Agilent 16454A Magnetic Material Test Fixture

Operation and Service Manual

Agilent Technologies

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Notice

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Manual Printing History

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July 2001 .... Fifth Edition (part number: 16454-90020)

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* given elsewhere in this manual 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.

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 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 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 the 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.**

The voltage levels found in this test fixture when used with the intended instruments do not warrant more than normal safety precautions for operator safety.

Operating Precaution

Do not exceed the operating input power, voltage, and current level and signal type appropriate for the instrument being used, refer to your instrument's operation manual.

Caution

Electrostatic discharge (ESD) can damage the highly sensitive microcircuits in your instrument. ESD damage is most likely to occur as the test fixtures are being connected or disconnected. Protect them 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.

Never touch the test clip contacts.

Use a work station equipped with an anti-static work surface.

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.

Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of one year from the date of shipment, except that in the case of certain components listed in *Instrument Specifications* of this manual, the warranty shall be for the specified period. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent Technologies from another country.

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.

Limitation Of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. Agilent Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are buyer's sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Assistance

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

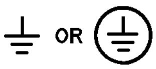
For any assistance, contact your nearest Agilent Technologies Sales and Service Office. Addresses are provided at the back of this manual.

Safety Symbols

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

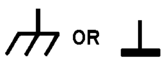
Instruction manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with wiring terminals to indicate the terminal that must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (Operation) manual, and before operating the equipment.



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

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

Warning 

Warning 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 

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 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.

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General Information

Introduction

This manual contains the following information:

- The specifications of the 16454A (in this chapter).
- Initial inspection of the 16454A (see Chapter 2).
- Ordering replaceable parts for the 16454A (see Chapter 5).

For measurement procedures using the 16454A, see the *4291B RF Impedance/Material Analyzer User's Guide*.

Product Description

The 16454A is used to measure the permeability of a toroidal core.

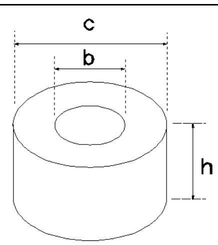
Specifications

This section lists the complete 16454A specifications. These specifications are the performance standards and limits against which the 16454A is tested. When shipped from the factory, the 16454A meets the following listed specifications.

Supplemental characteristics are intended to provide information that is useful in applying the instrument by giving non-warranted performance parameters. These are denoted as *typical, typically, nominal* or *approximate*.

Applicable MUT (Material Under Test) Size .... See Table 1-1
Maximum DC Bias Current .... ± 500 mA
Frequency Range .... 1 kHz to 1.0 GHz typically
Operating Temperature .... −55°C to +200°C
Operating Humidity (@ wet bulb temperature <40°C) .... Up to 95% RH
Non-operating Temperature .... −55°C to +200°C
Non-operating Humidity (@ wet bulb temperature <65°C) .... Up to 90% RH
Weight
(Large Test Fixture) .... 140 g typically
(Small Test Fixture) .... 120 g typically
Dimension
(Large Test Fixture) .... ϕ 30 mm × 35 mm H typically
(Small Test Fixture) .... ϕ 24 mm × 30 mm H typically

Table 1-1. Applicable MUT Size

<table>
<tr><td rowspan="5">
</td><td>Fixture</td><td colspan="2">Small</td><td colspan="2">Large</td></tr>
<tr><td>Holder</td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>b</td><td>$\geq \phi$ 3.1 mm</td><td>$\geq \phi$ 3.1 mm</td><td>$\geq \phi$ 6 mm</td><td>$\geq \phi$ 5 mm</td></tr>
<tr><td>c</td><td>$\leq \phi$ 8 mm</td><td>$\leq \phi$ 6 mm</td><td>$\leq \phi$ 20 mm</td><td>$\leq \phi$ 20 mm</td></tr>
<tr><td>h</td><td>$\leq$ 3 mm</td><td>$\leq$ 3 mm</td><td>$\leq$ 8.5 mm</td><td>$\leq$ 8.5 mm</td></tr>
</table>

Applicable Instruments
.... 4291B RF Impedance/Material Analyzer
.... 4294A Precision Impedance Analyzer
.... E4991A RF Impedance/Material Analyzer

Model	**Necessary options**
4291B	Option 002 Option 012/014[1]
4294A	I-BASIC sample program disk[2]
E4991A	Option 002

1 Used for temperature characteristics measurement.

2 Furnished with 4294A manual set

Supplemental Performance Characteristics

This section shows supplemental performance characteristics data. This supplemental performance characteristics is not specification. Magnetic Material Measurement Accuracy used with High Temperature Test Head of 4291B, see the *4291B RF Impedance/Material Analyzer Function Reference*.

Typical Measurement Accuracy

$\mu_r{}'$ **Accuracy** $(\frac{\Delta\mu'_{rm}}{\mu'_{rm}})$

@$\tan\delta < 0.1$

f < 1 MHz .... $4 + \frac{25}{F\mu'_{rm}} + \left(\frac{0.1}{F\mu'_{rm}f}\right)$ [%] (Typical)

f ≥ 1 MHz .... $4 + \frac{25}{F\mu'_{rm}} + F\mu'_{rm}\left(1 + \frac{15}{F\mu'_{rm}}\right)^2 f^2$ [%] (Typical)

Loss Tangent Accuracy of $\dot{\mu}_r$ $(\Delta\tan\delta)$

@$\tan\delta<0.1$ .... $E_a + E_b$ (Typical)

f < 1 MHz

.... $\mathbf{E_a} = 0.002 + \frac{0.001}{F\mu'_{rm}f}$ (Typical)

.... $\mathbf{E_b} = \frac{\Delta\mu'_{rm}}{\mu'_{rm}}\frac{\tan\delta}{100}$ (Typical)

f ≥ 1 MHz

.... $\mathbf{E_a} = 0.002 + \frac{0.001}{F\mu'_{rm}f} + 0.004f$ (Typical)

.... $\mathbf{E_b} = \frac{\Delta\mu'_{rm}}{\mu'_{rm}}\frac{\tan\delta}{100}$ (Typical)

Where,

f is measurement frequency [GHz]
F = $h\ln\frac{c}{b}$ [mm]

h is the height of MUT [mm]
b is the inner diameter of MUT
c is the outer diameter of MUT
tan δ is the measured value of loss tangent
$\mu_{\mathbf{rm}}{}'$ is the measured value of permeability

Conditions of accuracy characteristics
■ Use the Low Z Test Head for permeability measurement ■ OPEN/SHORT/50 Ω calibration must be done. Calibration ON. ■ Averaging (on point) factor is larger than 32 at which calibration is done if Cal points is set to USER DEF. ■ Measurement points are same as the calibration points if Cal point is set to USER DEF. ■ Environment temperature is within ±5°C of temperature at which calibration is done, and within 13°C to 33°C. Beyond this environmental temperature condition, accuracy is twice as bad as specified.

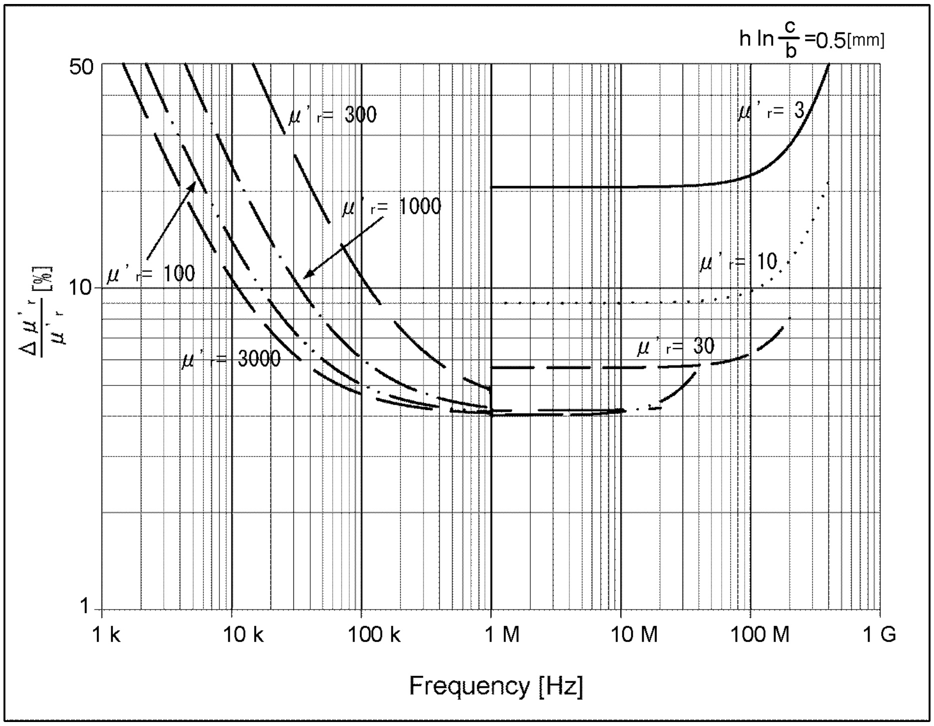


Figure 1-1. Typical Permeability Measurement Accuracy (@F* = 0.5)

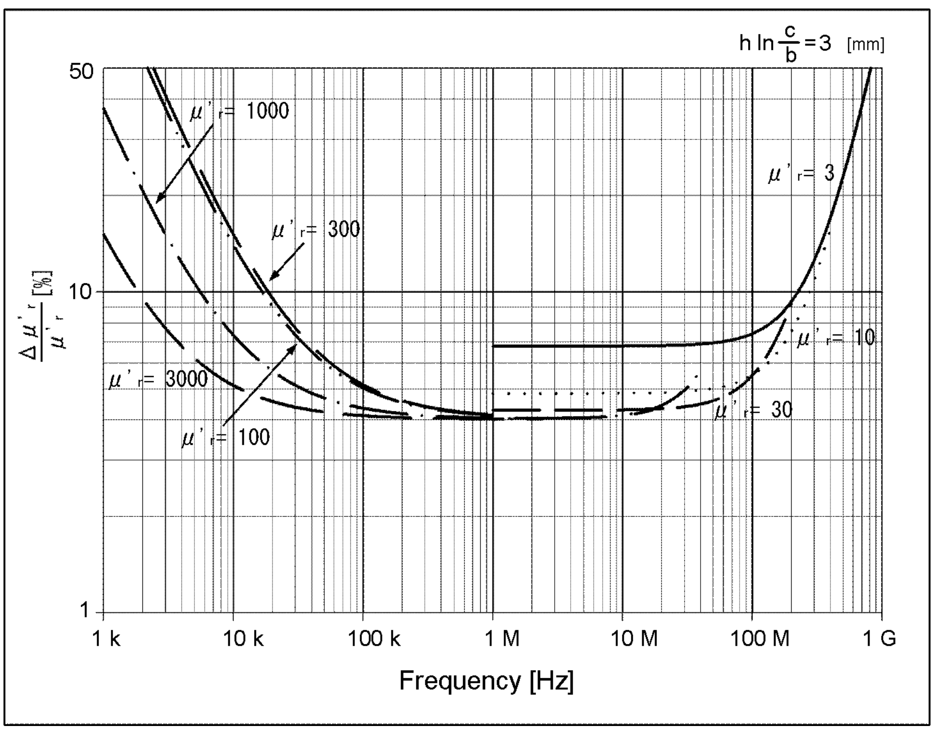


Figure 1-2. Typical Permeability Measurement Accuracy (@F* = 3)

$* F = h \ln \frac{c}{b}$

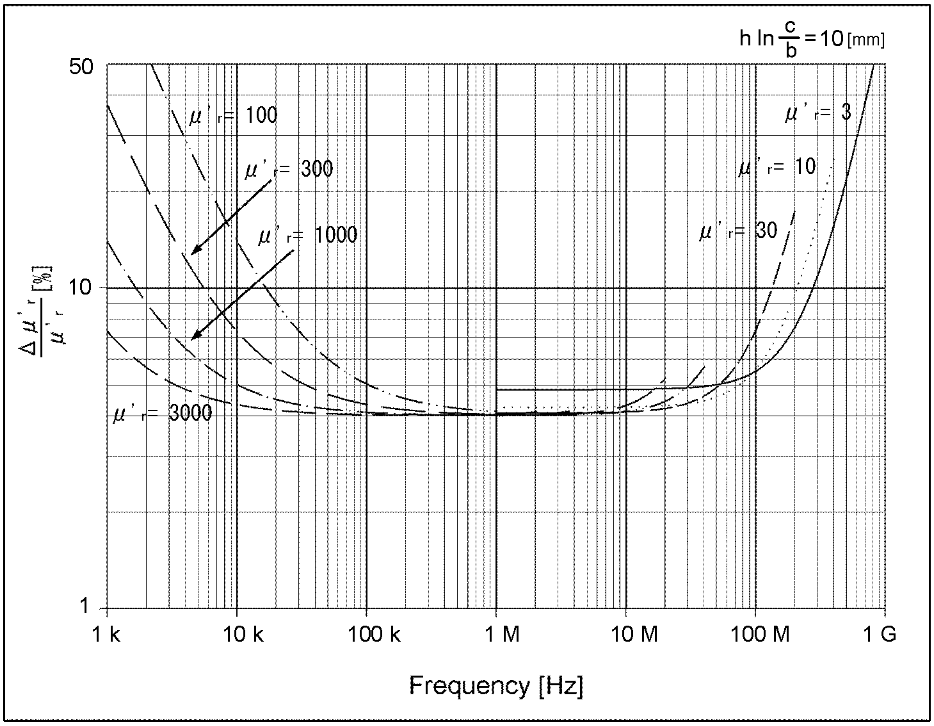


Figure 1-3. Typical Permeability Measurement Accuracy (@F* = 10)

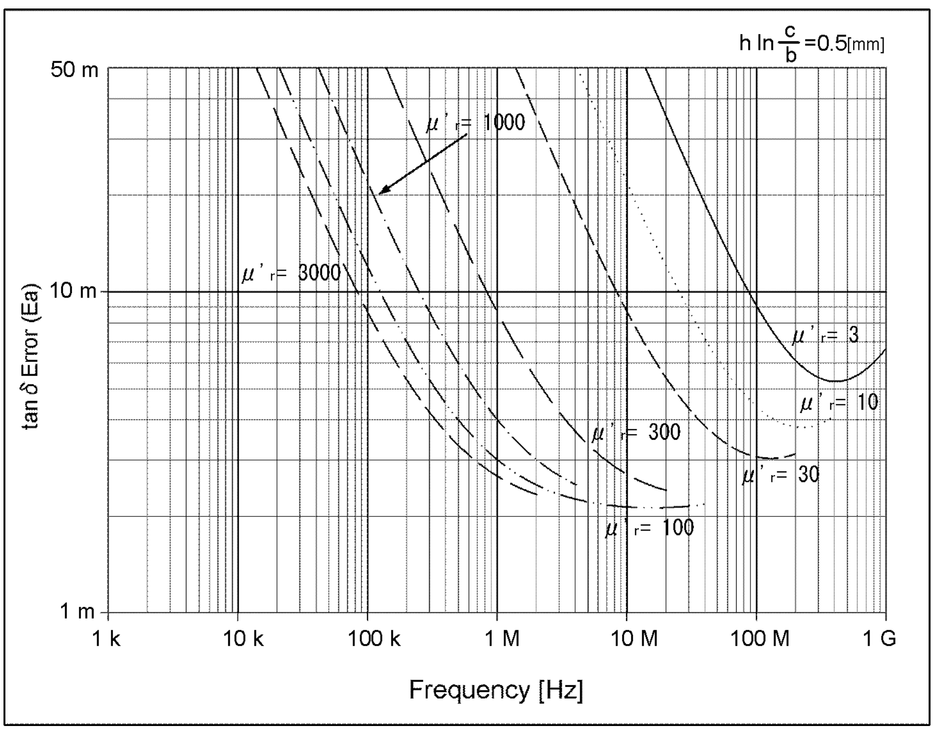


Figure 1-4. Typical Permeability Loss Tangent (tanδ) Measurement Accuracy (@F* = 0.5)

$* F = h \ln \frac{c}{b}$

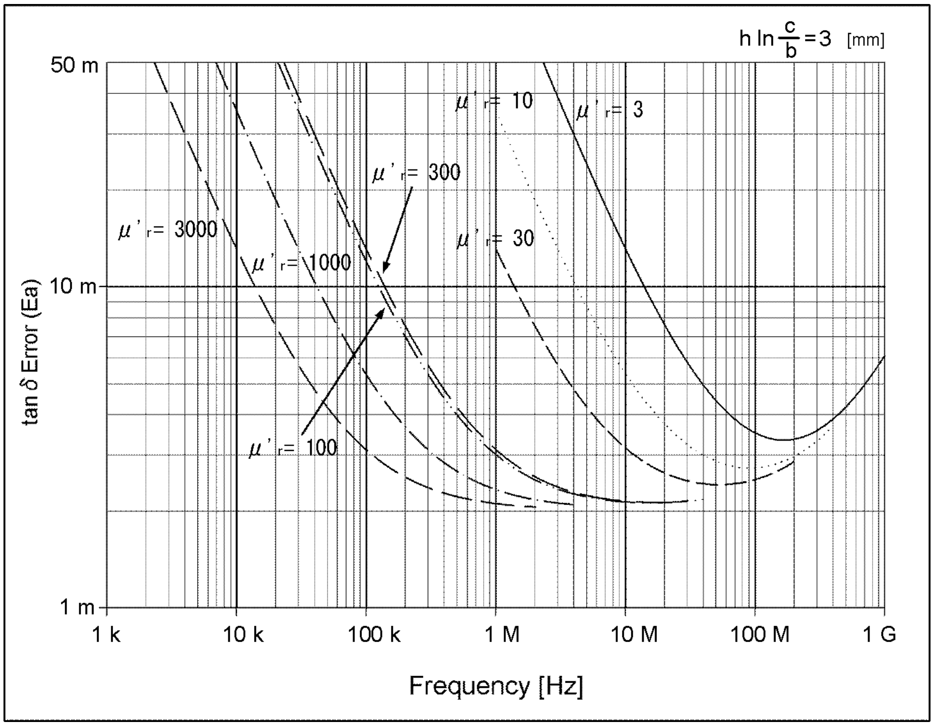


Figure 1-5. Typical Permeability Loss Tangent (tanδ) Measurement Accuracy (@F* = 3)

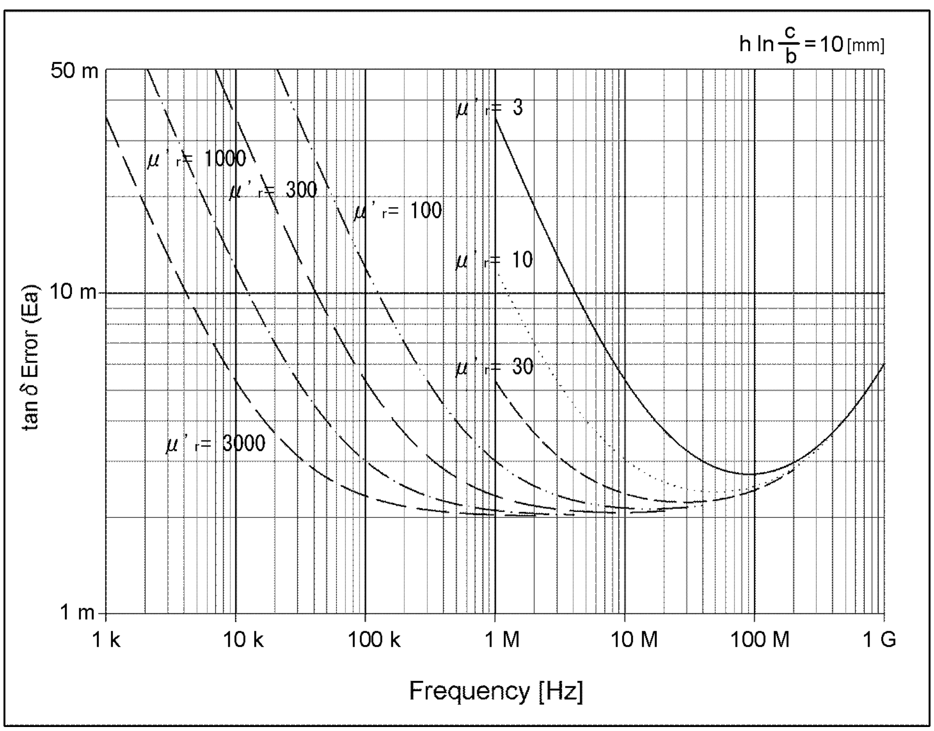


Figure 1-6. Typical Permeability loss Tangent (tanδ) Measurement Accuracy (@F* = 10)

$* F = h \ln \frac{c}{b}$

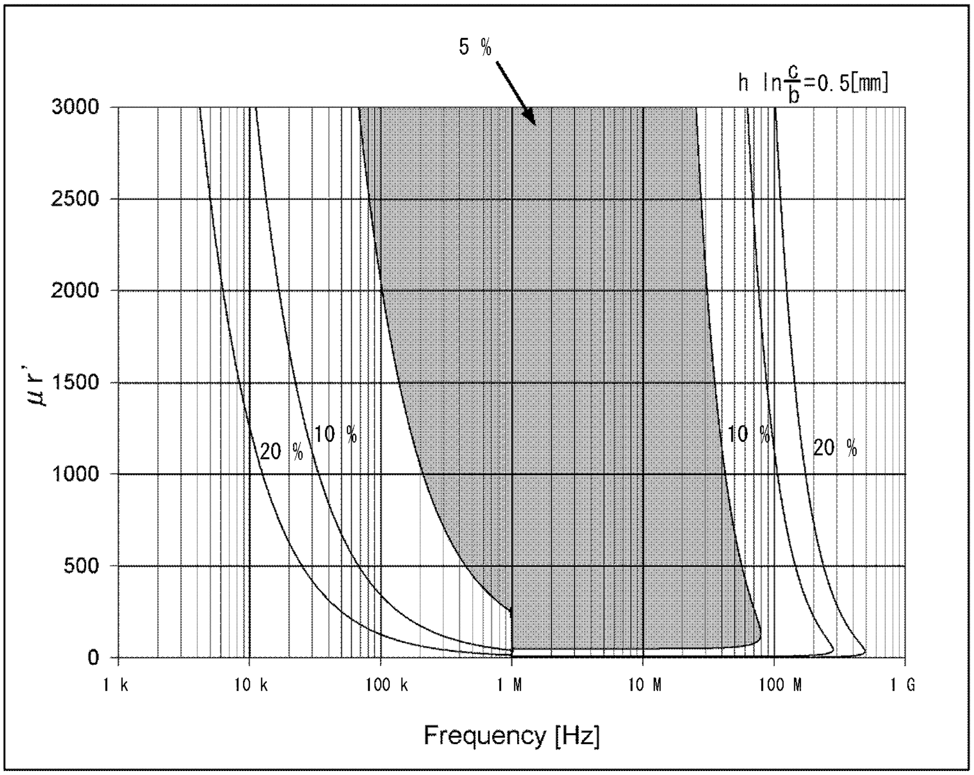


Figure 1-7. Typical Permeability Measurement Accuracy (μ_r v.s. Frequency, @$F^* = 0.5$)

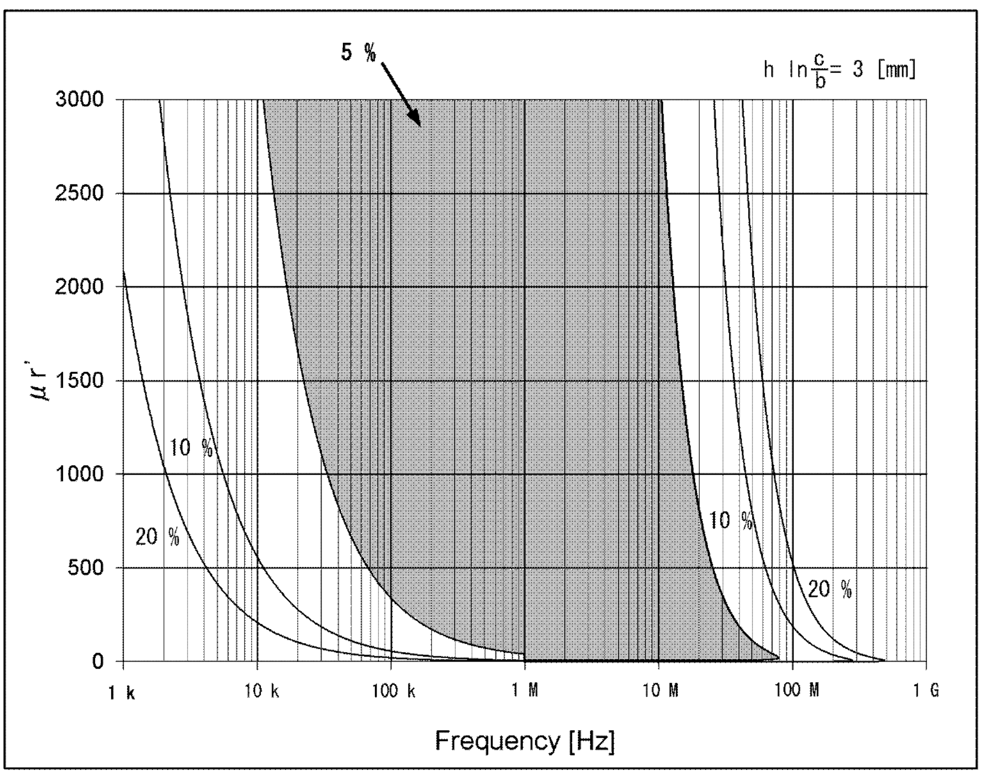


Figure 1-8. Typical Permeability Measurement Accuracy (μ_r v.s. Frequency, @$F^* = 3$)

$* F = h \ln \frac{c}{b}$

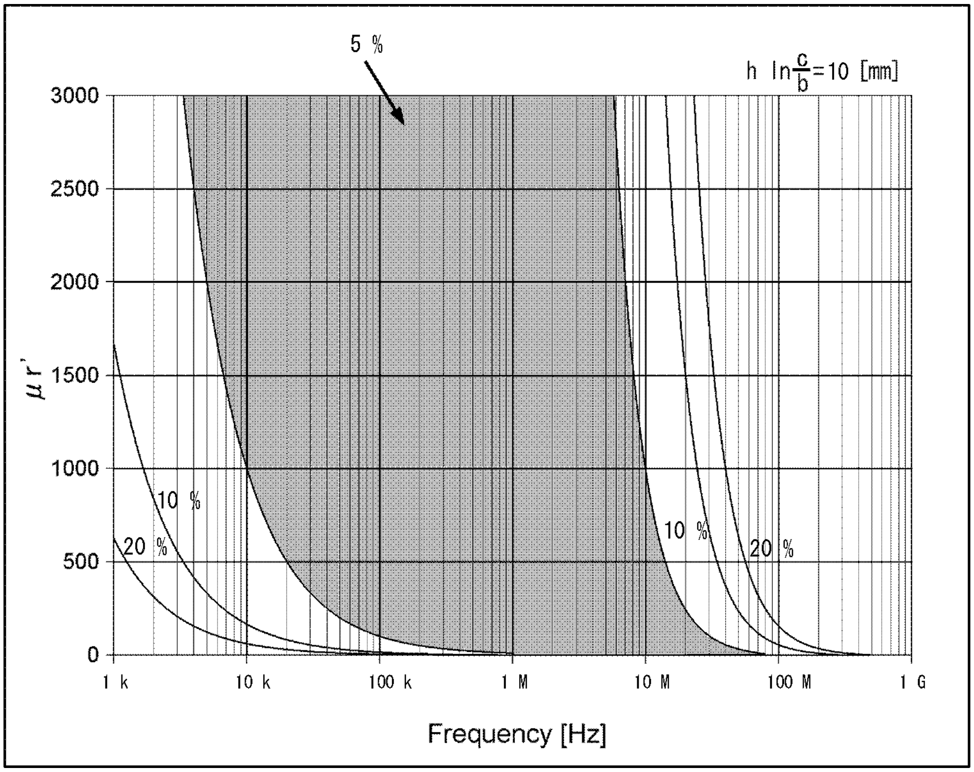


Figure 1-9. Typical Permeability Measurement Accuracy (μ_r v.s. Frequency, @F* = 10)

$* \; F = h \ln \frac{c}{b}$

2

Initial Inspection

Introduction

This chapter contains the following information:

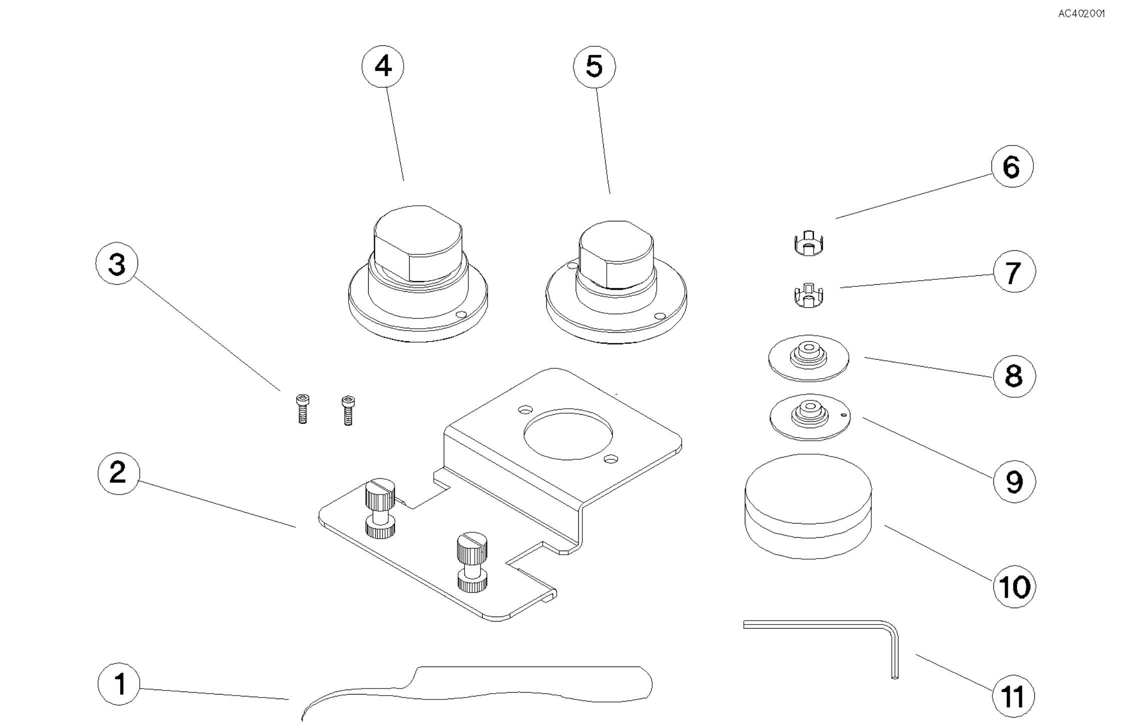
- Initial inspection.
- Repackaging the test fixture for shipment.

Initial Inspection

The magnetic material test fixture has been carefully inspected before being shipped from the factory. It should be in perfect physical condition, no scratches, dents or the like. It should also be in perfect electrical condition. Verify this by carefully performing an incoming inspection to check the magnetic material test fixture set for signs of physical damage and missing contents. If any discrepancy is found, notify the carrier and Agilent Technologies. Your Agilent Technologies sales office will arrange for repair and replacement without waiting for the claim to be settled.

- Inspect the shipping container for damage. Keep the shipping materials until the inspection is completed.
- Verify that the shipping container contains everything listed in Table 2-1.
- Inspect the exterior of the 16454A for any signs of damage.

Table 2-1. 16454A Contents



Reference Designator	Description	Agilent Part Number	Quantity
1	Tweezers	8710-2081	1
2	Fixture Holder	16454-00601	1
3	Screw, Hex Recess	0515-1050	2
4	Test fixture (Large)	(not assigned)	1
5	Test fixture (Small)	(not assigned)	1
6	Holder A	16454-25002	1
7	Holder B	16454-25001	1
8	Holder C	16454-25003	1
9	Holder D	16454-25004	1
10	Holder Case	1540-0622	1
11	Hex Key, 2.5mm Across Flats	8710-1181	1
–	Carrying Case[1]	16454-60101	1
–	Operation and Service Manual[1]	16454-90010	1

1 These parts are not shown in this figure.

Repackaging the Test Fixture For Shipment

If shipment to a Agilent Technologies service center is required, each test fixture should be repackaged using the original factory packaging materials.

If this material is not available, comparable packaging materials may be used. Wrap the magnetic material test fixture in heavy paper and pack in anti-static plastic packing material. Use sufficient shock absorbing material on all sides of the 16454A to provide a thick, firm cushion and to prevent movement. Seal the shipping container securely and mark it *FRAGILE*.

3

Theory on Material Measurement

This chapter explains the basic principle and the concept of material measurement.

Magnetic Material Measurement

Permeability Definition

Permeability in the alternating-current magnetic field is defined as complex relative permeability ($\mu^*{}_r$) (See Equation 3-1). The real component of the complex relative permeability ($\mu'{}_r$) represents the amount of energy stored in the magnetic material from the alternating-current magnetic field. On the other hand, the imaginary component ($\mu''{}_r$) indicates energy loss to the alternating current magnetic field.

Equation 3-1. Definition of Complex Relative Permeability

$$\mu_r^* = \mu_r' - j\mu_r''$$

As shown in Figure 3-1, complex relative permeability can be expressed in a vector diagram. The loss factor of a magnetic material is expressed as loss tangent (tanδ), which is the ratio of the imaginary component ($\mu''{}_r$) to the real component ($\mu'{}_r$) of the complex relative permeability.

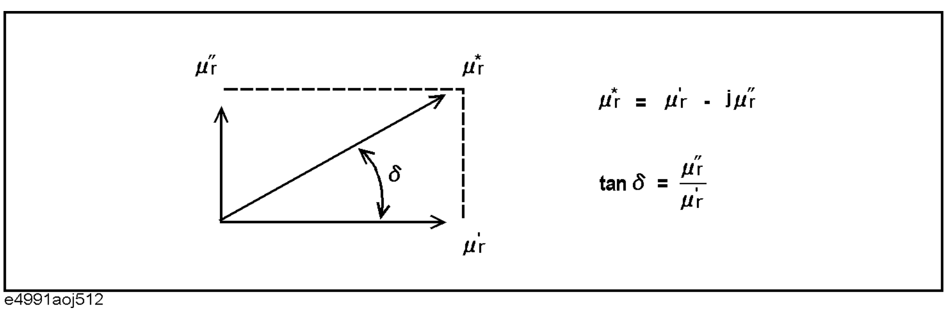


Figure 3-1. Vector Diagram of Complex Relative Permeability and Loss Tangent

Measurement Principle of Magnetic Material

When using a LCR meter or an Impedance Anlyzer, the inductance measurement method is employed to measure complex relative permeability. In this method, a DUT (toroidal core) is coiled with a wire and relative permeability is calculated from the measured inductance values. This section explains the measurement principle when using the test fixture, 16454A.

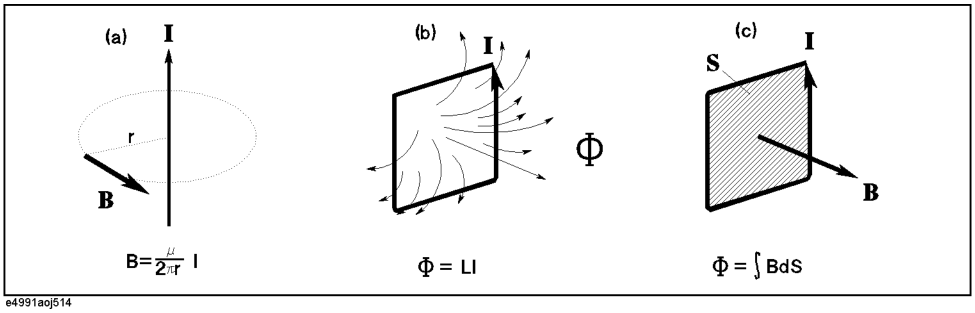


Figure 3-2. Relationship among Current, Magnetic Flux, and Magnetic Flux Density

Generally, the magnetic flux density (B) induced by the current flowing in an infinitely long straight wire shown in (a) of Figure 3-2 is expressed as Equation 3-2.

Equation 3-2. Magnetic Flux Density Induced by Current Flowing in an Infinitely Long Straight Wire

$$B = \frac{\mu I}{2\pi r}$$

On the other hand, the magnetic flux (Φ) induced by current flowing in the closed loop shown in (b) of Figure 3-2 is expressed as Equation 3-3. Note that L indicates the self-inductance of the closed loop.

Equation 3-3. Magnetic Flux Induced by Current in Closed Loop

$$\Phi = LI$$

Furthermore, this magnetic flux (Φ) also can be expressed by integrating the magnetic flux density (B) throughout the enclosed surface, as shown in Figure 3-2 (See Equation 3-4).

Equation 3-4. Relationship between Magnetic Flux and Magnetic Flux Density

$$\Phi = \int B\, ds$$

When a DUT (toroidal core) is mounted in 16454A, an ideal (no magnetic flux leakage) one turn inductor is formed, as shown in Figure 3-3.

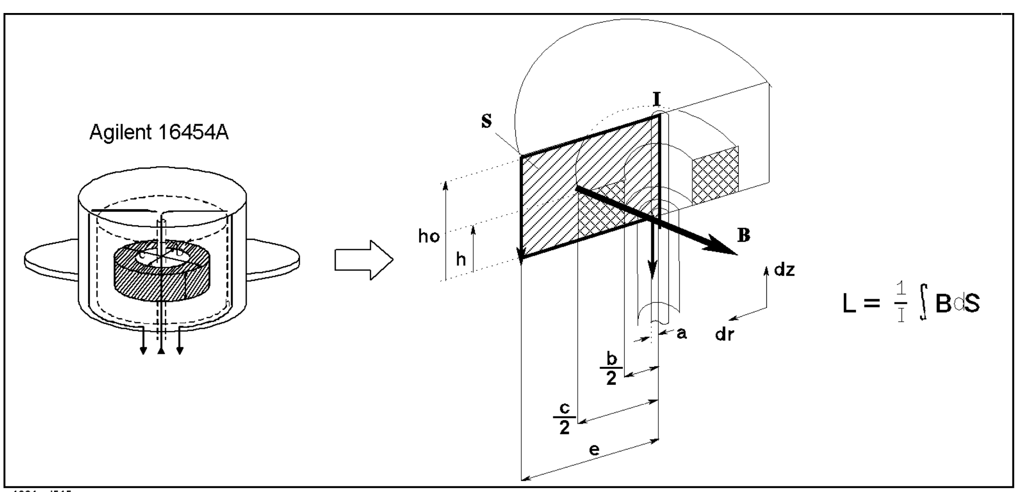


Figure 3-3. Measurement Principle When Using 16454A Test Fixture

The self-inductance of the measurement circuit including the DUT is derived as Equation 3-5 from Equation 3-2, Equation 3-3, Equation 3-4, and the physical shape of 16454A.

Equation 3-5. Self-Inductance of Measurement Circuit

$$L = \frac{1}{I}\int B\,ds = \int_a^e \int_0^{h_0} \frac{\mu}{2\pi r} dr\,dz$$

By unfolding Equation 3-5 with μ_0 as permeability of free space and μ_r as relative permeability of the DUT, Equation 3-6 can be obtained.

Equation 3-6. Self-Inductance of Measurement Circuit

$$L = \int_{\frac{c}{2}}^{e} \int_0^{h_0} \frac{\mu_0}{2\pi r} dr\,dz + \int_{\frac{b}{2}}^{\frac{c}{2}} \int_0^{h} \frac{\mu_0 \mu_r}{2\pi r} dr\,dz + \int_{\frac{b}{2}}^{\frac{c}{2}} \int_h^{h_0} \frac{\mu_0}{2\pi r} dr\,dz + \int_a^{\frac{b}{2}} \int_0^{h_0} \frac{\mu_0}{2\pi r} dr\,dz$$

By further unfolding Equation 3-6, Equation 3-7 can be obtained.

Equation 3-7. Self-Inductance of Measurement Circuit

$$L = \frac{\mu_0}{2\pi}\{(\mu_r - 1)h ln\frac{c}{b} + h_0 ln\frac{e}{a}\}$$

By transforming Equation 3-7 to calculate the relative permeability (μ_r) of the DUT, Equation 3-8 can be obtained.

Equation 3-8. Relative Permeability of DUT

$$\mu_r = \frac{2\pi(L - L_{ss})}{\mu_0 h ln\frac{c}{b}} + 1$$

L_{ss} in Equation 3-9 indicates the self-inductance when a DUT is not mounted in the test fixture.

Equation 3-9. Self-Inductance When DUT Is Not Mounted in Test Fixture

$$L_{ss} = \frac{\mu_0}{2\pi} h_0 ln\frac{e}{a}$$

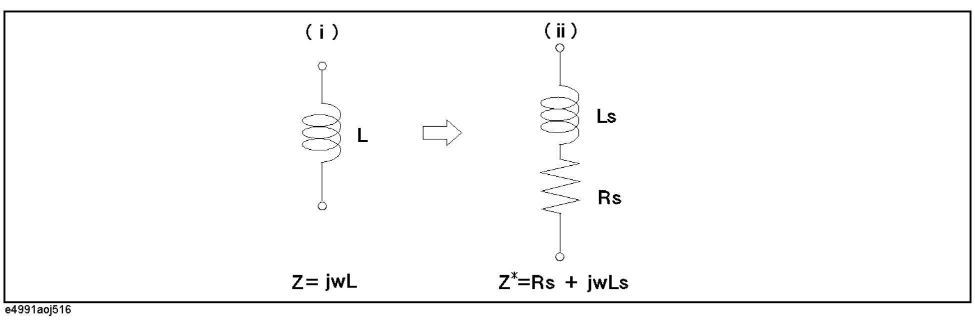


Figure 3-4. Loss of Magnetic Material

The impedance Z of the circuit (i) in Figure 3-4 is expressed as Equation 3-10, and the complex impedance Z^* of the circuit (ii) is expressed as Equation 3-11.

Equation 3-10. Impedance of Circuit (i)

$$Z = j\omega L$$

Equation 3-11. Complex Impedance of Circuit (ii)

$$Z^* = R_s + j\omega L_s = j\omega\left(\frac{R_s}{j\omega} + L_s\right)$$

As alternating current causes inductance loss, the self-inductance L of the measurement circuit is expressed as complex impedance, as shown in Equation 3-12.

Equation 3-12. Self-Inductance of Measurement Circuit Expressed as Complex Impedance

$$L = \frac{Z^*}{j\omega}$$

Substituting “L” from Equation 3-12 to Equation 3-8 yields Equation 3-13.

Equation 3-13. Complex Relative Permeability of DUT

$$\mu_r^* = \frac{2\pi(Z^* - j\omega L_{ss})}{j\omega\mu_0 h l n \frac{c}{b}} + 1$$

Structure of 16454A Test Fixture

As shown in Figure 3-5, 16454A has a residual impedance Z^*_{res}.

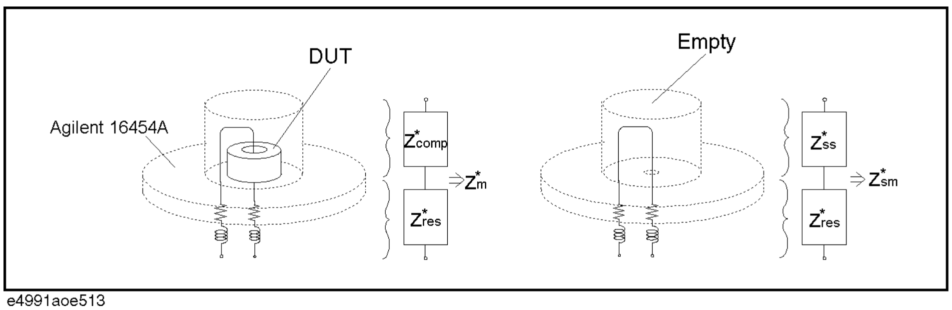


Figure 3-5. 16545A Residual Impedance

Given the ideal impedance Z^*_{ss} of the 16454A text fixture with no DUT mounted, the residual impedance Z^*_{res} can be calculated from the measured impedance Z^*_{sm} with no DUT mounted in 16454A (in SHORT state).

Equation 3-14. 16454A Residual Impedance

$$Z^*_{res} = Z^*_{sm} - Z^*_{ss}$$

Errors due to residual impedance can be minimized by SHORT compensation. The impedance after error compensation Z^*_{comp} can be calculated from the measured impedance Z^*_m with a DUT mounted in 16454A, as shown in Equation 3-15.

Equation 3-15. Compensated Impedance

$$Z^*_{comp} = Z^*_m - Z^*_{res}$$

Assuming that Z^*_{ss} consists only of inductance elements ($Z^*_{ss} = j\omega L_{ss}$), the complex relative permeability of the DUT can be calculated using Equation 3-13 and compensated impedance, $Z^*_{comp} = Z^*$, as shown in Equation 3-16.

Equation 3-16. Complex Permeability of DUT

$$\mu_r^* = \frac{2\pi(Z^*_m - Z^*_{sm})}{j\omega\mu_0 h l n \frac{c}{b}} + 1$$

4

Operation

Connecting the Test Fixture

Selecting Fixture and Holder

The 16454A consists of two fixtures, a large one and a small one. The applicable MUT size for each fixture is listed in Table 5-1.

Table 4-1. MUT Size For Test Fixtures

Fixture	Small		Large	
Holder	**A**	**B**	**C**	**D**
MUT Outer Diameter (mm)	$\leq \phi 8$ mm	$\leq \phi 6$ mm	$\leq \phi 20$ mm	$\leq \phi 20$ mm
MUT Inner Diameter (mm)	$\geq \phi 3.1$ mm	$\geq \phi 3.1$ mm	$\geq \phi 6$ mm	$\geq \phi 5$ mm
MUT Height (mm)	≤ 3 mm	≤ 3 mm	≤ 8.5 mm	≤ 8.5 mm

Figure 4-1 shows the dimensions of the MUT holder.

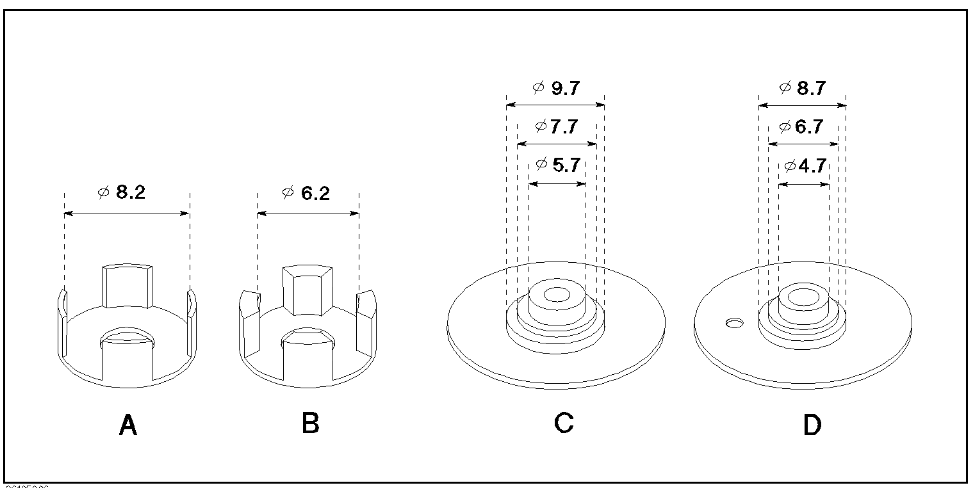


Figure 4-1. Dimensions of the MUT Holder

Connecting the Test Fixture to the Test Head

To connect your fixture to the Test Head, perform the following steps:

1. Turn the APC-7® connector on the test head as shown in Figure 4-2.
2. Verify that the connector sleeve is retracted fully as shown in Figure 4-3.

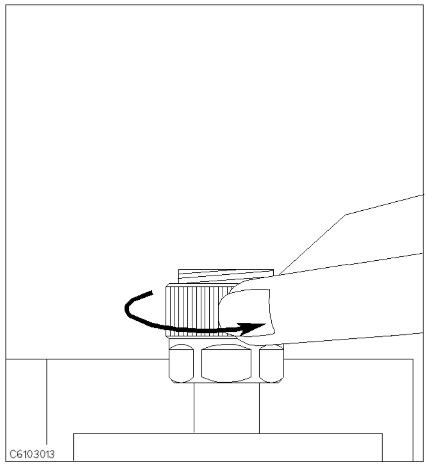


Figure 4-2.

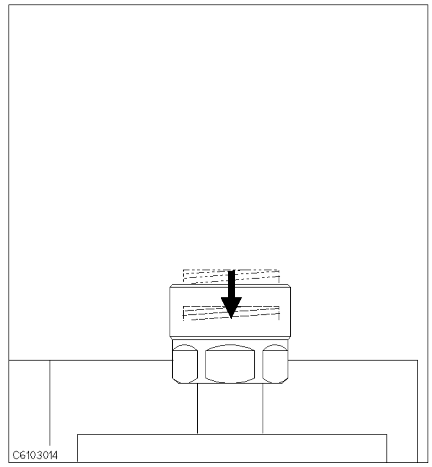


Figure 4-3.

3. Secure the test fixture to the fixture holder using the two screws.
4. Connect the connector on the underside of the test fixture to the APC-7 connector on the test head.
5. Secure the fixture holder to the test station using the two screws.

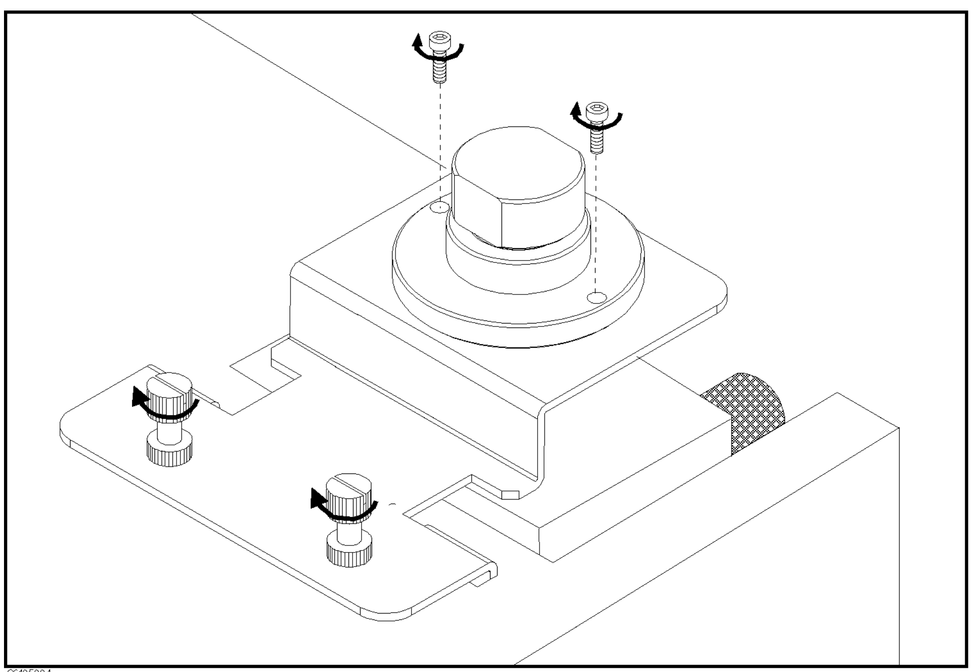
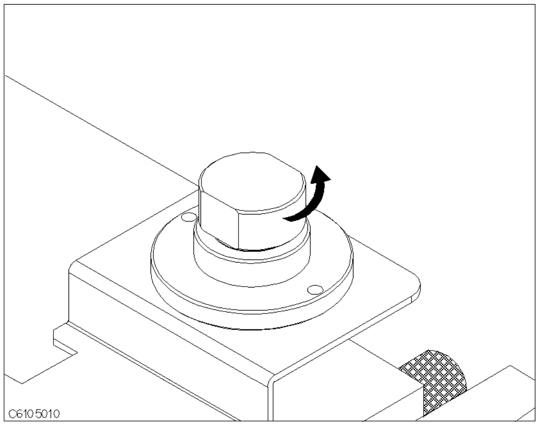


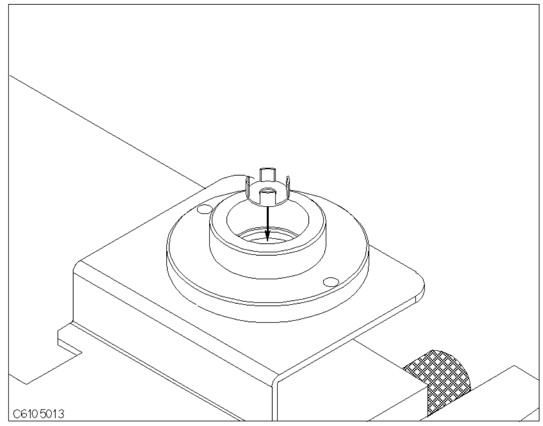
Figure 4-4. Connecting the Test Fixtures (16454A Small)

Performing SHORT Compensation

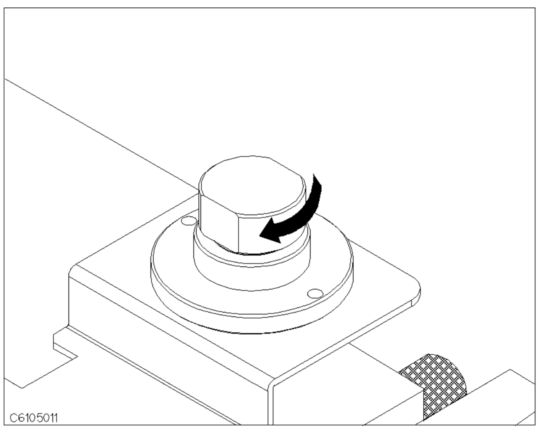
The SHORT Compensation corrects for the residual impedance due to the test fixture.



1. Remove the cap of the fixture.



2. Place a MUT holder only in the fixture.

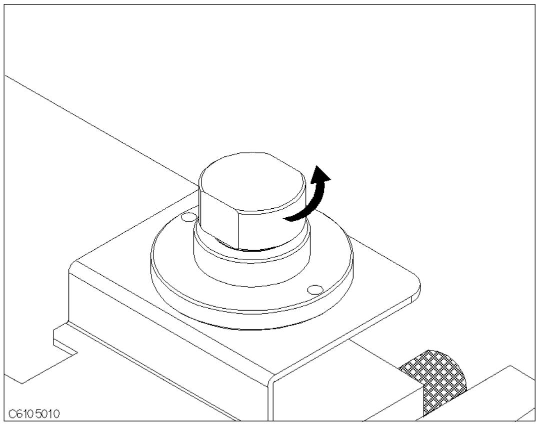


3. Replace the cap by screwing tightly.

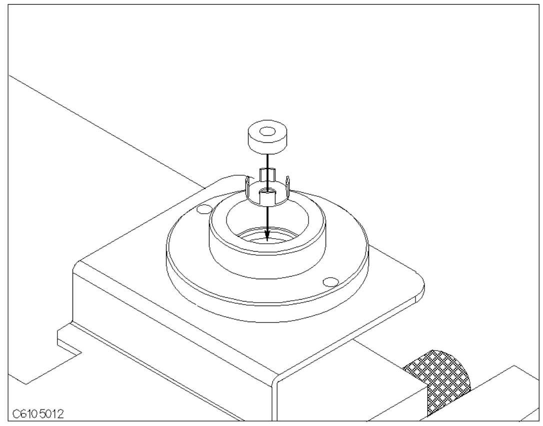
:

Placing the MUT into the Test Fixture

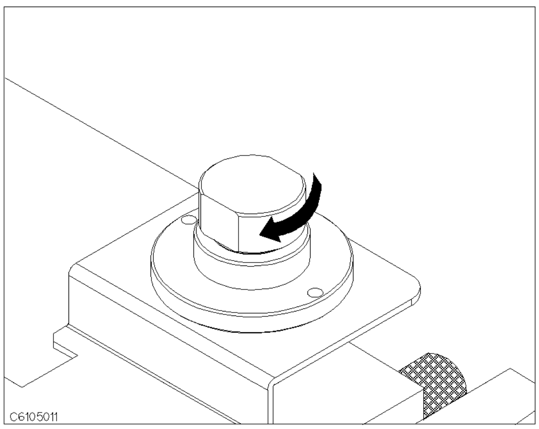
How to place the MUT on the 16454A is shown below:



1. Remove the cap of the fixture.



2. Place a MUT onto the MUT holder and insert it into the fixture.



3. Replace the cap by screwing tightly.

:

5

Service

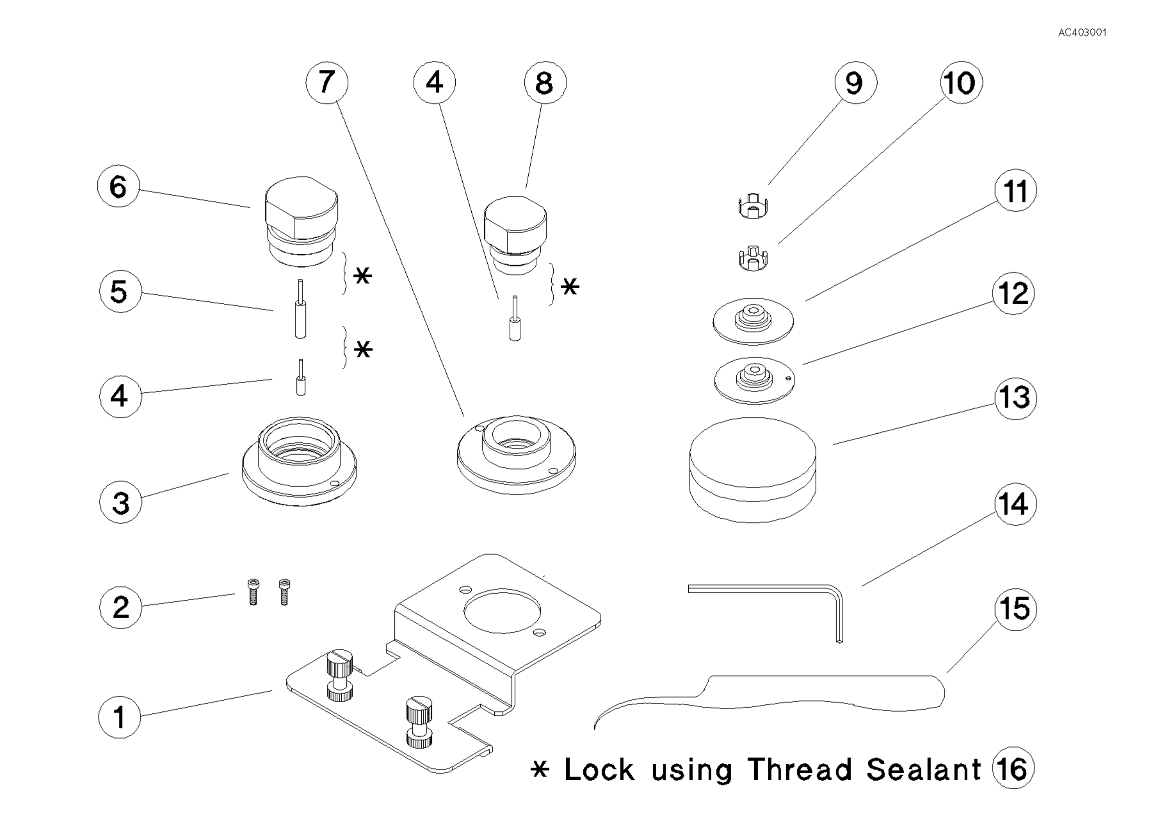
Introduction

This chapter gives the service information for the 16454A Magnetic Material Test Fixture.

Replaceable Parts

Table 5-1 lists the replaceable parts. The parts listed in this table can be ordered from your nearest Agilent Technologies office. Ordering information should include the Agilent part number and the quantity required.

Table 5-1. Replaceable Parts List



Reference Designator	Agilent Part Number	Qty.	Description
1	16454-00601	1	Fixture Holder
2	0515-1050	2	Screw, Hex Recess
3	16454-23004	1	Fixture Flange (Large)
4	1250-0816	2	Conn-RF Conn
5	16454-23005[1]	1	Center Pin
6	16454-23003[1]	1	Fixture Cap (Large)
7	16454-23002	1	Fixture Flange (Small)
8	16454-23001[1]	1	Fixture Cap (Small)
9	16454-25002	1	Holder A
10	16454-25001	1	Holder B
11	16454-25003	1	Holder C
12	16454-25004	1	Holder D
13	1540-0622	1	Case
14	8710-1181	1	Hex Key, 2.5mm Across Flats
15	8710-2081	1	Tweezers
16	0470-0013	1	Thread Sealant
–	16454-60101	1	Carrying Case[2]
–	16454-90000	1	Specification and Service Manual[2]

1 Agilent internal-only part number.

2 These parts are not shown in this figure.

Functional Test

This section provides the functional test procedure to check the 16454A performance. The functional test can be used for post repair function verification.

Fixture Impedance Check

1. Perform calibration at the APC-7® terminal of the measurement instrument.
2. Place the fixture (small) on the calibrated APC-7® terminal of the measurement instrument.
3. Read L_S and R_S values for each test fixture. The guideline is as follows:

Table 5-2. Fixture Impedance Check Guideline

Fixture	Frequency	Parameter	Guideline
Small	100 MHz	L_S	1 nH ± 0.5 nH
		R_S	$<$ 100 mΩ
Large	100 MHz	L_S	5.5 nH ± 2.5 nH
		R_S	$<$ 300 mΩ

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