSC Level	500 mV
Point Averaging	32

NOTE When using a measuring instrument other than 4291B, refer to the Operation Manual for the measuring instrument and make the same settings as given in the above table.

Procedure

Step 1. Remove the cap and ensure that nothing is inserted into the fixture.

Step 2. Clean the fixture’s upper and lower electrodes as described in “Cleaning” on page 39.

Step 3. Connect the fixture to the 7-mm connector.

Step 4. Place the cap on the fixture body.

Step 5. In order to contact the upper electrode and the lower electrode, use the provided hex wrench to turn the screw on the top of the cap approximately 6 turns to the left.

Step 6. Measure Rs and Ls at 100 MHz and 1 GHz in this state.

Step 7. Confirm that the Rs and Ls values are within the limits given in the table below. If the results are outside the limit range, first check the attachment of the upper and lower electrode. If these are correctly attached but the results still remain outside the limit range, the fixture main body may be damaged. In this case, please contact a Agilent Technologies Sales or Service office.

Step 8. Tighten the screw on top of the cap loosened in Step 5.

Table 4-9 Electrode Check and Limits (16196A)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	30 mΩ ~ 150 mΩ –500 pH ~ 0 pH
1 GHz	Rs Ls	100 mΩ ~ 480 mΩ –500 pH ~ 0 pH

Table 4-10 Electrode Check and Limits (16196B)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	40 mΩ ~ 160 mΩ –400 pH ~ 0 pH
1 GHz	Rs Ls	120 mΩ ~ 510 mΩ –400 pH ~ 0 pH

Table 4-11 Electrode Check and Limits (16196C)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	40 mΩ ~ 170 mΩ –300 pH ~ 100 pH
1 GHz	Rs Ls	120 mΩ ~ 540 mΩ –300 pH ~ 100 pH

Short Plate Check

Measuring the fixture's impedance with the short plate in place should check the condition of the short plate.

CAUTION "Short Plate Check" should be performed after the "Electrode Check" has been completed.

Required Tools

- 1.5-mm hex wrench (provided accessory)
- Impedance measuring instrument (with 7-mm connector and calibrated)

Table 4-12 Setting of Measuring Instrument (4291B)

Measurement condition	Set Value
Electrical Length	16196A: 26.2 mm 16196B: 26.9 mm 16196C: 27.1 mm
Measurement Parameter	Ls, Rs
OSC Level	500 mV
Point Averaging	32

NOTE When using a measuring instrument other than 4291B, refer to the Operation Manual for the measuring instrument and make the same settings as given in the above table.

Procedure

Step 1. Clean the short plate as described in "Cleaning" on page 39.

Step 2. Remove the cap and place the short plate with the protruding surface down on the insulator assembly.

Step 3. Place the cap on the fixture body and fasten it.

Step 4. Measure Rs and Ls at 100 MHz and 1 GHz in this condition.

Step 5. Confirm that the Rs and Ls values are within the representative values given in the table below. If the results are outside the limit range, please replace the short plate.

Table 4-13 Short Plate Check and Limits (16196A)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	30 mΩ ~ 160 mΩ 200 pH ~ 800 pH
1 GHz	Rs Ls	100 mΩ ~ 510 mΩ 200 pH ~ 600 pH

Table 4-14 Short Plate Check and Limits (16196B)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	40 mΩ ~ 170 mΩ 100 pH ~ 600 pH
1 GHz	Rs Ls	120 mΩ ~ 540 mΩ 100 pH ~ 400 pH

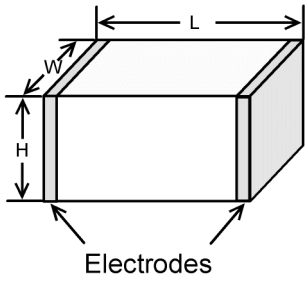
Table 4-15 Short Plate Check and Limits (16196C)

Parameter	Frequency	Limit (Absolute value)
100 MHz	Rs Ls	40 mΩ ~ 180 mΩ 100 pH ~ 600 pH
1 GHz	Rs Ls	120 mΩ ~ 570 mΩ 50 pH ~ 350 pH

5 Specifications and Supplemental Performance Characteristics

This chapter provides specifications and supplemental performance characteristics of the 16196A/B/C test fixture.

Specifications

Applicable Instruments		Refer to the Table 1-4,1-5.
Applicable DUT Type		Surface Mount Device with side electrodes.
		Model Length (L) × Width (W) × Height (H) 16196A (1.6 ± 0.15) × (0.8 ± 0.15) × (0.4 to 0.95) mm 16196B (1.0 ± 0.1) × (0.5 ± 0.1) × (0.3 to 0.6) mm 16196C (0.6 ± 0.03) × (0.3 ± 0.03) × (0.27 to 0.33) mm
Frequency		DC to 3 GHz
Maximum Voltage		± 40V peak max. (AC+DC)
Maximum Current		5 A
Operating Environment	temp.	-55°C to +85°C
	humidity	15% to 95%RH (@ wet bulb temp. < 40°C)
Non Operating Environment	temp.	-55°C to +85°C
	humidity	≤ 90 % RH (@ wet bulb temp. <65°C)
Dimension		78 (D) × 140 (W) × 48 (H) mm
Weight		250g
Safety Standards		EN61010-1:1993 +A2:1995 IEC61010-1:1990 +A1:1992 +A2:1995 CSA C22.2 No.1010.1:1992 INSTALLATION CATEGORY I POLLUTION DEGREE 2 INDOOR USE

Supplemental Performance Characteristics

This section provides useful data on the 16196A/B/C. These supplemental performance characteristics should not be considered specifications.

Additional Error

Additional errors are calculated as follows.

|Z| Measurement

Additional error for Impedance Ze [%] is calculated by substituting the values in the table below into the following equation.

$Ze\ [\%] = \pm \{A + (Zs/Zx + Yo \times Zx) \times 100\}$

where

A [%]	Test Fixture's Proportional Error [%]
Yo [S]	Test Fixture's Open Repeatability [S]
Zs [Ω]	Test Fixture's Short Repeatability [Ω]
Zx [Ω]	Measured Impedance Value of DUT [Ω]

Zs	$(30 + 125 \times f) \times 10^{-3}$[Ω]
Yo	$(5 + 40 \times f) \times 10^{-6}$[S]
A	$1 \times f^2$ [%]

where f is frequency (GHz).

D Measurement

Additional error for Dissipation Factor De is calculated by using the additional error for Impedance Ze [%] as follows.

If $Dx \leq 0.1$:

$$De = Ze / 100$$

If $0.1 < Dx \leq 0.5$:

$$De = (Ze / 100) \times (1 + Dx)$$

where Dx is the measured value of D. It is necessary for Ze to be below 10 %.

NOTE D is not expressed as a percentage but as an absolute value.

Rs (ESR) Measurement

Additional error Rse[%] of the Rs measurement is calculated by using the additional error for Impedance Ze [%] as follows.

If $Dx \leq 0.1$:

$$Rse\ [\%] = Ze / Dx$$

If $0.1 < Dx \leq 0.5$:

$$Rse\ [\%] = (Ze / Dx) \times \sqrt{(1 + Dx^2)}$$

Dx is the measured value of D and is calculated as follows.

$$Dx = 2 \times \pi \times f \times Csx \times Rsx,$$

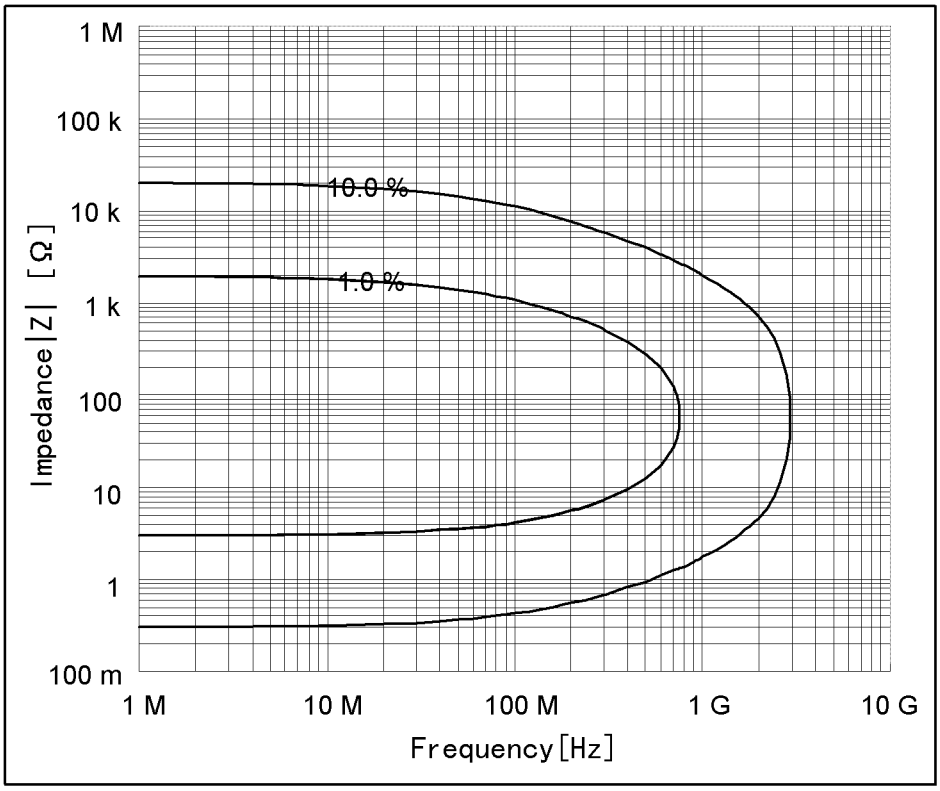
where

f: measurement signal frequency

Csx: measured value of Cs

Rsx: measured value of Rs.

Figure 5-1 Additional Error for Impedance



6 Service

This chapter describes the proper maintenance of the fixture and parts replacement.

Replaceable Parts

Check the part number by the exploded view below. Do not disassemble the fixture beyond what is shown in this exploded view.

To order parts, specify the Agilent part number and the check digit (C/D). If the part, which is causing problems, is a part that cannot be disassembled, please order the part, which the affected part is, a part of. Sales and Service offices of Agilent Technologies also accept products for repairs.

Block Assembly

Figure 6-1 **Block Assembly Exploded View**

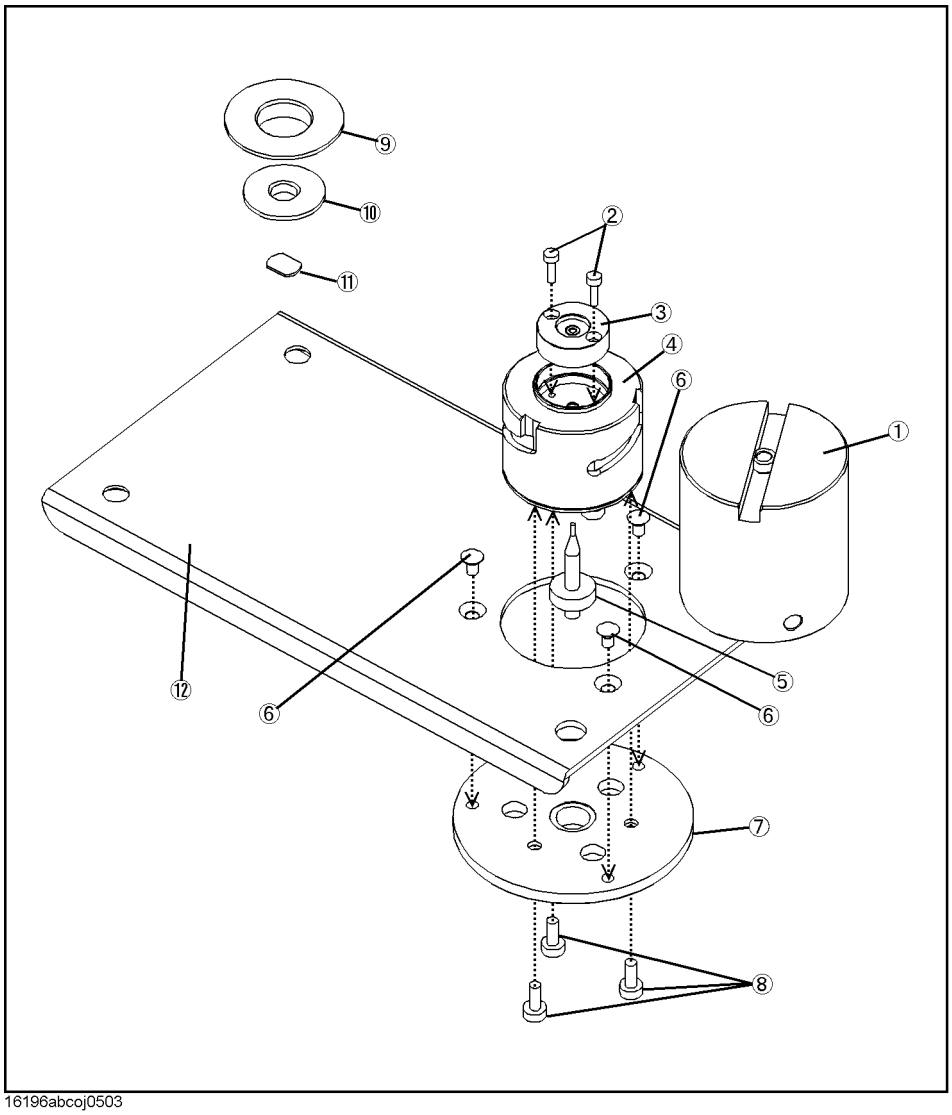


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Table 6-1 Replaceable Parts (Block Assembly)

Ref. Desig.	Agilent Part No.	C/D	Qty.	Description
1	16196-60010	2	1	Cap Assembly
2	0515-1044	7	2	Cap Screw Mach M1.6
3	16196-60112	5	1	ϕ1.34 Insulator (for 16196A)
	16196-60113	6	1	ϕ1.14 Insulator (for 16196A)
	16196-60114	7	1	ϕ1.08 Insulator (for 16196A)
	16196-60212	6	1	ϕ0.85 Insulator (for 16196B)
	16196-60213	7	1	ϕ0.75 Insulator (for 16196B)
	16196-60214	8	1	ϕ0.68 Insulator (for 16196B)
	16196-60312	7	1	ϕ0.48 Insulator for (16196C)
4	N/A		1	Ground Assembly
5*1	16196-60111	4	1	Lower Electrode (for 16196A)
	16196-60211	5	1	Lower Electrode (for 16196B)
	16196-60311	6	1	Lower Electrode (for 16196C)
6	0515-0954	4	3	Screw M-2.5
7	16196-24001	5	1	Base
8	0515-0905	7	3	Screw M-2.5
9	16196-24004	8	1	Push Ring
10	16196-29002	6	1	Open Plate
11*1	16196-29026	4	1	Short Plate (for 16196A)
	16196-29027	5	1	Short Plate (for 16196B)
	16196-29028	6	1	Short Plate (for 16196C)
12	16196-00601	1	1	Plate (for 16196A)
	16196-00611	3	1	Plate (for 16196B)
	16196-00621	5	1	Plate (for 16196C)

*1. Maintenance Kit consisting of 5 replaceable parts is available. Refer to “Maintenance Kit” on page 64 for details.

Cap

Figure 6-2 **Cap Exploded View**

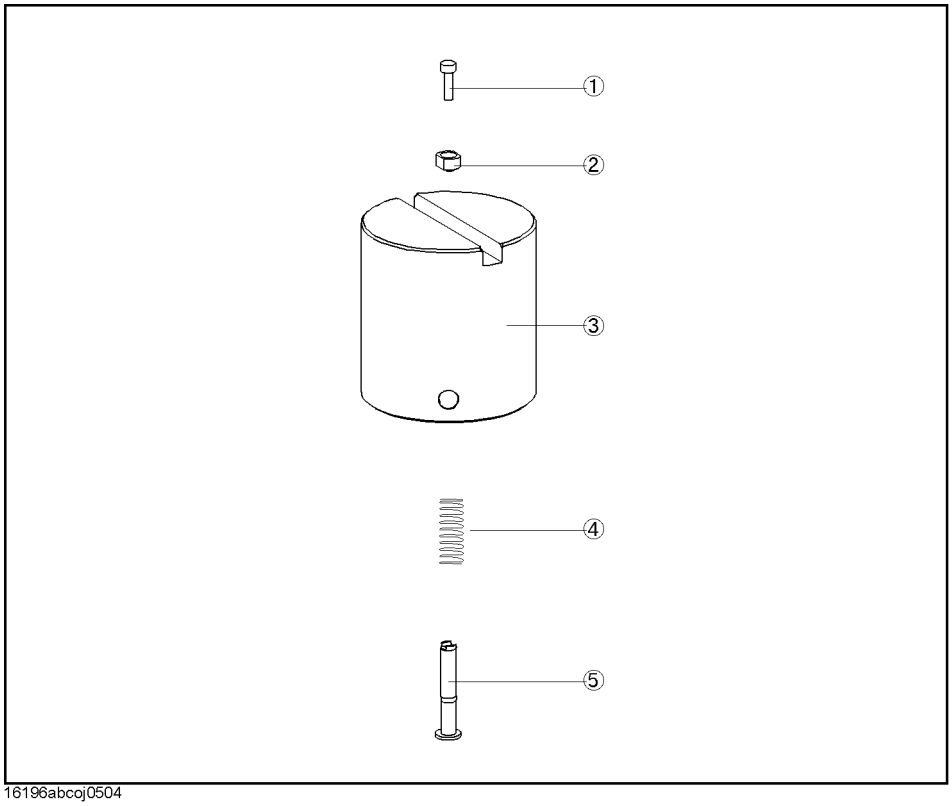

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Table 6-2 **Replaceable Parts (Cap)**

Ref. Desig.	Agilent Part No.	C/D	Qty.	Description
1	0515-1044	7	1	Screw Mach M1.6
2	16196-24005	9	1	Stopper
3	N/A	2	1	Cap
4	1460-2618	7	1	Spring
5*1	16196-23008	0	1	Upper Electrode

*1. Maintenance Kit including 5 replaceable parts is available. Refer to “Maintenance Kit” on page 64 for details.

Other Parts

Table 6-3 Replaceable Parts (Other Parts)

Ref. Desig.	Agilent Part No.	C/D	Qty.	Description
1	16196-60150	1	1	Carrying Case (for 16196A)
	16196-60250	2	1	Carrying Case (for 16196B)
	16196-60350	3	1	Carrying Case (for 16196C)
2	16193-60002	9	2	Magnifying Glass
3	5182-7586	2	1	Cleaning Rod
4	8710-0909	3	1	Key 1.5 mm Hex
5	8710-2081	6	1	Tweezers
6	1540-0622	9	1	Case for OPEN and SHORT plate
7	9282-0114	4	1	Cushion

Maintenance Kit

The 16196U-maintenance kit is available to provide consumable products and replaceable parts for the 16196A/B/C.

16196U Maintenance Kit

The 16196A/B/C common option and options for each model separately are available.

Table 6-4 16196A/B/C Common Option

Opt010	Upper Electrode Set (5 pieces)

Table 6-5 16196A Option

Opt100	1608(mm) Short Plate Set (5 pieces)
Opt110	1608(mm) Lower Electrode Set (5 pieces)

Table 6-6 16196B Option

Opt200	1005(mm) Short Plate Set (5 pieces)
Opt210	1005(mm) Lower Electrode Set (5 pieces)

Table 6-7 16196C Option

Opt300	0603(mm) Short Plate Set (5 pieces)
Opt310	0603(mm) Lower Electrode Set (5 pieces)

Replacement Procedure

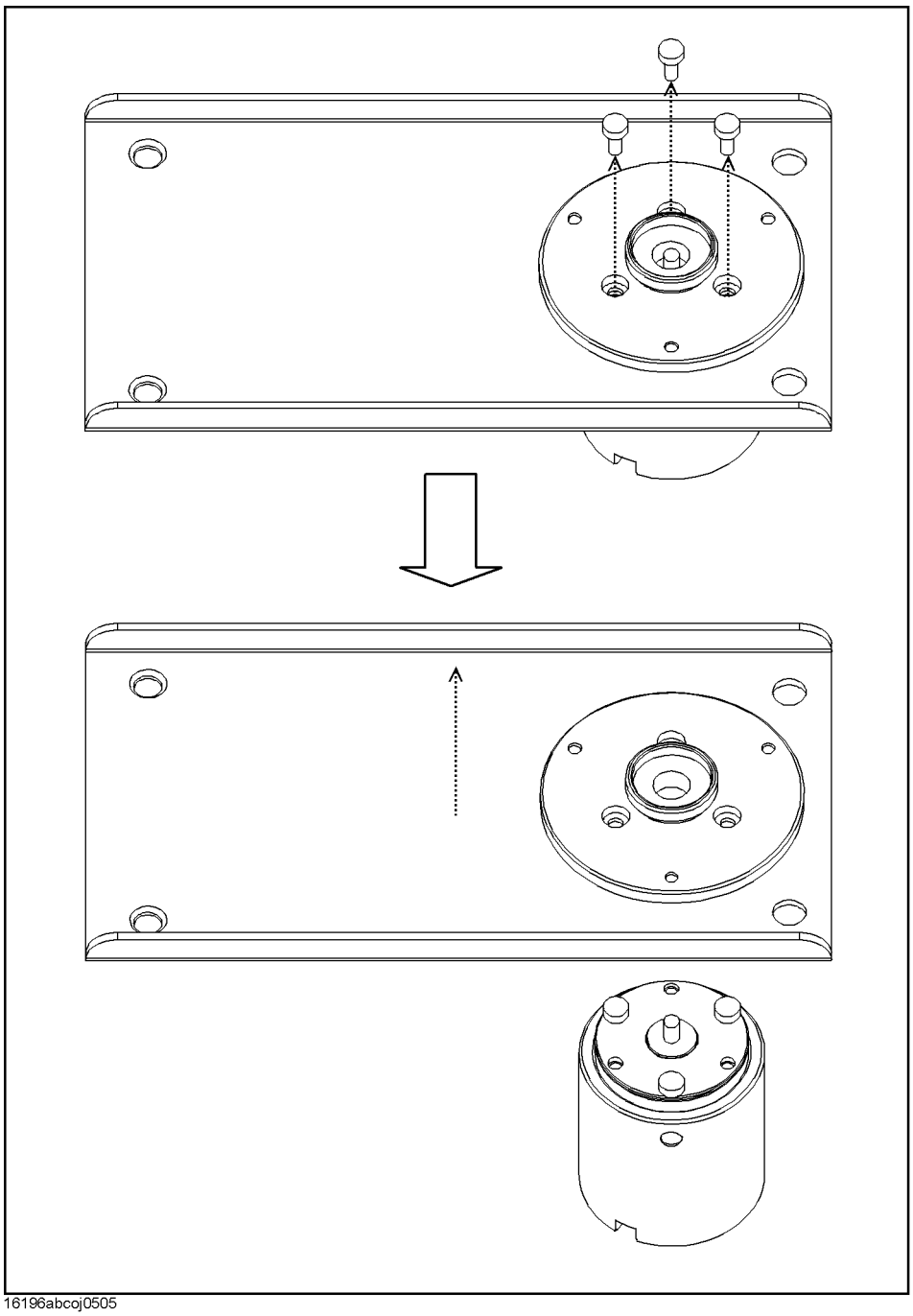
This section describes the replacement methods for the lower electrode, insulator and upper electrode. After replacing the respective parts, check the operation of the parts with reference to "Operation Check."

To replace the insulator and upper electrode, the 1.5-mm hex wrench (Agilent Part No. 8710-0909), included with the fixture, is required.

Lower Electrode

1. Prepare the replacement center electrode.
2. Take out the 3 screws from the bottom of the fixture and take out the DUT insert.

Figure 6-3 **Removing the Bottom of the Fixture**



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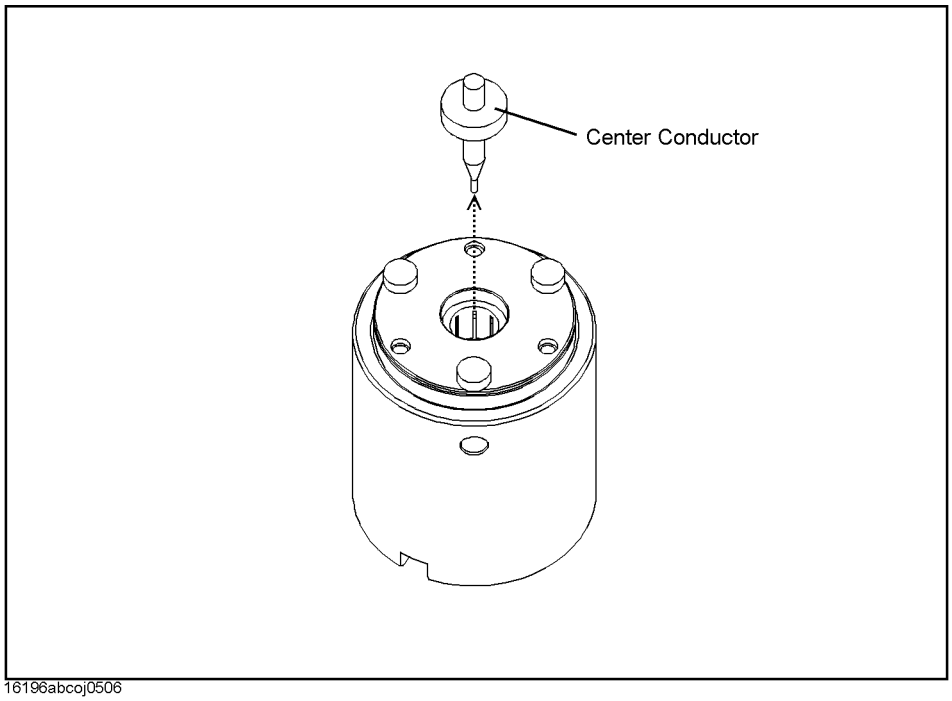
3. Remove the lower electrode from the DUT insert.

Figure 6-4 Removing the Lower Electrode



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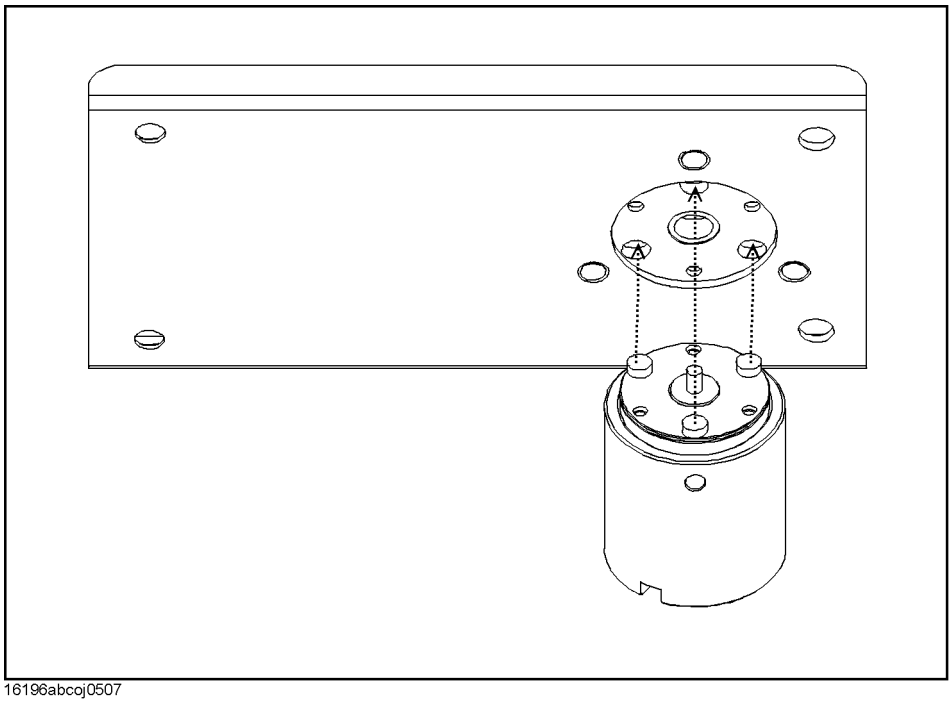
4. Insert the replacement lower electrode in the DUT insert.
5. Insert the DUT insert in the bottom of the fixture so that the bottom screws settle into the holes in the bottom of the fixture.

Figure 6-5 **Mounting the DUT Insert**



6. Fasten the DUT insert to the bottom of the fixture using the screws.

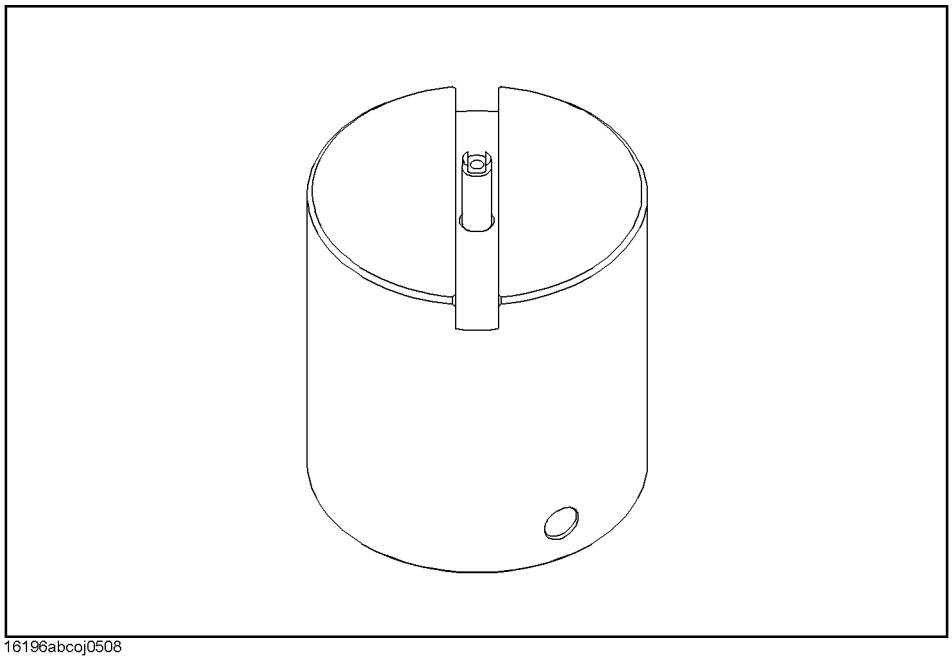
Insulator

Replace the insulator with reference to “Selecting and Changing the Insulator Assembly” on page 25.

Upper Electrode

1. Prepare the replacement electrode.
2. Remove the cap from the fixture.
3. Take out the screw from the top of the cap and remove the electrode from the cap.
4. Take the electrode out of the spring and insert the replacement electrode.
5. Push the electrode in from the bottom of the cap so that the top of the electrode protrudes out of the top of the cap.

Figure 6-6 **Electrode Replacement 1**



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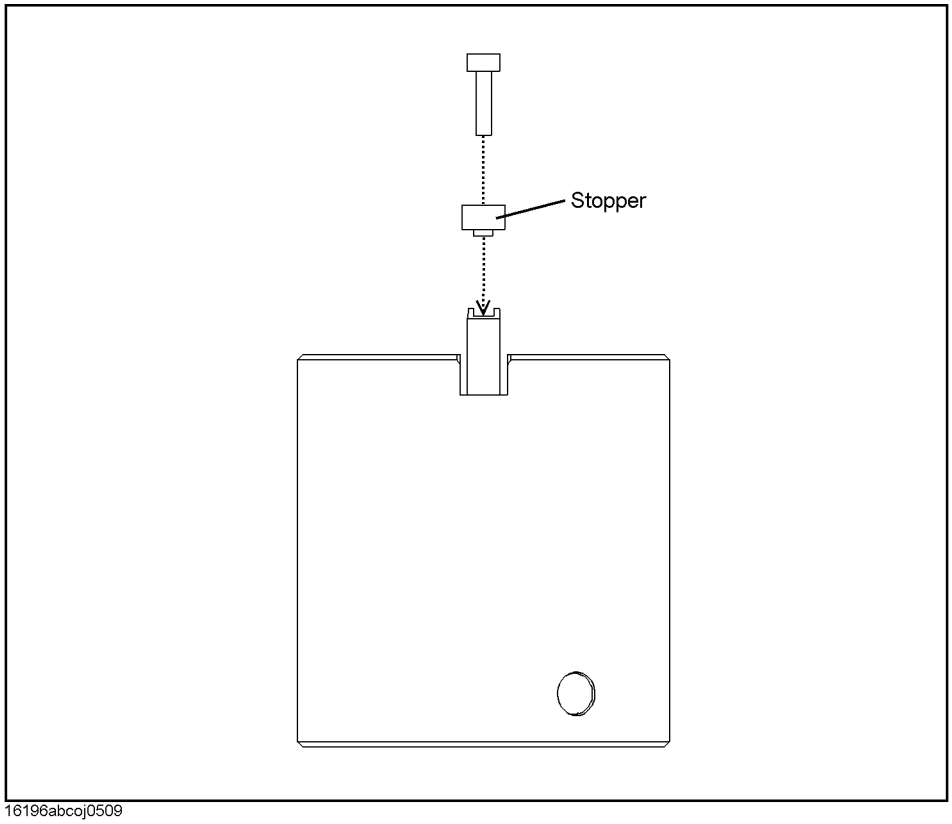
6. Place the stopper removed in step 3 so that the protrusion in the bottom aligns with the indent in the top of the electrode and tighten the screw.

Figure 6-7 **Electrode Replacement 2**



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Assembling Check

The assembling check need to be performed following replacement of parts. The impedance measurement instrument or the network analyzer is required for the assembling check. The impedance measurement instrument is more recommendable. Refer to “Assembling Check” on page 51 for the procedure using the impedance measurement instrument.

The assembly check methods with the network analyzer are explained in the following.

NOTE The network analyzer can be used only for the assembling check. The network analyzer has no function to measure DUT with the 16196A/B/C.

Method Using Network Analyzer

Required Tools

- Agilent 8753E
- Open plate
- Short plate

Procedure

Step 1. Conduct S11 full-calibration with the 7-mm connector to be connected to the fixture.

NOTE For details on the calibration method, see the User’s Guide for the measuring instrument.

Step 2. Connect the fixture to the measuring instrument.

Step 3. Remove the cap and place the open plate on the insulator assembly. Then attach and fasten the cap.

Step 4. Set the measuring instrument as follows.

Measurement Parameter	Primary:Mag, Secondary:Phase
Power	–10 dBm
IF BW	100 Hz
Point Averaging	16
Port Extension	16196A: 26.2 mm
	16196B: 26.9 mm
	16196C: 27.1 mm

NOTE For details on the setting and measurement procedures, see the User’s Manual for the measuring instrument.

Step 5. Take Mag and Phase value readings at 100 MHz and 1 GHz and record the results. Check if the Mag and Phase values are within the typical value ranges shown in the following table.

Table 6-8 Operation Check Typical Values (Open, common for 16196A/B/C)

Parameter	Frequency	Typical Value (Absolute value)
Mag	100 MHz	–0.2 ~ 0.2
Mag	1 GHz	–0.2 ~ 0.2
Phase	100 MHz	–0.5° ~ 0.5°
Phase	1 GHz	–0.5° ~ 0.5°

Step 6. Remove the open plate, and place the short plate on the insulator assembly. Then attach and fasten the cap.

Step 7. Take Mag and Phase value readings at 100 MHz and 1 GHz in this short state and record the results. Check if the Mag and Phase values are within the typical value ranges shown in the following table.

Table 6-9 Operation Check Typical Values (Short, 16196A)

Parameter	Frequency	Typical Value (Absolute value)
Mag	100 MHz	–0.06 ~ –0.01
Mag	1 GHz	–0.18 ~ –0.03
Phase	100 MHz	178° ~ 180°
Phase	1 GHz	171° ~ 178°

Table 6-10 Operation Check Typical Values (Short, 16196B)

Parameter	Frequency	Typical Value (Absolute value)
Mag	100 MHz	–0.06 ~ –0.01
Mag	1 GHz	–0.19 ~ –0.04
Phase	100 MHz	179° ~ 180°
Phase	1 GHz	174° ~ 180°

Table 6-11 Operation Check Typical Values (Short, 16196C)

Parameter	Frequency	Typical Value (Absolute value)
Mag	100 MHz	–0.07 ~ –0.01
Mag	1 GHz	–0.20 ~ –0.04
Phase	100 MHz	179° ~ 180°
Phase	1 GHz	174° ~ 180°

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