製品見本

Agilent 16314A Balanced/Unbalanced 4-Terminal Converter
Agilent 16315A 50Ω Balanced/50Ω Unbalanced Converter
Agilent 16316A 100Ω Balanced/50Ω Unbalanced Converter
Agilent 16317A 600Ω Balanced/50Ω Unbalanced Converter

Operation and Service Manual

Agilent Technologies

Agilent Part No. 16315-90001
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Notice

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

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Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of three months from the date of shipment, except that in the case of certain components listed in 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 which prove to be defective.

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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 which are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

March 1993 ..... First Edition

October 1994 ..... Second Edition (part number: 16315-90001)

August 2001 ..... Third Edition (part number: 16315-90001)

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 only 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 injury, always disconnect power and discharge circuits before touching them.

Do NOT Service or Adjust While Alone

Do *not* attempt internal service or adjustment unless another person, capable of turning off power and 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

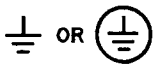
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.

Safety Symbols

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

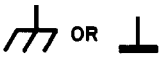
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

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



Protective ground terminal. For protection against electrical shock in case of a fault in the instrument. Used with wiring terminals to indicate the terminal which 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 a fault in the instrument. 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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1

General Information

Introduction

The purpose of this manual is to enable you to use your 16314A, 16315A, 16316A and 16317A efficiently and confidently. This manual contains both general and specific information. To find specific information without reading the entire manual, see the "Using the 16314A/5A/6A/7A" paragraph.

Using the 16314A/5A/6A/7A

The 16314A/5A/6A/7A has been designed to operate with Agilent Technologies 4-terminal-pair impedance analyzers or network analyzers.

- To install the 16314A/5A/6A/7A, see Chapter 2.
- To operate the 16314A/5A/6A/7A, see Chapter 3 and Chapter 4.
- To order replaceable parts for the 16314A/5A/6A/7A, see Chapter 5.

Product Description

The 16314A has been designed to operate with impedance analyzers. The 16315A, 16316A and 16317A have been designed to operate with network analyzers. All are used to measure a balanced device using an unbalanced measurement instrument. Each product has the following features:

16314A :

- Unbalanced 4-terminal-pair to balanced binding posts configuration.
- 100 Hz to 10 MHz Frequency Coverage.
- 50Ω load resistor and shorting plate furnished.

16315A, 16316A and 16317A :

- Unbalanced BNC to balanced binding posts configuration.
- Various characteristic impedances (50Ω for the 16315A, 100Ω for the 16316A, 600Ω for the 16317A).
- 100 Hz to 10 MHz Frequency Coverage for the 16345A/6A and 100 Hz to 3 MHz Frequency Coverage for the 16317A
- Load resistor and shorting plate furnished.

Accessories Supplied

The accessories listed in Table 1-1 through Table 1-4 are supplied with each product:

Table 1-1. The 16314A Furnished Accessories

Description	Part Number	Quantity
50Ω Load Resistor	P/N 16315-60002	1
Shorting Plate	P/N 16315-60003	1
Operation and Service Manual	P/N 16315-90001	1

Table 1-2. The 16315A Furnished Accessories

Description	Part Number	Quantity
50Ω Load Resistor	P/N 16315-60002	1
Shorting Plate	P/N 16315-60003	1
Operation and Service Manual	P/N 16315-90001	1

Table 1-3. The 16316A Furnished Accessories

Description	Part Number	Quantity
100Ω Load Resistor	P/N 16316-60002	1
Shorting Plate	P/N 16315-60003	1
Operation and Service Manual	P/N 16315-90001	1

Table 1-4. The 16317A Furnished Accessories

Description	Part Number	Quantity
600Ω Load Resistor	P/N 16317-60002	1
Shorting Plate	P/N 16315-60003	1
Operation and Service Manual	P/N 16315-90001	1

Specifications

This section lists the complete 16314A/5A/6A/7A specifications. These specifications are the performance standards and limits against which the 16314A/5A/6A/7A is tested. When shipped from the factory, the 16314A/5A/6A/7A meets the following listed specifications:

Common Specifications for the 16314A/5A/6A/7A

Maximum AC Input Level ..... 0.5 V
Maximum DC Input Level ..... 0 V
Operating Temperature ..... 0 to 55 °C
Operating Humidity ..... ≤95% RH (at 40°C)
Non-operating Temperature ..... −40 to 70 °C
Non-operating Humidity ..... ≤90% RH (at 65°C)

Specifications for the 16314A

Terminal Configuration
  UNBAL(Unbalanced) side ..... 4 BNC Terminals (4-Terminal-Pair configuration)
  BAL(Balanced) side ..... 3 Binding Posts(2 signal and 1 ground terminals)
Nominal Characteristic Impedance
  UNBAL(Unbalanced) side 50Ω
  BAL(Balanced) side 50Ω
Terminal Spacing of BAL side ..... 14 mm (between 2 signal terminals)
Dimensions ..... 89 (W) × 56 (H) × 133 (D) [mm]
Weight ..... 400 g

Specifications for the 16315A

Terminal Configuration
  UNBAL(Unbalanced) side ..... 1 BNC Terminal
  BAL(Balanced) side ..... 3 Binding Posts(2 signal and 1 ground terminals)
Nominal Characteristic Impedance
  UNBAL(Unbalanced) side 50Ω
  BAL(Balanced) side 50Ω
Terminal Spacing of BAL side ..... 14 mm (between 2 signal terminals)
Dimensions ..... 89 (W) × 55 (H) × 121 (D) [mm]
Weight ..... 350 g

Specifications for the 16316A

Terminal Configuration
  UNBAL(Unbalanced) side ..... 1 BNC Terminal
  BAL(Balanced) side ..... 3 Binding Posts(2 signal and 1 ground terminals)
Nominal Characteristic Impedance
  UNBAL(Unbalanced) side 50Ω
  BAL(Balanced) side 100Ω
Terminal Spacing of BAL side ..... 14 mm (between 2 signal terminals)
Dimensions ..... 89 (W) × 55 (H) × 121 (D) [mm]
Weight ..... 350 g

Specifications for the 16317A

Terminal Configuration
- UNBAL(Unbalanced) side ..... 1 BNC Terminal
- BAL(Balanced) side ..... 3 Binding Posts(2 signal and 1 ground terminals)

Nominal Characteristic Impedance
- UNBAL(Unbalanced) side 50Ω
- BAL(Balanced) side 600Ω

Terminal Spacing of BAL side ..... 14 mm (between 2 signal terminals)
Dimensions ..... 89 (W) × 55 (H) × 121 (D) [mm]
Weight ..... 350 g

Typical Characteristics

This section lists typical characteristics. Typical characteristics are not specifications, but do provide additional information for the operator. Typical characteristics are not guaranteed.

Typical Characteristics for the 16314A

Frequency Range ..... 100 Hz to 10 MHz
Insertion Loss (at 23±5°C,100kHz) ..... ≤1.0 dB
Frequency Response (at 23±5°C,100kHz) ..... ≤±1.0 dB
Return Loss (at 23±5°C)
- 100 Hz ≤ Freq. < 300 Hz ..... ≥10 dB
- 300 Hz ≤ Freq. ≤ 7 MHz ..... ≥20 dB
- 7 MHz < Freq. ≤ 10 MHz ..... ≥17 dB

Common Mode Loss (at 23±5°C)
- 100 Hz ≤ Freq. ≤ 3 MHz ..... ≥50 dB
- 3 MHz < Freq. ≤ 5 MHz ..... ≥45 dB
- 5 MHz < Freq. ≤ 10 MHz ..... ≥40 dB

Typical Characteristics for the 16315A

Frequency Range ..... 100 Hz to 10 MHz
Insertion Loss (at 23±5°C,100kHz) ..... ≤1.0 dB
Frequency Response (at 23±5°C,100kHz) ..... ≤±1.0 dB
Return Loss (at 23±5°C)
- 100 Hz ≤ Freq. < 300 Hz ..... ≥10 dB
- 300 Hz ≤ Freq. ≤ 7 MHz ..... ≥20 dB
- 7 MHz < Freq. ≤ 10 MHz ..... ≥17 dB

Common Mode Loss (at 23±5°C)
- 100 Hz ≤ Freq. ≤ 3 MHz ..... ≥50 dB
- 3 MHz < Freq. ≤ 5 MHz ..... ≥45 dB
- 5 MHz < Freq. ≤ 10 MHz ..... ≥40 dB

Typical Characteristics for the 16316A

Frequency Range ..... 100 Hz to 10 MHz
Insertion Loss (at 23±5°C,100kHz) ..... ≤1.0 dB
Frequency Response (at 23±5°C,100kHz) ..... ≤±1.0 dB
Return Loss (at 23±5°C)
  100 Hz ≤ Freq. < 300 Hz ..... ≥10 dB
  300 Hz ≤ Freq. ≤ 7 MHz ..... ≥20 dB
  7 MHz < Freq. ≤ 10 MHz ..... ≥17 dB
Common Mode Loss (at 23±5°C)
  100 Hz ≤ Freq. ≤ 3 MHz ..... ≥50 dB
  3 MHz < Freq. ≤ 5 MHz ..... ≥45 dB
  5 MHz < Freq. ≤ 10 MHz ..... ≥40 dB

Typical Characteristics for the 16317A

Frequency Range ..... 100 Hz to 3 MHz
Insertion Loss (at 23±5°C, 100 kHz) ..... ≤1.0 dB
Frequency Response (at 23±5°C, 100 kHz) ..... ≤±1.5 dB
Return Loss (at 23±5°C)
  100 Hz ≤ Freq. < 300 Hz ..... ≥10 dB
  300 Hz ≤ Freq. ≤ 1 MHz ..... ≥20 dB
  1 MHz < Freq. ≤ 3 MHz ..... ≥15 dB
Common Mode Loss (at 23±5°C)
  100 Hz ≤ Freq. ≤ 1 MHz ..... ≥50 dB
  1 MHz < Freq. ≤ 3 MHz ..... ≥45 dB

Typical Characteristics for 50Ω/100Ω/600Ω Load Resistors

DC R ..... ±0.1 %
Parallel Capacitance ..... ≤3 pF
Series Inductance ..... ≤200 nH

Additional Impedance Measurement Error (Typical Data) When Using the 16314A

Figure 1-1 shows the additional impedance measurement error of the 16314A. The actual measurement accuracy can be approximately calculated by adding the 16314A's additional impedance measurement error to the impedance analyzer's measurement accuracy.

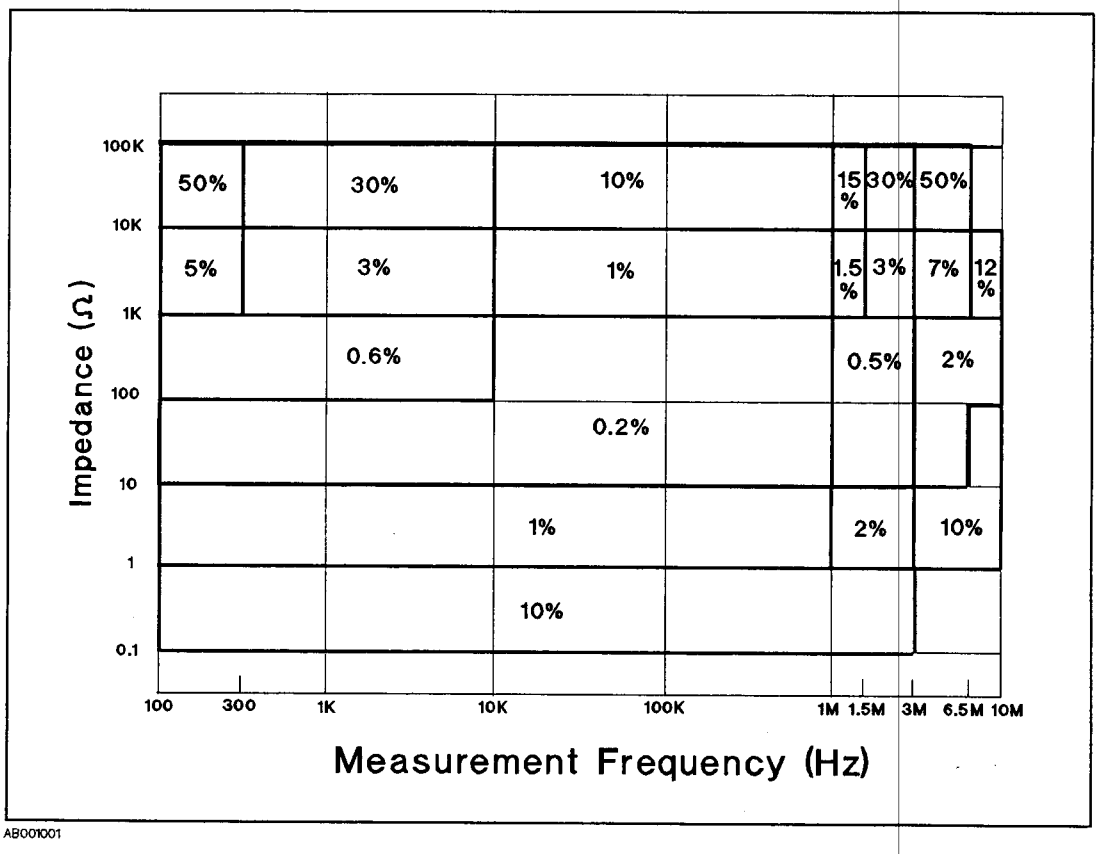

Figure 1-1. 16314A Additional Impedance Measurement Error (Typical Data)

This measurement error is obtained under the following conditions:

1. Measurement Instruments : 4194A and 16314A
2. Compensation : 0Ω/0S/50Ω correction at the BAL terminal of the 16314A.
3. DUT : Fixed resistor
4. The neutral point of converter (16314A) is not grounded.
5. 4194A's setting :
   a. Integ Time MED
   b. Averaging 4
   c. Osc Level 0.5 V
6. Temperature : 23±5°C

Note The DUT's unbalanced factor influences the impedance measurement accuracy.

2

Preparation for Use

Introduction

This chapter explains how to install the 16314A/5A/6A/7A. The topics covered include initial inspection, ambient environmental considerations, connecting the converter for use, and packaging the converter for shipping.

Initial Inspection

The 16314A/5A/6A/7A has been carefully inspected electrically and mechanically before being shipped from the factory. It should be in perfect physical condition, no scratches, dents or the like, and it should be in perfect electrical condition. Verify this by carefully performing an incoming inspection to check the converter 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.

1. Inspect the shipping container for damage. Keep the shipping materials until the incoming inspection is completed.
2. Verify that the shipping container contains everything shown in Figure 2-1 and listed in Table 2-1 through Table 2-4.
3. Inspect the exterior of the 16314A/5A/6A/7A for any signs of damage.

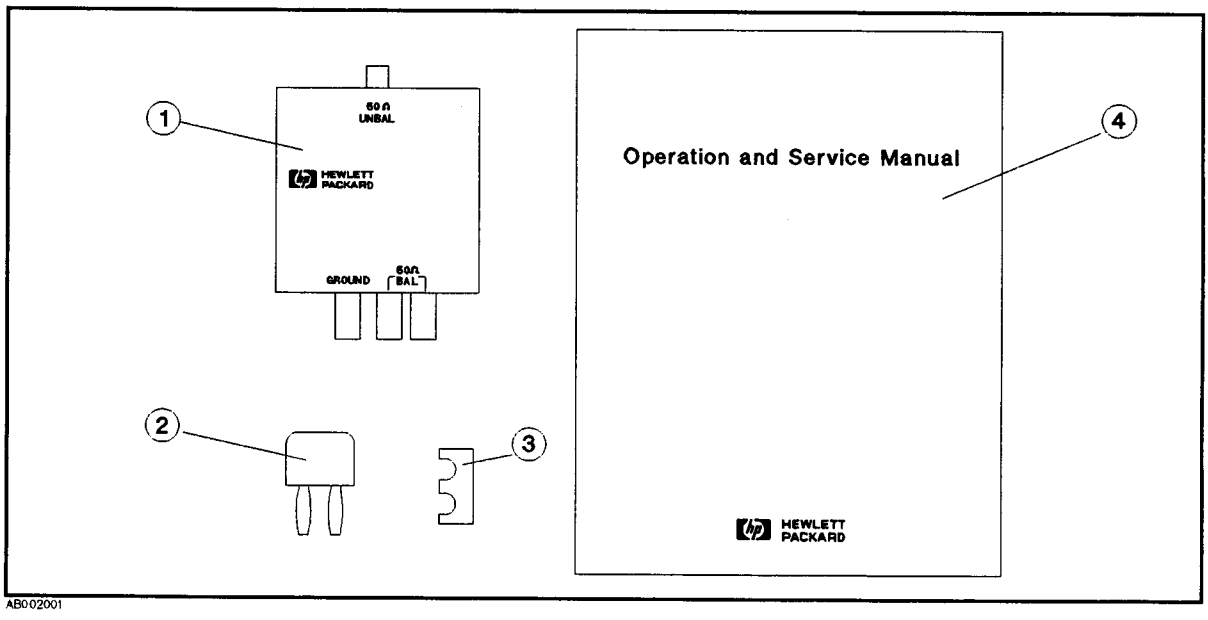

Figure 2-1. Product Overview

Table 2-1. 16314A Contents

Description	Agilent Part Number	Qty.
① Balanced/Unbalanced 4-Terminal Converter	16314-60001	1
② 50Ω Load Resistor	16315-60002	1
③ Shorting Plate	16315-60003	1
④ Operation and Service Manual	16315-90001	1

Table 2-2. 16315A Contents

Description	Agilent Part Number	Qty.
① 50Ω Balanced/50Ω Unbalanced Converter	16315-60001	1
② 50Ω Load Resistor	16315-60002	1
③ Shorting Plate	16315-60003	1
④ Operation and Service Manual	16315-90001	1

Table 2-3. 16316A Contents

Description	Agilent Part Number	Qty.
① 100Ω Balanced/50Ω Unbalanced Converter	16316-60001	1
② 100Ω Load Resistor	16316-60002	1
③ Shorting Plate	16315-60003	1
④ Operation and Service Manual	16315-90001	1

Table 2-4. 16317A Contents

Description	Agilent Part Number	Qty.
① 600Ω Balanced/50Ω Unbalanced Converter	16317-60001	1
② 600Ω Load Resistor	16317-60002	1
③ Shorting Plate	16315-60003	1
④ Operation and Service Manual	16315-90001	1

Environmental Considerations

The 16314A/5A/6A/7A must be operated within an ambient temperature range of 0°C to 55°C and relative humidity up to 95% RH at 40°C (non-condensing).

The 16314A/5A/6A/7A may be stored within a temperature range of −40°C to +70°, and at a relative humidity up to 90% RH at +65°C (non-condensing).

Note If the converters are used in a strong magnetic field environment, the noise level will get worse.

Recommended Measurement Instruments

The recommended measurement instruments to be used with the 16314A/5A/6A/7A are listed below. For detailed information, refer to the technical data sheet of each instrument.

Recommended Measurement Instruments for the 16314A:

4194A	Impedance/Gain-phase Analyzer
4284A	Precision LCR Meter
4285A	Precision LCR Meter

Recommended Measurement Instruments for the 16315A/6A/7A:

8751A	Network Analyzer
4195A	Network/Spectrum Analyzer
4396A	Network/Spectrum Analyzer

3

Operation for 16314A

Introduction

This chapter describes the features, measurement setups, and measurement considerations for the 16314A.

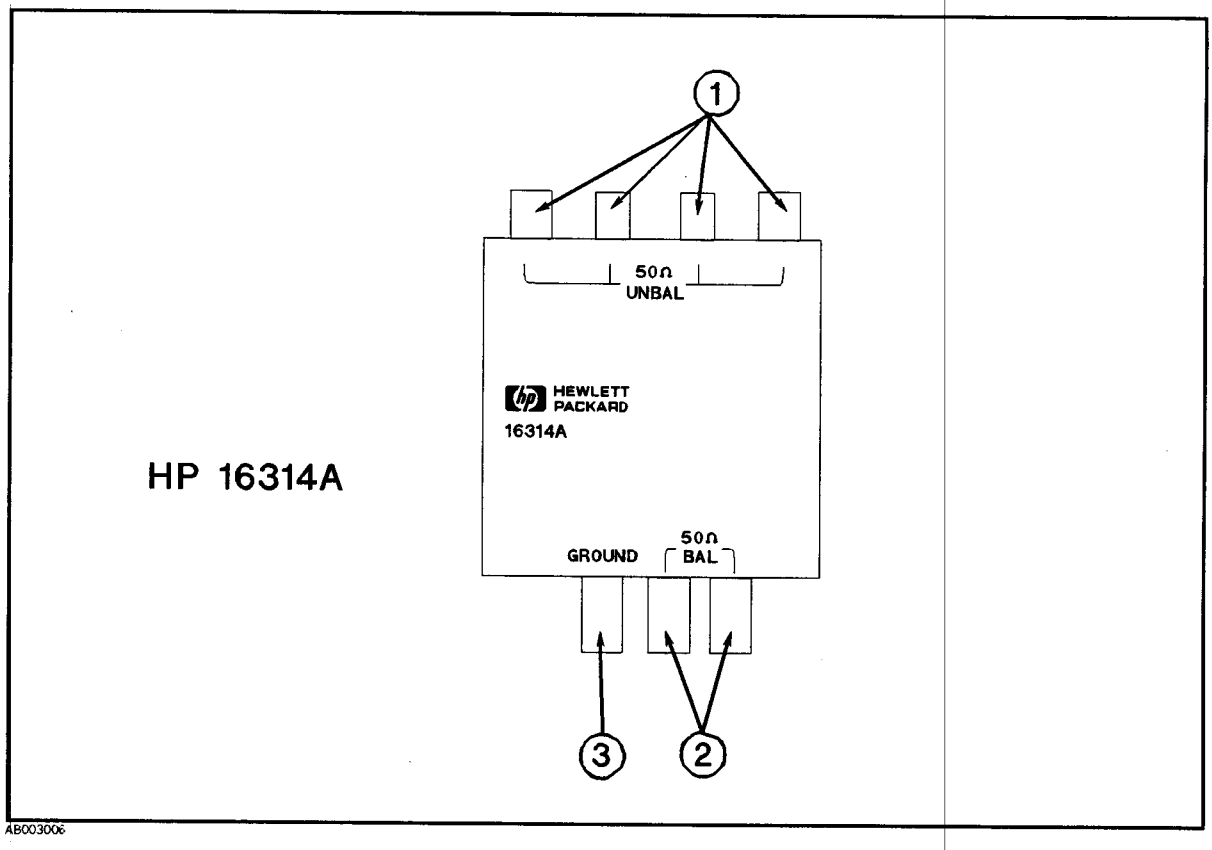

Figure 3-1. External Appearance

- ① *50Ω UNBAL Terminals(4 BNC Terminals).* The unbalanced signal is supplied to these connectors from an impedance analyzer that has a 4-terminal pair configuration.
- ② *50Ω BAL Terminals.* These terminals supply the converted balanced signal to the DUT.
- ③ *GROUND Terminal.*

Connecting the 16314A to an Impedance Analyzer

Caution Before connecting the 16314A to a 4-terminal impedance analyzer, set the analyzer's AC signal output level to equal or less than 0.5 V and set DC level to 0 V to protect the 16314A.

Connect the 16314A to the analyzer, as shown in Figure 3-2.

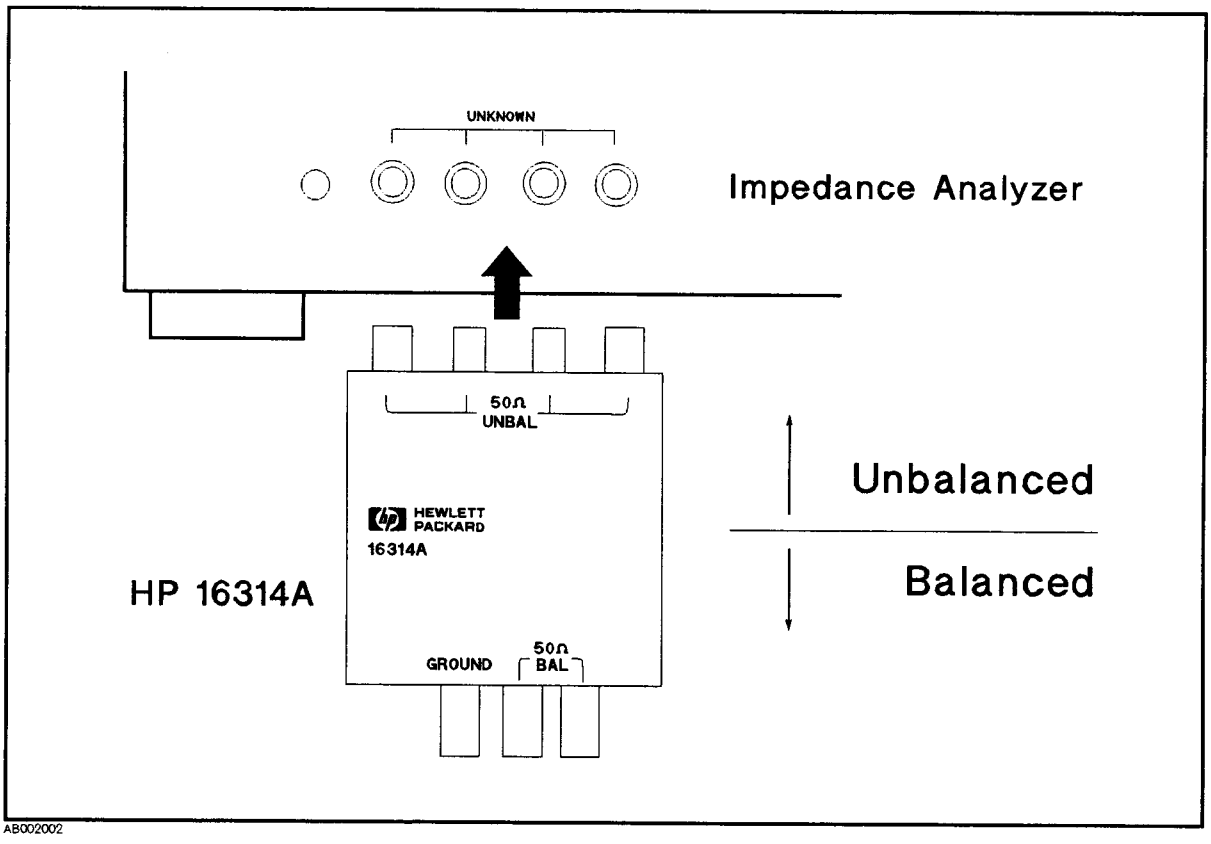

Figure 3-2. Connecting the 16314A to an Impedance Analyzer

Error Correction

For an accurate measurement, an error correction must be done before the actual measurement. The 4194A, 4284A, and 4285A, use the 0S/0Ω/50Ω calibration (OPEN/SHORT/LOAD Correction) function to compensate for residual impedance.

0S/0Ω/50Ω Calibration using the 4194A

The following procedure is an example of 0S/0Ω/50Ω Calibration using the 4194A.

1. Connect the 16314A to the 4194A (see Figure 3-3).
2. Do not connect anything to the 16314A (OPEN).
3. Press (COMPEN), `more 1/3`, `more 2/3`, `0S CAL` and (ENTER).
4. Connect the Shorting Plate to the 16314A (SHORT).
5. Press `0Ω CAL` and (ENTER).
6. Connect the 50Ω Load Resistor to the 16314A(LOAD).
7. Press `STD CAL` and (ENTER).
8. Press `CAL on/off` to enable the compensation.
9. Connect the DUT to the 16314A and measure it.

See the *4194A Operation Manual* for more information.

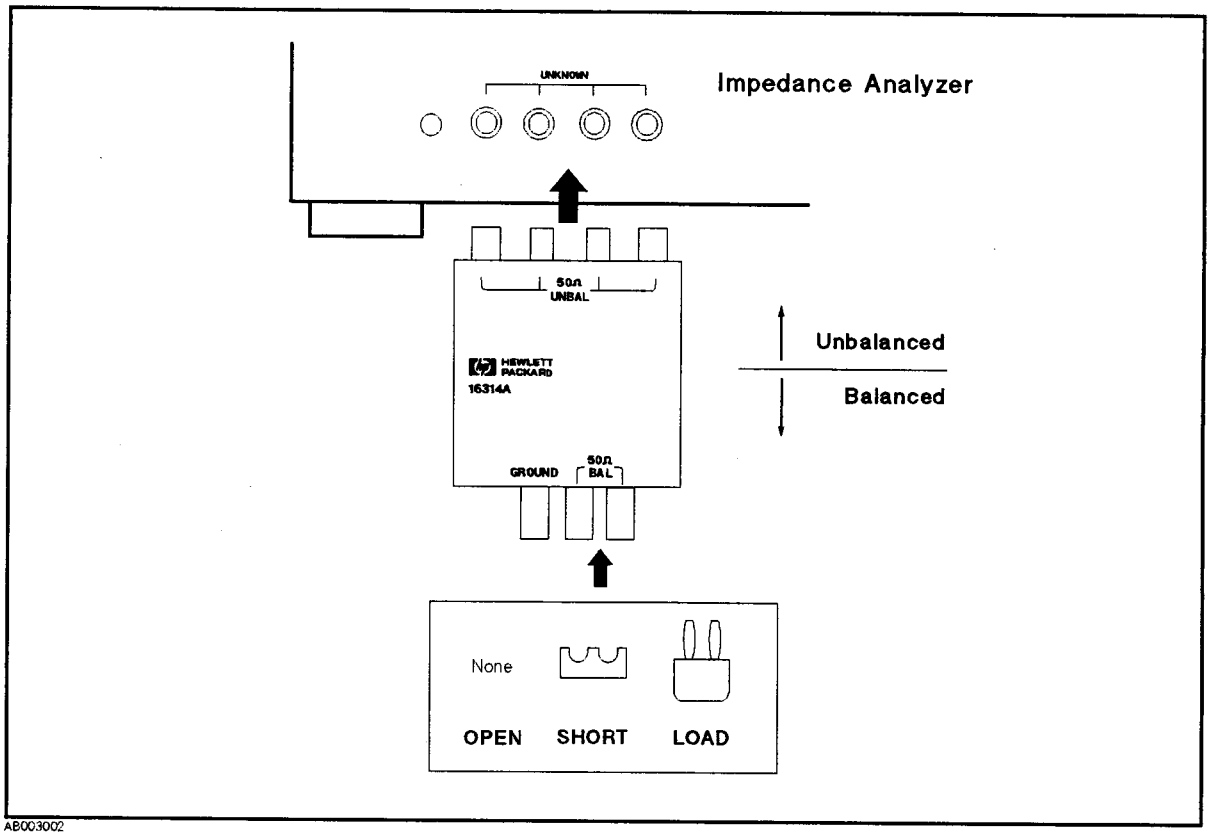

Figure 3-3. 0S/0Ω/50Ω Calibration Using the 4194A

Impedance Measurement Example

The following procedure is example of the characteristic impedance measurement using the 16314A.

Characteristic Impedance Measurement (OPEN/SHORT method)

Perform the following steps to measure the characteristic impedance:

1. Connect the equipment as shown in "Connecting the 16314A to an Impedance Analyzer". Perform the 0S/0Ω/50Ω calibration (see "Error Correction").
2. Connect the DUT to the balanced terminals of the 16314A.

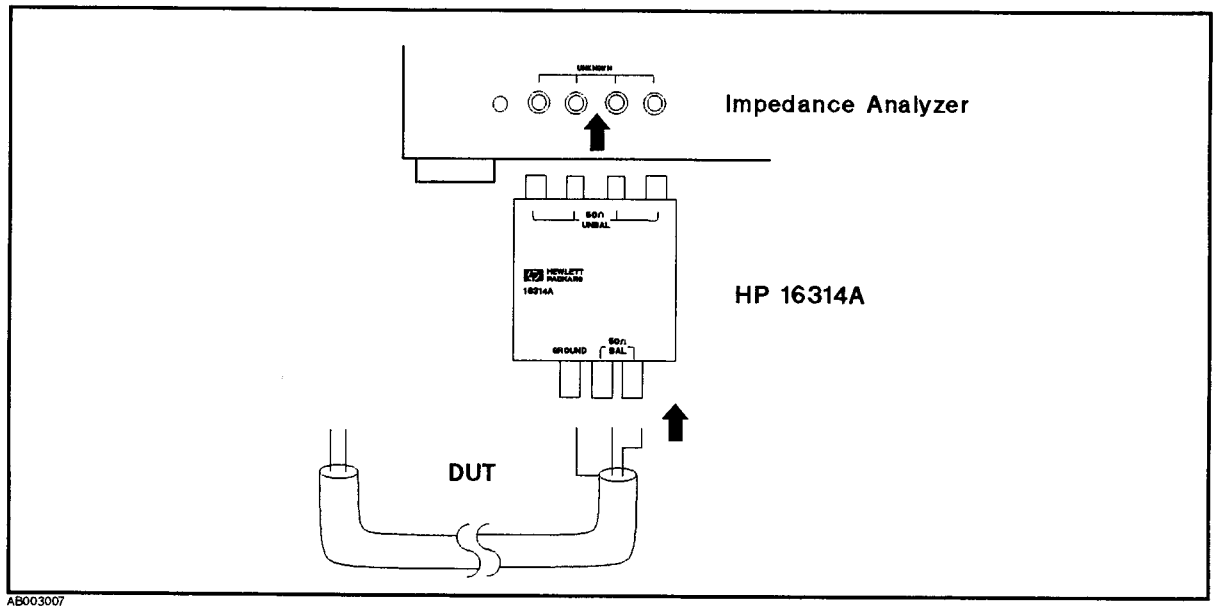

Figure 3-4. Characteristic Impedance Measurement of Balanced Cable

3. Measure the OPEN impedance (Zop) by opening the end of the cable.

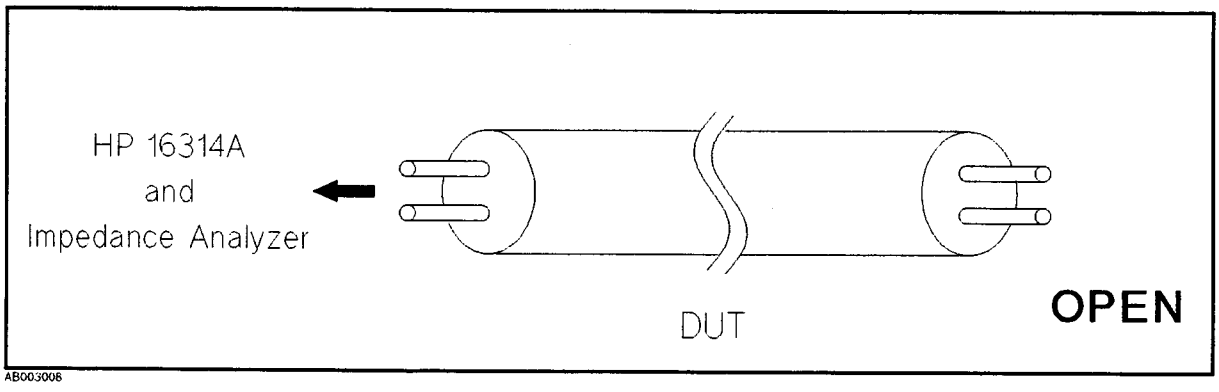

Figure 3-5. Measuring OPEN Impedance

4. Measure the SHORT impedance (Zst) by shorting the end of the cable.

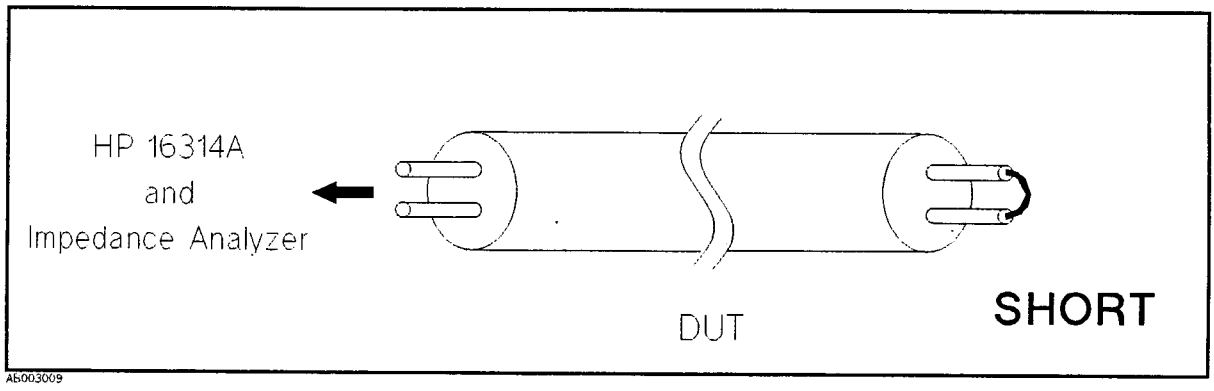

Figure 3-6. Measuring SHORT Impedance

5. Calculate the characteristic impedance using the following equations.

   Characteristic Impedance:

$$|Z| = \sqrt{|Z_{op}||Z_{st}|}$$

$$\theta = (\theta_{op} + \theta_{st})/2$$

   where

   Z_{op}, θ_{op} : *Measured values from the OPEN measurement*

   Z_{st}, θ_{st} : *Measured values from the SHORT measurement*

6. Calculate the attenuation constant and phase constant using the following equations.

   Attenuation Constant [dB/km] :

$$\alpha = \frac{8685.9}{2l} \log \sqrt{\frac{(1+R)^2 + X^2}{(1-R)^2 + X^2}}$$

   Phase Constant [rad/km] :

$$\beta = \frac{1000}{2l}\left(\pi - \arctan\frac{R+1}{X} + \arctan\frac{R-1}{X}\right)$$

   where

$$P = \sqrt{|Z_{st}|/|Z_{op}|}$$

$$\phi = (\theta_{st} - \theta_{op})/2$$

$$R = P\cos\phi$$

$$X = P\sin\phi$$

l : *Cable Length* [m]

When calculating these parameters, the 4194A use the Auto Sequence Program (ASP) function. The following is an ASP programming example:

```
10  ! ##### BALANCED CABLE MEASUREMENT #####
20  ! RST
```

```
 30  SWT2;CMPN2;ITM2;IMP1;RAD
 40  START=100 HZ
 50  STOP=10 MHZ
 60  RO=401
 70  NOP=RO      ! NO. OF POINT
 80  BEEP
 90  DISP "INPUT CABLE LENGTH (m)"
100  PAUSE
110  R1=Z        ! CABLE LENGTH
120  BEEP
130  Z=0
140  DISP "NEED COMPENSATION ? Y-->1"
150  PAUSE
160  IF Z=0 THEN GOTO 300
170  ! ##### CALIBRATION #####
180  BEEP
190  DISP "CONNECT OPEN"
200  PAUSE
210  CALY
220  BEEP
230  DISP "CONNECT SHORTING PLATE"
240  PAUSE
250  CALZ
260  BEEP
270  DISP "CONNECT LOAD RESISTOR"
280  PAUSE
290  CALSTD
300  !##### CABLE MEASUREMENT #####
310  CAL1
320  IMP1
330  BEEP
340  DISP "CABLE OPEN MEAS"
350  PAUSE
360  SWTRG
370  AUTOA;RE=A;RF=B
380  BEEP
390  DISP "CABLE SHORT MEAS"
400  PAUSE
410  SWTRG
420  AUTOA;RG=A;RH=B
430  DISP ""
440  !##### CHARACTERISTIC IMPEDANCE #####
450  RA=SQR(RE*RG);RB=(RF+RH)*180/PI/2
460  CMT"CHARACTERISTIC IMPEDANCE OF CABLE"
470  DEG;A=RA;B=RB;AUTOA;BMAX=180;BMIN=-180
480  BEEP
490  DISP "PRESS CONT"
500  PAUSE
510  !##### ATT./PHASE CONSTANTS #####
520  CMT"ATTENUATION / PHASE CONSTANT"
530  DISP "CALCULATING"
540  RAD
550  C=SQR(RG/RE);D=(RH-RF)/2
560  E=C*COS(D);F=C*SIN(D)
570  G=((1+E)*(1+E)+F*F)/((1-E)*(1-E)+F*F)
```

```
580  RC=1/2/R1*LN(SQR(G))*8685.9
590  RD=1/2/R1*(PI-ATAN((E+1)/F)+ATAN((E-1)/F))*1000
600  !## PHASE EXPANSION FOR PHASE CONST. ##
610  R22=0;RI=RD
620  FOR R3=2 TO R0
630  R2=R3-1;R11=RI(R2)-RI(R3)
640  IF R11>2*PI THEN R22=R22+R11
650  RI(R2)=RI(R3)+R22
660  NEXT R3
670  RI(R0)=RI(R0)+R22
680  BEEP
690  A=RC;B=RI;AUTO;UNITO
700  DISP "A=DB/KM  B=RAD/KM"
710  END
```

4

Operation for 16315A/6A/7A

Introduction

This chapter describes the features, measurement setups, and measurement considerations for the 16315A/6A/7A.

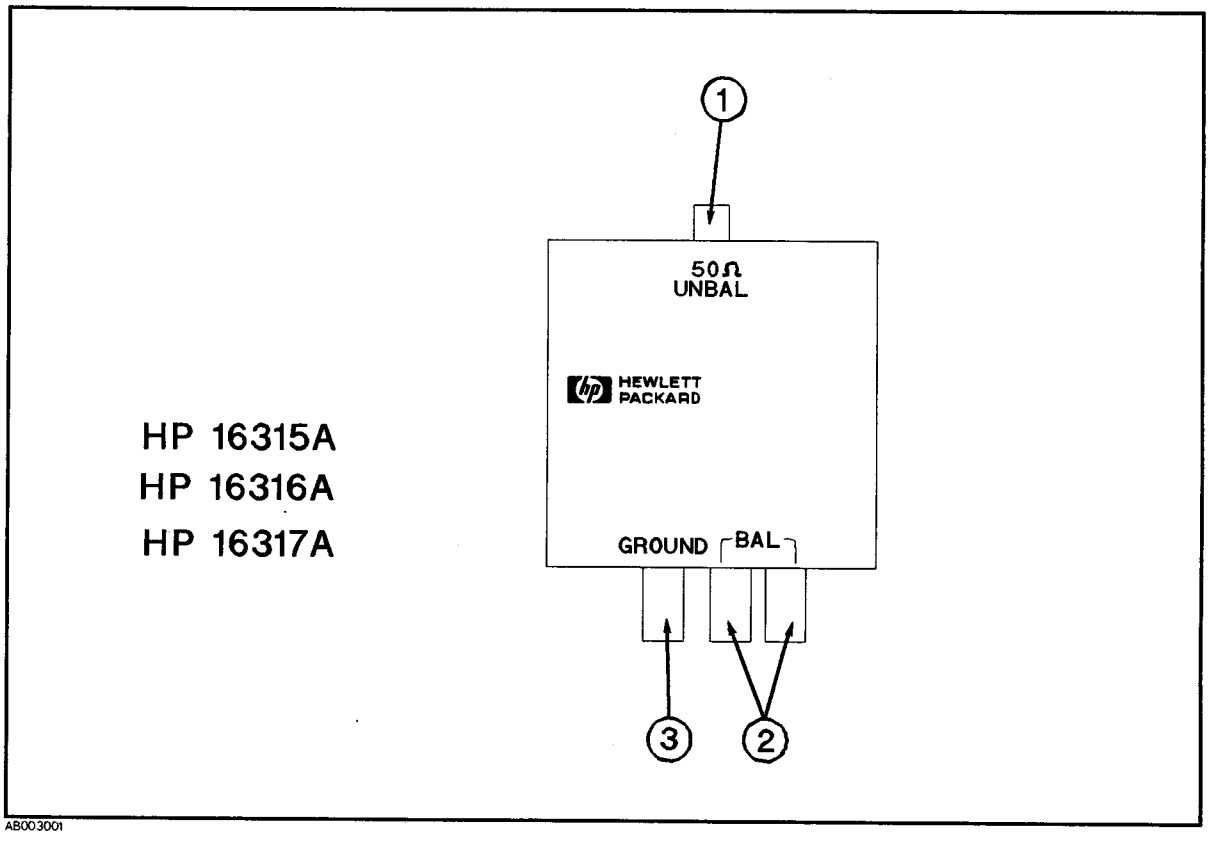

Figure 4-1. External Appearance

- ① *50Ω UNBAL Terminals(BNC Terminal).* The unbalanced signal is supplied to this connector from a network analyzer.
- ② *50Ω/100Ω/600Ω BAL Terminals.* These terminals supply the converted balanced signals to the DUT.
- ③ *GROUND Terminal.*

Connecting the 16315A/6A/7A to Network Analyzer

Caution Before connecting the 16315A/6A/7A to a network analyzer, set the analyzer's AC signal output level to equal or less than 0.5 V and set DC level to 0 V to protect the 16315A/6A/7A.

Figure 4-2 and Figure 4-3 show how to connect the 16315A/6A/7A to a network analyzer using an S-parameter test set or a T/R test kit. Shown below are two examples using the 8751A.

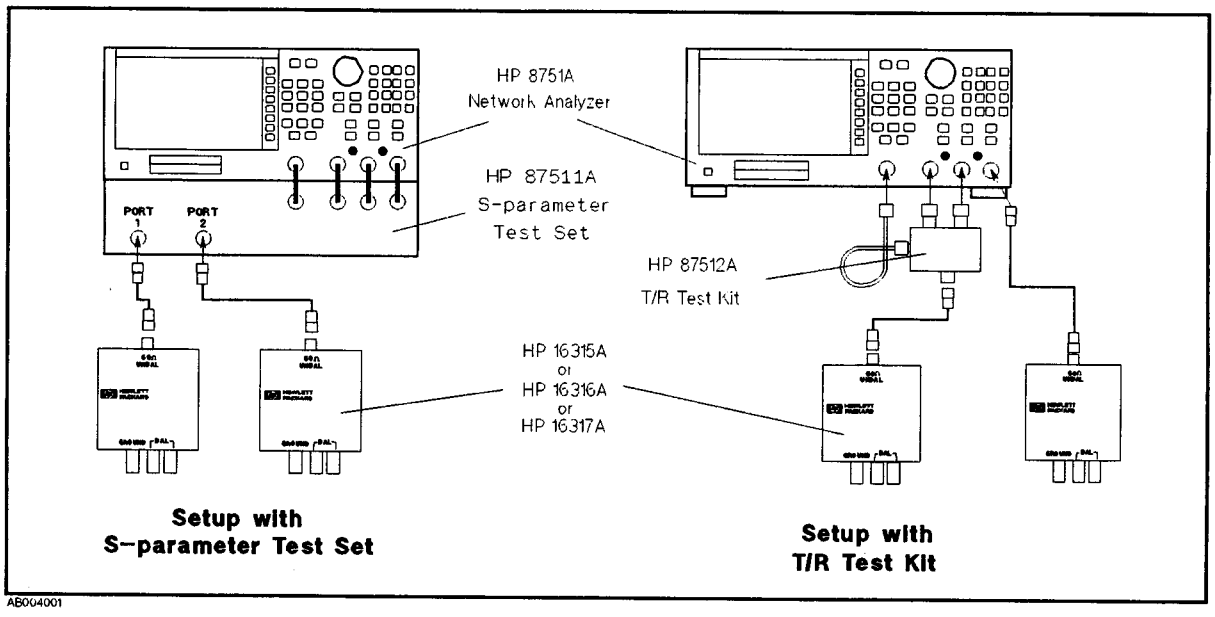

Figure 4-2. Connecting Converters for Transmission Measurement

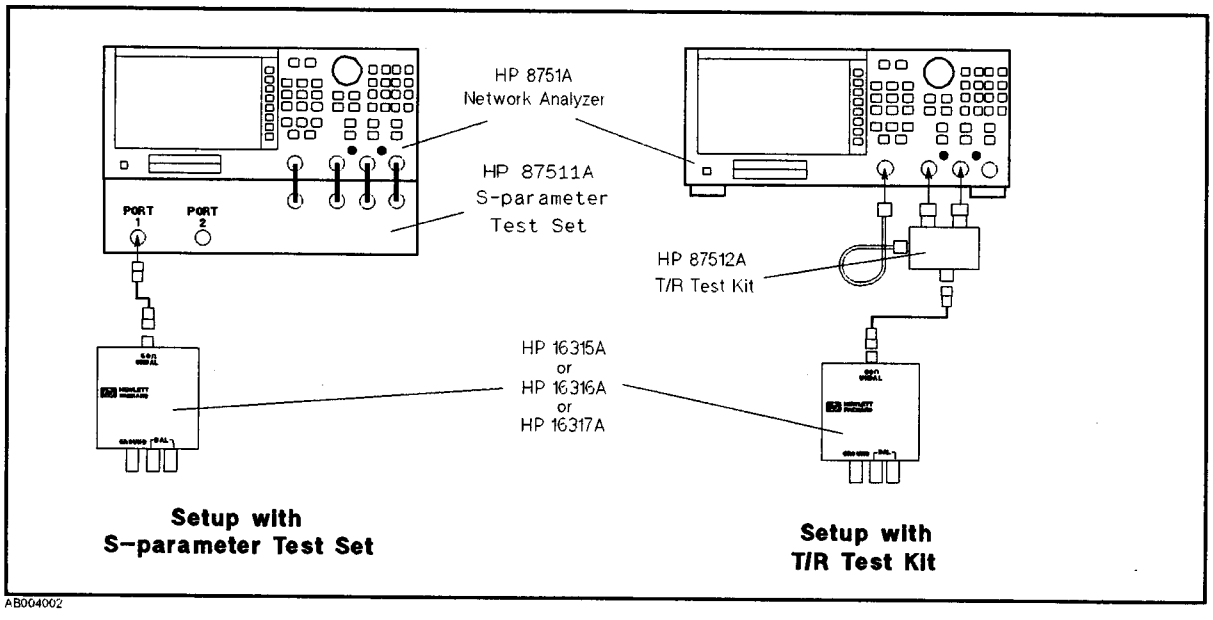

Figure 4-3. Connecting Converters for Reflection Measurement

Error Correction

For an accurate measurement, an error correction must be done before the actual measurement. Perform the transmission or reflection calibration for the network measurement using the 16315A/6A/7A. The following examples are described:

- How to modify the Calibration Standard Value.
- Calibration for Transmission Measurement:
  - RESPONSE&ISOL'N calibration using the 8751A.
  - NORM&ISN calibration using the 4195A.
- Calibration for Reflection Measurement:
  - ONE PORT FULL calibration using the 8751A.
  - ONE PORT FULL calibration using the 4195A.
- Calibration for both Transmission and Reflection Measurement.

Modifying Calibration Kits

To perform a calibration of the 16315A/6A/7A for a network measurement, the calibration standard value of the network analyzer should be modified so that the standard value matches the 16315A/6A/7A, shorting plate and load resistor.

Example using the 8751A

Set the Standard Definitions and the Standard Class Assignments using the following procedures:

1. On the 8751A front panel, press (CAL), `CAL KIT`, `MODIFY` and `DEFINE STANDARD` to open the Define Standard menu.
2. The Define Standard for the 16315A/6A/7A is shown in Table 4-1. Modify the values. For example, the procedure to modify the OPEN C0 is as follows:
   a. Press `STD NO.2`, `STD TYPE:OPEN` and `C0`.
   b. Enter 330 and press `STD DONE`.

Note

The arbitrary impedance should be match the converter's characteristic impedance value (50 Ω for the 16315A, 100 Ω for the 16316A, 600 Ω for the 16317A).

3. The Standard Class Assignments for the 16315A/6A/7A is shown in Table 4-2. Modify the values. For example, the procedure to modify S11A is as follows:
   a. Press `SPECIFY CLASS` and `S11A`.
   b. Enter 2 and press `CLASS DONE`.
4. Press `LABEL KIT`, enter the label name and press `DONE`.
5. Press `KIT DONE`.
6. Press `CAL KIT`, `SAVE USER KIT` and `USER KIT` to select the user kit as standards.

The lists of Standard Definition and Standard Class Assignments can be displayed by using the (COPY) function of the 8751A. For more information, see the *8751A Operation Manual.*

Table 4-1. STANDARD DEFINITIONS

STANDARD		C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz	Termianl Impedance	OFFSET			STANDARD LABEL
NO.	TYPE					DELAY ps	LOSS MΩ/s	Z_0 Ω	
1	SHORT					0	*[1]	*[1]	SHORT
2	OPEN	330	0	0		0	*[1]	*[1]	OPEN
3	Arbitary Impedance				50[2]	0	*[1]	*[1]	BROADBAND
4	DELAY THRU					0	*[1]	*[1]	THRU
5									
6									
7									
8									

1 Don't care the value, because the delay is 0.

2 50 for the 16315A, 100 for the 16316A, 600 for the 16317A

Table 4-2. STANDARD CLASS ASSIGNMENTS

	A	B	C	D	E	F	G	STANDARD CLASS LABEL
S_{11} A	2							OPEN
S_{11} B	1							SHORT
S_{11} C	3							LOAD
S_{22} A	2							OPEN
S_{22} B	1							SHORT
S_{22} C	3							LOAD
Forward Transmission	4							THRU
Reverse Transmission	4							THRU
Forward Match	4							THRU
Reverse Match	4							THRU
Response	1	2	4					RESPONSE
Response& Isolation	1	2	4					RESPONSE& ISOL'N

Modify the characteristic impedance value depending on the converter to be used. This makes it possible to obtain the actual impedance value using a Smith Chart. The following procedure shows how to change the characteristic impedance:

1. Press (CAL), `more` and `SET Z0`.
2. Enter the characteristic impedance of the converter and press `RETURN`.

For more information, see the *8751A Operation Manual.*

Example using the 4195A

Modify the Calibration Standard Values using the following procedures. The values for the 16315A/6A/7A are listed in Table 4-3.

1. Press (CAL) and `more 1/2`.
2. Press `CAL STD modify`.
3. Press `OPEN CAL STD` and enter the OPEN value.
4. Press `SHORT CAL STD` and enter the SHORT value.
5. Press `LOAD CAL STD` and enter the LOAD value.
6. Press `return` to finish the modification.

For more information, see the *4195A Operation Manual.*

Table 4-3. Calibration Standard Values of the 16315A/6A/7A

OPEN :	0.00000 [S]	+ 330.000f [F]	
SHORT:	0.00000 [Ω]	+ 0.00000 [H]	
LOAD :	50.0000 [Ω]	+ 0.00000 [H]	(16315A)
	100.000 [Ω]	+ 0.00000 [H]	(16316A)
	600.000 [Ω]	+ 0.00000 [H]	(16317A)

Transmission Measurement Calibrations

Before doing a transmission measurement, a transmission calibration (THRU) should be performed to eliminate the residuals of the converters and cables. Shown below are examples using the 8751A and the 4195A.

RESPONSE&ISOL'N Calibration using the 8751A

1. Connect the converter to the 8751A (see Figure 4-2).
2. Press (CAL), `CALIBRATE MENU` and `RESPONSE&ISOL'N`.
3. Connect the converters' terminals directly to make a THRU connection. See Figure 4-4.

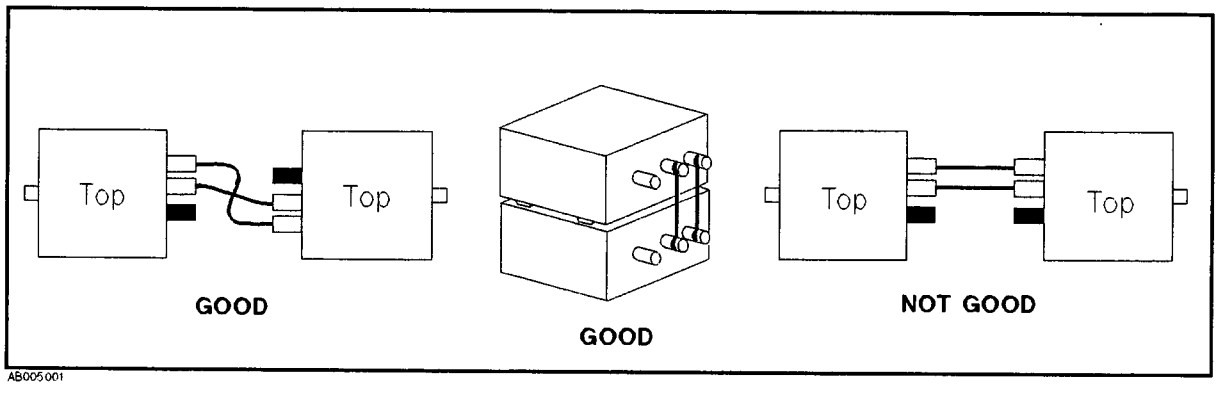

Figure 4-4. THRU Calibration Connection

Note

Be careful about the direction. The corresponding terminals of the converters must be connected each other.

To connect converters, use lead wires that have very little resistance. These wires should be as short as possible.

4. Press THRU to perform the THRU calibration.
5. Press DONE: RESPONSE when the sweep is completed.
6. Place the two converters in the positions that will be used in the actual measurement. Maintain the converters' distance while connecting the 50Ω/100Ω/600Ω load Resistors to each converter.
7. Press ISOL'N STD to perform the isolation calibration.
8. Press DONE RESP ISOL'N CAL when the sweep is completed.

See the *8751A Operation Manual* for more information.

NORM&ISOL Calibration using the 4195A

1. Connect the converter to the 4195A.
2. Press (CAL), TRANS CAL menu and NORM&ISN CAL .
3. Connect the corresponding terminals of the converters to make a THRU connection.
4. Press THRU and (ENTER). Wait until the sweep is completed.
5. Place the two converters in the positions that will be used in the actual measurement. Maintain the converters' distance while connecting the 50Ω/100Ω/600Ω load Resistors to each converter.
6. Press ISOLATN and (ENTER). Wait until the sweep is completed.
7. Press CORRECTN on OFF to enable the calibration.

See the *4195A Operation Manual* for more information.

Reflection Measurement Calibration

Before doing a reflection measurement, perform a reflection calibration to eliminate the residual elements of the converters and cables. Shown below is an example using the 8751A and the 4195A.

ONE PORT FULL Calibration Using the 8751A

1. Press (CAL), CALIBRATE MENU , S11 1-PORT .
2. Do not connect anything to the converter (OPEN).
3. Press (S11):OPENS , OPEN , and DONE:OPENS .
4. Connect the Shorting Plate (P/N 16315-60003) to the converter (SHORT).
5. Press (S11):SHORTS , SHORT and DONE:SHORTS .
6. Connect the 50Ω/100Ω/600Ω Load Resistor to the converter (LOAD).
7. Press LOAD and DONE:1-PORT CAL .

See the *8751A Operation Manual* for more information.

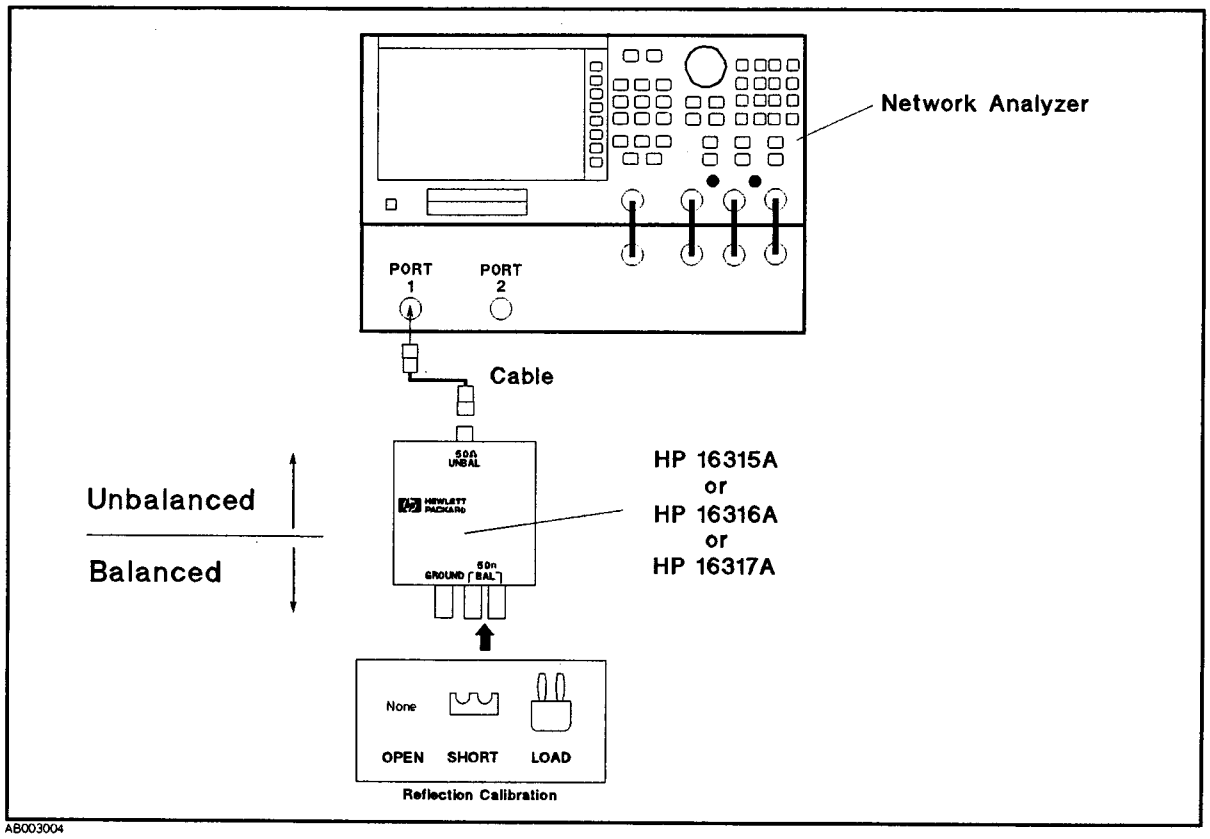

Figure 4-5. Reflection Calibration Using the 8751A

ONE PORT FULL Calibration using the 4195A

1. Press (CAL), `REFLECTN CAL menu` and `ONE PORT FULL CAL`.
2. Do not connect anything to the converter (OPEN).
3. Press `OPEN` and (ENTER).
4. Connect the Shorting Plate (P/N 16315-60003) to the converter (SHORT).
5. Press `SHORT` and (ENTER).
6. Connect the 50Ω/100Ω/600Ω Load Resistor to the converter (LOAD).
7. Press `LOAD` and (ENTER).
8. Press `CORRECTN on off` to enable the calibration.

See the *4195A Operation Manual* for more information.

Calibrations For Both Transmission and Reflection Measurement

Before doing both transmission and reflection measurement at the same time, perform the following calibrations. See the Operation Manual of each instrument for detailed procedures.

For 8751A :

- ONE-PATH 2-PORT calibration.
- FULL 2-PORT calibration.

Network Measurement Example

Examples of two kinds of network measurements using the 16315A/6A/7A are shown below. In these measurements, the 8751A is used as a network analyzer.

- Return Loss Measurement of Balanced Transformer.
- Crosstalk Measurement of Balanced Cable.

Return Loss Measurement of a Balanced Transformer

The return loss of a balanced transformer can be obtained by performing a reflection measurement. The procedure is as follows:

1. Connect the equipment as shown in "Connecting the 16315A/6A/7A to Network Analyzer". Perform the ONE-PORT FULL calibration (see "Error Correction").
2. Connect the DUT to the balanced terminals of the converter.

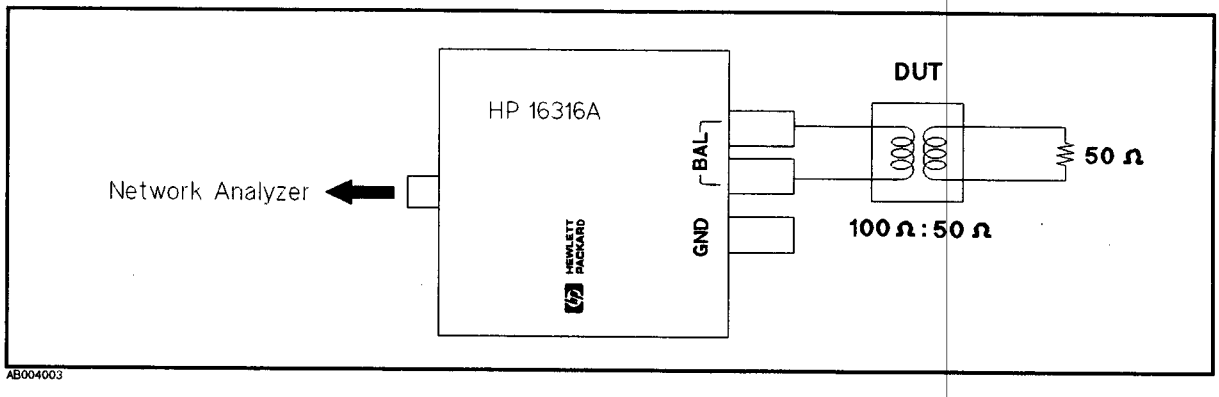

Figure 4-6. Return Loss Measurement Setup (Example)

3. Measure the magnitude and the phase on the network analyzer. Shown below is an example of a return loss measurement result.

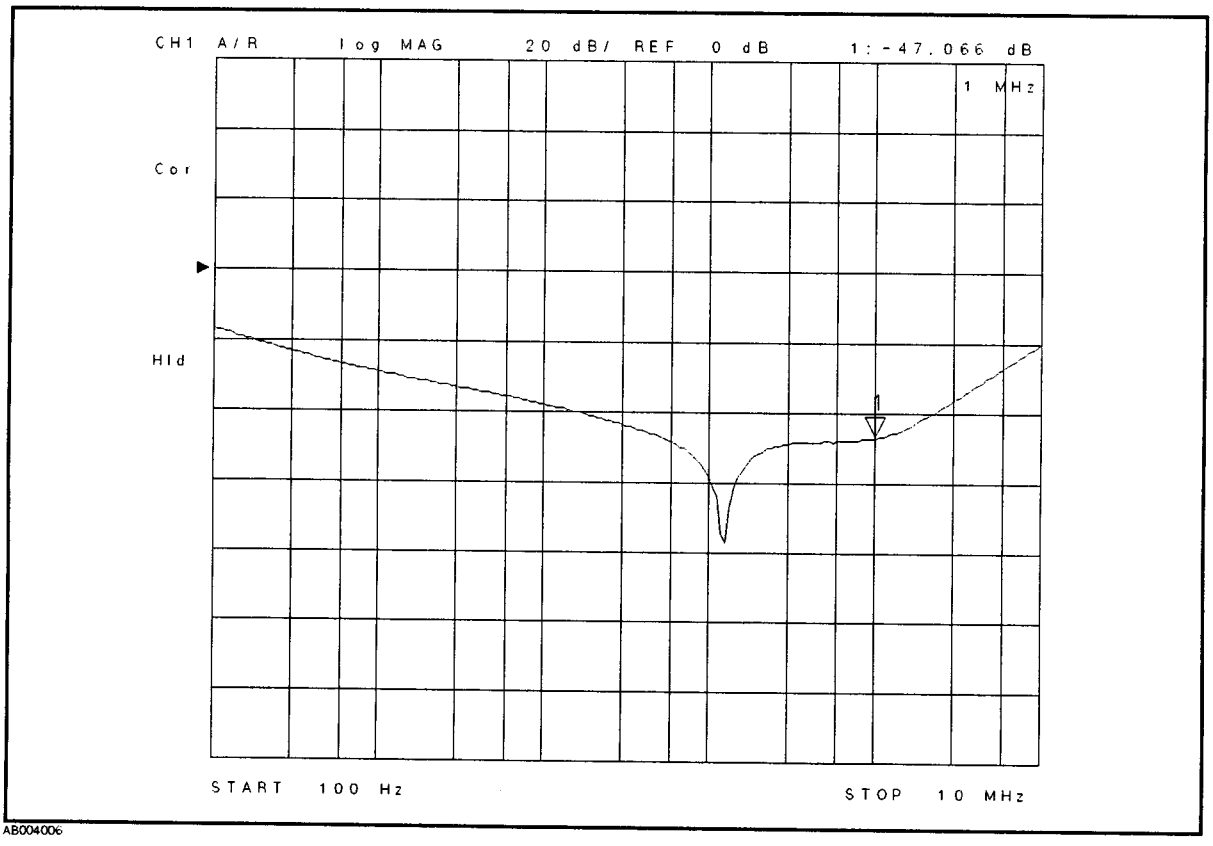

Figure 4-7. Return Loss Measurement Result (Example)

Crosstalk Measurement of a Balanced Cable

The crosstalk for the cable can be obtained by performing a transmission measurement. The procedure is as follows:

1. Connect the equipment as shown in "Connecting the 16315A/6A/7A to Network Analyzer". Perform the RESPONSE&ISOL'N calibration or the ONE-PATH 2 PORT calibration (see "Error Correction").
2. Connect the DUT to the balanced terminals of the converter.

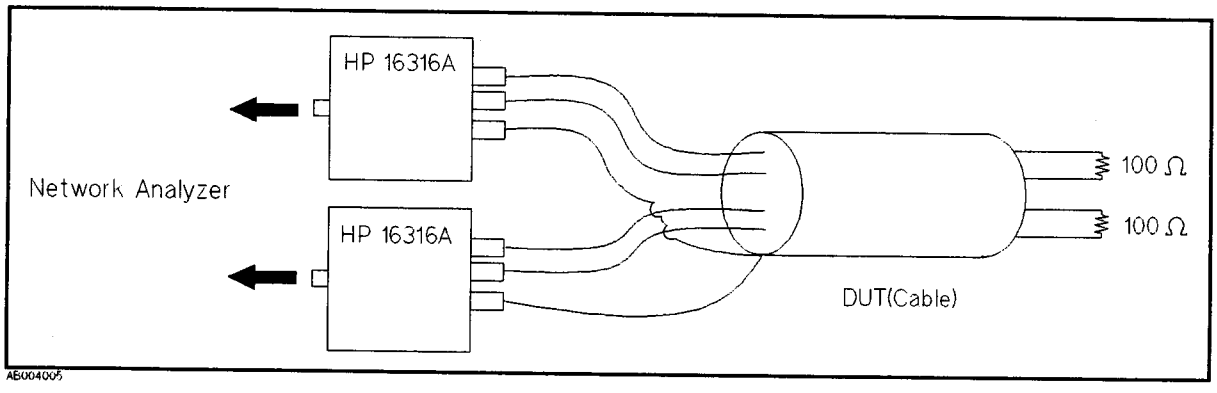

Figure 4-8. Crosstalk Measurement Setup (Example)

3. Measure the magnitude and the phase using the network analyzer. Shown below is an example of the near-end crosstalk measurement result.

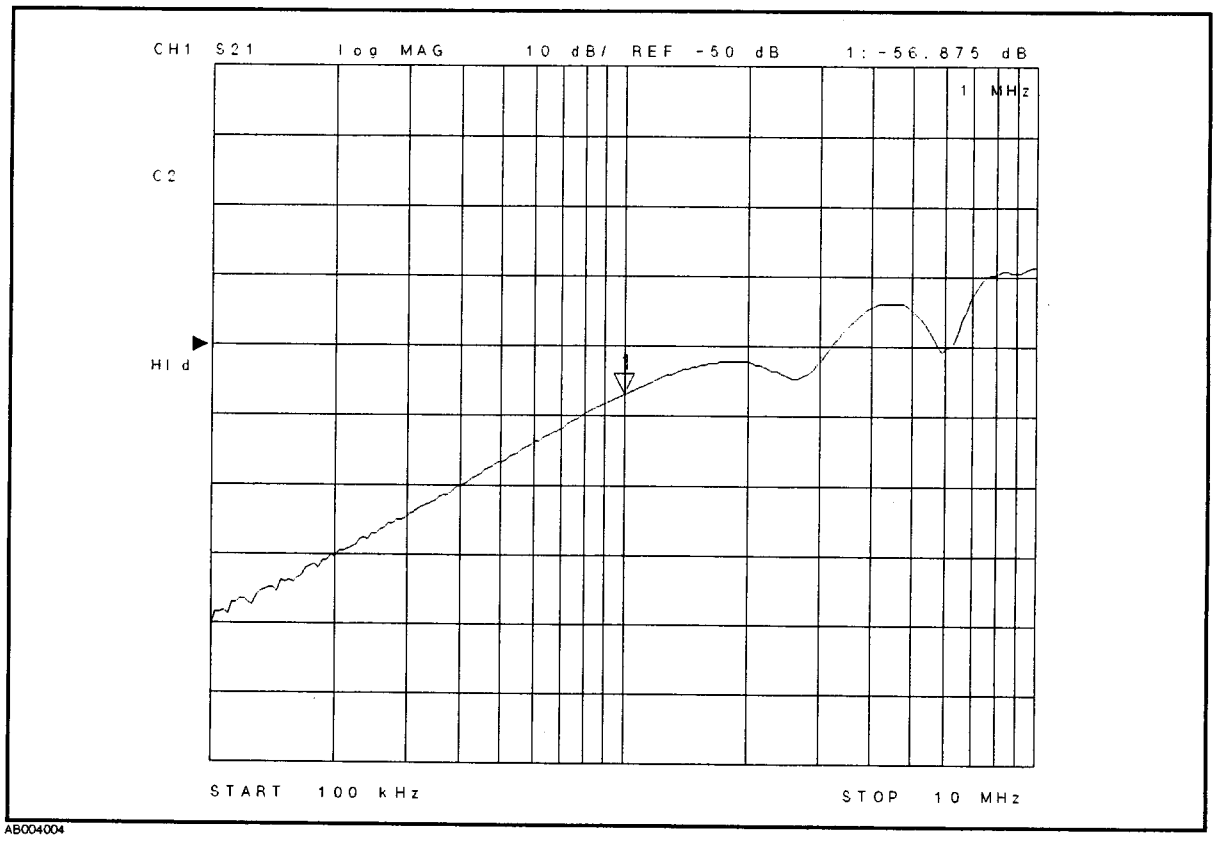

Figure 4-9. Crosstalk Measurement Result (Example)

5

Service

Introduction

This chapter covers the replaceable parts information and the schematic diagram of the 16314A/5A/6A/7A.

16314A Replaceable Parts

Table 5-1 lists the replaceable parts for the 16314A. The parts listed can be ordered from your nearest Agilent Technologies Office. Ordering information must include the Agilent part number and the quantity required.

Table 5-1. 16314A Replaceable Parts

Agilent Part Number	Qty.	Description
16314-60001	1	Balanced/Unbalanced 4-Terminal Converter
16315-60002	1	50Ω Load Resistor
16315-60003	1	Shorting Plate
16315-90001	1	Operation and Service Manual

16315A Replaceable Parts

Table 5-2 lists the replaceable parts for the 16315A. The parts listed can be ordered from your nearest Agilent Technologies Office. Ordering information must include the Agilent part number and the quantity required.

Table 5-2. 16315A Replaceable Parts

Agilent Part Number	Qty.	Description
16315-60001	1	50Ω Balanced/50Ω Unbalanced Converter
16315-60002	1	50Ω Load Resistor
16315-60003	1	Shorting Plate
16315-90001	1	Operation and Service Manual

16316A Replaceable Parts

Table 5-3 lists the replaceable parts for the 16316A. The parts listed can be ordered from your nearest Agilent Technologies Office. Ordering information must include the Agilent part number and the quantity required.

Table 5-3. 16316A Replaceable Parts

Agilent Part Number	Qty.	Description
16316-60001	1	100Ω Balanced/50Ω Unbalanced Converter
16316-60002	1	100Ω Load Resistor
16315-60003	1	Shorting Plate
16315-90001	1	Operation and Service Manual

16317A Replaceable Parts

Table 5-4 lists the replaceable parts for the 16317A. The parts listed can be ordered from your nearest Agilent Technologies Office. Ordering information must include the Agilent part number and the quantity required.

Table 5-4. 16317A Replaceable Parts

Agilent Part Number	Qty.	Description
16317-60001	1	600Ω Balanced/50Ω Unbalanced Converter
16317-60002	1	600Ω Load Resistor
16315-60003	1	Shorting Plate
16315-90001	1	Operation and Service Manual

Schematic Diagram

Figure 5-1 is the simplified schematic diagram of the 16314A/5A/6A/7A. When troubleshooting, check the converter connections using this schematic diagram.

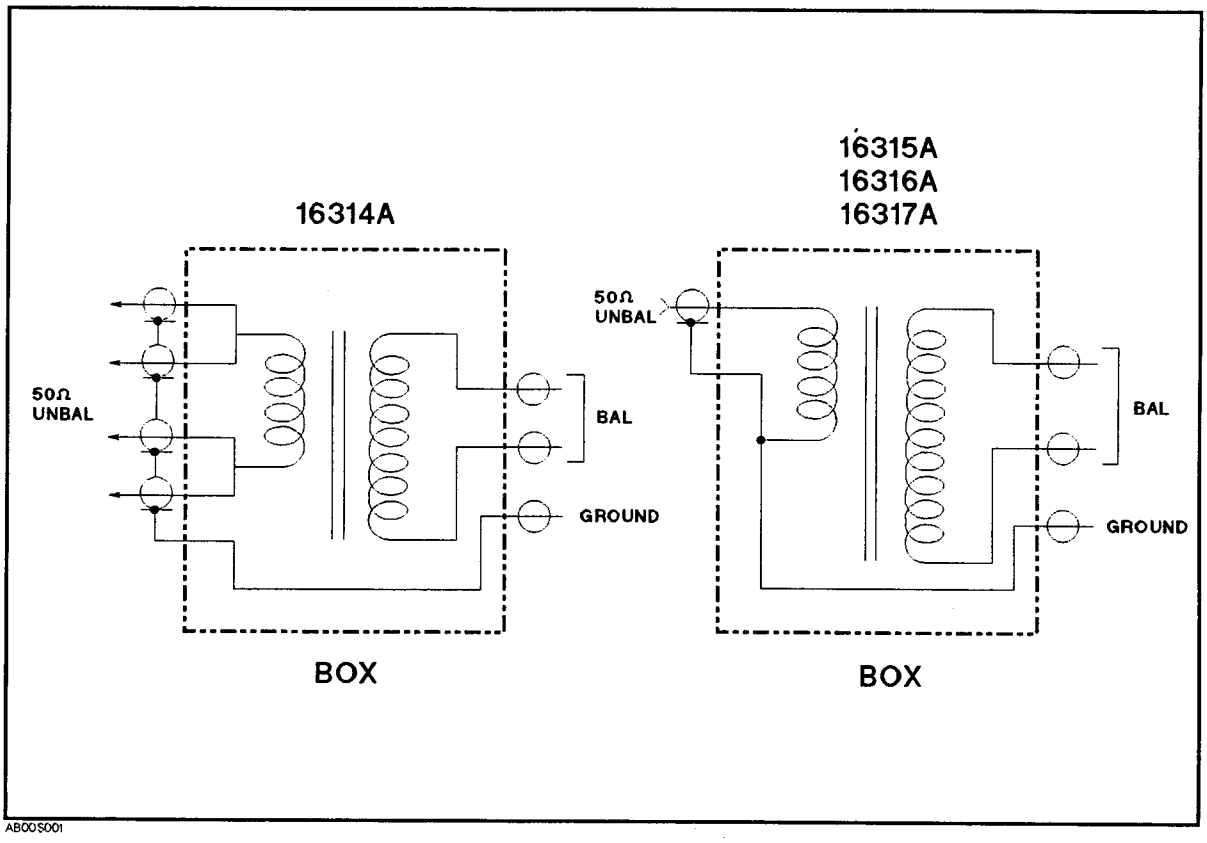

Figure 5-1. Schematic Diagram of 16314A/5A/6A/7A

A

Appendix

Impedance Measurement Error Factor Using the 16314A

The impedance measurement accuracy when using the 16314A is affected by the DUT's impedance value and the 16314A's OPEN/SHORT residuals.

The additional impedance measurement error in Figure 1-1 is obtained in accordance with this factor.

DUT's Impedance Value and 16314A's OPEN/SHORT Residuals

The measurement error can be calculated using the following equation:

$$Measurement\ Error\,(\%) = \frac{R_{short}}{Z_m} + \frac{Z_m}{R_{open}} + E_{std}$$

where

R_{short}	Short residual of the 16314A
R_{open}	Open residual of the 16314A
Z_m	Impedance value of the DUT
E_{std}	Uncertainty of the load correction resistor

Figure 1-1 (Typical Data) was obtained using the 16314A, the furnished shorting plate, and the furnished 50Ω load resistor.

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