Introduction to New Features

Agilent Technologies 8510C Network Analyzer
Revision 7.XX (7.00 and Greater)

Agilent Technologies

11575- 90024

Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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General Safety Considerations

WARNING   **Before you turn on this instrument, make sure it has been properly grounded through the protective conductor of the ac power cable to a socket outlet provided with protective earth contact.**

Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal can result in personal injury.

Typeface Conventions

The following conventions are used in the HP 8510 series documentation:

Italics

Italic type is used for emphasis, and for titles of manuals and other publications. It is also used to designate a variable entry value.

`Computer`

Computer type is used for information displayed on the instrument and to designate a programming command or series of commands.

(Hardkeys)

Instrument keys are represented in "key cap." You are instructed to *press* a hardkey.

`Softkeys`

Softkeys are located along side of the display, and their functions depend on the current display. These keys are represented in "softkey." You are instructed to *select* a softkey.

1

General Information

Introduction to this Document

This *Introduction to New Features of the HP 8510C* is designed to provide you with a quick introduction to the new features and operating details of firmware revision 7.0 or greater of the HP 8510C Network Analyzer.

Note	A working knowledge of the HP 8510, and basic familiarity with front-panel operation is assumed, and only new features are explained. Demonstration sequences assume that your are using an HP 8510C (color display), executing firmware revision C.07.00, or higher.

For more comprehensive information, see the *HP 8510 Operating and Programming Manual*. A companion volume, the *HP 8510 Keyword Dictionary* expands upon the Operating and Programming Manual by providing a complete alphabetical list of HP 8510 front–panel hardkeys, menu softkeys, and programming mnemonics. Each entry also includes information about how to use the function in programmed operation.

Turn Power On

There are now two line power switches. First turn on all other system instruments, then switch the LINE rocker switch on the bottom box to ON, then press the latching pushbutton LINE switch on the top box to ON. The self–test will execute, the HP 8510C issues a device preset to instruments on the HO 8510 System Bus, the the HP 8510 internal user–defined Instrument State 8 is recalled.

Introduction to Limit Lines and Limit Points Measurements

On the HP 8510C network analyzer, you can define limits that are displayed on the screen, while the trace is displayed. These limits allow you to visually compare the trace values with the limits that are defined.

In addition to the limits display on the screen, you can select to have the HP 8510C perform a numeric `PASS/FAIL` comparison with the defined limits. The comparison will indicate whether the current trace meets the user-defined limits. `PASS` appears if the trace meets the defined limits, or `FAIL` appears if the trace exceeds the defined limits.

Types of Limits

There are two limit types:

Limit Lines   This type of limit consists of two end points with a line drawn between the end points. The end points of the line are defined by a stimulus value, usually a frequency, and a limit value. The limit line drawn between the two end points may be either flat or sloping, depending upon the end point settings. Make certain that you enter an end-point value that is greater than the begin-point value.

Limit Points   This type of limit consists of a single point, having a single stimulus value and limit value. a limit point is drawn on the display as **v**; symbol. The sharp point in the **v**; indicates the position of the limit point.

Limit Testing

For the purpose of limit `PASS/FAIL` testing, limit lines and points may be defined as being either "upper" (maximum) limits, or "lower" (minimum) limits. When limit `PASS/FAIL` testing is turned on, the measurement points that are on-screen, and fall within any defined limits, are tested. Either a `PASS` or `FAIL` message is displayed relating to the results of the test.

For limit lines, keep in mind that only data points that are *actually measured* are tested against the limits. For example, a limit line could end between two measurement points. If this happens, the end point of the limit line is *not* tested.

Note   For limit lines, only the measurement points that fall between the limit line end points are tested.

For limit points, if the limit point does not fall exactly on a measurement point, then the nearest actual measurement point is used for the limit `PASS/FAIL` test. In addition, any limit point that is not in the measurement range (off the edge of the display), of course, is not tested.

When no limits are defined, turning limit testing ON displays a `PASS` message. Any limits that are defined, but are not in the current measurement range (they are off the edge of the display) are also not tested.

If desired, limit `PASS/FAIL` may be turned on without limits being displayed.

Limit Tables

Each limit table can consist of from 0 to 12 limits, in any combination of limit lines and limit points.

An instrument state in the HP 8510C can contain eight limit tables. There are four tables for each channel. One table for each of the four "primary" parameters (one each for `S11`, `S21`, `S12`, and `S22`, but the same limit table is used for `S11` and `User 1`.) By having multiple limit tables, separate tables of limits may be defined for each parameter while in 4-parameter display mode.

After a limit table has been created for one parameter on one channel, that table may be copied to any other parameter on either of the channels, using the `COPY LIMITS` function.
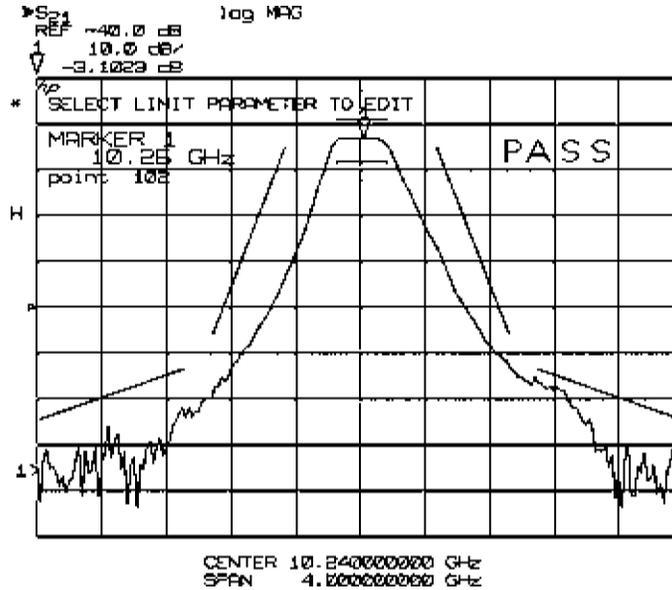
Figure 1-1. Example of a Limit Test using Limit Lines

Creating a Limit Test

Use the following example to set up an example limit test for an RF filter.

Note	This procedure assumes a device response is displayed on the network analyzer screen.

To Set Up the Measurement

1. Connect the RF filter between the network analyzer RF OUT and RF IN ports.

2. Press (PRESET), (FREQ), then (CENTER). Enter the center frequency of the RF filter being tested.

   For this example, enter 175 MHz for the center frequency.

3. Press (SPAN) and enter a frequency span that simplifies viewing the passband of the RF filter.

   Use a 200 MHz span, as an example.

4. Press (SCALE) then `AUTOSCALE` to view the entire measurement trace.

To Set the Limit Test Values

Limits create boundaries between which an active trace must remain for the measurement to pass. To develop the limits, you select an appropriate softkey and adjust its position (value) with the RPG, the step keys, or by entering the numeric value via the key pad.

5. Press (DISPLAY) then LIMITS . The network analyzer display splits into two sections. One section displays the limit table and the other shows the selected limits on the display.

6. Press ADD LIMIT to display the Add Limit Menu.

To Define the Maximum Limit

In the following example, the response of the filter is measured against three maximum limit lines. The values are determined from the displayed trace, then limit parameters are entered for a limit test. The values used for determining the limits are as follows:

Location	Frequency of Interest
The low side of the cut-off frequency portion	125 MHz to 150 MHz
The bandpass portion	155 MHz to 195 MHz
The high-side of the cut-off frequency portion	200 MHz to 225 MHz

There are two ways to define the test limits:

1. Use a marker to determine the frequencies of the trace you plan to limit test:

   ■ Press MARKER .

   ■ Use the RPG knob to move the marker along the trace, or use the = MARKER key to enter values directly.

2. Or, use the softkeys and the RPG, step keys, or numeric keys in any combination to visually adjust the limits in real-time, about the displayed measurement trace.

   a. Press ADD MAX LINE to set a limit above the device's response trace.

   b. Press BEGIN STIMULUS , then enter 125 MHz. This is the beginning frequency value of the first, maximum limit line.

Note   Correct a mistake by using the following technique:

   □ If your incorrect value is entered and you have not pressed (MHz), back space over the error, then enter the correct value.

   □ If you have pressed (MHz) for the incorrect value, press BEGIN STIMULUS and enter the corrected value.

---

   c. Press END STIMULUS . Enter 150 MHz, the ending frequency of the first maximum limit line. A limit line is drawn between the two frequency values you entered, at a zero (0.0) unit level.

d. Press `BEGIN LIMIT` and watch the limit segment and measurement trace as you rotate the RPG knob to adjust the beginning of the limit segment.

e. Place the beginning of the limit line at −25 dB, which is the device's maximum allowable output power level, for the beginning frequency.

Note   Notice that the power level and frequency value appear in the limit-test table. You can iterate between setting the beginning and ending of the limit line position.

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f. Press `END LIMIT`, and watch the traces on the display as you rotate the RPG to adjust the end of the limit segment.

g. Place the end of the limit line at 0.0 dB, which is the device's maximum allowable output power level, for the ending frequency.

3. Press (PRIOR MENU), then `ADD MAX LINE`. Repeat the above steps for the frequencies of the second and third maximum limit lines. For this example:

     1) 155 MHz to 195 MHz, and *2)* 200 MHz to 225 MHz

To Define Minimum Limit Lines

If desired, use the RPG, step keys, or numeric keypad to define minimum limits. Minimum limits may be at frequencies that are different from the maximum limit frequencies. It is acceptable to enter minimum limits before or after entering maximum limits.

For this example, the frequencies used for maximum and minimum limit lines are slightly different. Refer to the table below:

Location	Frequency of Interest
The low side of the cut-off frequency portion	125 MHz to 150 MHz
The bandpass portion	155 MHz to 195 MHz
The high-side of the cut-off frequency portion	200 MHz to 225 MHz

1. Press (PRIOR MENU), then `ADD MIN LINE` to set up the limit line for the device's lower level response.

2. Press `BEGIN STIMULUS` and enter 125 MHz, the beginning frequency of the first minimum limit line.

Note   Correct a mistake by using the following technique:

     □ If your incorrect value is entered and you have not pressed (MHz), back space over the error, then enter the correct value.

     □ If you have pressed (MHz) for the incorrect value, press `BEGIN STIMULUS` and enter the corrected value.

---

3. Press `END STIMULUS` . Enter 150 MHz, the ending frequency of the first minimum limit line. A limit line is drawn between the two frequency values you entered, at a zero (0.0) unit level.

4. Press `BEGIN LIMIT` and watch the limit segment and measurement trace as you rotate the RPG knob to adjust the limit segment.

5. Place the beginning of the limit line at −50 dB, which is the device's minimum allowable output power level for the beginning frequency.

Note   Notice that the power level and frequency value appear in the limit-test table. You can iterate between setting the beginning and ending of the limit line position.

---

6. Press `END LIMIT` and rotate the RPG to position the end of the limit line at −10 dB, the device's minimum allowable output power level for the ending frequency.

7. Press (`PRIOR MENU`), then `ADD MIN LINE` and repeat the steps above for the second and third minimum limit lines. For this example, *1)* 155 MHz to 195 MHz, and *2)* 200 MHz to 225 MHz.
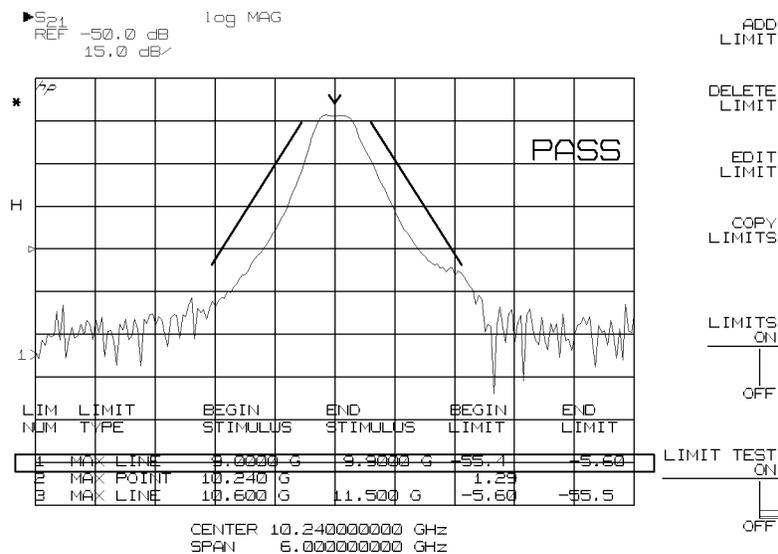
Figure 1-2. Limit Test Example Using Limit Lines and Limit Points

Editing the Limits in the Limits Table

You may edit any individual frequency, limit, or limit line after you have created it. Become familiar with the information below about modifying a limit value:

1. Press (`DISPLAY`), then `LIMITS` . The display shows the test device response with limit lines and the tabular listing of the limits set. The highlighted box surrounding one segment indicates the currently selected limit for editing.

2. Press the arrow keys or use the RPG to move the highlighted box to the portion of the test parameter to edit.

3. Press `EDIT LIMITS`, then press the keys that correspond to the portions of the limit you want to edit (begin frequency, end frequency, begin limit, or end limit, as an example.

4. Enter new limit values.

5. Press (PRIOR MENU) to return to the limits menu.

6. Press `LIMIT TEST ON` to activate the limit test with the new limits. Test results are displayed on the screen as `PASS` or `FAIL`.

2

Changing the Calibration Type

Introduction

You can create new calibration sets from an active two-port calibration set. The two-port set can be a full two-port, a one-path two-port or a TRL two-port calibration set.

2-PORT to: S_{11} 1-PORT creates an S_{11} 1-port calibration from the currently active 2-port calibration set.

2-PORT to: S_{22} 1-PORT creates an S_{22} 1-port calibration from the currently active 2-port calibration set. Use the following key sequenceto create the new calibration set.

1. (CAL) MORE
2.   MODIFY CAL SET
3.   CHANGE CAL TYPE
4.   2-PORT to: S_{11} 1-PORT
5.   CHANGE & SAVE
6.   CAL SET n (and select a new cal set,
different from the existing cal set. If the same cal set is used,
its original contents are overwritten.)

Modifying a Cal Set with Connector Compensation

Connector compensation is a feature that provides for compensation of the discontinuity found at the interface between the test port and a connector. The connector here, although mechanically compatible, is not the same as the connector used for the calibration. There are several connector families that have the same characteristic impedance, but use a different geometry. Examples of such pairs include:

  3.5 mm / 2.92 mm
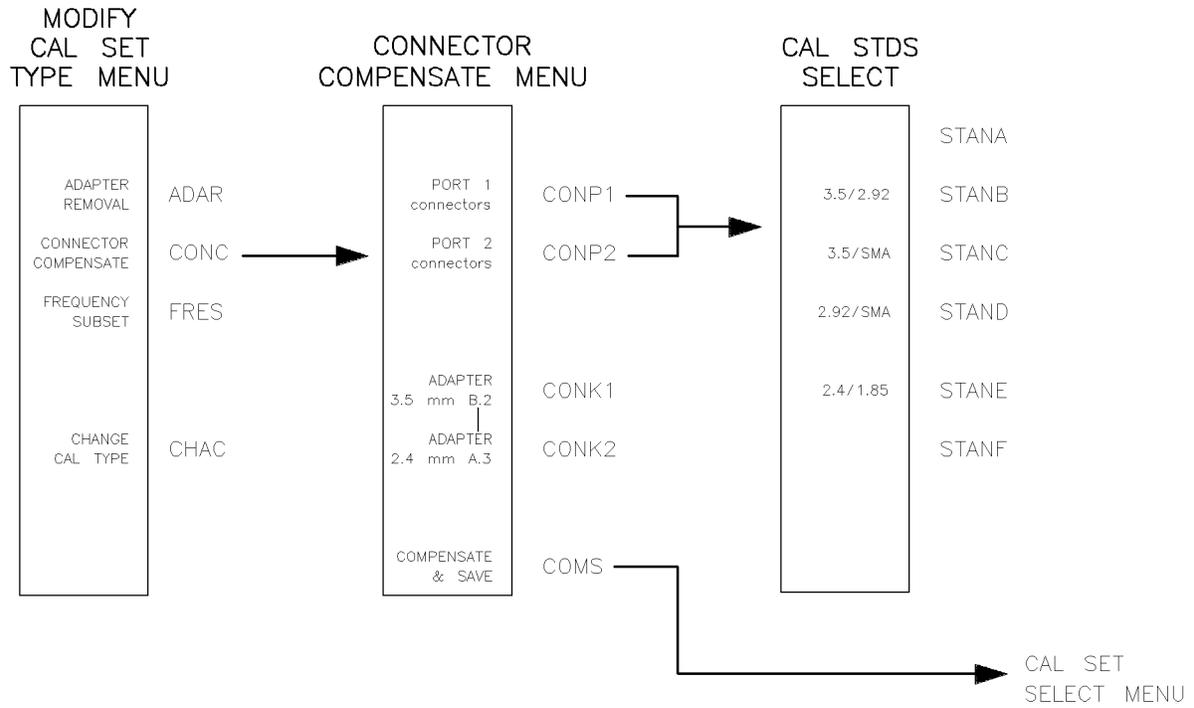
  3.5 mm / SMA

    SMA / 2.92 mm

  2.4 mm / 1.85 mm

The interface discontinuity is modeled as a lumped, shunt-susceptance at the test port reference plane. The susceptance is generated from a capacitance model of the form:

$$C = C_0 + C_1 \times F + C_2 \times F^2 + C_3 \times F^3$$

where F is the frequency. The coefficients are provided in the default Cal Kits for a number of typically used connector-pair combinations. To add models for other connector types, or to change the coefficients for the pairs already defined in a Cal Kit, use the "Modifying a Calibration Kit" procedure on the previous pages. Note that the definitions in the default Cal Kits are additions to the Standard Class ADAPTER, and are Standards of type "OPEN."

MODIFY
CAL SET
TYPE MENU

CONNECTOR
COMPENSATE MENU

CAL STDS
SELECT

STANA

ADAPTER
REMOVAL   ADAR

PORT 1
connectors   CONP1

3.5/2.92   STANB

CONNECTOR
COMPENSATE   CONC

PORT 2
connectors   CONP2

3.5/SMA   STANC

FREQUENCY
SUBSET   FRES

2.92/SMA   STAND

ADAPTER
3.5 mm B.2   CONK1

2.4/1.85   STANE

CHANGE
CAL TYPE   CHAC

ADAPTER
2.4 mm A.3   CONK2

STANF

COMPENSATE
& SAVE   COMS

CAL SET
SELECT MENU

calmod

Figure 2-1. Connector Compensation Menu Keys

Using Connector Compensation

1. Press (CAL), then press `MORE`.

2. Press `MODIFY CAL SET`, then press `CONNECTOR COMPENSATE`.

Note   Connector compensation requires that the active Cal Set be a 1-Port or 2-Port calibration. If a Cal Set of any other type is selected, the message `ACTIVE CALSET WRONG TYPE` appears.

3. Choose the connector pair at either `PORT 1 connectors` or `PORT 2 connectors` to apply connector compensation.

4. From the standards menu, choose the correct pair of connectors.

Note   If the connector pairs listed do not include the connector pairs you you are using, return to the prior menu to choose the alternate Cal Kit before repeating the procedure.

If the connector pairs you are using are not listed in either Cal Kit 1 or Cal Kit 2, then you need to modify the calibration kit. Use the `MODIFY 1` or `MODIFY 2` functions to enter an appropriate set of coefficients. Refer to the previous section, "Modifying a Calibration Kit."

After selecting a connector pair, the previous menu re-appears with the selected Port selection underlined.

5. To apply connector compensation to the other port, repeat Step 3 for the other port.

6. Press `COMPENSATE & SAVE` to compute the modified Cal Set.

7. Select a Cal Set to store the modified calibration terms.

Other than the changes to the error coefficients, all other properties of the Cal Set remain unchanged.

Note that you do not need to overwrite the original (uncompensated) Cal Set. You may also compare the *compensated* Cal Set with the *uncompensated* Cal Set and view the effect of compensation.

3

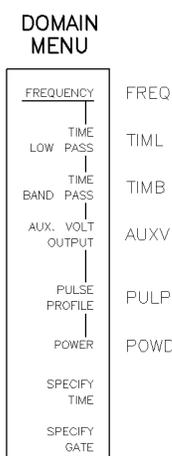# Power Domain Measurements

Introduction

This chapter explains the function and use of power domain in the HP 8510C network analyzer, with firmware revision 7.0, or higher. The following sections explain the concept of power domain, how to set up the HP 8510C to use power domain, the calibration implications, and limitations, as well as detailed measurement examples.

This chapter also includes a description of Receiver Cal function, which is required to allow calibrated measurements in power domain mode.

What is Power Domain?

Power domain allows measurements of a device under test, over a power range of interest, at a constant frequency. In contrast, a frequency domain mode measurement measures power over a frequency range of interest. A typical application for power domain is measuring the compression of amplifiers. In power domain, the independent variable (STIMULUS) swept or stepped by the network analyzer system (normally frequency) is changed to power. The STIMULUS block keys ((START), (STOP), (CENTER), and (SPAN)) refer to power and affect the horizontal axis of a rectangular display. A frequency point must be selected, and is displayed beside the range of power.

Without a calibrated receiver (`RECEIVER CAL`) and source flatness calibration (`FLATNESS CAL`), the test port absolute power cannot be known. The power is varied by controlling the HP 8360 synthesized source.

DOMAIN
MENU

FREQUENCY	FREQ
TIME LOW PASS	TIML
TIME BAND PASS	TIMB
AUX. VOLT OUTPUT	AUXV
PULSE PROFILE	PULP
POWER	POWD
SPECIFY TIME	
SPECIFY GATE	

domainmain

Figure 3-1. Domain Menu With Power Domain Function Keys

What is Receiver Cal?

The HP 8510C network analyzer receiver calibration (RECEIVER CAL) feature provides a display of unratioed receiver inputs, calibrated in absolute power (usually dBm). The feature is normally used in association with power domain since the power levels displayed are otherwise those determined by the source and do not account for losses in the path between the source and the test ports. Receiver calibration is performed after calibrating the HP 8360 Series source with a power meter and ensuring that it remains leveled across the frequency range of operation. A receiver calibration is stored as a Cal Set and corrects Port 1 ($a1$) output power and Port 2 ($b2$) input power, only.

Note   There are a number of assumptions associated with receiver calibration. Specifically, the feature relies on the linearity of the detectors and does not make any correction for mismatches at the test ports.
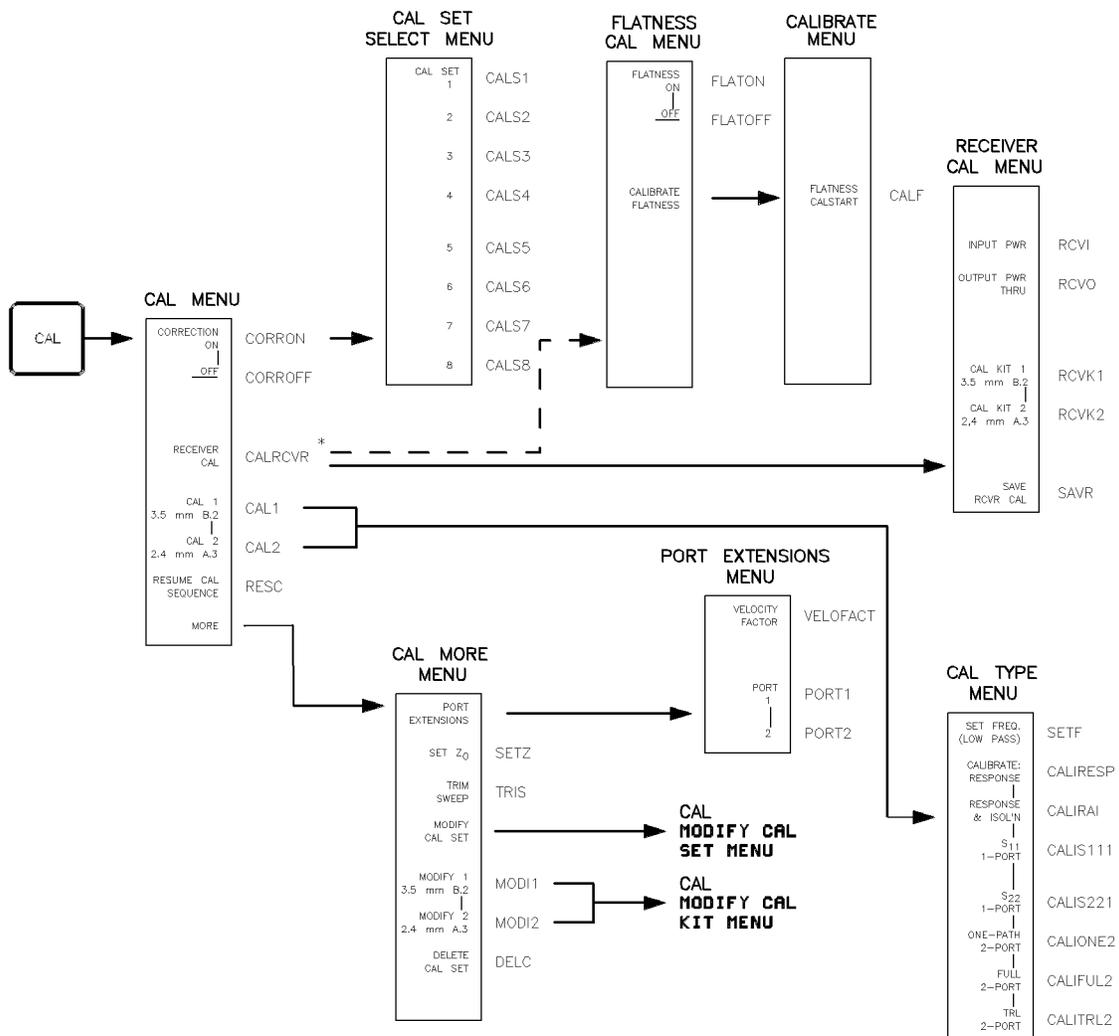
Figure 3-2. Receiver Calibration Menu

Making a Power Domain Measurement

The HP 8510C must already be calibrated in the frequency range of choice, or the user should perform the calibration at the beginning of this power domain procedure.

It is recommended that you choose a frequency range that gives frequency steps of a convenient size. Doing so allows the measurement frequencies to be easily recalled later. For example, setting (START) to 50 MHz, and (STOP) to 5050 MHz, with the number of points set to 101, gives measurement frequencies in even 50 MHz increments.

1. In frequency domain, set the HP 8510C to the frequency range of interest. Press the appropriate STIMULUS block keys to enter the values. ((START) and (STOP), or (CENTER), and (SPAN).)

2. Press the STIMULUS block (MENU) key, then press STEP to underline step mode.

Note	Step mode is required while using the power domain function. If you calibrate or use a previously stored Cal Set, the power domain frequency of measurement must be a point in the original (frequency domain) calibration.

3. Either calibrate the system at this point, or recall a previously stored Cal Set to use.

4. Activate a marker and set the marker to the frequency at which you wish to make a power sweep. If the marker is not used, the power domain is entered at 2 GHz.

Note	If multiple markers are ON, the active marker is used for the power domain frequency of measurement.

5. Press (DOMAIN), POWER, then press the appropriate STIMULUS block keys to set the power levels of interest.

Note	The default power level values are START equals −10 dBm, STOP equals 0 dBm. The POWER SOURCE 1 softkey in the STIMULUS POWER MENU has no effect in power domain mode. Pressing the key and entering a value displays an error message. When you enter frequency domain mode again, source 1 power is reset to its original value.

6. With the power level set, you may change frequency setting using the FREQ. of MEASUREMENT key.

   a. To choose a calibrated frequency point, use the NEXT PT HIGHER or NEXT PT LOWER keys.
   b. Select a valid (calibrated) frequency value. Notice that as you change frequencies, the trace changes as the calibration is first turned *OFF*, then back *ON* again.

Note	When in power domain mode, you may use only one Cal Set for 4-parameter display. If power domain is selected with more than one Cal Set applied, then the active parameter calibration is converted to power domain and applied to the measurements. All others are reset. Dual channel display may be used to view power domain data and frequency domain data simultaneously, however, UNCOUPLED CHANNELS must first be selected.

Performing a Receiver Calibration

1. Set the HP 8510C system to Frequency Domain and set the frequency range of interest.

2. Select the desired number of points to measure. If you plan to use power domain, STEP sweep mode must be selected.

3. Set the source power level.

   a. Press the HP 8510C STIMULUS block (MENU) key.

   b. Press POWER MENU, then press POWER SOURCE 1 .

   c. Adjust the source power to a value appropriate for the device under test.

If you have carried out a power flatness calibration since cycling the system power, skip to Step 5, otherwise, continue with the flatness calibration at Step 4.

The Flatness Calibration Must be Completed

Flatness calibration must be completed before beginning the receiver calibration. Data obtained during the flatness calibration is used during the receiver calibration.

4. Connect the power sensor from a zeroed power meter to Port 1 of the test set.

   a. Press the STIMULUS block (MENU) key, then press the following keys:

   □ POWER MENU
   □ POWER FLATNESS
   □ CALIBRATE FLATNESS
   □ FLATNESS CAL START

   b. Wait until the completion message is displayed before continuing.

Note	The source must remain leveled during the flatness calibration process. Calibration fails and displays an error message if the source is unleveled at any frequency. Refer to *Product Note 8510-16* for a complete description of the flatness correction feature.

   c. Remove the power sensor from Port 1 of the test set.

5. Perform the receiver calibration. If valid power flatness data is not available, the system requires that a flatness calibration be completed. Return to Step 4, above.

6. Connect a thru between Port 1 and Port 2 of the HP 8510C. It is not necessary for the thru to be zero length or lossless, but should be appropriately defined in the selected Cal Kit.

7. In the MENUS block, press `CAL`, then press `RECEIVER CAL`.

   a. Press `INPUT PWR` to measure power at Port 1. The softkey label is underlined after the measurement is completed.

   b. Press `OUTPUT PWR` to measure power at Port 2. If several THRUs have been defined in the Cal Kit, a further menu appears to allow selection of the appropriate standard. At the completion of the measurement, the `OUTPUT PWR` key is underlined.

   c. Press `SAVE RCVR CAL` then select a Cal Set number and store the receiver cal data.

Note   Unless both input and output power have been measured, pressing `SAVE RCVR CAL` generates an error message.

When Receiver Cal is turned on, parameter `User 1 a1` displays input power (`Pin`) in dBm and `User 2 b2` displays output power (`Pout`). Note that once calibrated, the measurements are valid even if the source power level is changed and whether flatness is turned ON or OFF.

Swept-Frequency Gain Compression Measurement Exercise

Making a swept-frequency gain compression measurement requires the receiver calibration feature to obtain the output power at the desired compression level, in absolute power units.

1. Set the HP 8510C to the frequency range of interest.

2. Set the power to a value low enough to avoid driving the device under test (DUT) into compression.

3. Perform a receiver calibration as appropriate. Then connect the (DUT).

4. Display S_{21} and perform an S_{21} Response Cal (Thru) with the DUT in place.

5. Press `SCALE` `1` `x1` for convenient viewing.

6. Select split channel display mode.

   a. Press `DISPLAY`, then `DISPLAY MODE`.

   b. Select either `DUAL CHAN SPLIT` or `DUAL CHAN OVERLAY`.

   c. Press `CHANNEL 2`, PARAMETER `MENU`, then `USER 2 b2`.

   d. Confirm that the display on Channel 2 reads `Pout` in units of dBm.

7. Press `CHANNEL 1`, and increase the source power until the gain (S_{21}) decreases to −1 dB at any frequency point.

8. Press `MARKER` and set the marker to the frequency point at which S_{21} is −1 dB.

Note	Marker search may be used by pressing `(MARKER)`, `MORE`, and `MINIMUM`.

9. Read the absolute power at the output from the marker readout for Channel 2.

Swept-Power Gain Compression Measurement Exercise

Making a swept-power gain compression measurement requires using the power domain and receiver calibration features.

1. Set up the HP 8510C for this measurement as for the "Swept-Frequency Gain Compression Measurement Exercise" above.

2. Ensure that a receiver calibration has been completed, and an appropriate calibration for S_{21} is done (a response cal is usually adequate for well-matched amplifiers).

3. Connect the DUT and display S_{21} on Channel 1 with calibration turned ON.

4. Display `a1` (`Pin`) or `b2` (`Pout`) on Channel 2. Turn on the previously stored Cal Set having a receiver calibration.

Note	Channels 1 and 2 must be in uncoupled mode.

5. Set a marker to the desired frequency of measurement for Power Domain.

6. Select Power Domain. Press `(DOMAIN)`, then `POWER`.

7. Set the start- and stop-power points to values that drive the amplifier into compression during the trace.

8. Use the marker search function to locate a gain drop of 1 dB on the S_{21} trace.

9. Read the marker value for Channel 2 to determine the absolute input power (`Pin`) or output power (`Pout`) at the 1 dB compression point.

   a. Press `(CHANNEL 2)`, then `(MENU)` in the PARAMETER block.

   b. Press `USER 1 a1` or `USER 2 b2`.

10. To make calibrated compression measurements at other frequencies of interest, use the steps that follow:

    a. Press `DOMAIN`, `POWER`, then `NEXT PT HIGHER` or `NEXT PT LOWER` to select the next point from the original frequency domain calibrations.

    b. *OR*

    c. Enter a valid frequency of measurement using the numeric keypad. This method may be used provided the exact frequency point entered is contained in the original frequency domain calibration. Press `DOMAIN`, `POWER`, then `FREQUENCY OF MEAS.` and enter the valid frequency.

Note	Entering a frequency of measurement not contained in the original frequency domain calibration causes the calibrations to be turned OFF.

11. Repeat steps 8 and 9 above for the new frequency of measurement.