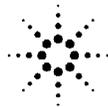


Agilent 41900A PI-Network Test Fixture  
**Operation and Service Manual**



**Agilent Technologies**

**Agilent Part No. 41900-90020  
Printed in JAPAN January 2000**

**Fourth Edition**

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

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March 1998 .....	Third Edition (part number: 41900-90010)
January 2000 .....	Fourth Edition (part number: 41900-90020)

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## Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific **WARNINGS** 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.

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#### Warning



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

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## Safety Symbols

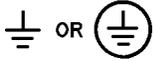
General definitions of safety symbols used on equipment or in manuals:



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

### Note



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

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## General Information

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### Introduction

The purpose of this manual is to enable you to use your 41900A PI-Network Test Fixture efficiently and confidently. This manual contains the following:

- The specifications of the 41900A (see this chapter).
- Installing the 41900A (see chapter 2).
- Operating the 41900A (see chapter 3).
- Ordering replaceable parts for the 41900A (see chapter 4).

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### Specifications

This section lists the complete 41900A specifications. These specifications are the performance standards and limits against which the 41900A is tested. When shipped from the factory, the 41900A meets the following specifications:

#### For the 41900A

**Available Test Device** ..... Leaded Crystal Resonator

**Available Measurement Configuration** .... Direct Measurement or Measurement with Load Capacitor

#### Dimensions

PI-Network Test Fixture Main Assembly ..... approx. 30 (H) × 50 (W) × 110 (D) mm

#### Weight

PI-Network Test Fixture Main Assembly ..... approx. 0.4 kg

#### For the 41900A used with the 87510A

The following specifications show the performance when the 41900A is used with the 87510A Gain-Phase Analyzer:

**Calibration method** ..... 3-term calibration (OPEN/SHORT/LOAD)  
(at the measurement terminal to which a device under test (DUT) is connected)

#### Circuit model of the calibration standards

OPEN Capacitance :  $C_0$

SHORT and LOAD Impedance @ frequency  $f$ :

$$R_0 + R_0 \left( \frac{f}{f_C} \right)^2 + j2\pi f L_0$$

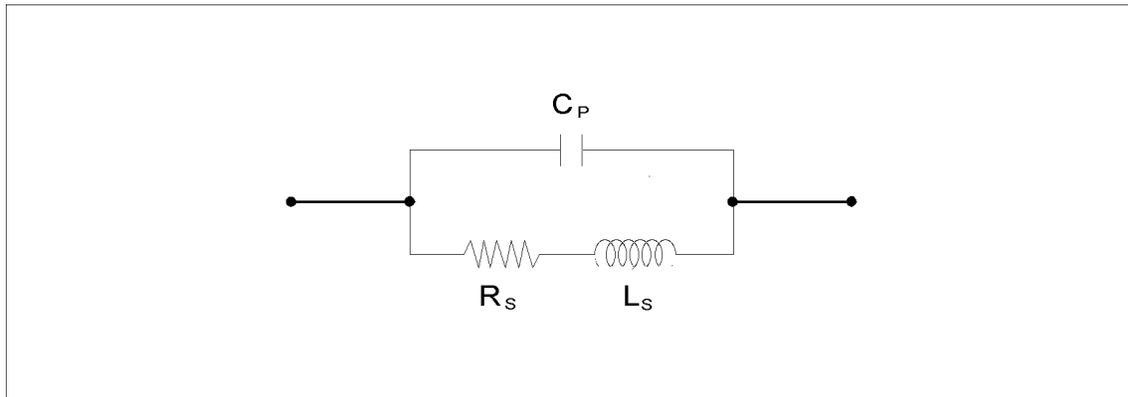
Parameters:

**Table 1-1. Parameters**

Standard	Value
OPEN	$C_0 = 0.1 \text{ pF}$
SHORT	$R_0 = 1 \text{ } \mu\Omega$ $L_0 = 0.6 \text{ nH}$
LOAD	$f_C = 1.1 \text{ GHz}$ $R_0 = 50 \text{ } \Omega$ $L_0 = 14 \text{ nH}$ $f_C = 1.1 \text{ GHz}$

**For the 41900A used with the E5100A/B**

The following specifications show the performance when the 41900A is used with the E5100A/B Network Analyzer:



AH001001

**Figure 1-1. Circuit model of the calibration standards**

Parameters:

**Table 1-2. Parameters**

Standard	Value
OPEN	$C_P = 0.1 \text{ pF}$ $R_S = 1 \text{ T}\Omega$ $L_S = 0 \text{ nH}$
SHORT	$C_P = 17.409 \text{ pF}$ $R_S = 1 \text{ } \mu\Omega$ $L_S = 0.6 \text{ nH}$
LOAD	$C_P = 0.703 \text{ pF}$ $R_S = 50 \text{ } \Omega$ $L_S = 15.7587 \text{ nH}$

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## Supplemental Performance Characteristics

This section lists supplemental performance characteristics. Supplemental performance characteristics are not specifications, but do provide additional information for the operator. Supplemental performance characteristics are not guaranteed.

### For the 41900A

<b>Maximum Input Level</b> .....	500 mW @ Input BNC Connector (approx. 7 mW @ device under test)
<b>Frequency Range</b> .....	1 MHz to 200 MHz
Repeatability	
Connection of the Shorting Plate .....	$\pm (0.1 \Omega + 0.6 \text{ nH})$
Connection of a leaded crystal resonator .....	$\pm (0.1 \Omega + 2 \text{ nH})$



## Preparation for Use

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### Introduction

This chapter describes how to prepare the 41900A PI-Network Test Fixture for use. The topics include the following:

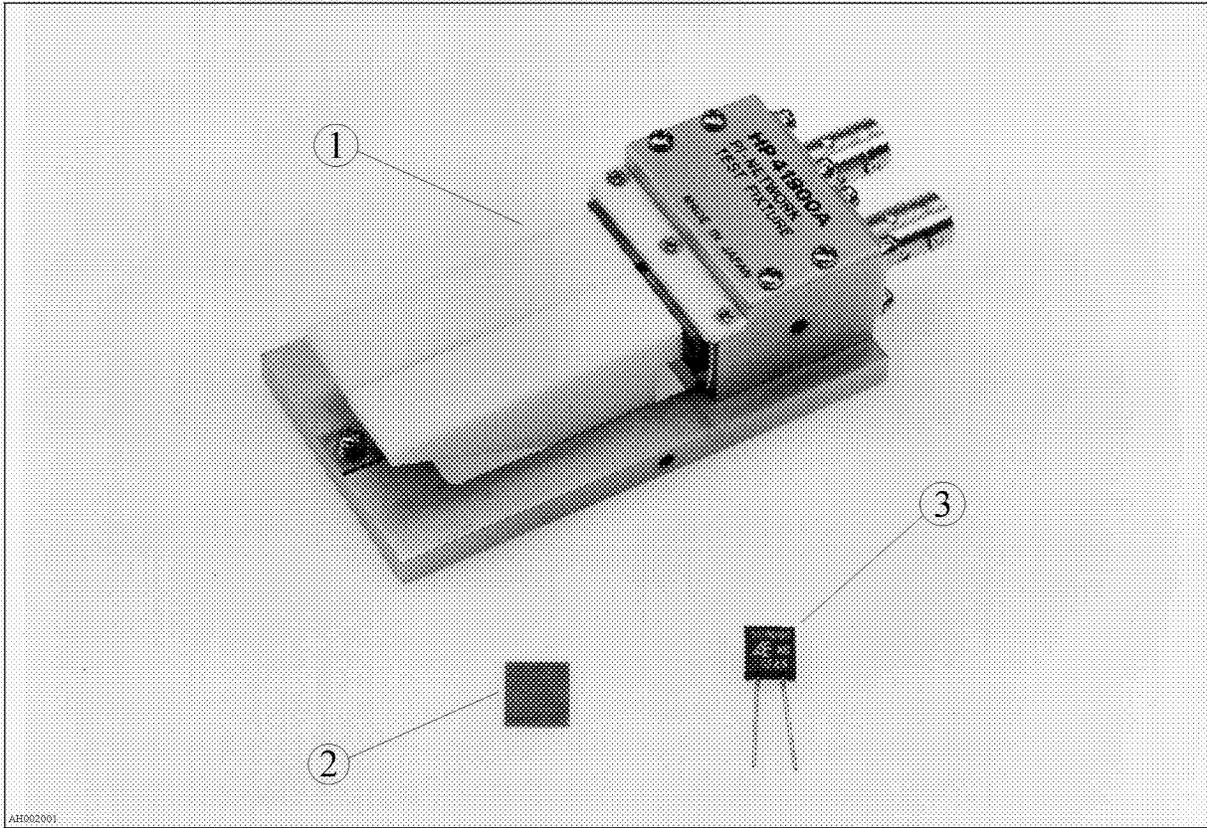
- Initial inspection.
- Repackaging the 41900A for shipment.

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### Initial Inspection

The 41900A 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 fixture 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. If the 41900A is ordered with Option 001 (Load Capacitor Adapter Kit), it should also contain the parts listed in Table 2-2.
3. Inspect the exterior of the 41900A for any signs of damage.

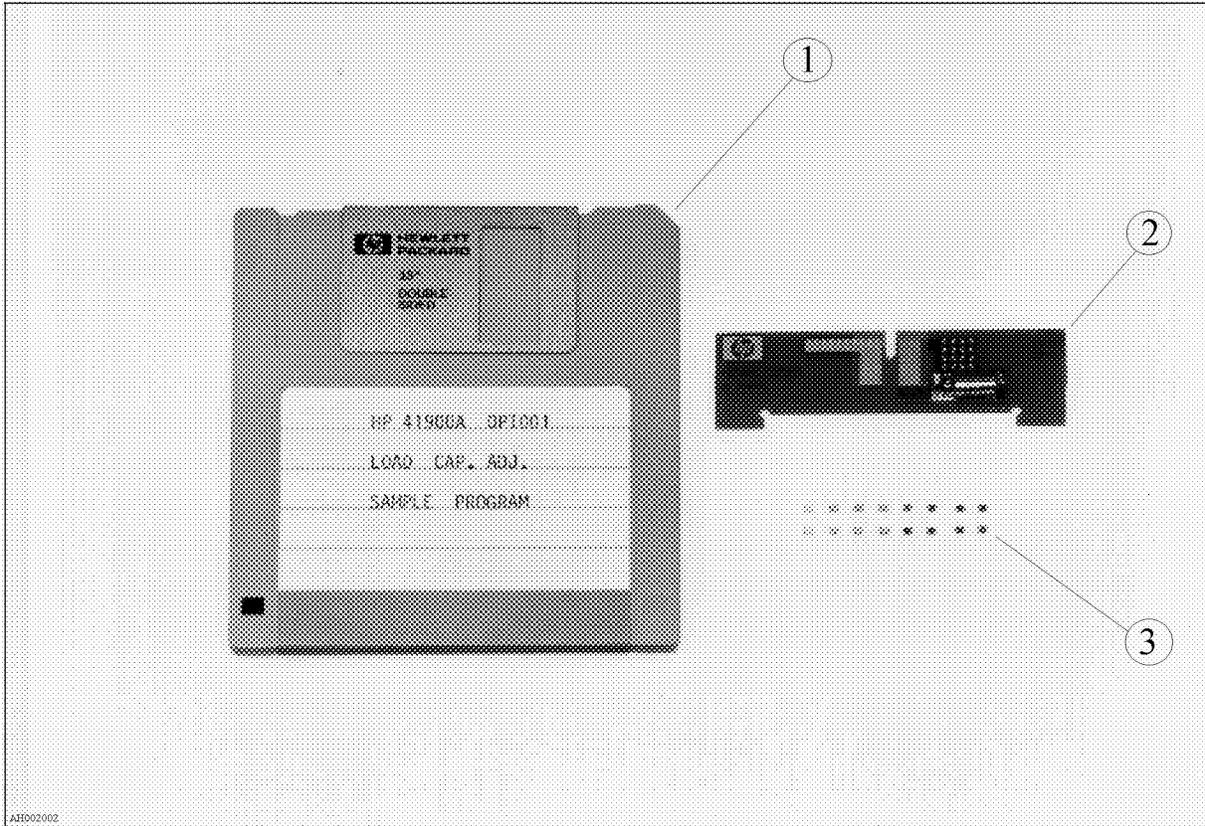


**Figure 2-1. 41900A PI-Network Test Fixture Product Overview**

**Table 2-1. 41900A Contents**

<b>Reference Designator</b>	<b>Agilent Part Number</b>	<b>Description</b>	<b>Qty.</b>
1	(Not assigned)	PI-Network Test Fixture Main Assembly	1
2	41900-29002	Shorting Plate for Calibration	1
3	0699-2014	50 $\Omega$ Resistor for Calibration	1
-	41900-66001	C <sub>L</sub> Adapter Board Kit <sup>1</sup>	
		5.0pF Fixed CL Board	1
		5.5pF Fixed CL Board	1
		6.0pF Fixed CL Board	1
		7.0pF Fixed CL Board	1
-	41900-66002	C <sub>L</sub> Adapter Board Kit <sup>1</sup>	
		8.0pF Fixed CL Board	1
		9.0pF Fixed CL Board	1
		10.0pF Fixed CL Board	1
		11.0pF Fixed CL Board	1
-	41900-66003	C <sub>L</sub> Adapter Board Kit <sup>1</sup>	
		12.0pF Fixed CL Board	1
		13.0pF Fixed CL Board	1
		14.0pF Fixed CL Board	1
		16.0pF Fixed CL Board	1
-	41900-66004	C <sub>L</sub> Adapter Board Kit <sup>1</sup>	
		18.0pF Fixed CL Board	1
		20.0pF Fixed CL Board	1
		24.0pF Fixed CL Board	1
		32.0pF Fixed CL Board	1
-	41900-90020	Operation and Service Manual <sup>1</sup>	1

<sup>1</sup> Not shown in the figure.



**Figure 2-2. Option 001 Load Capacitor Adapter Kit Product Overview**

**Table 2-2. Option 001 Contents**

Reference Designator	Agilent Part Number	Qty.	Description
1	41900-87001	1	C <sub>L</sub> Adjustment Sample Program Disk
2	41900-66501	1	Blank C <sub>L</sub> Adapter Board
3	0160-5942	2	Capacitor, 1 pF
3	0160-5978	2	Capacitor, 2.2 pF
3	0160-5971	2	Capacitor, 4.7 pF
3	0160-5973	2	Capacitor, 6.8 pF
3	0160-5975	2	Capacitor, 10 pF
3	0160-5962	2	Capacitor, 15 pF
3	0160-5961	2	Capacitor, 22 pF
3	0699-3752	2	Resistor, 0 Ω

---

## **Repackaging the 41900A for Shipment**

If shipment to a Agilent Technologies service center is required, the 41900A should be repackaged using the original factory packaging materials.

If this material is not available, comparable packaging materials may be used. Wrap the 41900A in heavy paper and pack in anti-static plastic packing material. Use sufficient shock absorbing material on all sides of the 41900A to provide a thick, firm cushion and to prevent movement. Seal the shipping container securely and mark it *FRAGILE*.



## Operation

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### Introduction

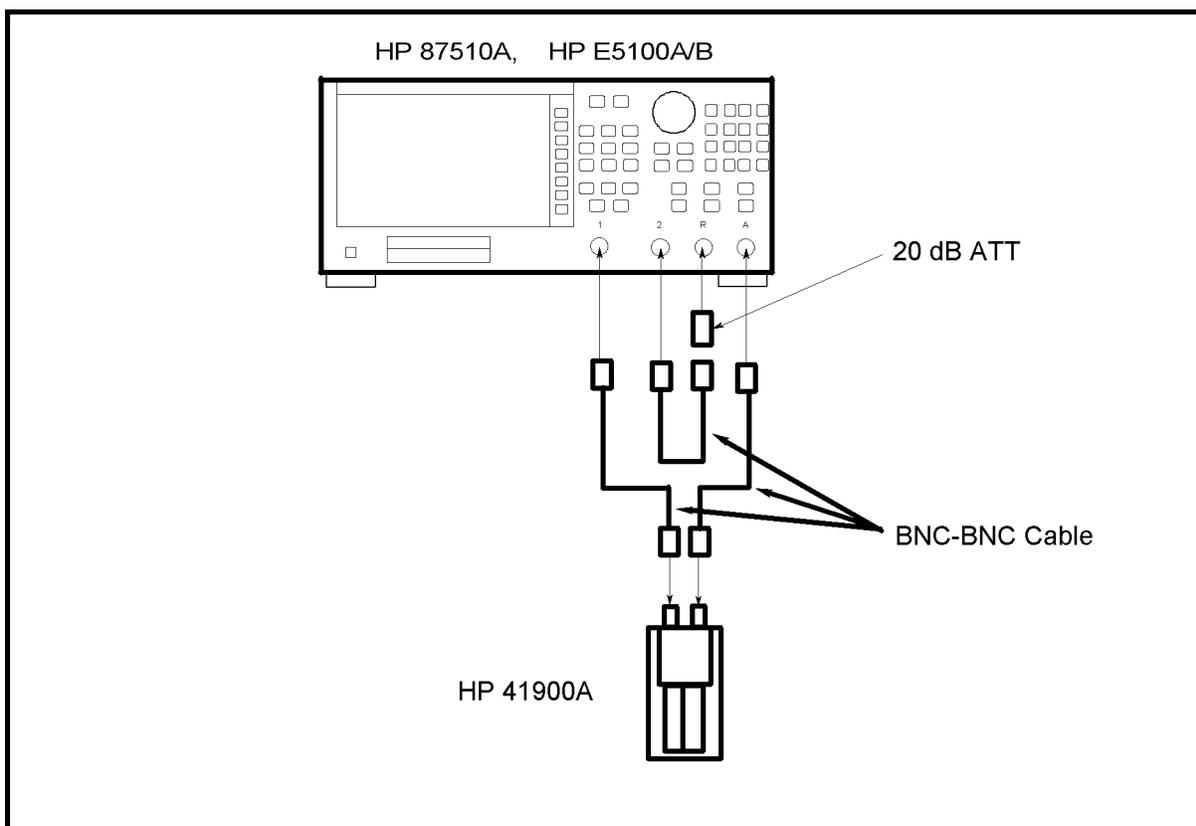
This chapter describes how to use the 41900A. The topics include the following:

- Connecting the 41900A for Use.
- Using the Sample Programs (Option 001).

---

### Connecting the 41900A for Use

Figure 3-1 shows how to connect the 41900A to the 87510A Gain-Phase Analyzer, E5100A/B Network Analyzer. If the instrument is the E5100A/B with option 600, the connection of the 20dB ATT is not necessary.



AH003002

Figure 3-1. Connecting the 41900A to the 87510A, E5100A/B

## Assembling the $C_L$ Adapter Board (Option 001)

The  $C_L$  Adapter Board initially has only a trimmer capacitor on it. It is necessary to choose the appropriate capacitors and then solder them on the board to provide the required load capacitance ( $C_L$ ). Figure 3-2 shows a circuit diagram of the  $C_L$  Adapter Board and Table 3-1 lists an example of the  $C_1$ ,  $C_2$ ,  $C_S$  combinations to obtain the required load capacitance.

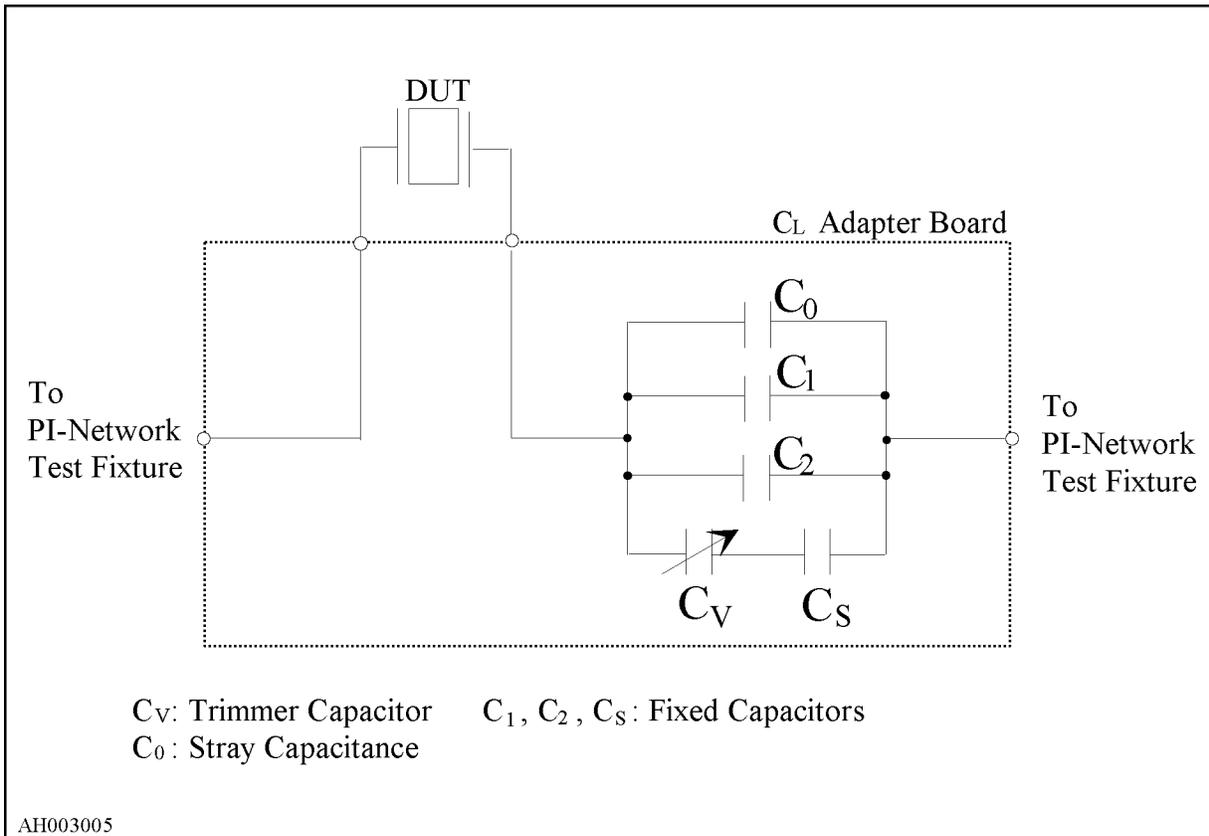
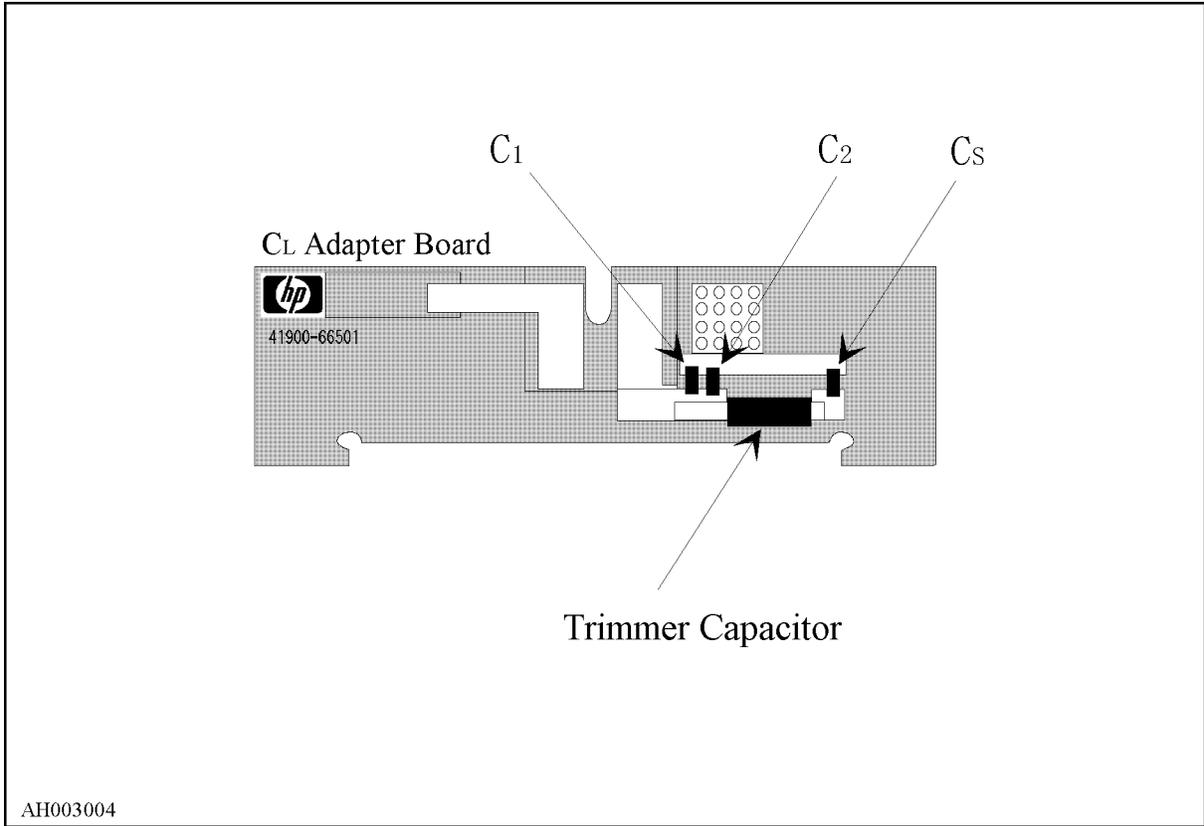


Figure 3-2.  $C_L$  Adapter Board Circuit Diagram

**Table 3-1. Example of C<sub>1</sub>, C<sub>2</sub>, C<sub>s</sub> Combinations**

<b>C<sub>L</sub> [pF]</b>	<b>C<sub>1</sub> [pF]</b>	<b>C<sub>2</sub> [pF]</b>	<b>C<sub>s</sub> [pF]</b>	<b>C<sub>Lmin</sub> [pF]</b>	<b>C<sub>Lmax</sub> [pF]</b>
33	22	6.8	(short)	31.7	35.6
32	22	4.7	(short)	29.6	33.5
31	22	4.7	(short)	29.6	33.5
30	15	10	(short)	27.9	31.8
29	22	2.2	(short)	27.1	31.0
28	22	1	(short)	25.9	29.8
27	22	(open)	(short)	24.9	28.8
26	15	6.8	(short)	24.7	28.8
25	10	10	(short)	22.9	26.8
24	15	4.7	(short)	22.6	26.5
23	15	2.2	(short)	20.1	24.0
22	10	6.8	(short)	19.7	23.6
21	15	1	(short)	18.9	22.8
20	10	4.7	(short)	17.6	21.5
19	10	4.7	(short)	17.6	21.5
18	10	2.2	(short)	15.1	19.0
17	6.8	4.7	(short)	14.4	18.3
16	6.8	4.7	22	14.4	17.5
15	10	(open)	22	12.9	16.0
14	4.7	4.7	22	12.3	15.4
13	6.8	2.2	22	11.9	15.0
12	6.8	1	22	10.7	13.8
11	6.8	(open)	22	9.7	12.8
10	4.7	1	22	8.6	11.7
9	2.2	2.2	22	7.1	10.4
8	2.2	1	15	6.1	8.9
7	2.2	(open)	15	5.1	7.9
6	2.2	(open)	15	5.1	7.9
5	1	(open)	15	3.9	6.7
4	(open)	(open)	15	2.9	5.7



AH003004

**Figure 3-3. C<sub>1</sub>, C<sub>2</sub>, C<sub>S</sub> Location**

**Note**



To short the C<sub>S</sub> location on the C<sub>L</sub> Adapter Board, mount the 0 Ω Resistor (Agilent Part Number 0699-3752) instead of a capacitor. To open the C<sub>1</sub> or C<sub>2</sub> location on the C<sub>L</sub> Adapter Board, do not mount any components.

---

## Using the Sample Programs (Option 001)

The sample programs included in the disk (Agilent Part Number 41900-87002) are used to perform the 3-Term Calibration and the load capacitance ( $C_L$ ) adjustment for the 41900A PI-Network Test Fixture. The program which file name is “FLCI\_EQV” and “CAP\_ADJ” should be used with the 87510A Gain-Phase Analyzer. The program which is “FLCI\_EQV.BAS” and “CAP\_ADJ.BAS” should be used with the E5100A/B Network Analyzer.

The file names of the sample programs contained in the sample program disk are as follows:

**Table 3-2. Contents of Disk**

Filename	File Type	Description
FLCI_EQV	ASCII	3-Term Calibration and $C_L$ Adjustment Program including measurement setup and equivalent circuit analysis routine.
FLCI_EQV.BAS	DOS	ibid.
CAP_ADJ	ASCII	3-Term Calibration and $C_L$ Adjustment Program (an extract of “FLCI_EQV”).
CAP_ADJ.BAS	DOS	ibid. (an extract of “FLCI_EQV.BAS”).
PI_DATA	BDAT	Calibration Data File (used in “FLCI_EQV” and “CAP_ADJ”).
E5100a.DAT	BDAT	Calibration Data File (used in “FLCI_EQV.BAS” and “CAP_ADJ.BAS”).

### Connecting the 41900A to the 87510A, E5100A/B

1. Turn the 87510A, E5100A/B ON.
2. Connect the 41900A to the 87510A, E5100A/B as shown in Figure 3-1.

### Executing the Sample Program

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**Note**

The sample program can be used with or without an external keyboard. However, it is recommended that you use an external keyboard to enter the required parameters.

- 
1. Insert the disk into the disk drive of the 87510A, E5100A/B.
  2. Get the program, “FLCI\_EQV” or “FLCI\_EQV.BAS”.
  3. Run the program.
  4. “Center frequency ? (MHz)” is displayed on the bottom of the display. Enter the required center frequency in MHz and press **(X1)** on the 87510A’s front panel, **(Enter)** on the E5100A/B’s front panel or **(Return)** on the external keyboard.
  5. “Span frequency” is displayed on the bottom of the display. Enter the required span frequency in kHz and press **(X1)** on the 87510A’s front panel, **(Enter)** on the E5100A/B’s front panel or **(Return)** on the external keyboard.
  6. “POWER ( $\mu W$ )” is displayed on the bottom of the display. Enter the required test signal power in  $\mu W$  that should be applied to the DUT (device under test). Press **(X1)** on the 87510A’s front panel, **(Enter)** on the E5100A/B’s front panel or **(Return)** on the external keyboard. To enter the default power (10  $\mu W$ ), just press **(X1)**, **(Enter)** or **(Return)**.

7. "RESISTANCE (OHM)" is displayed on the bottom of the display. Enter the resonant resistance of the DUT in  $\Omega$  and press **(X1)** of the 87510A's front panel, **(Enter)** on the E5100A/B's front panel or **(Return)** on the external keyboard. This resistance is used to set the signal power at the output connector of the 87510A, E5100A/B. To enter the default resistance (15  $\Omega$ ), just press **(X1)**, **(Enter)** or **(Return)**.
8. Predefined standard values for the calibration and "MODIFY ? (Yes=1, No=0, DEFAULT=0)" are displayed on the bottom half of the display.

To change the constants:

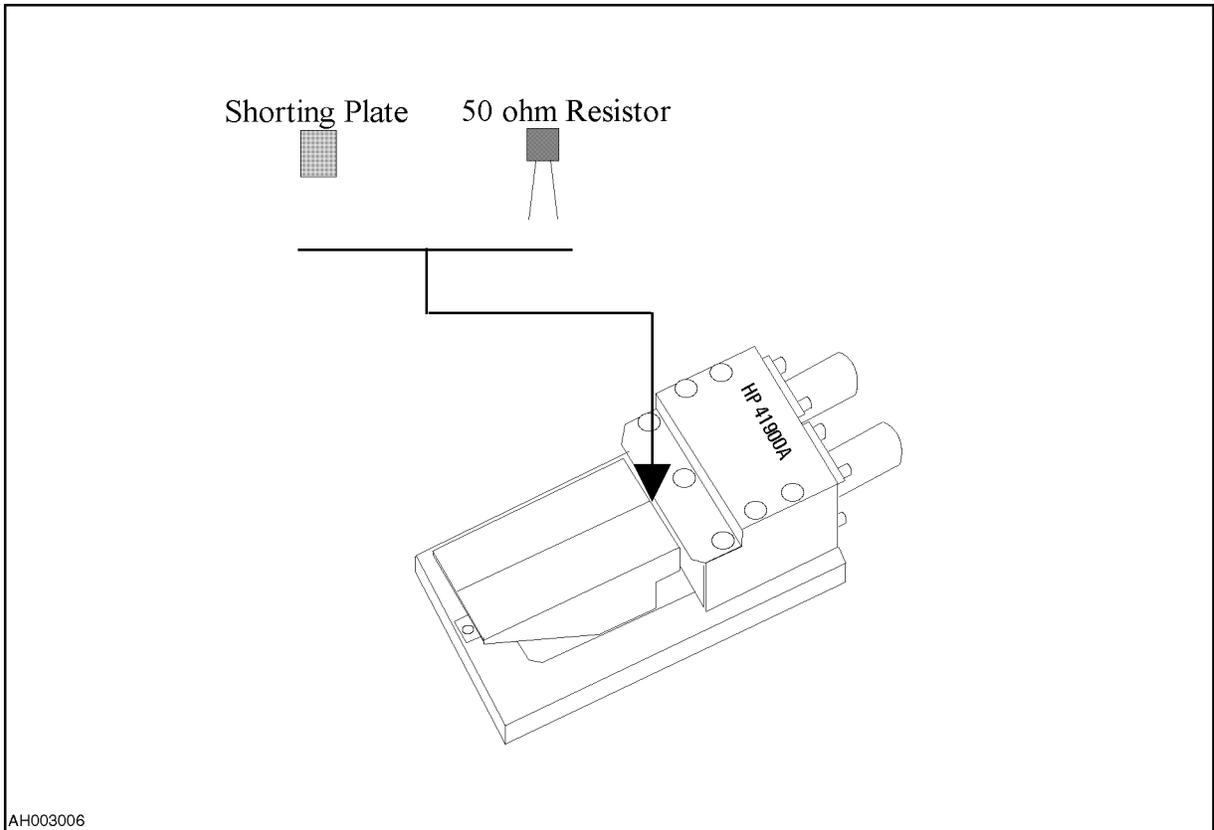
- a. Type 1 and then press **(X1)** on the 87510A's front panel, **(Enter)** on the E5100A/B's front panel or **(Return)** on the external keyboard to modify the standard values.
- b. The 87510A, E5100A/B asks for a new standard value for each parameter. Enter a new value using the numeric keys and then press **(X1)**, **(Enter)** or **(Return)**.

If you do not want to change the value, just press **(X1)** on the 87510A's front panel, **(Enter)** on the E5100A/B's front panel or **(Return)** on the external keyboard for each standard.

- c. After modifying the standard values, the 87510A, E5100A/B asks you to save the new data to the data file. If you want to save the modified data, press **(X1)** on the 87510A's front panel, **(Enter)** on the E5100A/B's front panel or **(Return)** of the external keyboard. The saved data is used as the default setting the next time you run the program. If you want to use the predefined data, purge the file "PI\_DATA" for the 87510A or "E5100a.DAT" for the E5100A/B from the disk.

9. Set the positioning plate as shown in Figure 3-4. Connect the standards as follows and make the measurements:

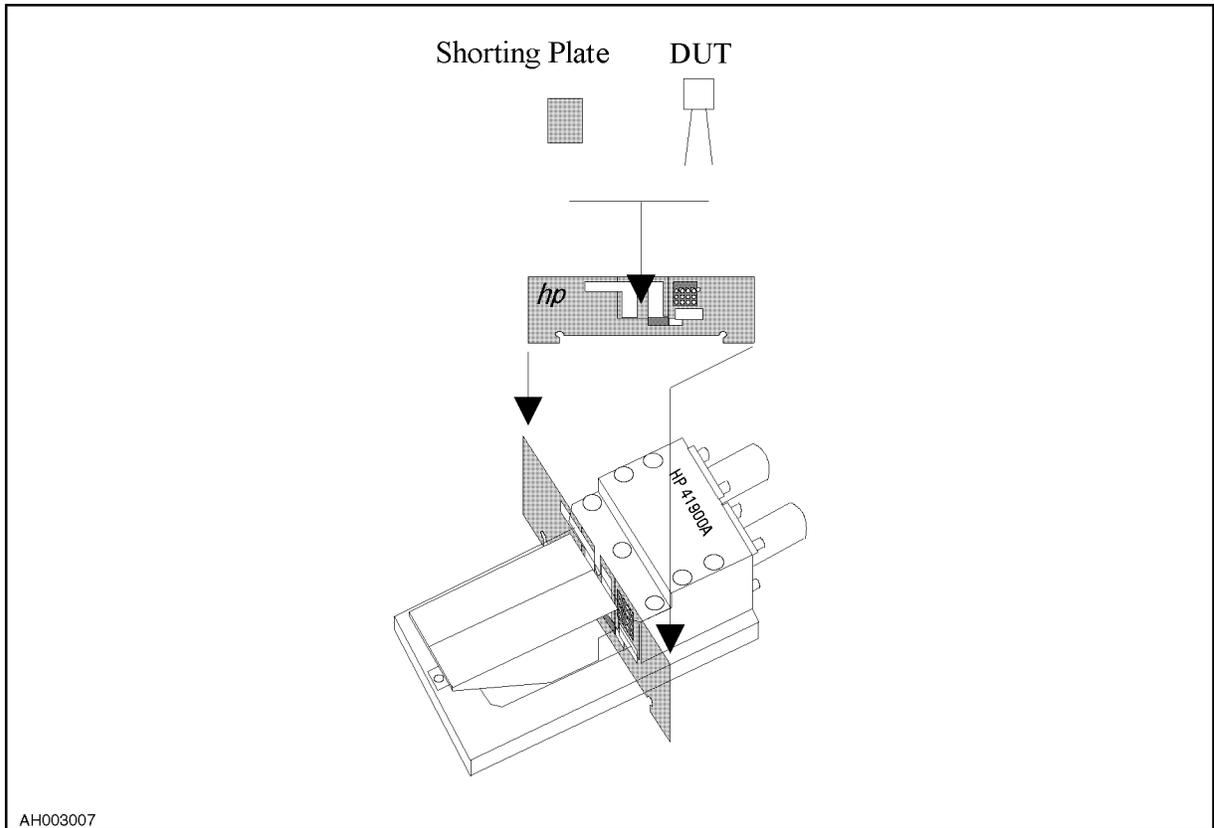
OPEN	Verify that nothing is connected to the electrodes of the 41900A, then press <b>OPEN</b> on the 87510A's or E5100A/B's front panel. When completed, double parentheses enclose the <b>OPEN</b> softkey label.
SHORT	Connect the Shorting Plate as shown in Figure 3-4, then press <b>SHORT</b> on the 87510A's or E5100A/B's front panel. When completed, double parentheses enclose the <b>SHORT</b> softkey label.
LOAD	Connect the 50 $\Omega$ Resistor as shown in Figure 3-4, then press <b>LOAD</b> on the 87510A's or E5100A/B's front panel. When completed, double parentheses enclose the <b>LOAD</b> key label.



**Figure 3-4. SHORT and LOAD Calibration**

To abort the calibration, press **CAL BREAK**. The program is terminated by this key.

10. After completing the measurement of the standards, press **DONE: 3 TERM CAL** on the 87510A's or E5100A/B's front panel to complete the calibration.  
 "COMPUTING CAL COEFFICIENTS" is displayed while the 87510A, E5100A/B is calculating the calibration coefficients.
11. Enter the frequency for the load capacitance adjustment in MHz and press **(X1)** on the 87510A's front panel, **(Enter)** on the E5100A/B's front panel or **(Return)** on the external keyboard.
12. Insert the **C<sub>L</sub> Adapter Board** and **Shorting Plate** as shown in Figure 3-5, and then press softkey **Continue** on the 87510A, E5100A/B or **(F2)** of the external keyboard.



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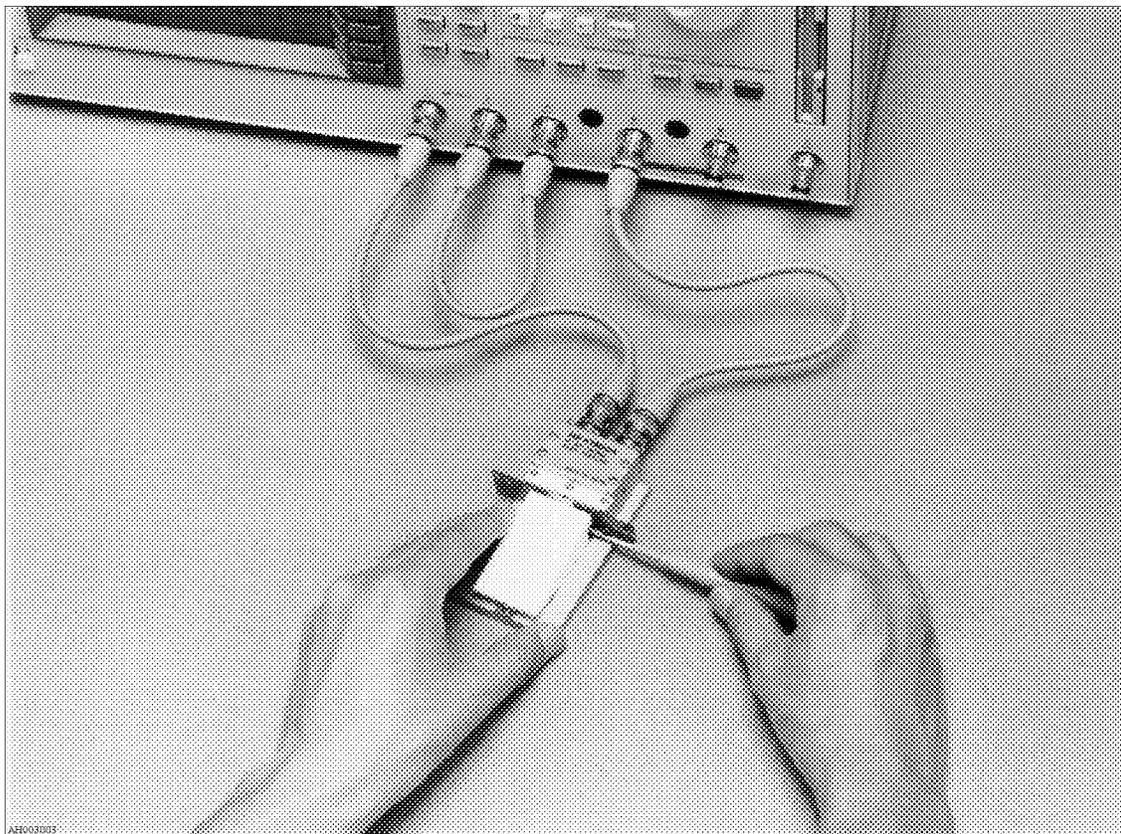
**Figure 3-5.  $C_L$  Adapter Board Insertion**

13. Load capacitance  $C_L$  is measured continuously and the result is displayed on the display.
14. Adjust the load capacitance with a screw driver as shown in Figure 3-6.

**Note**



Use a screwdriver with a ceramic or plastic blade to adjust the trimmer capacitor. *VESSEL® Ceramic Adjustment Screwdriver No.9000 (-) 1.8×30* is recommended.



**Figure 3-6. Load Capacitance Adjustment**

15. Press softkey **ADJUSTMENT END** on the 87510A or E5100A/B after completing the adjustment.
16. Replace the Shorting Plate with the DUT as shown in Figure 3-5.  
This is the end of the  $C_L$  adjustment procedure. If it is necessary to obtain the equivalent circuit parameters of the DUT, perform the remaining steps.
17. Press softkey **Continue** on the 87510A, E5100A/B or **(F2)** on the external keyboard.  
Frequency characteristics and the following parameters of the DUT are displayed:

**Table 3-3. Parameters Measured**

<b>Parameter</b>	<b>Unit</b>
Resonance Frequency ( $F_r$ )	MHz
Resonance Impedance CI ( $Z_r$ )	$\Omega$
Shunt Capacitance ( $C_0$ )	pF
Motional Capacitance ( $C_1$ )	pF
Motional Inductance ( $L_1$ )	mH
Motional Resistance ( $R_1$ )	$\Omega$

18. Connect a new DUT and press softkey **Continue** on the 87510A, E5100A/B Network Analyzer or **(F2)** on the external keyboard.

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**Note**

To skip the steps 4 through 7 and 17 through 18, use the program “CAP\_ADJ” or “CAP\_ADJ.BAS”.



## Service

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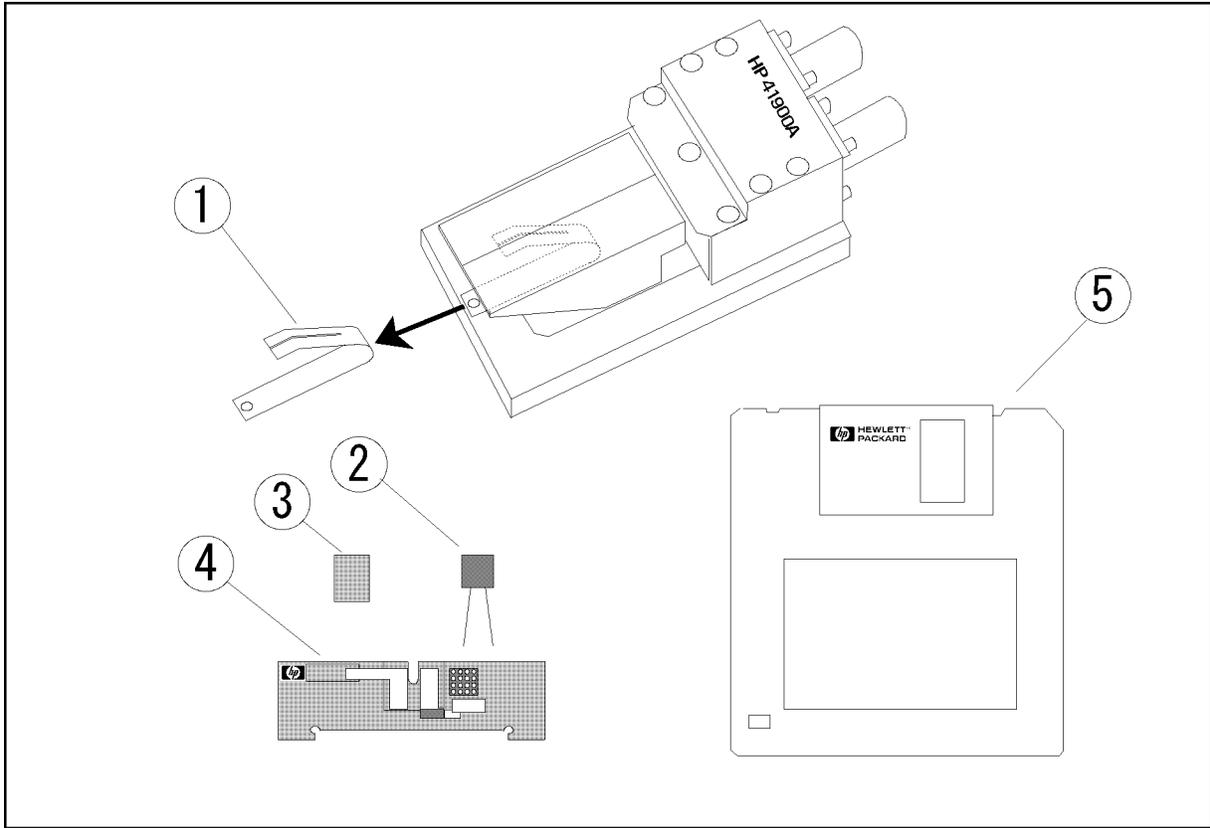
### Introduction

This chapter covers the replaceable parts information for the 41900A.

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### 41900A Replaceable Parts

Table 4-1 lists the replaceable parts for the 41900A. The parts listed can be ordered from your nearest Agilent Technologies Office. Ordering information must include the Agilent part number and the quantity required.



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Figure 4-1. Replaceable Parts

**Table 4-1. Replaceable Parts**

<b>Reference Designator</b>	<b>Agilent Part Number</b>	<b>Qty.</b>	<b>Description</b>
1	41900-08001	1	Spring
2	0699-2014	1	50 $\Omega$ Resistor for Calibration
3	41900-29001	1	Shorting Plate
-	41900-66001		C <sub>L</sub> Adapter Board Kit <sup>1</sup>
		1	5.0pF Fixed CL Board
		1	5.5pF Fixed CL Board
		1	6.0pF Fixed CL Board
		1	7.0pF Fixed CL Board
-	41900-66002		C <sub>L</sub> Adapter Board Kit <sup>1</sup>
		1	8.0pF Fixed CL Board
		1	9.0pF Fixed CL Board
		1	10.0pF Fixed CL Board
		1	11.0pF Fixed CL Board
-	41900-66003		C <sub>L</sub> Adapter Board Kit <sup>1</sup>
		1	12.0pF Fixed CL Board
		1	13.0pF Fixed CL Board
		1	14.0pF Fixed CL Board
		1	16.0pF Fixed CL Board
-	41900-66004		C <sub>L</sub> Adapter Board Kit <sup>1</sup>
		1	18.0pF Fixed CL Board
		1	20.0pF Fixed CL Board
		1	24.0pF Fixed CL Board
		1	32.0pF Fixed CL Board
4	41900-66501	1	Blank C <sub>L</sub> Adapter Board
-	0160-5942	2	Capacitor, 1 pF
-	0160-5978	2	Capacitor, 2.2 pF
-	0160-5971	2	Capacitor, 4.7 pF
-	0160-5973	2	Capacitor, 6.8 pF
-	0160-5975	2	Capacitor, 10 pF
-	0160-5962	2	Capacitor, 15 pF
-	0160-5961	2	Capacitor, 22 pF
-	0699-3752	2	Resistor, 0 $\Omega$
5	41900-87001	1	C <sub>L</sub> Adjustment Sample Program Disk
-	41900-90020	1	Operation and Service Manual <sup>1</sup>

<sup>1</sup> Not shown in the figure.

**Note**



Repair of the 41900A PI-Network Test Fixture is limited to the replacement of the parts listed in Table 4-1.

