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DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies Japan, Ltd.
Manufacturer's Address: Component Test PGU-Kobe
1-3-2, Murotani, Nishi-ku, Kobe-shi,
Hyogo, 651-2241 Japan

Declares, that the product

Product Name: Network Analyzer
Model Number: E5100A/B
Product Options: All options and customized products based on the above

Is in conformity with:

EMC European Council Directive 89/336/EEC and carries the CE-marking accordingly
EMC Standards required by the Australia Radio Communications Act
IEC 61326-1:1997+A1 / EN 61326-1:1997+A1
CISPR 11:1990 / EN 55011:1991 / AS/NZS 2064.1– Group 1 Class A [1]

IEC 61000-4-2:1995 / EN 61000-4-2:1995	(4 kV CD, 8 kV AD)
IEC 61000-4-3:1995 / EN 61000-4-3:1996	(3 V/m 80% AM 27 - 1000 MHz)
IEC 61000-4-4:1995 / EN 61000-4-4:1995	(1 kV power line, 0.5 kV Signal line)
IEC 61000-4-5:1995 / EN 61000-4-5:1995	(0.5 kV line-line, 1 kV line-earth)
IEC 61000-4-6:1996 / EN 61000-4-6:1996	(3 V 80% AM, power line)
IEC 61000-4-11:1994 / EN 61000-4-11:1994	(100% 1cycle)

Safety European Council Directive 73/23/EEC and carries the CE-marking accordingly
IEC 61010-1:1990+A1+A2 / EN 61010-1:1993+A2

Additional Information:

LEDs in this product are Class 1 in accordance with EN 60825-1:1994.

[1] The product was tested in a typical configuration.

Dec. 15, 1999
Date

Yukihiko Ota
Name Yukihiko Ota / Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Safety Summary

When you notice any of the unusual conditions listed below, immediately terminate operation and disconnect the power cable.
Contact your local Agilent Technologies sales representative or authorized service company for repair of the instrument. If you continue to operate without repairing the instrument, there is a potential fire or shock hazard for the operator.

- Instrument operates abnormally.
- Instrument emits abnormal noise, smell, smoke or a spark-like light during the operation.
- Instrument generates high temperature or electrical shock during operation.
- Power cable, plug, or receptacle on instrument is damaged.
- Foreign substance or liquid has fallen into the instrument.

Herstellerbescheinigung

GERÄUSCHEMISSION

LpA < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19

Manufacturer's Declaration

ACOUSTIC NOISE EMISSION

LpA < 70 dB
operator position
normal operation
per ISO 7779

Caution

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

Agilent E5100A/B Network Analyzer

Function Reference

SERIAL NUMBERS

This manual applies directly to instruments with serial number prefix JP2KC,JP3KC,JP4KC,JP5KC and MY405, or firmware revision 2.xx and 3.xx. For additional important information about serial numbers, read "Serial Number" in Appendix A.

Agilent Technologies

Agilent Part No. E5100-90070
Printed in Japan May 2003

Eighth 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's 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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September 1998 ..... Fifth Editon (part number: E5100-90050)

March 2000 ..... Sixth Edition (part number: E5100-90050)

July 2001 ..... Seventh Edition (part number: E5100-90060)

May 2003 ..... Eighth Edition (part number: E5100-90070)

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* elsewhere in this manual may impair the protection provided by the equipment. In addition it 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.

Note 

E5100A/B comply with INSTALLATION CATEGORY II and POLLUTION DEGREE 2 in IEC1010-1. E5100A/B are INDOOR USE product.

Note 

LEDs in E5100A/B are Class 1 in accordance with IEC825-1.
CLASS 1 LED PRODUCT

Ground The Instrument

To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

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 definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install 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 that safety features are maintained.

Dangerous Procedure Warnings

Warnings , such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

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

Safety Symbols

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


Instruction manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.


Alternating current.

Direct current.

On (Supply).


Off (Supply).


In position of push-button switch.


Out position of push-button switch.


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

Warning 
This **Warning** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

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

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


Affixed to product containing static sensitive devices use anti-static handling procedures to prevent electrostatic discharge damage to component.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

Warranty

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

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

Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instruction when property installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

Limitation Of Warranty

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

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

Exclusive Remedies

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

Assistance

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

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

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 LCD are enclosed in ▢.

Contents

Figures

Tables

1

General Information

Instruments Covered by This Manual

The instrument you received with this manual is covered by this manual without change. Any other instrument with one of the serial number prefixes listed on the title page is also described in this manual. (The serial number plate, shown in Figure 1-1, is attached to the rear panel of the analyzer.)

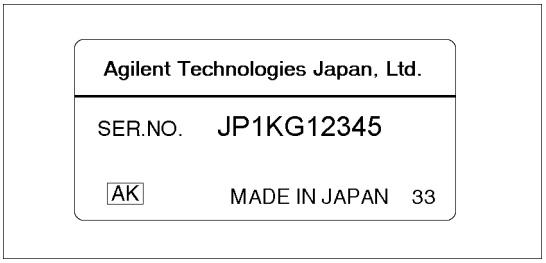


Figure 1-1. Typical Serial Number Plate

Other instrumentsmay differ from the instruments covered directly by this manual. Those differences are documented in Appendix A. See Appendix A if the serial number prefix of your instrument is not listed on the title page.

E5100A/B Description

The E5100A/B is a 10 kHz to 300 MHz network analyzer. It integrates a high resolution synthesized RF source and a one- to four-input receiver to measure and display magnitude, phase, and group delay responses of active and passive RF networks.

Digital signal processing and microprocessor control combine to provide easy operation and improved measurements. Measurement functions are selected with front panel keys and softkey menus. Displayed measurement results can be printed directly with a compatible peripheral. A built-in flexible disk drive and a FLASH disk can store and recall instrument states and trace data (measurement data).

Trace math, trace smoothing, electrical delay, and accuracy enhancement provide performance improvement and flexibility. Accuracy enhancement methods range from normalizing data to 3-term vector error correction.

Additional Features

In addition to the above capabilities, this analyzer has several other important features:

Advanced List Sweep Mode (E5100A only)

The analyzer can measure at specific user-defined frequencies, power levels, IF bandwidths, and number of points (as defined in the List Segment). The list sweep mode can make the display resolution appear even, even if the frequency points are not evenly distributed. It also makes the frequency base display appear even.

Automatic Sweep Time

The analyzer can automatically shorten the sweep time as much as possible for the specified IF bandwidth, number of points, smoothing mode, frequency range, and sweep type.

Automatic Interpolated Error Correction

This allows you to perform any type of calibration, and then display any subset of that frequency range or use a different number of points. If you change the stimulus parameter, the analyzer turns the interpolated error correction ON, and new error coefficients are interpolated from the coefficients of the original calibration. Interpolated error correction provides a great improvement over uncorrected measurements, but the accuracy of the interpolated error corrected points is not specified.

Simultaneous Measurement and Display of Four Traces

The analyzer can simultaneously measure and display a maximum four traces.. In addition, the stimulus values (frequency and power) can range independently.

Instrument BASIC

This allows analyzer programmability without an external controller. Instrument BASIC is a subset of HTBasic that allows all of the analyzer's measurement capabilities and any other GPIB compatible instrument to be programmed. When the analyzer is equipped with option UKR, Instrument BASIC capability is deleted.

I/O port

This allows the creation of a production line measurement system when used with an automatic handler.

Waveform Analysis Commands

The waveform analysis function provides filter and resonator specific measurement commands. These commands can be used to perform the following functions:

- Analyze filter ripple.
- Obtain filter parameters (for example 3 dB bandwidth)
- Search for a resonator's series-resonant mode frequency and its parallel-resonant mode (antiresonant) frequency and to derive parameters for the equivalent circuit of resonators.

General Purpose Interface Bus (GPIB)

The analyzer is factory-equipped with a remote programming interface using the General Purpose Interface Bus (GPIB). This provides a remote operator with the same control of the instrument available to the local operator, except for control of the power line switch and some internal tests. Remote control is maintained by a controlling computer that sends commands or instructions to and receives data from the analyzer using GPIB. Several output modes are available for output data. A complete general description of GPIB is available in *Condensed description of the General Purpose Interface Bus* (Agilent part number 59401-90030), and in the *Tutorial Description of the General Purpose Interface Bus* (Agilent literature number 5952-0156).

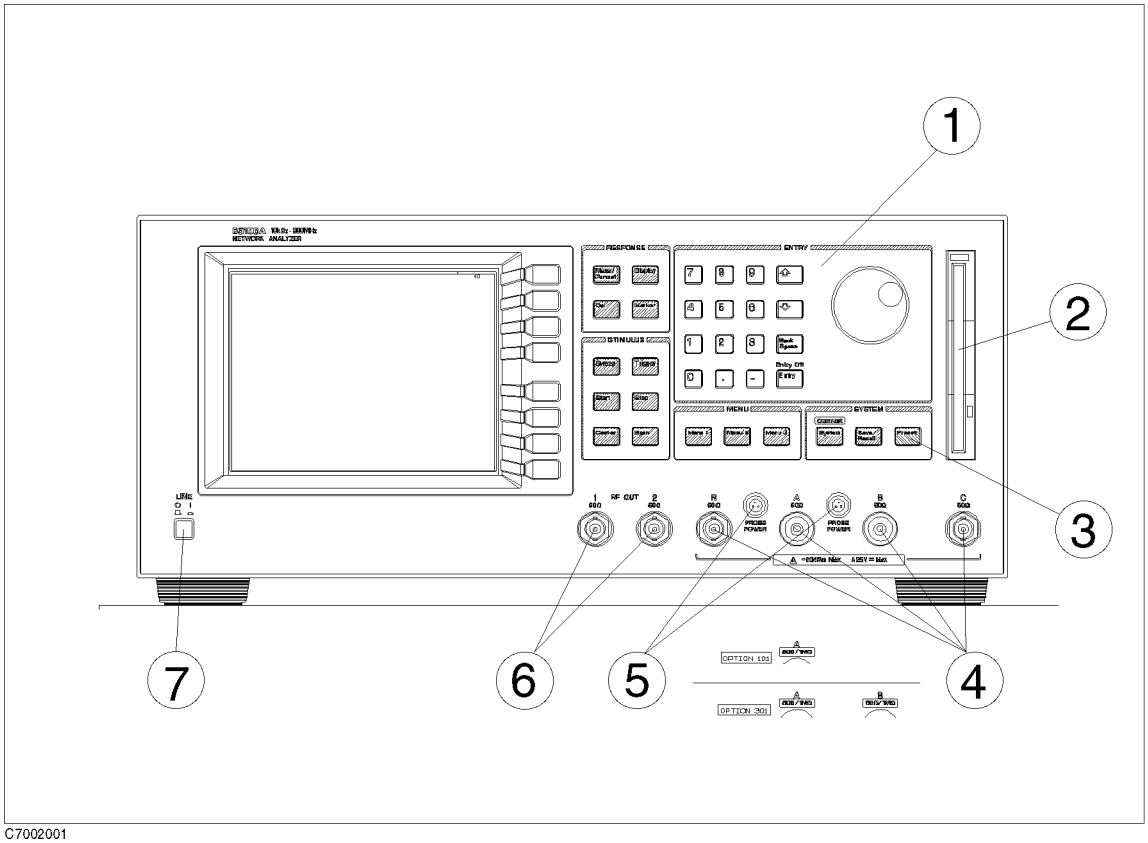
2

Front and Rear Panel

This chapter describes the features of the front and rear panels of the analyzer. It provides illustrations and descriptions of the front panel features, the LCD display and its labels, and the rear panel features and connectors.

Front Panel

Analyzer functions are activated from the front panel (Figure 2-1) by using the front panel hardkeys or softkeys.



C7002001

Figure 2-1. Analyzer Front Panel

Caution

⚠ Do not exceed the operating input power and voltage appropriate for the instrument being used, refer to your instrument's function reference.

1. Front Panel Keys and Softkeys

Some of the front panel keys change instrument functions directly, and others provide access to additional functions available in softkey menus. Softkey menus are lists of up to eight related functions that can be displayed in the softkey label area at the right-hand side of the display. The eight keys to the right of the LCD are the softkeys. Pressing one of the softkeys selects the adjacent menu function. This executes the labeled function and makes it the active function, causes instrument status information to be displayed, or presents another softkey menu.

Some of the analyzer's menus are accessed directly from front panel keys and some from other menus. For example, the sweep menu accessed by pressing the (Sweep) key presents all the sweep functions such as sweep type, number of points, and sweep time. Pressing `NUMBER of POINTS` allows the required number of points displayed per sweep to be entered directly from the number pad. `RETURN` softkeys return to previous menus. `DONE` indicates completion of a specific procedure and then returns to an earlier menu.

Usually, when a menu changes, the present active function is cleared.

Softkeys that are Joined by Vertical Lines

When several possible choices are available for a function, the softkeys are joined by vertical lines. For example, in the trigger menu under the (Trigger) key, the available inputs are listed as: `HOLD` , `SINGLE` , and `CONTINUOUS` with a vertical line between them. Note that only one softkey can be selected at a time. When a selection has been made from the listed alternatives, that selection is underlined until another selection is made.

Softkeys That Toggle On or Off

Some softkey functions can be toggled ON or OFF (for example, SMOOTHING). The current state, ON or OFF, is capitalized in the softkey label as shown below:

Example:

`SMOOTHING ON off`	The word on is capitalized, showing that smoothing is currently ON.
`SMOOTHING on OFF`	The word off is capitalized, showing that smoothing is currently OFF.

Softkeys that Show Status Indications in Brackets

Some softkey labels show the current status of a function in brackets. These include simple toggle functions and status-only indicators. An example of a toggled function is `SWEEP DIR [UP]` or `SWEEP DIR [DOWN]` softkey. The `TRIG EVENT [ ]` softkey is an example of a status-only indicator, where the selected equation of the data math function is shown in brackets in the softkey label.

2. Built-in Flexible Disk Drive

Stores the measurement data, instrument status, and HP Instrument BASIC programs. The applicable disk format is DOS (disk operating system) format.

3. Preset

This key returns the instrument to a known standard preset state from any step of any manual procedure. A complete listing of the instrument preset conditions is provided in Appendix B.

⚠ 4. Inputs R, A, B, and C

These inputs receive signals from the source or the DUT. The R input is used as the reference input. The number of inputs depends on the option (see Chapter 9). The input impedance of each input is 50 Ω. When the analyzer is equipped with option 101 or 301, the input impedance can be selected (50 Ω or 1 MΩ).

INSTALLATION CATEGORY I

5. PROBE POWER Connector

This connector (fused inside the instrument) supplies power to an active probe for in-circuit measurements of AC circuits. Applicable active probes are described in Chapter 9.

6. RF OUT Connectors

These two connectors output the RF signal. The same RF signals are provided from these two connectors because the power splitter is in the analyzer. The output impedance at these connectors is 50 Ω. When the analyzer is equipped with option 001, the output is from a single connector. When the analyzer is equipped with option 003, a switch is installed instead of the power splitter.

7. LINE Switch

This switch controls ac power to the analyzer (1 is ON, 0 is OFF).

Screen display

Displays a grid on which the measurement data, the currently selected measurement traces, and other information describing the measurement are displayed. Figure 2-2 shows the locations of the different information labels.

In addition to the full-screen display shown in Figure 2-2, a split display is available. In this case, information labels are provided for each half of the display.

The screen can also be used as the HP Instrument BASIC display. HP Instrument BASIC uses either a full-screen display or a half-screen display (below the graticule display) as a text screen.

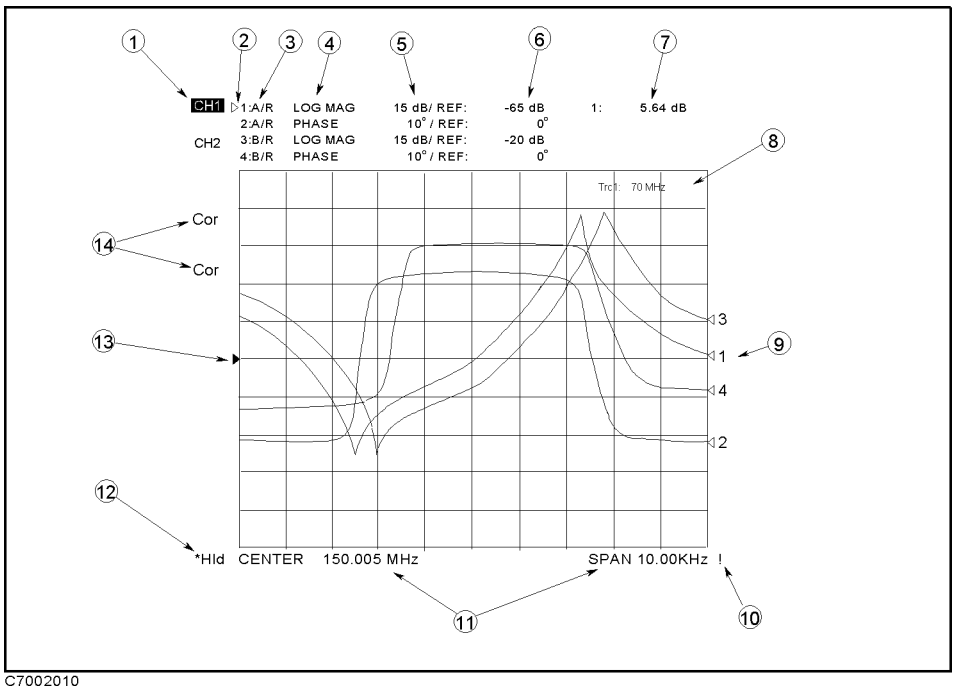


Figure 2-2. Screen Display

1. Channel Number

Highlights the displayed channel number. The active channel is indicated by reverse display characters.

2. Trace Number

Displays trace numbers. The active trace is indicated by a small triangle to the left of the trace number.

3. Measured Input(s)

Shows the input or ratio of inputs currently measured as selected using `Meas` under the (Meas/Format) key. The measured inputs is shown when the function is set to gain-phase

4. Format

Shows the format selected using `Format` under the (Meas/Format) key.

5. Top and Bottom Value

Displays the top and bottom values of the grid selected by `SCALE MENU` under the (Display) key. When the function is set to impedance measurement and the Y-axis is set to log format, the grid scale is not scale/div format but top and bottom format.

6. Reference Level

Displays the value of a reference line in Cartesian formats. It is selected using SCALE MENU under the [Display] key. However, the reference line is invisible (it is indicated by a small triangle adjacent to the graticule at the left).

7. Marker Data Readout

Displays the values of the marker in units appropriate to the current measurement.

8. Marker Stimulus

Displays the stimulus value of the marker.

9. Trace number

Indicates the trace number for the measurement trace.

10. Service Notation

Indicates the analyzer is in service mode or self test was failed. See *E5100A/B Service Manual*

11. Stimulus Value

Displays the start/stop or the center/span values of frequency or power.

12. Sweep Notations

Displays one of the following the sweep conditions:

Hld	Hold sweep (HOLD under the [Trigger] key).
Ext	Wait external trigger (TRIG EVENT under the [Trigger] key).
↑	Under sweep
*	Stimulus parameters changed: measured data in doubt until a complete fressh sweep has been taken.

13. Reference Position

Indicates the reference position.

14. Status Notations

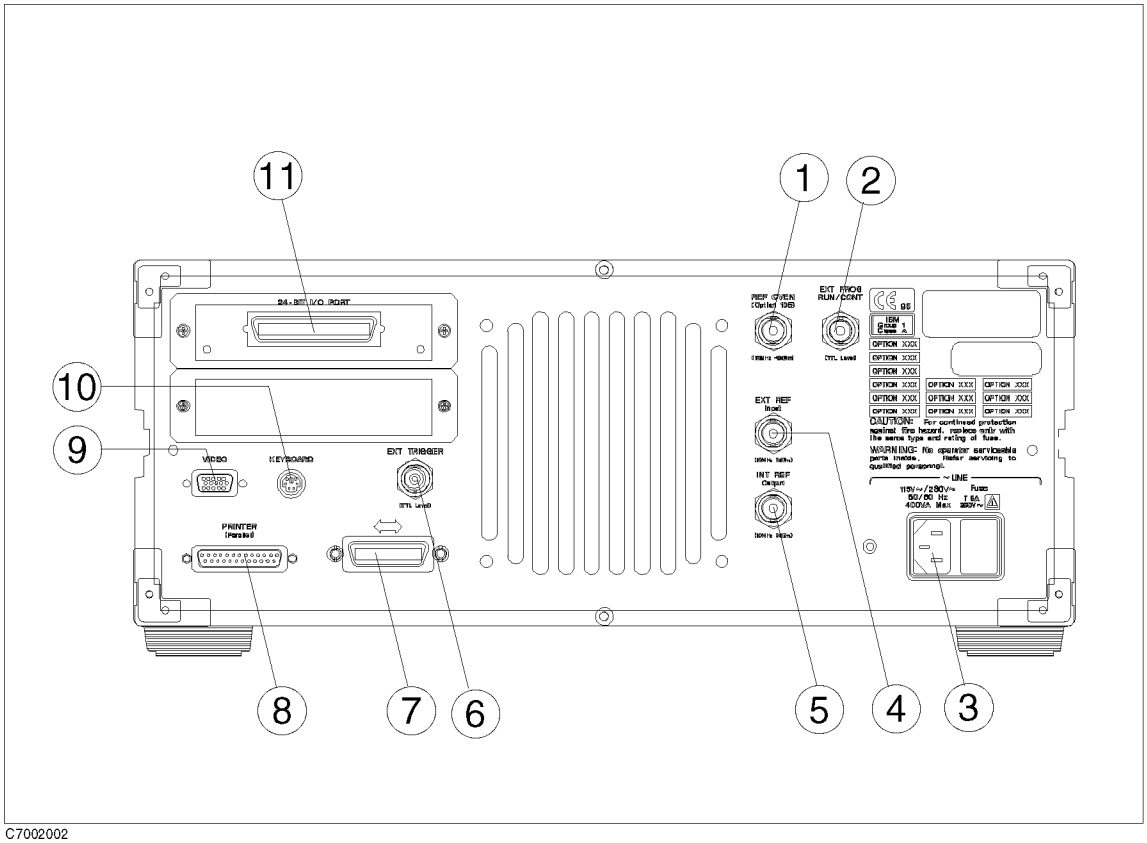
Displays the current status of various functions for each channels. The following notations are used:

Cor	Error correction is on (Correction on OFF under the [Cal] key).
C?	Stimulus parameters have changed, and interpolated error correction is on (see "[Cal]" in Chapter 4).
C!	Stimulus parameters have changed, and interpolated error correction is not available (see "[Cal]" in Chapter 4).
Del	Electrical delay or phase offset has been added or subtracted (SCALE MENU under the [Display] key).
Smo	Trace smoothing is on (SMOOTHING on OFF under the [Display] key).

For example, the upper Cor in Figure 2-2 is for channel 1 and the lower one is for channel 2.

Rear Panel Features and Connectors

Figure 2-3 shows the features and connectors on the rear panel. Requirements for the input signals to the rear panel connectors are provided in Chapter 10.



C7002002

Figure 2-3. Analyzer Rear Panel

1. Reference Oven Output (Option 1D5 Only)

Connects to the EXT REF INPUT connector when Option 1D5 is installed. Option 1D5 improves the frequency accuracy and stability of the analyzer.

2. External Program RUN/CONT Input

Externally triggers RUN or CONT of the HP Instrument BASIC program. The positive edge of a pulse more than 20 μs wide in the LOW state triggers RUN or CONT. The signal is TTL-compatible. When the analyzer is equipped with option UKR, this connector is deleted.

3. Power

This is input for the main power cable. Insert the main-power cable plug only into a socket outlet that has a protective ground contact.

4. External Reference Input

Connects an external frequency reference signal to the analyzer that is used to phase lock the analyzer for increased frequency accuracy.

When the analyzer is equipped with option 1D5, this connector must be connected to REF OVEN connector.

The external frequency reference function is automatically enabled when a signal is connected to this input. When the signal is removed, the analyzer automatically switches back to its internal frequency reference.

5. Internal Reference Output

Connects to the frequency reference input of an external instrument to phase lock it to the analyzer.

6. External Trigger Input

Triggers a measurement sweep. The positive edge of a pulse more than 20 μs wide in the LOW state starts a measurement. The signal is TTL-compatible. To use this connector, set the trigger mode to external using softkey functions.

7. GPIB Interface

Connects the analyzer to an external controller and other instruments in an automated system. This connector is also used when the analyzer itself is the controller of compatible peripherals.

8. Printer Interface

Connects the analyzer to an external printer. The interface is centronics compatible.

9. Video Outputs (VGA)

Connects the VGA video monitor.

10. DIN Keyboard Connector

Connects the keyboard that is usually used with HP Instrument BASIC. DIN keyboard is furnished when the analyzer is equipped with HP Instrument BASIC (option 1D5)

11. I/O Port

Connects to external devices such as a handler on a production line.

3

Entry Block

The ENTRY block contains the numeric and unit's keypad, the knob, and the step keys. These controls are used in combination with other front panel keys and softkeys to modify the active entry, to enter or change numeric data, and to change the value of the marker. In most cases, the keypad, knob, and step keys can be used interchangeably.

Before a function can be modified, it must be made the active function by pressing a front panel key or softkey. It can then be modified directly with the knob, the step keys, or the digits' keys and a terminator.

Numeric Keypad

The numeric keypad selects the digits, a decimal point, and the minus sign for numerical entries. When the numeric key pad is pressed, the terminator keys are displayed on the softkey area. These specify units of numerical entries from the keypad and also terminate the entries. A numerical entry is incomplete until a terminator is entered. The units are abbreviated on the terminator keys as follows:

`x M`	Mega (10^6)
`x k`	kilo (10^3)
`x 1`	basic units: dB, dBm, degrees, seconds, Hz, V, A, F, H, Ω, or S. (can also be used to terminate unitless entries such as averaging factor).
`EXP`	Exp (10^x)
`CANCEL`	Cancels the active entry and displays the current setting value. Before terminator keys `x M`, `x k`, `x 1` are pressed, this key allows you to cancel the entry.
`ENTRY OFF`	Clears and turns off the active entry area and any displayed prompts, error messages, or warnings. Use `ENTRY OFF` to clear the display before plotting. This key also prevents active values from being changed by accidentally moving the knob.

RPG Knob

The knob adjusts the current values continuously for functions such as scale, reference level, and others. If a marker is on, and no other function is active, the knob can adjust the marker position. Values changed by the knob are effective immediately and require no terminator.

⇧ and ⇩

The ⇩ and ⇧ keys step the current value of the active function up or down. The steps are predetermined and cannot be altered. No unit's terminator is required with these two keys.

Back Space

Deletes the last entry (or the last digit entered from the numeric keypad).

4

Response Block

The response block keys and associated menus provide control of the function, measurement parameter, input port, display, resolution or IF bandwidth, and calibration. The following list shows the functions controlled by each key in the measurement block.

Meas/Format	Selecting function (Gain-Phase, Impedance: reflection, Impedance: transmission) Selecting input port Selecting display format
Display	Selecting display trace (data and memory) Storing data trace to memory trace Performing trace math Selecting display mode Allocating screen between analyzer and HP Instrument BASIC Displaying titles Scaling trace Controlling group delay and phase offset Storing the trace
Cal	Performing calibration measurement Defining standards for Calibration
Marker	Controlling the marker, and delta-marker Setting the range for the marker search function Searching for the maximum, minimum, or point specified by the amplitude value Searching bandwidth Calculating statistics values

Active Channel

The `ACTIVE CH []` softkey (under each hard key in the response block) selects the active channel.

The active channel is the channel currently controlled by the front panel keys, and its trace and data annotations are displayed on the display. All channel specific function selections apply to the active channel.

The analyzer has a maximum of four digital channels for independent measurement and display data. The `NUM of CH` softkey under (Meas/Format) sets the number of channels. `ACTIVE CH []` toggles from `CH1` through `CH4`, depending on the number of channels.

Meas/Format

The softkey menus accessed by using the Meas/Format key are shown in Figure 4-1 and Figure 4-2.

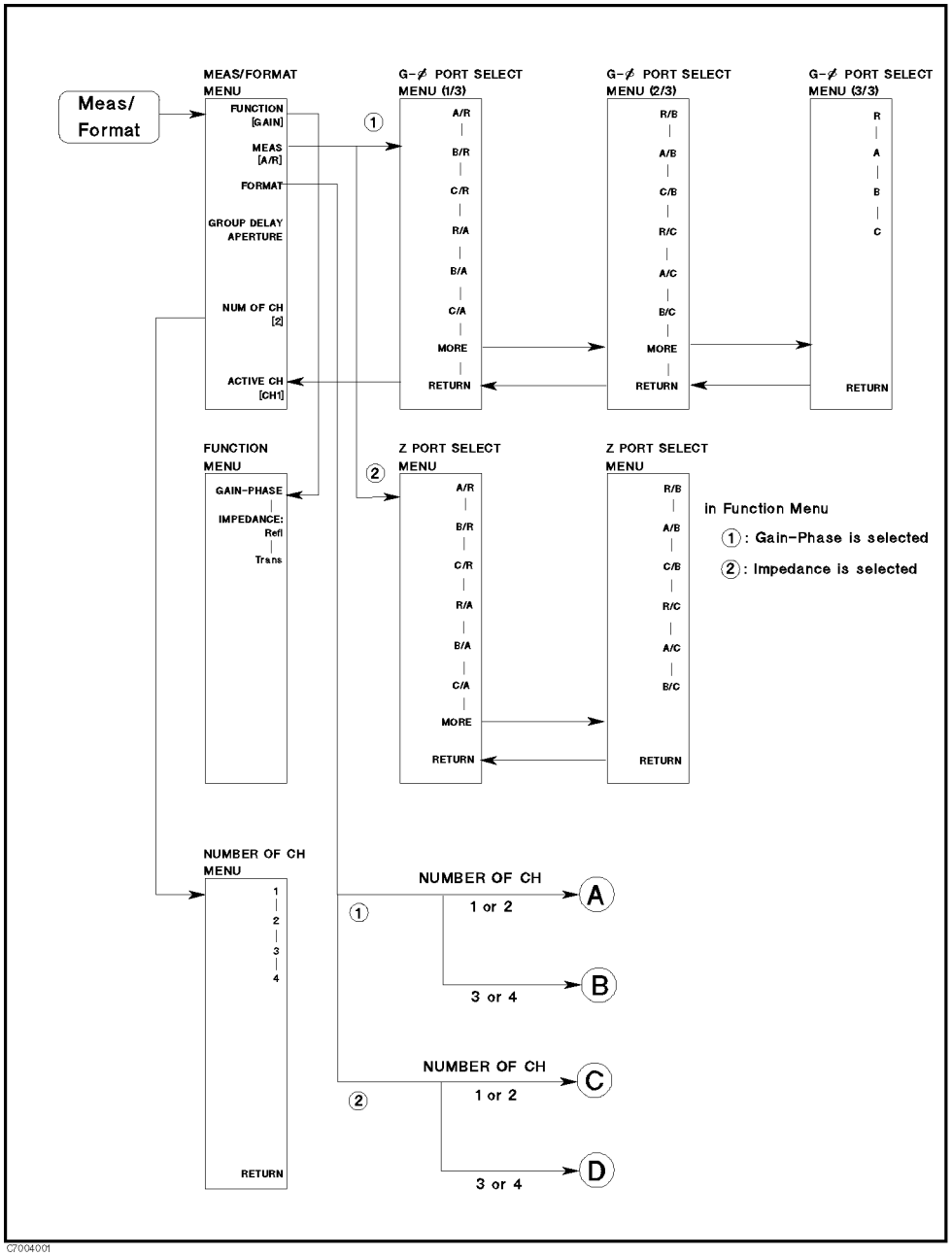


Figure 4-1. Softkey Menus Accessed from the Meas/Format Key (1/2)

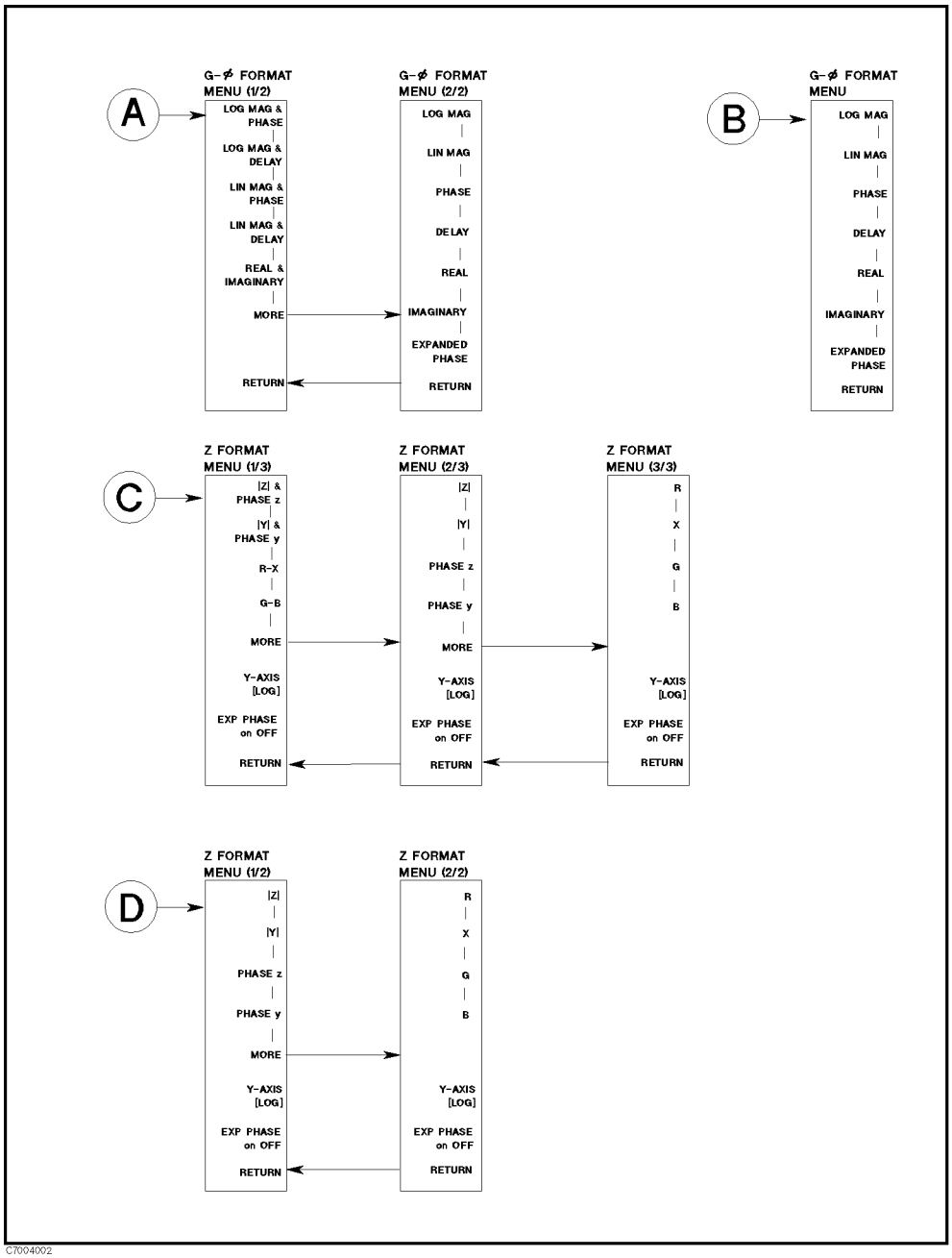


Figure 4-2. Softkey Menus Accessed from the Meas/Format Key (2/2)

Meas/Format Menu

Key Label	Description
FUNCTION []	Displays the *function menu* that selects measurement function, Gain-Phase, Impedance: reflection, and Impedance: transmission.
MEAS	Displays the *port select menu* that selects the measurement port.
FORMAT	Displays the *gain-phase format menu* or the *Z format menu* that is used to select the appropriate display format for the measured data. The formats are changed to correspond to the function setting (gain-phase or impedance).
GROUP DELY APERTURE	Sets the aperture for group delay measurements as a percentage of the span. The frequency aperture (Δf) at the active marker is displayed under the percentage value when the format is delay.
NUM of CH	Sets the number of channels. The maximum channel number is 4. The default number is 2.

Function Menu

Key Label	Description
GAIN-PHASE	Selects the gain-phase mode as the measurement function. This function is same as the measurement function of a conventional network analyzer. For applications using the impedance conversion function of a conventional network analyzer (such as the 87510A), using one of the following two functions is more convenient than using the Gain-Phase function with impedance conversion. (The impedance conversion function for the 87510A or other conventional network analyzers is not available using front-panel key operations. However, compatible GPIB commands are available.)
IMPEDANCE:Refl	Selects the impedance mode as the measurement function. The analyzer calculates the reflection data to obtain its equivalent impedance values or admittance values.
Trans	Selects the impedance mode as the measurement function. The analyzer calculates the transmission data to obtain its equivalent impedance values or admittance values.

Table 4-1.
Relationship Between the E5100A/B Function Selection and the Z-Conversion Function of a Conventional Network Analyzer

E5100A/B		Conventional Network Analyzer
Function	**Format**	
GAIN–PHASE	LOG MAG, LIN MAG, PHASE, DELAY, REAL, IMAGINARY	Network Measurement
IMPEDANCE:Refl	LOG |Z|, LIN |Z|, Phase Z, R, Z	Z Conversion (Z:Ref)
	LOG |Y|, LIN |Y|, Phase Y, G, B	Z Conversion (Y:Refl)
IMPEDANCE:Trans	LOG |Z|, LIN |Z|, Phase Z, R, Z	Z Conversion (Z:Trans)
	LOG |Y|, LIN |Y|, Phase Y, G, B	Z Conversion (Y:Trans)

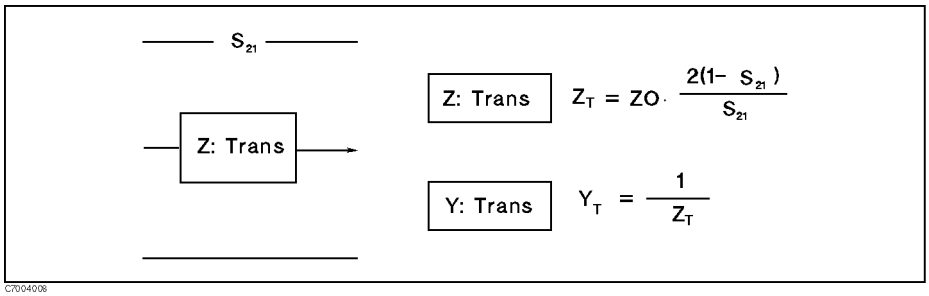


Figure 4-3. Z:Transmission Model

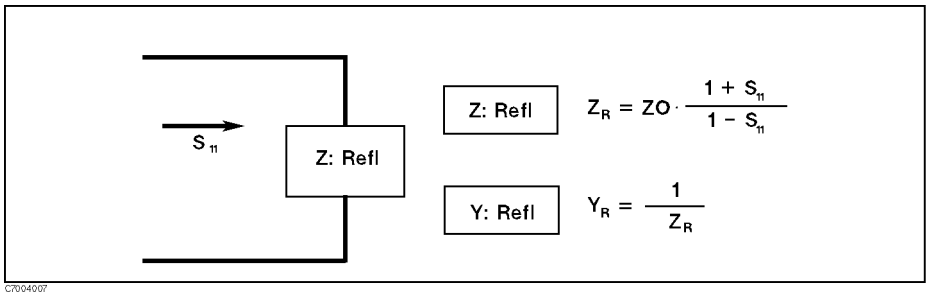


Figure 4-4. Z:Reflection

Port Select Menu

Calculates and displays the complex ratio of the selected input to the reference signal or the absolute power amplitude at the selected input. When the impedance measurement is selected in the *function menu*, only the softkeys related with complex ratio are displayed. The softkey labels are changed depending on which option is related to the inputs.

Gain-Phase Format menu

When the number of channels is 2 or less, dual traces in a channel are available (for example, `LOG MAG & PHASE`).

Key Label	Description
`LOG MAG & PHASE`	Displays the log magnitude format as the main trace and the phase format as the sub trace. This softkey is not displayed when the *number of channels* is set to 3 or 4.
`LOG MAG & DELAY`	Displays the log magnitude format as the main trace and the group delay format as the sub trace. It also sets the aperture for the group delay measurements as a percentage of the span. This softkey is not displayed when the *number of channels* is set to 3 or 4.
`REAL & IMAGINARY`	Displays the real format as the main trace and the imaginary format as the sub trace. This softkey is not displayed when the *number of channels* is set to 3 or 4.
`LOG MAG`	Displays the log magnitude format.
`PHASE`	Displays a Cartesian format of the phase portion of the data (measured in degrees).
`DELAY`	Selects the group delay format and sets the aperture for the group delay measurements as a percentage of the span.
`LIN MAG`	Displays the linear magnitude format. This is a Cartesian format used for unitless measurements.
`REAL`	Displays only the real (resistive) portion of the measured data on a Cartesian format. This is similar to the linear magnitude format, but can show both positive and negative values.
`IMAGINARY`	Displays only the imaginary (reactive) portion of the measured data on a Cartesian format. This format is similar to the real format except that reactance data is displayed on the trace instead of impedance data.
`EXPANDED PHASE`	Displays the phase plot over 360°. When it is turned on, the analyzer avoids the phase plot wrap-around every 360°.

Z Format Menu

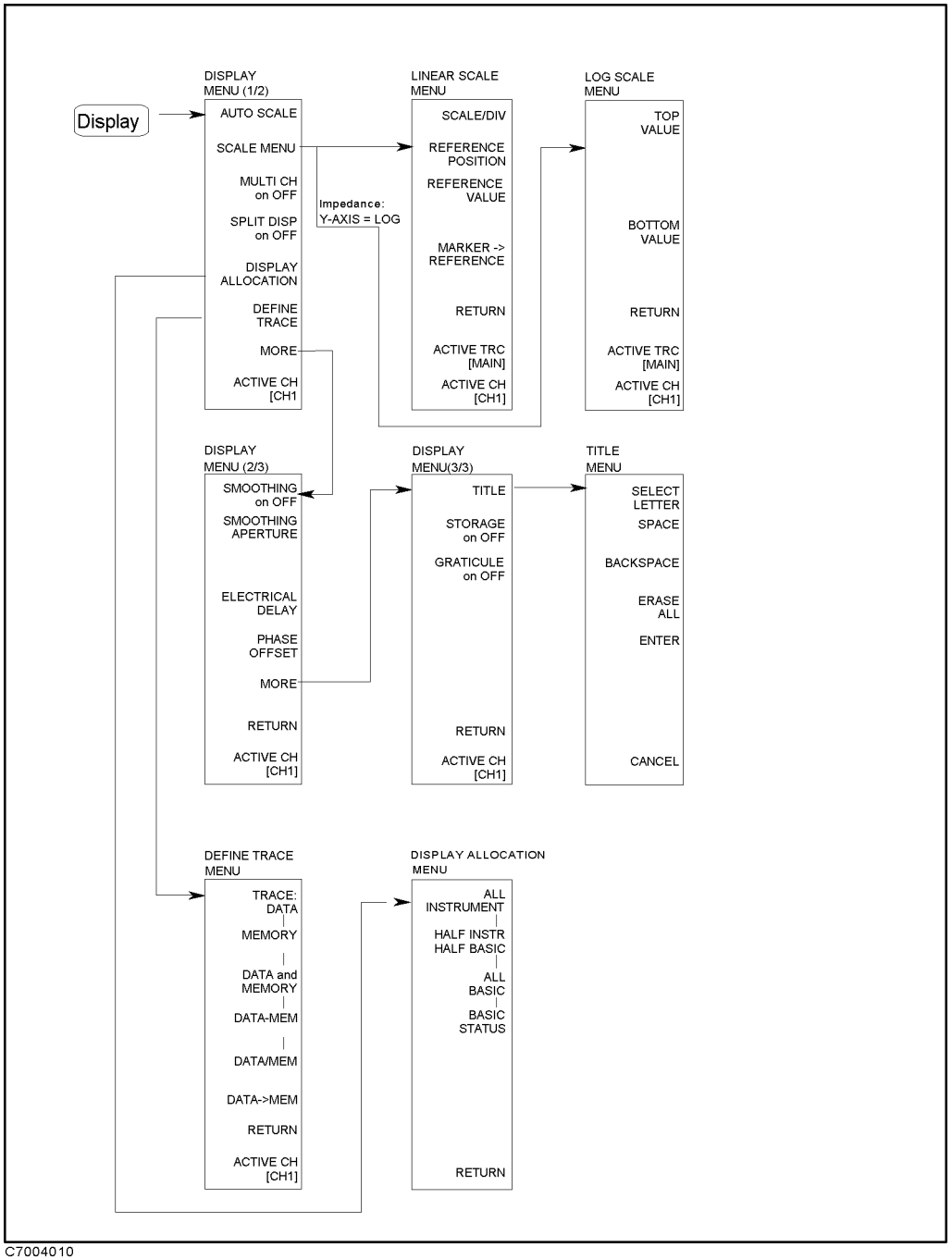
When the number of channels is 2 or less, dual traces in a channel are available (for example, `|Z| & PHASE z`.

Meas/Format

Key Label	Description
|Z| & PHASE z	Displays the impedance value as the main trace and the phase format as the sub trace. This softkey is not displayed when the *number of channels* is set to 3 or 4.
|Y| & PHASE y	Displays the admittance value as the main trace and the phase format as the sub trace. This softkey is not displayed when the *number of channels* is set to 3 or 4.
R-X	Displays the resistance value as the main trace and the reactance value as the sub trace. This softkey is not displayed when the *number of channels* is set to 3 or 4.
G-B	Displays the conductance value as the main trace and the susceptance value as the sub trace.
|Z|	Displays the impedance value.
|Y|	Displays the admittance value.
PHASE z	Displays a phase value Cartesian format of the phase portion of the data (measured in degrees).
PHASE y	Displays a phase value Cartesian format of the phase portion of the data (measured in degrees).
R	Displays the resistance value.
X	Displays the reactance value.
G	Displays the conductance value.
B	Displays the susceptance value.
Y-AXIS []	Toggles between log format and linear format for y axis.
EXPANDED PHASE on OFF	Displays the phase plot over 360°. When this is turned on, the analyzer avoids the phase plot wrap-around every 360°.

Display

The softkey menus accessed from the Display key are shown in Figure 4-5.



C7004010

Figure 4-5. Softkey Menus Accessed from the Display key

Display

Display menu (1/3) (2/3) (3/3)

Key Label	Description
AUTOSCALE	Fits the trace data onto the display with one keystroke. Sweep values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto the vertical graticule.
SCALE MENU	Displays the *scale menu* that is used to scale the trace manually.
MULTI CH on OFF	Toggles between display of all channels or the active channel only. This is used in conjunction with SPLIT DISP on OFF to display all channels.
SPLIT DISP on OFF	Toggles between a full-screen single graticule display of one channel, and a split display with multi graticules for all channels.
DISPLAY ALLOCATION	Displays the *display allocation menu* used to allocate the BASIC screen area on the display. This function is not available when option UKR is installed in the analyzer.
DEFINE TRACE	Displays the *define trace menu* used to define the memory trace and perform the trace math.
SMOOTHING on OFF	Turns the smoothing function ON or OFF for the active channel. When smoothing is ON, the annotation "Smo" is displayed in the status notations area.
SMOOTHING APERTURE	Lets you change the value of the smoothing aperture as a percentage of the span. The allowed range is 0.05 through 100 % of span and the resolution is 0.001%.
ELECTRICAL DELAY	Adjusts the electrical delay to balance the phase shift of the DUT.
PHASE OFFSET	Adds or subtracts a phase offset that is constant with frequency (rather than linear). This is independent of ELECTRICAL DELAY.
TITLE	Displays the title menu in the softkey labels and the character set in the active entry area. They are used to display the title in the active channel title area on the screen.
STORAGE on OFF	Toggles the storage function. When this function is turned on, the measurement trace is not erased after a sweep.
GRATICULE on OFF	Toggles the graticule display on the screen. This function does not affect the trace display.

The algorithm used for smoothing

$$S_{m(n)} = \frac{D_{(n-m)} + \ldots + D_{(n)} + \ldots + D_{(n+m)}}{2m + 1}$$

where

$S_{m(n)}$ = smoothed data

$D_{(n)}$ = unsmoothed data

m : determined by smoothing aperture

Example: The velocity factor of Teflon

The velocity factor of teflon is:

$$V_f = \frac{1}{\sqrt{\varepsilon_R}} = 0.666$$

Linear Scale Menu

Key Label	Description
SCALE/DIV	Changes the response value scale per division of the displayed trace. This key is not available when the function is set to impedance mode and Y-AXIS is set to log format.
REFERENCE POSITION	Sets the position of the reference line on the graticule of a Cartesian display (with 0 at the bottom line of the graticule and 10 at the top line). The reference position is indicated with a small triangle just outside the graticule, on the CENTER. This key is not available when the function is set to impedance mode and Y-AXIS is set to log format.
REFERENCE VALUE	Changes the value of the reference line, moving the measurement trace correspondingly. This key is not available when the function is set to impedance mode and Y-AXIS is set to log format.
MARKER -> REFERENCE	Changes the value of the reference line to the active marker value.
ACTIVE TRC []	Toggles between main and sub trace. Is scaled by prior functions in this menu when a format that has dual traces in a channel is selected (for example, LOG MAG & PHASE).

Log Scale Menu

Key Label	Description
TOP VALUE	Changes the value at the top line of the graticule, scaling the measurement trace correspondingly.
BOTTOM VALUE	Changes the value at the bottom line of the graticule, scaling the measurement trace correspondingly.
ACTIVE TRC []	Toggles between main and sub trace. Is scaled by prior functions in this menu when a format that has dual traces in a channel is selected (for example, LOG MAG & PHASE).

Define Trace Menu

Key Label	Description
TRACE: DATA	Displays the current measurement data trace for the active channel.
MEMORY	Displays the memory trace. If no data is stored in memory for this channel, a warning message is displayed.
DATA and MEMORY	Displays both the current data and the memory traces.
DATA-MEM	Subtracts the memory from the data.
DATA/MEM	Divides the data by the memory.
DATA→MEMORY	Stores the current active measurement data into the memory of the active channel. It then becomes the memory trace (for use in subsequent math manipulations or display). When the number of points (NOP) is changed, the memory trace becomes invalid.

Display Allocation Menu

Key Label	Description
ALL INSTRUMENT	Selects a single full screen or two half-screen graticules.
HALF INSTR HALF BASIC	Selects two half-screens, one graticule is displayed above the HP Instrument BASIC display.
ALL BASIC	Selects a full screen single HP Instrument BASIC display.
BASIC STATUS	Selects a full screen graticule and three status lines for HP Instrument BASIC under the graticule.

Title Menu

Key Label	Description
SELECT LETTER	Selects the letter pointed to by the arrow (↑) on the screen. The arrow can be moved by rotating the knob. Three sets of letters can be scrolled using the step keys, ⇧ and ⇩.
SPACE	Inserts a space in the title.
BACK SPACE	Deletes the last character entered.
ERASE ALL	Deletes the entire title.
ENTER	Terminates the title entry and returns to the display menu
CANCEL	Cancels the title entry and returns to the display menu without any change.

Cal

The softkey menus accessed from the Cal key are shown in Figure 4-6 and Figure 4-7.

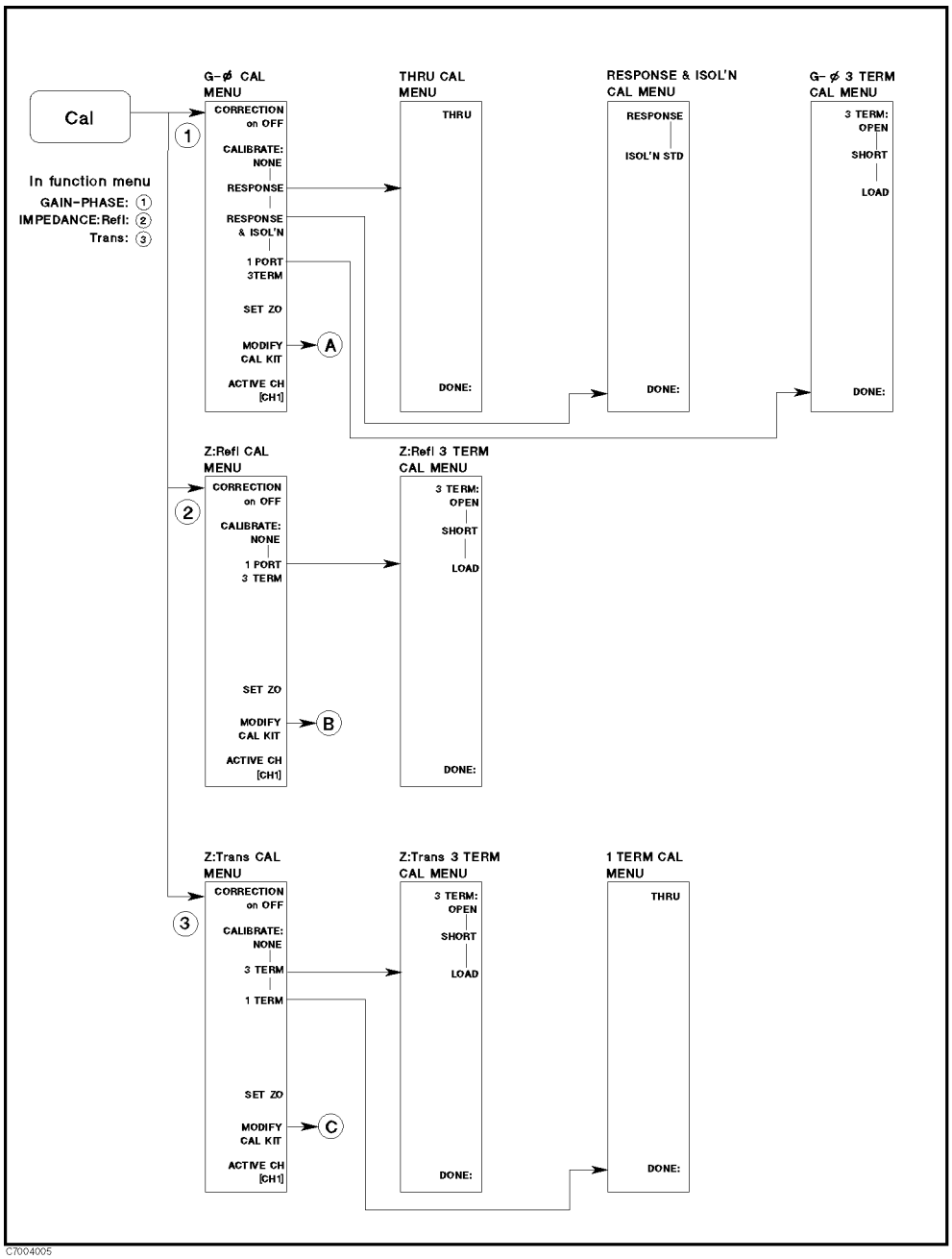


Figure 4-6. Softkey Menus Accessed from the Cal Key (1/2)

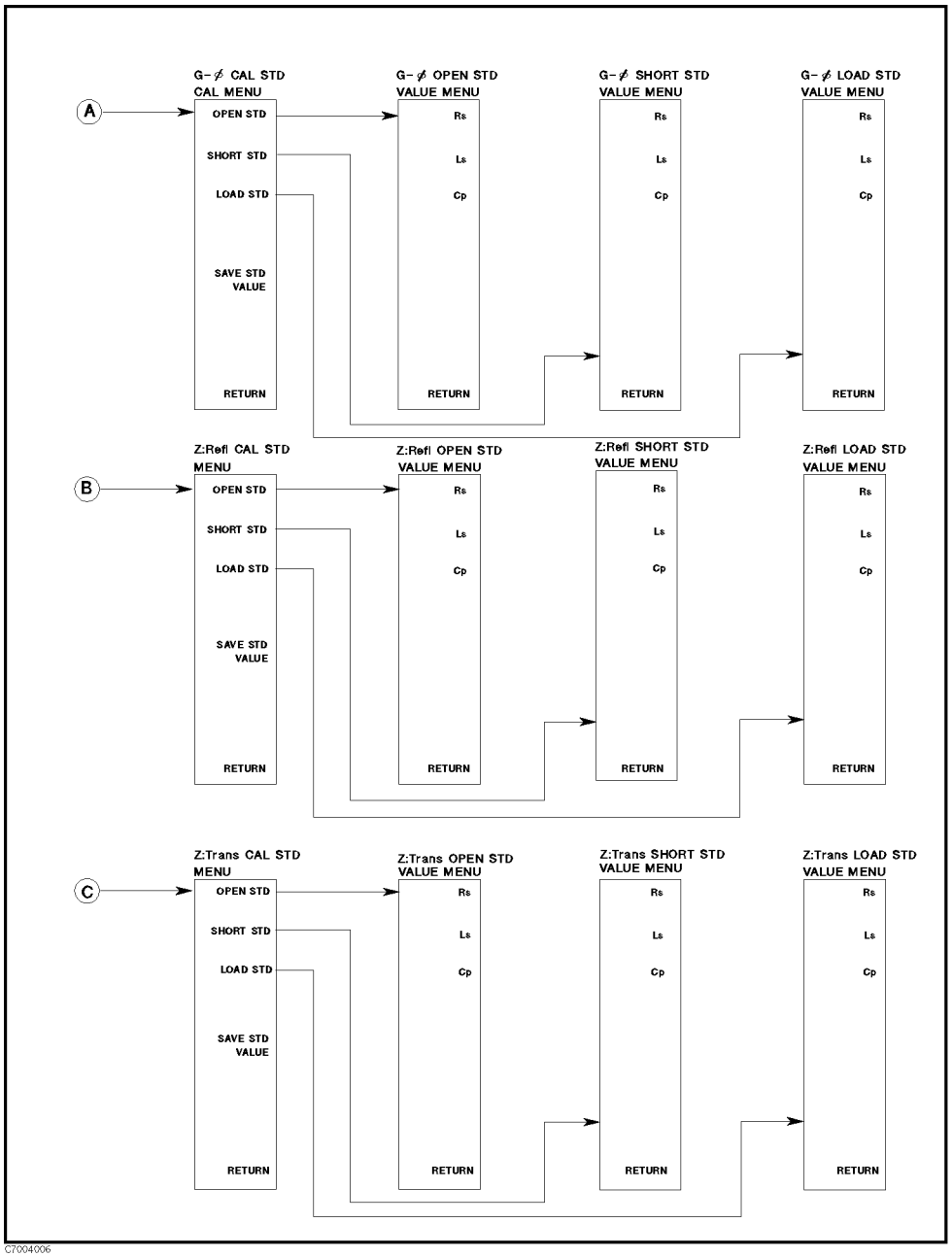


Figure 4-7. Softkey Menus Accessed from the Cal Key (2/2)

Cal

Gain-Phase CAL Menu

Key Label	Description
CORRECTION on OFF	Turns error correction ON or OFF. The analyzer uses the most recent calibration data for the displayed parameter. If one of the following sweep parameters is changed, error correction is automatically turned OFF: ■ Input measurement port is changed. ■ Calibration type is changed.
CALIBRATE: NONE	This softkey is underlined if no calibration has been performed or if the calibration data has been cleared. Unless the calibration data is saved on the flexible floppy disk or FLASH disk, the calibration data is lost when Preset is pressed, power is cycled on and off, or if an instrument state is recalled.
RESPONSE	Displays the *thru cal menu*. This calibration is the simplest and fastest accuracy enhancement procedure. However, it should only be used when very high accuracy is not required. It effectively removes the frequency response errors of the test setup for transmission measurement. A thru calibration standard is required with this procedure.
RESPONSE & ISOL'N	Displays the *response & isol'n cal menu* used to perform a response and isolation measurement calibration (used to measure devices with wide dynamic range). This procedure effectively reduces the same errors as the response calibration. In addition, it also reduces the isolation (crosstalk) error in a transmission measurement. In addition to the devices required for a response calibration, an isolation standard is required. The standard normally used to correct for isolation is an impedance-matched LOAD (usually 50 or 75 Ω) standard.
1-PORT 3-TERM	Displays the *gain-phase 3-term cal menu* that is used to perform a 3-term calibration (S_{11} 1-port measurement calibration). Usually, this correction is used to measure a 1-port measurement with a transmission/reflection test set.
MODIFY CAL KIT	Displays the *gain-phase cal std menu* that defines calibration standards of the 3-term calibration.

THRU CAL menu

Key Label	Description
THRU	Measures THRU standard for response calibration.

Gain-Phase 3-term CAL menu

Key Label	Description
OPEN	Measures OPEN standard for 3-term calibration.
SHORT	Measures SHORT standard for 3-term calibration.
LOAD	Measures LOAD standard for 3-term calibration.

Gain-Phase CAL STD value menu

Key Label	Description
OPEN STD	Defines the open standards values (Rs, Ls, Cp) that are used for the 3-term calibration in gain-phase measurement.
SHORT STD	Defines the short standards values (Rs, Ls, Cp) that are used for the 3-term calibration in gain-phase measurement.
LOAD STD	Defines the load standards values (Rs, Ls, Cp) that are used for the 3-term calibration in gain-phase measurement.
SAVE STD VALUE	Saves the open/short/load standard values to memory. When the analyzer is turned off, the input value is saved. The open/short/load standard values are saved in the file named "CALDATA" in the FLASH disk.

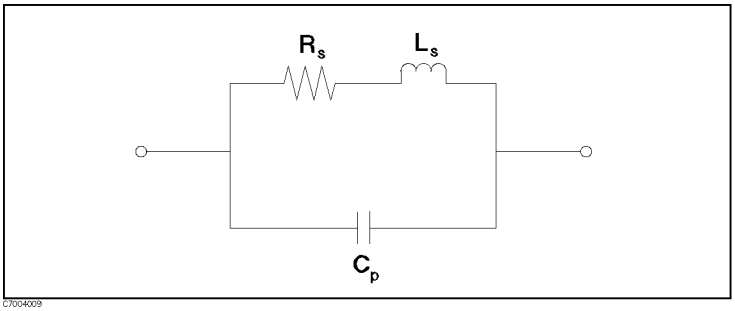


Figure 4-8. Equivalent Circuit Model of Standards

Cal

Z:Refl CAL Menu

Key Label	Description
CORRECTION on OFF	Turns error correction ON or OFF. The analyzer uses the most recent calibration data for the displayed parameter. If one of the following sweep parameters is changed, error correction is automatically turned OFF: ■ Input measurement port is changed. ■ Calibration type is changed.
CALIBRATE: NONE	This softkey is underlined if no calibration has been performed or if the calibration data has been cleared. Unless a calibration is saved on the internal disk, the calibration data is lost when Preset is pressed, power is cycled on and off, or if an instrument state is recalled.
1-PORT 3-TERM	Displays the *Z:refl 3-term cal menu* used to perform a 3-term calibration for reflection impedance measurement.
SET ZO	Sets the characteristic impedance used by the analyzer in calculating measured impedance. Characteristic impedance must be set correctly before calibration procedures are performed.
MODIFY CAL KIT	Displays the *Z:refl cal std menu* that defines calibration standards.

Z:Refl CAL menu

Key Label	Description
OPEN	Measures OPEN standard.
SHORT	Measures SHORT standard.
LOAD	Measures LOAD standard.

Z:Refl CAL STD value menu

Key Label	Description
OPEN STD	Defines the open standards values (Rs, Ls, Cp) that are used for the Z:Refl calibration.
SHORT STD	Defines the short standards values (Rs, Ls, Cp) that are used for the Z:Refl calibration.
LOAD STD	Defines the load standards values (Rs, Ls, Cp) that are used for the Z:Refl calibration.
SAVE STD VALUE	Saves the open/short/load standard values to memory. When the analyzer is turned off, the input value is saved. The open/short/load standard values are saved in the file named "CALDATA" in the FLASH disk.

Z:Trans CAL Menu

Key Label	Description
CORRECTION on OFF	Turns error correction ON or OFF. The analyzer uses the most recent calibration data for the displayed parameter. If one of the following sweep parameters is changed, correction is automatically turned OFF: ■ Input measurement port is changed. ■ Calibration type is changed.
CALIBRATE: NONE	This softkey is underlined if no calibration has been performed or if the calibration data has been cleared. Unless a calibration is saved on the internal disk, the calibration data is lost when Preset is pressed, power is cycled on and off, or if an instrument state is recalled.
3-term	Displays the *Z:trans 3-term cal menu* used to perform a 3-term calibration for transmission impedance measurement. This calibration also applies to error correction for the π network measurement.
1-term	Displays the *Z:trans cal menu* used to perform a 1-term calibration for a transmission impedance measurement.
SET ZO	Sets the characteristic impedance used by the analyzer in calculating measured impedance. Characteristic impedance must be set correctly before calibration procedures are performed.
MODIFY CAL KIT	Displays the *Z:trans cal std menu* that defines calibration standards.

Z:Trans 3-term CAL menu

Key Label	Description
OPEN	Measures OPEN standard.
SHORT	Measures SHORT standard.
LOAD	Measures LOAD standard.

1-term CAL menu

Key Label	Description
THRU	Measures THRU standard for 1-term calibration.

Cal

Z:Trans CAL STD value menu

Key Label	Description
OPEN STD	Defines the open standards values (Rs, Ls, Cp) that are used for the Z:Trans calibration.
SHORT STD	Defines the short standards values (Rs, Ls, Cp) that are used for the Z:Trans calibration.
LOAD STD	Defines the load standards values (Rs, Ls, Cp) that are used for the Z:Trans calibration.
SAVE STD VALUE	Saves the open/short/load standard values to memory. When the analyzer is turned off, the input value is saved. The open/short/load standard values are saved in the file named "CALDATA" in the FLASH disk.

Table 4-2. Standard Values for 85032B (50 Ω)

Type	L	C	R
OPEN (M)	0 H	108 fF	100 GΩ
SHORT (M)	0 H	0 pF	0 Ω
OPEN (F)	0 H	413 fF	100 GΩ
SHORT (F)	877.3 pH	0 pF	0 Ω
LOAD	0 H	0 pF	50 Ω

Table 4-3. Standard Values for 85036B (75 Ω)

Type	L	C	R
OPEN (M)	0 H	63.5 fF	100 GΩ
SHORT (M)	0 H	0 pF	0 Ω
OPEN (F)	0 H	275 fF	100 GΩ
SHORT (F)	1316 pH	0 pF	0 Ω
LOAD	0 H	0 pF	75 Ω

Table 4-4. Standard Values for 85031 B (APC7)

Type	L	C	R
OPEN	0 H	92.85 fF	100 GΩ
SHORT	0 H	0 pF	0 Ω
LOAD	0 H	0 pF	50 Ω

Calibration

Measurement calibration is an accuracy enhancement procedure that effectively reduces the system errors that cause uncertainty when making a DUT measurement. Known standard devices are measured, and the results of these measurements are used to characterize the system.

This section explains the theoretical fundamentals of accuracy enhancement and the sources of measurement errors. It describes the different measurement calibration procedures available in the analyzer, which errors they correct, and the measurements for which each should be used.

Accuracy Enhancement

If it were possible for a perfect measurement system to exist, it would have infinite dynamic range, isolation, and directivity characteristics, no impedance mismatches in any part of the test setup, and flat frequency response. Vector accuracy enhancement, also known as measurement calibration or error correction, provides the means to simulate a perfect measurement system.

In any high frequency measurement, there are measurement errors associated with the system that contribute uncertainty to the results. Parts of the measurement setup such as interconnecting cables and signal separation devices (as well as the analyzer itself) all introduce variations in magnitude and phase that can mask the actual performance of the DUT.

For example, crosstalk due to the channel isolation characteristics of the analyzer can contribute an error equal to the transmission signal of a high-loss test device. The measurement system cannot distinguish the true value of the signal reflected by the device under test from the signal arriving at the receiver input due to leakage in the system. For transmission measurements, impedance mismatches within the test setup cause measurement uncertainties that appear as ripples superimposed on the measured data.

Measurement calibration simulates a perfect analyzer system. It measures the magnitude and phase responses of known standard devices, and compares the measurement with actual device data. It uses the results to characterize the system and effectively remove the system errors from the measurement data of a test device, using vector math capabilities internal to the analyzer.

When measurement calibration is used, the dynamic range and accuracy of the measurement are limited only by system noise and stability, connector repeatability, and the accuracy to which the characteristics of the calibration standards are known.

Correcting for Measurement Errors

The analyzer has three different measurement calibration routines to characterize one or more of the systematic error terms and remove their effects from the measured data.

The **Response Calibration** effectively reduces the frequency response errors of the test setup for reflection or transmission measurements. This calibration procedure may be adequate for measurement of well-matched low-loss devices.

The **Response and Isolation Calibration** effectively removes frequency response and crosstalk errors in transmission measurements. This procedure may be adequate for measurement of well-matched high-loss devices.

The **1-term calibration** procedures provide the same correction measurements as the response thru calibration of conventional network analyzers. This calibration is used for the impedance transmission measurement.

Cal

The **3-term calibration** procedures provide the same correction measurements as the S_{11} 1-port calibration of conventional network analyzers. This calibration also applies to error correction for the π network measurement to test crystal resonators in Z:trans measurement.

Calibration should be performed before measurement of a test device. The analyzer uses one of several different procedures to measure the systematic (repeatable) errors of the system and remove their effects from the measured data. Each procedure compensates for one or more of the systematic error terms.

Interpolated Error Correction

The interpolated error correction feature allows you to change sweep range or sweep type, without re-calibration. Interpolation is activated automatically when one or more stimulus parameters is changed. When interpolation is activated, the following notation is displayed in the notation area.

- When "C?" is displayed in the notation area:

  If one of the following sweep parameters is changed, interpolated correction is automatically turned on and the status notation is changed to "C?" :

  - Sweep range is changed to fall inside the calibrated range.
  - Sweep type is changed.
  - Number of points is changed.

- When "C!" is displayed in the notation area:

  If one of the following sweep parameters is changed, the status notation is changed to "C!". In this status, error corrections at a sweep point are done using the calibration coefficient at the nearest calibrated frequency point or at the CW frequency.

  - Sweep range is changed so both the start and stop (or one of the start and stop) sweep values are out of the calibrated range.
  - Sweep type is changed from the power sweep. (If the span is zero and the measurement frequency is equal to the CW frequency of the power sweep, the status is not changed.)
  - Sweep type is changed to power sweep and CW frequency is out of the calibration range.

When the power sweep is used, the interpolated error correction is not activated, even stimulus parameters are changed. Re-calibration is recommended when the sweep range is changed in the power sweep.

Omitting Isolation Calibration

Isolation calibration can be omitted for most measurements except where wide dynamic range is a consideration. Use the following guidelines when the measurement requires a dynamic range of:

- X [dB] $\leq$ D [dB] + 20 [dB]
  Where,
  X : Measurement result using the response calibration
  D : Dynamic range of DUT

Saving Calibration Data

The calibration data can be saved on the built-in disk or on the RAM or FLASH disk if required. If a calibration is not saved, it is lost if another calibration procedure is selected for the same channel. Instrument preset, power on, and instrument state recall also clears the calibration data.

Calibration When Using PI-Network Test Fixture

When using Agilent PI-network test fixtures (41900A and 41901A) or a user-prepared one, you must set the calibration standard value corresponding to the individual test fixture before performing a calibration. In particular, when measuring high-frequency (100 MHz or higher) resonators, be sure to provide the instrument with the calibration standard values for the PI-network test fixture you use. This is because the effect of Ls in the 3-element equivalent circuit for the calibration standard becomes significant. For more information on defining the PI-network test fixture calibration standard for resonator measurement, see Appendix C.

- When using the Agilent 41900A or 41901A

  You must set the calibration standard values described in the operation manual of each PI-network test fixture.

- When using a user-prepared PI-network test fixture

  You must define the calibration standard values for the PI-network test fixture as based on an actual measurement. For the method of defining them, see Appendix C.

Marker

The softkey menus accessed from the Marker key are shown in Figure 4-9.

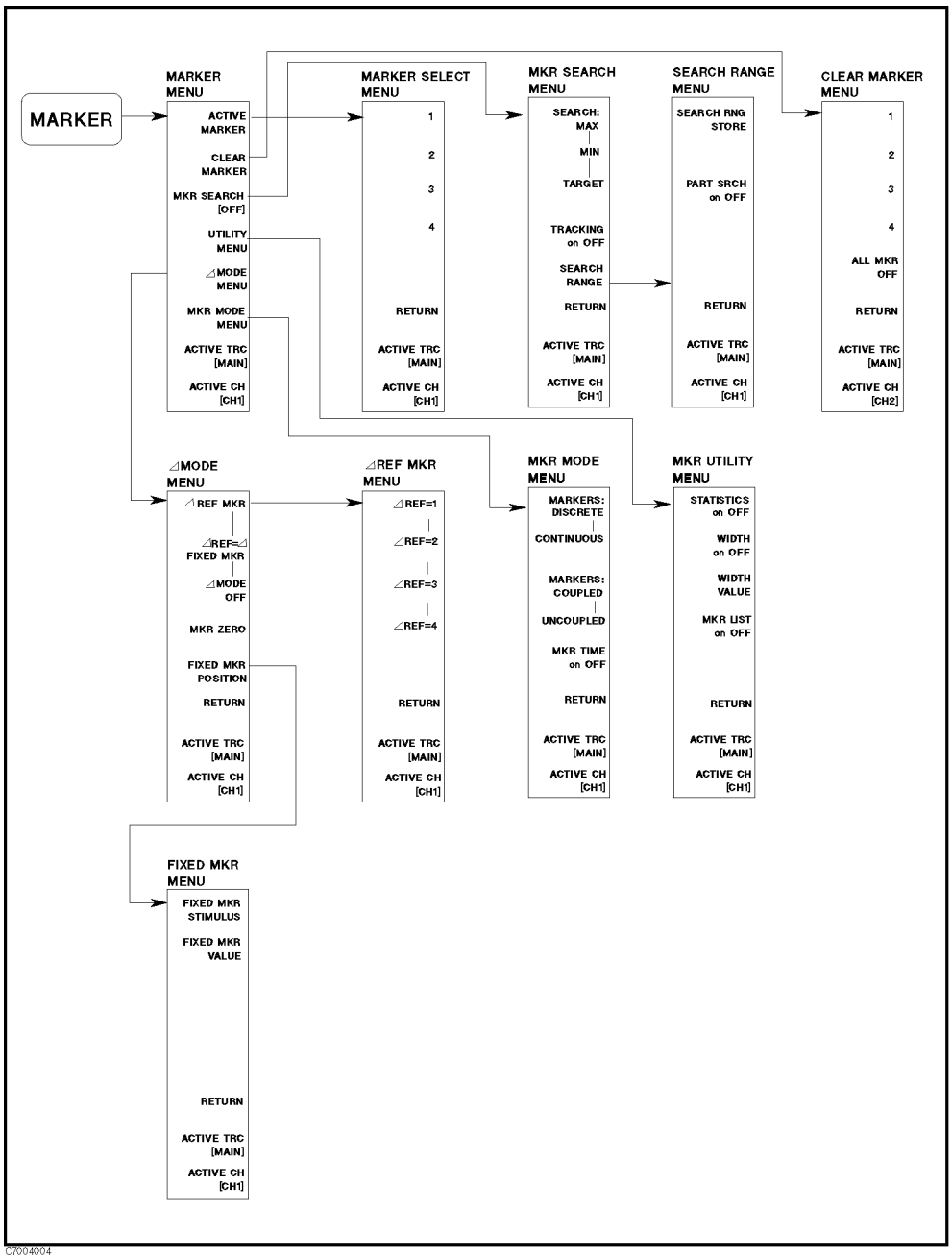


Figure 4-9. Softkey Menus Accessed from the Marker key

Marker Menu

Key Label	Description
ACTIVE MARKER	Displays the *active marker menu* that is used to turn on active markers.
CLEAR MARKER	Turns off a specific active marker.
MKR SEARCH []	Displays the *marker search menu* that searches for max, min and target points on the trace.
UTILITY MENU	Displays the *utility menu* to calculate the statistic value and search bandwidth.
ΔMODE MENU	Displays the Δ*mode menu* to turn on Δ markers.
MKR MODE MENU	Displays the *marker mode menu* to select the marker mode.

Active Trace

ACTIVE TRC [] key is displayed at the bottom of the softkey. This key toggles between the main trace and the sub trace. This key is available when a format that has dual traces in a channel is selected (for example, LOG MAG & PHASE).

Active Marker Menu

This menu turns on a selected marker and makes it the active marker. The active marker appears on the display as "▽". The active marker stimulus value is displayed in the active entry area, together with the marker number. If there is a marker turned ON, and no other function is active, the stimulus value of the active marker can be controlled with the knob, the step keys, or the numeric keypad. The marker response and stimulus values are displayed in the upper right-hand corner of the screen.

Marker Search Menu

Key Label	Description
SEARCH:MAX	Moves the marker to the maximum amplitude point on the trace.
MIN	Moves the marker to the minimum amplitude point on the trace.
TARGET	Moves the marker to a specified target point on the trace and displays the target menu that is used to search right and search left to resolve multiple solutions. This softkey appears in the network analyzer mode only.
TRACKING on OFF	Is used in conjunction with other search features to track the search of each new sweep. Turning ON tracking makes the analyzer search every new trace for the specified target value and puts the active marker on that point.
SEARCH RANGE	Displays the *search range menu* that defines the range for a partial search and activates the partial search.

Search Range Menu

Key Label	Description
SEARCH RNG STORE	Stores a search range, which is defined using the active marker and the delta reference marker. If there is no reference marker, the message "NO MARKER DELTA - RANGE NOT SET" is displayed.
PART SRCH on OFF	Activates partial search. The search range is displayed by two small triangles, "△", at the bottom of the graticule. If no search range is defined, the search range is the entire trace.

To set the search range

1. Press Marker to active the marker.
2. Position the marker at the left side of the required search range.
3. Press ΔMODE MENU MKR ZERO RETURN to display the Δ marker.
4. Position the marker at the right side of the required search range.
5. Press MARKER SEARCH [] SEARCH RANGE.
6. Toggle the PART SRCH on OFF to PART SRCH ON off.
7. Verify that two small triangles ("△") appear at the bottom of the graticule.

Mkr Utility Menu

Key Label	Description
STATISTICS on OFF	Calculates and displays the mean, standard deviation, and peak-to-peak values of the section of the displayed trace in the search range. If Partial Search is OFF, the statistics are calculated for the entire trace. The statistics are absolute values.
WIDTHS on OFF	Calculates the center stimulus value, bandwidth, Q, insertion loss, and cutoff point deviation from the center of a band pass or band reject shape on the trace. The amplitude value that defines the pass band or reject band is set using the WIDTH VALUE softkey.
WIDTH VALUE	Sets the amplitude parameter (for example −3 dB) that defines the Start and Stop points for a bandwidth search. The bandwidth Search feature analyzes a band pass or band reject trace and calculates the center point, bandwidth, and Q (quality factor) for the specified bandwidth. Bandwidth units are in the units of the current format. When Δ mode is ON, the bandwidth value specified is the difference from the delta reference.
MKR LIST on OFF	Lists stimulus values and response values of all markers.

ΔMode Menu

Key Label	Description
Δ REF MARKER	Displays the *delta marker menu*, that establishes a marker as a delta reference.
ΔREF=Δ FIXED MKR	Sets a user-specified fixed reference marker. The stimulus and response values of the reference can be set arbitrarily, and can be anywhere in the display area. Unlike markers 1 to 4, the fixed marker need not be on the trace. The fixed marker is indicated by a small triangle △, and the active marker stimulus and response values are shown relative to this point. Pressing this softkey turns ON the fixed marker. Its stimulus and response values can then be changed using the *fixed marker menu*, which is accessed with the FIXED MKR POSITION softkey described below. Alternatively, the fixed marker can be set to the current active marker position, using the MKR ZERO softkey in the marker menu.
Δ MODE OFF	Turns OFF the delta marker mode, so that the values displayed for the active marker are absolute values.
MKR ZERO	Puts a fixed reference marker at the present active marker position, and sets the fixed marker stimulus and response values at that position equal to zero. All subsequent stimulus and response values of the active marker are then read out relative to the fixed marker. The fixed marker is shown on the display as a small triangle "△" (delta), smaller than the inactive marker triangles. The softkey label changes from MKR ZERO to MKR ZERO Δ REF = Δ. The marker zero is canceled by turning the delta mode OFF from the delta marker menu or turning all the markers OFF with the ALL MKR OFF softkey.
FIXED MKR POSITION	Displays the *fixed marker menu*, where the stimulus and response values for a fixed reference marker can be set arbitrarily.

Delta Marker Menu

This menu establishes a marker as a delta reference. The active marker stimulus and response values are shown relative to this delta reference. If marker 1 is selected as the delta reference, ΔREF=1 is underlined in this menu.

Fixed Mkr Position Menu

Key Label	Description
ΔMKR STIMULUS	Changes the sweep parameter value of the fixed Δmarker. The fixed Δmarker sweep parameter values can be different for each channel if the channel markers are uncoupled.
FIXEDΔMKR VALUE	Changes the amplitude value of the fixed Δmarker. In a Cartesian format, this is the y-axis value. It applies to a magnitude/phase marker and a real/imaginary marker. Fixed Δmarker amplitude values are always uncoupled in traces.

Marker Mode Menu

Key Label	Description
MARKERS: COUPLED	Couples the marker sweep parameter values for all markers.
UNCOUPLED	Allows the marker sweep parameter values to be controlled independently. Only the marker on the active trace of the active channel can be controlled. This is the default marker mode.
MARKERS: DISCRETE	Places markers only on the measured trace points as determined by the sweep parameter settings.
CONTINUOUS	Interpolates between the measured points to allow the markers to be placed at any point on the trace. Displayed marker values are also interpolated. This is the default marker mode.
MKR TIME on OFF	Sets the x-axis marker readout to the sweep time (ON), or cancels the setting (OFF).

5

Stimulus Block

The stimulus block keys and associated menus provide control of the sweep, source, and trigger functions. The following list shows the functions controlled by each key in the stimulus block.

Sweep	Controlling sweep time Selecting sweep type Editing list table for list sweep (E5100A Only) Controlling RF output signal source Setting CW frequency for power sweep Selecting stimulus and stimulus mode
Trigger	Selecting trigger mode Selecting event caused by trigger Restarting measurement
Start	Setting start value of stimulus parameter
Stop	Setting stop value of stimulus parameter
Center	Setting center value of stimulus parameter
Span	Setting span of stimulus parameter

Sweep

The softkey menus accessed from the Sweep key are shown in Figure 5-1.

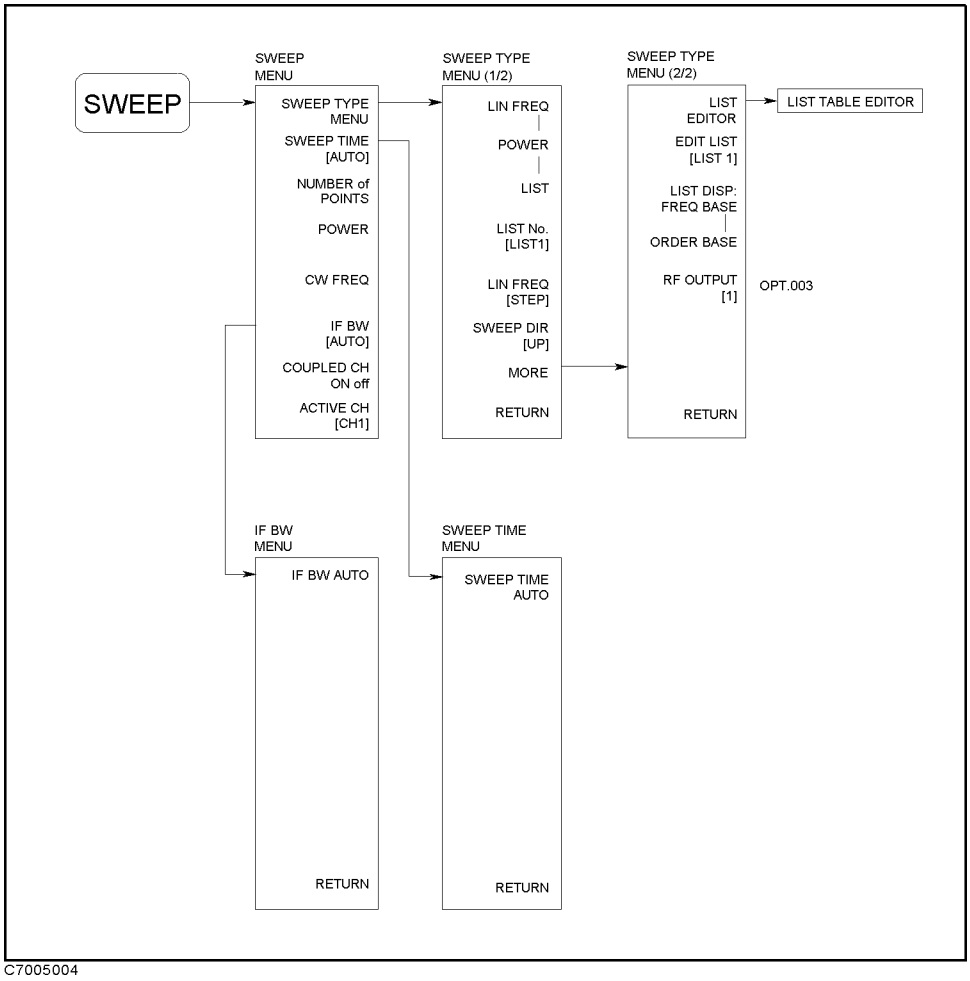


Figure 5-1. Softkey Menus Accessed from the Sweep Key

Sweep Menu

Key Label	Description
SWEEP TYPE MENU	Displays the *sweep type menu* where one of the available types of stimulus sweep can be selected.
SWEEP TIME	Displays the *sweep time menu* that sets the sweep time.
NUMBER of POINTS	Sets the number of data points per sweep. Using fewer points allows a faster sweep time but the displayed trace shows less horizontal detail. Using more points gives greater data density and improved trace resolution, but slows the sweep. In list frequency sweep, the number of points displayed is the total number of frequency points for the defined list.
POWER	Sets the output power level.
CW FREQ	Sets the frequency for power sweep.
IF BW	Sets the bandwidth value for IF bandwidth reduction. Allowed values (in Hz) are from 10 Hz to 30 kHz and 1, 1.5, 2, 3, 4, 5, and 8 steps. Any other value will default to the closest allowed value. A narrow bandwidth provides better signal-to-noise ratio. The selected bandwidth value is shown in brackets in the softkey label.
COUPLED CH on OFF	Toggles channel coupling of the stimulus values. With COUPLED CH ON (default setting), all channels have the same stimulus values. With COUPLED CH OFF, the stimulus value of each channel depends on the number of channels as described below: **NUM of CH When COUPLED CH is OFF:** 2 — Ch1 and Ch2 can have different stimulus. 3 — Ch1 and Ch2 have same stimulus. Ch3 can have different stimulus from Ch1 and Ch2. 4 — Ch1 and Ch2 have same stimulus, and Ch3 and Ch4 have same stimulus. Ch1 and Ch2 can have different stimulus from Ch3 and Ch4.
ACTIVE CH [CH1]	Selects the active channel.

Sweep

Sweep Type Menu

Key Label	Description
LIN FREQ	Selects the linear frequency sweep mode.
LIST FREQ	Selects the frequency list mode. Before using the frequency list mode, the frequency list must be created. If the list is not defined, this softkey performs no function. The E5100B does not have frequency list mode.
POWER SWEEP	Power sweep mode. Used to characterize power-sensitive DUTs. In this mode, power is swept at a single frequency from a start power value to a stop power value. Values are selected using the START and STOP keys and the entry block.
LIST NO. []	Toggles between list1 and list2 to select list table. The E5100B does not have this softkey.
LIN FREQ []	Toggles between the step frequency sweep and the ramp frequency sweep mode. The analyzer sweeps frequency by measuring each point that is defined by the settings of the start and stop frequencies and the number of points. In ramp frequency sweep mode, the analyzer sweeps frequency continuously from start frequency to stop frequency. The ramp frequency sweep is faster than the step frequency sweep.
SWEEP DIR []	Toggles between the up and down sweep. The up and down sweep functions are valid in the linear frequency, ramp frequency, and power sweep.
LIST EDITOR	Displays the *list table editor* to define or modify the frequency sweep list table. When this softkey is pressed, the *list table editor* is displayed instead of measurement display. The *list table editor* can define or modify a list table, such as spreadsheet. The E5100B does not have this softkey.
EDIT LIST []	Toggles between list1 and list2 to select a list table for edit. Before entering the *list table editor*, select the list table number. The E5100B does not have this softkey.
LIST DISP: FREQ BASE	Displays data measured as the frequency base in the frequency list mode. The frequency scale is linear across the total range. Because the frequency points may not be distributed evenly across the graticule, the display resolution may be uneven and more compressed in some parts of the trace than in others. The E5100B does not have this softkey.
ORDER BASE	Displays data measured as the order base in the frequency list mode. The displayed frequency resolution is even across the graticule, even though the frequency points are not distributed evenly. The E5100B does not have this softkey.
RF OUT []	Toggles between 1 and 2 to select RF OUTPUT port. This softkey appears when the analyzer is equipped with Option 003.

Frequency List
Frequency list mode allows you to measure DUT response over several different frequency ranges or at specific frequency points. Each entry in the frequency list is called a *SEGMENT*, regardless of it being a frequency range or single point. Each segment can specify the number of points, source power level, and IF bandwidth. Up to 201 segments can be specified in any combination.

When the warning "Too small Span for Ramp sweep" is displayed

When the warning "Too small Span for Ramp sweep" is displayed, the measurement frequency is not correct. In the ramp frequency sweep mode, set the span value within the following range:

SPAN > A × (NOP − 1) μHz

where, A is a constant, which depends on the IFBW value to be set as follows:

IFBW	A	IFBW	A	IFBW	A
10 Hz	8000	200 Hz	400	4 kHz	20
15 Hz	5332	300 Hz	268	5 kHz	16
20 Hz	4000	400 Hz	200	8 kHz	12
30 Hz	2668	500 Hz	160	10 kHz	8
40 Hz	2000	800 Hz	100	15 kHz	8
50 Hz	1600	1 kHz	80	20 kHz	8
80 Hz	1000	1.5 kHz	56	30 kHz	4
100 Hz	800	2 kHz	40		
150 Hz	532	3 kHz	28		

Sweep Time Menu

Key Label	Description
SWEEP TIME AUTO	Selects the optimum sweep time automatically.
	Enters " : " for the manual sweep time entry.

List Table Editor

This editor edits the list table. The list table contains segments defined by the frequency range, number of points, power level and IF bandwidth.

The segments can be defined in any of the following terms:

- start / stop / number of points / power / IF bandwidth
- start / stop / step / power / IF bandwidth
- center / span / number of points / power / IF bandwidth
- center / span / step / power / IF bandwidth

The segments can overlap, and do not have to be entered in any particular order. The analyzer sorts the segments automatically after exiting the editor. When the editor is re-opened, the segments are sorted in order of increasing start frequency. If duplicate frequencies exist, the analyzer makes multiple measurements on identical points to maintain the specified number of points for each segment. The data is displayed as a single trace that is a composite of all data taken when the list display function is frequency based.

The data in the list table is cleared on instrument preset, cycling the power, and instrument state recall. The list and segment data can be saved using the built-in flexible disk drive and the RAM/FLASH disk.

Sweep

Key Label	Description
	Moves the cursor to the upper cell.
	Moves the cursor to the lower cell.
→	Moves the cursor to the right cell.
←	Moves the cursor to the left cell.
FREQUENCY [ ]	Toggles between SRT&STOP and CNTR&SPN. Pressing SRT&STOP changes the frequency segment to the start/stop format. Pressing CNTR&SPN changes the frequency segment to the center/span format.
NOP/STEP [ ]	Toggles between NOP and STEP. Pressing NOP changes the frequency segment to the start/stop format. Pressing STEP changes the frequency segment to the center/span format.
INSERT SEGMENT	Inserts a segment cell at the current cursor position.
DELETE SEGMENT	Deletes a cell at the current cursor position.
CLEAR LIST	Clears the current list table.
CANCEL EDIT	Cancels the list edit menu.
END EDIT	Ends editing the list table and creates the list table.

Trigger

The softkey menus accessed from the Trigger key are shown in Figure 5-2.

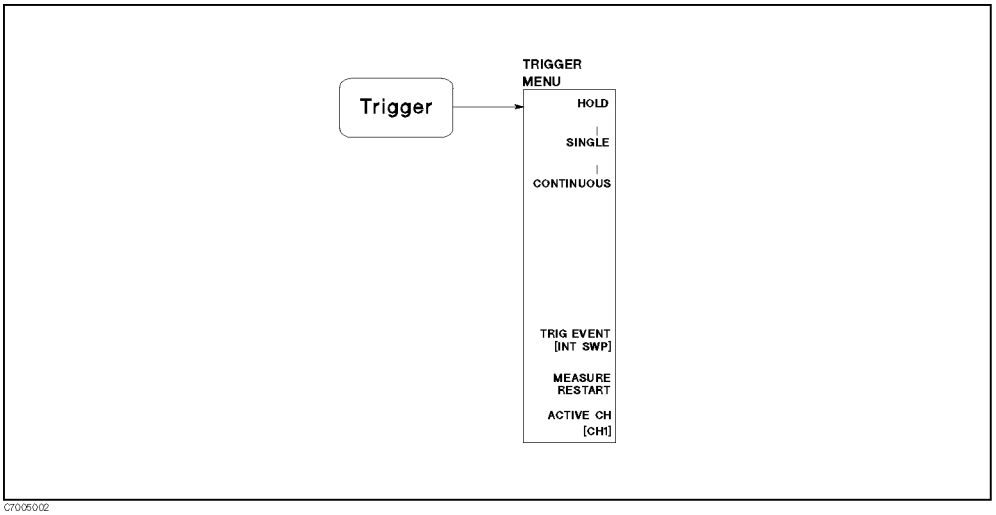


Figure 5-2. Softkey Menus Accessed from the Trigger Key

Trigger Menu

Key Label	Description
HOLD	Freezes the data trace on the display and the analyzer stops sweeping and taking data. The notation "Hld" is displayed at the left of the graticule. If the "*" indicator is on (at the left side of the display), trigger a new sweep by pressing SINGLE.
SINGLE	Makes one sweep of data and returns to the hold mode.
CONTINUOUS	Triggers the sweep automatically and continuously (the trace is updated with each sweep). This is the standard sweep mode.
TRIG EVENT []	Toggles between an internal trigger and an external trigger. With an internal , the sweep is triggered automatically. With an external trigger, the sweep is triggered by an externally generated signal input applied to the rear panel EXT TRIGGER input. The sweep is started with a low-to-high transition of a TTL signal. If this key is pressed when no external trigger signal is connected, the notation "Ext" is displayed at the left side of the display to indicate that the analyzer is waiting to be triggered. When a trigger signal is connected, the "Ext" notation is replaced by the sweep speed indicator "↑" either in the status notations area or on the trace. External trigger mode is allowed in all sweep modes.
MEASURE RESTART	Aborts the sweep in progress and then restarts the measurement. This can be used to update a measurement following an adjustment of the DUT or test signal source. If the sweep trigger is in the HOLD mode, MEASURE RESTART executes a single sweep.

Start Stop Center Span

The softkey menu accessed from the Start, Stop, Center, or Span keys are shown in Figure 5-3.

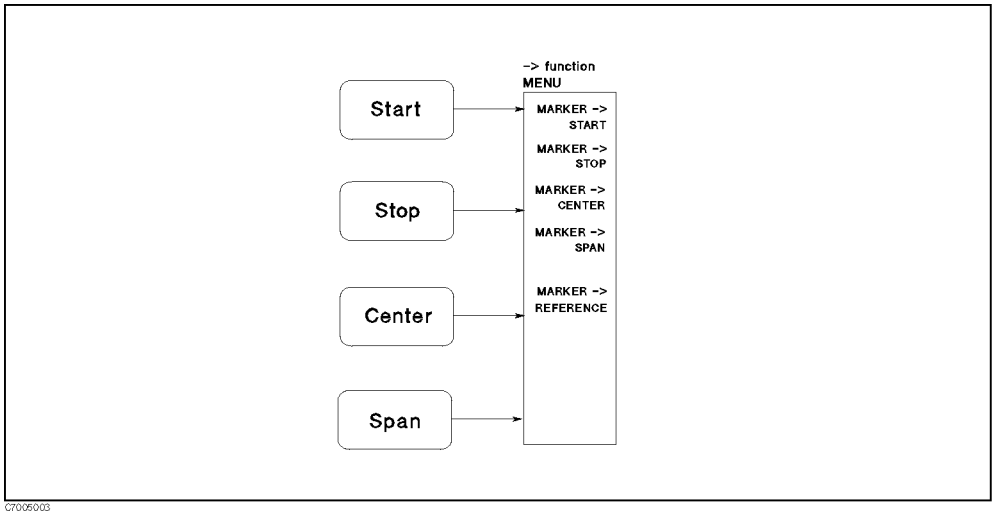


Figure 5-3. Softkey Menu Accessed from the Start, Stop, Center, or Span Keys

These keys define the start value and the stop value, or the center value and the span value of the frequency range or power range of the stimulus parameter. The range can be expressed as either start/stop or center/span. When one of these keys is pressed, its function becomes the active function. The value is displayed in the active entry area and can be changed with the knob, step keys, or numeric keypad. Current stimulus parameter values for the active stimulus are also displayed along the bottom of the graticule. In power sweep, the sweep parameter value is in dBm.

→ Function Menu

Key Label	Description
MKR→START	Changes the start value to the active marker's stimulus parameter value.
MKR→STOP	Changes the stop value to the active marker's stimulus parameter value.
MKR→CENTER	Changes the center value to the active marker's stimulus parameter value.
MKR→SPAN	Changes the span value to the span between the active marker and delta marker.
MARKER -> REFERENCE	Changes the value of the reference line to the active marker value.

6

Menu Block

The menu block keys and associated menus provide analysis of the filter and resonator. The following list shows the functions controlled by each key in the menu block.

Menu1	Displays the filter analysis menu
Menu2	Displays the resonator analysis menu
Menu3	Not used (empty menu)

The softkey menus accessed from the Menu1, Menu2, or Menu3 keys are shown in the Figure 6-1.

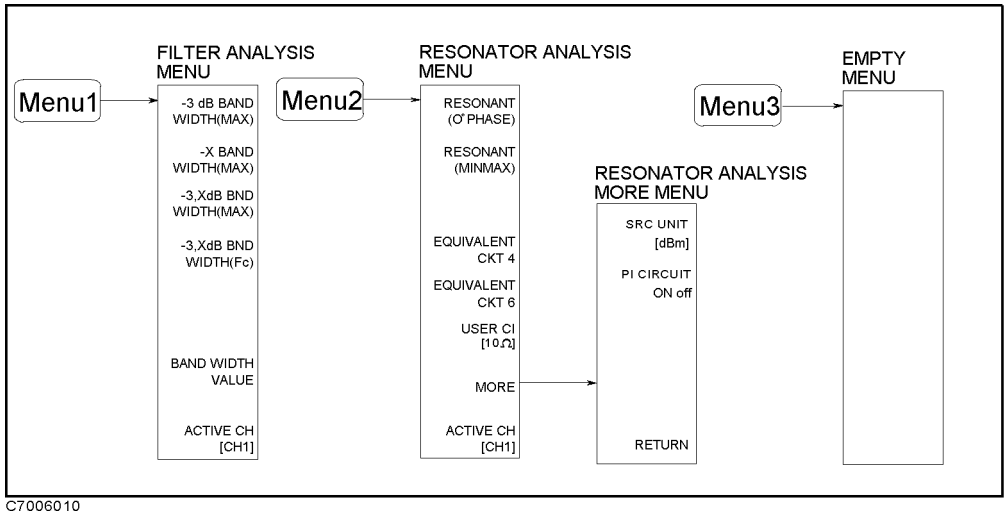


Figure 6-1. Softkey Menus Accessed from the Menu1, Menu2, or Menu3 Keys

Menu1

Key Label	Description
–3 dB BAND WIDTH(MAX)	Displays filter specific parameters, insertion loss, –3dB band width, frequency at the center point of two cutoff points (f_{cent}), Q, left cutoff point frequency (ΔLF), and right cutoff point frequency (ΔRF). This command uses the maximum peak value of the measurement trace as the reference. This is equivalent to the GPIB command "OUTPFILT? -3".
–X BAND WIDTH(MAX)	Displays filter specific parameters, insertion loss, $-x$ band width, frequency at the center point of two cutoff points (f_{cent}), Q, left cutoff point frequency (ΔLF), and right cutoff point frequency (ΔRF). This command uses the maximum peak value of the measurement trace as the reference. This is equivalent to the GPIB command "OUTPFILT?".
–3,X dB BND WIDTH(MAX)	Displays filter specific parameters, insertion loss, –3 dB band width, frequency at the center point of two cutoff points (f_{cent}), Q, left cutoff point frequency (ΔLF) for –3 dB, right cutoff point frequency (ΔRF) for –3 dB, left cutoff point frequency (ΔLF) for –X dB, and right cutoff point frequency (ΔRF) for –X dB. This function is combination of the –3 dB BAND WIDTH(MAX) and the –X BAND WIDTH(MAX) keys. The command uses the maximum peak value of the measurement trace as the reference. These parameters are part of the query of the GPIB command "OUTPXFIL? -3,X".
–3,X dB BND WIDTH(Fc)	Displays filter specific parameters, insertion loss, –3 dB band width, frequency at the center point of – 3 dB band width (f_{cent}), Q, left cutoff point frequency (ΔLF) for –3 dB, right cutoff point frequency (ΔRF) for –3 dB, left cutoff point frequency (ΔLF) for –X dB, and right cutoff point frequency (ΔRF) for –X dB. This command uses the value of the measurement trace at the center frequency as the reference value. These parameters are part of the query of the GPIB command "OUTPCFIL? Fc,-3,X".
BAND WIDTH VALUE	Sets the band width value *X* that is used in the –X BAND WIDTH, –3,X dB BND WIDTH(MAX), and –3,X dB BND WIDTH(Fc).

–3 dB Bandwidth Command

Figure 6-2 shows a typical example of a band pass filter measurement trace. The insertion loss is the absolute value of the difference of the maximum value within a specified range and 0 dB. BW is the stimulus width between two cutoff points (f_1 and f_2) and the center point of the two cutoff points is given as f_{cent}. Q is calculated as:

$$Q = \frac{\sqrt{f_1 \times f_2}}{BW}$$

ΔLF is the stimulus difference between the left –3 dB cutoff point and the center point of a specified range. Similarly, ΔRF is the difference between the right cutoff point and the center of a specified range.

Zeros will be returned for all parameters when two –3 dB points can not be found.

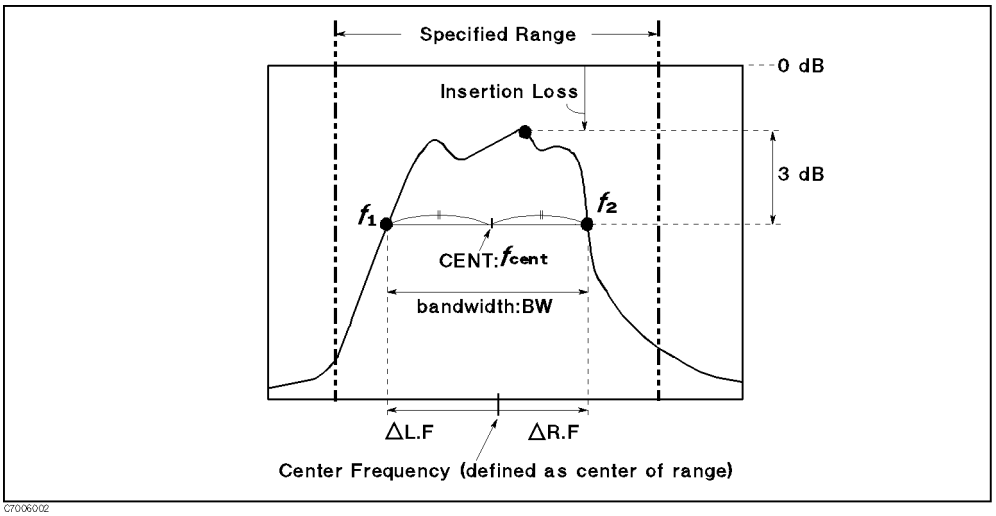


Figure 6-2. Filter Parameter for –3 dB BAND WIDTH(MAX) and X dB BAND WIDTH(MAX)

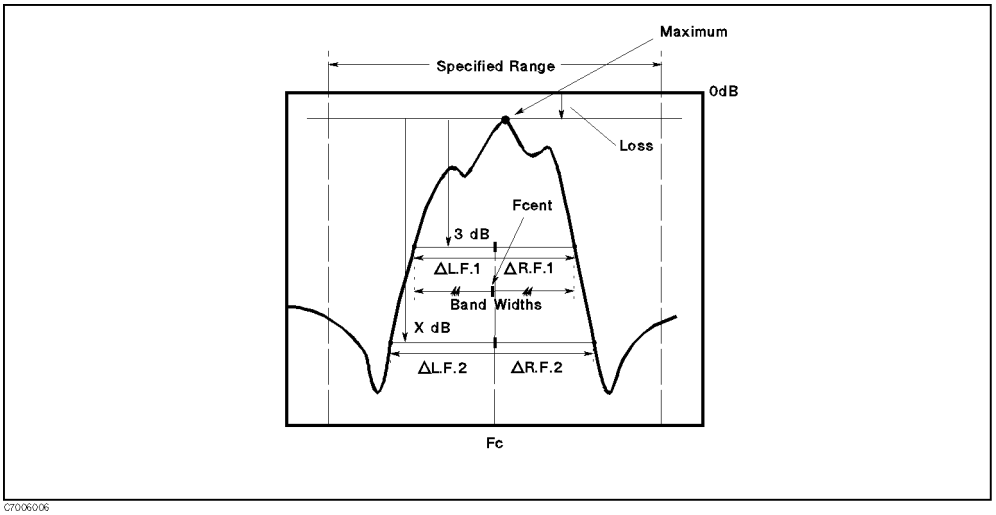


Figure 6-3. Filter Parameter for –3 dB,X BAND WIDTH(MAX)

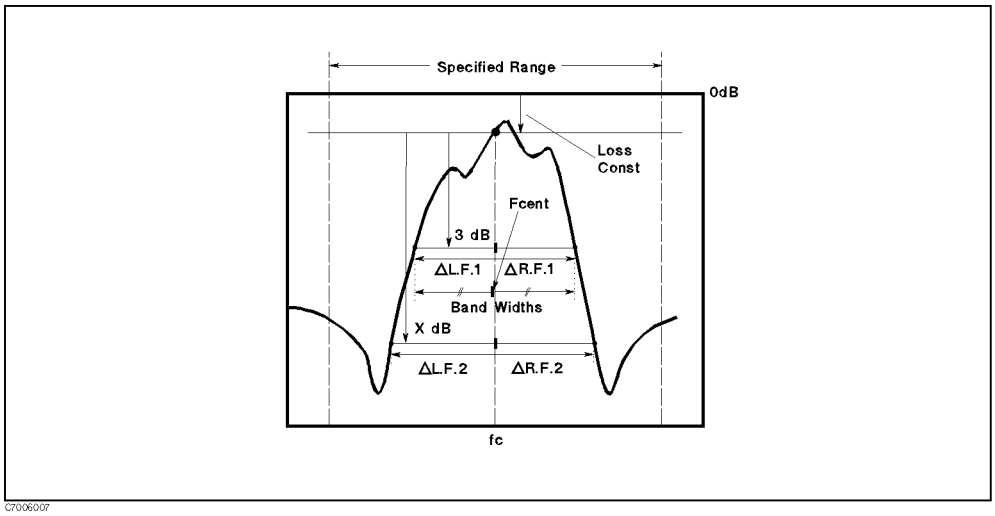


Figure 6-4. Filter Parameter for `–3 dB BAND WIDTH(Fc)`

Menu2

Key Label	Description
RESONANT (0° PHASE)	Derives the series resonant (Resonant) and parallel resonant (Anti-resonant) parameters, 0 ° phase point frequency fr (Resonant frequency) and fa (Anti-Resonant frequency), and the corresponding gain values Gr and Ga. This is equivalent to the GPIB command "OUTPRESO?".
RESONANT (MINMAX)	Derives the maximum and minimum values. This is equivalent to the GPIB command "OUTPMINMAX?".
EQUIVALENT CKT 4	Derives the four-element equivalent circuit parameters for the crystal resonator. The equivalent circuit is shown in Figure 6-7. Zeros will be returned for all parameters if no parameters can be found. This is equivalent to the GPIB command "EQUCPARS4?".
EQUIVALENT CKT 6	Derives the six-element equivalent circuit parameters for the crystal resonator. The equivalent circuit is shown in Figure 6-8. Zeros will be returned for all parameters if no parameters can be found. This is equivalent to the GPIB command "EQUCPARA?".
USER CI [Ω]	Defines the user difine CI value.
MORE	Leads the following softkey menu, which is used to a π network test fixture is used.

Key Label	Description
SRC UNIT [ ]	Selelcts the unit for the test signal power input.
PI CIRCUIT on OFF	Selects to use π network test fixture. When PI CIRCUIT is set to ON, the analyser sets the test signal power level so that the power level appried to the DUT is equal to the power setting value, even the power unit is selected as W or A. This command uses the CI value set by USER CI. The power unit can be selected by SRC UNIT.

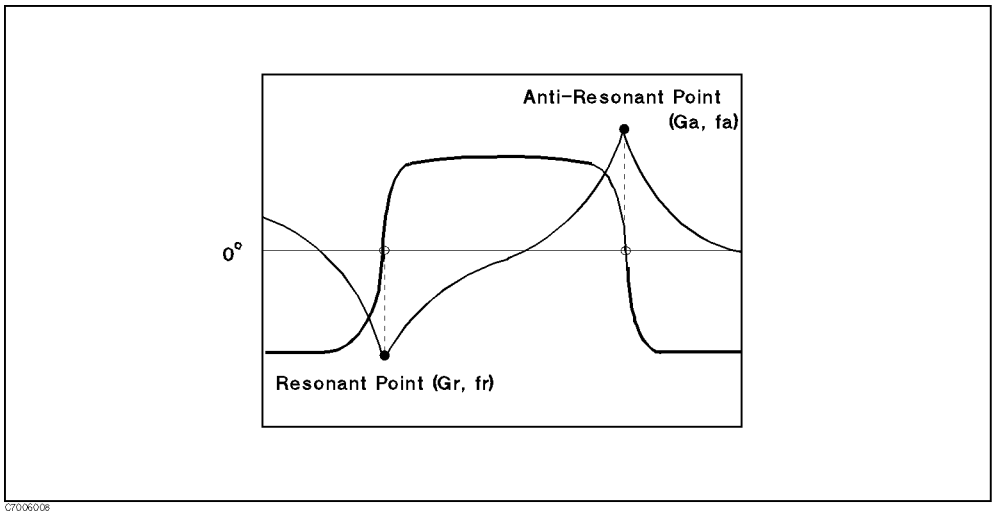


Figure 6-5. Resonant Analysis (0° phase)

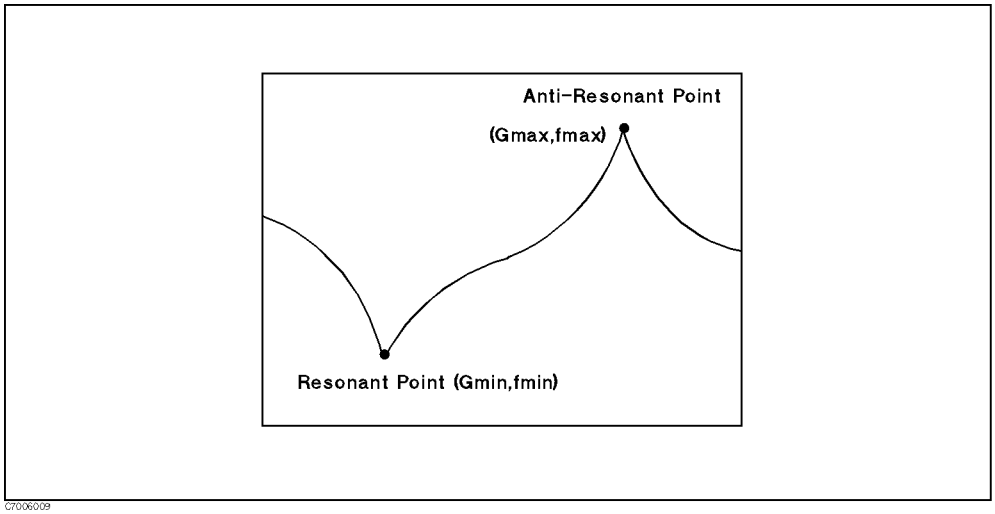


Figure 6-6. Resonant Analysis (Min & Max)

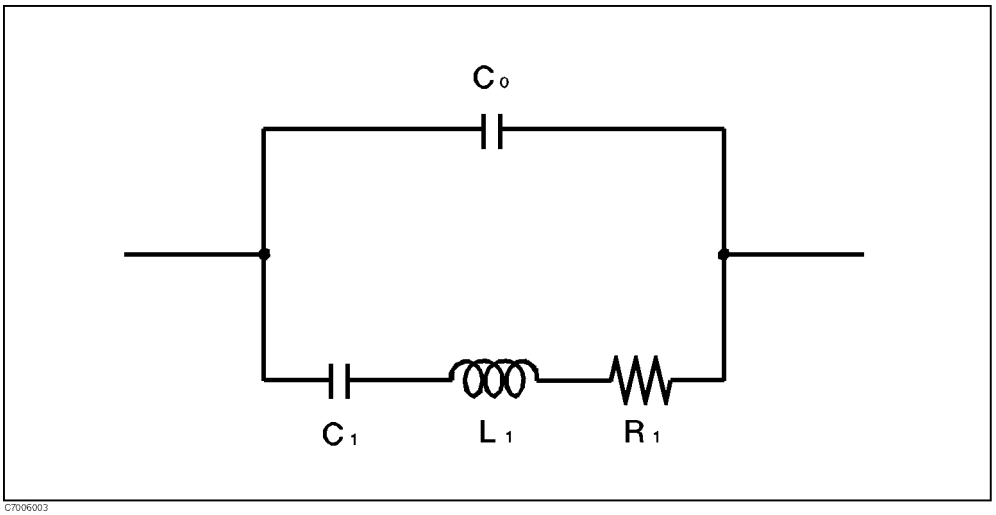


Figure 6-7. Four-Element Equivalent Circuit for Crystal Resonator

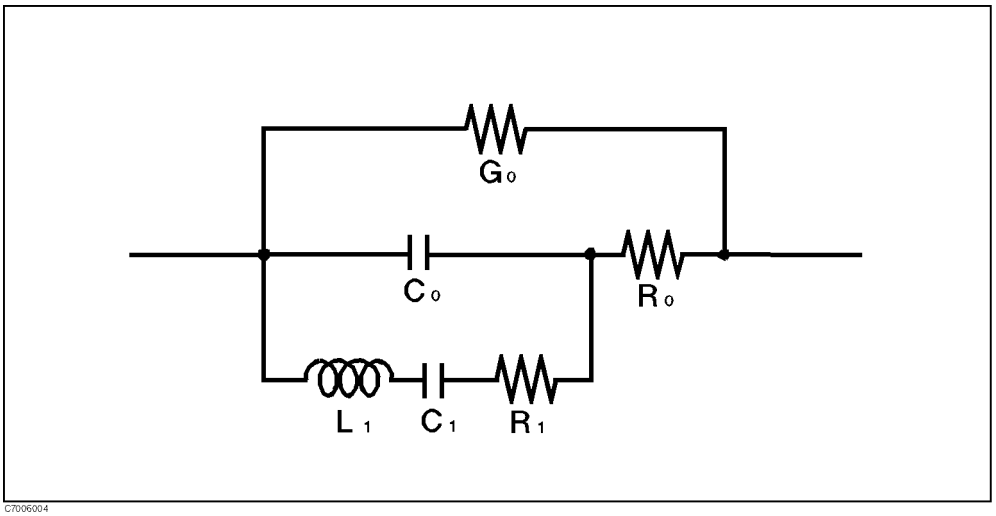


Figure 6-8. Six-Element Equivalent Circuit for Crystal Resonator

Menu3

User define menu.

Softkey menu of Menu3 can be defined by user. The menu is defined by GPIB commands from an external controller or HP Instrument BASIC. The following table summarize the GPIB commands to be used for the Menu3 definition.

■ **MENU3**␣<*Softkey position*>,<*Upper softkey lable*>,<*Lower softkey lable*>,<*GPIB command to be executed*>

Description

Defines the user softkey menu of Menu3.(No Query)

The softkey label position is defined by 1 to 8. Up to 10 characters can be used for each softkey label.

Examples

```
OUTPUT @E5100;"MENU3 1,""START"",""100 MHz"",""STAR 100M"""
```

■ **CLEMNU3**

Description

Clears the softkey definitions of Menu3. (No Query)

Examples

```
OUTPUT @E5100;"CLEMNU3"
```

■ **SAVDMNU3**␣<*string*>

Description

Saves the definition of Menu3 menu. (No Query, Save/Recall SAVE MENU3)

Examples

```
OUTPUT @E5100;"SAVDMNU3 ""USERMENU"""
```

■ **PRIR**␣<*Query command*>

Description

Displays the query value of the GPIB command given as a parameter. The query value is displayed on the Instrument BASIC print area.

Examples

```
OUTPUT @E5100;"MENU3 1,""START"",""FREQ"",""PRIR 'STAR?'"""
```

The examples can be used in the programs on an external controller or HP Instrument BASIC. You can also execute the examples using the external keyboard while in any display allocation type except for ALL INSTRUMENT. Enter an example using a keyboard in the BASIC screen and press Enter, the command is executed.

7

System Block

The system block keys control system functions. These functions include the controller modes, analyzer addresses, real time clock, HP Instrument BASIC, printing, saving and recalling systems and trace data on a built-in disk, and preset state.

The following list shows the functions controlled by each key in the system block:

System	Controlling HP Instrument BASIC.
	Adjusting the LCD contrast.
	Setting GPIB mode and addresses.
	Printing screen image.
	Service Menu (used for testing). See the *Service Manual* for more information.
Save/Recall	Saving and recall the instrument state and data from the built-in disk drive.
Preset	Presets the state of the instrument.

System

The softkey menus accessed from the System key is shown in Figure 7-1.

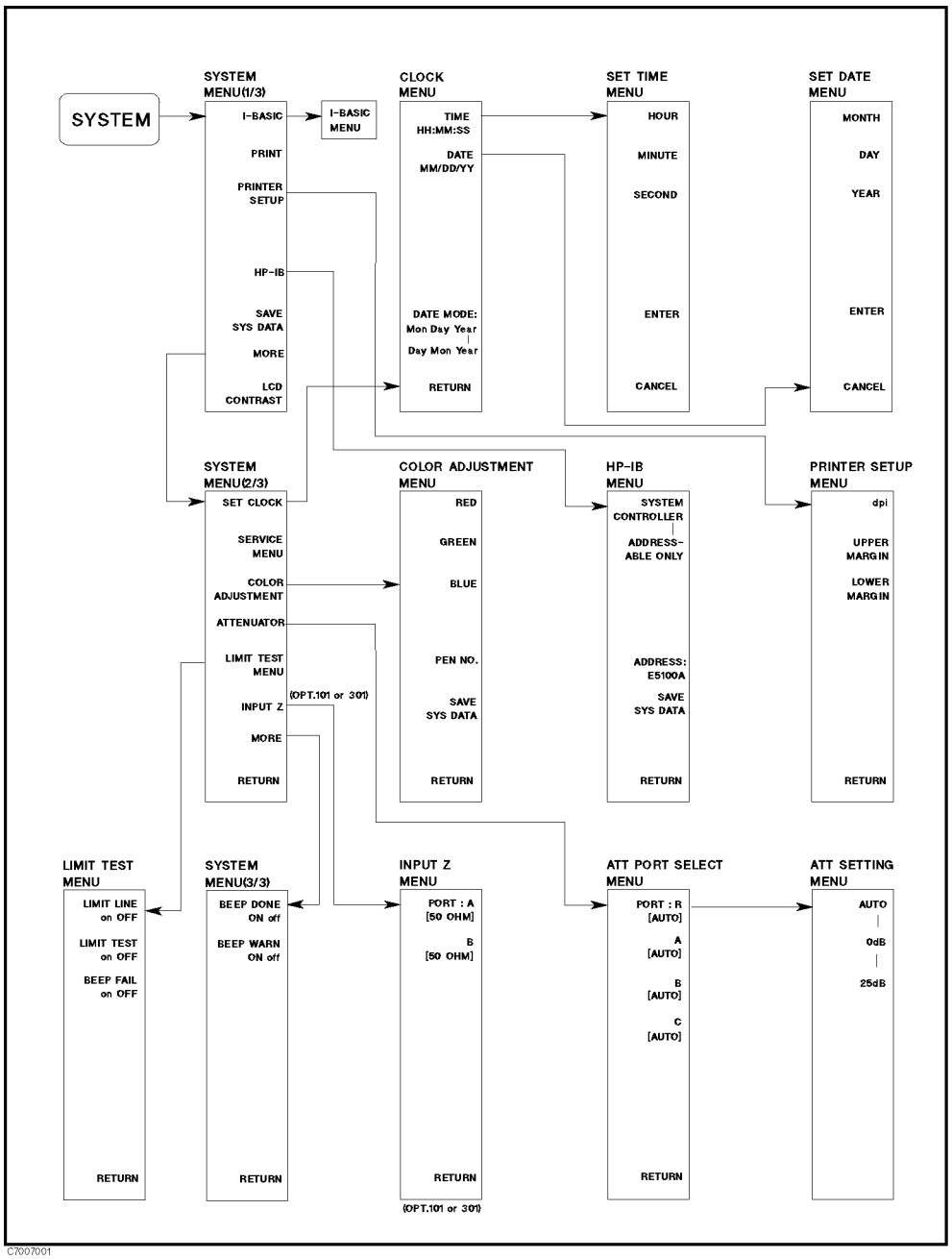


Figure 7-1. Softkey Menus Accessed from the System Key

System Menu (1/3) (2/3) (3/3)

Key Label	Description
IBASIC	Displays the *i-basic menu* used to operate Instrument BASIC. This softkey disappears if the analyzer is equipped with Option UKR.
PRINT	Causes an exact copy of the display to be printed.
PRINTER SETUP	Displays the *printer setup menu*. This menu allows you to copy the display to a printer capable of graphics plotting. For information on compatible printers, see Chapter 9.
GPIB	Displays the *gpib menu* that sets GPIB address.
SET CLOCK	Displays the series of menus that set the internal clock.
SAVE SYS DATA	Stores the current system related setting, LCD contrast values, color adjustment for VGA display, priter setup and GPIB setting. These setting is memorized even if the instrument is powered off. The setting is saved as the file named "SYS_DATA" in the FLASH disk.
SERVICE MENU	Displays the series of service menus described in detail in the *Service Manual*.
LCD CONTRAST	Sets the contrast for LCD display. The rpg knob, numeric keys, arrow keys can control the contrast.
COLOR ADJUSTMENT	Displays the *color adjustment menu* that adjusts the color balance for the external VGA display.
ATTENUATOR	Displays the *attenuator menu* that selects the attenuator setting for each input.
LIMIT TEST MENU	Display *limit test menu* that defines specifications used to test a DUT.
INPUT Z	Displays the *input impedance menu* that selects the input impedance for port A or B. This soft key appears if the analyzer is equipped with option 101 or option 301.
BEEP DONE ON off	toggles an annunciator which sounds to indicate completion of certain operations such as calibration or instrument state save.
BEEP WARN ON off	toggles the warning annunciator. When the annunciator is on it sounds a warning when a cautionary message is displayed.

Printer Setup Menu

Key Label	Description
dpi	Sets the dpi (dots per inch) of a printer.
UPPER MARGIN	Sets the upper margin of a printer.
LOWER MARGIN	Sets the lower margin of a printer.

System

GPIB Menu

Key Label	Description
SYSTEM CONTROLLER	Sets the analyzer as the system controller. This mode is used when peripheral devices are to be used and there is no external controller. This mode must be selected manually from the analyzer's front panel and can only be used if no active system controller is connected to the system through the GPIB. If you try to set system controller mode when another system controller is present, the message "CAUTION: CAN'T CHANGE - ANOTHER CONTROLLER ON BUS" is displayed.
ADDRESSABLE ONLY	Sets the analyzer as addressable only. This mode is used when an external controller controls peripheral devices or the analyzer. This mode is also used when the external computer passes control of the bus to the analyzer.
ADDRESS:E5100A	Sets the GPIB address of the analyzer using the entry controls. There is no physical address switch to set in the analyzer.
SAVE SYS DATA	Stores the current system related setting, LCD contrast values, color adjustment for VGA display, priter setup and GPIB setting. These setting is memorized even if the instrument is powered off. The setting is saved as the file names of "SYS_DATA" in the FLASH disk.

Local Key
The analyzer ignores all front panel keys (except the local key). The LOCAL softkey is displayed when the instrument is under the control of an external computer. The LOCAL softkey returns control of the front panel to the user. The analyzer is in "local mode" when the user has front panel control. The analyzer is in the "remote mode" when an external computer controls the analyzer.

Clock Menu

Key Label	Description
TIME HH:MM:SS	Displays the current time in the active entry area and displays the page used to adjust the time.
DATE MM/DD/YY	Displays the current date on the active entry area to adjust date.
DATE MODE: MonDayYear	Changes the displayed date to the "month:day:year" format.
DayMonYear	Changes the displayed date to the "day:month:year" format.

Set Time Menu

Key Label	Description
HOUR	Enables changing the hour setting using the knob or the numeric entry keys. After you change the hour setting, press ENTER to restart the clock.
MIN	Enables changing the minute setting using the knob or the numeric entry keys. After you change the minute setting, press ENTER to restart the clock.
SEC	Enables changing the second setting using the knob or the numeric entry keys. After you change the second setting, press ENTER to restart the clock.
ENTER	Restarts the internal clock.
CANCEL	Returns to the previous page. Pressing this key does not affect the internal clock setting.

Set Date Menu

Key Label	Description
MONTH	Enables changing the month setting using the knob or the numeric entry keys. After you change the month setting, press ENTER to restart the clock.
DAY	Enables changing the day setting using the knob or the numeric entry keys. After you change the day setting, press ENTER to restart the clock.
YEAR	Enables changing the year setting using the knob or the numeric entry keys. After you change the year setting, press ENTER to restart the clock.
ENTER	Restarts the internal clock.
CANCEL	Returns to the previous page. Pressing this key does not affect the internal clock setting.

Color Adjustment Menu

Key Label	Description
RED	Sets the red factor in color adjustment for the external VGA monitor.
GREEN	Sets the green factor in color adjustment for the external VGA monitor.
BLUE	Sets the blue factor in color adjustment for the external VGA monitor.
PEN NO.	Selects Pen No. **Pen No.** — **Display Elements** 0 — Background 1 — Title, Grid 2 — Main Trace 3 — Sub Trace
SAVE SYS DATA	Stores the current system related setting, LCD contrast values, color adjustment for VGA display, priter setup and GPIB setting. These setting is memorized even if the instrument is powered off. The setting is saved as the file named "SYS_DATA" in the FLASH disk.

Att Port Select Menu

Selects the input port for which you want to set the attenuator setting. The softkey labels for port R, A, B, and C appear depending on the option related with inputs.

Att Setting Menu

Key Label	Description
AUTO	Selects the optimum attenuator setting automatically. When AUTO is selected, the maximum input level is –5 dBm.
0 dB	Sets the input attenuator to 0 dB. When 0 dB is selected, the maximum input level is –20 dBm.
25 dB	Sets the input attenuator to 25 dB. When 25 dB is selected, the maximum input level is –5 dBm.

Limit Test Menu

Key Label	Description
LIMIT LINE on OFF	Turns limit lines ON or OFF. If limits have been defined and limit lines are turned on, the limit lines are displayed for visual comparison of the measured data in all Cartesian formats.
LIMIT TEST on OFF	Turns limit testing ON or OFF. When limit testing is ON, the data is compared with the defined limits at each measured point.
BEEP FAIL on OFF	Turns ON or OFF the limit fail beep. The limit beeper is independent of the warning beeper and the operation complete beeper.

System

Instrument BASIC Menu

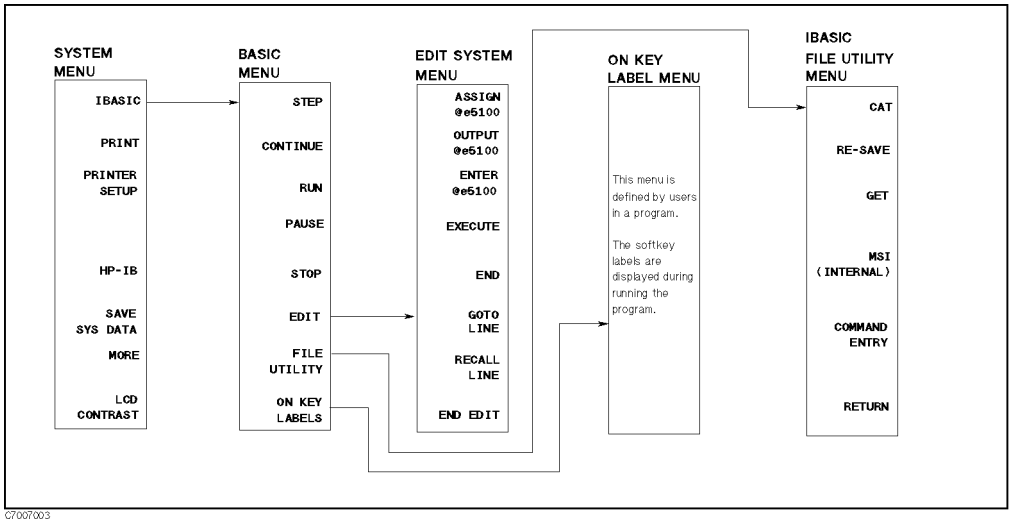


Figure 7-2. IBASIC Menu

Basic Menu

Key Label	Description
STEP	Allows you to execute one program line at a time. This is particularly useful for debugging.
CONTINUE	Resumes program execution from the point where it paused.
RUN	Starts a program from its beginning.
PAUSE	Pauses program execution after the current program line is executed.
STOP	Stops program execution after the current line. To restart the program, press RUN.
EDIT	Enters into the EDIT mode. In the EDIT mode, the following softkeys are displayed on the softkey menu area.
FILE UTILITY	Displays to *file utility menu*.
ON KEY LABEL	Displays a softkey menu defined during program execution (if the softkey menu has been defined).

ON Key Label Menu

The softkeys in this menu are defined in a program and are labeled during program execution.

Edit System Menu

Key Label	Description
ASSIGN @Hpe5100	Produces the command ASSIGN @Hpe5100 TO 800 at the cursor's current position.
OUTPUT @Hpe5100	Produces the command OUTPUT @Hpe5100;"" at the cursor's current position.
ENTER @Hpe5100	Produces the command ENTER @Hpe5100; at the cursor's current position.
END	Produces the command END.
GOTO LINE	Allows you to move the cursor to any line number or to a label. After pressing GOTO LINE, type a line number or a label and then press Return. The cursor moves to the specified line or label.
RECALL LINE	Recalls the last deleted line.
END EDIT	Exits the edit mode.

File Utility Menu

Key Label	Description
CAT	Produces the command "CAT". CAT lists the contents of a mass storage directory.
RE-SAVE	Produces the command "RE-SAVE"". RE-SAVE creates a specified ASCII file if it does not exist; otherwise, it re-writes a specified ASCII file by copying program lines as strings into that file.
GET	Produces the command "GET"". GET reads the specified ASCII file and attempts to store the strings into memory as program lines.
MSI []	Selects the flexible disk drive or the FLASH disk as the storage device used with Instrument BASIC programs. This setting is independent of the setting of the STOR DEV under the SAVE key.
COMMAND ENTRY	Displays the *command entry menu* that allows you to execute Instrument BASIC commands from the front panel keys.

Command Entry Menu

Displays the softkeys that are used to enter BASIC commands. The active entry area displays the letters, digits, and some special characters. Three sets of letters can be scrolled using the step keys, ⇧, and ⇩.

Save/Recall

The softkey menus accessed from the Save/Recall key is shown in Figure 7-3.

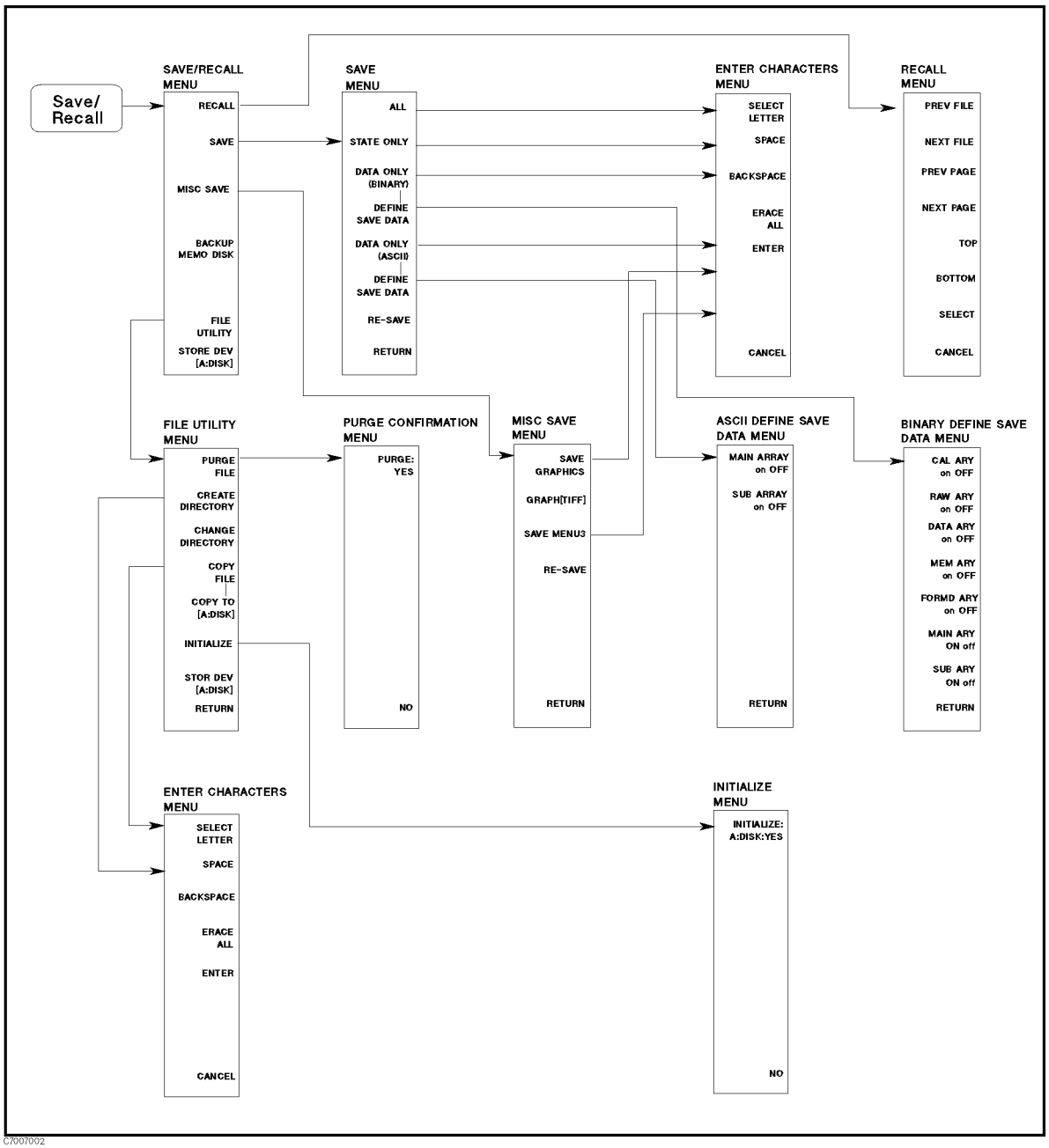


Figure 7-3. Softkey Menus Accessed from the Save/Recall Key

Save/Recall Menu

Key Label	Description
Recall	Displays the *file select menu* that recalls the instrument state and data.
Save	Displays the *save menu* that saves the instrument state and data.
BACKUP MEMO DISK	Stores the all files in the RAM disk to the FLASH disk. Refer to "RAM disk and FLASH disk".
MISC SAVE	Displays the *misc save menu* that saves the screen image and Menu3 definition.
FILE UTILITIES	Displays softkeys that initialize a new disk or purge a file from a disk.
STOR DEV [ ]	Toggles between the flexible disk drive and the FLASH disk as the storage device. [A:DISK] shows the built-in flexible disk is selected and [B:MEMO] shows the RAM disk is selected. This setting does not change even when the line power is cycled or the Preset key is pressed.

Auto Recall

When the analyzer is turned on, it looks for a file named "AUTOREC" from the built-in flexible disk or FLASH disk, and if found, the analyzer automatically reads that file to retrieve its data.

Save Menu

Key Label	Description
ALL	Specifies saving the calibration coefficients and measurement data and the instrument stats.
STATE ONLY	Specifies saving the instrument states and the calibration coefficients.
DATA ONLY (BINARY)	Specifies saving the internal data arrays as a binary file. The arrays saved are defined by the DEFINE SAVE DATA key. The applicable data arrays are saved.
DEFINE SAVE DATA	Displays the *binary define save data menu* that selects the applicable data arrays to be saved as a binary file.
DATA ONLY (ASCII)	Specifies saving the internal data arrays as an ASCII file. The arrays saved are defined by the DEFINE SAVE DATA key.
DEFINE SAVE DATA	Displays the *ASCII define save data menu* that selects the applicable data arrays to be saved.
RE-SAVE FILE	Displays the re-save File menu used to update a file that is already saved as an ASCII file.

Note DATA ONLY does not save instrument settings such as start and stop frequencies. Always make sure that you save the existing STATE if you want to use the setup again.

Note When saving internal data arrays, note that ASCII data files cannot be recalled on the analyzer. If you need to recall the data, save the file in binary format.

File Utility Menu

Key Label	Description
PURGE FILE	Displays the *file select menu* used to select the file that you want to purge.
CREATE DIRECTORY	Creates a new directory.
CHANGE DIRECTORY	Changes the current directory.
COPY FILE	Copies files. When a file is copied between the flexible disk and the RAM disk.
INITIALIZE	Displays the *initialize menu*. A new disk must be initialized before data can be stored on it.
STOR DEV [ ]	Toggles between the flexible disk drive and the RAM disk as the storage device for initialize. [A:DISK] shows the built-in flexible disk is selected and [B:MEMO] shows the RAM disk is selected.

Binary Define Save Data Menu

Key Label	Description
RAW ARY on OFF	Toggles saving or not saving the raw data arrays.
CAL ARY on OFF	Toggles saving or not saving the calibration coefficients arrays.
DATA ARY on OFF	Toggles saving or not saving the data arrays. The data is complex.
MEM ARY on OFF	Toggles saving or not saving the memory arrays.
FORMD ARY on OFF	Toggles saving or not saving the formatted trace arrays.
MAIN ARY on OFF	Toggles saving or not saving the main trace data arrays.
SUB ARY on OFF	Toggles saving or not saving the sub trace data arrays.

Note The stored data structure depends on the setting of NUM of CH and MULTI CH. See "File Structure for Single Channel and Multi Channel".

ASCII Define Save Data Menu

Key Label	Description
MAIN ARRAY on OFF	Toggles saving or not saving the main trace data arrays.
SUB ARRAY on OFF	Toggles saving or not saving the sub trace data arrays.

Note

The stored data structure depends on the setting of NUM of CH and MULTI CH. See "File Structure for Single Channel and Multi Channel".

Purge Confirmation Menu

Key Label	Description
PURGE: YES	Removes the file and returns to the previous menu.
NO	Returns to the previous menu without purging the file.

Initialize Confirmation Menu

Key Label	Description
INITIALIZE A:DISK:YES	Initializes the disk or the RAM disk.
NO	Returns to the previous menu without initialize the flexible disk or the RAM disk.

Misc Save Menu

Key Label	Description
SAVE GRAPHICS	Saves the display image to the disk in the built-in flexible disk drive or the RAM disk drive.
GRAPH [ ]	Selects the graphic format to be save the display image on the disk drive. Two graphic file formats, TIFF and PCL, are available.
SAVE MENU3	Save the user definition of softkey accessed from (Menu3).
RE-SAVE	Displays the re-save File menu used to update a file.

File Types and Data Saved

Binary Files and ASCII Files

The analyzer supports two file formats (binary and ASCII) that you can use to save data on a disk and memory. Binary files are used to save measurement conditions and data using the SAVE function, and to retrieve binary data using the RECALL function. External controllers and Instrument BASIC can read measurement data from binary data files. ASCII measurement data can be read by commonly available IBM PC based software for data analysis or other secondary functions. The RECALL function CANNOT read ASCII files.

Note 

ASCII data files cannot be recalled on the analyzer. If you need to recall the data, save the file in binary format. This binary data can be recalled and saved as an ASCII file at any time.

Data Groups

You can select and save one of the following five combinations between two file types and four data groups to a disk.

- Binary File
  - Instrument states
  - Internal data arrays
  - all data arrays (Instrument states and internal data arrays)
- ASCII File
  - Internal data arrays (ASCII format)

Note 

DATA ONLY does not save instrument settings such as Start and Stop frequencies. When you first start a series of measurements. Always ensure that you save ALL of your first measurement with a particular setting.

Instrument States

The instrument state group consists of all front panel settings and the calibration coefficient arrays. This data group can retrieve identical measurement conditions for later use.

Internal Data Arrays

The internal data arrays, which are essentially stored in the analyzer's memory, consist of the following seven data arrays:

- *Raw data arrays* hold the raw data just after a measurement. These data arrays are complex.
- *Calibration Coefficients data arrays* hold the calibration coefficients obtained by calibration. These data arrays are complex.
- *Data arrays* hold the corrected data by calibration coefficients data. These data arrays are complex.
- *Memory arrays* hold the data in data arrays when the DATA->MEM under Display key is pressed. These data arrays are complex.

- *Formatted data arrays* hold the data after the process of format and smoothing. These data arrays are complex.
- *Main trace arrays* hold the main trace data arrays for each channels. These data arrays are floating point.
- *Sub trace arrays* hold the sub trace data arrays for each channels. These data arrays are available only when the dual traces format, such as `LOGMAG & PHASE`, is selected. These data arrays are floating point.

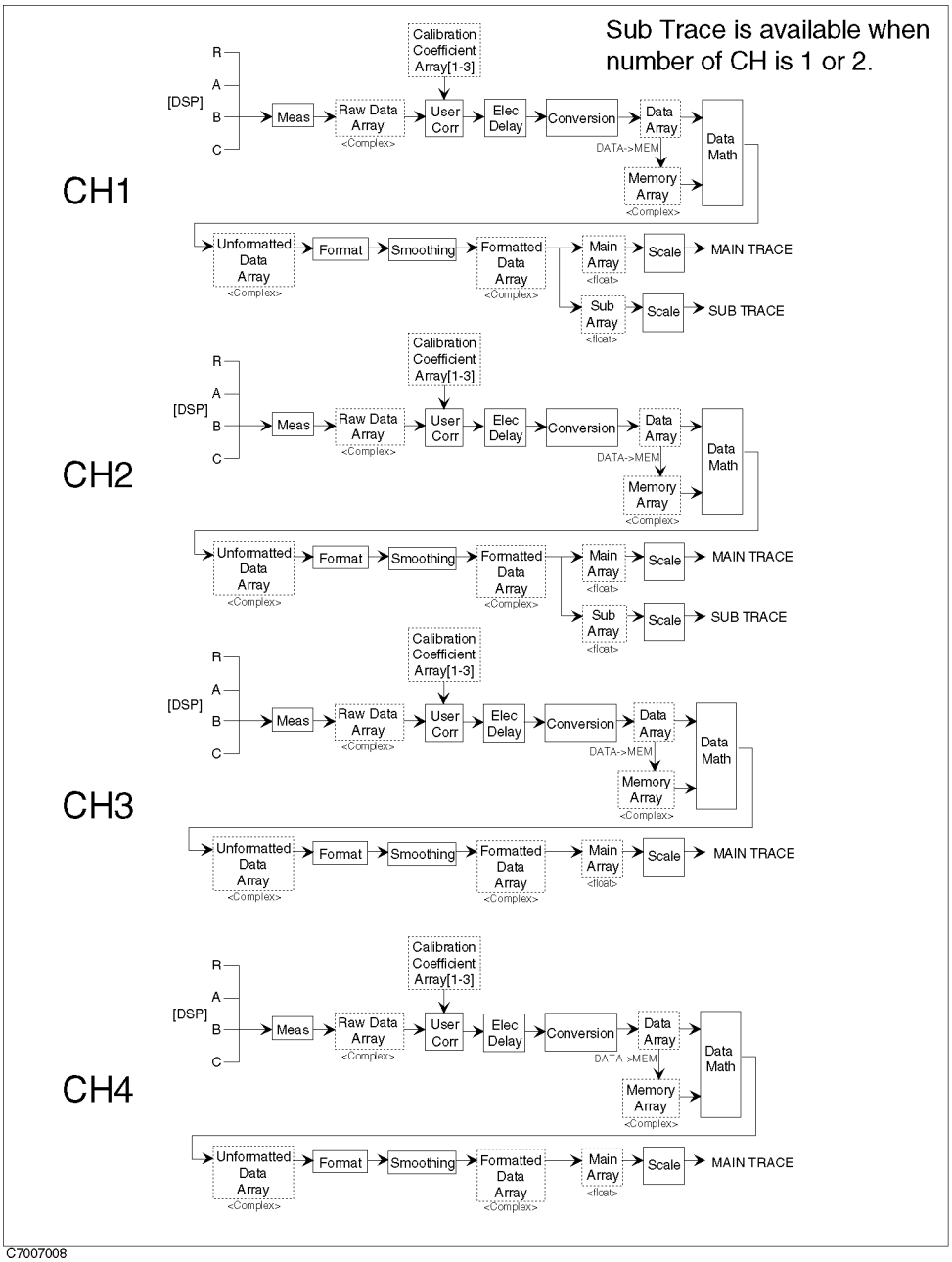


Figure 7-4. Data Processing Flow

Save/Recall

These arrays can be saved selectively to suit the application. Saving only the necessary arrays reduces the disk space required and the disk access time.

All Data Arrays (Instrument States and Internal Data Arrays)

These consist of the instrument states, which includes all measurement data.

Internal Data Arrays (ASCII file)

The internal data arrays saved in an ASCII file consist of the main trace arrarys and/or sub trace arrays.

Additional Information

RAM disk and FLASH disk

The analyzer has two memory disk, the RAM disk and the FLASH disk. The RAM disk is 256kbyte volatile storage and the FLASH disk is 256kbyte non-volatile storage. The commands of save/recall access only the RAM disk directly. Pressing `BACKUP MEMO DISK` key makes the all contents in the RAM disk copy to the FLASH disk. At power on, the all files in the FLASH disk copy to the RAM disk. This section describes the basic procedure for using the analyzer's disk drive.

WRITE Times Limitation of FLASH Disk

The FLASH disk has a limit on the number of write operations. The guaranteed number of write operations to the FLASH disk is 100,000 times.

Disk Formats

The analyzer disk drive uses a 720 Kbytes, or 1.44 Mbytes 3.5 inch micro-flexible disk. The flexible disk drive can access DOS formatted disks. The flexible disk drive can also initialize a new disk in DOS format. The RAM/FLASH disk can also use in a DOS format.

The following list shows the applicable DOS formats for the analyzer.

- 720 Kbytes, 80 tracks, double-sided, 9 sectors/track
- 1.44 Mbytes, 80 tracks, double-sided, 18 sectors/track

File Names

All data saved using the built in disk drive has an identifying file name. A file name consists of the lower and upper case alphabet, numbers, and valid symbol characters. Up to 8 characters can be used for a file name. The following table shows the valid characters for file names.

Table 7-1. Valid Characters for File Names

Valid Characters	Description
A - Z	Upper case alphabet
a - z	Lower case alphabet
0 - 9	Numeric characters
$ & # % ' ! () - _ @ ^ {} ~	Symbol characters

One of the following suffixes or extensions is automatically added to the file name depending on the data group type stored in the file.

Table 7-2. Suffixes and Extensions Added Automatically

Data Group	Extensions
Instrument States And Internal Data Arrays (`ALL`)	.ALL
Instrument States (`STATE ONLY`)	.STA
Internal Data Arrays (`DATA ONLY (binary)`)	.DAT
Internal Data Arrays (`DATA ONLY (ASCII)`)	.TXT

To Copy Files Between the RAM Disk and the Flexible Disk

A copy function is provided to copy files between the RAM disk and the flexible disk. `FILE UTILITY` in the SAVE menu displays the softkey used to copy files.

Auto Recall Function

When the analyzer is turned on, it looks for a file named "AUTOREC" from the built-in flexible disk. The sequence for search is "AUTOREC.ALL", "AUTOREC.STA", and "AUTOREC.DAT". If the file is found, the analyzer automatically reads the file to retrieve its data. If the analyzer does not find the file, the analyzer looks for the file in the FLASH disk.

File Structure of Internal Data Array File for ASCII File

Numerical data abd strings in an ASCII data file are separated by a tab, and a string is bound by double quotation marks.

Status Block and Data Block

An ASCII data file consists of a status block and data blocks. The status block consists of two lines, the revision number and the date code. The Data block consists of three parts, the state part, the title line, and the data part.

- State

  The state part consists of the following instrument states:
  - Channel number
  - Title on the screen
  - Measurement type
  - Format type
  - Number of points

- □ Sweep time
- □ Sweep type
- □ Source power
- □ IF bandwidth

■ Title

The title part consists of the data array names saved. Data array names are described in the next section.

■ Data

The data part consists of stimulus and measurement numerical data.

Table 7-3 shows an example of an ASCII data file.

Table 7-3. Contents of ASCII Files

Block Names		Contents
Status Block		"E5100A REV1.00" "DATE: May 21 1995"[1]
Data Block	State	"CHANNEL: 1" "TITLE: This is a title."[2] "MEAS TYPE: AR" "FORMAT TYPE: LOGMP" "NUMBER of POINTS: 10" "SWEEP TIME: 12.2 ms" "SWEEP TYPE: LINF" "SOURCE POWER: 0.000000E+00 dBm" "IF BANDWIDTH: 3.000000E+04 Hz"
	Title	"Frequency"→"Main Array"→"Sub Array"→…[3,4]
	Data[5]	1.00000000000E+04→8.20007E-1→4.09729E-1→…[3] 3.33422222222E+07→9.32143E-1→-4.1914E-2→… ⋮

1 This is the date when the file is saved.

2 This line is listed when the title is defined (displayed).

3 "→" means tab code. Data is separated by the tab code.

4 This line lists the names of the data array saved in this file.

5 Each line lists the measurement data at each measurement point. The number of Lines in the data block is the same as the number of points.

File Structure for Single Channel and Multi Channel

If you save an ASCII file when MULTI CHANNEL is turned OFF, the ASCII data file consists of the active channel's data. If MULTI CHANNEL is turned ON, the ASCII data file consists of the data of all channels which is set by `NUM of CH` under Meas/Format. The data for each channels are saved in order of channel number.

Preset

This key presets the instrument state to the preset default value. The preset default values are listed in Appendix B. Preset has no effect on the following states:

- Clock Time/Date
- GPIB Address
- GPIB Mode (system controller and addressable)
- Calibration Standard Definition
- LCD Contrast
- Color Adjustment
- Display Allocation
- Printer Setup

8

Parallel I/O Ports

The parallel I/O ports on the rear panel of E5100A/B allow information communication with external devices such as a handler on a production line.

There are four types of parallel I/O ports: a standard parallel I/O port and three optional parallel I/O ports (Options 005, 006, and 007). Two or more parallel I/O ports cannot be used at the same time.

I/O Ports for Standard Parallel I/O Ports and Option 006 Parallel I/O Mode B

This section provides information on the standard parallel I/O ports and Option 006 Parallel I/O Mode B.

I/O Ports

The analyzer with a standard or option 006 I/O port has two output ports and two bi-directional ports.

- Output-Only Port
  - Port A: 8 bits wide
  - Port B: 8 bits wide

  Signals are output from the latches at the TTL level.
- Bi-directional ports
  - Port C: 4 bits wide
  - Port D: 4 bits wide

  Output signals (latch output signals) are TTL-compatible. Use an GPIB command to switch between input/output directions. When the E5100A/B is turned ON, both ports C and D are defined as input ports. (Related GPIB commands: `OUTCIO`, `OUTDIO`, `OUTPINPCIO?`, and `OUTPINPDIO?`.)

  Combining the above ports using GPIB commands provides the following four different ports:
- Bi-directional Port
  - Port E: 8 bits wide (Port C + Port D)
- Output Ports
  - Port F: 16 bits wide (Port A + Port B)
  - Port G: 20 bits wide (Port A + Port B + Port C)
  - Port H: 24 bits wide (Port A + Port B + Port C + Port D)

Control Signal Lines

I/O ports include nine types of output signal lines and one input signal line. Control signals are TTL-compatible (excluding the power supply line). These signals are described below.

Port C Status Output Signal or Port D Status Output Signal

This signal is set at the low level when port C or D is defined as an input port. It is set at the high level when port C or D is defined as an output port. This signal is used to report the direction (input or output) of port C or D to external devices. (Related GPIB commands: `CIN`, `COUNT`, `DIN`, and `DOUT`.)

WRITE STROBE Output Signal for Output Port

When data is output to any output port, a negative pulse is output to WRITE STROBE OUTPUT. This negative output pulse notifies external devices of output to the parallel I/O port. Figure 8-1 shows the write strobe output signal and data output timing.

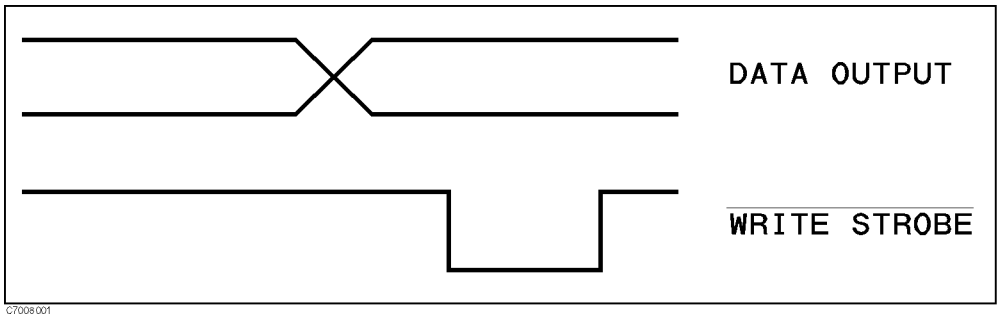


Figure 8-1. Write strobe signal timing chart

INPUT1 Input Signal

When a negative pulse is input to INPUT1, OUTPUT1 and OUTPUT2 are set at the low or high level. An GPIB signal is used to determine whether the high or low level is to be set. The width of the signal input to INPUT1 must be 1 μs or more. (Related GPIB commands: `OUT1ENVH`, `OUT1ENVL`, `OUT2ENVH`, and `OUT2ENVL`.)

OUTPUT1 Output Signal or OUTPUT2 Output Signal

This signal (latch output signal) can be set at the low or high level by inputting a negative pulse to INPUT1 or using an GPIB command. (Related GPIB commands: `OUT1H`, `OUT1L`, `OUT2H` and `OUT2L`.)

PASS/FAIL Output Signal

This signal is set to a high level (positive logic) or to a low level (negative logic) when the limit testing result is OK (PASS). It is set to a low level (positive logic) or to a high level (negative logic) when the test result is NG (FAIL). This signal is effective only when the limit test function is ON.

WRITE STROBE Output Signal for PASS/FAIL Output

When the limit testing result is output to the PASS/FAIL output line, a negative pulse is output to WRITE STROBE OUTPUT. This output signal notifies external devices of the limit testing result output to the PASS/FAIL OUTPUT.

SWEEP END Output Signal

When the E5100A/B completes a sweep, a negative pulse is output. The pulse width is 10 μs.

Power Lines

A +5 V output pin is provided for an external device. A maximum of 100 mA current can be supplied. This line has no phase. However, if an excess current flows, a protective circuit functions to cut off the main power of the E5100A/B. When the overcurrent subsides, the main power is turned ON again. In this case, all device settings are initialized.

Figure 8-2 shows the schematic drawing of input/output ports and control signal lines.

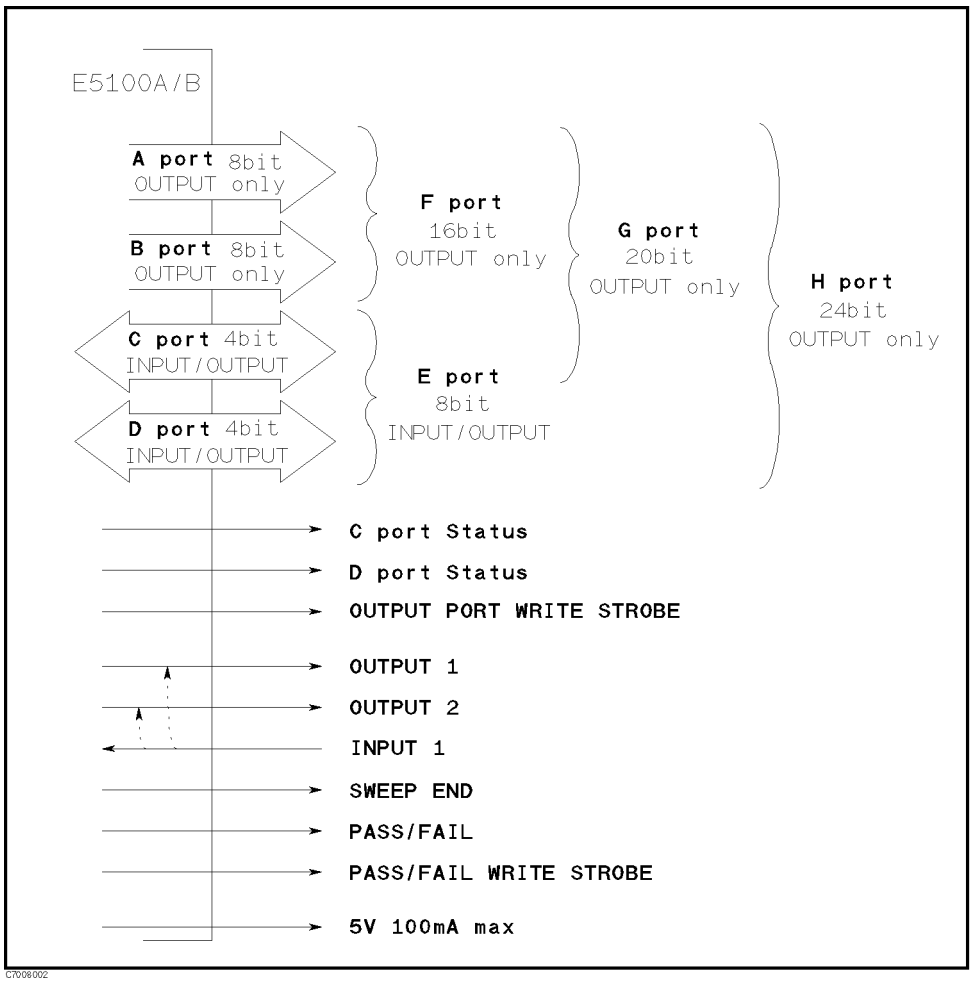


Figure 8-2. Schematic Drawing of Parallel I/O Ports

Figure 8-3 shows the internal circuits of the output port (Port A, Port B) and the output signal (OUTPUT1, OUTPUT2, Port C status, Port D status, Sweep end, Pass/Fail, Data write strobe, Pass/Fail write strobe)

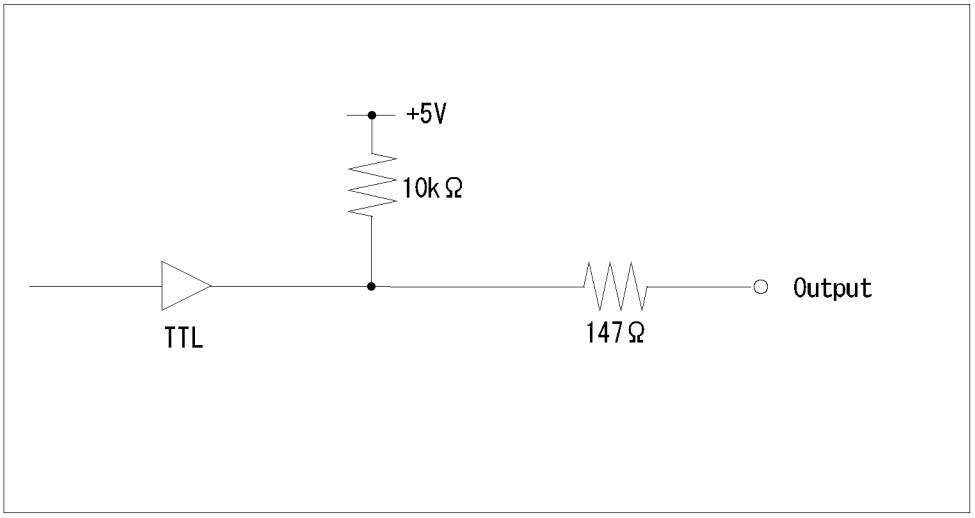


Figure 8-3. Circuit of Output Port

Figure 8-4 shows the internal circuits of the bi-directional port (Port C, Port D).

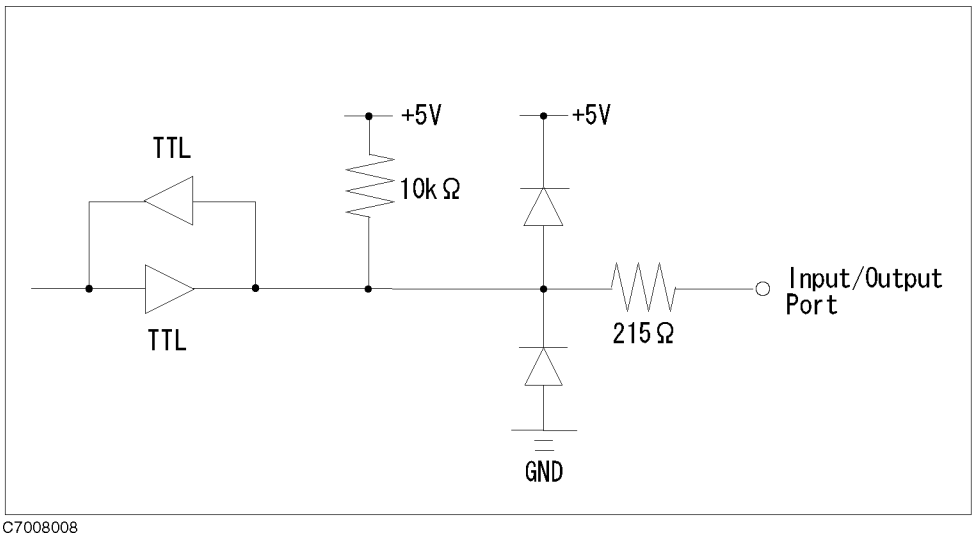
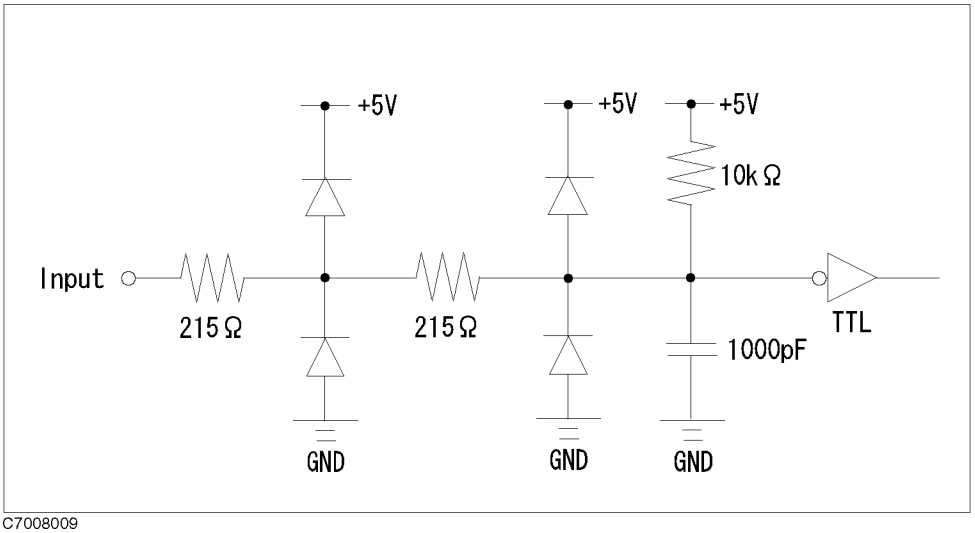


Figure 8-4. Circuit of Bi-directional Port

Figure 8-5 shows the internal circuits of the input1.



C7008009

Figure 8-5. Circuit of Input1

Pin Assignment

Figure 8-6 shows the pin numbers. Table 8-1 shows the assignment of signals to pins.

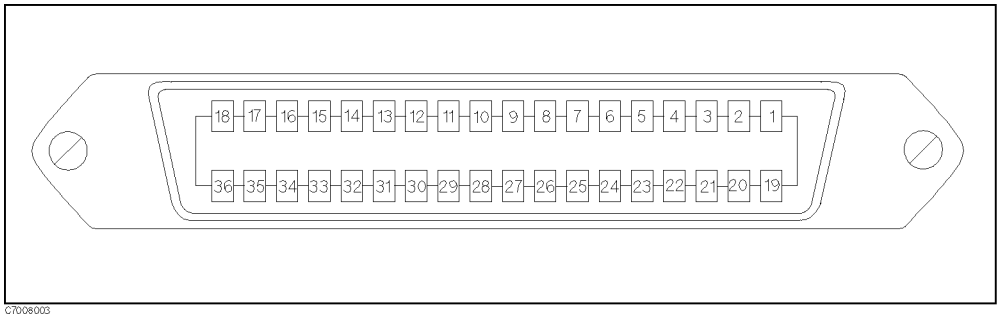


Figure 8-6. Parallel I/O Port Connector Pin Numbers

Table 8-1. Assignment of Signals to Pins (Standard)

Pin No.	Signal Name	Signal Standard
1	GND	0 V
2	INPUT1	TTL level, Pulse input (Width: $\geq$1 μs)
3	OUTPUT1	TTL level, Latch output
4	OUTPUT2	TTL level, Latch output
5	Output port A0	TTL level, Latch output
6	Output port A1	TTL level, Latch output
7	Output port A2	TTL level, Latch output
8	Output port A3	TTL level, Latch output
9	Output port A4	TTL level, Latch output
10	Output port A5	TTL level, Latch output
11	Output port A6	TTL level, Latch output
12	Output port A7	TTL level, Latch output
13	Output port B0	TTL level, Latch output
14	Output port B1	TTL level, Latch output
15	Output port B2	TTL level, Latch output
16	Output port B3	TTL level, Latch output
17	Output port B4	TTL level, Latch output
18	Output port B5	TTL level, Latch output
19	Output port B6	TTL level, Latch output
20	Output port B7	TTL level, Latch output
21	Input/output port C0	TTL level, Latch output
22	Input/output port C1	TTL level, Latch output
23	Input/output port C2	TTL level, Latch output
24	Input/output port C3	TTL level, Latch output
25	Input/output port D0	TTL level, Latch output
26	Input/output port D1	TTL level, Latch output
27	Input/output port D2	TTL level, Latch output
28	Input/output port D3	TTL level, Latch output
29	Port C status	TTL level, Input mode: Low, Output mode: High
30	Port D status	TTL level, Input mode: Low, Output mode: High
31	Write strobe signal	TTL level, Negative logic, Pulse output
32	+5 V pull-up	
33	SWEEP END signal	TTL level, Negative logic, Pulse output (Width: $\geq$10 μs)
34	+5 V	+5 V, 100 mA max.
35	PASS/FAIL signal	TTL level, Latch output
36	Write strobe signal	TTL level, Negative logic, Pulse for pass/fail output

Table 8-2. Assignment of Signals to Pins (Option 006)

Pin No.	Signal Name	Signal Standard
1	GND	0 V
2	INPUT1	TTL level, Pulse input (Width: $\geq$1 μs)
3	OUTPUT1	TTL level, Latch output
4	OUTPUT2	TTL level, Latch output
5	Output port A0	TTL level, Latch output
6	Output port A1	TTL level, Latch output
7	Output port A2	TTL level, Latch output
8	Output port A3	TTL level, Latch output
9	Output port A4	TTL level, Latch output
10	Output port A5	TTL level, Latch output
11	Output port A6	TTL level, Latch output
12	Output port A7	TTL level, Latch output
13	Output port B0	TTL level, Latch output
14	Output port B1	TTL level, Latch output
15	Output port B2	TTL level, Latch output
16	Output port B3	TTL level, Latch output
17	Output port B4	TTL level, Latch output
18	Not used	
19	Output port B5	TTL level, Latch output
20	Output port B6	TTL level, Latch output
21	Output port B7	TTL level, Latch output
22	Input/output port C0	TTL level, Latch output
23	Input/output port C1	TTL level, Latch output
24	Input/output port C2	TTL level, Latch output
25	Input/output port C3	TTL level, Latch output
26	Input/output port D0	TTL level, Latch output
27	Input/output port D1	TTL level, Latch output
28	Input/output port D2	TTL level, Latch output
29	Input/output port D3	TTL level, Latch output
30	Port C status	TTL level, Input mode:Low, Output mode:High
31	Port D status	TTL level, Input mode:Low, Output mode:High
32	Write strobe signal	TTL level, Negative logic, Pulse output
33	SWEEP END signal	TTL level, Negative logic, Pulse output (Width: $\geq$10 μs)
34	PASS/FAIL signal	TTL level, Latch output
35	+5 V	+5 V, 100 mA max.
36	Write strobe signal	TTL level, Negative logic, Pulse for pass/fail output

Related GPIB Commands

The GPIB commands related to the parallel I/O ports are summarized below. For more information on GPIB commands, see the *GPIB Programming Manual.*

Data Output Commands

The following commands output data to the corresponding ports (A to H). When ports C, D, E, F, G, and H are used as output ports, ports C and D must be defined as output ports using GPIB commands (`COUT` and `DOUT`).

GPIB Command	Description
`OUTAIO`	outputs 8-bit data to port A.
`OUTBIO`	outputs 8-bit data to port B.
`OUTCIO`	outputs 4-bit data to port C.
`OUTDIO`	outputs 4-bit data to port D.
`OUTEIO`	outputs 8-bit data to port E.
`OUTFIO`	outputs 16-bit data to port F.
`OUTGIO`	outputs 20-bit data to port G.
`OUTHIO`	outputs 24-bit data to port H.

Data Input Commands

The following commands read data from the corresponding input ports (C to E) and return the values to the GPIB. Before receiving data, ports C and D must be defined as input ports using GPIB commands (`CIN` and `DIN`).

GPIB Command	Description
`OUTPINPCIO?`	reads 4-bit data from port C and returns its value to the GPIB.
`OUTPINPDIO?`	reads 4-bit data from port D and returns its value to the GPIB.
`OUTPINPEIO?`	reads 8-bit data from port E and returns its value to the GPIB.

Commands for Setting Input/Output Directions of Ports C and D

The following commands set the input/output directions of ports C and D. When the power is turned ON, ports C and D are defined as input ports. Pressing the Preset key does not affect this setting. This setting is saved to an instrument state file using the Save function.

GPIB Command	Description
`CIN`	defines port C as an input port.
`COUT`	defines port C as an output port.
`DIN`	defines port D as an input port.
`DOUT`	defines port D as an output port.

Positive and Negative Logic Setting Commands

The following commands set positive or negative logic for port input/output signals and pass/fail output signal. When the power is turned ON, negative logic is set. Pressing the Preset

key does not affect this setting. This setting is saved to an instrument state file using the Save function.

GPIB Command	Description
NEGL	sets negative logic.
POSL	sets positive logic.

OUTPUT1 and OUTPUT2 Level Setting Commands

The following commands set OUTPUT1 and OUTPUT2 levels:

GPIB Command	Description
OUT1H	sets OUTPUT1 at the high level.
OUT1L	sets OUTPUT1 at the low level.
OUT2H	sets OUTPUT2 at the high level.
OUT2L	sets OUTPUT2 at the low level.

Commands for Setting OUTPUT1 and OUTPUT2 at the High or Low Level Upon Input of a Pulse to INPUT1

The following commands set OUTPUT1 and OUTPUT2 at the high or low level when a negative pulse is input to INPUT1. When the power is turned ON, both OUTPUT1 and OUTPUT2 are set at the high level. Pressing the (Preset) key does not affect this setting. This setting is saved to an instrument state file using the Save function.

GPIB Command	Description
OUT1ENVH	sets OUTPUT1 at the high level when a pulse is input to INPUT1.
OUT1ENVL	sets OUTPUT1 at the low level when a pulse is input to INPUT1.
OUT2ENVH	sets OUTPUT2 at the high level when a pulse is input to INPUT1.
OUT2ENVL	sets OUTPUT2 at the low level when a pulse is input to INPUT1.

Command for Checking Input to INPUT1

This command checks whether a pulse has been input to INPUT1. Sending this command after a pulse is input to INPUT1 will return a "1‘". If no pulse has been input to INPUT1, the return values will be "0". After "1" is received, succeeding values will be cleared (set to "0").

GPIB Command	Description
INPT?	checks a pulse to input1.

I/O Port for Option 005 Parallel I/O Mode A

This section provides information on Option 005 Parallel I/O Mode A (8-bit).

Pin Assignment

The 8-bit I/O port consists of 15 TTL compatible signals, which are 8-bit output, 4-bit input, sweep end, pass/fail, and ground. The pin assignments are shown in Figure 8-7.

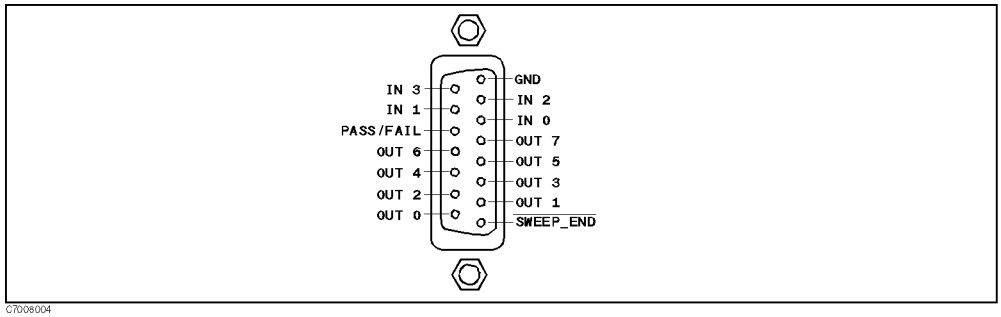
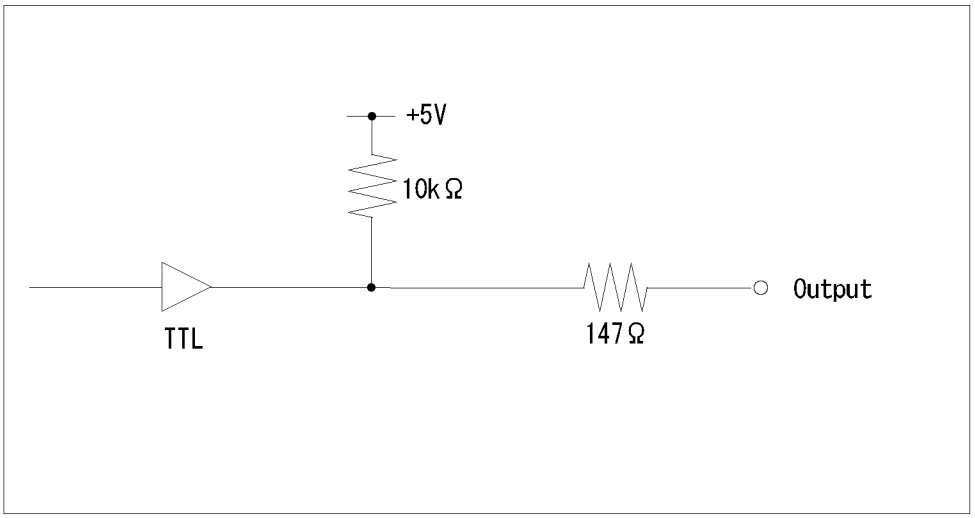


Figure 8-7. 8-bit I/O Port Pin Assignments

The signals carried through each pin are described below.

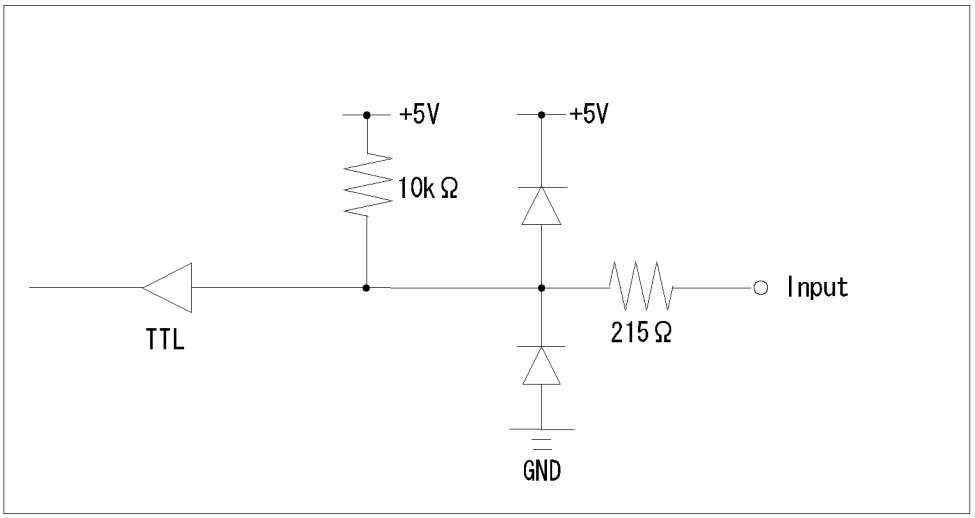
$\overline{\text{SWEEP\_END}}$	outputs a negative pulse when the analyzer completes a sweep. The pulse width is > 10 μs.
OUT 0 thru 7	output signals to external devices. They are controlled by the GPIB command, `OUT8IO`, as described below. Once `OUT8IO` is executed, the signal is latched until `OUT8IO` is executed again.
IN 0 thru 4	input signals from external devices. They are read by the GPIB command `INP8IO`, as described below.
PASS/FAIL	is affected only when the limit testing is active. This signal presents HIGH and LOW if the test result is pass and fail (positive logic), or fail and pass (negative logic), respectively.

Figure 8-8 and Figure 8-9 show the internal circuits of the input and output.



C7008007

Figure 8-8. Circuit of output



C7008013

Figure 8-9. Circuit of Input

Related GPIB Commands

The GPIB commands related to parallel I/O ports are summarized below. For more information on GPIB commands, see the *GPIB Programming Manual*.

GPIB Command	Description
`OUT8IO`	outputs 8-bit data to the OUT 0 thru 7 lines. The OUT 0 signal is the LSB (least significant bit), while the OUT 7 signal is the MSB (most significant bit).
`INP8IO`	inputs 4-bit data from the IN 0 thru 3 signals to the analyzer's memory. The IN 0 signal is the LSB (least significant bit), while the IN 3 signal is the MSB (most significant bit).
`INP8IO?`	inputs data from the 4-bit parallel input port to the 87510A, and outputs the data to the controller.
`OUTPINP8IO?`	is a query command that outputs 8-bit data to the controller. The data is obtained as 4-bit data by the `INP8IO` command and four upper significant bits (value = 0) are attached to extend the 4-bit data to 8-bit data.
`NEGL`	sets negative logic for pass/fail output signal. When the power is turned ON, negative logic is set. Pressing the (Preset) key does not affect this setting, This setting is saved to an instrument file using the Save function.
`POSL`	sets positive logic for pass/fail output signal. When the power is turned ON, positive logic is set. Pressing the (Preset) key does not affect this setting, This setting is saved to an instrument file using the Save function.

I/O port for Option 007 Opto-Isolated Parallel I/O

This section provides information on Option 007 Opto-Isolated Parallel I/O.

I/O Ports

- Output ports
  - Port A: 8 bits wide (A0 to A7, A0 is the lowest bit)
  - Port B: 8 bits wide (B0 to B7, B0 is the lowest bit)
  - Port F: 16 bits wide (A0 to A7, B0 to B7, A0 is the lowest bit)
- Input ports
  - Port C: 4 bits wide (C0 to C3, C0 is the lowest bit)
  - Port D: 4 bits wide (D0 to D3, D0 is the lowest bit)
  - Port E: 8 bits wide (C0 to C3, D0 to D3, C0 is the lowest bit)

Control Signal Lines

I/O ports include eight output signal lines and one input signal line. These signal lines are photo-isolated. They are described below.

WRITE STROBE Output Signal for Output Port

When data is output to any output port, a negative pulse is output to WRITE STROBE OUTPUT. This negative output pulse notifies external devices of output to the parallel I/O port. Figure 8-10 shows the write strobe output signal and data output timing.

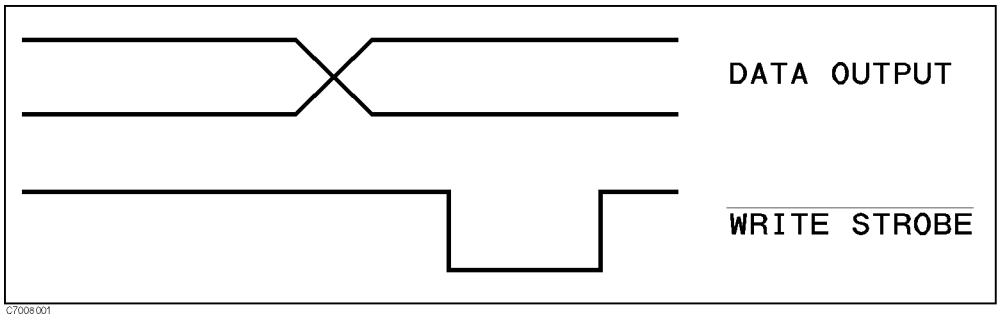


Figure 8-10. Write Strobe Signal Timing Chart

OUTPUT1 Output Signal or OUTPUT2 Output Signal

This signal (latch output signal) can be set at the low or high level by inputting a negative pulse to INPUT1 or using an GPIB command. (Related GPIB commands: `OUT1H`, `OUT1L`, `OUT2H` and `OUT2L`.)

PASS/FAIL Output Signal

This signal is set to a high level (positive logic) or to a low level (negative logic) when the limit testing result is OK (PASS). It is set to a low level (positive logic) or to a high level (negative logic) when the test result is NG (FAIL). This signal is effective only when the limit test function is ON.

WRITE STROBE Output Signal for PASS/FAIL Output

When the limit testing result is output to the PASS/FAIL output line, a negative pulse is output to WRITE STROBE OUTPUT. This output signal notifies external devices of the limit testing result output to the PASS/FAIL OUTPUT.

SWEEP END Output Signal

When the E5100A/B completes a sweep, a negative pulse is output. The pulse width is 10 μs.

INTERRUPT Input Signal

When a negative pulse is input to INTERRUPT, the analyzer is interrupted. The width of the signal input to INTERRUPT must be 10 μs or more.

ALARM Output Signal

This signal is set to a low level until the analyzer is booted up and can make measurements. After the analyzer is booted up and can make measurements, this signal is set to a high level.

Power Lines

+5 V

This line applies +5 V voltage for an external device. A maximum of 100 mA current can be supplied.

Instrument GND

This line applies the GND voltage of the analyzer.

External Vcc

This line should be connected to an external VCC.

External GND

This line should be connected to an external GND.

Recommended Operation Condition

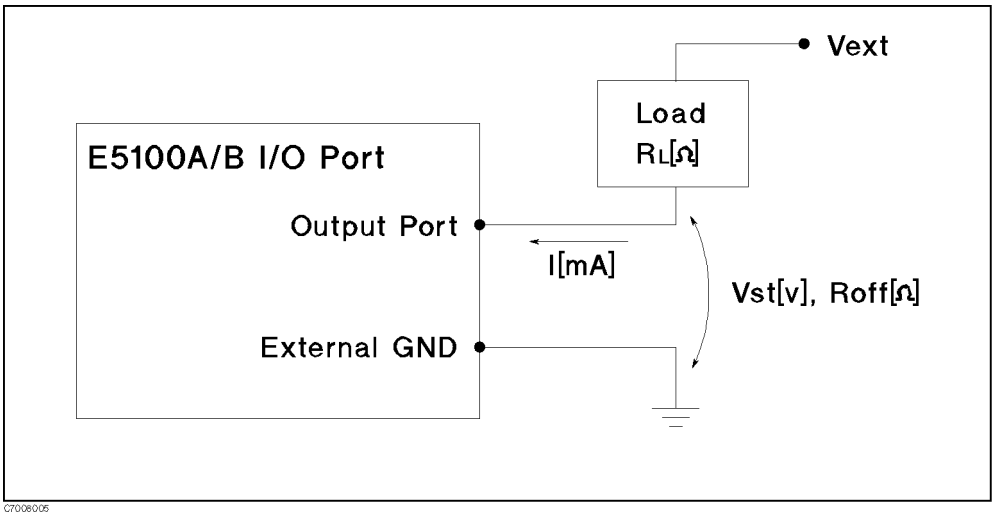


Figure 8-11. External GND

Vext and *Rl* are calculated by the following equation.

$$\frac{\left(\frac{V_ext}{2}\right)^2}{R_L} < 75mW$$

Table 8-3. Assignment of Signals to Pins (Standard)

Parameter	Symbol	Rating
External Power Voltage	Vext	< 40 V
Maximum Current	Imax	12 mA
Saturation Voltage	Vsat	0.6V @ I= 12 mA
Propagation Delay[1]	Data Strobe, Pass/Fail Strobe	200 μs
	Other Lines	100 μs

1 Compare with TTL output

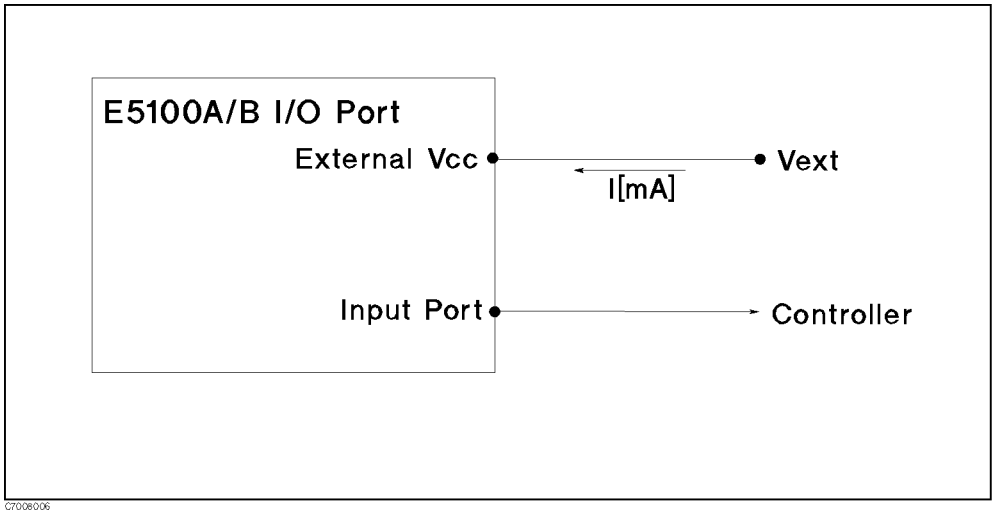


Figure 8-12. External Vcc

Table 8-4. Assignment of Signals to Pins (Standard)

Parameter	Symbol	Rating
External Voltage	Vext	5V to 25V[1]
Propagation Delay[2]	Interrupt	10 μs
	Other Lines	100 μs

1 See "External Voltage Setting".

2 Compare with TTL output

External Voltage Setting

External Voltage range is 5V to 25V. However, the default setting at factory is 10V to 25V. When the external voltage from 5V to 10V is required, follow the instruction described below.

1. Remove the opto-isolated Parallel I/O board from the rear panel.
2. Set the J3 position from N to opposite side.
3. Reinstall the opto-isolated Parallel I/O board.

Pin Assignment

Figure 8-13 shows pin numbers. Table 8-5 shows assignment of signals to pins.

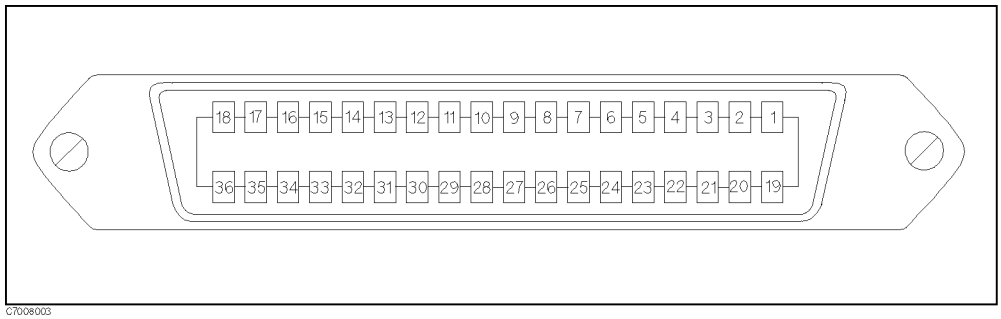


Figure 8-13. Parallel I/O Port Connector Pin Numbers

Table 8-5. Assignment of Signals to Pins (Standard)

Pin No.	Signal Name	Signal Standard
1	GND	0 V
2	Output 1	Photo-Isolated Latch output
3	Output port A0	Photo-Isolated Latch output
4	Output port A2	Photo-Isolated Latch output
5	Output port A4	Photo-Isolated Latch output
6	Output port A6	Photo-Isolated Latch output
7	Output port B0	Photo-Isolated Latch output
8	Output port B2	Photo-Isolated Latch output
9	Output port B4	Photo-Isolated Latch output
10	Output port B6	Photo-Isolated Latch output
11	Input port C0	Photo-Isolated input
12	Input port C2	Photo-Isolated input
13	Input port D0	Photo-Isolated input
14	Input port D2	Photo-Isolated input
15	Data Write Strobe	Photo-Isolated Pulse output, Negative logic (Width: $\geq$10 μs)
16	Sweep End	Photo-Isolated Pulse output, Negative logic (Width: $\geq$20 μs)
17	Interrupt	Photo-Isolated Pulse output, Negative logic (Width: $\geq$10 μs)
18	External Vcc	External Power Source
19	+5V	+5 V, 100 mA max
20	Output 2	Photo-Isolated Latch output
21	Output port A1	Photo-Isolated Latch output
22	Output port A3	Photo-Isolated Latch output
23	Output port A5	Photo-Isolated Latch output
24	Output port A7	Photo-Isolated Latch output
25	Output port B1	Photo-Isolated Latch output
26	Output port B3	Photo-Isolated Latch output
27	Output port B5	Photo-Isolated Latch output
28	Output port B7	Photo-Isolated Latch output
29	Input port C1	Photo-Isolated input
30	Input port C3	Photo-Isolated input
31	Input port D1	Photo-Isolated input
32	Input port D3	Photo-Isolated input
33	pass/fail strobe	Photo-Isolated Pulse output, Negative logic (Width: $\geq$10 μs)
34	pass/fail	Photo-Isolated Latch output
35	Alarm	Photo-Isolated Latch output
36	External GND	External GND

Figure 8-14 shows the internal circuits of the output port (Port A, Port B) and the output signal(OUTPUT1, OUTPUT2, Port C status, Port D status, Sweep end, Pass/Fail, Data write strobe, Pass/Fail write strobe)

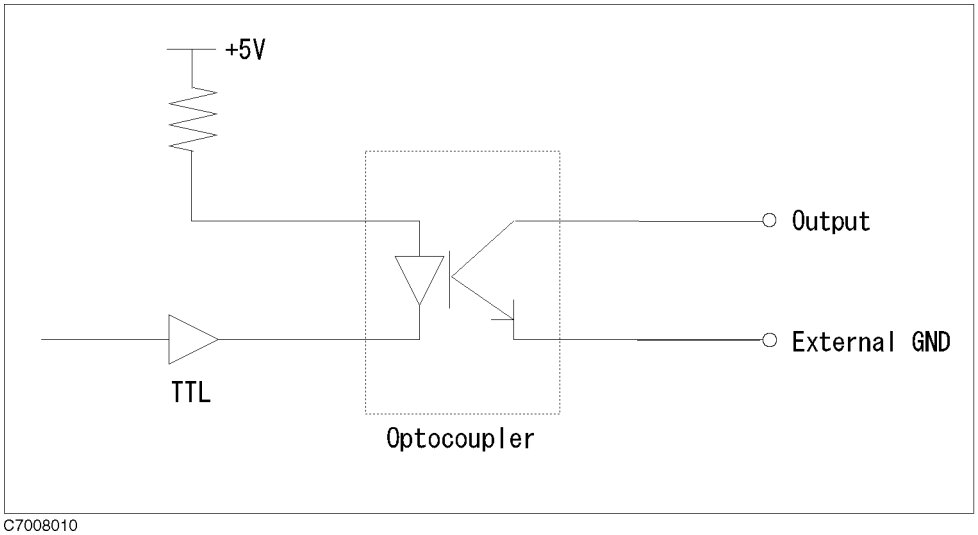


Figure 8-14. Circuit of Output

Figure 8-15 shows the internal circuits of the input port (Port C, Port D).

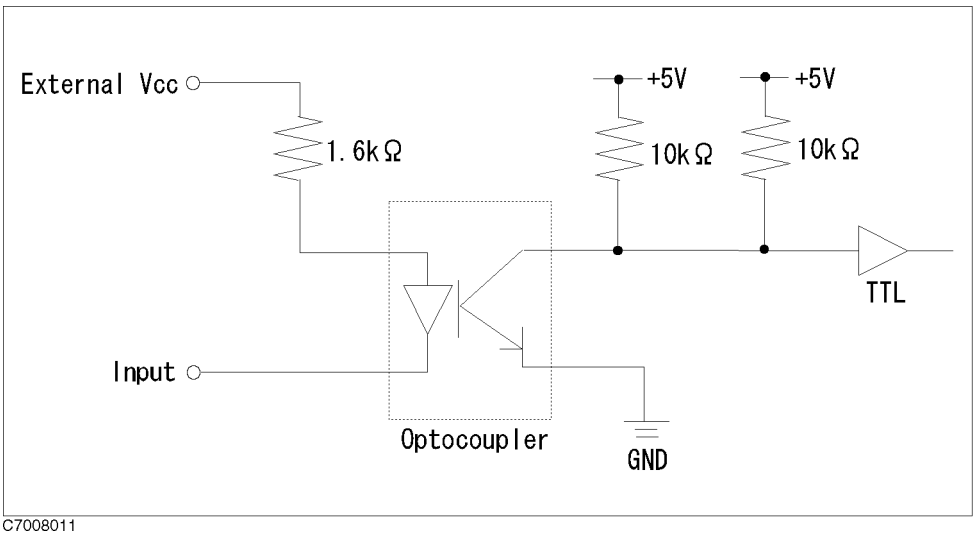


Figure 8-15. Circuit of Input Port

Figure 8-16 shows the internal circuits of the interrupt.

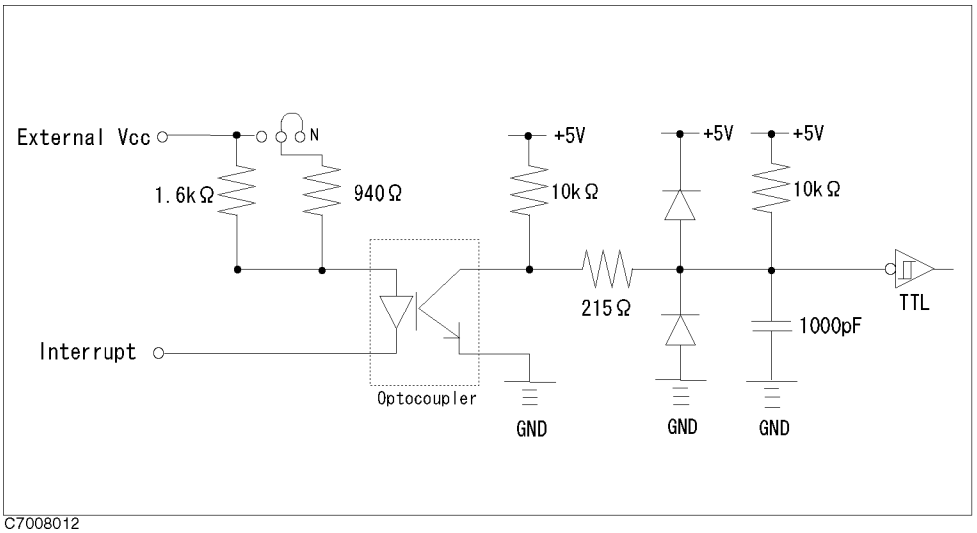


Figure 8-16. Circuit of Interrupt

Related GPIB Commands

The GPIB commands related to parallel I/O ports are summarized below. For more information on GPIB commands, see the *GPIB Programming Manual*.

Data Output Commands

The following commands output data to the corresponding ports (A, B and F ports).

GPIB Command	Description
OUTAIO	outputs 8-bit data to port A.
OUTBIO	outputs 8-bit data to port B.
OUTFIO	outputs 16-bit data to port F.

Data Input Commands

The following commands read data from the corresponding input ports (C to E) and returns the values to the GPIB.

GPIB Command	Description
OUTPINPCIO?	reads 4-bit data from port C and returns its value to the GPIB.
OUTPINPDIO?	reads 4-bit data from port D and returns its value to the GPIB.
OUTPINPEIO?	reads 8-bit data from port E and returns its value to the GPIB.

Positive and Negative Logic Setting Commands

The following commands set positive or negative logic for port input/output signals and pass/fail output signal. When the power is turned ON, negative logic is set. Pressing the (Preset) key does not affect this setting. This setting is saved to an instrument state file using the Save function.

GPIB Command	Description
NEGL	sets negative logic.
POSL	sets positive logic.

OUTPUT1 and OUTPUT2 Level Setting Commands

The following commands set OUTPUT1 and OUTPUT2 levels:

GPIB Command	Description
OUT1H	sets OUTPUT1 at the high level.
OUT1L	sets OUTPUT1 at the low level.
OUT2H	sets OUTPUT2 at the high level.
OUT2L	sets OUTPUT2 at the low level.

9

Accessories and Options

Options Available

Crystal Resonator Test w/PI-network (Option 600)

This option can apply higher power through a π network and an external attenuator is not required. This option provides two receivers (Ports R and A). It supplies −52 to +18 dBm power at RF OUT1 and −65 to +5dBm at RF OUT2. This option cannot be used with options 100, 200, 300, 400, 101, 301, 302, 001, 002, 003 and 010.

1 Receiver, Port A (Option 100)

This option provides one receiver (Port A). This option cannot be used with options 200, 300, 400, and 600.

2 Receivers, Ports R and A (Option 200)

This option provides two receivers (Ports R and A). This option cannot be used with options 100, 300, 400, and 600.

3 Receivers, Ports R, A, and B (Option 300)

This option provides one receiver (Port A). This option cannot be used with options 100, 200, 400, and 600. This option cannot be used with E5100B.

4 Receivers, Ports R, A, B, and C (Option 400)

This option provides four receivers (Ports R, A, B, and C). This option cannot be used with options 100, 200, 300, and 600. This option cannot be used with E5100B.

One RF OUT Port (Option 001)

This option provides one RF OUT port. This option cannot be used with options 002, 003, and 600)

Two RF OUT Ports, Built-in Power Splitter (Option 002)

This option provides two RF OUT ports whose output signals are divided by a built-in power splitter. This option cannot be used with options 002, 003, and 600)

Two RF OUT Ports, Switched Single Output (Option 003)

This option provides two RF OUT ports. The two outputs are switched. This option cannot be used with options 001, 002, 101, 301, and 600. This option cannot be used with E5100B.

50/1M Ω Selectable Input on Port A (Option 101)

This option provides the selectable input for port A. The input impedance is selectable, 50 Ω or 1 MΩ. This option is for options 100 and 200 only and cannot be used with option 003.

50 Ω Input Connector on Port A (Option 701)

This option provides the 50 Ω input connector on port A. The input impedance is not selectable. This option is for options 100, 200 and 218 only.

Type-N Input Connector on Port A (Option 102)

This option changes port A to a type-N connector and provides probe power output for port A to use with an active probe and a high input impedance adapter. This option is for options 100 and 200 only.

50/1M Ω Selectable Inputs on Ports A and B (Option 301)

This option provides selectable inputs for port A and B. The input impedance is selectable, 50 Ω or 1 MΩ. This option is for options 300 and 400 only, and cannot be used with option 003. This option cannot be used with E5100B.

50 Ω Input Connectors on Ports A and B (Option 702)

This option provides the 50 Ω input connectors on ports A and B. The input impedance is not selectable. This option is for options 300, 318 and 400 only.

Type-N Input Connectors on Ports A and B (Option 302)

This option changes ports A and B to type-N connectors and provides probe power outputs for ports A and B to use with an active probe and a high input impedance adapter. This option is for options 300 and 400 only. This option cannot be used with E5100B.

Extended Output Power Range (Option 010)

This option adds the power sweep capability and increases the output power range. This option cannot be used with option 600.

Limited Frequency Range up to 180 MHz (Option 218, 318, 618)

These options limit the frequency range up to 180 MHz. If frequency is over 180 MHz, the specifications are not guaranteed.

High Stability Frequency Reference (Option 1D5)

This option is a 10 MHz crystal oscillator in a temperature stabilized oven that improves the source signal frequency accuracy and stability.

Parallel I/O Mode A (Option 005)

This option provides an 8-bit output, 4-bit input parallel I/O using a 15-pin 8751A compatible connector on the rear panel instead of the standard 24-bit parallel I/O. This option cannot be used with options 006 and 007.

Parallel I/O Mode B (Option 006)

This option provides a 24-bit output, 8-bit input parallel I/O using a 36-pin connector on the rear panel instead of the standard 24-bit parallel I/O. This option cannot be used with options 005 and 007.

Opto-Isolated Parallel I/O (Option 007)

This option provides a 16-bit output, 8-bit input parallel I/O using a 36-pin opto-isolated connector on the rear panel instead of the standard 24-bit parallel I/O. This option cannot be used with options 005 and 006.

Evaporation Monitoring Function (Option 022)

This option controls metal deposition during a deposition process of crystal resonators.

Phase Tracking Function (Option 023)

This option adds the phase tracking function to measures the drive level characteristics of the resonant frequency (Fr) and the resonant impedance (CI) of crystal resonators quickly and precisely. This option cannot be used with E5100B.

Color LCD Display (Option 030)

This option changes the monochrome LCD to the color TFT LCD.

Delete Instrument BASIC (Option UKR)

This option deletes Instrument BASIC. Instrument BASIC is a subset of HTBasic that allows all the analyzer's measurement capabilities and any other GPIB compatible instrument to be programmed.

Add DIN Keyboard (Option 1F0)

The option adds DIN keyboard for editing Instrument BASIC programs on the E5100A/B display.

Handle Kit (Option 1CN)

This option is a rack mount kit containing a pair of handles and the necessary hardware to mount the instrument.

Rack Mount Kit (1CM)

This option is a rack mount kit containing a pair of flanges and the necessary hardware to mount the instrument, with handles detached, in an equipment rack with 482.6 mm (19 inches) horizontal spacing.

Rack Mount and Handle Kit (Option 1CP)

This option is a rack mount kit containing a pair of flanges, and the necessary hardware to mount the instrument with handles attached in an equipment rack with 482.6 mm (19 inches) horizontal spacing.

Measurement accessories available

Active Probes

41800A Active Probe (5 Hz to 500 MHz)

This is a high input impedance probe for in-circuit measurements that cover the frequency range of 5 Hz to 500 MHz.

41802A 1 MΩ Input Adapter (5 Hz to 100 MHz)

This adapter allows the use of a high impedance probe. It has a frequency range of 5 Hz to 100 MHz.

Test Sets

87512A Transmission/Reflection Test Set

These test sets contain the hardware required to measure simultaneous transmission and reflection characteristics of a device in one direction only. The test port connector is 50 Ω type-N(f).

Power Splitters

11850C 50 Ω Three-way Power Splitters

These are four-port, three-way power splitters. One output arm is used as the reference in making ratio measurements and the other two output arms are test channels. The 11850C has a frequency range of DC to 3 GHz and an impedance of 50 Ω.

Calibration Kits

The following calibration kits contain the precision standards (and the required adapters) for the indicated connector types. The standards facilitate measurement calibration (also called vector error correction). Refer to the applicable data sheet and ordering guide for additional information. Part numbers for the standards are in their respective manuals.

- 85033C 3.5 mm Calibration Kit
- 85031B 7 mm Calibration Kit
- 85032B 50 Ω Type-N Calibration Kit
- 85036B 75 Ω Type-N Calibration Kit

Cables

The following RF cables are used to return the transmitted signal to the test set when measuring two-port devices. These cables provide shielding for high dynamic range measurements.

11851B 50 Ω Type-N RF Cable Set

This kit contains the three phase-matched 50 Ω type-N cables necessary to connect the 87512A/B transmission/reflection test kits or a power splitter to the analyzer. It also contains an RF cable used to return the transmitted signal of a two-port device to the network analyzer.

Adapters

11852B 50 Ω to 75 Ω Minimum Loss Pad (DC to 2 GHz)

This device converts the impedance from 50 Ω (type-N, female) to 75 Ω (type-N, male) or from 75 Ω to 50 Ω. It provides a low SWR impedance match between a 75 Ω DUT and the analyzer or a 50 Ω measurement accessory. An 11852B pad is included with the 87512B 75 Ω transmission/reflection test kit. Three 11852B pads are included with the 11850D 75 Ω power splitter.

Adapter Kits

The following adapter kits contain the connection hardware required for making measurements on devices of the indicated connector type.

- 11853A 50 Ω Type-N Adapter Kit
- 11854A 50 Ω BNC Adapter Kit

System Accessories Available

System rack

The 85043B system rack is a 124 cm (49 inch) high metal cabinet designed to rack mount the analyzer in a system configuration. The rack is used with a large built-in work surface, a drawer for calibration kits and other hardware, a bookshelf for system manuals, and a locking rear door for secured access. Lightweight steel rails support the instrument along their entire depth. Heavy-duty casters make the cabinet easily movable even with the instruments in place. Screw-down lock feet permit leveling and semi-permanent installation. The cabinet is extremely stable when the lock feet are down. Power is supplied to the cabinet through a heavy-duty grounded primary power cable and to the individual instruments through special power cables included with the cabinet.

Printer

The analyzer is capable of the monochrome printing of displayed measurement results directly to a compatible peripheral. The compatible printers are:

- HP DeskJet 560C
- HP DeskJet 1200C
- HP DeskJet 672C
- HP DeskJet 694C
- HP DeskJet 880C
- HP DeskJet 895Cxi
- HP DeskJet 930C
- HP DeskJet 970Cxi

Centronics Cable

A Centronics cable is required to interface the analyzer with a printer. The following cable is available:

- 92284A Centronics Cable, 2.1 m

GPIB Cable

An GPIB cable is required to interface the analyzer with a computer or other external instruments. The following cables are available:

- 10833A (1 m)
- 10833B (2 m)
- 10833C (4 m)
- 10833D (0.5 m)

External monitor

The analyzer can drive both its internal LCD and an external monitor simultaneously. One recommended color monitor is the 35741A/B. A monochrome monitor, such as the 35731A/B, can also be used if the analyzer is operated in the monochrome mode.

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Instrument Specifications

These specifications are the performance standards or limits against which the instrument is tested. When shipped from the factory, the E5100A/B meets the specifications listed in this section. The specification test procedures are contained in the *E5100A/B Service Manual*.

Values followed by (SPC) are Supplemental Performance Characteristics.

Source

Frequency Characteristics

Range ..... 10 kHz to 300 MHz

Accuracy (at 23 ± 5°C, step sweep)

..... ±20 ppm
with option 1D5 (at 0 to 55°C, 20 minutes after power on) ..... ±1 ppm

Stability (at 23 ± 5°C)

..... $\pm 5 \times 10^{-6}$/day (SPC)
with option 1D5 (48 hours after power on) ..... $\pm 2.5 \times 10^{-9}$/8 hours (SPC)

Resolution ..... 1 mHz

Output Power Characteristics

(measured at RF OUT 1, RF OUT 2 is terminated with 50 Ω termination)

Range (Nominal)

with option 001 ..... −9 dBm to +11 dBm
with option 002 ..... −15 dBm to +5 dBm
with option 003 ..... −12 dBm to +8 dBm
with both option 001 and 010 ..... −48 dBm to +22 dBm
with both option 002 and 010 ..... −54 dBm to +16 dBm
with both option 003 and 010 ..... −51 dBm to +19 dBm
with option 600 (at RF OUT 1) ..... −52 dBm to +18 dBm
with option 600 (at RF OUT 2) ..... −65 dBm to +5 dBm

Resolution ..... 0.1 dB

Level Accuracy (at 23 ±5°C, 0 dBm output level, 50 MHz) ..... ± 1 dB

Flatness (at 23 ±5°C, relative to 0 dBm output level at 50 MHz)

..... +2 dB, −4 dB
with option 003 and without option 010 ..... +2.5 dB, −4.5 dB
with option 010
10 kHz ≤ freq. < 50 kHz ..... +1.5 dB, −6 dB (SPC)

50 kHz ≤ freq. ≤ 100 MHz ..... +2.5 dB, −4.5 dB
100 MHz < freq. ≤ 300 MHz ..... +3 dB, −5 dB

with option 600

10 kHz ≤ freq. < 50 kHz ..... +1.5 dB, −7 dB (SPC)
50 kHz ≤ freq. ≤ 100 MHz ..... +2.5 dB, −4.5 dB
100 MHz < freq. ≤ 300 MHz ..... +3 dB, −5 dB

Linearity (at 23 ±5°C, relative to 0 dBm output level at 50 MHz)

..... ±1 dB

with option 010

maximum power level −70 dB ≤ power level < maximum power level −60 dB .. ±1.5 dB
maximum power level −60 dB ≤ power level ≤ maximum power level ..... ±1 dB

Power Splitter

(When the analyzer is equipped with option 001 or 003, delete this section.)

Insertion Loss (When the analyzer is equipped with option 600, delete this item.)

..... 6 dB (nominal)

Output Tracking

without option 600

10 kHz ≤ freq. ≤ 100 MHz ..... 0.1 dB (SPC)
100 MHz < freq. ≤ 300 MHz ..... 0.2 dB (SPC)

with option 600

10 kHz ≤ freq. ≤ 100 MHz ..... 13 dB±0.3 dB (SPC)
100 MHz < freq. ≤ 300 MHz ..... 13 dB±0.5 dB (SPC)

Equivalent Output SWR

without option 600

10 kHz ≤ freq. < 100 MHz ..... ≤1.2 (SPC)
100 MHz ≤ freq. ≤ 300 MHz ..... ≤1.4 (SPC)

with option 600

10 kHz ≤ freq. < 50 kHz ..... ≤2.5 (SPC)
50 kHz ≤ freq. ≤ 100 MHz ..... ≤1.2 (SPC)
100 MHz < freq. ≤ 300 MHz ..... ≤1.4 (SPC)

Spectral Purity Characteristics

Harmonics (these are supplemental performance characteristics for the 5100B)

with option 001 (at −4 dBm output level) ..... < −35 dBc
with option 002 (at −10 dBm output level) ..... < −35 dBc
with option 003 (at −7 dBm output level) ..... < −35 dBc
with option 600 (at +15 dBm output level) ..... < −20 dBc
with both option 001 and 010 (at +21 dBm output level) ..... < −20 dBc
with both option 002 and 010 (at +15 dBm output level) ..... < −20 dBc
with both option 003 and 010 (at +18 dBm output level) ..... < −20 dBc

Non-harmonic Spurious Signals (at < 300 MHz)

with option 001 (at −4 dBm output level) ..... < −45 dBc
with option 002 (at −10 dBm output level) ..... < −45 dBc
with option 003 (at −7 dBm output level) ..... < −45 dBc
with option 600 (at 0 dBm output level) ..... < −45 dBc
with both option 001 and 010 (at +6 dBm output level) ..... < −45 dBc

with both option 002 and 010 (at 0 dBm output level) ..... < −45 dBc
with both option 003 and 010 (at +3 dBm output level) ..... < −45 dBc

Phase Noise (at 10 kHz offset from 0 dBm fundamental) ..... < −90 dBc/Hz

Other Source Information

Reverse Power Protection ..... 20 dBm, 25 Vdc (SPC)

Output Connector ..... BNC female

Output Impedance ..... 50 Ω (nominal)

Receiver

Input Characteristics

Frequency Range

..... 10 kHz to 300 MHz
1 MΩ input for option 101 or 301 ..... 10 kHz to 5 MHz

IF Bandwidth (IF BW) ..... 10 Hz to 30 kHz, 1, 1.5, 2, 3, 4, 5, 8 step (nominal)

Impedance

..... 50 Ω (nominal)
1 MΩ input for option 101 or 301 ..... 1 MΩ // 30 pF (nominal)

Return Loss (at 50 Ω input)

10 kHz ≤ freq. < 100 MHz ..... 20 dB (SPC)
100 MHz ≤ freq. ≤ 300 MHz ..... 15 dB (SPC)

Maximum Input Level

50 Ω Input

Frequency	RF attenuator	Maximum Input Level
10 kHz ≤ freq. < 200 kHz	25 dB	0 dBm
10 kHz ≤ freq. < 200 kHz	0 dB	−25 dBm
200 kHz ≤ freq. ≤ 300 MHz	25 dB	+5 dBm
200 kHz ≤ freq. ≤ 300 MHz	0 dB	−20 dBm

1 MΩ Input for option 102 or 302

Frequency[1]	RF attenuator	Maximum Input Level
10 kHz ≤ freq. < 200 kHz	25 dB	0.22 Vrms
10 kHz ≤ freq. < 200 kHz	0 dB	0.013 Vrms
200 kHz ≤ freq. ≤ 300 MHz	25 dB	0.40 Vrms
200 kHz ≤ freq. ≤ 300 MHz	0 dB	0.022 Vrms

1 Measurement Frequency ≤ 5 MHz)

Damage Level

DC ..... 25 Vdc
AC ..... 20 dBm

Averaging Noise Level (at magnitude measurement, 23 ±5°C, RF attenuator: 0 dB, 50 Ω input)

- E5100A
  - IF BW 30 kHz (at > 1 MHz) ..... −100 dBm
  - IF BW 10 kHz (at > 300 kHz) ..... −105 dBm
  - IF BW 3 kHz (at > 100 kHz) ..... −110 dBm
  - IF BW 1 kHz
    - 30 kHz ≤ freq. < 100 kHz ..... −95 dBm
    - 100 kHz ≤ freq. ≤ 300 MHz ..... −115 dBm
  - IF BW 300 Hz
    - 10 kHz ≤ freq. < 100 kHz ..... −100 dBm
    - 100 kHz ≤ freq. ≤ 300 MHz ..... −120 dBm
  - IF BW 100 Hz
    - 10 kHz ≤ freq. < 100 kHz ..... −105 dBm
    - 100 kHz ≤ freq. ≤ 300 MHz ..... −125 dBm
- E5100B
  - IF BW 30 kHz (at > 1 MHz) ..... −100 dBm
  - IF BW 10 kHz (at > 300 kHz) ..... −105 dBm
  - IF BW 3 kHz (at > 100 kHz) ..... −110 dBm
  - IF BW 1 kHz
    - 30 kHz ≤ freq. < 100 kHz ..... −95 dBm
    - 100 kHz ≤ freq. ≤ 300 MHz ..... −115 dBm

- When the analyzer frequency is identical to the transmitted interference signal frequency, refer to "EMC" in "General Characteristics".

Input Crosstalk (When the analyzer is equipped with option 100, delete this section.)

reference input (0 dBm input level at 10 kHz to 200 kHz and +5 dBm input level at 200 kHz to 300 MHz, RF attenuator: 25 dB, 50 Ω input)
test input (RF attenuator: 0 dB, terminated with 50 Ω termination)

- E5100A
  - 10 kHz ≤ freq. < 100 kHz ..... < −110 dB
  - 100 kHz ≤ freq. ≤ 300 MHz ..... < −120 dB
- E5100B
  - 10 kHz ≤ freq. < 100 kHz ..... < −85 dB
  - 100 kHz ≤ freq. < 250 MHz ..... < −105 dB
  - 250 MHz ≤ freq. ≤ 300 MHz ..... < −95 dB

Source Crosstalk
(all RF OUT and input connectors are terminated with 50 Ω terminations)

- E5100A
  - without option 010 (at +5 dBm output level, RF attenuator: 0 dB, 50 Ω input)
    - 10 kHz ≤ freq. < 100 kHz ..... < −110 dB(SPC)
    - 100 kHz ≤ freq. < 250 MHz ..... < −125 dB(SPC)
    - 250 MHz ≤ freq. ≤ 300 MHz ..... < −120 dB(SPC)
  - with option 010 (at +16 dBm output level, RF attenuator: 0 dB, 50 Ω input)
    - 10 kHz ≤ freq. < 100 kHz ..... < −120 dB(SPC)
    - 100 kHz ≤ freq. < 250 MHz ..... < −135 dB(SPC)
    - 250 MHz ≤ freq. ≤ 300 MHz ..... < −130 dB(SPC)
- E5100B

without option 010 (at +5 dBm output level, RF attenuator: 0 dB, 50 Ω input)
10 kHz ≤ freq. < 100 kHz ..... < −85 dB(SPC)
100 kHz ≤ freq. < 250 MHz ..... < −100 dB(SPC)
250 MHz ≤ freq. ≤ 300 MHz ..... < −95 dB(SPC)
with option 010 (at +16 dBm output level, RF attenuator: 0 dB, 50 Ω input)
10 kHz ≤ freq. < 100 kHz ..... < −95 dB(SPC)
100 kHz ≤ freq. < 250 MHz ..... < −110 dB(SPC)
250 MHz ≤ freq. ≤ 300 MHz ..... < −105 dB(SPC)

Residual Response (RF attenuator: 0 dB, except for the following points) ..... < −80 dBm

50 kHz, 62.5 kHz, 83.333 kHz, 100 kHz, 125 kHz, 250 kHz, 95.825 MHz, 95.875 MHz, 159.791667 MHz, 159.825 MHz, 159.841667 MHz, 159.875 MHz, 199.75 MHz, 207.75 MHz, 239.6875 MHz, 239.75 MHz, and 239.875 MHz

Input Connector

..... BNC female
with option 102 or 302 ..... BNC female, Type-N female (for A, B inputs)

Measurement Mode

with option 100 ..... A
with option 200 or 600 ..... A/R, A/R, R, A
with option 300 ..... A/R, B/R, R/A, B/A, R/B, A/B, R, A, B
with option 400 ..... A/R, B/R, C/R, R/A, B/A, C/A, R/B, A/B, C/B, R/C, A/C, B/C, R, A, B, C

(When the Measurement Mode is either R/A, B/A, C/A, R/B, A/B, C/B, R/C, or A/C, the specification is SPC.)

Magnitude Characteristics

Absolute Characteristics

Absolute Amplitude Accuracy
(at 23 ±5°C, −30 dBm input level for RF attenuator: 0 dB or −5 dBm input level for RF attenuator: 25 dB, 50 Ω input)

E5100A ..... ±1 dB
E5100B ..... ±2 dB (SPC)

Ratio Characteristics

Frequency Response
(at 23 ± 5°C, −30 dBm input level for RF attenuator: 0 dB or −5 dBm input level for RF attenuator: 25 dB, the same RF attenuator setting for both inputs)

50 Ω input

- E5100A
  10 kHz ≤ freq. < 100 kHz ..... ±1 dB
  100 kHz ≤ freq. ≤ 100 MHz ..... ±0.5 dB
  100 MHz < freq. ≤ 300 MHz ..... ±1 dB
- E5100B
  100 kHz ≤ freq. < 100 kHz ..... ±2 dB (SPC)
  100 kHz ≤ freq. ≤ 100 MHz ..... ±1 dB (SPC)
  100 MHz < freq. ≤ 300 MHz ..... ±2 dB (SPC)

1 MΩ input for option 101 or 301

(using 50 Ω feedthrough) ..... ±3 dB

Note Frequency response can be improved by calibration.

Dynamic Accuracy

(at 23 ±5°C, 10 Hz IF BW, −10 dBm reference input level relative to maximum input level, −20 dBm test input level relative to maximum input level, except for ramp frequency sweep)

Test Channel Input Level RF Attenuator		Dynamic Accuracy Frequency	
25 dB	**0 dB**	**Other**	**10 kHz to 50 kHz**
+5 to −5 dBm[1]	−20 to −30 dBm[2]	±0.4 dB	±0.4 dB (SPC)
−5 to −15 dBm	−30 to −40 dBm	±0.09 dB	±0.09 dB (SPC)
−15 to −45 dBm	−40 to −70 dBm	±0.05 dB	±0.05 dB (SPC)
−45 to −55 dBm	−70 to −80 dBm	±0.06 dB	±0.1 dB (SPC)
−55 to −65 dBm	−80 to −90 dBm	±0.1 dB	±0.3 dB (SPC)
−65 to −75 dBm	−90 to −100 dBm	±0.3 dB	±0.9 dB (SPC)
−75 to −85 dBm	−100 to −110 dBm	±0.9 dB	±3 dB (SPC)
−85 to −95 dBm	−110 to −120 dBm	±3 dB	N/A

1 0 to −5 dBm at 10 kHz to 200 kHz

2 −25 to −30 dBm at 10 kHz to 200 kHz

with option 100
(at 23 ±5°C, 10 Hz IF BW, −20 dB input-A level relative to maximum input level, except for ramp frequency sweep, right after measuring reference)

Test Channel Input Level RF Attenuator		Dynamic Accuracy Frequency	
25 dB	**0 dB**	**Other**	**10 kHz to 50 kHz**
+5 to −5 dBm[1]	−20 to −30 dBm[2]	±0.4 dB	±0.4 dB (SPC)
−5 to −45 dBm	−30 to −70 dBm	±0.1 dB	±0.1 dB (SPC)
−45 to −55 dBm	−70 to −80 dBm	±0.1 dB	±0.2 dB (SPC)
−55 to −65 dBm	−80 to −90 dBm	±0.2 dB	±0.6 dB (SPC)
−65 to −75 dBm	−90 to −100 dBm	±0.6 dB	±1.8 dB (SPC)

1 0 to −5 dBm at 10 kHz to 200 kHz

2 −25 to −30 dBm at 10 kHz to 200 kHz

Trace Noise

(at 1 kHz IF BW, frequency > 305 kHz, −5 dBm input level for RF attenuator: 25 dB or −30 dBm input level for RF attenuator: 0 dB) ..... < 10 mdB rms

Stability

..... 0.02 dB/°C (SPC)

with option 100
(at 23±5 °) ..... 0.05 dB/°C (SPC)

Phase Characteristics

(When the analyzer is equipped with option 100, delete this section.)

Measurement Mode ..... Normal/Expanded

Frequency Response
(at 23 ± 5°C, −30 dBm input level for RF attenuator: 0 dB or −5 dBm input level for RF attenuator: 25 dB, the same RF attenuator setting for both inputs, 50 Ω input)

- E5100A
  - 10 kHz ≤ freq. < 100 kHz ..... ±5°
  - 100 kHz ≤ freq. ≤ 100 MHz ..... ±2.5°
  - 100 MHz < freq. ≤ 300 MHz ..... ±5°
- E5100B
  - 100 kHz ≤ freq. < 100 kHz ..... ±10° (SPC)
  - 100 kHz ≤ freq. ≤ 100 MHz ..... ±5° (SPC)
  - 100 MHz < freq. ≤ 300 MHz ..... ±10° (SPC)

Note This frequency response is only for the deviation from linear phase. Frequency response can be improved by calibration.

Dynamic Accuracy
(at 23 ±5°C, 10 Hz IF BW, −10 dBm reference input level relative to maximum input level, −20 dBm test input level relative to maximum input level, except for ramp frequency sweep)

Test Channel Input Level RF Attenuator		Dynamic Accuracy Frequency	
25 dB	0 dB	Other	10 kHz to 50 kHz
+5 to − 5 dBm[1]	−20 to −30 dBm[2]	±3°	±3° (SPC)
−5 to −15 dBm	−30 to −40 dBm	±0.6°	±0.6° (SPC)
−15 to −45 dBm	−40 to −70 dBm	±0.3°	±0.3° (SPC)
−45 to −55 dBm	−70 to −80 dBm	±0.3°	±0.6° (SPC)
−55 to −65 dBm	−80 to −90 dBm	±0.6°	±1.8° (SPC)
−65 to −75 dBm	−90 to −100 dBm	±1.8°	±6° (SPC)
−75 to −85 dBm	−100 to −110 dBm	±6°	±18° (SPC)
−85 to −95 dBm	−110 to −120 dBm	±18°	N/A

1 0 to −5 dBm at 10 kHz to 200 kHz

2 −25 to −30 dBm at 10 kHz to 200 kHz

Trace Noise
(at 1 kHz IF BW, frequency > 305 kHz, −5 dBm input level for RF attenuator: 25 dB or −30 dBm input level for RF attenuator: 0 dB) ..... < 50 mdeg rms

Stability ..... 0.15 deg/°C (SPC)

Delay Characteristics

Aperture Frequency ..... $\frac{200}{N-1}$% to 100% of span, where N is Number of Points

Accuracy (at 23 ±5°C, SPC)

In general, the following formula can be used to determine the accuracy, in seconds, of a specific group delay measurement:

$$\frac{Phase\,Accuracy[\text{deg}]}{360[\text{deg}] \times Aperture[Hz]}(sec)$$

Depending on the aperture, input level, and device length, the phase accuracy used in either incremental phase accuracy or worst case phase accuracy.

General Characteristics

Operating Conditions

When disk drive is in operation
- Temperature ..... 10 to 40 °C
- Humidity (at wet bulb ≤ 29°C, without condensation) ..... 15% ≤ RH ≤ 80%

When disk drive is not in operation
- Temperature ..... 5 to 40 °C
- Humidity (at wet bulb ≤ 29°C, without condensation) ..... 15% ≤ RH ≤ 80%

Altitude ..... 0 to 2,000 meters
Warm Up Time ..... 30 minutes

Non−operating Conditions

Temperature ..... −20 to 60 °C
Humidity (at wet bulb ≤ 40°C, without condensation) ..... 15 % ≤ RH ≤ 90 %
Altitude ..... 0 to 4,572 meters

Safety ..... Certified by CSA-C22.2 No. 231-M89, Complies with IEC 1010-1(1990) including Amendment 1 (1992)

EMC ..... Complies with CISPR 11 (1990)/EN 55011(1991): Group 1, Class A

Complies with IEC 801-2 (1991)/EN 50082-1(1992): 4 kV CD, 8 kV AD
Complies with IEC 801-3 (1984)/EN 50082-1(1992): 3 V/m
Complies with IEC 801-4 (1988)/EN 50082-1(1992): 1 kV power lines, 0.5 kV signal lines

Note: When tested at 3 V/m according to IEC 801-3/1984, the averaging noise level will be within specifications over the full immunity test frequency range of 27 MHz to 1000 MHz except when the analyzer frequency is identical to the transmitted interference signal test frequency.

This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Power Requirement ..... 90 to 132 V or 198 to 264 V, 47 to 63 Hz, 400 VA max

Weight (depending on option) ..... 12 kg (SPC)

Cabinet Dimensions ..... 425(W) × 177(H) × 425(D) mm (SPC)

Supplemental Characteristics

Measurement Function

Number of Measurement Channels ..... 1 to 4

Display Format ..... Cartesian

Sweep Parameter ..... frequency, power

Sweep Type

E5100A ..... linear (step, ramp), list
E5100B ..... linear (step, ramp)

Measurement Point per Sweep

E5100A ..... 2 to 801
E5100B ..... 2 to 401

Others

Measurement Calibration ..... Response, Response & Isolation, 1-Port 3-term

Display ..... 6.3 inch monochrome LCD, 640×480 dots

Flexible Disk Drive ..... 720 Kbytes/1.44 Mbytes, DOS format, binary or ASCII format

Flash Disk ..... 256 Kbytes

Ram Disk ..... 256 Kbytes

Programming ..... HP Instrument BASIC

GPIB ..... ANSI/IEEE 488.2 compatible.

Parallel I/O Port

..... 16 bit output, 8 bit input/output, TTL level
option 005 ..... 8 bit output, 4 bit input, TTL level
option 006 ..... 16 bit output, 8 bit input/output, TTL level
option 007 ..... 16 bit output, 8 bit input, open collector, opto-isolated

Printer ..... Parallel I/F (Centronics compatible), HP PCL

Keyboard ..... DIN (IBM PC compatible)

External Video Monitor Output ..... VGA

Connectors

Probe Power ..... +15 V(300 mA max.), −12.6 V(160 mA max.), GND nominal

(the maximum current values are total values of each probe connector)

EXT REF INPUT 10 MHz

Frequency ..... 10 MHz ±5 ppm
Amplitude ..... 0 ±5 dBm (SPC)
Nominal Impedance ..... 50 Ω

REF OVEN (OPTION 1D5)

Frequency (at 0 to 55 °C, 20 minutes after power ON) ..... 10 MHz ± 1.0 ppm
Amplitude ..... 2 ±5 dBm (SPC)

Nominal Impedance ..... 50 Ω

INT REF OUTPUT

Frequency (at 23±5 °C) ..... 10 MHz ±20 ppm
Amplitude ..... 0 ±5 dBm (SPC)
Nominal Impedance ..... 50 Ω

EXT TRIGGER and **EXT PROG RUN/CONT**
(Positive edge trigger)

V_{ih} ..... +2 V to +5 V (SPC)
V_{il} ..... 0 V to +0.5 V (SPC)
Sink current (Is) ..... Is $\leq$ 0.4 mA (SPC)
Pulse width (Tp) ..... Tp $\geq$ 20 μsec (SPC)

A

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the E5100A/B than the current printing date of this manual. The information in this manual applies directly to the E5100A/B Network Analyzer serial number prefix listed on the title page of this manual.

Manual Changes

To adapt this manual to your E5100A/B, see Table A-1 and Table A-2, and make all of the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different than 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.

Turn on the instrument or execute the "`*IDN?`" GPIB command to confirm the firmware version. See the *GPIB Command Reference* for information on the "`*IDN?`" command.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes
JP1KC	Change 1
JP2KC,JP3KC,JP4KC,JP5KC	none

Table A-2. Manual Changes by Firmware Version

Version	Make Manual Changes
REV 1.xx	Change 1
REV.2.xx, 3.xx	none

Serial Number

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

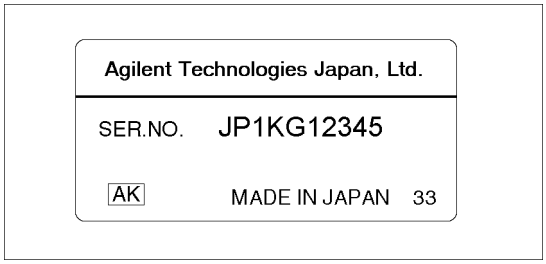

Figure A-1. Serial Number Plate (Sample)

Change 1

The firmware revision 1.xx does not support the following softkeys.

- Display Start Stop Center Span

  MARKER -> REFERENCE

- Marker

  MKR TIME on OFF

- Save/Recall

  MISC. SAVE

  SAVE GRAPHICS

  GRAPH [ ]

  SAVE MENU3

- Menu2

  USER CI [Ω]

  SRC UNIT [ ]

  PI CIRCUIT on OFF

The firmware rev1.xx does not support the following functions.

- User define softkey menu of Menu3
- 1601 measurement points

B

Default

Preset State

When the (PRESET) key is pressed, or the analyzer is turned on, the analyzer reverts to a known state. There are subtle differences between the preset state and the power-up state, and these states are defined in Table B-1 to Table B-4.

When line power is cycled the analyzer performs a self-test routine. Upon successful completion of the self-test routine, the instrument state is set to the following preset conditions. The same conditions are true following a "PRES" or "*RST" command over the GPIB bus.

Table B-1. Preset Conditions

Operating Parameter	Initialization Method	
	Power-On	**(PRESET) key**
Stimulus Conditions		
Sweep Type	Linear frequency	Linear Frequency
Display Mode	Start/Stop	Start/Stop
Trigger Type	Continuous	Continuous
Trigger Event	Internal	Internal
Sweep Time	0.06432 ms	0.06432 ms
Start Frequency	10 kHz	10 kHz
Stop Frequency	300 MHz	300 MHz
Source Power	0 dBm	0 dBm
CW Frequency	150.005 MHz	150.005 Hz
Coupled Channel	ON	ON
Frequency List		
Frequency List	Empty	Empty
Edit Mode	Start/Stop, Number of Points	Start/Stop, Number of Points

Table B-2. Preset conditions

Operating Parameter	Initialization Method	
	Power-On	(PRESET) key
Response Conditions		
Function	Gain-Phase	Gain-Phase
Measurement Parameter	A/R	A/R
Format	Log Mag & Phase (all inputs)	Log Mag & Phase (all inputs)
Active Channel	Channel 1	Channel 1
Number of channel	2	2
Display	Data	Data
Title	Empty	Empty
Multi Channel	OFF	OFF
Split Display	ON	ON
Number of Points	201	201
IF Bandwidth	30 kHz	30 kHz
Smoothing Aperture	1% Span; OFF	1% Span; OFF
Group Delay Aperture	1% Span	1% Span
Phase Offset	0°	0°
Electrical Delay	0 s	0 s
Velocity Factor	1	1
Storage	OFF	OFF
Graticule	ON	ON
Calibration		
Correction	OFF	OFF
Calibration Type	None	None
System Impedance	50 Ω	50 Ω
Calibration Kit		
Open STD value		
Rs	backup memory	same as before preset
Ls	backup memory	same as before preset
Cp	backup memory	same as before preset
Short STD value		
Rs	backup memory	same as before preset
Ls	backup memory	same as before preset
Cp	backup memory	same as before preset
Load STD value		
Rs	backup memory	same as before preset
Ls	backup memory	same as before preset
Cp	backup memory	same as before preset

Table B-3. Preset conditions

Operating Parameter	Initialization Method	
	Power-On	(PRESET) key
Markers		
Markers 1,2,3,4	10 kHz	10 kHz
Active Marker	1	1
Reference Marker	None	None
Marker Mode	Continuous	Continuous
Delta Marker Mode	OFF	OFF
Coupling	ON	ON
Marker Search	OFF	OFF
Marker Target Value	−3 dB	−3 dB
Marker Width Value	−3 dB; OFF	−3 dB; OFF
Marker Tracking	OFF	OFF
Marker Stimulus Offset	0 Hz	0 Hz
Marker Value Offset	0 dB	0 dB
Marker Statistics	OFF	OFF
Marker List	OFF	OFF
System		
LCD Contrast	Backup memory	same as before preset
Color Adjustment		
Backgrand (Pen No.=0)		
Red	backup memory	same as before preset
Green	backup memory	same as before preset
Blue	backup memory	same as before preset
Title, Grid (Pen No.=1)		
Red	backup memory	same as before preset
Green	backup memory	same as before preset
Blue	backup memory	same as before preset
Main Trace (Pen No.=2)		
Red	backup memory	same as before preset
Green	backup memory	same as before preset
Blue	backup memory	same as before preset
Sub Trace (Pen No.=3)		
Red	backup memory	same as before preset
Green	backup memory	same as before preset
Blue	backup memory	same as before preset

Table B-4. Preset conditions

Operating Parameter	Initialization Method	
	Power-On	**(PRESET) key**
System		
GPIB Addresses	backup memory	same as before preset
GPIB Mode	backup memory	same as before preset
Printer		
dpi	backup memory	same as before preset
Upper Margin	backup memory	same as before preset
Lower Margin	backup memory	same as before preset
Waveform Analysis		
Analysis range	Full	Full
Parallel I/O		
Direction of Port C and D	Input	same as before preset
Positive and Negative Logic Setting	Negative	same as before preset
OUTPUT1 and 2 output level	High	same as before preset

Factory Setting

The following calibration standard values are saved as the file "CALKDATA" in non-volatile memory (FLASH memory) so that the states are memorized even if the analyzer is turned off. If the file "CALKDATA" is erased, these states is set to the factory setting which is shown in Table B-5.

Table B-5. Preset conditions

Parameter	Factory Setting
Calibration Kit	
Gain-Phase	
Open STD value	
Rs	100G
Ls	0
Cp	0
Short STD value	
Rs	0
Ls	5n
Cp	0
Load STD value	
Rs	50
Ls	0
Cp	0
Z:reflection	
Open STD value	
Rs	100G
Ls	0
Cp	0
Short STD value	
Rs	0
Ls	5n
Cp	0
Load STD value	
Rs	50
Ls	0
Cp	0
Z:transmission	
Open STD value	
Rs	100G
Ls	0
Cp	0
Short STD value	
Rs	0
Ls	5n
Cp	0
Load STD value	
Rs	50
Ls	0
Cp	0

Note

When you want to set these states to the factory setting, follow the instruction described below.

1. Press (Save/Recall) `FILE UTILITY`.
2. Toggle `STORE DEV [A:DISK]` to `STORE DEV [B:MEMO]`.

3. Select "CALKDATA" file.
4. Press PURGE FILE PURGE YES .
5. Press BACKUP MEMO DISK under (Save/Recall).
6. Turn off and turn on the analyzer.
7. −257 File name not found is displayed after self test.
8. Press (Cal) MODIFY CAL KIT SAVE STD VALUE .

The following states are saved as the file "SYS_DATA" in non-volatile memory (FLASH memory) so that the states are memorized even if the analyzer is turned off. If the file "SYS_DATA" is erased, these states is set to the factory setting which is shown in Table B-6.

Table B-6. Preset conditions

Parameter	Factory Setting
System	
GPIB Address	17
GPIB mode	Addressable Only
LCD Contrast	180
Printer Setup	
dpi	100
Upper Margin	2.5
Lower Margin	0.5
Color Adjustment	
Backgrand (Pen No.=0)	
Red	0
Green	0
Blue	0
Title, Grid (Pen No.=1)	
Red	0.762
Green	0.762
Blue	0.762
Main Trace (Pen No.=2)	
Red	0.825
Green	0.762
Blue	0
Sub Trace (Pen No.=3)	
Red	0
Green	0.635
Blue	0.825

Note

When you want to set these states to the factory setting, follow the instruction described below.

1. Press (Save/Recall) FILE UTILITY .
2. Toggle STORE DEV [A:DISK] to STORE DEV [B:MEMO] .
3. Select "SYS_DATA" file.

4. Press PURGE FILE PURGE YES.
5. Press BACKUP MEMO DISK under (Save/Recall).
6. Turn off and turn on the analyzer.
7. −257 File name not found is displayed after self test.
8. Press (System) SAVE SYS DATA.

Defining PI-Network Test Fixture Calibration Standard values for Resonator Measurement (100 MHz or higher)

C

The E5100A/B employs the calibration standard values that are defined with 3-element equivalent circuit as shown in Figure C-1. Those of the 3 values, Rs, Ls, and Cp can be differently specified for the OPEN, SHORT, and LOAD standards. When measuring high-frequency (100 MHz or higher) resonators using a PI-network test fixture, the definition values of the 3-element equivalent circuit for the calibration standard may play a significant role in the measurement. In such cases, the calibration standard of the PI-network test fixture you use should be properly specified, referring to the following method. For initial values of the E5100A/B for each standard, refer to Table C-1.

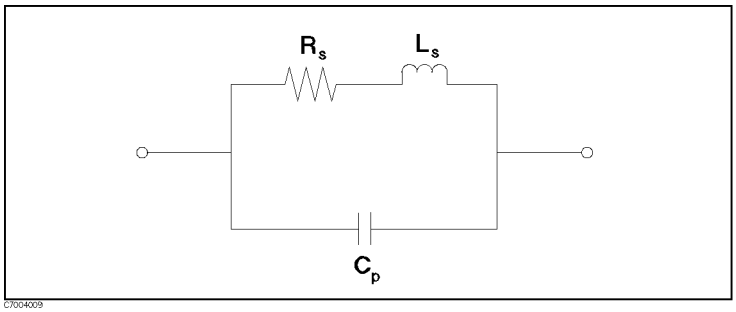

Figure C-1. Equivalent circuit model of calibration standard

Table C-1. Initial values of the E5100A/B for each standard

Standard	Value
OPEN	C_P = 0 pF
	R_S = 1 GΩ
	L_S = 0 nH
SHORT	C_P = 0 pF
	R_S = 0 μΩ
	L_S = 0 nH
LOAD	C_P = 0 pF
	R_S = 50 Ω
	L_S = 0 nH

When Using the Agilent 41900A or 41901A

Set calibration standard values according to Table C-2 and Table C-3.

Table C-2. Standard values for 41900A

Standard	Value
OPEN	C_P = 0.1 pF
	R_S = 1 TΩ
	L_S = 0 nH
SHORT	C_P = 17.409 pF
	R_S = 1 μΩ
	L_S = 0.6 nH
LOAD	C_P = 0.703 pF
	R_S = 50 Ω
	L_S = 15.7587 nH

Table C-3. Standard values for 41901A

Standard	Value
OPEN	C_P = 0.1 pF
	R_S = 1 TΩ
	L_S = 0 nH
SHORT	C_P = 0 pF
	R_S = 1 μΩ
	L_S = 0.1 nH
LOAD	C_P = 0.14 pF
	R_S = 50 Ω
	L_S = 3.75 nH

When Using User-prepared PI-Network Test Fixture

When using a user-prepared PI-network test fixture, define the calibration standard values as follows.

Defining OPEN Standard Values

Rs, Ls

Set Rs: 1 TΩ and Ls: 0 H as the definition values.

Cp

Cp denotes to the capacitance between both terminals of the PI-network test fixture. Normally, it is set to Cp: 0 F as the definition value. For measurement without load capacitance, Cp does not impact serial resonance frequency (fr), but does measurement results of equivalent constant C0 and parallel resonance frequency (fa). For measurement with load capacitance, Cp impacts not only C0 and fa but also serial resonance frequency (fr) and other measurement parameters. Therefore, in the following cases, setting the values properly defined for the PI-network test fixture you use is required.

Measurement without load capacitance:

- Parallel resonance (fa) (for example, ceramic resonators).
- Equivalent constant C0 which is small but the relative Cp value is not negligible.

Measurement with load capacitance:

- Equivalent constant C0 which is small but the relative Cp value is not negligible.

When defining Cp is required as described above, use the network analyzer to obtain the Cp value as follows.

1. Connect the PI-network test fixture in the same way as measureing a resonator using the network analyzer.
2. Select the tranmission mode as the measurement function and set the display format to `G-B`.

   `RESPONSE:[Meas/Format] FUNCTION IMPEDANCE:Trans`

   `RESPONSE:[Meas/Format] FORMAT G-B`
3. Set the characteristic impedance value (Z0) to 12.5 Ω.

   `RESPONSE:[Cal] Set Z0` 12.5
4. Connect the SHORT plate to the PI-network test fixture and perform the THRU calibration only.

   `RESPONSE:[Cal] CALIBRATE: 1-TERM THRU`

   When the TRUE calibration completes, press `DONE:`.

Note

Before performing the THRU calibration, set the IFBW value to a sufficiently small for better repeatability. (For example, 10 Hz)

---

5. Place the PI-network test fixture into the OPEN state. Read G-B at the desired frequency (for example, using the marker) and calculate the C value.

Defining the SHORT Standard Values

Rs, Ls, Cp

Set Rs: 0 Ω, Ls: 0 H, and Cp: 0 F as the definition values.

Defining the LOAD (50 Ω) Standard Values

Rs

Set Rs: 50 Ω as the definition value.

Ls

Set the measured value of the 50 Ω resistor used as the LOAD standard using, for example, equivalent circuit analysis of the impedance analyzer. As frequency becomes higher, the value converted to impedance cannot be ignored relative to the value of Rs (50 Ω). For example, for 41900A PI-Network Test Fixture, Ls=15.8 nH. The values converted to impedance are as

follows: 10 MHz: approximately 1 Ω, 80 MHz: approximately 8 Ω, and 125 MHz: approximately 12 Ω.

Cp

Set Cp to 0 F, if the frequency characteristics of Ls-R within the measurement frequency range shows a flatness by measuring the LOAD standard in the same way as Ls. When frequency increases and exceeds a certain value, however, the value of Rs (50 Ω) becomes larger. This is because the effect of Cp is significant at higher frequencies and R becomes relatively larger. If this increase exceeds 1 %, set the Cp value obtained by equation (1) below.

Obtaining Cp of the LOAD standard. Cp is defined by the following equation.

$Cp = 1 / (2\pi f_0)^2 L_s$ . . . . . .(1)

fo is a frequency satisfying $(f/fo)^2 = 0.1$,where f is measurement frequency. (fo = f / $\sqrt{0.1}$: when the measurement frequency is 125 MHz, fo is approximately 395 MHz.)

Equation (1) can be also derived as follows.

The impedance of the 3-element equivalent circuit is obtained by the following equation.

$Z = 1 / \{ 1 / (Rs + j\omega Ls) + j\omega Cp \}$

When $1 \gg \omega^2 Ls\ Cp$:

$Z \equiv [Rs \{ 1 + (f / fo)^2 \} + j\omega Ls (1 - CpRs^2 / Ls)] / (1 + \omega^2\ Cp^2\ Rs^2)$

,where

$fo = 1 / 2\ \pi\ \sqrt{L_s C_p}$

Therefore,

$Cp = 1 / (2\ \pi\ fo)^2\ Ls$. . . . . Same as Equation (1).

Error Messages

This section lists the error messages that are displayed on the analyzer display or transmitted by the instrument over GPIB. Each error message is accompanied by an explanation, and suggestions are provided to help in solving the problem. Where applicable, references are given to related sections of the Operation and Maintenance manuals.

When displayed, error messages are usually preceded with the word "CAUTION:". That part of the error message has been omitted here for the sake or brevity. Some messages are for information only, and do not indicate an error condition. Two listings are provided: the first is in alphabetical order, and the second in numerical order.

In addition to error messages, instrument status is indicate by status notations on the display. Examples are "!" and "#". Sometimes these appear in conjunction with error messages. A complete listing of status and notations and their meanings is provided in "Front and Rear Panel".

Error Messages in Alphabetical Order

152 ADDITIONAL STANDARDS NEEDED

Error correction for the selected calibration class cannot be computed until all the necessary standards have been measured.

153 CALIBRATION REQUIRED

No valid calibration coefficients were found when user attempted to turn calibration ON.

5 CAN'T CHANGE-ANOTHER CONTROLLER ON BUS

The analyzer cannot assume the mode of system controller until the active controller is removed from the bus or relinquishes the bus.

55 CAN'T COPY A DIRECTORY

A directory name is selected as a source file. Select a file to be copied before pressing COPY FILE.

−281 CANNOT CREATE PROGRAM

Indicates that an attempt to create a program was unsuccessful. A reason for the failure might include not enough memory.

−253 CORRUPT MEDIA

A legal program command could not be executed because of corrupt media; for example, a bad disk or wrong format.

−104 **DATA TYPE ERROR**

Improper data type used (for example, string data was expected, but numeric data was received).

−255 **DIRECTORY FULL**

A legal program command could not be executed because the media directory was full.

−257 **FILE NAME ERROR**

A legal program command could not be executed because the file name on the device media was in error; for example, an attempt was made to copy to a duplicate file name.

−256 **FILE NAME NOT FOUND**

A legal program command could not be executed because the file name on the device media was not found; for example, an attempt was made to read or copy a nonexistent file.

−282 **ILLEGAL PROGRAM NAME**

The name used to reference a program was invalid; for example, redefining an existing programm deleting a nonexistent program, or in gerenral, referencing a nonexsitent program.

−282 **ILLEGAL VARIABLE NAME**

An attempt was made to reference a nonexistent variable in a program.

154 **LIST TABLE EMPTY OR INSUFFICIENT TABLE**

The frequency list is empty. To implement the list frequency mode, make the list table.

126 **LOCAL MAX NOT FOUND**

The maximum peak whose sharpness is defined by the peak define function cannot be found.

127 **LOCAL MIN NOT FOUND**

The minimum peak whose sharpness is defined by the peak define function cannot be found.

−250 **MASS STORAGE ERROR**

A mass storage error occurred. This error message is used when the device cannot detect the more specific errors described for errors −251 trough −259.

−254 **MEDIA FULL**

A legal program command could not be executed because the media was full.

−258 **MEDIA PROTECTED**

A legal program command could not be executed because the media was protected; for example, the disk was write-protected.

−251 **MISSING MASS STORAGE**

A legal program command could not be executed because of missing mass storage; for example, attempt to access an external disk drive by using Instrument BASIC.

−252 **MISSING MEDIA**

A legal program command could not be executed because of a missing media; for example, no disk.

−109 **MISSING PARAMETER**

A command with an improper number of parameters received.

129 **NO MARKER DELTA - RANGE NOT SET**

The SEARCH RNG STORE softkey requires that delta marker mode be turned ON, with at least two markers displayed.

128 **NO MARKER DELTA - SPAN NOT SET**

The MARKER → SPAN softkey requires that delta marker mode be turned ON, with at least two markers displayed.

156 **NO VALID MEMORY TRACE**

If a memory array is to be displayed or otherwise used, a data must first be stored to memory by GPIB.

56 **NOT A DIRECTORY**

A file name is selected when CHANGE DIRECTORY is pressed. Select a directory name before pressing CHANGE DIRECTORY.

−321 **OUT OF MEMORY**

An internal operation needed more memory than was available.

145 **OVERLOAD ON INPUT**

The power level at one of the receiver inputs exceeds a certain level greater than the maximum input level.

−108 **PARAMETER NOT ALLOWED**

Too many parameters for the command received.

1 **PRINTER NOT POWERED ON OR DISCONNECTED**

The printer does not respond to control. Verify power to the printer and connection between the analyzer and the printer.

−284 **PROGRAM CURRENTLY RUNNING**

Certain operations dealing with programs may be illegal while the program is running; for example, deleting a running program might not be possible.

−280 **PROGRAM ERROR**

Indicates that a downloaded program-ralated execution error occured. This error message should be used when the device cannot detect the more specific errors described for errors −281 through −289. A downloaded program is used to add algorithmic capability to a device. The syntax used in the program and the mechanism for downloading a program is device-specific.

−286 **PROGRAM RUNTIME ERROR**

Runtime error has occured,

−285 **PROGRAM SYNTAX ERROR**

Indicats that a syntax error appears in a downloaded program. The syntax used when parsing the downloaded program is device-specific.

−430 **QUERY DEADLOCKED**

Input buffer and output buffer are full; cannot continue.

−400 **QUERT ERROR**

Query is improper.

−410 **QUERY INTERRUPTED**

Query is followed by DAB or GET before the response was completed.

−420 **QUERY UNTERMINATED**

Addressed to talk, incomplete program message received.

115 **RECALL: CRC ERROR**

A serious error, for example corrupted data, is detected on recalling a file, and this forced the analyzer to be PRESET.

116 **RECALL: INVALID OPTION ERROR**

The recalled file was saved by the other analyzer which is equipped with the diffrerence option.

103 **SAVE: CRC ERROR**

A serious error, for example physically damaged disk surface, is detected on saving a file. Change the disk.

−102 **SYNTAX ERROR**

Unrecognized command or data type was received.

155 **TOO MANY SEGMENTS OR POINTS**

In list table editor, the total of number of points exceeds 801 so that the new segment can not be made.

–113 **UNDEFINED HEADER**

Undefined header or an unrecognized command was received (operation not allowed).

139 **WRONG I/O PORT DIRECTION**

The direction of I/O port C or D is opposite.

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