

User's Guide Supplement

**Firmware Revisions 7.40 and Above
for the
HP 8719D/20D/22D,
HP 8753E, and HP 8753E Option 011**



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Introduction

This document is intended for those who installed firmware upgrade 7.40 into their network analyzer. This firmware upgrade gives your analyzer four-parameter display capability. With this upgrade, you can measure and display all four S-parameters of a two-port device simultaneously. This firmware upgrade also makes it easier to characterize duplexers using the HP 8753D Option K36 Duplexer Test Adapter or similar adapter.

This supplement describes the new features of this firmware upgrade and how to use them. It is assumed that you have a basic knowledge of the analyzer. Where appropriate, this supplement refers to the analyzer's *User's Guide* when it will enhance your understanding of the features in this upgrade.

Four-Parameter Display Overview

The four-parameter display firmware upgrade adds two channels to your analyzer. These new channels, 3 and 4, make it possible to measure and display all four S-parameters of a device simultaneously.

Although independent of the other channels in most respects, channels 3 and 4 are permanently coupled to channels 1 and 2 respectively by stimulus. That is, if channel 1 is set for a center frequency of 200 MHz and a span of 50 MHz, channel 3 will have the same stimulus values. This is a reciprocal relationship in that changes made to channel 3's stimulus immediately apply to channel 1. The coupling between channels is:

Channel 1= channel 3 (by stimulus)
Channel 2 = channel 4 (by stimulus)

Channels 1 and 2 are referred to as the **primary channels** and channels 3 and 4 are referred to as the **auxiliary channels**. Once channel 3 or 4 is made active, it can be configured independently of its primary channel in these variables:

- Measurement (S-parameters only)
- Format
- Scale/Div
- Reference position
- Reference value
- Electrical delay
- Phase offset
- Memory trace storage
- Markers
- Limit lines
- Trace colors

Four-Parameter Display and Calibration

A full two-port calibration must be active before an auxiliary channel can be enabled. For the measurement examples used in this supplement, a full two-port calibration covering the entire frequency range of the analyzer was used. Interpolated error correction was then turned on to narrow the calibration to the range of the DUT (Device Under Test).

The calibration may be recalled from a previously saved instrument state or performed before enabling an auxiliary channel. If recalled, you may need to modify some of the parameters from the recalled instrument state in order to test your particular device. The recalled calibration must cover the range of the device to be tested.

Enabling and Activating the Auxiliary Channels

NOTE **Hardkey and Softkey Representation:**

Throughout this supplement, hardkeys are represented as **Hardkey** and softkeys are represented as **SOFTKEY**.

The primary channel hardkeys **Chan 1** and **Chan 2** now activate auxiliary channels 3 and 4 as well as primary channels 1 and 2. Before an auxiliary channel can be made active, it must be enabled by setting **AUXCHAN on OFF** to **ON** in the Display menu. Enabled and active are defined as:

Enabled: A channel must be enabled before it can be made active. Both primary channels are always enabled. The auxiliary channels must be enabled via the Display menu before they can be made active by the primary channel hardkeys **Chan 1** or **Chan 2**.

Active: When made active, a channel can be configured for measurement type, format, limit lines, etc.

Auxiliary channel 3 or 4 is enabled by pressing **Chan 1** or **Chan 2** **Display**
DUAL | QUAD SETUP AUXCHAN on OFF.

Once the auxiliary channels are enabled, a hardkey will alternately make a primary channel or its auxiliary channel active. The amber LED adjacent to the **Chan 1** or **Chan 2** hardkey indicates which channel is active: when the LED is constantly lit, the primary channel is active; when it is flashing, the auxiliary channel is active. Pressing a channel hardkey toggles between a primary channel and its auxiliary channel.

Quick Four-Parameter Display Setup

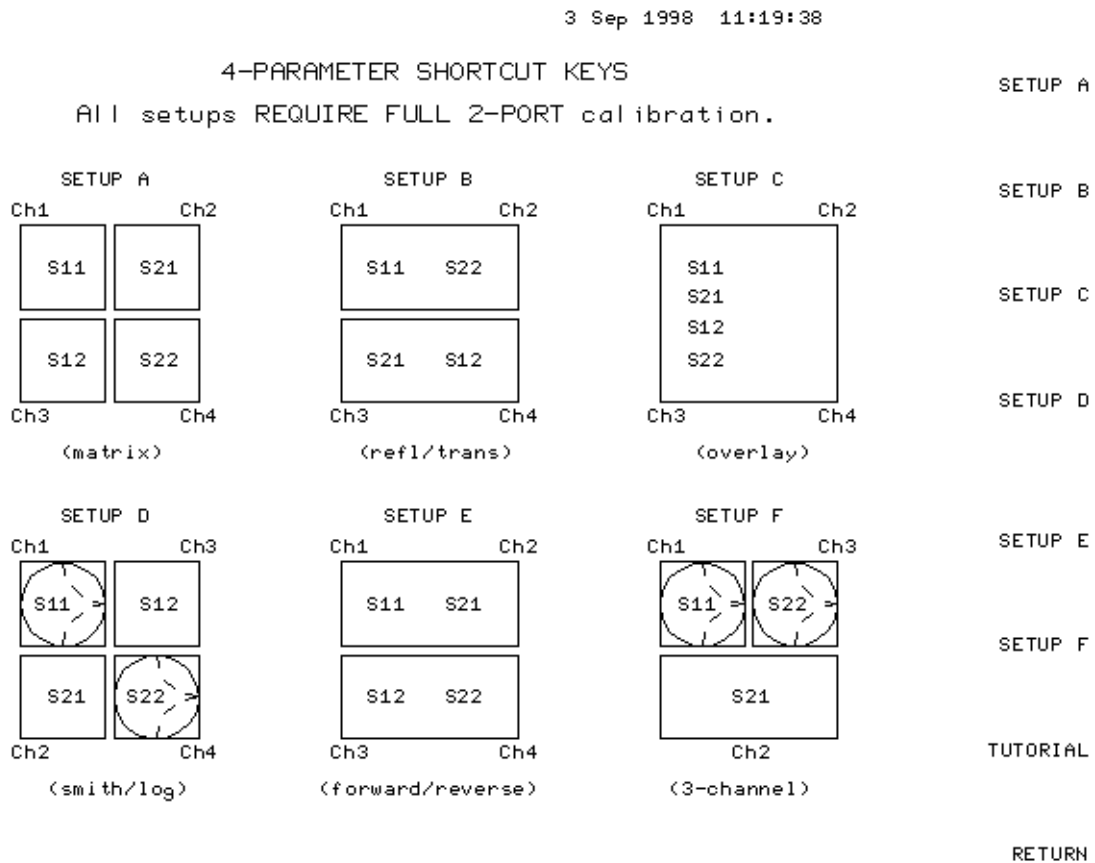
To quickly set up a four-parameter display, you can use the 4-PARAMETER SHORTCUT KEYS menu to set up a choice of common configurations. *A full two-port calibration must be active before you can enable the auxiliary channels.*

To use the **4 PARAM DISPLAYS** menu to quickly set up a four-parameter display, press:

Display **DUAL** | **QUAD SETUP** **DUAL CHAN on OFF** **4 PARAM DISPLAYS** **SETUP A**

Pressing **TUTORIAL** brings up a screen which color-codes each channel to the keys which affect it. For example, in **SETUP A**, channel 1 is shown in yellow as well as the keys **Chan 1**, **MEAS S11**, and **AUXCHAN on OFF**. Pressing all of the keys listed below **SETUP A** in order from top to bottom achieves the same results (four-parameter display) as pressing **SETUP A** in the **4-PARAM DISPLAYS** menu.

Figure 1. 4 Param Displays Menu



Measurement Examples

Displaying All Four S-Parameters of a Two-Port Device

This measurement example demonstrates how to display all four S-parameters of a two-port device. (If you are using an HP 8753E Option 011, you must have an S-parameter test set connected to your analyzer.) In this example, the device to be tested is a bandpass filter with a center frequency of 134 Mhz.

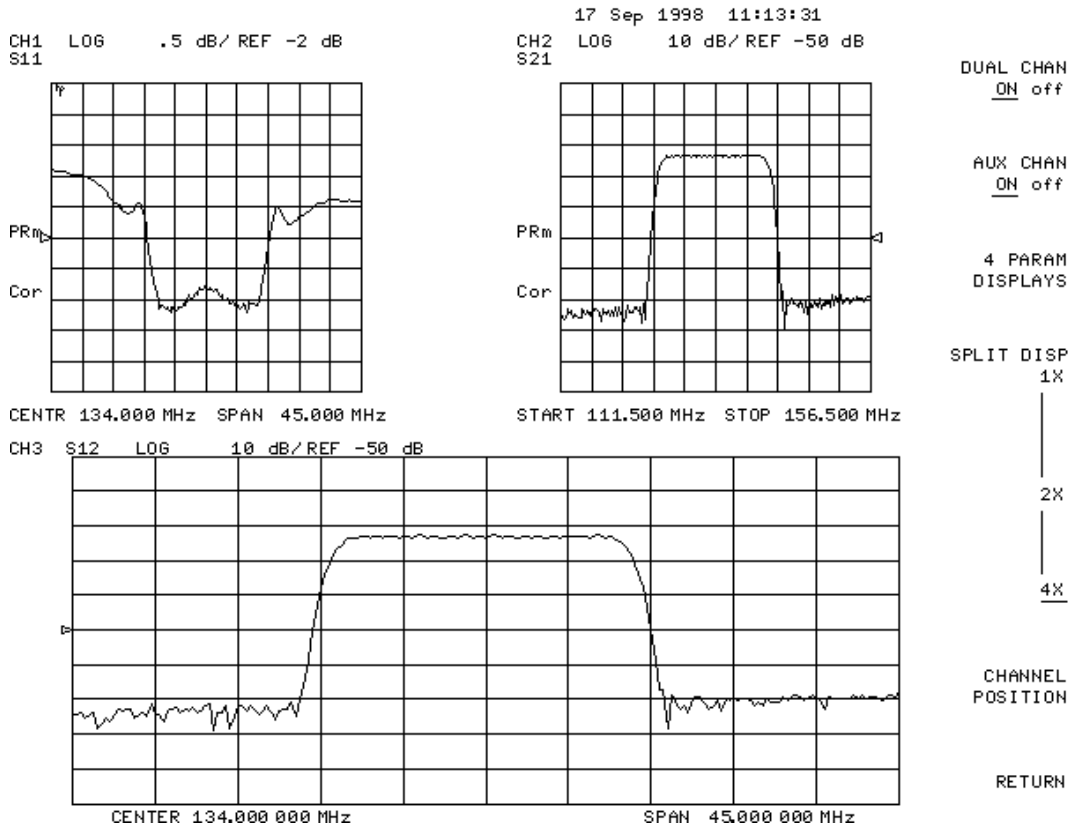
NOTE Before enabling an auxiliary channel, you must perform a full two-port calibration or recall one from an instrument state. See [“Four-Parameter Display and Calibration” on page -3](#). The measurement examples in this supplement use a two-port calibration covering the entire range of the analyzer, then narrowed to the range of the DUT using interpolated error correction.

1. Press **(Preset)**.
2. If a full two-port calibration has been performed or recalled from a previously saved instrument state, go on to step 5. If not, then proceed to the next step. See [“Four-Parameter Display and Calibration” on page -3](#).
3. Set the stimulus values for the DUT (Device Under Test). For this example, a center frequency of 134 MHz and span of 45 MHz were chosen, and the IF bandwidth was left at its default value of 3700 Hz.
4. Perform a full two-port calibration on your instrument.
5. Connect the DUT to the analyzer.
6. Set the format type for the DUT. This example uses **LOGMAG** format.
7. If channel 1 is not active, make it active by pressing **(Chan 1)**.
8. Press **(Display) DUAL | QUAD SETUP**. Set **DUAL CHAN on OFF** to **ON**, **AUX CHAN on OFF** to **ON**, and **SPLIT DISP** to **4X**.

The display will appear as shown in [Figure 2.](#) Channel 1 is in the upper left-hand quadrant of the display, channel 2 is in the upper right-hand quadrant, and channel 3 is in the lower half of the display.

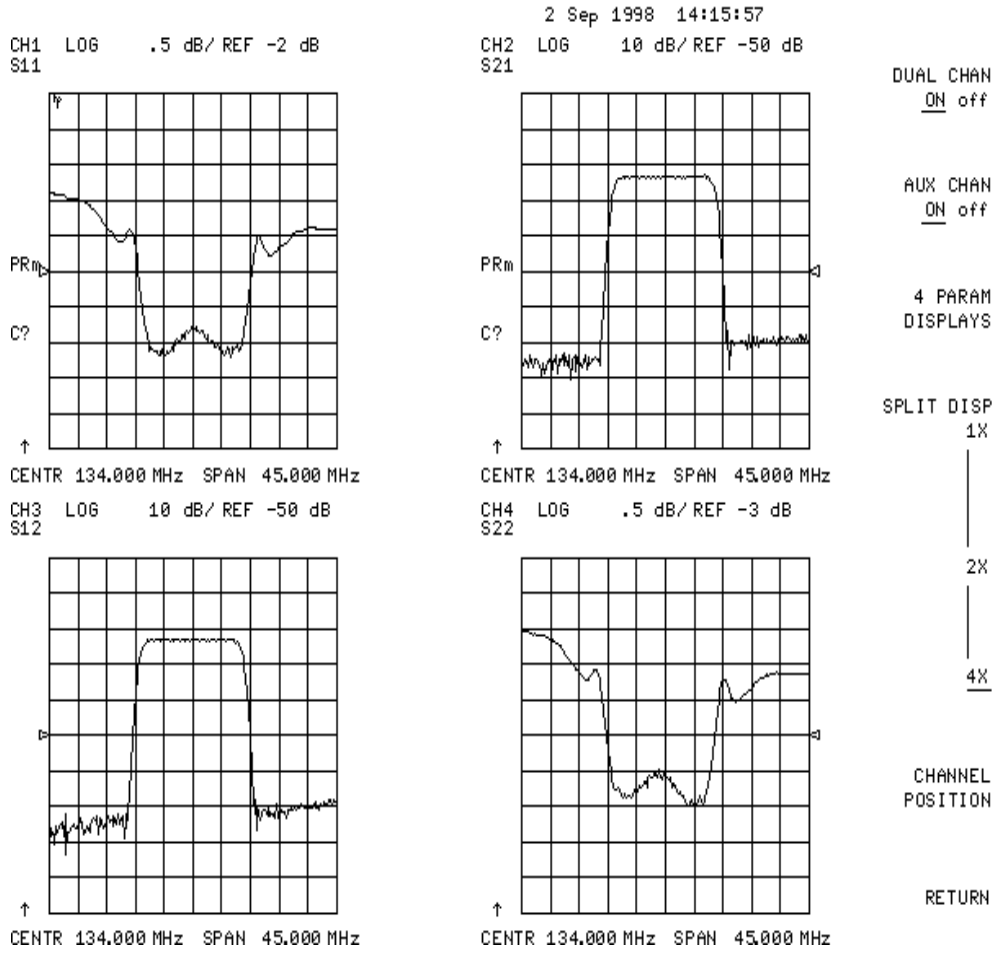
Notice that the default S-parameters are: S_{11} for channel 1; S_{21} for channel 2; and S_{12} for channel 3. These can be changed by making a channel active, then pressing **(Meas)** and selecting a different S-parameters for the channel.

Figure 2. Three-Channel Display



9. Press **Chan 2** and set **AUX CHAN on OFF** to **ON** . This enables channel 4, and the screen now displays four separate graticules as shown in [Figure 3](#). Channel 1 is in the upper left-hand quadrant of the display, channel 2 is in the upper-right, channel 3 is in the lower-left, and channel 4 is in the lower-right.

Figure 3. Four-Channel Display



Activate the Auxiliary Channels

10. Press **Chan 2**.
The amber LED adjacent to the **Chan 2** hardkey flashes. This indicates that channel 4 is now active and can be configured.
11. Press **Marker** and **MARKER 1** and **MARKER 2**.
Markers 1 and 2 appear on all four channel traces and can be moved using the front panel control knob.
12. Press **Chan 1**.
The LED is constantly lit, indicating channel 1 is active. Press **Chan 1** again and notice that the LED flashes, indicating that channel 3 is active.
13. Rotate the front panel control knob.
Notice that marker 2 moves in all four channels.

Uncouple the Display Markers

14. Press **Marker Fctn** **MARKER MODE MENU**. Set **MARKERS COUPLED UNCOUPLED** to **UNCOUPLED**.
15. Rotate the front panel control knob.
Notice that marker 2 moves only on channel 3. If you activate another channel and rotate the control knob, the marker will move only in that channel.

Characterizing a Duplexer

This measurement example demonstrates how to characterize a 3-port device, in this case a duplexer, using four-parameter display mode. (If you are using an HP 8753E Option 011, you must have an S-parameter test set connected to your analyzer.) You must use a test adapter to route the signals from the analyzer (a two-port instrument) to the duplexer (a three-port device). This example procedure is performed using an 8753E and one of the following test adapters:

□HP 8753D Option K36 duplexer test adapter

□HP 8753D Option K39 3-port test adapter

1. Press **Preset**.
2. Connect the test adapter to the analyzer according to the instructions for your particular model. Connect any test fixture or cables to the duplexer test adapter.
3. Set up channel 1 for the Tx-Ant stimulus parameters (start/stop frequency, power level, IF bandwidth).
4. Uncouple the primary channels from each other:
Press **Menu**, then set **COUPLED CH on OFF** to **ON**.
5. Set up control of the test adapter so that channel 1 is Tx:
Press **Seq** **TTL I/O** **TTL OUT** **TESTSET I/O FWD** **7** **x1** **TESTSET I/O REV** **7** **x1**.
6. Perform a full 2-port calibration on channel 1 (refer to the *User's Guide* if necessary).
Press **Cal** **CALIBRATE MENU** **FULL 2-PORT**.

NOTE Make sure you connect the standards to the Tx port of the test adapter (or a cable attached to it) for the FORWARD calibration, and to the Ant port for the REVERSE calibration.

7. Save the instrument state:
Press **Save/Recall** **SAVE STATE**.
8. Press **Chan 2**.
9. Set up channel 2 for the Ant port-to-Rx port stimulus parameters.
10. Set up control of the test adapter so that channel 2 is Rx:
Press **Seq** **TTL I/O** **TTL OUT** **TESTSET I/O FWD** **6** **x1** **TESTSET I/O REV** **6** **x1**.
11. Perform a full 2-port calibration on channel 2.
Press **Cal** **CALIBRATE MENU** **FULL 2-PORT**.

NOTE Make sure you connect the standards to the Rx port of the test adapter (or a cable attached to it) for the FORWARD calibration, and to the Ant port for the REVERSE calibration.

12. Save this state in the analyzer:
Press **Save/Recall** **SAVE STATE**.
13. Connect the DUT (Device Under Test) to the test adapter.

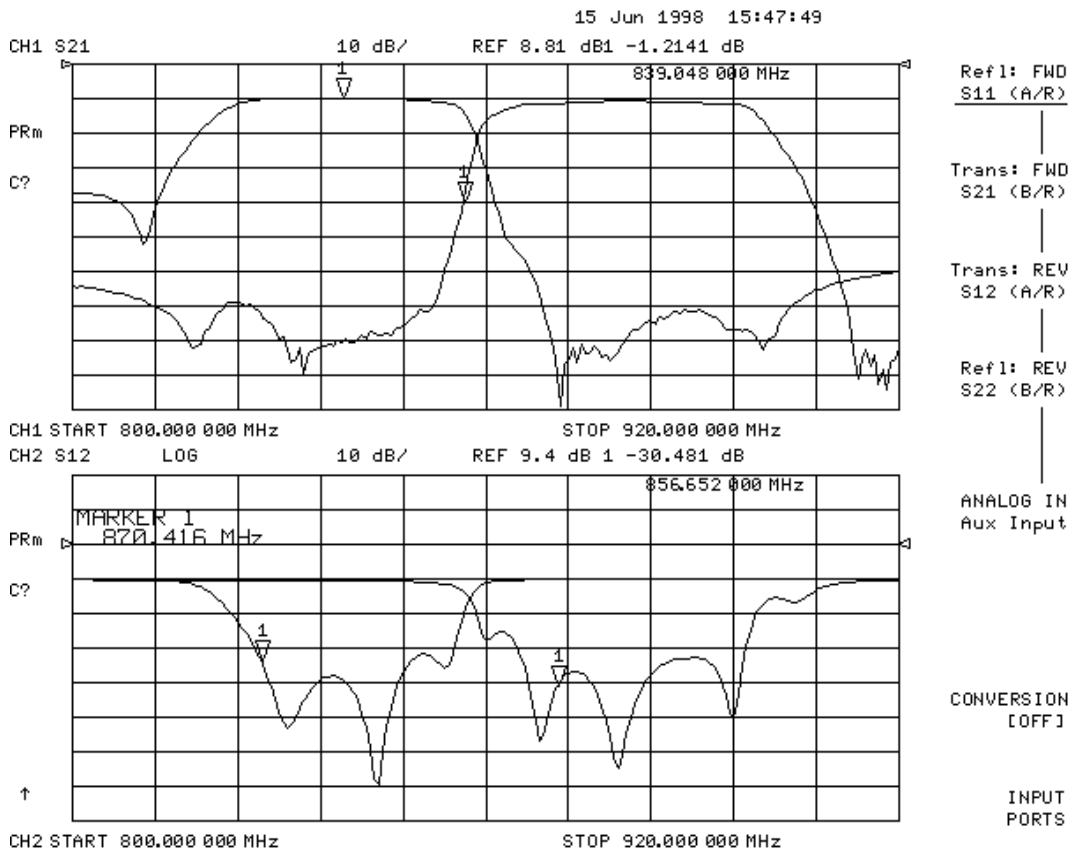
14. Set up a 2-graticule, 4-parameter display with Tx-Ant measurements on the top graticule and Ant Rx measurements on the bottom graticule:
 Press **[Display]**, **DUAL|QUAD SETUP**, then set **DUAL CHAN on OFF** to **ON**.

15. The display will be similar to [Figure 4](#).

Normally a 2-port calibration requires a forward and reverse sweep to complete before the displayed trace updates. For faster tuning, it is possible to set the number of sweeps for the active display (S_{11} and S_{21} for channel 1 in this case) to update more often than the unused parameters. In this example we choose 8 updates of the forward parameters to 1 update of the reverse in channel 1, and 8 updates of the reverse to 1 update of the forward in channel 2 (where the active parameters are S_{22} and S_{12}).

Press **[Chan 1]** **[System]** **CONFIGURE MENU** **TESTSET SW CONTINUOUS** **[8]** **[x1]**.
 Press **[Chan 2]** **[System]** **CONFIGURE MENU** **TESTSET SW CONTINUOUS** **[8]** **[x1]**.

Figure 4. Duplexer Measurement



Configuring Four-Parameter Display

Adjusting the Position of Displayed Channels

Once a multi-channel display has been created, the channels can be positioned using the **CHANNEL POSITION** softkey in the **Display** menu. The following example shows how to arrange the channels on your display.

1. Set up a four-channel display as described in **“Measurement Examples” on page -5**.
2. Press **Display** **DUAL | QUAD SETUP CHANNEL POSITION** . In the 4X column, $\begin{matrix} \underline{[1]} & [2] \\ [3] & \underline{[4]} \end{matrix}$ is selected (underlined).
3. Press $\begin{matrix} [1] & [3] \\ [2] & [4] \end{matrix}$ and notice that channels 2 and 3 exchange places on the screen.

You also have a choice of channel position in the 2X display mode. If $\begin{matrix} [1] & \& 2] \\ [3] & \& 4] \end{matrix}$ is selected, channels 1 and 2 will both be on the upper graticule. If $\begin{matrix} [1] & \& 3] \\ [2] & \& 4] \end{matrix}$ is selected, channels 1 and 3 will both be in the upper graticule and channels 2 and 4 will both be in the lower graticule.

Note that the number of channels appearing in 2X or 4X display mode is a function of the interaction between how many auxiliary channels are enabled, and the state of softkeys **DUAL CHAN on OFF** and **SPLIT DISPLAY 1X 2X 4X** . Refer to [Table 1](#) for a description of this interaction.

Adjusting the Display Colors

The colors of the auxiliary channels' elements may be changed in the **Display** menu. Press **Display** **MORE** **ADJUST DISPLAY** **MODIFY** **MORE** to change the colors of the auxiliary channels. Channel-specific display elements whose color may be modified are data, limit lines, and memory traces.

Once an auxiliary channel element has been selected for color modification, its tint, brightness, and color may be changed in the same way that a primary channel's display colors are changed. For example, pressing **CH3 DATA LIMIT LN** opens the “Color Adjust Menu” where you can adjust the display colors according to your preference.

[Table 5](#) lists the default auxiliary channel display trace colors.

Interaction between Display Softkeys

The interaction between softkeys **DUAL CHAN on OFF** , **AUX CHAN on OFF** , and **SPLIT DISP 1X 2X 4X** in the Display menu determines the number of displayed channels. [Table 1](#) describes the interaction between these softkeys. The **CHANNEL POSITION** softkey in the **Display** menu determines how the channels are displayed.

Table 1. Display Softkey Interaction



NUMBER OF GRIDS	SPLIT DISP	DUAL CHAN ON	AUX CHANNELS ON
1	1X	XX ¹	XX
	1X/2X/4X	Off	None
2	2X or 4X	Off	One or both
	2X	On	XX
3	4X	On	One
4	4X	On	Both

1. XX as an entry means that the value entered does not affect the number of grids displayed.

Markers

There are five markers available to each auxiliary channel and they can be configured similarly to the primary channel markers.

Normally, the markers are coupled. For example, moving marker 1 (using the front panel control knob) moves marker 1 on all displayed channels. To move a marker on a single channel, uncouple all markers by pressing **(Marker Fctn) MARKER MODE MENU**, and setting **MARKERS:COUPLED UNCOUPLED** to **UNCOUPLED**.

If you want to see the traces clearly but need to keep marker information displayed, press the backspace key  beneath the front panel control knob. This will hide the softkey menu and move the marker information into the softkey menu area. The softkey menu can be restored and the marker information moved back into the graticules by pressing  again, or any softkey or hardkey which brings up a menu.

[Figure 5](#). shows a four-parameter display with four markers on for all channels. After pressing the backspace key, the display appears as in [Figure 6](#).. Notice that the softkey menu is not visible and that the marker information for channels 2 and 4 has moved to the right side of the screen.

Rules Governing the Interaction between the Backspace Key, Markers, and the Softkey Menu

- The backspace key will not hide the softkey menu if an active entry is in progress, such as when you are entering a new stimulus value.
- Marker information will move into the softkey menu area only if there are two or more markers present in the right-half of the display.
- The softkey menu is restored when the backspace key or another hardkey or softkey which brings up a menu is pressed.

Figure 5. Marker Display Before Pressing the Backspace Key

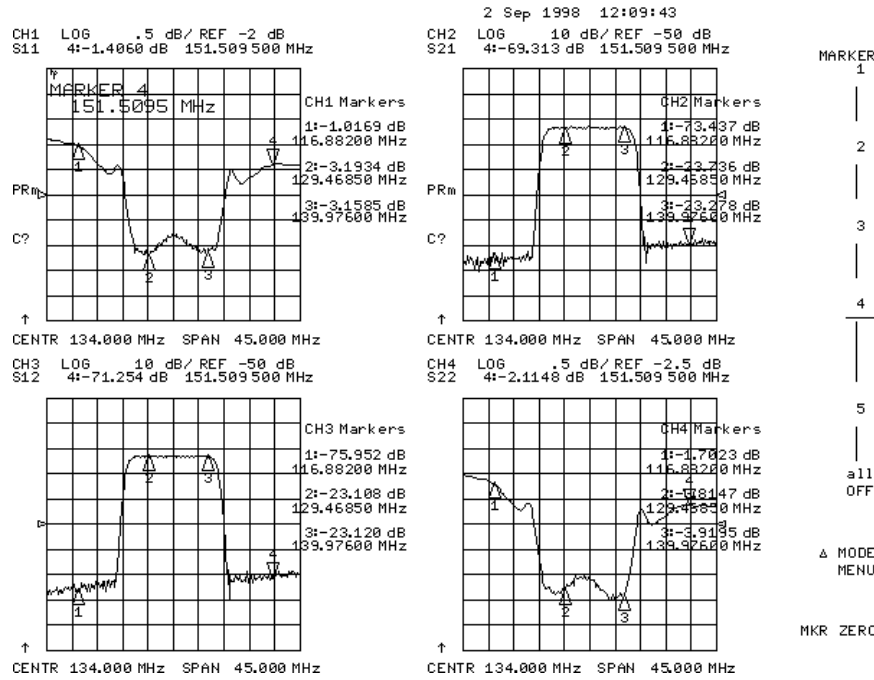
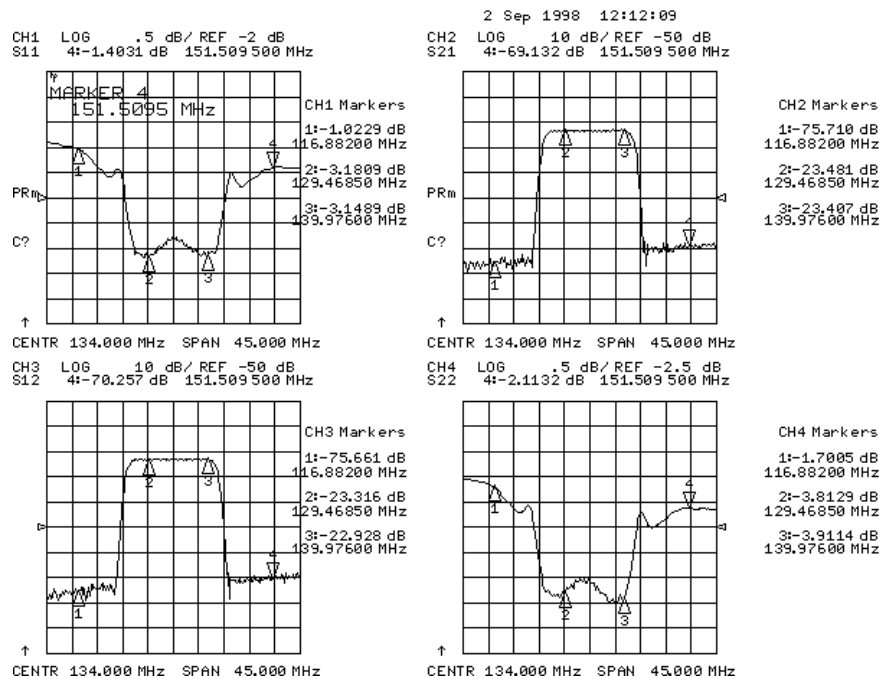


Figure 6. Marker Display After Pressing the Backspace Key



New Four-Parameter Display Features

This section describes the new features of the Four-Parameter Display firmware upgrade.

New Remote Commands

The four-parameter display upgrade adds new remote commands to configure the new display functions. Table 2 lists these new remote commands. Where a command has the same effect as a front-panel key, the key name is listed in the column “Equivalent Key.” These are new commands, and they do not change the commands of earlier versions of firmware.

Table 2. New Remote Commands

Mnemonic	OPC- Compatible	Action	Equivalent Key
AUXC	Yes	Enables and disables auxiliary channels.	AUX CHAN on OFF
CHAN 3	Yes	Makes channel 3 active.	CHAN 1
CHAN 4	Yes	Makes channel 4 active.	CHAN 2
COLOCH3D	No	Selects channel 3 data/limit line color.	CH3 DATA LIMIT
COLOCH3M	No	Selects channel 3 memory trace color.	CH3 MEM
COLOCH4D	No	Selects channel 4 data/limit line color.	CH4 DATA LIMIT
COLOCH4M	No	Selects channel 4 memory trace color.	CH4 MEM
COLOLREF	No	Selects the display reference line color	REF LINE
D2XUPCH3	No	Orients channels in 2-grid display with channel 3 on top.	2X: $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$
D2XUPCH2	No	Orients channels in 2-grid display with channel 2 on top.	2X: $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
D4XUPCH3	No	Orients channels in 4-grid display with channel 3 in upper right-hand quadrant of display.	4X: $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$
D4XUPCH2	No	Orients channels in 4-grid display with channel 2 in upper right-hand quadrant of display.	4X: $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
SPLID1	No	Displays all active channels in one full-size graticule.	SPLIT DISP 1X
SPLID2	No	Displays all active channels in two full-size graticules.	SPLIT DISP 2X
SPLID4	No	Displays each active channel in four separate graticules.	SPLIT DISP 4X
PCOLODATA3	No	Prints color for channel 3 data.	
PCOLODATA4	No	Prints color for channel 4 data.	

Mnemonic	OPC- Compatible	Action	Equivalent Key
PCOLOMEMO3	No	Prints color for channel 3 memory.	
PCOLOMEMO4	No	Prints color for channel 4 memory.	
PCOLOREFL	No	Prints color for the reference line.	

New Error Messages

The Four-Parameter Display firmware upgrade includes new error messages. They are shown below, along with a description of each new message.

❑ 2-PORT CAL REQUIRED FOR AUX CHANNEL USE

ERROR NUMBER 217

This message is displayed if you pressed **AUX CHAN on OFF** without a full 2-port calibration being active. Perform (or recall) a full 2-port calibration and set **CORRECTION on OFF** to **ON** in the Cal menu. Then you can enable an auxiliary channel by pressing **AUX CHAN on OFF** in the Display menu.

❑ CAUTION: AUX CHANNELS MEASURE S-PARAMETERS ONLY

ERROR NUMBER 216

This message is displayed if you attempt to select a non-S-parameter as the measurement type for an auxiliary channel.

❑ CAUTION: CORRECTION OFF: AUX CHANNEL(S) DISABLED

ERROR NUMBER 215

This message is displayed if you turn correction off while an auxiliary channel is enabled.

❑ CORRECTION ON: AUX CHANNEL(S) RESTORED

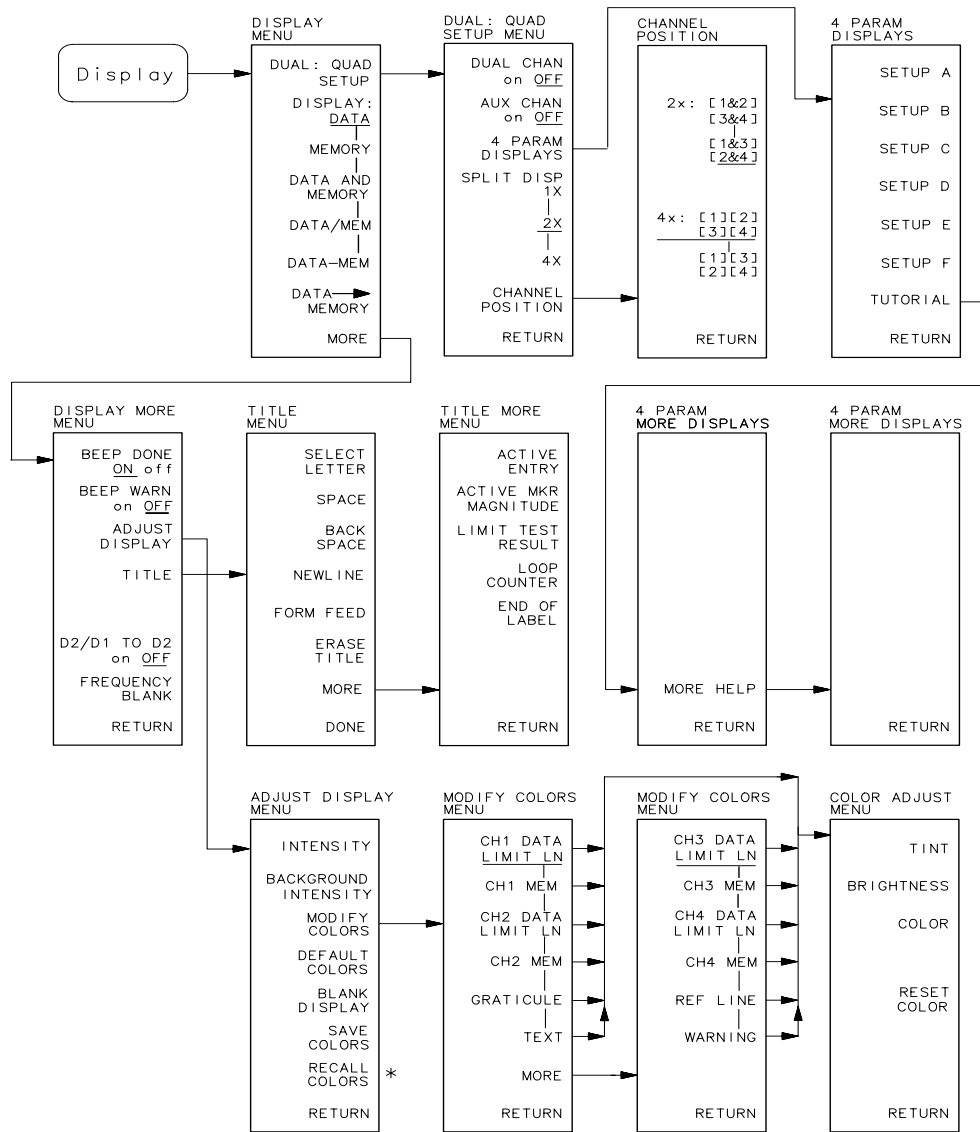
ERROR NUMBER 214

This message is displayed when a calibration is restored (from a recalled instrument state) and that instrument state had one or both auxiliary channel(s) enabled.

Display Menu Map

This menu map shows the new Display menu and sub-menus. The most significant change to the Display menu is the addition of the **DUAL | QUAD SETUP** sub-menu.

Figure 7. Display Menu Map



* APPEARS ONLY WHEN COLORS HAVE BEEN SAVED.

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Preset

Pressing **Preset** sets the new softkeys to the values shown in [Table 3](#). Where a softkey existed prior to the release of Four-Parameter Display firmware, but its preset value has changed as a result of this firmware upgrade, the softkey name is preceded by an asterisk.

Table 3. Preset Values of Softkeys

Softkey	Power On or Preset
AUX CHAN ON OFF	OFF
SPLIT DISP 1X 2X 4X	2X
CHANNEL POSITION	2X: [1 & 3] [2 & 4]
	4X: [1] [2] [3] [4]
Channel 3 (measurement/format)	S12/Log Magnitude
Channel 4 (measurement/format)	S22/Log Magnitude
CH 3 DATA LIMIT LN (display color)	Magenta
CH 4 DATA LIMIT LN (display color)	Green
CH 3 MEM (display color)	Magenta
CH 4 MEM (display color)	Green
REF LINE (display color)	White
GRATICULE (display color)	Grey
TEXT (display color)	White
CH3 DATA (print color)	Magenta
CH3 MEM (print color)	Green
CH4 DATA (print color)	Blue
CH4 MEM (print color)	Red
REF LINE (print color)	Black
*INTERPOL ON off	ON

Saving Measurement Data to Disk

This section describes the changes Four-Parameter Display firmware makes to data files saved to disk. For more information on saving data files to disk, refer to the chapters “Printing, Plotting, and Saving Measurement Results” and “Preset State and Memory Allocation” in your *User's Guide*.

ASCII Files

.P files: these are instrument state files which can be read by instruments with pre-7.40 firmware.

.W files: these are instrument state files which can be read by instruments with firmware version 7.40 and later.

If **FORMATTED DATA** is selected in **DEFINE DISK SAVE** , and one or both auxiliary channels are displayed, files with extensions .d3 and/or .d4 will be saved.

Binary Files

If **DATA ARRAY** is selected, and one or both auxiliary channels are displayed, files with extensions .d3 and/or .d4 will be saved.

If **FORMAT ARRAY** is selected and one or both auxiliary channels are displayed, files with extensions .f3 and/or .f4 are saved.

New Files

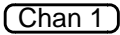
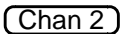

A file with a “P” suffix is saved to disk anytime an instrument state is saved to disk. This file can only be read by analyzers without Four-Parameter Display capability.

A file with a “W” suffix is saved to disk anytime an instrument state is saved to disk. This file can only be read by analyzers with Four-Parameter Display capability.

Softkey and Hardkey Functions

The new four-parameter display hardkey and softkey functions are described in [Table 4](#).

Table 4. New Hardkey and Softkey Functions

Key	Function
	Makes channel 1 or auxiliary channel 3 active.
	Makes channel 2 or auxiliary channel 4 active.
AUX CHAN on OFF	Enables and disables an auxiliary channel.
4 PARAM DISPLAYS	Describes the basic features of four-parameter display and provides quick setup keys.
SPLIT DISP 1X 2X 4X	Splits the screen into 1, 2, 3, or 4 separate grids.
CHANNEL POSITION	Orients the auxiliary channels below or adjacent to their primary channels.
 (backspace key)	Turns off the softkey menu and, if there is more than one marker in the right-half of the display, moves the marker information into the softkey menu area. Makes marker information and trace data easier to view.
CH3 DATA LIMIT LN	Selects channel 3 data and limit lines display for color modification.
CH3 MEM	Selects channel 3 display memory trace for color modification.
CH4 DATA LIMIT LN	Selects channel 4 data and limit lines display for color modification.
CH4 MEM	Selects channel 4 display memory trace for color modification.
REF LINE	Selects the display reference line for color modification.
GRATICULE	Selects the display graticule for color modification.
TEXT	Selects display text for color modification.
CH3 DATA [COLOR]	Selects Channel 3 print data for color modification.
CH3 MEM [COLOR]	Selects Channel 3 print memory for color modification.
CH4 DATA [COLOR]	Selects Channel 4 print data for color modification.
CH4 MEM [COLOR]	Selects Channel 4 print memory for color modification.
REF LINE [COLOR]	Selects the print reference line for color modification.

Display Colors

Table 5 lists the default values for the auxiliary channels display colors.

Table 5. Auxiliary Channel Default Display Colors

Display Element	Tint	Brightness	Color
Ch3 Data/Limit Line	85	100%	100%
Ch3 Memory	90	100%	100%
Ch4 Data Limit/Line	33	100%	100%
Ch4 Memory	45	100%	100%

Changes to Menu Maps

In the Save/Recall menu, **ISTATE UTILITIES** has been removed from the **FILE UTILITIES** sub-menu.

In the **Cal** menu, the default status of interpolated error-correction is now set to **ON**.

In the **CONFIGURATION** sub-menu of the **System** menu, softkey **USER SETTINGS** has been added. Pressing **USER SETTINGS** leads to **PRESET SETTINGS**, then to **CAL INTERP on OFF**. Pressing this key will cause the analyzer to power-up with interpolated error-correction turned off.

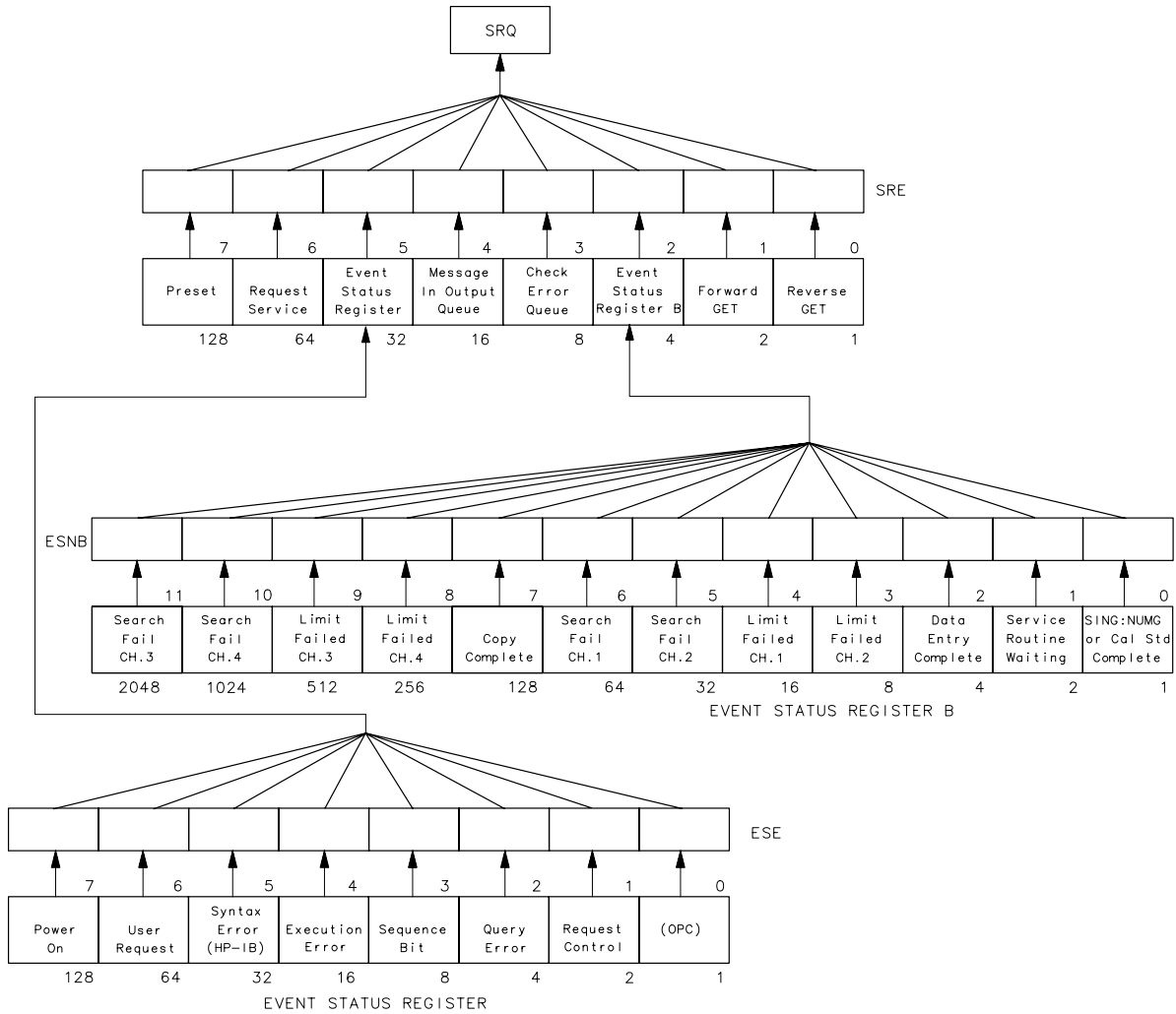
Changes to the Display

The symbols **C?** and **C2** have been changed to **CΔ**. The meaning is the same as the original notation as described in Chapter 1, "Description and Options" in your analyzer's *User's Guide*.

Status Reporting Structure

The status reporting structure of your analyzer has been changed to include extra bits associated with the auxiliary channels. Notice the addition of bits 8 through 11 to event status register B.

Figure 8. Status Reporting Structure



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