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OPERATION NOTE

# 41951A

## IMPEDANCE TEST KIT

## for HP 4195A



NOV. 1987

HEWLETT PACKARD



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# MANUAL CHANGES

## HP 41951A

Impedance Test Kit
for HP 4195A

**MANUAL IDENTIFICATION**

Model Number: HP 41951A
Date Printed: November, 1987
Part Number: 41951-90000

This supplement contains information for correcting manual errors and for adapting the manual to newer instruments that contain improvements or modifications not documented in the existing manual.

To use this supplement
1. Make all ERRATA corrections
2. Make all appropriate serial-number-related changes listed below

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|
| ALL | 1 |
| | |
| | |
| | |

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|
| | |
| | |
| | |
| | |

▶ New Item

### ERRATA

▶ Page 1-3, Table 1-2. Contents

Change the part number of item 1, Impedance Test Adapter, to 41951-61001.

Page 1-6, Figure 1-3. Impedance Measurement Accuracy

Change the chart's inductance axis 10fH and 100fH scale labels to 10pH and 100pH, respectively.

**NOTE**

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies, quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.



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**CHANGE 1**

Page 6-6, Table 6-3. Replaceable Parts

Change item 5 as follows.

| Reference Designator | HP Part Number | Qty. | Description |
|---|---|---|---|
| 5 | 1250-1811<br>2190-0054 | 3<br>3 | N(f)-SMA(f) Adapter (with NUT)<br>Washer |



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OPERATION NOTE

# MODEL 41951A

# IMPEDANCE TEST KIT

# for HP 4195A

**SERIAL NUMBERS**

This operation note applies directly to 41951As with 2746J- prefixed serial numbers.

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9-1, TAKAKURA-CHO, HACHIOJI-SHI, TOKYO, JAPAN

Manual Part No. 41951-90000
Microfiche Part No. 41951-90050

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# TABLE OF CONTENTS


| Section | Title | Page |
|---|---|---|
| *1. GENERAL INFORMATION* | | |
| 1-1. | INTRODUCTION | 1-1 |
| 1-2. | DESCRIPTION | 1-1 |
| 1-3. | SPECIFICATIONS | 1-1 |
| 1-4. | SAFETY CONSIDERATIONS | 1-1 |
| 1-5. | UNITS COVERED BY THIS MANUAL | 1-2 |
| 1-6. | CONTENTS | 1-3 |
| 1-7. | ACCESSORIES AVAILABLE | 1-3 |
| *2. INSTALLATION* | | |
| 2-1. | INTRODUCTION | 2-1 |
| 2-2. | INITIAL INSPECTION | 2-1 |
| 2-3. | INTERCONNECTIONS | 2-1 |
| 2-4. | STORAGE ENVIRONMENT | 2-2 |
| 2-5. | PACKING | 2-2 |
| *3. OPERATION* | | |
| 3-1. | INTRODUCTION | 3-1 |
| 3-2. | BLOCK DIAGRAM | 3-1 |
| 3-3. | APC-7 CONNECTOR | 3-1 |
| 3-4. | CONNECTING TEST FIXTURE | 3-2 |
| 3-5. | MEASUREMENT CALIBRATION CONSIDERATION | 3-2 |
| 3-5-1. | One Port Full Calibration | 3-2 |
| 3-5-2. | Port Extension | 3-3 |
| 3-5-3. | Offset Compensation | 3-3 |
| 3-6. | TEST SIGNAL LEVEL AND OUTPUT IMPEDANCE | 3-4 |
| 3-7. | DC BIAS | 3-5 |
| 3-7-1. | Internal DC Bias | 3-5 |
| 3-7-2. | External DC Bias | 3-5 |
| *4. VERIFICATION TEST* | | |
| 4-1. | INTRODUCTION | 4-1 |
| 4-2. | EQUIPMENT REQUIRED | 4-1 |
| 4-3. | CALIBRATION CYCLE | 4-1 |
| 4-4. | DC PATH CHECK | 4-2 |
| 4-5. | RF PATH CHECK | 4-3 |
| *5. MANUAL CHANGES* | | |
| 5-1. | INTRODUCTION | 5-1 |
| 5-2. | MANUAL CHANGES | 5-1 |
| *6. SERVICE* | | |
| 6-1. | INTRODUCTION | 6-1 |
| 6-2. | SCHEMATICS AND REPLACEABLE PARTS | 6-1 |


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*SECTION 1*

*GENERAL INFORMATION*

## 1-1. INTRODUCTION

This operation note provides the information necessary to use the HP 41951A Impedance Test Kit with the HP 4195A Network/Spectrum Analyzer. Refer to the 4195A's Operation Manual for specific 4195A operating procedures.

## 1-2. DESCRIPTION

The 41951A Impedance Test Kit is an accessory for the 4195A. Figure 1-1 shows the contents of the HP 41951A.

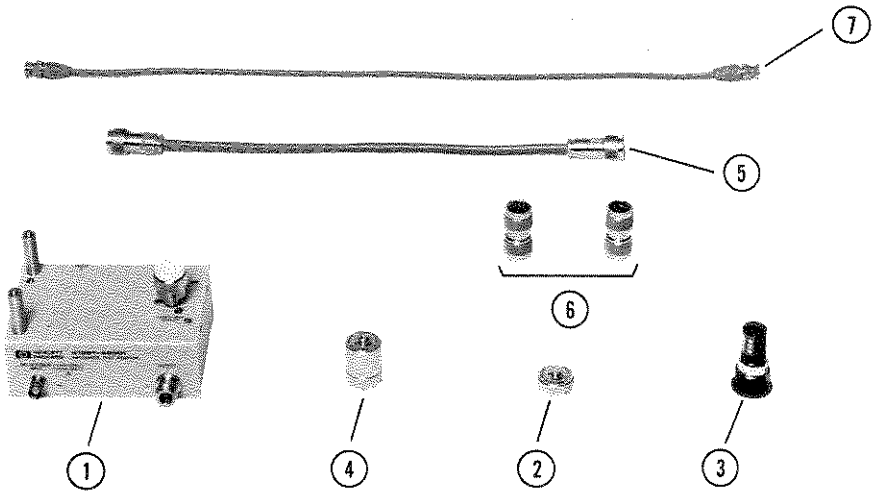



Figure 1-1. Contents of HP 41951A

## 1-3. SPECIFICATIONS

The specifications for the 41951A Impedance Test Kit is listed in Table 1-1. The specifications are performance standards or limits. The 41951A meets all of the specifications listed in Table 1-1 when shipped from the factory.

## 1-4. SAFETY CONSIDERATIONS

The 41951A Impedance Test Kit conform to the safety requirements for IEC 348, and CSA 556B instruments, and is shipped from the factory in a safe condition. This operation note contains information, **CAUTIONS**, and **WARNINGS** which must be followed by the user to ensure safe operation.



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## 1-5. UNITS COVERED BY THIS OPERATION NOTE

Hewlett-Packard uses a two-part, nine character serial number which is stamped on the serial number plate ( see Figure 1-2 ) attached to the inside of the carrying case. The first four digits and a letter are the prefix and the last five digits are the suffix of the serial number. The letter in the serial number identifies the country where the instrument was manufactured. The prefix is same for all identical instruments, it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. This operation note applies to instruments with serial number prefixes listed under **Serial Numbers** on the title page.




Figure 1-2. Serial Number Plate

Units manufactured after this operation note was printed may have a serial number prefix which is not listed on the title page. An unlisted serial number prefix indicates that the instrument may be different from those described in this operation note. Operation notes for new instruments may be accompanied by a yellow Manual Changes supplement page, or have a different part number. This supplement contains "**Change Information**" explaining how to adapt this operation note to newer instruments.

In addition to change information, the supplement may contain information for correcting errors ( Errata ) in previous operation notes. To keep this operation note as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Change supplements. The supplement for this operation note is identified by the **Print Date** and **Part Number**, both of which appear on the operation note's title page.

For information concerning the serial number prefixes not listed on the title page or in the Manual Change supplements, contact your nearest Hewlett-Packard Sales office.



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## 1-6. CONTENTS

Table 1-2 lists the contents, and includes **No.** which are the same as the designation in Figure 1-1, **Description, Qty.** ( Quantity ), and **HP part number.**

Table 1-2. Contents

| No. | Description | Qty. | HP Part Number |
|---|---|---|---|
| 1 | Impedance Test Adapter | 1 | PN 41951-69001 |
| 2 | 0 Ω Calibration Standard | 1 | PN 04191-85300 |
| 3 | 50 Ω Calibration Standard | 1 | PN 04191-85301 |
| 4 | 0S Calibration Standard | 1 | PN 04191-85302 |
| 5 | N(m)-N(m) Cable | 1 | PN 41951-61602 |
| 6 | N(m)-N(m) Adapter | 2 | PN 1250-0778 |
| 7 | BNC(m)-BNC(m) Cable | 1 | PN 8120-1839 |
| | Carrying case | 1 | PN 41951-60001 [1] |

**Note [1]:** The serial number plate is not included in the carrying case.

## 1-7. AVAILABLE ACCESSORIES

For making certain types of measurements and for convenience in connecting samples, five accessories are available. Each is designed to meet the various measurement requirements of a variety of test devices. All accessories are developed with careful consideration to accuracy, reliability, and ease of use. A brief description and a photo of each available accessory are given in Table 1-3.



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Table 1-1. Specifications ( 1 of 2 )

**41951A Specifications**

**Usable Frequency Range:**
100 kHz to 500 MHz

**DC Bias Range:**
±40 V, ±0.5 A

**UNKNOWN Port:**
APC-7 Connector

**Weight:**
Approx. 2.7 kg
Approx. 0.55 kg ( Test Adapter only )

**Operation Environment:**
0 °C to 55 °C
≤ 95% RH at 40 °C

**Storage Environment:**
-40 °C to 70 °C

The following specifications apply to the 4195A when used with the 41951A.

**Measurement Parameter:**
|Z|, |Y|, $\theta$, R, X, G, B, L, C, D, Q(=1/D)

**Test Frequency Range:**
100 kHz to 500 MHz

**Signal Level at DUT** ( nominal ):
-62 dBm to +3 dBm at 50 Ω load

Note: Signal level ( at DUT ) is 12 dB lower than 4195A output level.

**Output Impedance:**
Nominal 50 Ω

**DC Bias (supplied from 4195A):**

| | |
|---|---|
| Voltage Range | -40 V to 40 V |
| Resolution | 10 mV |
| Accuracy | ±( 0.12%+12 mV ) at 23 °C ±5 °C |
| Maximum Current | ±20 mA |



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Table 1-3. Specifications ( 2 of 2 )

**Measurement Range and Highest Resolution:**

| Parameter | Range | Resolution |
|---|---|---|
| \|Z\|, R, X | 30 mΩ to 30 kΩ | 10 mΩ |
| \|Y\|, G, B | 30 µS to 30 S | 10 µS |
| $\theta$ | -180° to 180° | 0.01° |
| L | 10 pH to 30 mH | 10 pH |
| C | 10 fF to 30 µF | 10 fF |
| D | 0.001 to 10 | 0.0001 |
| Q | 0.1 to 1000 | 0.01 |

**Measurement Accuracy** ( Supplemental Performance Characteristics ):

Measurement accuracy is specified at the connecting surface of the APC-7 connector, under the following conditions.

1) Warm up Time: >30 minutes

2) Ambient Temperature: 23°C ±5°C
at the same temperature at which Calibration was performed

3) Output Signal Level: 15 dB greater than the Input Range of reference port ( the value indicated by ' **RANGE R=** ' on the 4195A's display )

4) Signal Level at DUT: -20 to +3 dBm

5) Correction: ON

Figure 1-3 shows the impedance measurement accuracy of HP 4195A when used with the 41951A.



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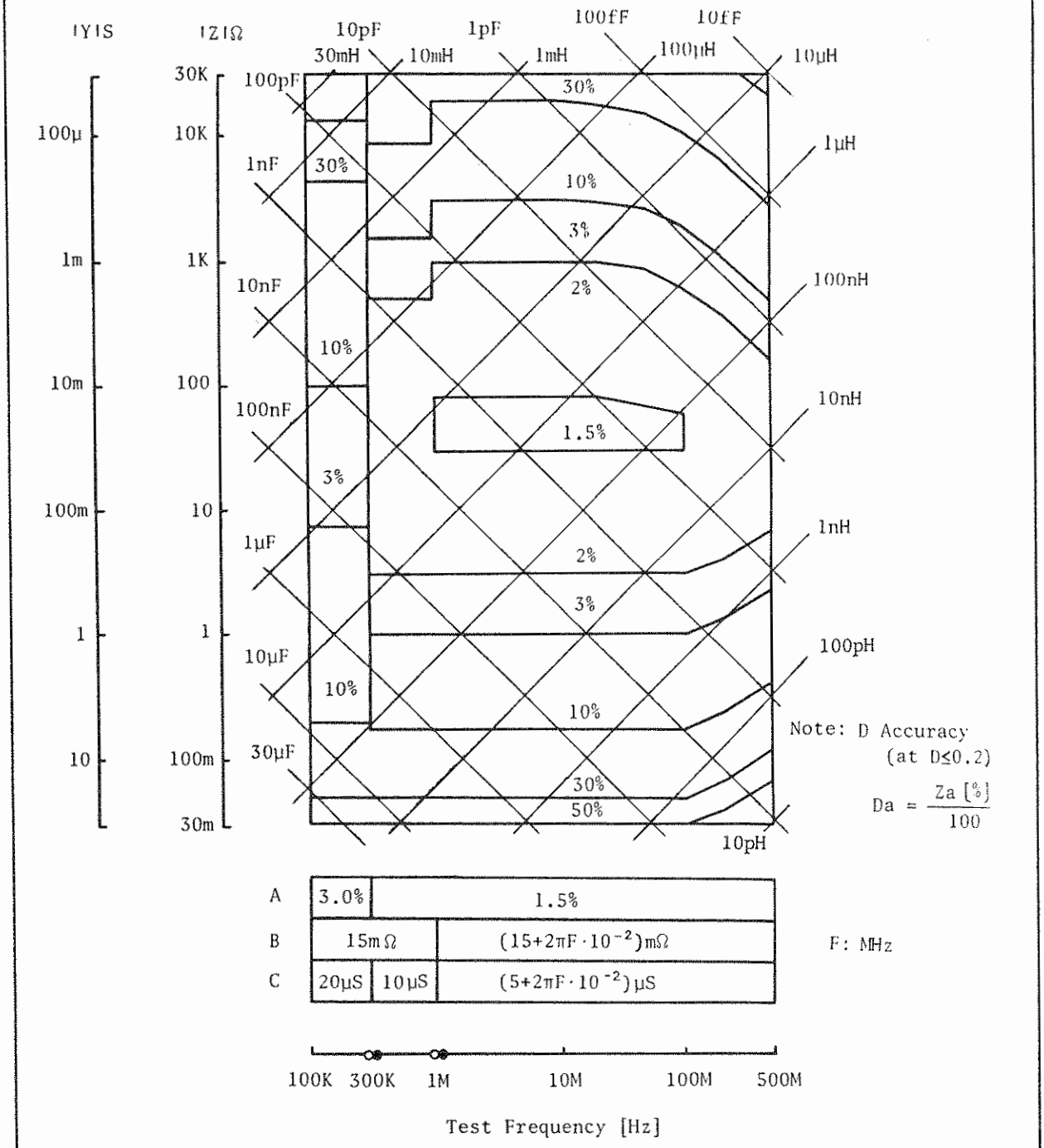



Figure 1-3. Impedance Measurement Accuracy ( 1 of 4 )

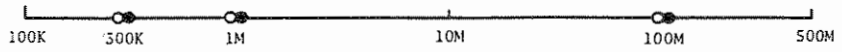


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Note: 1. The above data applies to the averaged measurement data ( applies when the VIDEO FILTER is on ).

2. When the DC bias is used, use the following value of A, B, and C in place of the above value, to calculate the measurement accuracy.

| | | | | |
|---|---|---|---|---|
| A | a | $(1.5+0.006 \times I)\%$ | | |
| B | $15 \times \frac{I+100}{100}$ mΩ | $(15+2\pi F \cdot 10^{-2}) \times \frac{I+250}{250}$ mΩ | b | I:mA F:MHz |
| C | $\frac{I+200}{10}$ μS | $\frac{I+250}{25}$ μS | $(5+2\pi F \cdot 10^{-2}) \times \frac{I+250}{250}$ μS | c |




Test Frequency [Hz]

a: $(3.0+0.006 \times I)\%$

b: $(15+2\pi F \cdot 10^{-2}) \times \frac{I+100}{100}$ mΩ

c: $(5+2\pi F \cdot 10^{-2}) \times \frac{I+100}{100}$ μS

**|Z|-θ Accuracy:**

| | |
|---|---|
| \|Z\| accuracy | $Za = A+(B/\|Zm\|+Cx\|Zm\|)\times 100$ (%) |
| θ accuracy | $\theta a = \sin^{-1}(Za/100)$ |

Where |Zm| is |Z| measured. A, B and C are obtained from the graph above.

**|Y|-θ Accuracy:**

| | |
|---|---|
| \|Y\| accuracy | $Ya = A+(B\times\|Ym\|+C/\|Ym\|)\times 100$ (%) |
| θ accuracy | $\theta a = \sin^{-1}(Ya/100)$ |

Where |Ym| is |Y| measured. A, B and C are obtained from the graph above.

Figure 1-3. Impedance Measurement Accuracy ( 2 of 4 )



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**R, X Accuracy** ( depends on D ):

| | D≤0.2 | 0.2<D≤5 | 5<D |
|---|---|---|---|
| Ra | $\pm Xm \cdot \frac{Za(X)}{100}$ (Ω) | $\frac{Za(R)}{\cos\theta}$ (%) | Za(R) (%) |
| Xa | Za(X) (%) | $\frac{Za(X)}{\sin\theta}$ (%) | $\pm Rm \cdot \frac{Za(R)}{100}$ (Ω) |

D can be calculated as R/X,
R/(2×π×f×Ls) or R×2×π×f×Cs

$\theta$ can be calculated as $\tan^{-1}$(X/R),
$\tan^{-1}$(2×π×f×Ls/R) or
$\tan^{-1}$(1/(R×2×π×f×Cs))

Za(R) = A+(B/|Rm|+C×|Rm|)×100 (%)
Za(X) = A+(B/|Xm|+C×|Xm|)×100 (%)

Rm and Xm are the measured R and X, respectively. A, B and C are obtained from the preceding graph.

**G, B Accuracy** ( depends on D ):

| | D≤0.2 | 0.2<D≤5 | 5<D |
|---|---|---|---|
| Ga | $\pm Bm \cdot \frac{Ya(B)}{100}$ (S) | $\frac{Ya(G)}{\cos\theta}$ (%) | Ya(G) |
| Ba | Ya(B) (%) | $\frac{Ya(B)}{\sin\theta}$ (%) | $\pm Gm \cdot \frac{Ya(G)}{100}$ (S) |

D can be calculated as G/B,
G/(2×π×f×Cp) or G×2×π×f×Lp

$\theta$ can be calculated as $\tan^{-1}$(B/G),
$\tan^{-1}$(2×π×f×Cp/G) or
$\tan^{-1}$(1/(G×2×π×f×Lp))

Ya(G) = A+(B×|Gm|+C/|Gm|)×100 (%)
Ya(B) = A+(B×|Bm|+C/|Bm|)×100 (%)

Gm and Bm are measured G and B, respectively. A, B and C are obtained from the preceding graph.

Figure 1-3. Impedance Measurement Accuracy ( 3 of 4 )



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**D Accuracy:**

| | D≤0.2 | 0.2<D |
|---|---|---|
| Da | Za/100 | $(Za/100)\times(1+D^2)$ |

Where Za is |Z| accuracy

**L Accuracy** ( depends on D ):

| | D≤0.2 | 0.2<D |
|---|---|---|
| La | La | La × (1+D) |

Where

La = A+(B/|Zl|+C×|Zl|)×100 (%)

Where |Zl| = 2×π×f×Lm, f is frequency in Hz and Lm is measured L. A, B and C are obtained from the preceding graph.

**C Accuracy** ( depends on D ):

| | D≤0.2 | 0.2<D |
|---|---|---|
| Ca | Ca | Ca × (1+D) |

Where

Ca = A+(B/|Zc|+C×|Zc|)×100 (%)

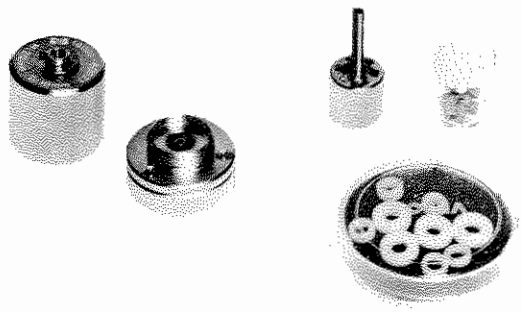
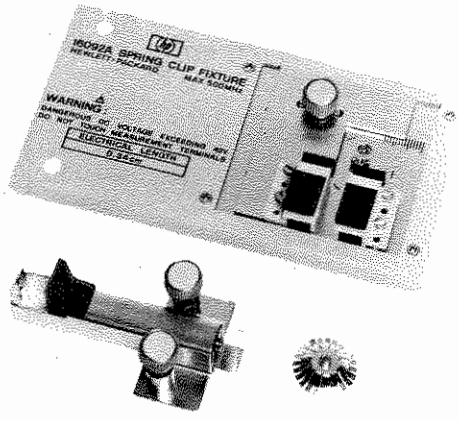
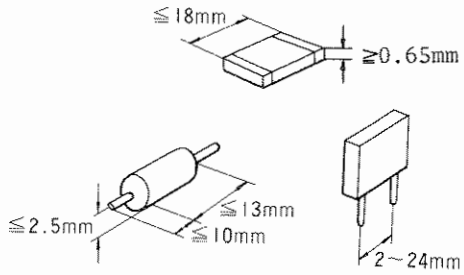
Where |Zc| = 1/2×π×f×Cm, f is frequency in Hz and Cm is the measured C. A, B and C are obtained from the preceding graph.

Figure 1-3. Impedance Measurement Accuracy ( 4 of 4 )



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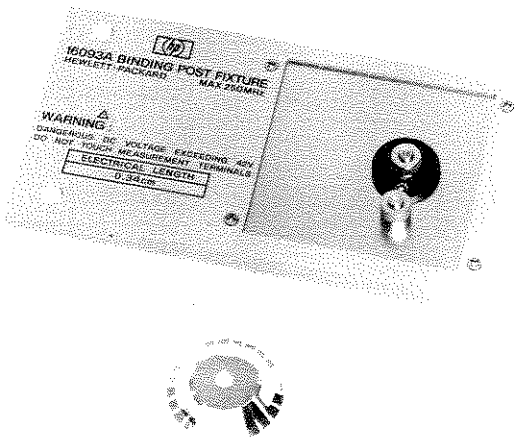
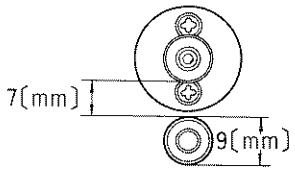
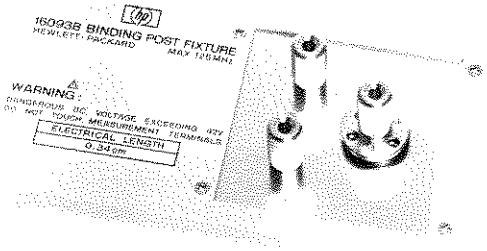
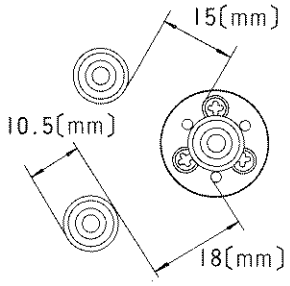
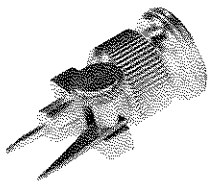
Table 1-3. Available Accessories ( 1 of 2 )

| Model | Description |
|---|---|
| HP 16091A  | Coaxial Fixtures<br><br>Test Fixtures ( coaxial termination type ) for holding a piece of sample holders accommodate a cylindrical sample in their respective inner chambers. Two kinds of fixtures fit samples dimensions given below:<br><br>Sample: d, ℓ<br>Fixture: 04191-85302 — Max. dimensions: d 7 mm, ℓ 20 mm<br>Fixture: 16091-60012 — Max. dimensions: d 10 mm, ℓ 20 mm<br><br>Usable frequency range: DC to 1000 MHz.<br>Electrical length: 1.87 cm ( typical ).<br>Maximum applied DC bias voltage: ±40 V.<br><br>Note: The 16091A fixture of 7 mm inner diameter ( P/N 04191-85302 ) is actually the same as the 0S standard termination. Thus, this fixture is not supplied with the 16091A fixture set since the furnished 0S termination can be used. |
| HP 16092A  | Spring Clip Fixture<br><br>Test fixture for connecting axial and radial lead components, and leadless chip components. The spring clip contacts can be adjusted to the dimensions given below.<br><br>  <br><br>A slide gauge provides direct read-out of the length of the test sample. Maximum applicable DC bias is ±150 V/±0.5 A. |



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Table 1-3. Accessories Available ( 2 of 2 )

| | |
|---|---|
| HP 16093A<br>  <br><br> | Binding Post Fixture<br><br>A test fixture used when measuring miniature axial and radial lead components. Two binding post terminals at intervals of 7 mm on the terminal deck ensure optimum contact of terminals and the test sample leads.<br>  <br><br>The maximum DC bias that can be applied is ±40 V/±0.5 A. |
| HP 16093B<br>  <br><br>  | Binding Post Fixture<br><br>A Test fixture for connecting common axial and radial lead components. Three binding post terminals are located on the terminal deck as shown below.<br>  <br><br>The maximum DC bias that can be applied is ±40 V/±0.5 A. |
| HP 16094A<br>  | Probe Fixture<br><br>Test Fixture for measurement of circuit impedances and components mounted on circuit assemblies. The probe adapter unit can be attached at the tip of an extension line connected to the test port. The probe connector fits APC-7 connector of a coaxial test cable or a flexible air line. Probe needle interval is variable from 1 mm to 15 mm. Electrical length compensation in the instrument must be adjusted for probe cable length.<br><br>Usable frequency range: DC to 125 MHz.<br>Electrical length: 2.32 cm ( typical ).<br>Maximum applied DC bias voltage: ±40 V. |



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*SECTION 2*

*INSTALLATION*

## 2-1. INTRODUCTION

This section provides installation instructions for the HP 41951A Impedance Test Kit. It also includes information on the initial inspection, damage claims, preparation for using the 41951A, packaging, storage, and shipment.

## 2-2. INITIAL INSPECTION

The 41951A Impedance Test Kit meet all of the specifications listed in Table 1-1. Upon receipt, inspect the shipping container for damage. If the shipping container or the cushioning material has been damaged, keep the container and packing material until the contents have been checked for completeness and the test kit has been checked out mechanically and electrically. The contents should be as shown in Figure 1-1. The procedures for checking the general electrical operation are given in Section 4.

If anything is missing, damaged ( scratches, dents, broken connectors, etc. ), or if performance does not meet the verification test limits, notify the nearest HP Sales office ( see the list at the back of this operation note ). The HP Sales Office will immediately arrange for repair or replacement without waiting for a claim settlement.

## 2-3. INTERCONNECTIONS

The interconnection between the 41951A and the 4195A, is achieved by connecting the **Impedance Test Adapter** to the 4195A's **Channel 1** or **2**, using the furnished Adapters and Cables.

1. Connect two female N-type connectors; **INPUT S** and **OUTPUT R**, to the 4195A's **OUTPUT S1** ( or **S2** ) and **INPUT R1** ( or **R2** ) connectors, using two furnished N(m)-N(m) Adapters, respectively.

**NOTE**

When connecting the **INPUT S** and **OUTPUT R** connectors, do not try to tighten one connector completely, alternately tighten each connector, little by little, until both connectors are tight.

2. Connect the **OUTPUT T** connector to the 4195A's **INPUT T1** ( or **T2** ) connector, using the furnished N(m)-N(m) Cable.

3. If the DC bias supplied from the 4195A is used, connect the **DC SOURCE INPUT** connector to the 4195A's **DC SOURCE OUTPUT** connector using the furnished BNC(m)-BNC(m) Cable.



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**NOTE**

If the DC bias supplied from an external DC power supply is used, connect the **DC SOURCE INPUT** connector to the power supply's output terminal. The outer conductor of the **DC SOURCE INPUT** connector is grounded.

## 2-4. STORAGE ENVIRONMENT

The 41951A may be stored or shipped under the following environmental conditions.

Temperature -40 °C to 70 °C

The unit must be protected from temperature extremes which can cause condensation.

## 2-5. PACKING

**Original Packing.**

Containers and packing material identical to those used in factory packaging are available from Hewlett-Packard. If the unit is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number and full serial number.

**Other Packing.**

The following general instructions should be used for repacking with commercially available materials:

a. Wrap the unit in heavy paper or plastic. If shipping to a Hewlett-Packard Sales Office or Service Center, attach a tag indicating the type of service required, return address, model number and the full serial number.

b. Use a strong shipping container. A double-walled carton made of 350 pound test material is adequate.

c. Use enough shock absorbing material ( a 3 to 4 inch layer ) around all sides of the unit to provide a firm cushion and to prevent the unit from moving inside the container.

d. Seal the shipping container securely.

e. Mark the shipping container **FRAGILE** to ensure careful handling.

f. In any correspondence, refer to unit by its model number and the full serial number.

**NOTE**

If you ever need to return the 41951A for servicing, HP recommends that you return your 4195A also so that system performance can be verified after repairs are made.



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*SECTION 3*

*OPERATION*

## 3-1. INTRODUCTION

This section provides the information necessary to use the 41951A. **WARNINGS**, **CAUTIONS**, and **NOTES** are given throughout, and they should be followed to insure operator safety and serviceability of the unit.

**NOTE**

For detailed information on 4195A operation, refer to the 4195A's Operation Manual.

## 3-2. BLOCK DIAGRAM

The Impedance Test Adapter's block diagram is shown in Figure 3-1. The number included in Figure 3-1, indicates the insertion loss of the Impedance Test Adapter when the 41951A is connected to the HP 4195A, and the 50 Ω load is connected to the measurement terminal ( APC-7 connector ) of the Impedance Test Adapter. The output signal to the **OUTPUT R** connector is approximately 18 dB lower than the input signal to the **INPUT S** connector, and the output signal to the DUT is approximately 12 dB lower than the input signal ( the voltage applied to DUT is about a quarter of the voltage supplied from the 4195A ).

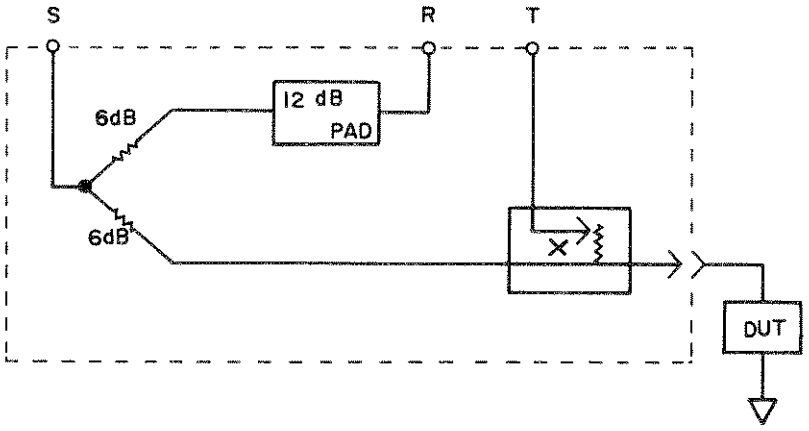



Figure 3-1. Impedance Test Adapter's Block Diagram

## 3-3. APC-7 CONNECTOR

The 41951A's measurement terminal is an APC-7 connector. This connector provides the capability for connecting and installing an accessory test fixture matched to the 41951A, or a user-built test fixture. The APC-7 connector test port, a two-terminal configuration, has a characteristics impedance of 50 Ω which is equal to the base impedance in reflection coefficient measurements. This base impedance represents the reference in the normalized impedance calculations for multiple parameter derivations.



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The connecting surface of the APC-7 connector, the calibration standards, and the test fixtures must be kept free of spots, dust, oil and adhesives which will cause poor contact. To maintain clean contact surfaces, it is recommended that the operator perform periodic cleaning as necessary. Use a lint-free cloth and, if a cleaning fluid is needed, use isopropyl alcohol.

**CAUTION**

**Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, di-oxane, gasoline, cellulose acetate, or carbon tetrachloride. Keep exposure of the connector parts to both the cleaning fluid and its vapors as brief as possible.**

## 3-4. CONNECTING TEST FIXTURE

The following five test fixture are available for the impedance measurement using the 41951A with the 4195A ( see Table 1-3 ).

| | |
|---|---|
| HP 16091A | Coaxial Fixture |
| HP 16092A | Spring Clip Fixture |
| HP 16093A/B | Binding Post Fixture |
| HP 16094A | Probe Fixture |

The test fixture is installed by connecting to the APC-7 connector on 41951A's Impedance Test Adapter. For the details, refer to the test fixtures' operation notes.

## 3-5. MEASUREMENT CALIBRATION CONSIDERATIONS

The 4195A provides the one port full calibration, port extension, and offset compensation capabilities for accurate impedance measurement. One port full calibration corrects for the measurement errors caused by the measurement instrument and Impedance Test Adapter. Port extension compensates for phase shifts in extension cables that connects the calibration plane and the DUT. Offset compensates for the measurement errors caused by the residual impedance and stray admittance, between the calibration plane and DUT. For details of the measurement calibration, refer to the 4195A's Operation Manual.

At the measurement which can perform the offset compensation at the measurement terminal, the one port full calibration and offset compensation should be performed. If the measurement terminal is extended using 50 Ω low loss cable ( as the air line ), or the offset compensation cannot be performed at the measurement terminal, the port extension should be performed instead of the offset compensation. If needed, all measurement calibration procedures can be performed under actual measurement conditions.

### 3-5-1. ONE PORT FULL CALIBRATION

The one port full calibration compensates for the measurement errors due to the frequency of the Impedance Test Adapter. This calibration is required to extend the calibration plane to the connecting surface of the APC-7 connector of the Impedance Test Adapter or the extended measurement terminal ( see Figure 3-2 ). If the measurement terminal is extended by a cable with APC-7 connectors, the one port full calibration should be performed at the



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extended measurement terminal. To perform one port full calibration, three calibration standards; 0S, 0 Ω, 50 Ω, are required. For the procedure of the one port full calibration, refer to the 4195A's Operation Manual.

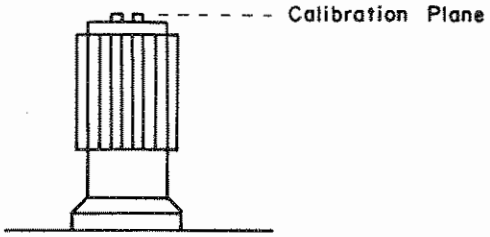



Figure 3-2. 41951A's Calibration Plane

The reference values of the furnished calibration standards are listed in Table 3-1.

Table 3-1. Reference Values for Calibration Standards

| Standard | Reference Value |
|---|---|
| 0 S admittance | 0 S + j × ω × 82 fF |
| 0 Ω impedance | 0 Ω + j × ω × 0 H |
| 50 Ω impedance | 50 Ω + j × ω × 0 H |

These values are stored in the 4195A's battery back-up memory as the calibration reference values.

**NOTE**

If you extend the calibration plane beyond the connecting surface of the APC-7 connector, and you have accurate standards that can be connected to the end of the extension, calibration will be accurate to the end of the extension. Refer to the 4195A's Operation Manual for the procedure for entering the reference values of your standards.

### 3-5-2. PORT EXTENSION

The port extension compensates for the phase shift in the extension cable. This capability is effective when the measurement terminal is extended by the 50 Ω low loss cable as the air line, or when the offset compensation cannot be performed. For procedure of the port extension capability, refer to the 4195A's Operation Manual.

### 3-5-3. OFFSET COMPENSATION

The 4195A applies three offset compensation; **0S & 0Ω** offset, **0S** offset, and **0Ω** offset compensation. The **0S & 0Ω** offset compensates for the residual impedance and stray admittance existing in the test fixture, that is attached on an Impedance Test Adapter. The **0S**



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offset compensates for the stray admittance, and the **0Ω** offset compensates for the residual impedance.

To perform the offset compensation, select the offset compensation mode by pressing the **' 0S OFFSET '**, **' 0Ω OFFSET '** or **' 0S&0Ω OFFSET '** softkey. If the 0S & 0 Ω offset compensation is selected, the **' 0S '** and **' 0Ω '** softkeys are displayed on the softkey area. If the 0S offset or 0 Ω offset compensation is selected, one of these softkeys is displayed. To perform the offset compensation, short ( or open ) the measurement terminal on the test fixture, and press the **' 0Ω** ( or **0S** ) **'** softkey and **ENTER/EXECUTE** key.

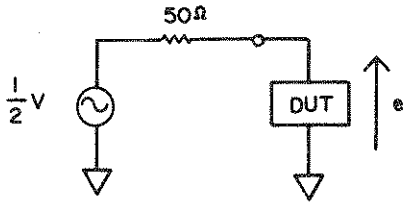
**NOTE**

The test fixture must be configured the same as it will be for performing compensation and for making a measurement.

## 3-6. TEST SIGNAL LEVEL AND OUTPUT IMPEDANCE

The test signal level applied to DUT depends on the test signal level applied from the 4195A, the output impedance and insertion loss of the Impedance Test Adapter, and the impedance of DUT. The 41951A's output impedance is approximately 50 Ω.

The equivalent circuit and equation to calculate the test signal level is shown in Figure 3-3.




$$e = V \times ZL / \{ 2 \times ( ZL + 50 ) \} [V]$$

Where V: 4195A's output Signal Level [V]
ZL: Impedance of DUT [Ω]
e: Test Signal Level at DUT

Figure 3-3. Test Signal Level Calculation

The calculation example of the test signal level at DUT is shown in Table 3-2.

Table 3-2. Test Signal Level

| Impedance of DUT | 4195A's Signal Level Setting | |
|---|---|---|
| | 0dBm | 1V |
| infinite | 112 mV | 0.5 V |
| 1 kΩ | 106 mV | 0.48 V |
| 100 Ω | 75 mV | 0.33 V |
| 50 Ω | 56 mV | 0.25 V |



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## 3-7. DC BIAS

### 3-7-1. Internal DC Bias

To use the 4195A's internal DC bias capability, connect the furnished BNC cable between the 4195A's **DC SOURCE OUTPUT** connector and the 41951A's **DC SOURCE INPUT** connector.

### 3-7-2. External DC Bias

External DC bias can be used up to ±40 V and ±500 mA.

**CAUTION**

**DO NOT SHORT CIRCUIT WHEN AN EXTERNAL A DC BIAS IS APPLIED, OR YOU WILL BLOW THE FUSE IN THE IMPEDANCE TEST ADAPTER.**

**CAUTION**

**DO NOT PERFORM A CALIBRATION MEASUREMENT WHILE A DC BIAS IS APPLIED. THE CALIBRATION STANDARDS MAY BE DAMAGED IF YOU DO.**



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*SECTION 4*

*VERIFICATION TEST*

## 4-1. INTRODUCTION

This section contains the basic operational checkout procedures for the HP 41951A. All tests can be performed without access to the interior of the 41951A. The verification test is typically used for incoming inspection of the 41951A, and to verify that the Impedance Test Adapter is in good order after it has been repaired.

## 4-2. EQUIPMENT REQUIRED

Table 4-1 lists the equipment required to perform the verification test. Equipment that meets or exceeds the critical specifications listed in the table may be used as a substitute for the recommended models. The equipment used for verification testing must be calibrated.

Table 4-1. Recommended Test Equipment

| Equipment | Critical Specifications | Recommended Model |
|---|---|---|
| Network Analyzer | Frequency: 100 kHz to 500 MHz<br>Impedance: 50 Ω<br>Accuracy: ±0.5 dB | HP 4195A |
| Digital Multimeter | Resistance Measurement Range: 5 to 30 Ω<br>Accuracy: ±1% | HP 3478A |
| Power Splitter | Frequency: 100 kHz to 500 MHz<br>Input Impedance: 50 Ω<br>Output Impedance: 50 Ω | HP 11667A |

### 4-3. CALIBRATION CYCLE

The 41951A requires periodic performance verification. The 41951A ( Impedance Test Adapter ) should be checked out using the verification test at least once a year or more depending on the frequency of use. Preventive maintenance should be performed at least twice a year to keep down-time to a minimum, and to insure optimum operation,



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## 4-4. DC BIAS PATH CHECK

This test checks the resistance of the path between the 41951A's **DC SOURCE INPUT** connector and the APC-7 connector.

REQUIRED EQUIPMENT:

| | |
|---|---|
| Digital Multimeter | HP 3478A |
| APC-7 to N(f) Adapter ( 1 ea. ) | HP 11524A |
| Test Leads | |

PROCEDURE:

1. Connect the Test Leads to the Digital Multimeter's high and low terminals.

2. Connect the APC-7 to N(f) Adapter to the Impedance Test Adapter's APC-7 connector.

3. Set the Digital Multimeter to the resistance measurement mode.

4. Connect a tip of the Test Lead connected to the DMM high input to the center conductor of the Impedance Test Adapter's **DC SOURCE INPUT** connector, and the tip of the Test Lead connected to the DMM's low input to the center conductor of the APC-7 to N(f) Adapter connected to the Impedance Test Adapter's APC-7 connector.

5. Check that the Digital Multimeter's reading is less than 10 Ω.



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## 4-5. RF PATH CHECK

This test checks the RF path of the Impedance Test Adapter.

REQUIRED EQUIPMENT:

| | |
|---|---|
| Network Analyzer | HP 4195A |
| Power Splitter | HP 11667A |
| N(m)-BNC(f) Adapter ( 4 ea. ) | HP 1250-0780 |
| BNC(m)-BNC(m) Cable ( 2 ea. ) | HP 8120-1838 |

**NOTE**

The N(m)-N(m) Cable ( 2 ea. : HP 11500B ) can be used instead of the N(m)-BNC(f) Adapter ( 4 ea. ) and BNC(m)-BNC(m) Cable ( 2 ea. ).

PROCEDURE:

1. Set the Network Analyzer as follows.

| | | |
|---|---|---|
| Source: | Frequency: | 100 kHz to 500 MHz, Log sweep |
| | OSC Level: | +5 dBm |
| | DC Bias: | OFF |
| Receiver: | RBW: | 1 kHz |
| | INPUT RANGE R-ch: | 0 dBm |
| | T-ch: | 0 dBm |

2. Connect the Power Splitter to the Network Analyzer, as shown in Figure 4-1 (1).

**NOTE**

Use the N(m) to N(m) Adapter included with the 41951A to connect the Power Splitter's **INPUT** terminal to the Network Analyzer's **SOURCE** terminal,

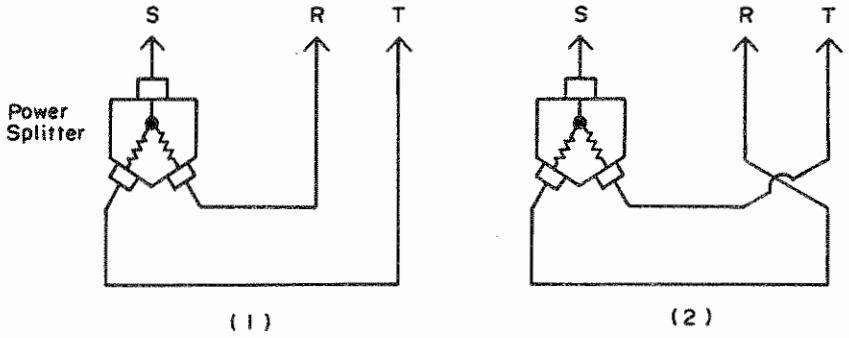



Figure 4-1. Power Splitter Connection



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3. Measure the T/R and store the data ( data $D_1$ ). All measured data in the measurement range, must be stored. This data is used to calculate the compensation data.

4. Swap the cable connection with the Adapter at the Network Analyzer's INPUT port ( do not try to swap the cables at the Power Splitter's OUTPUT ), as shown in Figure 4-1 (2).

5. Measure the T/R and store the data ( data $D_2$ ).

6. Perform the following calculation, and store the result ( data $D_3$ ). Data $D_3$ is used as the compensation data, in the following steps.

$$D_3 = \{ ( \text{data } D_1 ) + ( \text{data } D_2 ) \} / 2$$

7. Connect the Impedance Test Adapter to the Network Analyzer ( refer to paragraph 2-3, INTERCONNECTION ).

8. Connect the 0S Calibration Standard ( OPEN ) to the APC-7 connector of the Impedance Test Adapter, and measure the T/R.

9. Compensate the measured data by subtracting data $D_3$ from the measured data. Confirm that the compensated data is 0 ±3 dB.

10. Connect the 0 Ω Calibration Standard ( SHORT ) to the APC-7 connector of the Impedance Test Adapter, and measure the T/R.

11. Compensate the measured data by subtracting data $D_3$ from the measured data. Confirm that the compensated data is 0 ±3 dB.

12. Connect the 50 Ω Calibration Standard ( LOAD ) to the APC-7 connector of the Impedance Test Adapter, and measure the T/R.

13. Compensate the measured data by subtracting data $D_3$ from the measured data. Confirm that the compensated data is less than -30 dB.

**NOTE**

In steps 9, 11 and 13, the compensation can be performed easily, by using the 4195A's User Math capability. If the compensation data is stored in the 4195A's RA register, the following equation should be entered.

DMA = MA - RA

For the details of the User Math capability, refer to the 4195A's Operation Manual.



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*SECTION 5*

*MANUAL CHANGES*

## 5-1. INTRODUCTION

This section contains information for adapting this manual to instruments to which its contents do not directly apply. The following paragraphs explain how to adapt this manual to older instruments which have a serial prefix/number lower than that given on the title page.

## 5-2. MANUAL CHANGES

To adapt this manual to your instrument, refer to Table 5-1 and make all of the manual changes listed opposite your instrument's serial number. Perform these changes in the sequence given.

If your instrument serial number is not listed on the title page of this manual or in Table 5-1, it may be documented in a yellow MANUAL CHANGES supplement. For additional information about serial number coverage, refer to UNITS COVERED BY THIS OPERATION NOTE in Section 1.

Table 5-1. Manual Changes by Serial Number

| Serial Prefix or Number | Make Manual Changes |
|---|---|
| | |



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*SECTION 6*

*SERVICE*

## 6-1. INTRODUCTION

This section provides the information required to service the 41951A Impedance Test Kit. The Schematic Diagram, and the Replaceable Parts List are included.

## 6-2. SCHEMATICS AND REPLACEABLE PARTS

The 41951A consists of the assemblies listed in Table 1-2. Any assembly except for the Impedance Test Adapter, can be replaced by the assembly level, when it is damaged. The part numbers are shown in Figure 1-1, and Table 1-2.

The Impedance Test Adapter includes some replaceable parts. Figure 6-1 shows the schematic diagram of the Impedance Test Adapter. The replaceable parts mounted on the board in the Impedance Test Adapter, is listed in Table 6-1. The part's locations are shown in Figure 6-2.

**NOTE**

Parts that are not listed in Table 6-1 cannot be replaced, and the board assembly cannot be replaced. So if any of parts which are not listed are damaged, the Impedance Test Adapter must be replaced at the assembly level.

Table 6-2 shows an exploded view of the APC-7 connector mounted on the Impedance Test Adapter's top cover, and lists the APC-7 connecter's parts. Table 6-3 lists the Impedance Test Adapter's replaceable parts except for those on the board, and shows their location.



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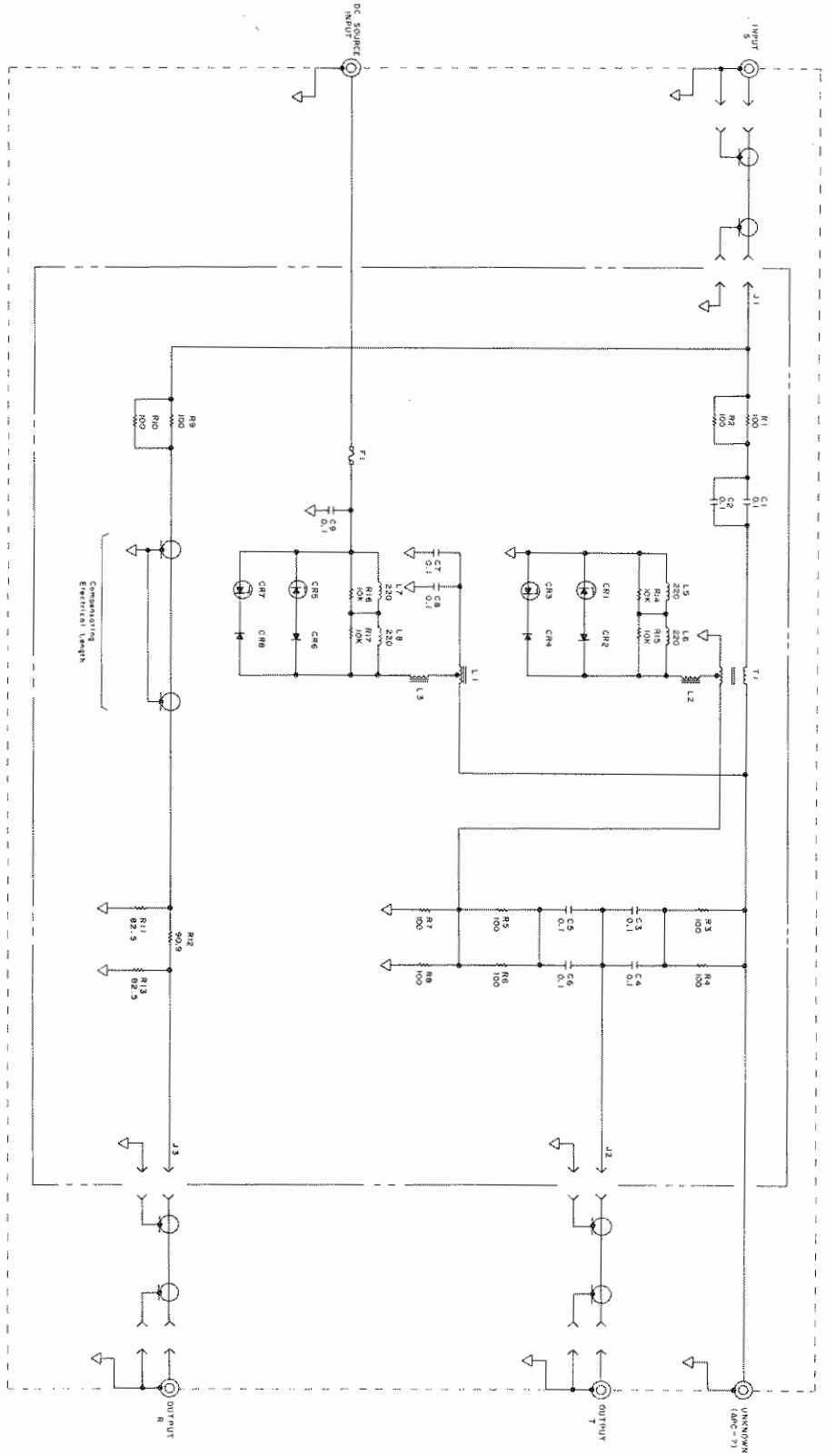



Figure 6-1. Schematic Diagram of the Impedance Test Adapter



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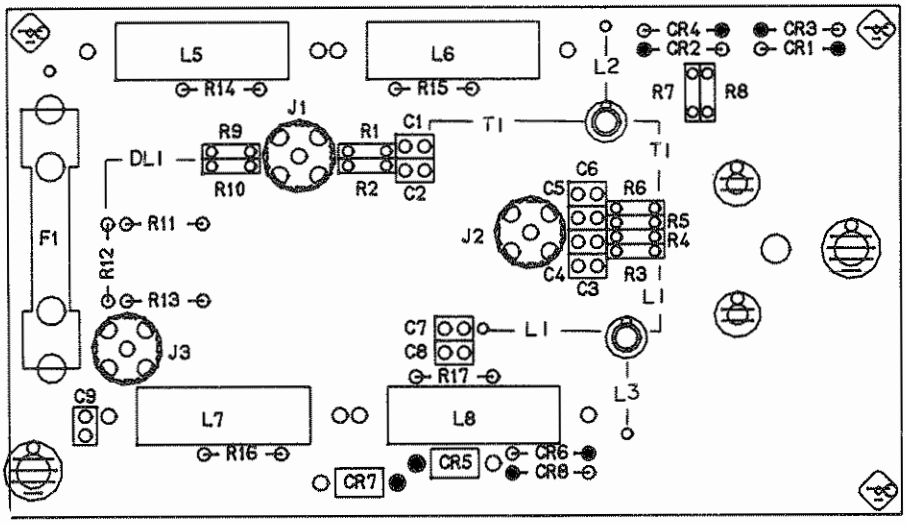



Figure 6-2. Parts Locations



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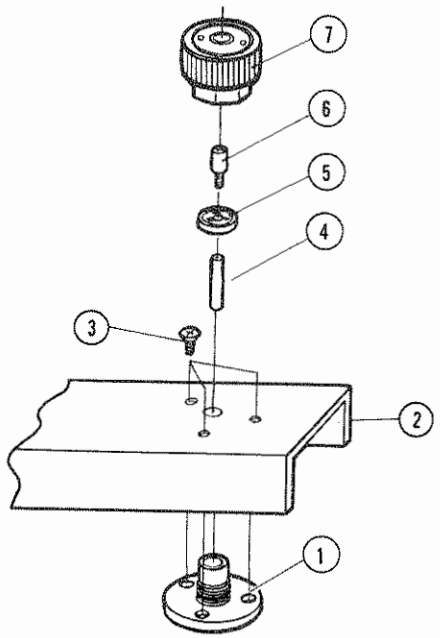
Table 6-1. Replaceable Parts List

| Reference Designator | HP Part Number | Description |
|---|---|---|
| C1 | 0160-0576 | Capacitor 1 µF |
| C2 | 0160-0576 | Capacitor 1 µF |
| C4 | 0160-0576 | Capacitor 1 µF |
| C5 | 0160-0576 | Capacitor 1 µF |
| C7 | 0160-0576 | Capacitor 1 µF |
| C8 | 0160-0576 | Capacitor 1 µF |
| C9 | 0160-0576 | Capacitor 1 µF |
| CR1 | 1902-0953 | Diode Zener |
| CR2 | 1901-0050 | Diode Switching |
| CR3 | 1902-0953 | Diode Zener |
| CR4 | 1901-0050 | Diode Switching |
| CR5 | 1902-0551 | Diode Zener |
| CR6 | 1901-0050 | Diode Switching |
| CR7 | 1902-0551 | Diode Zener |
| CR8 | 1901-0050 | Diode Switching |
| F1 | 2110-0001 | Fuse 1 A 250 V |
| J1 | 1250-0835 | Connecter-RF SMC |
| J2 | 1250-0835 | Connecter-RF SMC |
| J3 | 1250-0835 | Connecter-RF SMC |
| L5 | 5080-3244 | Inductor 220 µH |
| L6 | 5080-3244 | Inductor 220 µH |
| L7 | 5080-3244 | Inductor 220 µH |
| L8 | 5080-3244 | Inductor 220 µH |
| R1 | 0698-7212 | Resistor 100 Ω |
| R2 | 0698-7212 | Resistor 100 Ω |
| R13 | 0757-0399 | Resistor 82.5 Ω |
| R14 | 0757-0442 | Resistor 10 kΩ |
| R15 | 0757-0442 | Resistor 10 kΩ |
| R16 | 0757-0442 | Resistor 10 kΩ |
| R17 | 0757-0442 | Resistor 10 kΩ |



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Table 6-2. APC-7 Connector

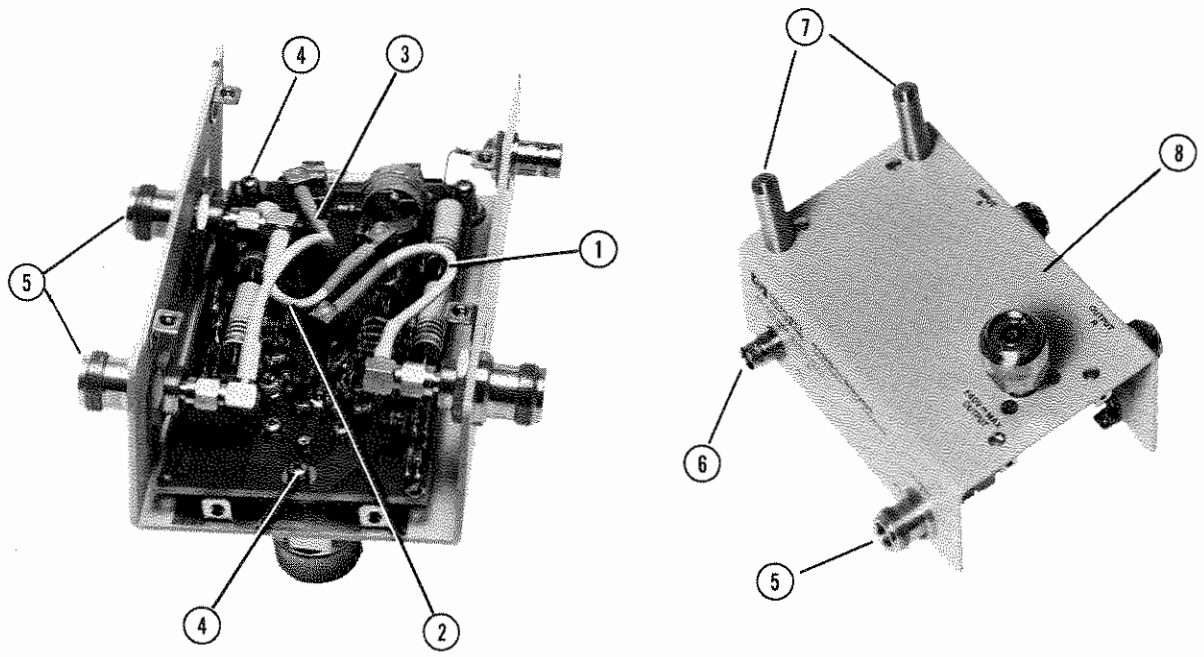



| Reference Designator | HP Part Number | Qty. | Description |
|---|---|---|---|
| 1 | 41951-21001 | 1 | Flange |
| 2 | 41951-04001 | 1 | Top Cover |
| 3 | 0515-0914 | 3 | Screw |
| 4 | 41951-23001 | 1 | Center Conductor |
| 5 | 5040-0306 | 1 | Insulator |
| 6 | 1250-0816 | 1 | Connector-RF |
| 7 | 1250-1466 | 1 | Connector-RF APC-7 ( with a cap ) |



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Table 6-3. Replaceable Parts List ( except for board )




| Reference Designator | HP Part Number | Qty. | Description |
|---|---|---|---|
| 1 | 41951-61604 | 1 | Cable Assembly |
| 2 | 41951-61601 | 1 | Cable Assembly |
| 3 | 41951-61603 | 1 | Cable Assembly |
| 4 | 0515-1550 | 5 | Screw |
| 5 | 1250-1811 | 3 | N(f)-SMA(f) Adapter ( with Nut and Washer ) |
| 6 | 1250-0083 | 1 | Connector-RF BNC |
| | 2190-0016 | 1 | Washer |
| | 2950-0001 | 1 | Nut |
| 7 | 41951-24001 | 2 | Post |
| | 2190-0084 | 2 | Washer |
| | 2950-0006 | 2 | Nut |
| 8 | 41951-04001 | 1 | Top Cover |
| | 41951-04002 | 1 | Bottom Cover |
| | 0515-0914 | 8 | Screw |
| | 6960-0016 | 3 | Plug-Hole |



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**LOS LOMAS**, Mexico, D.F.
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