Agilent 4396B Network/Spectrum/Impedance Analyzer Option 010

Operating Handbook

SERIAL NUMBERS

This manual applies directly to instruments which has the serial number prefix JP1KE.
For additional important information about serial
numbers, read "Serial Number" in Appendix A.

Agilent Technologies

Agilent Part No. 04396-90046
Printed in JAPAN November 2002

Fourth Edition

Notice

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

Agilent Technologies Japan, Ltd.
Component Test PGU-Kobe
1-3-2, Murotani, Nishi-ku, Kobe-shi,
Hyogo, 651-2241 Japan

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.

March 1997 .... First Edition (part number: 04396-97026)

July 1997 .... Second Edition (part number: 04396-90036)

March 2000 .... Third Edition (part number: 04396-90036)

November 2002 .... Fourth Edition (part number: 04396-90046)

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: **icons** are symbols.
Italics	Italic type is used for emphasis and for titles of manuals and other publications.
	Italic type is also used for keyboard entries when a name or a variable must be typed in place of the words in italics. For example: `copy` *filename* means to type the word `copy`, to type a space, and then to type the name of a file such as `file1`.
`Computer`	Computer font is used for on-screen prompts and messages.
(HARDKEYS)	Labeled keys on the instrument front panel are enclosed in ( ).
SOFTKEYS	Softkeys located to the right of the CRT are enclosed in .

How to Use This Manual

This manual describes the unique impedance measurement functions of the 4396B with Option 010. It also provides operation tutorials and technical information.

This manual is a supplement for the *Function Reference* Manual and the *Task Reference* Manual. This manual does not describe the information already described in the standard spectrum/network analyzer manuals. Use these manuals along with this manual when using an analyzer that has Option 10 installed.

Chapter 1 Product Overview

Provides overviews of the impedance measurement functions. It also provides the contents of the 43961A Impedance Test Kit and a list of available accessories.

Chapter 2 Operation Tutorial

Provides the operation tutorial for the impedance measurement functions. You can use this tutorial to quickly understand the basic operation flow of the impedance measurement. If you have not used the impedance measurement of the analyzer, perform this tutorial first.

Chatper 3 Task Reference

Provides operation procedures other than the tutorials. If you want to use the advanced functions that are provided with Option 010, read this chapter.

Chapter 4 Impedance Measurement Softkeys

Describes all softkey functions that are unique to the impedance measurement functions.

Chapter 5 Advanced Topics

Describes the basic concepts of the I-V measurement method that is used by the 4396B with the 43961A. This chapter also describes the voltage level applied to the DUT and the internal data processing.

Appendix A Manual Changes

Contains the information required to adapt this manual to earlier versions or configurations (if any exist) of the analyzer that are different from the current printing date of this manual.

Contents

3. Task Reference

4. Impedance Measurement Menu

Figures

Tables

1

Product Overview

This chapter provides information about the features provided by the Impedance Measurement Function (Option 010 of the 4396B Spectrum/Network/Impedance Analyzer) and the 43961A Impedance Test Kit. For additional information about the 4396B's features, see the *4396B Function Reference* manual. For the specification of the 4396B option 010,refer to the *4396B Function Reference* Chapter 10 Specification.

Product Overview

Option 010 adds the impedance measurement function to the 4396B. By installing this option into the 4396B spectrum/network/impedance analyzer, you can measure impedance parameters directly.

The 4396B with option 010 has the following added features:

- Directly displays the impedance measurement parameters.

  Measurement Parameters: $|Z|$, θ_z, R, X, $|Y|$, θ_y, G, B, $|\Gamma|$, θ_γ, Γ_x, Γ_y, Cp, Cs, Lp, Ls, Rp, Rs, D, Q

- Uses I-V method to measure impedance.

  Option 010 provides impedance measurements up to 1.8 GHz (a frequency range that was previously dominated by the reflection method using the network analyzer). The reflection coefficient method has difficulty measuring impedances that vary greatly from 50 Ω. However, the I-V (current and voltage) method can measure impedance equally well over a broad band impedance range.

- Provides OPEN/SHORT/LOAD fixture compensation and the port extension that eliminates additional errors by the fixture.

- External DC bias

  The 4396B and 43961A themselves do not have a function that applies DC voltage. However, you can apply DC bias by using an external power supply. The 43961A provides the external DC bias connector for this purpose.

- Equivalent Circuit Analysis

  There are 5 types of the equivalent circuit functions available. You can obtain the equivalent circuit parameters from the measured trace.

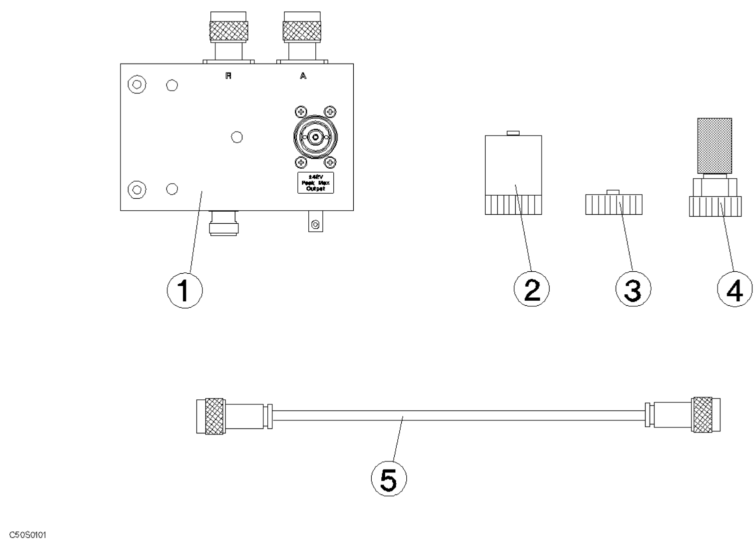
43961A Impedance Test Kit

The 43961A Impedance Test Kit is an impedance measurement accessory used by the 4396B.

Contents

Table 1-1 shows the contents of the 43961A Impedance Test Kit.

Table 1-1. Contents of the 43961A



No.	Description	Qty.	Agilent Part Number
1	Impedance Test Adapter	1	43961-61001
2	0 S Calibration Standard	1	04191-85302
3	0 Ω Calibration Standard	1	04191-85300
4	50 Ω Calibration Standard	1	04191-85301
5	N(m)-N(m) cable	1	41951-61602
	Carrying Case[1]	1	43961-60001
	Notice[1]	1	43961-90000

1 This part is not shown in above.

Dimention

Figure 1-1 shows the dimention of the 43961A.

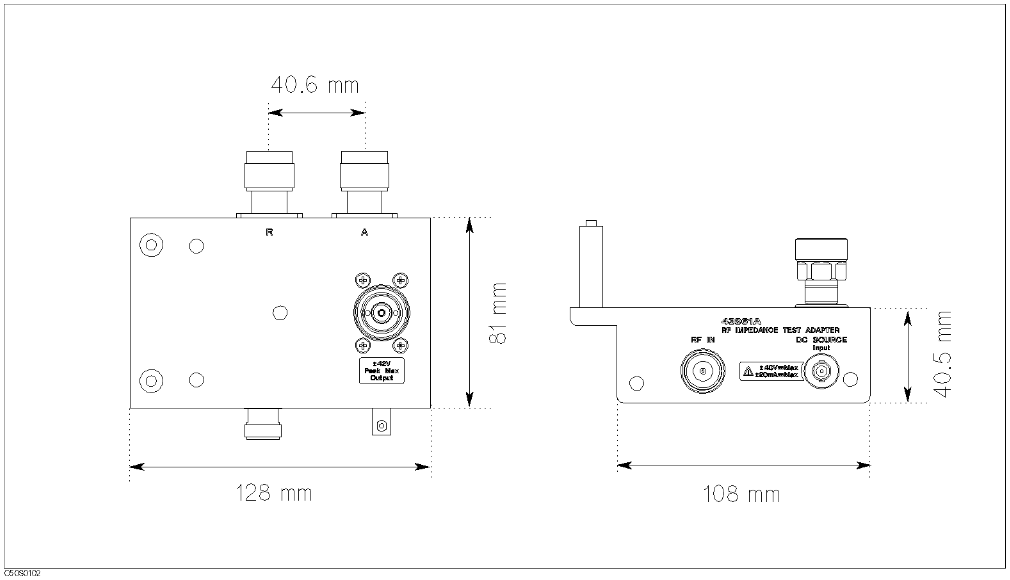


Figure 1-1. Dimention of the 43961A

Available Accessories

16191A Side electrode SMD test fixture

The 16191A is used to measure a side electrodes surface mount device (SMD) with high repeatability. The usable operating frequency is up 2 GHz.

16192A Parallel electrode SMD test fixture

The 16192A is used to measure a parallel electrodes surface mount device (SMD) with high repeatability. The usable operating frequency is up 2 GHz.

16193A Small side electrode SMD test fixture

The 16193A is used to measure a small, side electrodes surface mount device (SMD) with high repeatability. The usable operating frequency is up 2 GHz.

16194A High temperature component fixture

The 16194A is used to measure a component in wide temperature range. The operating temperature range is from −55°C through 200°C. The usable operating frequency is up to 2 GHz.

16091A Coaxial termination fixture set

The 16091A is suited to the measurement of lead-less material samples or small size, axial lead components whose leads can be shortened. Two types of fixtures are included in the fixture set to provide flexibility for various sample sizes. The usable operating frequency is up to 1 GHz.

16092A Spring clip test fixture

The 16092A provides a convenient capability for easily connecting and disconnecting samples. It has a usable operating frequency up to 500 MHz.

16093A/B Binding post test fixtures

The 16093A/B are suited for the measurement of relatively large size, axial and radial lead components or devices that do not fit other fixtures. The 16093A is provided with two small binding post measurement terminals set at 7 mm intervals. The usable frequency operating of the 16093A is up to 250 MHz. The 16093B employs a common type three binding post terminal arrangement that includes an extra guard post terminal. The terminal interval is 15 mm. The usable frequency operating of the 16093B is below 125 MHz.

16094A Probe test fixture

The 16094A provides probing capability for measuring circuit impedance and components mounted on circuit assemblies. The usable frequency operating of the 16094A is below 125 MHz.

2

Operation Tutorial

Overview

This chapter provides a quick start guide for impedance measurements using the analyzer. New users can quickly become familiar with the analyzer by performing the following procedures.

Required Equipment

Before starting tutorial, you need the following items:

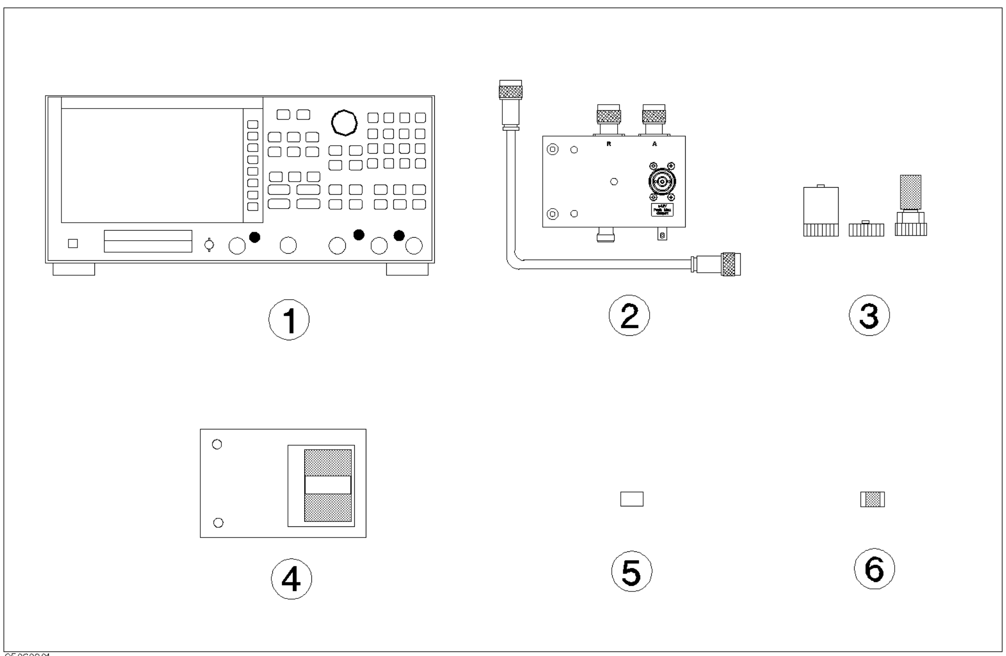


Figure 2-1. Required Equipment

1. 4396B with Option 010
2. 43961A Impedance Test Kit
3. Calibration Kit (furnished with the 43961A.)
4. Test Fixture
5. Shorting Device for the test fixture
6. Device to Measure

Basic Measurement Flow

The basic flow for an impedance measurement of the 4396B with Option 010 is as follows:

1. **Connect the 43961A Impedance Test Kit.**
2. **Set the impedance analyzer mode.**
3. **Set sweep parameters.**
4. **Set the output level.**
5. **Set IF bandwidth.**
6. **Perform calibration.**
7. **Connect the test fixture.**
8. **Perform fixture compensation.**
9. **Set the measurement parameters.**
10. **Connect the DUT to the test fixture.**
11. **Measure the DUT.**
12. **Analyze the measured result.**

The impedance analyzer requires two error correction procedures, calibration and fixture compensation. Calibration is required to prepare the impedance analyzer to measure the impedance correctly. Fixture compensation is required to eliminate the additional errors by an extension of the measurement port, such as the test fixture.

1. Connecting the 43961A Impedance Test Kit

To start the impedance measurement, you need to connect the 43961A Impedance Test Kit to the analyzer. See Figure 2-2.

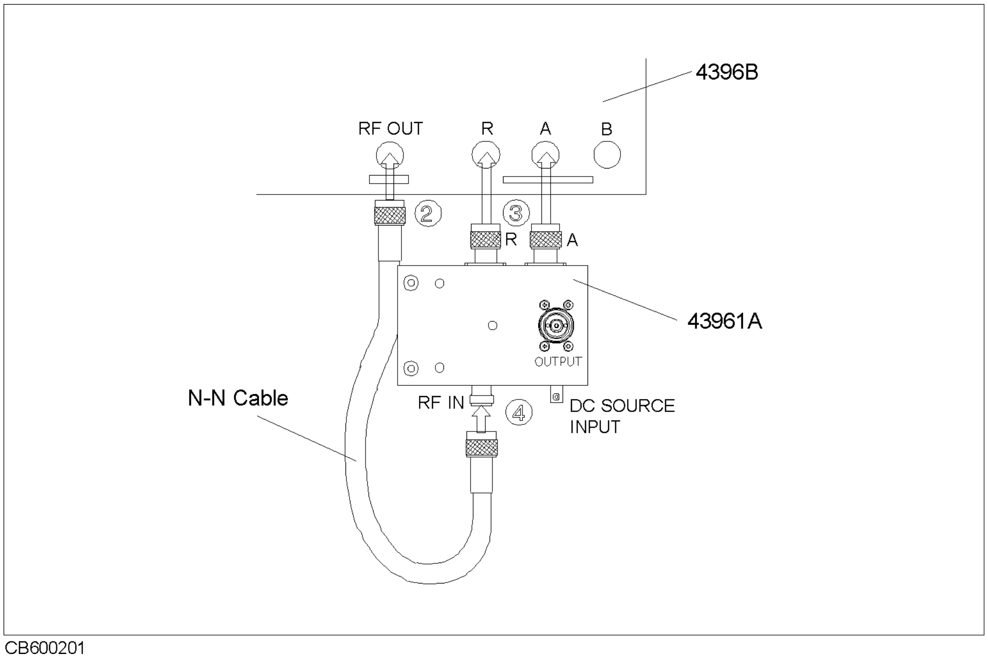


Figure 2-2. Connecting the Impedance Test Kit

1. Verify the 4396B is turned off.
2. Connect the N-cable to the RF OUT port of the analyzer.
3. Connect two connectors of the 43961A to the R and A ports of the 43961A.
4. Connect the other connector of the N-cable to the RF IN port of the 43961A.
5. Turn on the 4396B.

2. Setting the Impedance Analyzer Mode

1. Press (Meas) `ANALYZER TYPE`.
2. Press `IMPEDANCE ANALYZER`.

The active channel is set to the impedance analyzer mode.

3. Setting Sweep Parameters

This example sets the frequency range from 100 MHz to 1 GHz with a linear frequency sweep.

1. Press (Sweep) SWEEP TYPE MENU SWP TYPE: LIN FREQ to set the linear frequency sweep.
2. Press (Start) 100 (M/u).
3. Press (Stop) 1 (G/n).

4. Setting the Output Level

This example sets the output power level to 0.5 dBm.

1. Press (Source) POWER 0.5 (x1).

5. Setting IF Bandwidth

When you narrow the IF bandwidth, the trace noise is reduced but the measurement speed becomes slow. This example sets the IF Bandwidth to 1 kHz.

1. Press (Bw/Avg) IF BW 1 (k/m).

6. Performing Calibration

Calibration defines the measurement accuracy at the OUTPUT port on the impedance test kit. After calibration, the analyzer can measure within its specified measurement accuracy. The 0 S, 0 Ω, and 50 Ω terminations in the calibration kit are required.

Note You must use the calibration kit that is furnished to the 43961A for the standard calibraion kit.

1. Press (Cal).
2. Press CALIBRATE MENU.
3. Connect the 0 S termination to the OUTPUT port.
4. Press OPEN.

   After an open calibration sequence is completed, the OPEN softkey label is underlined.
5. Disconnect the 0 S termination, then connect the 0 Ω termination to the OUTPUT port.
6. Press SHORT.

   After a short calibration sequence is completed, the SHORT softkey label is underlined.
7. Disconnect the 0 Ω termination, then connect the 50 Ω termination.

8. Press LOAD.

   After a load calibration sequence is completed, the LOAD softkey label is underlined.

9. Press DONE:CAL.

10. Verify the "Cor" notation is displayed on the left of the screen.

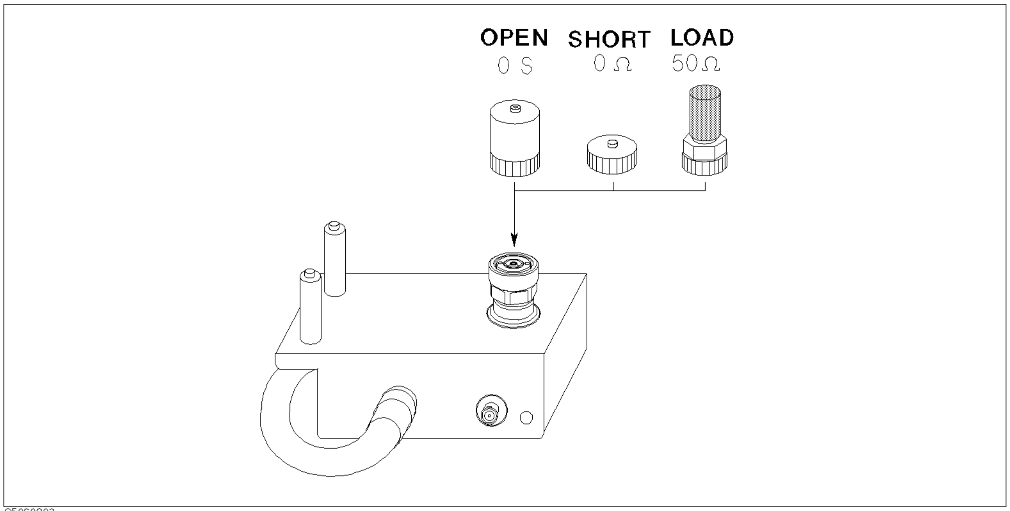


Figure 2-3. Connecting Calibration Standards

Note

The OUTPUT port of the impedance test kit and the calibration standards have APC-7 connectors. The APC-7 connector is very sensitive to damage and dirt. You need to do the following when handling and storing APC-7 connectors:

- Keep the connectors clean.
- Do not touch the mating plane surfaces.
- Do not set the connectors contact-end down.
- Before storing, extend the sleeve or connector nut.
- Use end caps over the mating plane surfaces.
- Never store connectors loose in a box or a drawer.

7. Connecting the Test Fixture

7-1. Connecting the Test Fixture to the Impedance Test Kit

To connect the test fixture to the impedance test kit, see the applicable test fixture manual for instructions. The following is a general procedure:

1. Turn the APC-7 connector of the impedance test kit OUTPUT port.
2. Verify that the connector sleeve is retracted fully.
3. Set the mounting posts of the test station into the twin locating holes at the corner of the test fixture.
4. Connect the connector on the underside of the test fixture to the OUTPUT port of the impedance test kit.

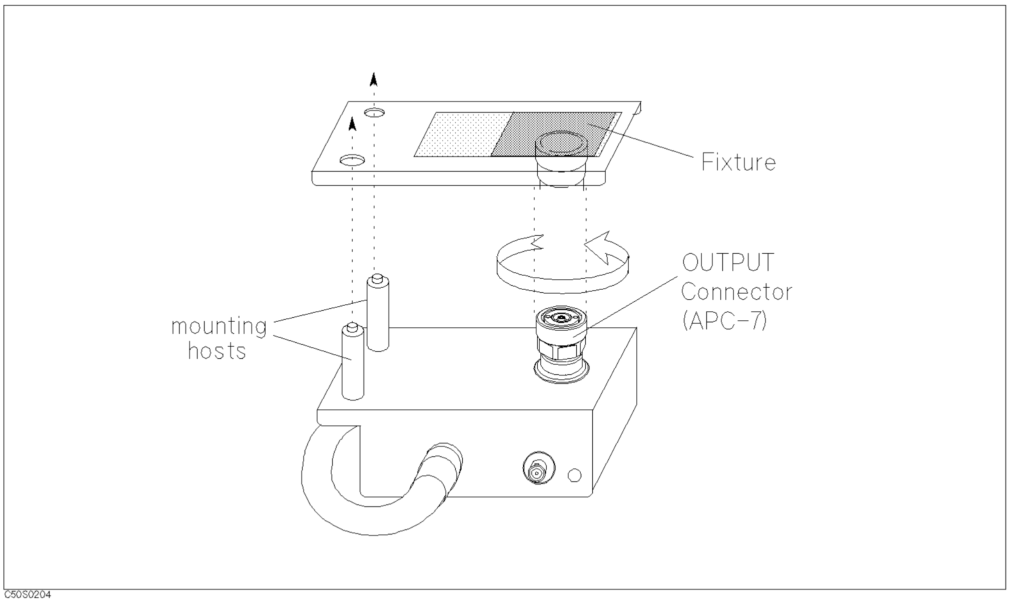


Figure 2-4. Connecting Test Fixture

7-2. Setting the Electrical Length of the Test Fixture

After connecting the test fixture, you need to enter the extended electrical length of the fixture. This is required to eliminate a phase shift error caused by the extended electrical length.

The analyzer has electrical length data for some fixtures as preset data.

1. Press (Meas).
2. Press `FIXTURE` `SELECT FIXTURE`.
3. Select the fixture model number that you are using.
4. Press `RETURN`.
5. Verify that "`Del`" notation appears on the left side of the display.

If your fixture is not listed on the softkey label in the fixture selection menu, use the user fixture setting menu. (See "Setting the User Defined Fixture" in Chapter 3.)

8. Performing Fixture Compensation

Fixture compensation reduces the parasitic error existing between the test fixture electrode and the impedance test kit OUTPUT port (where the measurement accuracy is specified). Fixture compensation consists of OPEN, SHORT and LOAD compensations. For basic measurements, the OPEN and SHORT compensations are required.

Note

For the instructions on how to connect the standards, see the applicable test fixture manual.

1. Connect the SHORT bar to the fixture.
2. Press (Cal) FIXTURE COMPEN COMPEN MENU.
3. Press SHORT.

   After the short compensation sequence is done, the SHORT softkey label is underlined.
4. Remove the SHORT bar and set the OPEN condition.
5. Press OPEN.

   After the open compensation sequence is done, the OPEN softkey label is underlined.
6. Press DONE: COMPEN.
7. Verify that "Cor" changes to "Cmp" notation.

9. Setting the Measurement Parameters

Before you start the measurement, you must set up the analyzer to fit your measurement requirements. This example uses the following settings:

Parameter	$\|Z\|$
Format	Linear

To set up the above parameters, press the front panel keys as shown in the following procedure:

1. Press (Meas) IMPEDACE: MAG (|Z|)
2. Press (Format) LIN Y-AXIS

10. Connecting the DUT to the Test Fixture

See the applicable test fixture manual for instructions.

11. Measuring the DUT

11-1. Triggering the Measurement.

After you place the DUT on the test fixture, the measured result is immediately displayed on the display. The measurement is performed immediately because the analyzer measures continuously using the internal trigger source selected as the power-on default setting.

To use trigger manually, see *Task Reference* for the operation.

11-2. Performing Automatic Scaling

The trace obtained after specifying the frequency range can be too large or too small vertically for the grid. However, by using the automatic scaling function, you can obtain the optimum vertical setting.

1. Press (Scale Ref).
2. Press AUTO SCALE to scale the trace automatically.

12. Analyzing the Measurement Result

You can use the same marker functions used in the network analyzer mode to analyze the measurement result. See the *Task Reference* manual.

3

Task Reference

This chapter describes how to use the impedance measurement functions. You can use this chapter to learn about the operations and the features of the impedance measurement functions.

This chapter describes the following tasks:

- Setting the user fixture.
- Applying DC bias.
- Using the Complex Plane format.
- Equivalent Circuit Analysis.
- Using Width Functions.
- Checking That the Instruments Work Correctly

Setting the User Defined Fixture

To use a fixture that is not listed in the fixture list that is displayed by pressing (Meas) FIXTURE [NONE], perform the following procedure:

1. Determine the following parameters before defining the user fixture:

   Port Extension The equivalent electrical length of the fixture [m].

   Label The fixture identification that is displayed in the softkey label.

2. Press (Meas) FIXTURE [NONE] MODIFY [NONE] to display the user fixture setting menu.
3. Press DEFINE EXTENSION. Then enter an equivalent electrical length by using the numerical keys.
4. Press LABEL FIXTURE. Enter a label by using the rotary knob and then press DONE. Pressing (⇧) (⇩) changes the character set for entry. Up to 8 characters are allowed.
5. Press KIT DONE.
6. To store the setting data into the non-volatile memory, press SAVE USER FXTR KIT.

To use the user fixture setting, select USER under (Meas) FIXTURE [NONE] SELECT FIXTURE.

Applying DC Bias

The 4396B does not have a DC bias source. However, you can use an external DC bias source by using the following procedure:

1. Confirm the external DC bias source is turned off.
2. Connect the external DC bias source to the DC SOURCE INPUT port of the impedance test kit. (See Figure 3-1.)

The external DC bias can be up to ±40 V and 20 mA.

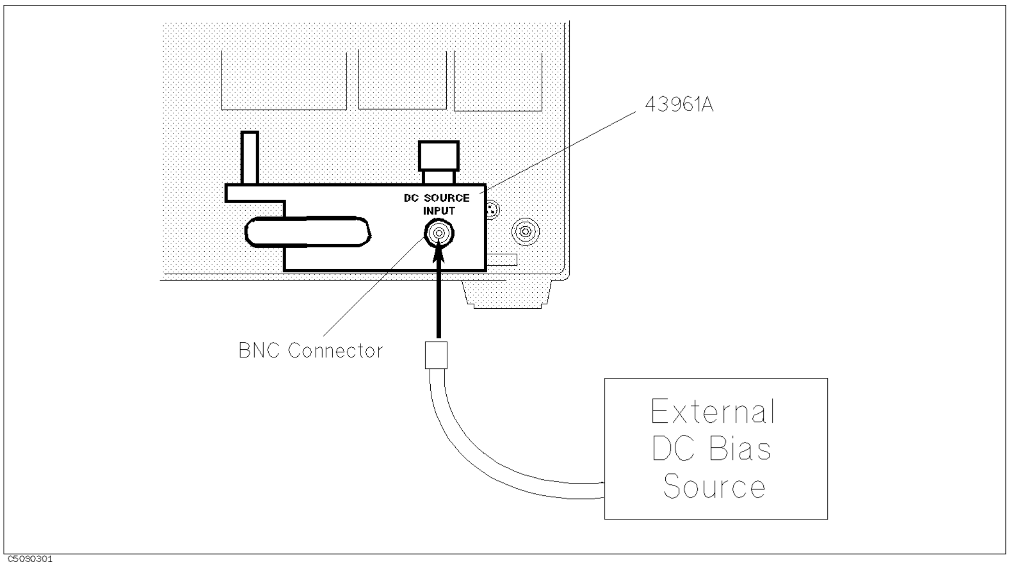


Figure 3-1. Connecting External DC Bias Source

Caution

Do NOT perform a calibration or fixture compensation while a DC bias is applied. The calibration and the fixture compensation standards can be damaged if you do.

Using the Complex Plane Format

Displaying R-X in the Complex Plane

1. Press (Meas) |Z| .

2. Press (Format) COMPLEX PLANE to select the complex plane format.

3. Press (Scale Ref) AUTO SCALE to adjust the scale.

In the complex plane, the measurement parameter is always a complex number even if you select a scalar parameter (such as |Z|).

Using the Marker

1. Press (Marker). Then move the marker using the rotary knob.

The marker displays the real and imaginary value of the marker position on the upper-right of the grid as shown in Figure 3-2.

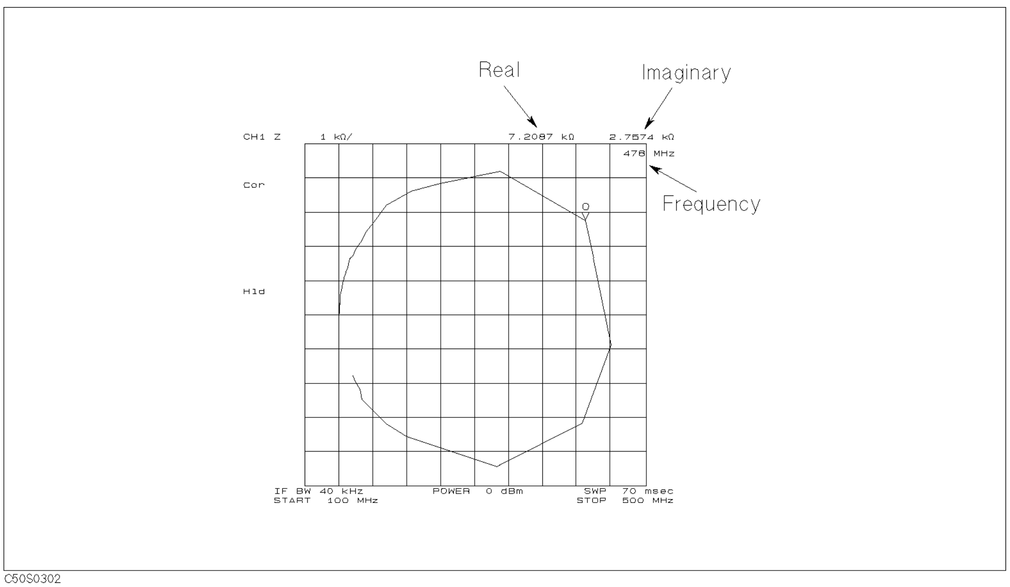


Figure 3-2. Marker Readout of Complex Plane

Changing Scale Setting

1. Press (Scale Ref).

2. Change the following settings to adjust the scale of the complex plane:

Scale Setting	Press
Scale/Div	SCALE/DIV. Then enter the scale per division value.
Reference X Value	MORE REFERENCE X VALUE. Then enter the reference X value.
Reference Y Value	MORE REFERENCE Y VALUE. Then enter the reference Y value.

The reference position of the complex plane is always at the center of the grid. You can adjust the scale by only changing the scale per division setting or the reference coordinate value.

Using the Equivalent Circuit Analysis

The analyzer has a function that can approximate the equivalent circuit constants of the five different circuit models using actual data. This function can also simulate the frequency characteristics of a component by specifying the equivalent circuit constants of the selected circuit model.

1. Press (Display) MORE EQUIV CKT MENU to display the equivalent circuit menu.
2. Press SELECT CKT [A] to display the equivalent circuit models.
3. Select one of the following:

Type of DUT	Press
Coils with high core loss	CKT A
Coils in general / Resistors	B
High-value resistors	C
Capacitors	D
Resonators	E

4. Press CALCULATE EQV PARAM to calculate the equivalent circuit parameters.

After the beep, the calculated equivalent parameters are displayed on the screen. To turn off the equivalent parameter display, press (Display) MORE EQUIV CKT MENU. Then toggle DISP EQV PARM [ON] to OFF.

You can simulate a frequency characteristic trace from the equivalent circuit parameters obtained and compare it with the measured trace.

5. Press RETURN.
6. Press SIMULATE F-CHRST.

After the beep, the simulated trace is displayed. The simulated trace is stored in the memory trace. To turn off the simulated trace, press (Display) DISPLAY: DATA.

Simulating a Trace from the Equivalent Circuit Parameters

You can also simulate the frequency characteristics of the equivalent circuit parameters that you entered.

1. Press (Display) EQUIV CKT MENU to display the equivalent circuit menu.
2. Press SELECT CKT to display the equivalent circuit models.
3. Select the equivalent circuit model. Then press RETURN.
4. Press DEFINE EQV PARAMS.
5. Enter the equivalent circuit parameter value for the activated parameters.
6. Press SIMULATE F-CHRST to simulate the frequency characteristics.

After the beep, the simulated frequency characteristics are displayed.

Determining Q Value Using the Width Functions

Using the Anti-Resonance Point

1. Press (Search) to make the marker active.
2. Press `SEARCH TRK on OFF` to change it to `SEARCH TRK ON off`. Then press `SEARCH:MAX` to move the marker to the anti-resonance point on the trace.
3. Press (Search) `WIDTH [off]` `WIDTH VALUE` `MKRVAL/(√2)` `RETURN`.
4. Press `WIDTH on OFF` to change it to `ON off`. The width value, Q factor, and several parameters are displayed on the screen.

Using the Resonance Point

1. Press (Search) to make the marker active.
2. Press `SEARCH TRK on off` to change it to `SEARCH TRK ON off`. Then press `MIN` to move the marker to the resonance point on the trace.
3. Press (Search) `WIDTH [OFF]` `WIDTH VALUE` `MKRVAL*(√2)` `RETURN`.
4. Press `WIDTH on OFF` to change it to `WIDTH ON off`. The width value, Q factor, and several parameters are displayed on the screen.

Using the Admittance Chart

1. Press (Utility) to make the marker active. Then press `SMTH/POLAR MENU` `G+jB` to read conductance and susceptance (assuming that the admittance circle has been displayed on the admittance chart).
2. Press (Search) `SEARCH TRK on off` to change it to `SEARCH TRK ON off`. Then press `Search:MAX` to move the marker to the point where the G value is maximum on the trace (resonance point).
3. Press (Search) `WIDTH [OFF]` `WIDTH VALUE` `MKRVAL/2` `RETURN`
4. Press `WIDTH on OFF` to change it to `WIDTH ON off`. The width value, Q factor, and several parameters are displayed on the screen.

The analyzer searches half of the maximum conductance points on the admittance circle.

Checking That the Instruments Work Correctly

You can check the impedance test kit is working correctly by performing the following procedures.

Table 3-1. Required Equipment

Equipment	Required Model
Analyzer	4396B
Multimeter	3458A or 3478A

Impedance Measurement Function Check

1. Connect the 43961A to the 4396B.
2. Press (System), SERVICE MENU , TESTS , MISC TESTS , and EXECUTE TEST
3. Follow the instructions displayed on the 4396B CRT to connect and measure the standards (0 S, 0 Ω, and 50 Ω) furnished in the 43961A. The 4396B checks the operation of the 43961A automatically.

DC Bias Function Check

1. Connect the test leads to the multimeter's high and low terminals.
2. Set the multimeter to the resistance measurement mode.
3. Connect the APC7-N(f) adapter to the 43961A's APC-7 connector.
4. Connect the tip of one test lead to the center conductor of the impedance test kit's DC SOURCE Input. Connect the other test lead to the center conductor of theAPC7-N(f) adapter.
5. Check the multimeter reading is 2 kΩ ± 200 Ω.

4

Impedance Measurement Menu

This chapter describes the unique softkeys and their functions when used with impedance analyzer mode. For information about the functions that are not described in this chapter, see the *Function Reference* manual. These functions in the impedance measurement mode are common to the network analyzer and spectrum analyzer mode.

Meas

Under the Meas key, the following menus are unique to the impedance analyzer mode:

- Impedance Measurement Menu (1/5) to (5/5)
  - Fixture Menu
    - Select Fixture Menu
    - Modify User Fixture Menu
  - Analyzer Type Menu

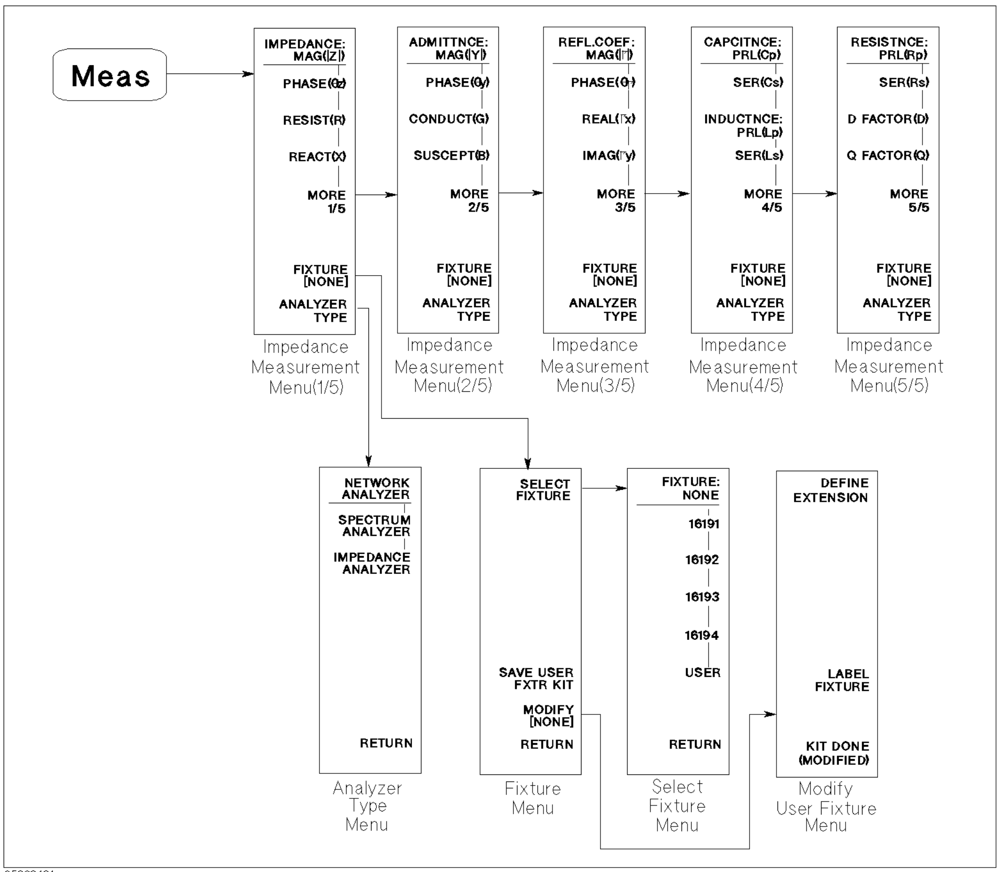


Figure 4-1. Softkey Menus Accessed from the Meas Key

Impedance Measurement Menu (1/5)

This menu defines the measurement parameters for the impedance analyzer mode.

Key Label	Description
IMPEDANCE:MAG(|Z|)	Measures absolute magnitude value of impedance.
PHASE(θ_z)	Measures absolute phase value of impedance.
RESIST(R)	Measures resistance value (R).
REACT(X)	Measures reactance value (X).
MORE 1/5	Displays the *Impedance Measurement Menu* (2/5).
FIXTURE []	Displays the *Fixture Menu* that is used to select a test fixture connected with the analyzer. The selected test fixture is displayed in brackets ([]).
ANALYZER TYPE	Displays the *Analyzer Type Menu* that selects the network, spectrum, or impedance analyzer mode of operation.

Impedance Measurement Menu (2/5)

This menu selects an admittance parameter as the measurement parameter.

Key Label	Description
ADMITTNCE:MAG(|Y|)	Measures absolute magnitude value of admittance (|Y|).
PHASE(θ_y)	Measures phase value of admittance (θ_y).
CONDUCT(G)	Measures conductance value (G).
SUSCEPT(B)	Measures susceptance value (B).
MORE 2/5	Displays the *Impedance Measurement Menu* (3/5).

Impedance Measurement Menu (3/5)

This menu selects a reflection coefficient as the measurement parameter.

Key Label	Description
REFL.COEF:MAG(|Γ|)	Measures absolute magnitude value of reflection coefficient (|Γ|).
PHASE(θ_Γ)	Measures phase value of reflection coefficient (θ_γ).
REAL(Γ_x)	Measures real part of reflection coefficient (Γ_x).
IMAG(Γ_y)	Measures imaginary part of reflection coefficient (Γ_y).
MORE 3/5	Displays the *Impedance Measurement Menu* (4/5).

Impedance Measurement Menu (4/5)

This menu selects a capacitance or inductance as the measurement parameter.

Key Label	Description
CAPCITNCE:PRL(Cp)	Measures parallel capacitance (C_p), which is used for small capacitance measurement.
SER(Cs)	Measures series capacitance (C_s), which is used for large capacitance measurement.
INDUCTNCE:PRL(Lp)	Measures parallel inductance (L_p), which is used for large inductance measurement.
SER(Ls)	Measures series inductance (L_s), which is used for small inductance measurement.
MORE 4/5	Displays the *Impedance Measurement Menu* (5/5).

Impedance Measurement Menu (5/5)

This menu selects a resistance, D, and Q as the measurement parameter.

Key Label	Description
RESISTNCE:PRL(Rp)	Measures parallel resistance (R_p), which is used for large resistance, large inductance, or small capacitance.
SER(Rs)	Measures series resistance (R_s), which is used for small resistance, small inductance, or large capacitance.
D FACTOR (D)	Measures dissipation factor (D).
Q FACTOR (Q)	Measures quality factor (Q).
MORE 5/5	Displays the *Impedance Measurement Menu (1/5)*.

Fixture Menu

This menu selects a test fixture for impedance measurement operation. This selection sets the electrical length of the fixture automatically to eliminate the phase shift error.

Key Label	Description
SELECT FIXTURE	Displays the *Select Fixture Menu*.
SAVE USER FXTR KIT	Saves electrical length and label as a user defined fixture.
MODIFY [NONE]	Displays the *Modify User Fixture Menu*, which are used to define the electrical length and label of a selected fixture.
RETURN	Returns to the *Impedance Measurement Menu*.

Select Fixture Menu

This menu selects the impedance measurement fixture by its name.

Key Label	Description
FIXTURE:NONE	Sets zero as electrical length value.
16191	Sets the electrical length that is suitable for the 16191A.
16192	Sets the electrical length that is suitable for the 16192A.
16193	Sets the electrical length that is suitable for the 16193A.
16194	Sets the electrical length that is suitable for the 16194A.
USER	Sets the electrical length, which is a user defined value.
RETURN	Returns to the *Fixture Menu*.

Modify User Fixture Menu

This menu defines the electrical length and label for a user defined fixture.

Key Label	Description
DEFINE EXTENSION	Sets the extension value of the user fixture.
LABEL FIXTURE	Sets the label name of the user fixture.
KIT DONE (MODIFIED)	Completes the procedure of the user fixture defintion.

Analyzer Type Menu

This menu toggles the analyzer mode of operation. You need to select the analyzer mode before setting up the analyzer.

Key Label	Description
NETWORK ANALYZER	Selects the network analyzer mode as the analyzer type. When the analyzer type is changed, all parameters of the active channel are preset.
SPECTRUM ANALYZER	Selects the spectrum analyzer mode as the analyzer type. When the analyzer type is changed, all parameters of the active channel are preset.
IMPEDANCE ANALYZER	Selects the impedance analyzer mode as the analyzer type. When the analyzer type is changed, all parameters of the active channel are preset.
RETURN	Returns to the *Impedance Measurement Menu*.

When you change the analyzer type from network analyzer to impedance analyzer, all calibration data of the network analyzer will be lost. Inversely, changing the impedance analyzer to network analyzer clears the calibration and fixture compensation data of the impedance analyzer mode.

Format

Under the Format key, the following menu is unique to the impedance analyzer mode:

- Format Menu

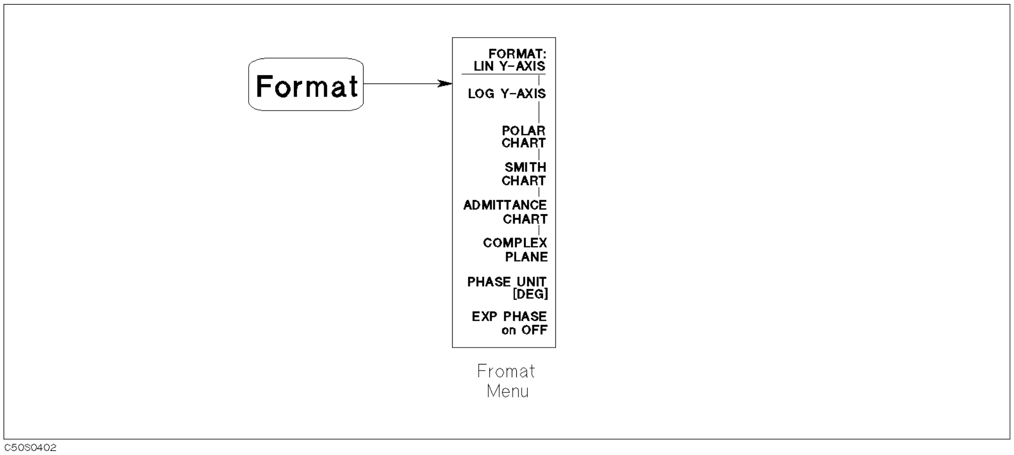


Figure 4-2. Softkey Menus Accessed from the Format Key

Format Menu

This menu selects the format of the graticule.

Key Label	Description
FORMAT:LIN Y-AXIS	Displays the linear magnitude format.
LOG Y-AXIS	Displays the logarithmic scale format.
POLAR CHART	Displays a polar chart format.
SMITH CHART	Displays a Smith chart format.
ADMITTANCE CHART	Displays an admittance chart format.
COMPLEX PLANE	Displays a complex plane format.
PHASE UNIT [DEG]	Selects the unit for phase measurement as DEG (degree) or RAD (radian). The unit selected is shown in brackets.
EXP PHASE ON off	Turns the expanded phase ON or OFF. When it is turned OFF, the analyzer wraps the phase plot around every 360°. When it is ON, the analyzer avoids the wrap and displays the phase plot over 360°.

Display

Under the Display key, the following menus are unique to the impedance analyzer mode:

- Equivalent Circuit Menu
  - Select Equivalent Circuit Menu
  - Define Equivalent Circuit Parameter Menu

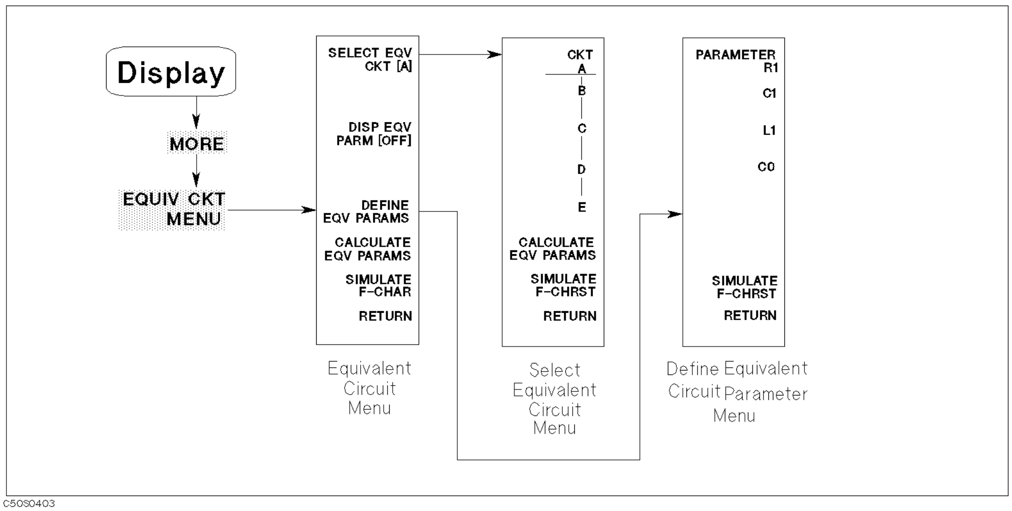


Figure 4-3. Softkey Menu Accessed from Display Key

Equivalent Circuit Menu

Pressing Display MORE EQUIV CKT MENU displays the *Equivalent Circuit Menu*. This menu is used to derive values of equivalent circuit parameters and simulate frequency characteristics of equivalent circuits. This is a unique function that is available only in the impedance analyzer mode.

Key Label	Description
SELECT EQV CKT [A]	Displays the *Select Equivalent Circuit Menu* that is used to select the equivalent circuit. (See Table 4-1.)
DISP EQV PARM [OFF]	Toggles the display of the equivalent circuit parameter value.
DEFINE EQV PARAMS	Displays the *Define Equivalent Circuit Parameter Menu* that is used to enter the equivalent circuit parameters.
CALCULATE EQV PARAMS	Calculates the equivalent circuit parameters. While the calculation is being performed, the message `Calculating EQV parameters` is displayed. After the calculation is completed, the values of the equivalent parameters are displayed.
SIMULATE F-CHRST	Simulates the frequency characteristics by using the current equivalent circuit parameters and shows simulation results on the screen using memory trace. In other words, simulation results are stored into the memory trace.
RETURN	Returns to the previous menu.

Select Equivalent Circuit Menu

This menu selects the equivalent circuit for parameter calculation.

Key Label	Description
CKT A	Selects equivalent circuit A, which is used to simulate inductors with high core loss.
B	Selects equivalent circuit B, which is used to simulate inductors in general and resisters.
C	Selects equivalent circuit C, which is used to simulate high-value resistors.
D	Selects equivalent circuit D, which is used to simulate capacitors.
E	Selects equivalent circuit E, which is used to simulate resonators.
CALCULATE EQV PARAMS	Same as the *Equivalent Circuit Menu*.
SIMULATE F-CHRST	Same as the *Equivalent Circuit Menu*.
RETURN	Returns to the *Equivalent Circuit Menu*.

Table 4-1 shows the equivalent circuit models and corresponding devices.

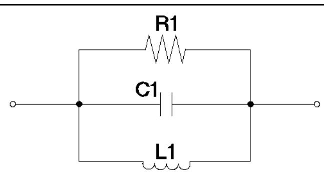
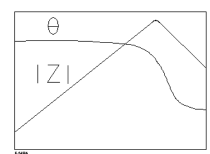
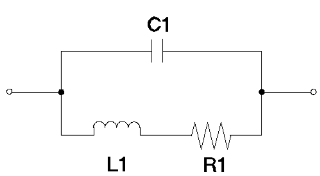
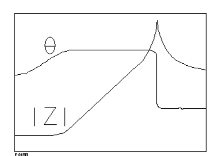
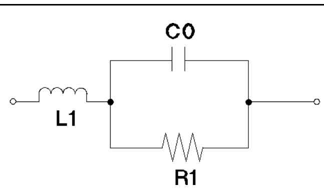
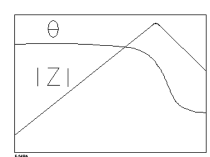
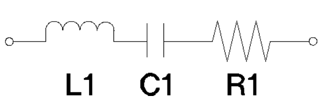
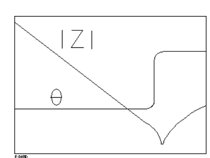
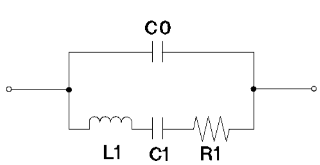
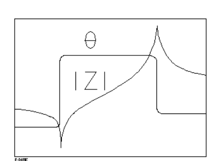
Define Equivalent Circuit Parameter Menu

This menu defines the equivalent circuit parameters for simulation.

Key Label	Description
PARAMETER R1	Sets R_1 value.
C1	Sets C_1 value.
L1	Sets L_1 value.
C0	Sets C_0 value.
SIMULATE F-CHRST	Same as the *Equivalent Circuit Menu*.
RETURN	Returns to the *Equivalent Circuit Menu*.

The frequency range used to calculate parameters can be specified using the menu accessed from the SEARCH RANGE MENU under the Search key.

Table 4-1. Equivalent Circuit Selection Guide

	Equivalent Circuit	Type of Devices	Typical Frequency Characteristics
A		Inductors with high core loss	
B		Inductors and resisters	
C		High-value resistors	
D		Capacitors	
E		Resonators	

Scale Ref

Under the Scale Ref key, the following menus are unique to the impedance analyzer mode:

- Scale Reference Menu
- Scale Reference More Menu

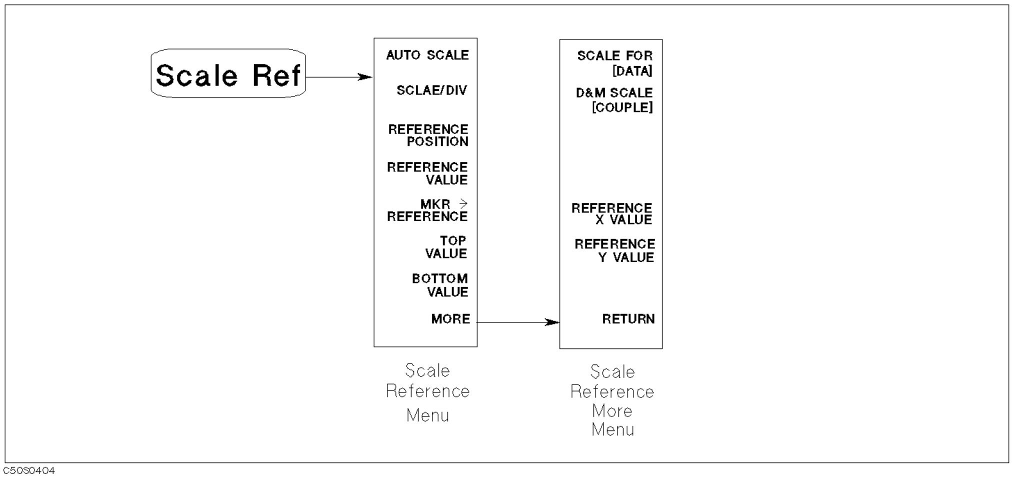


Figure 4-4. Softkey Menus Accessed from the Scale Ref Key

Scale Reference Menu

This menu defines the scale and reference settings.

Key Label	Description
AUTO SCALE	Adjusts the vertical scale setting to fit the trace in the optimum graticule automatically.
SCALE/DIV	Changes the scale per division of the displayed trace.
REFERENCE POSITION	Sets the position of the reference line on the graticule of a Cartesian display.
REFERENCE VALUE	Changes the value of the reference line, moving the measurement trace correspondingly.
MARKER→REFERENCE	Sets the current marker position as the reference value.
TOP VALUE	Changes the value at the top line of the graticule, moving the measurement trace correspondingly.
BOTTOM VALUE	Changes the value at the bottom line of the graticule, moving the measurement trace correspondingly.
MORE	Displays the *Scale Reference More Menu*.

Scale Reference More Menu

This menu sets the reference value for the complex plane and selects a target trace for the scale setting.

Key Label	Description
SCALE FOR [DATA]	Selects either the "DATA" or "MEMORY" trace as the target trace for the scale setting functions.
D&M SCALE [COUPLE]	Toggles COUPLE or UNCOUPLE the "DATA" and "MEMORY" traces to be scaled for the scale setting functions.
REFERENCE X VALUE	Changes the value of the center position of the X axis, moving the measurement trace correspondingly. This softkey is only available for the complex plane format.
REFERENCE Y VALUE	Changes the value of the center position of the Y axis, moving the measurement trace correspondingly. This softkey is only available for the complex plane format.
RETURN	Returns to the *Scale Reference Menu*.

Bw/Avg

Under the Bw/Avg key, the following menu is unique to the impedance analyzer mode:

- Averaging Menu

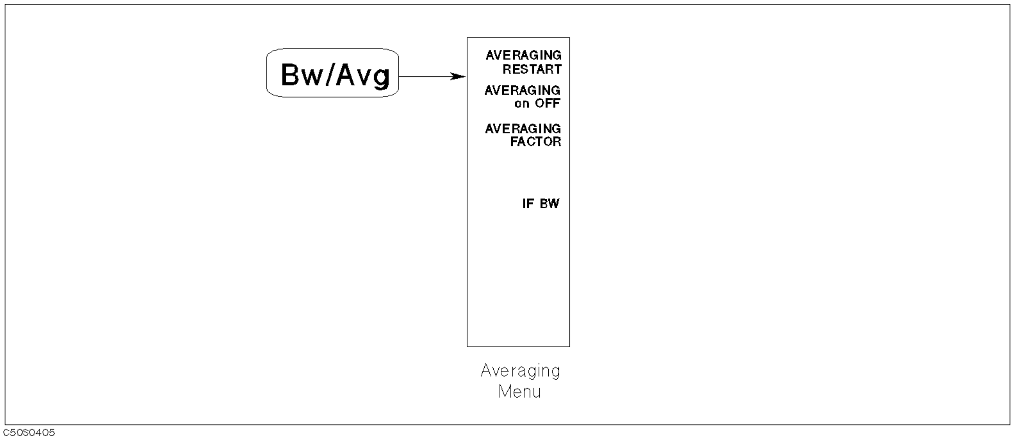


Figure 4-5. Softkey Menus Accessed from the Bw/Avg Key

Averaging Menu

This menu defines the averaging and IF bandwidth parameters.

Key Label	Description
AVERAGING RESTART	Resets the sweep-to-sweep averaging and restarts the sweep count at the beginning of the next sweep.
AVERAGING on OFF	Turns the averaging function on or off.
AVERAGING FACTOR	Makes the averaging factor the active function.
IF BW	Sets the bandwidth value of IF bandwidth.

Cal

Under the Cal key, the following menus are unique to the impedance analyzer mode:

- Calibration Menu
- Calibration Operation Menu
- Fixture Compensation Menu
  - Compensation Operation Menu
- Cal kit menu
  - Specify class menu
  - Label class menu
- Compensation Kit Menu
  - Modify Compensation Kit Menu
  - Define Compensation Standard Menu
- Port Extension Menu

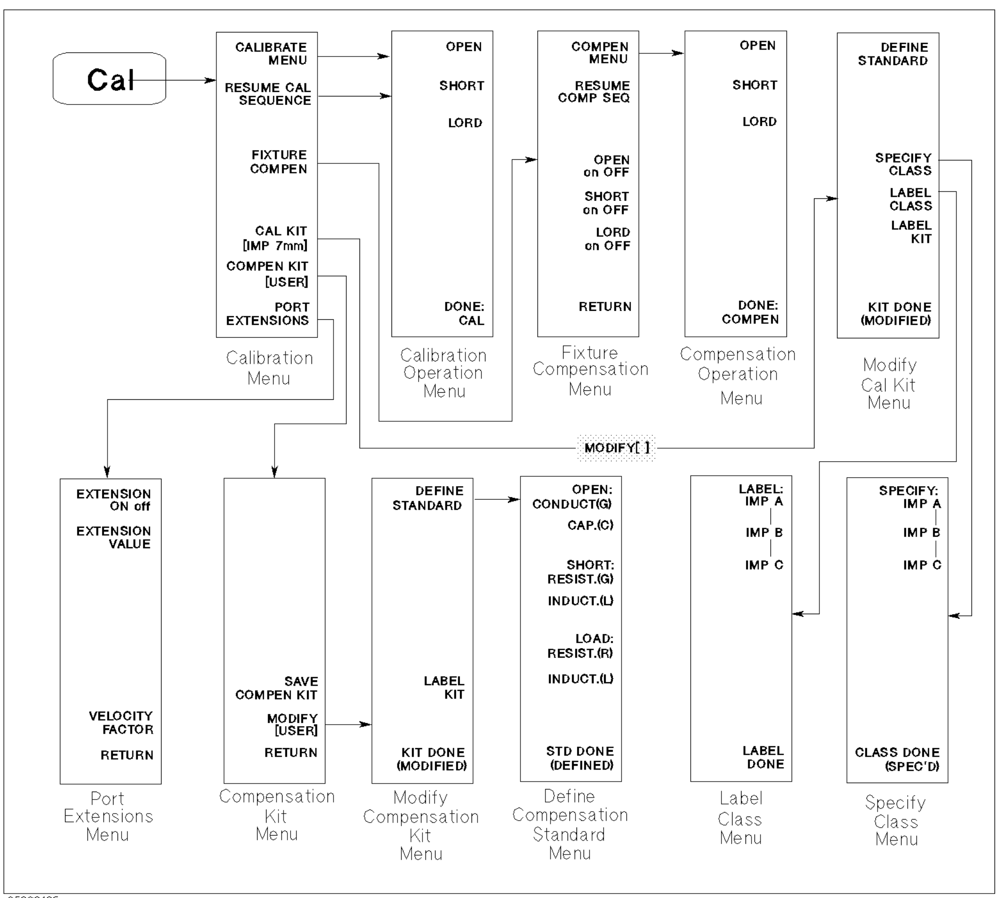


Figure 4-6. Softkey Menu Accessed from Cal key

Calibration Menu

This menu displays the calibration and the fixture compensation setting keys.

Key Label	Description
CALIBRATE MENU	Displays the *Calibration Operation Menu* that is used to perform a calibration measurement.
RESUME CAL SEQUENCE	Eliminates the need to restart a calibration sequence that was interrupted to access some other menu. Goes back to the point where the calibration sequence was interrupted. This key also displays the *Calibrate Menu* which are used to perform a resumed calibration measurement.
FIXTURE COMPEN	Displays the *Fixture Compensation Menu* that is used to perform the fixture compensation measurement in order to reduce measurement errors existing in the test fixture.
CAL KIT [IMP 7mm]	Displays the *Cal Kit Menu* that selects the default calibration kit and a user kit. This key displays additional softkeys used to define calibration standards other than those in the default kits. When a calibration kit has been specified, its label is displayed in brackets in the softkey label. The cal kit which is furnished to the 43961A is a standard cal kit. Select CAL KIT: 7mm (default) to use the standard cal kit.
COMPEN KIT [USER]	Displays the *Compensation Kit Menu* that is used to define user-define OPEN, SHORT, and LOAD for fixture compensation measurement. When a set of user-defined OPEN, SHORT, and LOAD values has been specified, its label is displayed in brackets in the softkey label.
PORT EXTENSIONS	Displays the *Port Extensions Menu* that is used to extend the apparent location of the measurement reference plane.

Calibration Operation Menu

This menu displays the calibration measurement keys.

Key Label	Description
OPEN	Measures OPEN standard of the cal kit for calibration.
SHORT	Measures SHORT standard of the cal kit for calibration.
LOAD	Measures LOAD standard of the cal kit for calibration.
DONE: CAL	Completes calibration and then computes and stores the error coefficients.

Fixture Compensation Menu

This menu leads keys for setting the fixture compensation.

Key Label	Description
COMPEN MENU	Displays the *Compensation Operation Menu* which are used to perform a fixture compensation measurement.
RESUME COMP SEQ	Goes back to the point where the fixture compensation sequence was interrupted when that was interrupted to access some other menu.
OPEN ON off	Turns OPEN fixture compensation ON or OFF.
SHORT ON off	Turns SHORT fixture compensation ON or OFF.
LOAD ON off	Turns LOAD fixture compensation ON or OFF.
RETURN	Returns to the *Calibration Menu*.

Compensation Operation Menu

This menu displays the fixture compensation measurement keys.

Key Label	Description
OPEN	Measures OPEN for the fixture compensation.
SHORT	Measures SHORT standard for the fixture compensation.
LOAD	Measures LOAD standard for the fixture compensation.
DONE: COMPEN	Completes the fixture compensation measurement and then computes and stores the compensation coefficients.

Status Notations

After you performing the fixture compensation, the following notations are displayed on the left of display:

Cmp	Fixture compensation is turned on when the calibration is not interpolated.
Cm*	Fixture compensation is turned on when the calibration is interpolated (C? or C!).
Cm?	Stimulus parameters have changed and interpolated fixture compensation is on.
Cm!	Fixture compensation is on but questionable. Caused by extrapolation.

Cal Kit Menu

This menu defined the calibration kit.

Key Label	Description
DEFINE STANDARD	Displays *Define Standard Menu*. See the description of the same manu of network analyzer mode in chapter 5 of *Function Reference*.
SPECIFY CLASS	Displays *Specify Class Menu*.
LABEL CLASS	Displays *Label Class Menu*.
LABEL KIT	Specifys the label of the re-defined calibration kit. This label will be displayed in the *Calibration Menu* when you select the user calibration kit.
KIT DONE (MODIFIED)	Completes the user calibraion kit modification.

Specify Class Menu

This menu assigns a standard to a standard class.

Key Label	Description
SPECIFY: IMP A	Enters the standard numbers for the first class required for an impedance calibration.
IMP B	Enters the standard numbers for the second class required for an impedance calibration.
IMP C	Enters the standard numbers for the third class required for an impedance calibration.
CLASS DONE (SPEC'D)	Completes specifying the calibration classes.

Label Class Menu

This menu gives the class a meaningful label for future reference. These labels become softkey labels during a measurement calibraion instead of OPEN, SHORT, and LOAD. A label can be up to ten characters long.

Key Label	Description
LABEL: IMP A	Defines a label for the first class required for an impedance calibration. (For predefined cal kits, this is OPEN.)
IMP B	Defines a label for the second class required for an impedance calibration. (For predefined cal kits, this is SHORT.)
IMP C	Defines a label for the third class required for an impedance calibration. (For predefined cal kits, this is LOAD.)
LABEL DONE	Completes setting the label of class.

Compensation Kit Menu

This menu defines the compensation kit.

Key Label	Description
SAVE COMPEN KIT	Stores the user-modified or user-defined OPEN, SHORT, and LOAD for fixture compensation into memory, after it has been modified.
MODIFY [USER]	Displays the *Modify Compensation Kit Menu* that is used to modify a default definition of OPEN, SHORT, and LOAD for the fixture compensation.
RETURN	Returns to the *Calibration Menu*.

Modify Compensation Kit Menu

This menu modifies the fixture compensation kit.

Key Label	Description
DEFINE STANDARD	Displays the *Define Compensation Standard Menu* that is used to define the parameters of OPEN, SHORT, and LOAD for the fixture compensation.
LABEL KIT	Displays the *Letter Menu* to define a label for a new set of user-defined OPEN, SHORT, and LOAD. This label appears in the COMPEN KIT softkey label in the *Calibration Menu* and the MODIFY label in the *Compensation Kit Menu*. It is saved with the data of OPEN, SHORT, and LOAD.
KIT DONE (MODIFIED)	Completes the procedure to define user-defined OPEN, SHORT, and LOAD for fixture compensation.

Define Compensation Standard Menu

This menu modifies the standard definition of the fixture compensation kit.

Key Label	Description
OPEN:CONDUCT(G)	Sets a conductance value (G) of OPEN.
CAP.(C)	Sets a capacitance value (C) of OPEN.
SHORT:RESIST.(R)	Sets a resistance value (R) of SHORT.
INDUCT.(L)	Sets an inductance value (L) of SHORT.
LOAD:RESIST.(R)	Sets a resistance value (R) of LOAD.
INDUCT.(L)	Sets an inductance value (L) of LOAD.
STD DONE (DEFINED)	Completes the procedure to define user-defined OPEN, SHORT, and LOAD.

Figure 4-7 shows the parameters of the equivalent circuit model of OPEN, SHORT, and LOAD for the fixture compensation. The 4396B uses these equivalent circuit models to determine the characteristics of OPEN, SHORT, and LOAD.

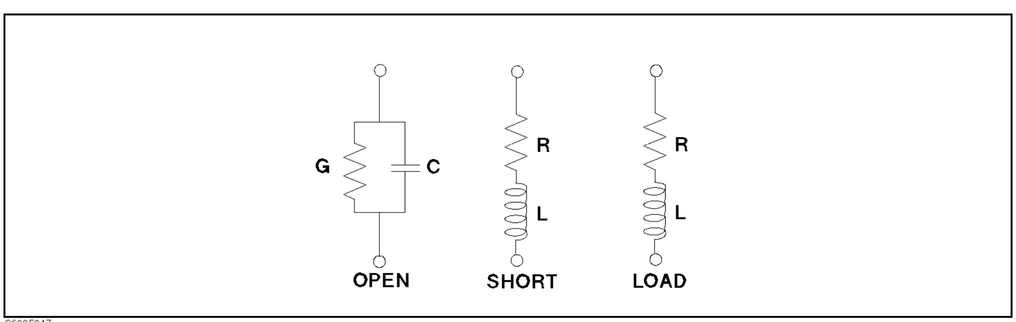


Figure 4-7. Compensation Kit Models

Port Extensions Menu

This menu defines the port extension.

Key Label	Description
EXTENSIONS ON off	Turns port extension ON or OFF. When this function is ON, all extensions defined below are enabled; when OFF, none of the extensions are enabled.
EXTENSION VALUE	Makes the port extension value the active function. This function is used to add electrical delay in seconds to extend the reference plane at the APC-7 connector on the test head to the end of the cable.
VELOCTY FACTOR	Enters the velocity factor used by the analyzer to calculate equivalent electrical length. See chapter 5 of *Function Reference* for more information.
RETURN	Returns to the *Calibration Menu*.

Source

Under the Source key, the following menu is unique to the impedance analyzer mode:

- Source Menu

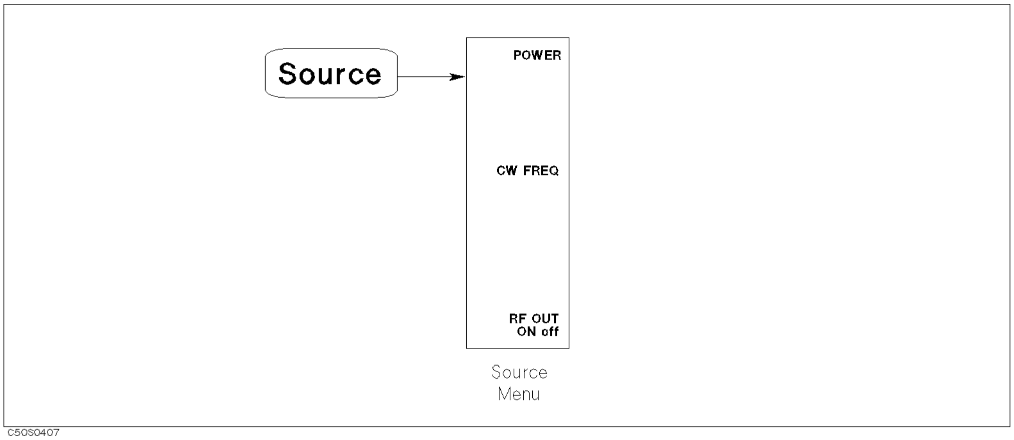


Figure 4-8. Softkey Menus Accessed from the Source Key

Source Menu

This menu defines the output level settings.

Key Label	Description
POWER	Sets the output power level. "Test Signal Level at DUT" in Chapter 5 provides the description about the actual applied level to the DUT.
CW FREQ	Sets the continuous wave frequency for the power sweep.
RF OUT on OFF	Toggles the output power ON and OFF.

Search

Under the Search key, the following menus are unique to the impedance analyzer mode:

- Search Menu
  - Widths Menu
    - Width Value Menu

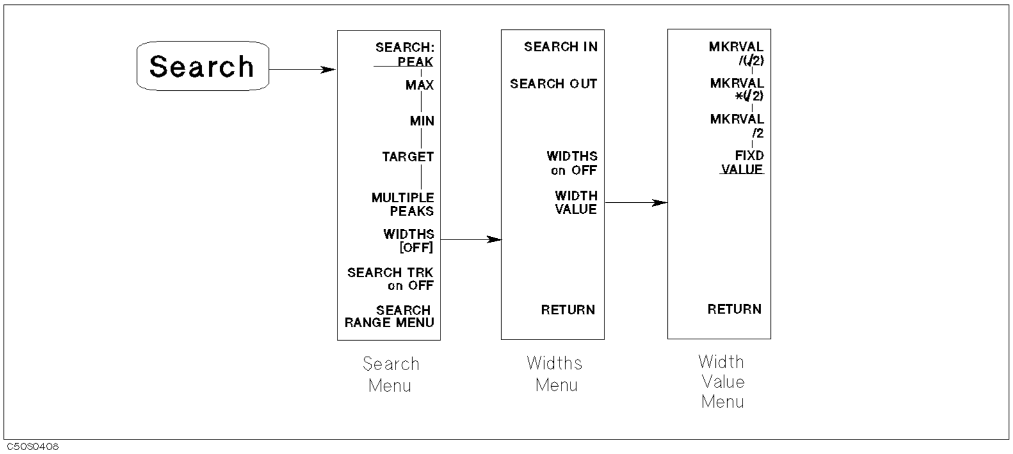


Figure 4-9. Softkey Menus Accessed from the Search Key

Search Menu

Key Label	Description
SEARCH: PEAK	Displays the *Peak Menu* that searches for peaks. See *Peak menu* in chapter 7 of the *Function Reference* manual.
MAX	Moves the marker to the maximum point on the trace.
MIN	Moves the marker to the minimum point on the trace.
TARGET	Displays the *Target Search Menu* that searches for a point that has a specified value. See *Target Menu* in chapter 7 of the *Function Reference* manual.
MULTIPLE PEAKS	Displays the *Multiple Peaks Menu* that searches the multiple peaks. See *Search Menu* in chapter 7 of the *Funciton Reference* manual.
WIDTHS [OFF]	Displays the *Widths Menu* that is used to define the start and stop points for a width search and to turn the width search ON and OFF. See “Width Function”.
SEARCH TRK on OFF	Toggles the search tracking.
SEARCH RANGE MENU	Displays the *Search Range Menu* that specifies the marker search range.

Widths Menu

This menu controls the width functions.

Key Label	Description
SEARCH IN	Searches for the cut-off point on the trace that is within the current cut-off points.
SEARCH OUT	Searches for the cut-off point on the trace outside the current cut-off points.
WIDTHS on OFF	Turns on the width search feature and calculates the center frequency of a lobe on the trace, width, Q, and cut-off point deviation from the center stimulus value. The cut-off point that defines the width parameters is set using the WIDTH VALUE softkey. The Δmarker is automatically changed to the tracking Δmarker when WIDTHS is turned on. When WIDTHS is ON, the (normal) Δmarker cannot be selected.
WIDTH VALUE	Sets a measurement value of a cut-off point that defines the start and stop points for a width search. The width search feature analyzes the center point and the width between the trace down from (or up to) the anti-resonance point or resonance point and the quality factor (Q) for the resonator. Width units are in the units of the current format.
RETURN	Returns to the *Search Menu*.

Width Function

The width search feature analyzes a resonator and displays the center point, width, and quality factor (Q) for the specified bandwidth. These parameters depend on the Δmarker mode. The following table shows how each parameter is determined for each Δmarker mode.

Parameter	Tracking ΔMarker	Fixed ΔMarker
bandwidth	Displays the bandwidth value between the cut-off points set by WIDTH VALUE.	
Center	Displays the center stimulus value between the cut-off points (this is marked by sub-marker 1).	Displays the stimulus value difference between the center stimulus value of the cut-off points and the fixed Δmarker (this is marked by sub-marker 1).
Q	Displays the Q value (= cent/BW) of the trace.	
Peak	Displays the amplitude value at the peak of the lobe.	Displays the amplitude value difference between the amplitude value at the peak of the lobe and the amplitude value of the fixed Δmarker.
ΔF (left)	Displays the stimulus value difference between marker 2 and the center frequency specified by the (Center) key.	Displays the stimulus value difference between marker 2 and the fixed Δmarker.
ΔF (right)	Displays the stimulus value difference between marker 3 and the center frequency specified by the (Center) key.	Displays the stimulus value difference between marker 3 and the fixed Δmarker.

Width Value Menu

Pressing (Search) WIDTH [] WIDTH_VALUE displays the menu that specifies the search condition for the width function.

Key Label	Description
MKRVAL/(√2)	Sets the width value to the value that equals the marker value divided by square root of 2.
MKRVAL*(√2)	Sets the width value to the value that equals the marker value multiplied by square root of 2.
MKRVAL/2	Sets the width value to the value that equals the marker value divided by 2.
FIXD VALUE	Makes the width value the active function and sets the width value to the value specified by this softkey.
RETURN	Returns to the *Widths Menu*.

Figure 4-10 shows an example of the bandwidth search feature.

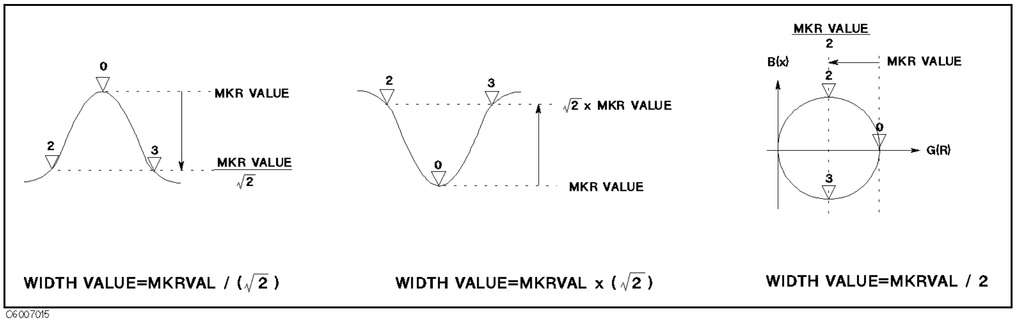


Figure 4-10. Q Measurement Examples

(Copy)

Under the (Copy) key, the following menus are unique to the impedance analyzer mode:

- Copy More Menu

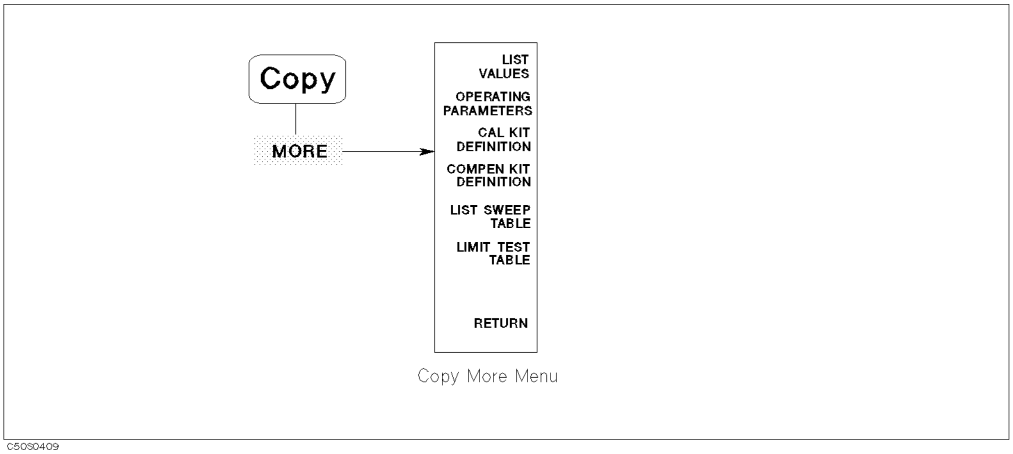


Figure 4-11. Softkey Menus Accessed from the (Copy) Key

Copy More Menu

Pressing Copy MORE displays the menu that lists and prints the measurement data or the analyzer settings.

Key Label	Description
LIST VALUES	Displays the measurement point ant its data as a tabular listing. The listed data is a currently selected parameter. When the Smith, admittance chart, and complex plane format, the real and imaginary part of the complex data are displayed. When the polar chart format is selected, the absolute value and the phase are displayed. This key also displays the *Screen Menu* that controls printing and plotting. See chapter 8 of the *Function Reference* manual.
OPERATING PARAMETERS	Displays the *Screen Menu*. Provides a tabular listing on the display of the key parameters for both channels. See chapter 8 of the *Function Reference* manual.
CAL KIT DEFINITION	Displays the *Copy Cal Kit Menu* that prints/plots the calibration kit definitions. See chapter 8 of the *Function Reference* manual.
COMPEN KIT DEFINITION	Displays the definitions of the fixture compensation kit and displays the *Screen Menu* to control the print and plot. See chapter 8 of the *Function Reference* manual.
LIST SWEEP TABLE	Displays the *Copy List Sweep Menu* that can display a tabular listing of the list sweep table and print or plot it. See chapter 8 of the *Function Reference* manual.
LIMIT TEST TABLE	Displays the *Copy Limit Test Menu* that can display a tabular listing of the limit value for limit testing and print and plot it. See chapter 8 of the *Function Reference* manual.
RETURN	Returns to the *Copy Menu*.

5

Advanced Topics

This chapter describes the inside topics of the analyzer. The following topics are described in this chapter:

- I-V measurement method
- Impedance measurement scheme
- Data processing of impedance analyzer mode
- Save data format

I-V Measurement Method

The 4396B, when combined with the 43961A, uses an I-V measurement method to measure the impedance of a DUT. This section describes this measurement method.

Basic Concept of I-V Method

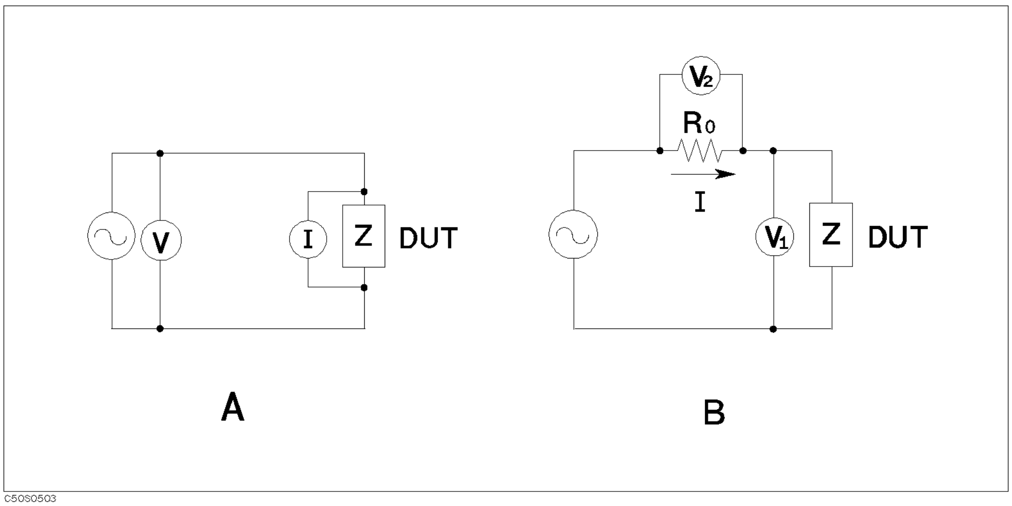


Figure 5-1. I-V Measurement Method

The unknown impedance, Z, can be calculated from the measured voltage and current using Ohm's law: (See circuit A in Figure 5-1.)

$$Z = \frac{V}{I}$$

The current, *I*, can be also obtained by the voltage level of the known resistance, R_0.

$$Z = \frac{V_1}{I} = \frac{V_1}{V_2} R_0$$

See circuit B in Figure 5-1.

The 4396B uses circuit B to determine the unknown impedance.

How This Is Different From Impedance Conversion in the Network Analyzer Mode

The network analyzer part of the 4396B has an impedance conversion feature that converts the reflection coefficient to impedance. The reflection is determined by the impedance of the DUT.

$$Z = R_0 \frac{1 - \Gamma}{1 + \Gamma} \qquad (-1 \leq \Gamma \leq 1)$$

If the DUT impedance is equal to the characteristic impedance, there is no reflection. When the impedance is an infinite value like OPEN, the all input signal is reflected. This means, the reflection signal level covers all impedance range (50 to infinite) by the output level. Thus, the reflected signal level difference is very small when compared to the impedance difference in the higher impedance ranges.

When the impednace is greater than characteristic impedance, the measurement error is increased. For example, for an impedance of 2 kΩ, a 1 percent error in the reflection coefficient is converted to a 24 percent error in impedance.

However, with the I-V method, the measurement error does not depend on the impedance of the DUT because the I-V method measures the impedance directly from the ratio of the voltage and current. Using the I-V method, you can measure a wide range impedance with constant accuracy. This is the major advantage of the I-V method.

Impedance Measurement Scheme

Measurement Block Diagram

With the 43961A connected, the measurement circuit is as shown in Figure 5-2.

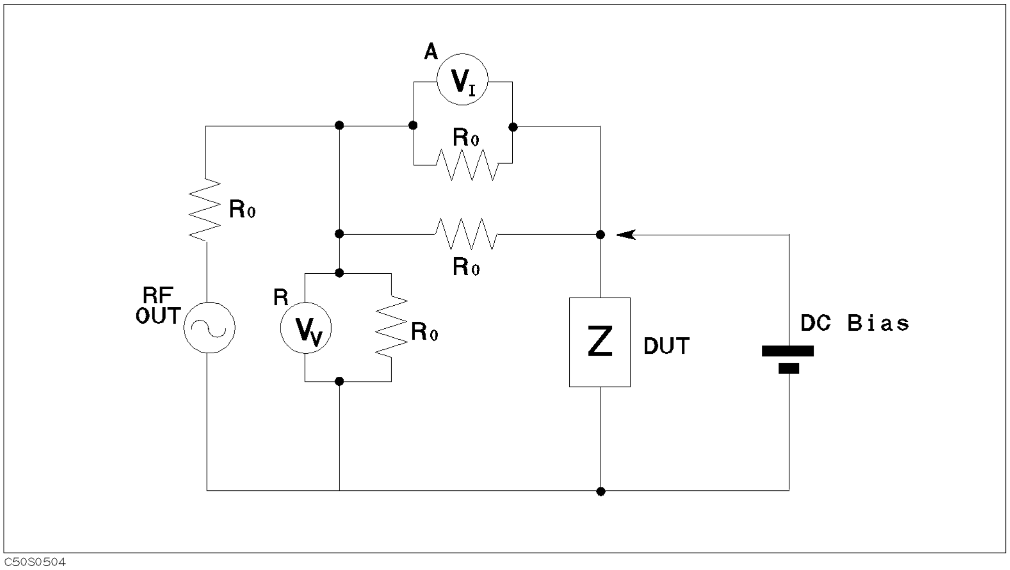


Figure 5-2. Impedance Test Kit Block Diagram

The source signal is output from RF OUT port. V_V voltmeter is R port receiver that measures a voltage. V_I voltmeter is A port receiver that measures a voltage of R_0 to obtain a current.

Test Signal Level at DUT

The test signal level actually applied to the DUT depends on the test signal level from the 4396B, the output impedance, the insertion loss of the Impedance Test Kit, and the impedance of the DUT.

Figure 5-3 shows the simplified equivalent circuit of the 4396B and 43961A.

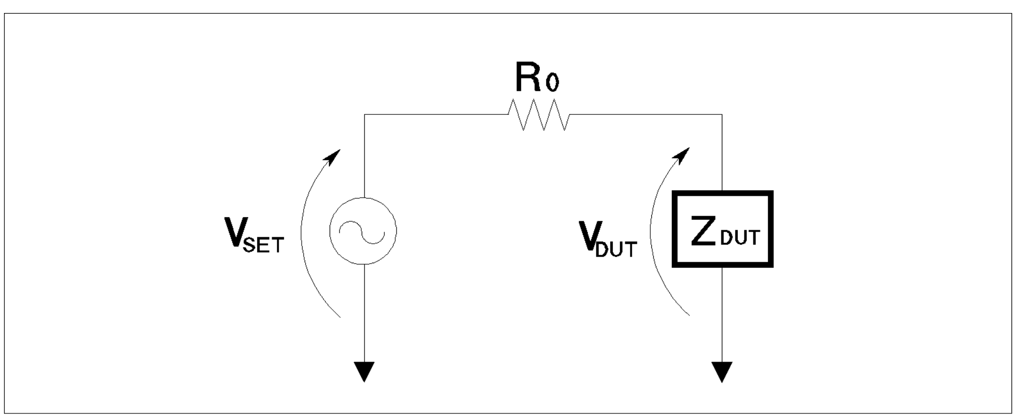


Figure 5-3. Test Signal Level

The output signal is divided by the input impedance (R_0) and the impedance of the DUT. You can use the following equation to determine the signal level actually applied to the DUT:

$$V_{DUT} = V_{SET} \times \frac{Z_{DUT}}{(Z_{DUT} + R_0)} [V]$$

Where,

V_{DUT}	Voltage level that is actually applied to the DUT.
V_{SET}	Voltage level that is set. See below.
Z_{DUT}	Impedance of the DUT.
R_0	Input impedance, 50 Ω.

The 4396B defines the output level as the level when the RF OUT port is 50 Ω terminated. Therefore, you can caluculate the voltage from dBm,

$$V_{SET} = \sqrt{10^{\frac{P_{SET}}{10}} \times 0.001 \times R_0}$$

Where,

P_{SET}	Output power setting level. [dBm]

Data Processing of Impedance Analyzer Mode

This section provides the data processing flow of the impedance analyzer mode. There are many sections that overlap with the network or spectrum analyzer mode of the analyzer. This section provides only the unique part of the impedance analyzer mode.

The data processing flow of the 4396B with Option 010 is as follows:

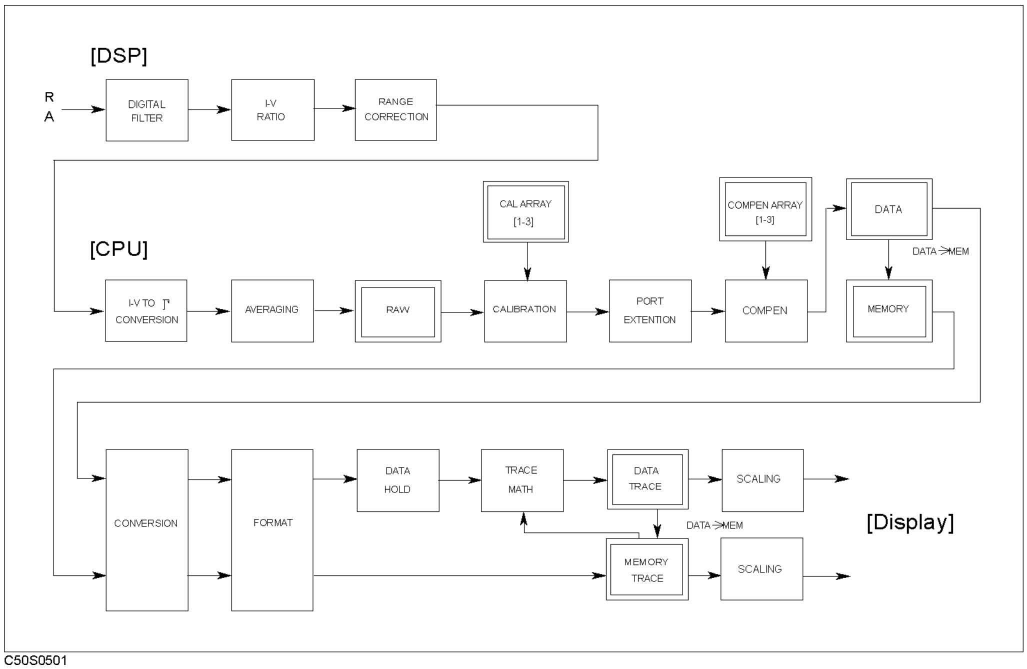


Figure 5-4. Data Processing Flow

Digital Filter

See chapter 12 of the *Function Reference* Manual.

I-V Ratio Conversion

The ratio processing calculates the ratio of the current and voltage values (V/I).

Range Adjustment

See chapter 12 of the *Function Reference* Manual.

I-V to Γ Conversion

This stage converts the measured I-V ratio to the Γ (reflection coefficient) data. The analyzer handles the internal data as a reflection coefficient.

Averaging

See chapter 12 of the *Function Reference* Manual.

Calibration

This stage determines the calibration plane at the APC-7 port of the 43961A. The analyzer performs an S_{11} 1-port calibration for the Γ data that is obtained in the "I-V to Γ Conversion" stage. See chapter 12 of the *Function Reference* Manual for details.

Calibration Coefficient Arrays

The analyzer measures the three standards automatically when the calibration measurement is performed. These arrays are directly accessible via GPIB, or by using the internal disk drive or the RAM disk memory.

Note

You cannot use the 4291A Impedance Analyzer's calibration and fixture compensation array data. The 4291A processes the internal data as an impedance. Therefore, the calibration and compensation coefficients are incompatible with the 4396B with option 010.

Raw Data Arrays

These arrays store the results of all the preceding data processing operations as reflection coefficient data. These arrays are directly accessible via GPIB, or using the internal disk drive or the RAM disk memory. Note that the numbers here are still complex pairs.

Port Extension

This is equivalent to "line-stretching" or artificially moving the measurement reference plane.

Fixture Compensation

This stage eliminates the error that is added by the fixture. The analyzer performs an S_{11} 1-port calibration for the raw data (Γ) that is used to correct the port extension. See chapter 12 of the *Function Reference* Manual for details.

Fixture Compensation Array

The analyzer measures the three standards automatically when the fixture compensation is performed. These arrays are directly accessible via GPIB, or by using the internal disk drive or the RAM disk memory.

Data Arrays

See chapter 12 of the *Function Reference* Manual.

Memory Arrays

See chapter 12 of the *Function Reference* Manual.

Conversion

Transforms the reflection coefficient data into the equivalent impedance or admittance when the impedance or admittance measurement parameter is selected.

Note that the raw data, data, and memory arrays contain reflection coefficient data.

Format

See chapter 12 of the *Function Reference* Manual.

Data Hold

See chapter 12 of the *Function Reference* Manual.

Trace Math

See chapter 12 of the *Function Reference* Manual.

Data Trace Arrays

See chapter 12 of the *Function Reference* Manual.

Memory Trace Arrays

See chapter 12 of the *Function Reference* Manual.

Scaling

See chapter 12 of the *Function Reference* Manual.

Save Data Format

When you store the internal data array by (Save) DATA ONLY, the stored binary file format is same as the network/spectrum analyzer except for the calibration and fixture compensation coefficients. This section provides the information about the save file format of the calibration and the fixture compensation coefficients. See appendix C of the *Function Reference* for all of other data format.

CAL Data Group

This group consists of the calibration and the fixture compensation coefficients data segements by a channel as shown in Figure 5-5. The first half of the segments are for channel 1 and the second half of the segments are for channel 2. The contents of each segment depend on the type of calibration performed.

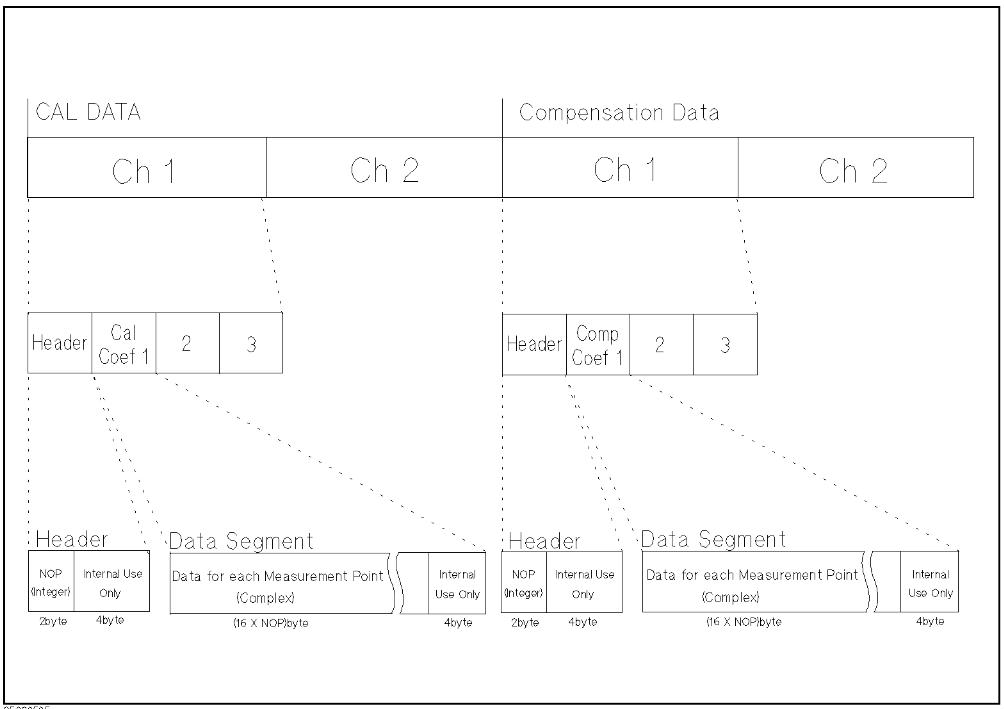


Figure 5-5. CAL Data Group Structure

A

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the analyzer than the current printing date of this manual. The information in this manual applies directly to the 4396B Network/Spectrum Analyzer serial number prefix listed on the title page of this manual.

Manual Changes

To adapt this manual to your 4396B, see Table A-1 and Table A-2, and make all the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument's serial number is not listed on the title page of this manual or in Table A-1, it may be documented in a *yellow MANUAL CHANGES* supplement.

In additions to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Agilent Technologies recommends that you periodically request the latest *MANUAL CHANGES* supplement.

For information concerning serial number prefixes not listed on the title page or in the *MANUAL CHANGE* supplement, contact the nearest Agilent Technologies office.

Turn on the line switch or execute the `*IDN?` command by GPIB to confirm the firmware version. See the *GPIB Command Reference* manual for information on the `*IDN?` command.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes

Table A-2. Manual Changes by Firmware Version

Version	Make Manual Changes

Serial Number

Agilent Technologies uses a two-part, nine-character serial number that is stamped on the serial number plate (see Figure A-1) attached to the rear panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix.

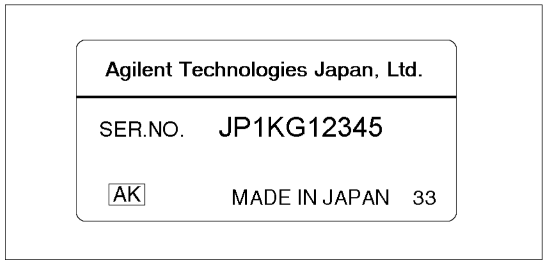


Figure A-1. Serial Number Plate

Index

REGIONAL SALES AND SUPPORT OFFICES

For more information about Agilent Technologies test and measurement products, applications, services, and for a current sales office listing, visit our web site: http://www.agilent.com/find/tmdir. You can also contact one of the following centers and ask for a test and measurement sales representative. *11/29/99*

United States:
Agilent Technologies
Test and Measurement Call Center
P.O.Box 4026
Englewood, CO 80155-4026
(tel) 1 800 452 4844

Canada:
Agilent Technologies Canada Inc.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
(tel) 1 877 894 4414

Europe:
Agilent Technologies
Test & Measurement
European Marketing Organization
P.O.Box 999
1180 AZ Amstelveen
The Netherlands
(tel) (31 20) 547 9999

Japan:
Agilent Technologies Japan Ltd.
Call Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192-8510, Japan
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Latin America:
Agilent Technologies
Latin American Region Headquarters
5200 Blue Lagoon Drive, Suite #950
Miami, Florida 33126
U.S.A.
(tel) (305) 267 4245
(fax) (305) 267 4286

Australia/New Zealand:
Agilent Technologies Australia Pty Ltd
347 Burwood Highway
Forest Hill, Victoria 3131
(tel) 1-800 629 485 (Australia)
(fax) (61 3) 9272 0749
(tel) 0 800 738 378 (New Zealand)
(fax) (64 4) 802 6881

Asia Pacific:
Agilent Technologies
24/F, Cityplaza One, 1111 King's Road,
Taikoo Shing, Hong Kong
(tel) (852)-3197-7777
(fax) (852)-2506-9284