About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual is the best copy we could find; it may be incomplete or contain dated information. If we find a more recent copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available. You will find any other available product information on the Agilent Test & Measurement website, www.tm.agilent.com.

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. In other documentation, to reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product number/name was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

User's Guide

HP 71501A and

HP 70874A Eye Diagram Analyzer

HEWLETT PACKARD

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Warning	*Before this instrument is switched on*, 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.

Caution	*Before this instrument is switched on,* make sure its primary power circuitry has been adapted to the voltage of the ac power source. Failure to set the ac power input to the correct voltage could cause damage to the instrument when the ac power cable is plugged in.

Caution	Total input signal power to the HP 70820A module's front-panel RF INPUT connectors must not exceed +16 dBm. Because there is no RF input attenuator, power in excess of +16 dBm may damage the instrument. The largest measurable power level before signal compression is 0 dBm.

| **Caution**	The RF INPUT 1 and RF INPUT 2 circuits can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel RF INPUT connectors. Before connecting any coaxial cable to the connectors, momentarily short the center and outer conductors of the cable together. Avoid touching the front-panel RF INPUT connectors without first touching the frame of the instrument. Be sure that the eye diagram analyzer is properly earth-grounded to prevent buildup of static charge.

Eye Diagram Analysis with the HP 70874A

This introduction provides the basic concepts you'll need to know. It can be quickly browsed. The HP 71501A eye diagram analyzer performs automated eye diagram measurements including repeatable extinction ratio measurements.

The HP 71501A consists of the following:

- HP 70874A eye diagram analyzer personality.
- HP 70820A microwave transition analyzer module.
- HP 70004A color display/mainframe.

In addition, you'll need a pattern generator and clock source. The recommended models are the HP 70841A/B pattern generator and HP 70311A clock source. These are modular measurement system (MMS) modules that require an additional HP 70001A mainframe. The HP 70874A eye diagram analyzer personality is an Instrument BASIC program residing on a memory card. The HP 70874A requires an HP 70820A module with firmware revision 1.1 or greater.
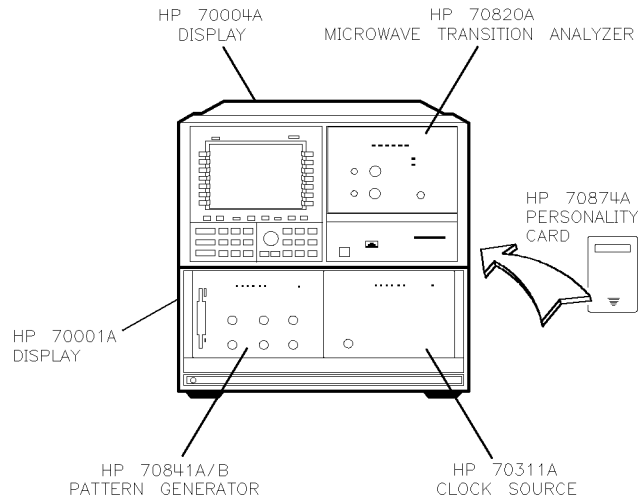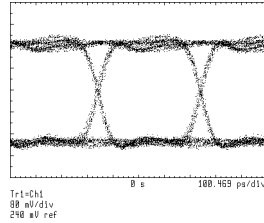
Select between eye, eyeline, and pattern modes

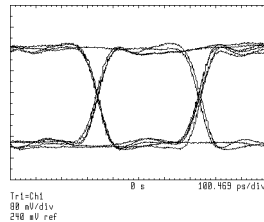The eye diagram analyzer can be operated in the following three modes:

■ *EYE MODE*: displays traces using individual dots in a manner that is similar to conventional sampling oscilloscopes.

Use this mode for:
  ◇ Typical eye diagram measurements.
  ◇ Extinction ratio measurements.

■ *EYELINE MODE*: displays continuous traces.

Use this mode to:

  ◇ Measure extinction ratio.
  ◇ Measure laser turn-on transition delay.
  ◇ Examine laser overshoot.
  ◇ Observe laser ringing.
  ◇ Apply eye-filter.
  ◇ Apply user corrections.

■ *PATTERN MODE*: displays the actual PRBS data stream bits.
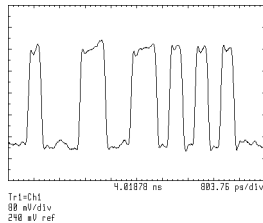
This mode uses the pattern trigger
which allows the display to show
the same portion of the data
stream from sweep to sweep.

Mask/limit lines provide pass/fail testing

Mask/limit lines are displayed geometric shapes that define the acceptable limits and shape of an eye diagram. The following figure shows a mask. Use masks for pass/fail testing and as an aid to error analysis. The eye diagram analyzer can capture and display the portion of the pattern that caused a mask violation. Built-in standard masks for the major SONET/SDH transmission rates are provided and can be applied with the press of a softkey. Or, you can create your own custom masks.
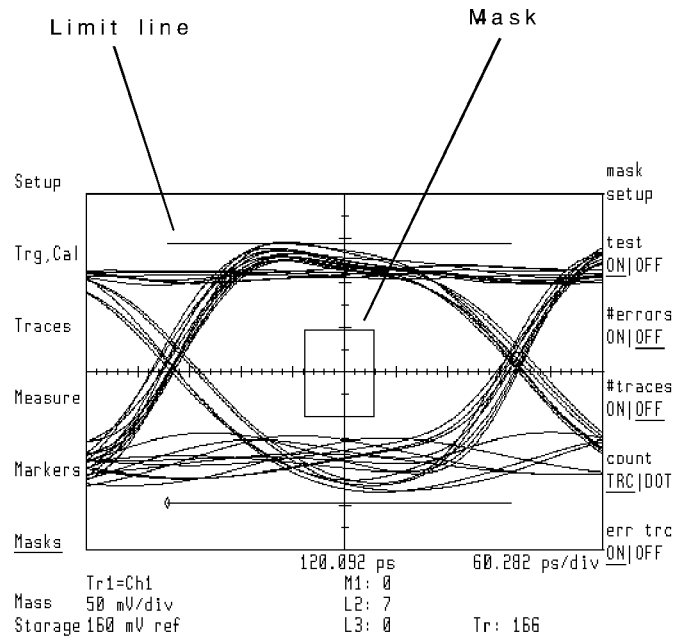
Apply software filters in eyeline mode

In eyeline mode, user frequency corrections can be applied to the data to simulate a hardware transmission filter. The eye diagram analyzer comes with several Bessel-Thomsom filters. These files are on the HP 70874A memory card. Refer to Chapters 2 and 7 for information on user corrections.

User Correction Files

File Name	File Data
a_bt248832	4th order Bessel-Thomsom filter for 2.48832 Gbit/sec transmission.
a_bt_62208	4th order Bessel-Thomsom filter for 622.08 Mbit/sec transmission.
a_bt_15552	4th order Bessel-Thomsom filter for 155.52 Mbit/sec transmission.

Control instrument menus from the front panel

Most front-panel controls are accessed via softkey menus. Softkeys are the seven buttons located on each side of the screen. The functions of softkeys change according to the menus displayed on the screen. Use the left-side softkeys to access the major menus. When the eye diagram analyzer first turns on, the Setup menu is selected.

Use the following three front-panel keys on the HP 70004A display to select the available softkey menus:

- (USER): press to select between the eye diagram analyzer and Instrument BASIC menus. (The HP 70874A eye diagram analyzer personality must first be loaded as described in Chapter 1.) To learn how to use Instrument BASIC, refer to the *HP 71500A and HP 70820A Instrument BASIC User's Guide*.

- (MENU): press to view menus for the HP 70820A microwave transition analyzer module. Refer to "Controlling an HP 70841A/B Pattern Generator" in Chapter 1 to learn how to view the pattern generator's menus.

- (DISPLAY): press to view the menus for the HP 70004A display.

pob2a

Setup · Trg,Cal · Traces · Measure · Markers · Masks · Mass Storage

diagram EYELINE · READ PAT GEN · CH2 1s: CLK OUT · BIT INTVL · DELAY · eyefltr ON|OFF · CLEAR DISPLAY

Tr1=Ch1
50 mV/div
100 mV ref
0 s   00.413 ps/div

(USER): **Eye diagram analyzer menus**

Control · Utility · Miscel · Disk · Print · Help

SCRATCH · SCRATCH ALL · SCRATCH COM · prev menu

```
10 ASSIGN @Mta TO 1000
20 CLEAR @Mta
30 OUTPUT @Mta;"SWE:TYPE FREQ"
40 OUTPUT @Mta;"SOUR:POW:STAT ON"
50
```

(USER): **Instrument BASIC menus**

Main · Trigger · Traces · Scale · Markers · Config

sweep: TIME · SEC/DIV · DELAY · PAT GEN setup · READ PAT GEN · noisflt ON|OFF

0 s   90 ps/div

page 1 of 2   more 1 of 2

(MENU): **HP 70820A module menus**

Main 7 · Hard Copy 6 · 5 · Mass Storage R 4 · Adjust Color O 3 · W 2 · Config Display 1 · Address Map 0 · Misc

DISPLAY PRESET · NEXT INSTR · REPORT ERRORS · INTEN ADJUST

70820A
MTA
HP-IB 11

9   10   11   12
COLUMN
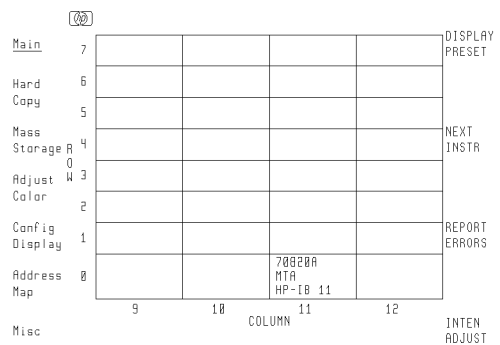
(DISPLAY): **HP 70004A display menus**

Right-side softkeys

When any of the left-side softkeys are pressed, lower-level softkey menu selections appear on the screen's right side. The display's active function area shows the value of any activated function. In the following figure, the `DELAY` function has been selected for change. Use the data-entry keypad or knob to enter a new value. Or, press a softkey to select another active function.
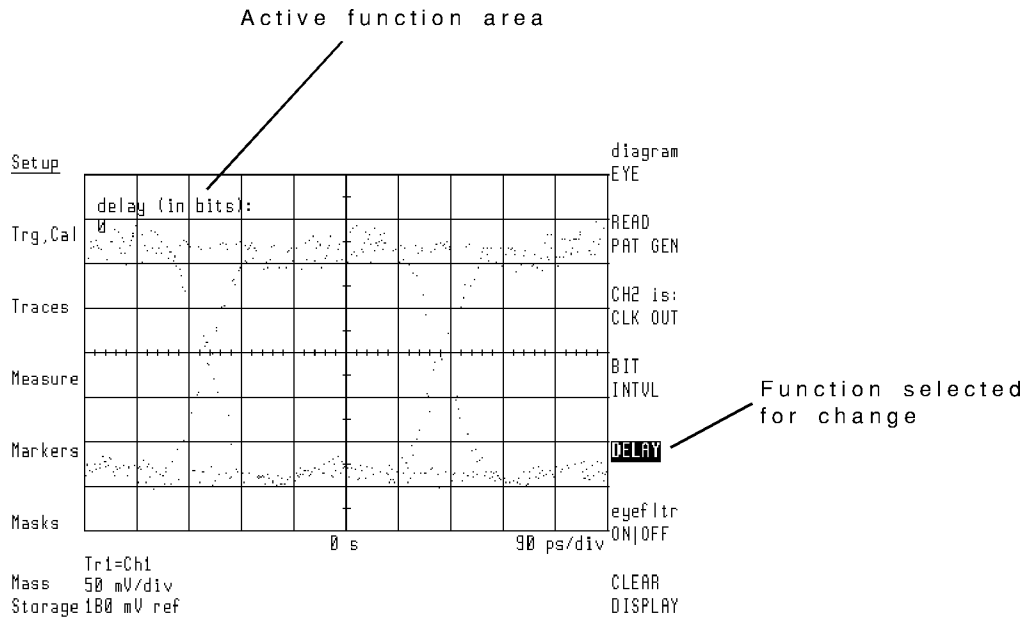
The eye diagram analyzer's Setup menu.

Pressing the [HOLD] key deactivates the active function. Pressing the [HOLD] key a second time blanks the right-side softkeys. Use the [←] (backspace) key to backspace over numbers entered using the data-entry keypad.

HOLD   DATA ENTRY KEYPAD
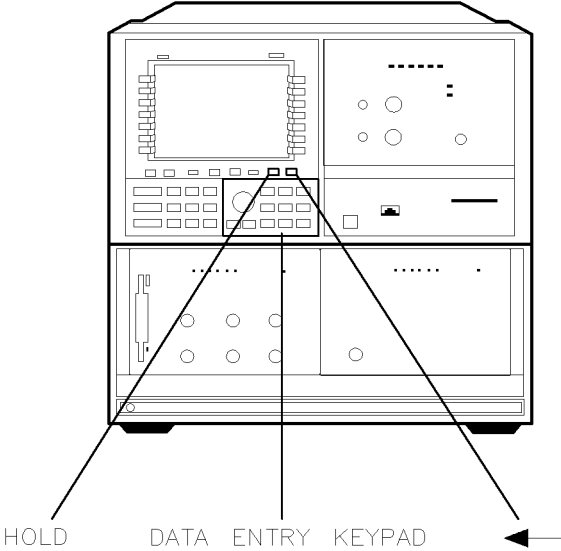
pob4a

Custom keypad

The eye diagram analyzer comes with a custom keypad that snaps into the front panel of HP 70004A displays. The keypad gives you quick access to common instrument functions. (Each of these functions can also be accessed using the normal softkey menus.)

If you have the custom keypad, practice using it. You'll find that the time required for many of the procedures in this book will be significantly reduced.

Caution   If you need to remove the custom keypad, do *not* pry it out. Simply push the tip of a small flat-blade screwdriver straight into the removal hole, and the keypad will pop out.

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pob3a

In This Book

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, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Regulatory Information

The specifications and characteristics chapter of the *HP 71500 Series Reference* contains regulatory information.

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This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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Contents

1

Getting Started

This chapter prepares the HP 71501A eye diagram analyzer for use. It should only take a few minutes for you to complete this installation.

Personality automatically loads from a memory card

Each time the eye diagram analyzer is turned on, the HP 70874A personality must be loaded into memory. This occurs automatically if the HP 70874A memory card is inserted in the front-panel card slot.

Self-guided screens make installation easy

Installing the eye diagram analyzer is easy due to a series of self-guided screens. Depending on the factory configuration of your system, one or more of these screens may not be displayed.

After connecting the equipment and loading the program, you'll need to respond to a series of screens from which to select the following:

■ The pattern generator used.

■ The source of the frequency reference.

Three configurations are possible

You can use your eye diagram analyzer in one of the following three configurations:

■ With HP Modular Measurement System (MMS) pattern generator and clock source modules. This is the preferred configuration.

■ With an HP MMS pattern generator module with a non HP MMS clock source module.

■ With non HP MMS pattern generator and clock source modules.

  If the eye diagram analyzer is configured with a non Hewlett-Packard pattern generator, you must manually set the trigger level. Refer to "Step 6. Manually set the trigger level" in this chapter.

Installing the Personality

Step 1. Connect the equipment

1. If you're using HP 70841A/B pattern generator and HP 70311A clock source modules with your eye diagram analyzer, install them into an MMS mainframe as shown in the following figure.
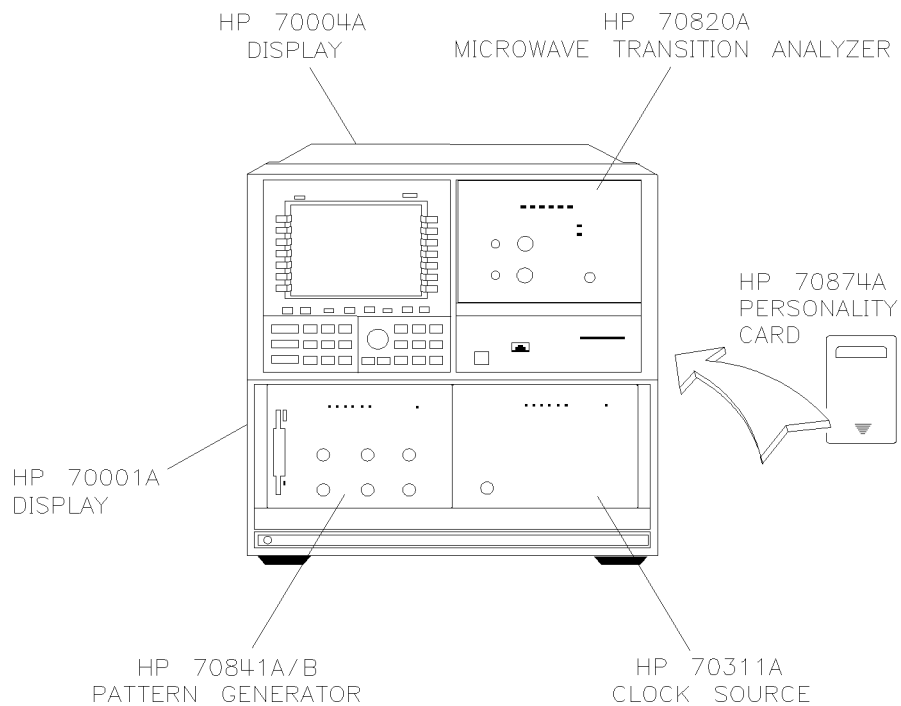
pob1a

2. Connect two HP-MSIB cables between the two mainframes as shown in the figure on this page.

3. Connect the frequency reference:

   ■ If you're using an HP 70311A clock source module, connect a cable between the HP 70820A's rear-panel 10 MHz REF OUTPUT connector and the HP 70311A clock source's EXT REF INPUT connector.

      Reference SMB to SMB cable .... HP p/n 8120-5025

   ■ If you're using a clock source other than an HP 70311A, make sure that the clock source and HP 70820A microwave transition analyzer module share the same frequency reference. Use the 10 MHz REF connectors on the rear panel of the HP 70820A.
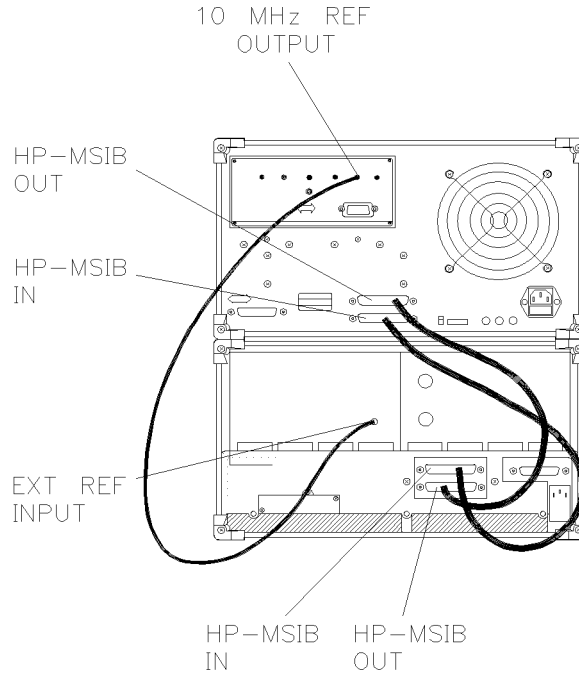
Required rear-panel cable connections

Step 2. Load the personality

1. Locate the HP 70874A eye diagram analyzer memory card.

2. Find the arrow printed on the card. Insert the card, with the arrow facing up, into the front-panel card slot. The arrow should match the arrow printed above the card slot.

3. Turn on both mainframes.

4. Wait for the system to complete its start-up routines and load the program. After a brief period of time, the display shows the message `Please wait ... Loading HP70874` at the bottom of the screen. Wait for the program to finish loading.

Note	Do not press any instrument keys until the program is loaded. Pressing keys can cause the automatic program loading to abort.

If the program doesn't load

The program has failed to load if one of the following occurs:

■ The message `Please wait ... Loading HP70874` never shows.

■ The left-side softkeys match those shown in the following figure.
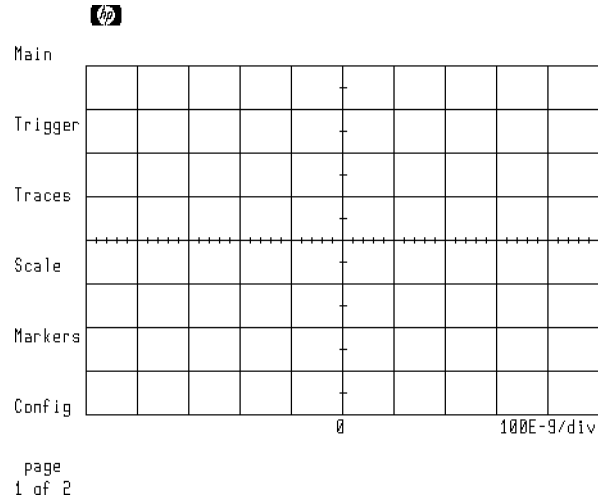
The HP 70820A module's main menu.

To remedy this situation, perform the following steps:

1. Press (DISPLAY) and then the left-side `Mass Storage` softkey.

2. Press `msi` and then `MEMORY CARD`.

3. Press (MENU) and then the left-side `page 1 of 2` and then `States` softkeys.

4. Press `more 1 of 2` and then `mass storage`.

5. Press `msi`, `HP-MSIB CARD`, and then `prev menu`.

6. Turn the front-panel knob to highlight the file "AUTOST." Then, press `LOAD FILE`.

```
Pulsgen                                                    msi:
                                                           HP-MSIB
        ┌──────┬──────┬──────┬──────┬──────┬──────┐
        │      │      │      │      │      │      │        PREV
Measure │      │      │      │      │      │      │        PAGE
        ┼──────┼──────┼──────┼──────┼──────┼──────┼
        │      │      │      │      │      │      │        NEXT
Table   │      │      │      │      │      │      │        PAGE
        │      │      │      │      │      │      │
        ├──────┴──────┴──────┴──────┴──────┴──────┤        LOAD
        │Prefix: ''                               │        FILE
Analyze │MSI: HP-MSIB,4          Page 1           │
        │                                         │
        │AUTOST     ASCII    1280                 │
        │a_bt248832 ASCII    1536                 │
Calib   │a_bt_62208 ASCII    1536                 │        save
        │a_bt_15552 ASCII    1536                 │
        │HP70874A   ASCII    112k                 │
States  │   (end of catalog)                      │        more
        │                                         │
        │                                         │
page    │                                         │        prev
2 of 2  └─────────────────────────────────────────┘        menu
```

Step 3. Follow the self-guided screens

■ If the displayed screen looks like the figure on the left side of this page, your system has been previously configured. Press `CONT` and then continue with "Step 4. Connect the front-panel cables". However, if you wish to reconfigure your system, press `RECNFIG`, and continue with the following explanation of the self-guided screens.

■ If the screen looks like the figure on the right side of this page, the first self-guided screen is displayed. Perform the following steps:

1. Press `HP7084X` if you are using an HP 70841A/B pattern generator. Otherwise, press `MANUAL`.

2. If you press `HP7084X`, the screen shown on the following page is displayed. The program automatically determines and displays the pattern generator module's HP-MSIB address. For most installations, press `CONT`. However, in rare cases where you want to manually enter the HP-MSIB address, use the displayed softkeys.

```
                                          RECNFIG


  ┼┼┼┼┼┼┼┼┼          ┼          ┼┼┼┼┼┼┼┼┼
                                          CONT

  The eye diagram analyzer is correctly
  configured with its pattern generator.
  If you would like to reconfigure your
  eye diagram analyzer system, press
  RECNFIG. Otherwise, press CONT.         EXIT
                                          PROGRAM
  Current source: HP7084X
```

Configuration previously done.

```
                                          HP7084X


  ┼┼┼┼┼┼┼┼┼          ┼          ┼┼┼┼┼┼┼┼┼
                                          MANUAL

  To configure the eye diagram analyzer
  with its pattern generator, please
  choose one of the following.

  HP7084X:  If you have an HP pattern
            generator, select this one.    EXIT
                                           PROGRAM
  MANUAL:   If you do not have an HP pattern
            generator, select this one.  You will
            be required to manually enter the clock
            frequency and the pattern length.
```

First self-guided screen.

```
                                          HP-MSIB
                                          ROW

                                          HP-MSIB
                                          COLUMN

  ┼┼┼┼┼┼┼┼┼┼┼┼┼┼┼┼┼          ┼┼┼┼┼┼┼┼┼┼┼┼┼
                                          CONT

  The address of the pattern generator must
  be selected unless it is slaved to an
  error detector. In that case, the address
  of the error detector must be selected.

  70841B,PATT GEN  at row 0 column 12      EXIT
                                           PROGRAM
  70841B,PATT GEN at row 0 col 12 selected.
  Press CONT to proceed if satisfied with the
  selection. Otherwise, manually enter the ROW
  and COLUMN address before pressing CONT.
                                           prev
                                           menu
```

3. Use the following self-guided screen to indicate the 10 MHz frequency reference used. Press `INTERNL` if the HP 70820A module is used as the reference. Press `EXTERNL` if the clock source is used as the reference.

```
                                                              INTERNL


                                                              EXTERNL



     The 10 MHz reference must be configured properly.
     Use INTERNAL for most system configurations. Refer
     to the configuration manual for more information.

     INTERNAL: Selects the HP70820A internal 10 MHz
               reference.  Connect the source 10 MHz
               input to the HP70820A 10 MHz output

     EXTERNAL: Selects the 10 MHz input to the
               HP70820A.  Connect the HP70820A 10 MHz
               input to the system 10 MHz reference.     EXIT
                                                         PROGRAM
```

Step 4. Connect the front-panel cables

1. The following screen should be displayed. Notice that the eye diagram analyzer's left-side Setup menu is selected.

```
Setup                                                      diagram
                                                           EYE

Trg,Cal                                                    READ
                                                           PAT GEN

Traces                                                     CH2 is:
                                                           CLK OUT

         Please use this setup procedure:                  BIT
Measure    - Connect the DATA OUT to Channel 1             INTVL
           - Connect the CLOCK OUT or TRIGGER OUT
             through a 6 dB pad to Channel 2
           - If the pad is not 6 dB, enter the value       DELAY
Markers      with CH2 EXT ATTEN (Trg,Cal menu)
           - Set CH2 is: to CLK OUT or TRG OUT (Setup menu)
           - Press READ PAT GEN  (Setup menu)
           - Press AUTOSCALE (Traces menu)                 eyefltr
Masks      - Use DEFINE USER IP to save this state as      ON|OFF
             the Instrument Preset state (Trg,Cal menu).

Mass                                                       CLEAR
Storage  Press Instrument Preset to exit this setup        DISPLAY
         —
```

2. Connect the front-panel cables as shown in the figure on the following page. Use an adapter between the cables and channel connectors. The data signal connects to the HP 70820A's **RF INPUT 1** connector. The trigger or clock signal connects to the HP 70820A's **RF INPUT 2** connector.

CHANNEL 1

CHANNEL 2

DATA OUT

CLOCK OUT

CLOCK
IN

CLOCK
OUT
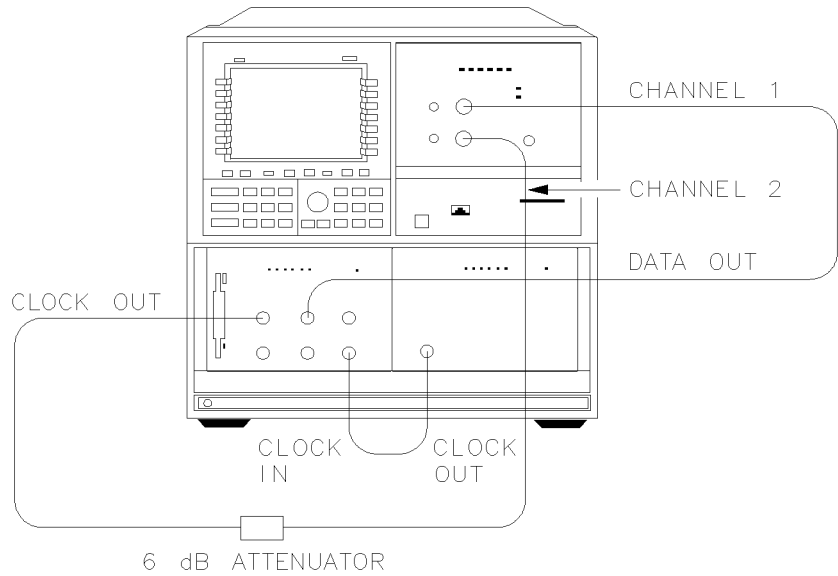
6 dB ATTENUATOR

pob5a

Cables:
   SMA to SMA (Channel 1) ....HP p/n 8120-4948
   SMA to SMA (Channel 2) ....HP p/n 8120-4948
   SMB to SMB (10 MHz Reference) ....HP p/n 8120-5025
Adapters:
   3.5mm (f) to 2.4mm (f) (two) ....HP p/n 1250-2277
6 dB attenuator ....HP 8493C
   Insert artwork here.

Required front-panel cable connections

3. If the attenuator connected to the HP 70820A's `RF INPUT 2` connector is not 6 dB, perform the following steps:

   a. Press the left-side `Trg,Cal` softkey.

   b. Press `CH2 EXT ATTEN`, and use the numeric keypad to enter the value of the pad.

Step 5. Enter trigger and data signal types

1. Press the left-side `Setup` softkey.

2. Press `CH2 is:`.

3. If the pattern generator's `CLOCK OUT` signal is connected to the `RF INPUT 2` connector, press `CLK OUT`. If the pattern generator's `TRIGGER OUT` signal is connected to the `RF INPUT 2` connector, press `TRG OUT`.

   Using the `CLOCK OUT` trigger signal provides faster data acquisition for eye diagrams. If the amplitude of the trigger signal is too large, an over-range message is displayed. Reduce the amplitude of the signal; use an external attenuator, and enter the value using `CH2 EXT ATTEN`.

4. If an HP 70841A/B pattern generator is used, press `READ PAT GEN`.

   The eye diagram analyzer reads the settings of the pattern generator.

5. If a non Hewlett-Packard pattern generator is used in place of an HP 70841A/B pattern generator, perform the following steps:

   a. Press `READ PAT GEN`.

   b. Press `CLOCK RATE`, and enter the rate of the clock signal.

   c. Press `CLOCK DIVISOR`, and enter the divisor for the clock signal.

      For example, when using a trigger or sync output, enter 16 if the clock signal is divided by 16.

   d. Press `PATTERN LENGTH`, and enter the pattern repetition length in bits or as the binary power depending on the position of the `2∧n-1 ON OFF` softkey. If the `2∧n-1 ON OFF` softkey is set to `ON`, binary powers are entered in the form $2^n - 1$. This makes it very easy to set the pattern length for PRBS sequences. When the `2∧n-1 ON OFF` softkey is set to `OFF`, the pattern length is entered directly in bits.

6. Press `PAT TRG FACTOR`, and enter the factor that relates how many repetitions of the pattern occur between trigger pulses.

   Frequently, 16 to 32 or more repetitions of the pattern occur between trigger pulses.

Note   When operating off a trigger or sync output with a divided clock frequency or a pattern trigger, be sure to set `CH2 is:` to `TRG OUT`.

---

7. Press `prev menu`.

8. If a clock source other than the HP 70311A is used, enter the precise clock frequency by pressing `CLOCK RATE`.

Step 6. Manually set the trigger level

If a non Hewlett-Packard pattern generator is used, you must perform the following steps to manually set the trigger level.

1. Press the left-side `Traces` softkey.

2. Press `prev menu`.

3. Press `select:` and then `TR2` to select trace two.

4. Press `display ON/OFF` until `ON` is underlined.

5. Press `AUTO-SCALE` to automatically scale the trigger trace.

6. Press the left-side `Trg,Cal` softkey.

7. Press `LEVEL`. Use the knob to position the trigger level indicator line so that it crosses an edge.

```
Setup                                                    SINGLE

        trigger:
Trg,Cal -290 mV                                          CONT |
                                                         STOP

Traces                                                   LEVEL

        Please use this setup procedure:
Measure   - Connect the DATA OUT to Channel 1            CH1 EXT
          - Connect the CLOCK OUT or TRIGGER OUT         ATTEN
            through a 6 dB pad to Channel 2
          - If the pad is not 6 dB, enter the value      CH2 EXT
Markers     with CH2 EXT ATTEN (Trg,Cal menu)            ATTEN
          - Set CH2 is: to CLK OUT or TRG OUT (Setup menu)
          - Press READ PAT GEN  (Setup menu)
Masks     - Press AUTOSCALE (Traces menu)                OFFSET
          - Use DEFINE USER IP to save this state as     CAL
            the Instrument Preset state (Trg,Cal menu).
Mass                                                     more
Storage Press Instrument Preset to exit this setup       1 of 2
```

8. Press the left-side `Traces` softkey.

9. Press `display ON|OFF` so that `OFF` is underlined.

10. Press `select:`, and then `TR1`.

Step 7. Set [INSTR PRESET]

1. Press the left-side `Traces` softkey to enter the Traces menu.

2. Press `AUTOSCALE`.

   This step automatically scales the screen to the displayed signal.

3. Press the left-side `Trg,Cal` softkey.

4. Press `more 1 of 2`, `DEFINE USER IP`, and then `CONT`.

   This step saves the current instrument state. This includes the pattern generator's HP-MSIB address, the frequency reference, scaling, and trigger level. Whenever [INSTR PRESET] is pressed, the eye diagram analyzer is automatically placed in these settings.

5. The eye diagram is now ready for use.

   Refer to "Controlling an HP 70841A/B Pattern Generator" in this chapter for information on controlling the pattern generator. Refer to Chapter 2 of this book for tutorials on operating the eye diagram analyzer.

Controlling an HP 70841A/B Pattern Generator

This section explains how to display the menus for the HP 70841A/B pattern generator. The display can be assigned to control either the eye diagram analyzer or the HP 70841A/B pattern generator.

1. Turn on the power for both mainframes. Wait until the start-up routines are completed and the mainframes are ready for key presses.

2. Press (DISPLAY), and then the right-side NEXT INSTR softkey.

   If several instruments are in the system, you may have to press NEXT INSTR several times.

3. If the HP 70841A/B's status screen, shown in the following figure, is not shown, the pattern generator is probably addressed as a slave instead of a master. Perform the following steps:

   a. Press the left-side Address Map softkey.

```
┌─────────┐                                        ┌─────────┐
│ T       │                                        │ MENU    │
select      HP 70841B PATTERN GENERATOR  (Status)    (0,15) POLRITY
pattern                    Data Normal                      NORMINV

edit                                                        DATA
usr-pat                  Pattern: PRBS 2^7-1               ECL
                  Trigger Pattern: 0000000
dat o/p                                                     DATA
err-add              Trigger Mode: CLOCK / 32              AMPLTD

trg o/p       Internal Clock Freq:  2,488,320,000 Hz        DATA
clk o/p                                                     HI-LEVL

                  Ampl      Hi-Lvl      Atten    Term      DAT O/P
misc        Data:  800.0 mV   0.000  V    0.0 dB    0 V    DELAY
            Clock: 500.0 mV   0.000  V    0.0 dB    0 V
            Data Output: ON,    Delay    0  s,   Optimize DATA  DAT O/P
                                                            ON  OFF

                                                            more
                                                            1 of 2
```

HP 70841A/B's status screen

   b. Use the front-panel knob to scroll the box to the column where the HP 70841A/B appears.

   c. Press ADJUST ROW, and rotate the knob to move the box to the row where the HP 70841A/B appears .

   d. Press ASSIGN BOTH .

4. Use the displayed softkey menus to set the pattern generator to the desired settings. For an example, refer to the paragraph "Configure the data signal" in "Preparing the Equipment" in Chapter 2.

5. Press (DISPLAY) and then NEXT INSTR to return control to the eye diagram analyzer.

6. Press (USER) to return to the eye diagram analyzer personality menus.

Manually Loading the Personality

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2` and then `mass storage`.

4. The display should show a listing of the files on the memory card.

```
Pulsgen                                                        msi:
                                                               HP-MSIB

Measure                                                        PREV
                                                               PAGE

Table                                                          NEXT
                                                               PAGE

        Prefix:''
        MSI: HP-MSIB,4          Page 1                         LOAD
Analyze                                                        FILE

        AUTOST       ASCII    1280
        a_bt24B832 ASCII    1536
Calib   a_bt_62208 ASCII    1536                               save
        a_bt_15552 ASCII    1536
        HP70874A    ASCII    112k
States       (end of catalog)                                 more

page                                                           prev
2 of 2                                                         menu
```

5. If the screen does not resemble the above figure, perform the following steps:

   a. Press `msi:`, `HP-MSIB CARD`, and then `prev menu`.

   b. Press `DISPLAY` and then the left-side `Mass Storage` softkey.

   c. Press `msi` and then `MEMORY CARD`.

   d. Press `MENU`. The list of files should now be displayed.

6. Turn the front-panel knob to highlight the file "AUTOST".

7. Press `LOAD FILE`.

   If you load the "HP70874" file by mistake, the message `7386 memory overflow` may be displayed. This error message is a result of the manual loading process and, in this instance, does not indicate a problem. The program still should be properly loaded.

2

Tutorials

This chapter contains nine tutorials that introduce important eye diagram analyzer features. The tutorials should be performed in the order listed. To create the data signal, you'll need a pseudo-random binary sequence (PRBS) pattern generator. Refer to "Preparing the Equipment" in this chapter before you start the tutorials.

Preparing the Equipment

Install the eye diagram analyzer and connect the pattern generator as explained in Chapter 1.
If you have access to a laser and an optical-to-electrical converter, use the connections shown
in the following figure. To protect the input connectors, use adapters between the cables and
the connectors. The laser is the device being tested.
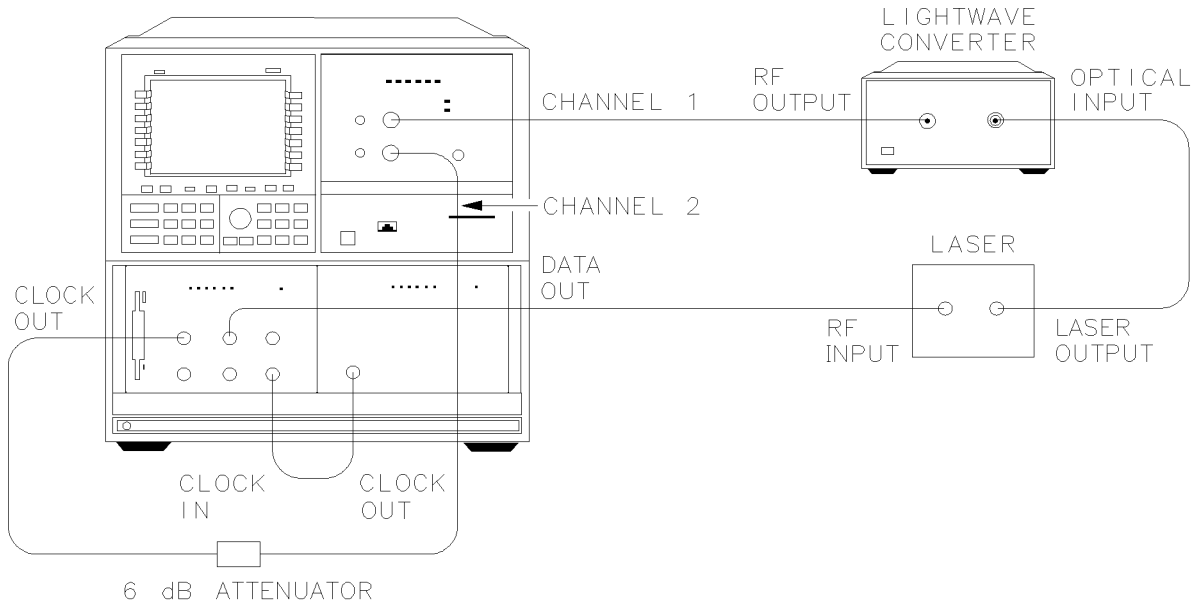
pob7a

Cables:
  SMA to SMA (Channel 1) ....HP p/n 8120-4948
  SMA to SMA (Channel 2) ....HP p/n 8120-4948
  SMB to SMB (10 MHz Reference) ....HP p/n 8120-5025
Adapters:
  3.5 mm (f) to 2.4 mm (f) (two) ....HP p/n 1250-2277
6 dB attenuator ....HP 8493C

Connections without a laser source and converter

If a laser source and optical-to-electrical converter are not available, use the alternate connection shown in the following figure. In this case, the pattern generator's data output is displayed. An electrical device could be inserted between the pattern generator and the eye diagram analyzer.
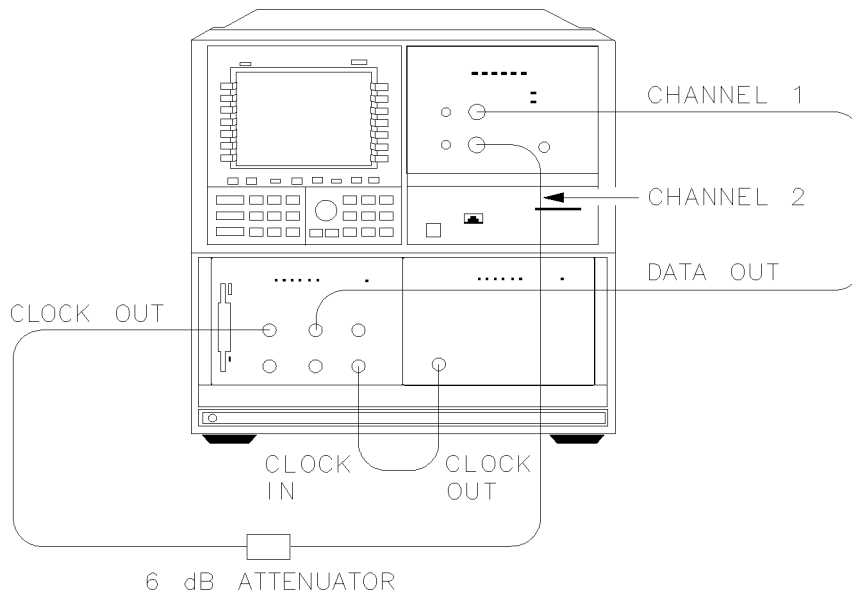
pob5a

Configure the data signal

The following list shows typical settings that can be used for the data signal. The list assumes you are using an HP 70841A/B pattern generator. The exact settings depend upon the system you are using. If the system includes an HP 70841A/B pattern generator, use the pattern generator's status screen to enter these values. The procedure for viewing the status screen is explained in "Controlling an HP 70841A/B Pattern Generator" in Chapter 1.

In the `select pattern` menu:

Pattern: .... PRBS 2^7-1

In the `dat o/p err-add` menu:

Data Ampl: .... typically 800 mV to 2 V (depending on laser)
Data Hi-Lvl: .... 0 V (depending on laser)

In the `trg o/p clk o/p` menu:

Clock Freq: .... 2.48832 GHz
Clock Ampl: .... 500 mV
Clock Hi-Lvl: .... 0 V

If you're performing these tutorials without the laser source and optical-to-electrical converter, reduce the level of the data signal as shown in the following settings:

Data Ampl .... 250 mV
Data Hi-Lvl .... 300 mV

Triggering non Hewlett-Packard pattern generators

If a non Hewlett Packard pattern generator is used, you must perform the following steps to manually set the trigger level.

1. Press the left-side `Traces` softkey in the eye diagram analyzer menus.

2. Press `select:` , and then `TR2` to select trace two.

3. Press `display ON|OFF` until `ON` is underlined.

4. Press `AUTO-SCALE` to automatically scale the trigger trace.

5. Press the left-side `Trg,Cal` softkey.

6. Press `LEVEL` , and use the knob to position the trigger level indicator line so that it crosses an edge.

7. Press the left-side `Traces` softkey.

8. Press `display ON|OFF` so that `OFF` is underlined.

9. Press `select:` , and then `TR1` .

Tutorial 1:
Setting the Instrument Preset

Note   The settings invoked by the (INSTR PRESET) key can be customized. This allows you to reset the eye diagram analyzer to your own user-defined settings.

1. Press the left-side `Setup` menu.

2. Press `diagram` and then `EYE`.

3. Press `CH2 is:` and then `CLK OUT`.

4. Press `BIT INTVL`, and enter 2.5 bits.

5. Press the left-side `Traces` softkey to enter the Traces menu.

6. Press `AUTOSCALE`.

   This step automatically scales the screen to the displayed signal.

7. Press the left-side `Trg,Cal` softkey.

8. Press `more 1 of 2`, `DEFINE USER IP`, and then `CONT`.

   The (INSTR PRESET) key is now configured with the following settings:
   ■ current instrument state.
   ■ default eye diagram analyzer mode.
   ■ pattern generator's HP-MSIB address.
   ■ frequency reference.
   ■ scaling.
   ■ trigger level.

   Whenever (INSTR PRESET) is pressed, the eye diagram analyzer automatically returns to these settings.

Tutorial 2:
Measuring Eye Parameters

Note   The eye diagram analyzer performs automatic eye measurements in eye mode. This mode is similar to that of conventional sampling oscilloscopes; the display shows individual dots on the screen.

compatible modes:
for eye parameters measurements .... eye
for extinction ratio measurements .... eye and eyeline

**View the signal**

1. Press (INSTR PRESET).

2. Press the left-side `Traces` softkey.

3. Press `persist` and then `VARIABL`.

   This turns the persistence mode on. Refer to Chapter 3 for an explanation of the available persistence modes.

4. Press `PERSIST SWEEPS`, and enter 8.

5. Press `prev menu`.

6. Press AUTO-SCALE. The display should look similar to the display of a sampling oscilloscope. See the following figure.

The large overshoot shown is a result of the particular laser bias setting used. If the edges of the waveform are unstable in time (indicating no trigger), refer to the "Triggering non Hewlett-Packard pattern generators" paragraph in "Preparing the Equipment" in this chapter.
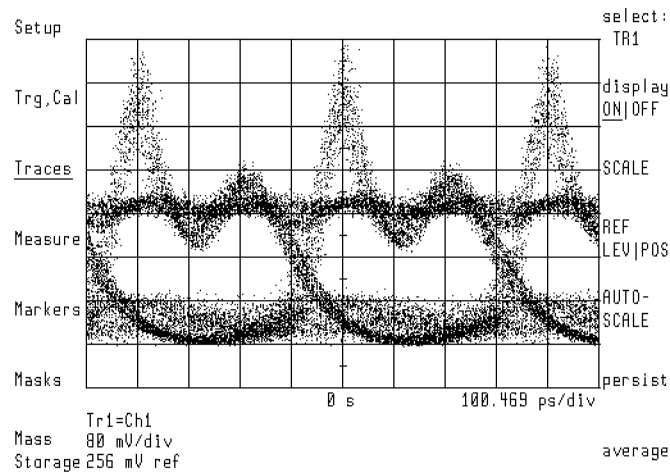
Display using a 1300 nm DFB laser.

Perform an offset calibration

This calibration procedure removes any offset that may be present in the optical-to-electrical converter. This is sometimes referred to as the "dark" level. The offset calibration ensures accurate measurements of the lasers's one and zero levels.

7. Turn the laser off. (If you're measuring the pattern generator directly, disconnect the input signal at channel 1.)

8. Press the left-side Trg,Cal softkey.

9. Press OFFSET CAL, and then CONT.

The calibration takes about a minute to execute. When the calibration is finished, DC NULL: done is displayed.

10. Turn the laser on. (If you're measuring the pattern generator directly, reconnect the input signal at channel 1.)

Measure signal parameters

11. Press the left-side Measure softkey.

12. Press r/f tim ON OFF so that ON is underlined.

This causes the rise and fall time measurement to be included in the displayed results. Enabling this function approximately doubles the measurement time.

13. Press MEASURE EYE . After a brief period of time, the display should look like the
    following figure. Refer to Chapter 3 for definitions of each measurement listed on the
    screen.
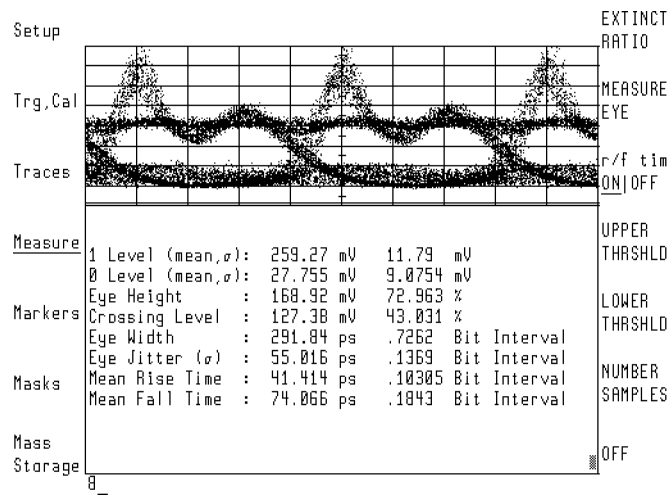
Eye measurements.

Measure extinction ratio

14. Press EXTINCT RATIO to measure the extinction ratio. The results are added to the displayed list of measurement results.

Extinction ratio measurement results →

```
Setup                                                    EXTINCT
                                                         RATIO

Trg,Cal                                                  MEASURE
                                                         EYE

Traces                                                   r/f tim
                                                         ON|OFF

Measure  Extinction Ratio:    5.644        7.516 dB      UPPER
         1 Level (mean,σ):  259.27 mV     11.79  mV      THRSHLD
         0 Level (mean,σ):   27.755 mV     9.0754 mV
         Eye Height       :  168.92 mV     72.963 %      LOWER
Markers  Crossing Level   :  127.38 mV     43.031 %      THRSHLD
         Eye Width        :  291.84 ps     .7262  Bit Interval
         Eye Jitter (σ)   :   55.016 ps    .1369  Bit Interval
Masks    Mean Rise Time   :   41.414 ps    .10305 Bit Interval   NUMBER
         Mean Fall Time   :   74.066 ps    .1843  Bit Interval   SAMPLES

Mass
Storage                                                  OFF
         8_
```
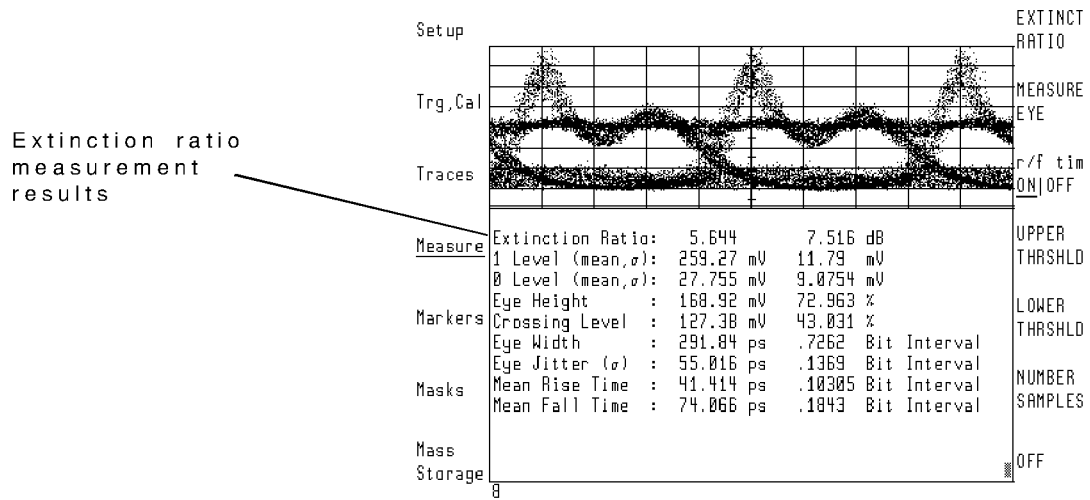
Extinction ratio measurement.

15. Use the NUMBER SAMPLES softkey to change the amount of data used for the histograms.

A larger value gives more accuracy, at the expense of a increased data acquisition time.

When making extinction ratio measurements in eyeline mode, the number of samples should be increased from the default of 1000 to something on the order of 20000 to insure a number of traces are evaluated to compute the extinction ratio.

16. Press OFF to clear the measured data from the screen.

Tutorial 3:
Measuring in Optical Power Units

Note   The display has the ability to show optical units referenced to the input of the optical-to-electrical converter. This changes the channel and marker readouts to watts/div.

        compatible modes ....eye, eyeline, and pattern

1. Press `INSTR PRESET`.

2. Press the left-side `Trg,Cal` softkey.

3. Press `CH1 EXT ATTEN`, and use the numeric keypad to enter the appropriate responsivity value in V/Watt. (For example, the following figure shows 350 V/Watt entered.

   Notice that the softkey label changes to `CH1 RSPVTY` (responsivity).
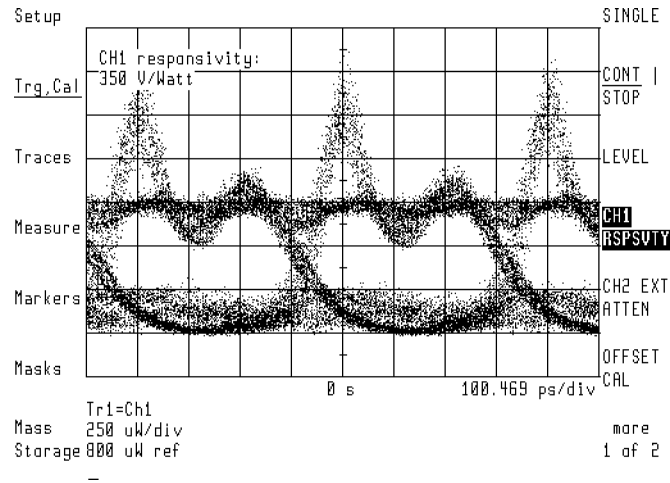
4. To use the markers to read optical power, press `Markers` and then `Y1 (--)`.

5. Adjust the marker line to the peak of the response. For example, the following figure shows a peak optical power of 1.5 mW.

Setup   Y1= 1.5 mW

Y1 adjust:
Trg,Cal   1.5 mW

Traces

Measure

Markers

Masks

Tr1=Ch1
Mass   250 uW/div
Storage 800 uW ref

X1 (|)
(off)

X2 (|)
(off)

Y1 (--)
TR1

Y2 (--)
(off)

MARKERS
OFF

0 s   100.469 ps/div
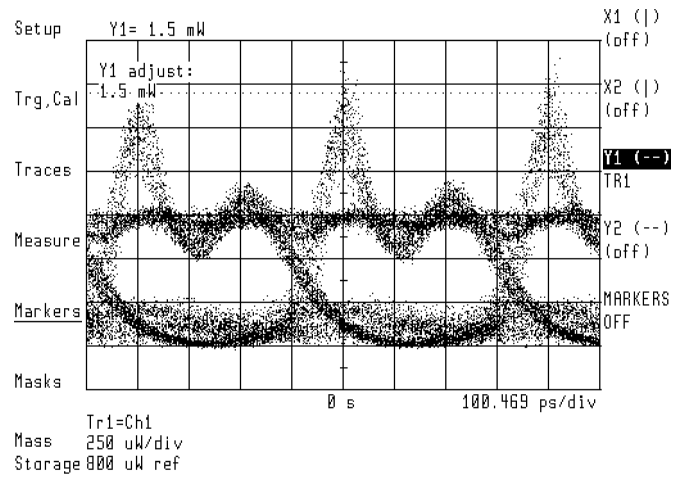
Tutorial 4:
Measuring Extinction Ratios on Low-level Signals

Note   Repeatable extinction ratio measurements can be made on low-level signals. This is accomplished by applying a filter to the signal. This filter improves measurement sensitivity and is useful for analyzing:

- low-level extinction ratios.

- pattern dependent transitions.

- intersymbol interference.

The eye diagram analyzer is placed in eyeline mode so that the eye filter can be applied to reduce trace noise. To measure the signal, a photodiode converter with a responsivity of 30 volts/watt is used.

When making extinction ratio measurements in eyeline mode, the number of samples should be increased from the default of 1000 to something on the order of 20000. This insures a number of traces are evaluated to compute the extinction ratio.

    compatible modes .... eyeline

Change to eyeline mode

1. Press INSTR PRESET.

2. Press the left-side `Setup` softkey.

3. Press `diagram` and then `EYELINE`.

4. Press the left-side `Traces` softkey.

5. Press `persist` and then `VARIABL`.

6. Press `PERSIST SWEEPS`, and enter a value of 5.

7. Then press `prev menu`.

8. Press the left-side `Trg,Cal` softkey and then `more 1 of 2`.

9. Press the left-side `Traces` softkey.

10. Press `AUTO-SCALE`. The display should look like the following figure.

   A low-amplitude response similar to that shown in this figure can result when using non-amplified lightwave converters to measure optical signals.
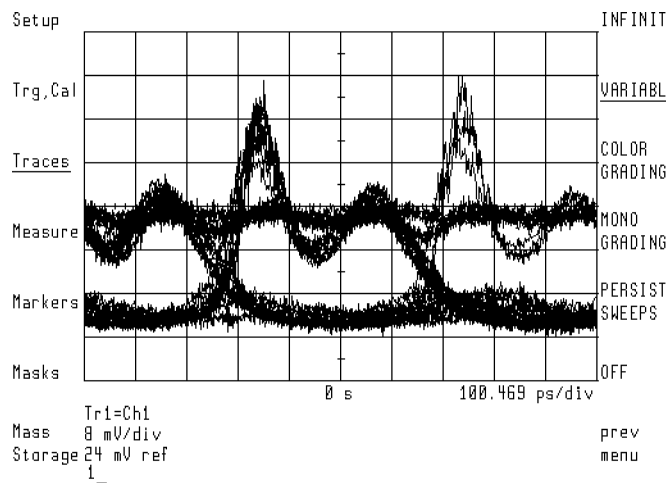
Autoscaled display of low level signal.

11. Press the left-side `Setup` softkey.

12. Press `eyefltr ON OFF` until `ON` is underlined.

Perform an offset calibration

This calibration procedure removes any offset that may be present in the optical-to-electrical converter. This is sometimes referred to as the "dark" level. The offset calibration This ensures accurate measurements of the lasers's level.

13. Turn the laser off. (If you're measuring the pattern generator directly, disconnect the input signal at channel 1.)

14. Press the left-side `Trg,Cal` softkey.

15. Press `OFFSET CAL`, and then `CONT`.

    The calibration takes about a minute to execute. When the calibration is finished, `DC NULL: done` is displayed.

16. Turn the laser on. (If you're measuring the pattern generator directly, reconnect the input signal at channel 1.)

Measure the extinction ratio

17. Press the left-side `Measure` softkey.

18. Press `NUMBER SAMPLES`, and enter a value of 20,000.

19. Press `EXTINCT RATIO` to perform an extinction ratio measurement. See the figure on the following page.
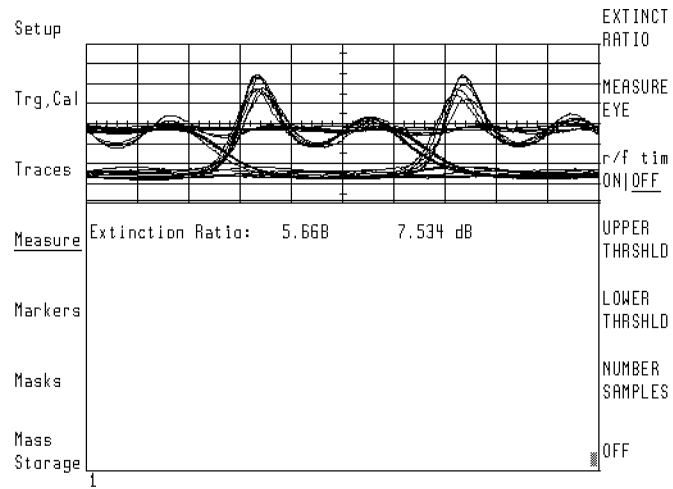
Extinction ratio measurement on a low-level signal with eye filtering on.

Display the signal in optical units

20. Press the left-side `Trg,Cal` softkey, and then press `CH1 EXT ATTEN`.

21. Enter a value of 30 V/Watt.

Tutorial 5:
Measuring Laser Turn-on Delay

| **Note**	On-screen markers can be used to measure both amplitude and time separation in eye diagrams.
	compatible modes for markers .... eye, eyeline, and pattern

Change to eyeline mode

1. Press `INSTR PRESET`.

2. Press left side `Setup` softkey, `diagram`, and then `EYELINE`.

3. Press `eyefltr ON OFF` so that `ON` is underlined.

4. Press `BIT INTVL`, and enter a bit interval value of 1.

5. Press the left-side `Traces` softkey.

6. Press `persist` and then `INFINIT`.

7. Press the left-side `Trg,Cal` softkey.

8. After several traces have been displayed, press the `CONT STOP` softkey so that `STOP` is underlined.

Turn on the markers

9. Press `X1` and `X2` to activate markers 1 and 2.

10. Turn the front-panel knob to move the markers to different transition crossing points on the waveform as show in the following figure.

    This provides a easy method to check the peak-to-peak difference in the laser turn-on time measured at the crossing point. Notice in the following figure a delta reading of 30 ps is displayed at the top of the screen.
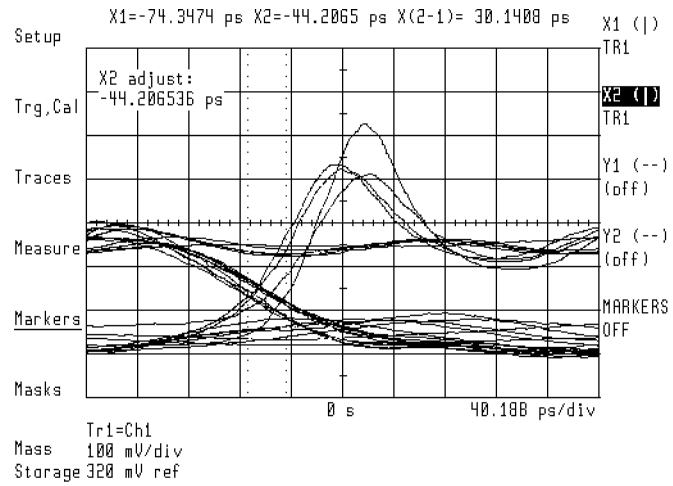
Laser overshoot and turn-on delay.

Tutorial 6:
Using Software Filters

Note   This tutorial enables a software filter. The filter is designed with user frequency corrections. User frequency corrections can be used for:

- Removing the effects of frequency response roll-off due to the optical-to-electrical converter and cables.

- Simulating hardware filters recommended for laser transmitter evaluation, such as 4th-order Bessel-Thomson filters.

The eye diagram analyzer must be in eyeline mode to apply user corrections. In eyeline mode, each sweep produces a continuous trace with the points connected. (This is opposed to unconnected dots with the eye mode.) Eyeline mode is especially useful for measuring variations in laser turn-on delay, overshoot, and ringing and for applying user frequency corrections.
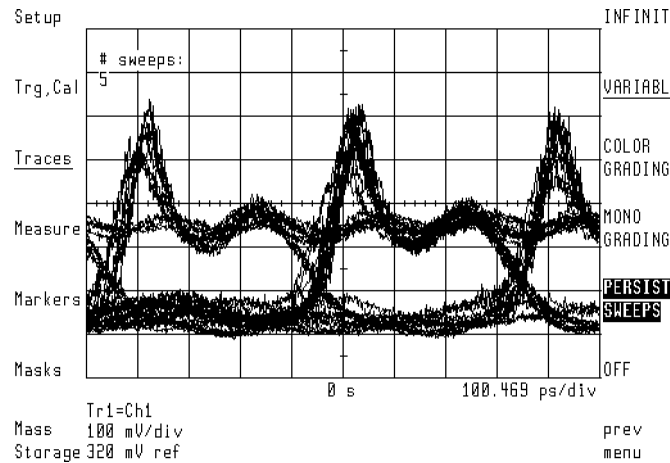
compatible modes .... eyeline

Change to eyeline mode

1. Press (INSTR PRESET).

2. Press the left-side `Traces` softkey.

3. Press `persist`.

4. Press `VARIABL`, and enter a value of 5.

5. Press `diagram` and then `EYELINE`.

   Notice that the level of the laser overshoot, and the turn-on delay, varies from sweep to sweep, dependent on the previous pattern of ones and zeros.

```
Setup                                              INFINIT
       # sweeps:
       5
Trg,Cal                                            VARIABL

                                                   COLOR
Traces                                             GRADING

                                                   MONO
Measure                                            GRADING

Markers                                            PERSIST
                                                   SWEEPS

Masks                                              OFF
                 0 s           100.469 ps/div
       Tr1=Ch1
Mass   100 mV/div                                  prev
Storage 320 mV ref                                 menu
```

Eyeline display showing laser overshoot.

Load the software filter

6. Place the HP 70874A memory card in the front-panel card slot.

7. Press the left-side `Mass Storage` softkey.

   This brings up a catalog of files present on the card.

8. Turn the front-panel knob to highlight the file "a_bt248832".

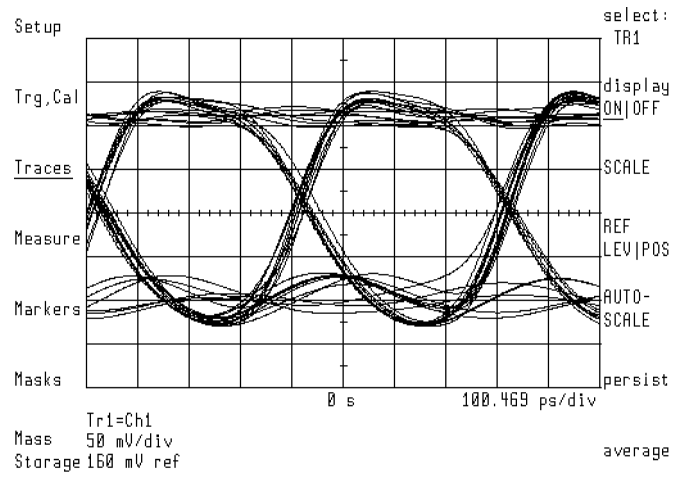9. Press `LOAD FILE` to load the file into user corrections.

   This file simulates a 4th-order Bessel-Thomson filter with a cutoff at three-quarters of the bit rate. This allows you to observe the laser transmitter signal in a specified bandwidth. This software filter is equivalent to using a hardware filter except that trace noise may be suppressed more.

10. Press the left-side `Trg,Cal` softkey.

11. Press `more 1 of 2` and then `usr cor ON OFF` until `ON` is underlined.

    This applies the filter data to the traces.

12. Press the left-side `Traces` softkey.

13. Press `AUTO-SCALE`. The display should look like the following figure.

    Notice that the laser overshoot is no longer visible, due to the filtering effect of the user corrections in the HP 71501A.

Setup

Trg,Cal

Traces

Measure

Markers

Masks

Mass
Storage

select:
TR1

display
ON|OFF

SCALE

REF
LEV|POS

AUTO-
SCALE

persist

average

0 s   100.469 ps/div

Tr1=Ch1
50 mV/div
160 mV ref

Filtered laser overshoot.

Tutorial 7:
Testing to Industry Standards

Note   Masks allow you to test eye diagrams against industry standards. The eye
diagram analyzer provides built-in masks for testing the major SONET/SDH
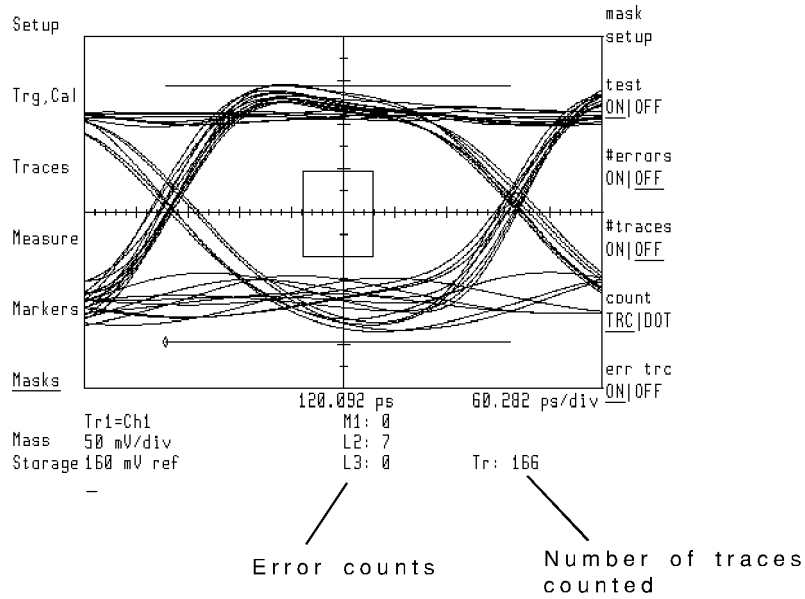transmission rates. Shown in this tutorial is the ability to:

- Count mask errors.

- Allow for specified amount of margin testing.

- Stop after a specified number of trace errors.

- Show the violation trace (eyeline mode only).

      compatible modes .... eye and eyeline

Select the mask

 1. Press `INSTR PRESET`.

 2. You can use your own hardware filter during this tutorial, or load a software filter as
    described in the previous tutorial.

 3. Press the left-side `Setup` softkey.

 4. Press `BIT INTVL`, and enter a value of 1.5.

 5. Press `DELAY`, and adjust the delay to center the eye.

 6. Press the left-side `Masks` softkey.

 7. Press `mask setup`, `default masks`, and then `STM-16 OC-48`. The display shows an
    unscaled rectangle mask.

 8. Press `MASK ALIGN` to align the mask. Wait for the displayd `# samp` count to reach 100%.

    This step aligns the mask to the data using automatic scaling. Notice that, for the
    purposes of clarity, the graticule is turned off. This was done using the HP 70820A
    `Config` menu.

```
Setup                                    mask
                                         setup

Trg,Cal                                  test
                                         ON|OFF

Traces                                   #errors
                                         ON|OFF

Measure                                  #traces
                                         ON|OFF

Markers                                  count
                                         TRC|DOT

Masks                                    err trc
                                         ON|OFF
           120.092 ps      60.282 ps/div
        Tr1=Ch1            M1: 0
Mass    50 mV/div          L2: 7
Storage 160 mV ref         L3: 0      Tr: 166


        Error counts          Number of traces
                              counted
```

Turn mask testing on

9. Press the left-side `Masks` softkey.

10. Press `test ON OFF` so that `ON` is underlined.

   This resets the error counters. Errors for the standard specifications show up beside the M1 screen annotation for mask violations, and beside L2 and L3 for upper and lower limit violations respectively.
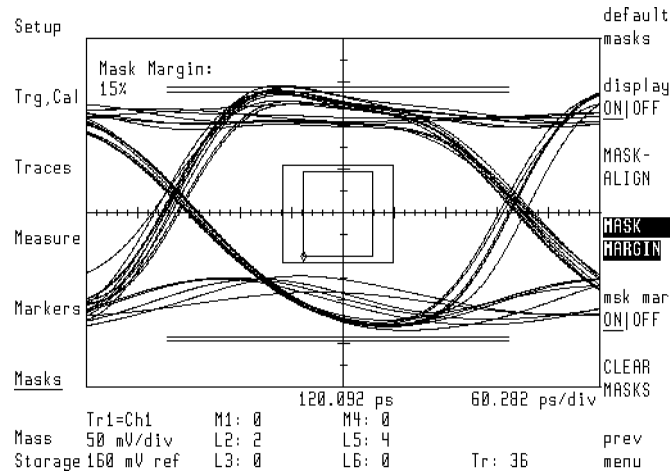
   Notice that in this case, violations are occurring due to too much overshoot.

Test with additional margin

11. Press `mask setup` and then `MASK MARGIN`. Use the numeric keypad to enter a value of 15%.

12. Press `msk mar ON OFF` so that `ON` is underlined.

    This displays a second set of mask and limit lines for the 15 percent margin. Errors for the specifications with the specified amount of margin show up beside the M4, L5 and L6 screen annotations.

    The eye diagram analyzer can count dot (trace point) errors instead of trace errors. Use the `count TRC DOT` softkey to make the selection. If a given error puts 12 trace points within the mask, then the error counter increments by 12. This is useful for determining the extent of any given error. These features can be used with either eye or eyeline modes.

```
Setup                                        default
                                             masks
                Mask Margin:
                15%                          display
Trg,Cal                                      ON|OFF

                                             MASK-
Traces                                       ALIGN

                                             MASK
Measure                                      MARGIN

                                             msk mar
Markers                                      ON|OFF

                                             CLEAR
Masks                                        MASKS
                      120.092 ps    60.282 ps/div
         Tr1=Ch1      M1: 0    M4: 0
Mass     50 mV/div    L2: 2    L5: 4         prev
Storage 160 mV ref    L3: 0    L6: 0  Tr: 36 menu
```

Stop on and display trace errors

The eye diagram analyzer has the ability to stop data acquisition when a mask violation occurs. The number of traces or errors that stop this data acquisition can be specified. In addition, if you are in eyeline mode, you can separately display the traces that have caused an error.

13. Press left side `Setup` softkey.

14. Press `BIT INTVL`, and enter a bit interval value of 1.

15. Press `DELAY`, and enter −3 bits to offset the mask to the right side of the display.

16. Press `#Errors ON OFF`. Use the numeric keypad to enter 2 errors. Then, press `ENTER`.

    Testing will stop after 2 errors have occurred.

17. Ensure that `OFF` is underlined in the `#Traces ON OFF` softkey.

    If `#Traces` is set to on, the eye diagram analyzer stops sweeping when either the error or trace limit is reached.

18. Press the `err trc ON OFF` until `ON` is underlined.

    Any trace which violates the mask shows on the lower-half of the screen.

19. Press `test ON OFF` so that `ON` is underlined. This resets and starts the trace and error counters.

    The instrument stops sweeping after 2 error traces have been accumulated. See the following figure. Note that for this figure, errors occur due to overshoot on a zero-to-one transition.


Display of error traces
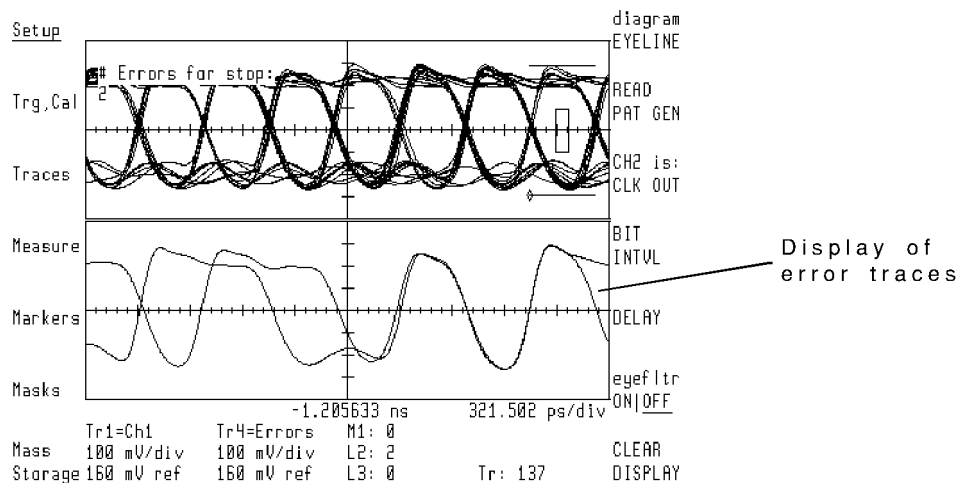
Turn off mask testing

20. Turn off the error trace by pressing `err trc ON OFF` so that `OFF` is underlined.

21. Press `mask setup`. Press `display ON OFF` so that `OFF` is underlined.

22. Press the left-side `Trg,Cal` softkey.

23. Press `CONT STOP` so that `CONT` is underlined.

Tutorial 8:
Creating Custom Masks

Note   Custom masks are easy to create by editing the supplied default shapes.

       compatible modes ....eye, eyeline, and pattern
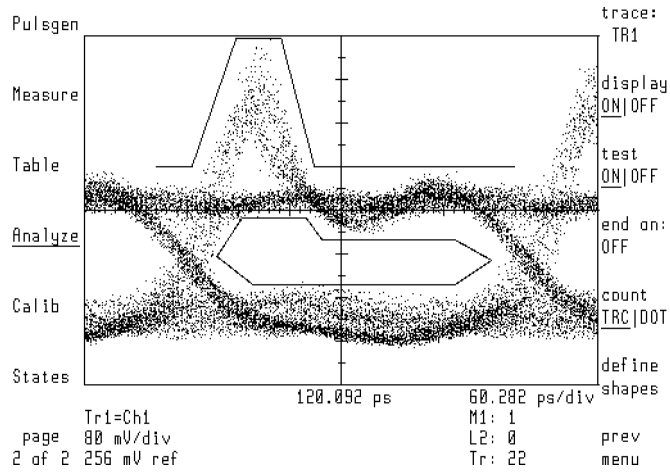
Example of a user-created mask

Enter the menu

1. Press `INSTR PRESET`.

2. Press the left-side `Setup` softkey.

3. Press `BIT INTVL`, and enter a value of 1.5.

4. Press the left-side `Traces` softkey.

5. Press `persist` and then `VARIABL` to turn on persistence mode.

6. Press `PERSIST SWEEPS`, and enter 8.

7. Press the `MENU`.

8. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

Define the shape

9. Press `masks,limits` and then `define shapes`.

10. Press `type:` and then `MASK`.

Select a default shape

11. Press `default shapes` and select the shape that most closely matches the mask you need. For example, press `hexagon` to display a hexagon shaped mask.

Edit the shape

12. Press `edit`.

13. To move a point perform the following steps:

    a. Press the ⇑ and ⇓ keys to select the point.

    b. Press `move X|Y` to select the direction.

    c. Rotate the front-panel knob to move the point. (Or, use the numeric keypad.)

14. To add a point perform the following steps:

    a. Press the ⇑ and ⇓ keys to select a point.

    b. Press `ADD POINT` to add a point at the location of the currently selected point.

Note	When adding points, try to avoid constructing figures where the lines cross. This can be accomplished by remembering the added point will be inserted between the current point and the next higher point.

    c. Press `move X|Y` to select the direction for moving the new point.

    d. Rotate the front-panel knob to move the point.

15. To delete a point perform the following steps:

    a. Press the ⇑ and ⇓ keys to select the point.

    b. Press `DELETE POINT`.

16. Press `prev menu`.

17. Use the `scale X|Y` and `offset X|Y` softkeys to stretch, reduce, or move the mask.

18. Press (USER) to return to the eye diagram analyzer menus.

19. Refer to Chapter 6 to learn more about saving, recalling, and erasing masks.

Tutorial 9:
Displaying the Data Pattern

Note

The eye diagram analyzer can display the data pattern. This is done by selecting the pattern mode and triggering the display trace update on the pattern trigger. This insures the trace on the screen remains the same from sweep to sweep. In this mode, trace averaging can be used for more repeatable measurements on noisy signals.

Masks and limit lines can be used with the pattern mode and are useful for testing specific portions of the data sequence for mask or template violations. This can uncover errors that happen only when a specific pattern of ones and zeros occur.

compatible modes ....pattern

Select pattern mode

1. Press `INSTR PRESET`.

2. If you're using an HP 70841A/B pattern generator, connect the `TRIGGER OUT` signal to the HP 70820A module's `RF INPUT 2` connector.

   This procedure uses the eye diagram analyzer's pattern mode. In pattern mode, the trigger signal must come from the `TRIGGER OUT` and not the `CLOCK OUT` connector.
   The pattern mode only works with a pattern trigger, and not with a clock signal. The pattern trigger is derived from the clock signal divided by the pattern length.

3. Press the left-side `Setup` softkey.

4. Press `diagram` and then `PATTERN`.

   Notice that the `CH2 is:` softkey label has changed to indicate that the trigger source is connected to the `TRIGGER OUT` signal.

5. Press `BIT INTVL`, and enter a value of 20 bits.

6. Press the left-side `Traces` softkey.

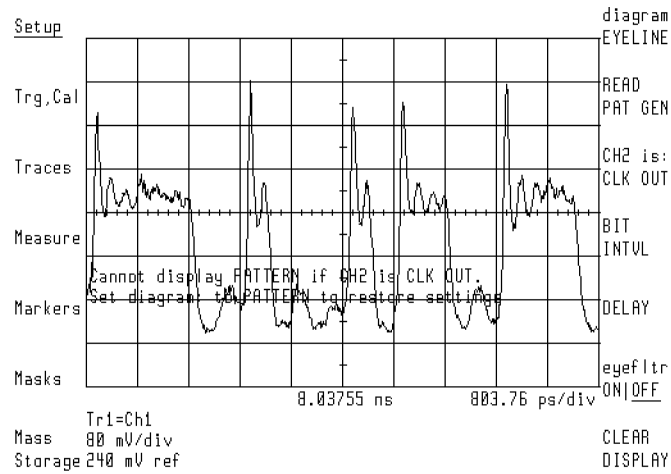7. Press AUTO-SCALE. The display should look like the following figure.
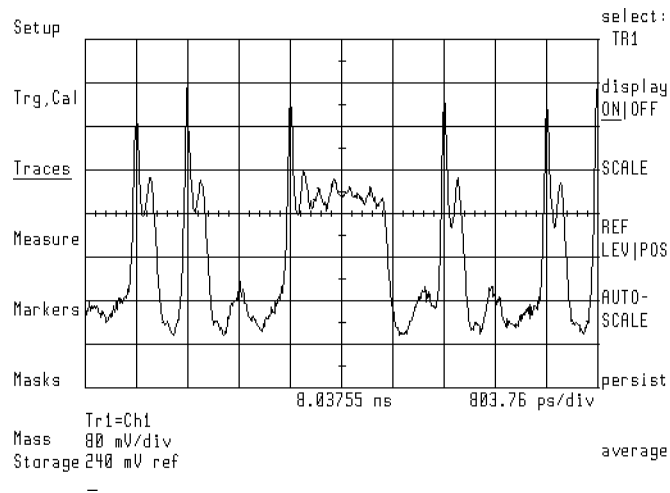
Pattern mode display.

Add time delay

8. Press the left-side Setup softkey.

9. Press DELAY.

10. Each push of the step keys (⬆ and ⬇) gives a change in delay equal to exactly one bit.

This technique can also be used to step the X offset of the mask one bit at a time, to check for mask violations at each bit position.

11. Disconnect the RF cable from the pattern generator's TRIGGER OUT connector and connect the cable to the CLOCK OUT connector.

12. Press `CH2 is:` and then `CLK OUT`.

Notice that the `diagram` softkey annotation no longer indicates pattern mode, and a note is displayed on the screen as shown in the following figure:

```
Setup                                           diagram
                                                EYELINE

Trg,Cal                                         READ
                                                PAT GEN

Traces                                          CH2 is:
                                                CLK OUT

Measure                                         BIT
                                                INTVL
          Cannot display PATTERN if CH2 is CLK OUT.
          Set diagram to PATTERN to restore settings
Markers                                         DELAY

Masks                                           eyefltr
                                                ON|OFF
                   8.03755 ns        803.76 ps/div
          Tr1=Ch1
Mass      80 mV/div                             CLEAR
Storage  240 mV ref                             DISPLAY
          —
```

Display of user error in pattern mode.

3

HP 70874A Menus

In this chapter, you'll find a description of each of the features accessed using the left-side softkeys. In addition, the first section contains maps that show the path to each softkey. The last section of this chapter shows you how to produce hard copies of the eye diagram analyzer's display.
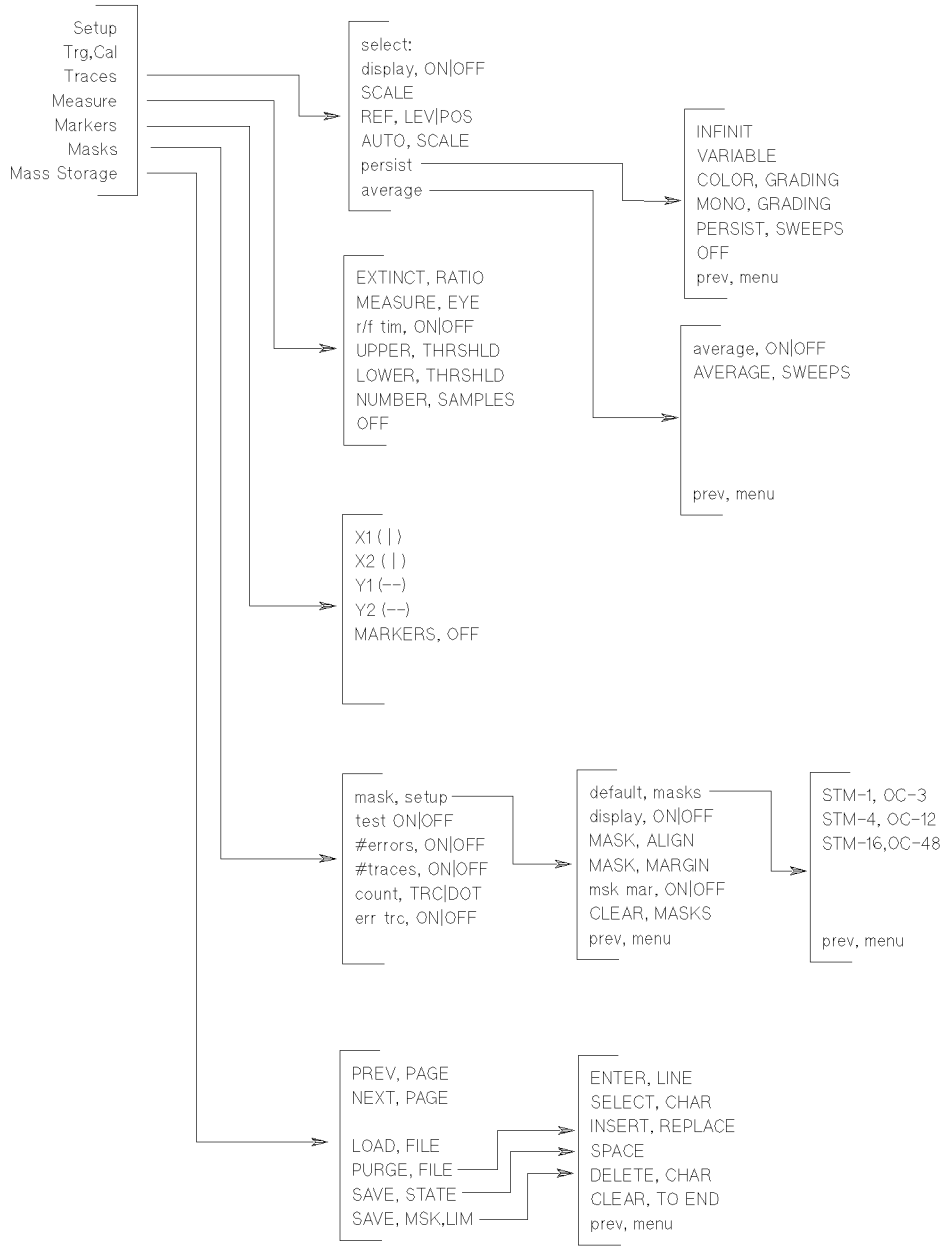
Menu Maps

The two menu maps in this section graphically represent the softkey menus. Menus maps for the HP 70820A module (presented when $\boxed{\text{MENU}}$ is pressed) are located in the *HP 71500 Series Reference*.
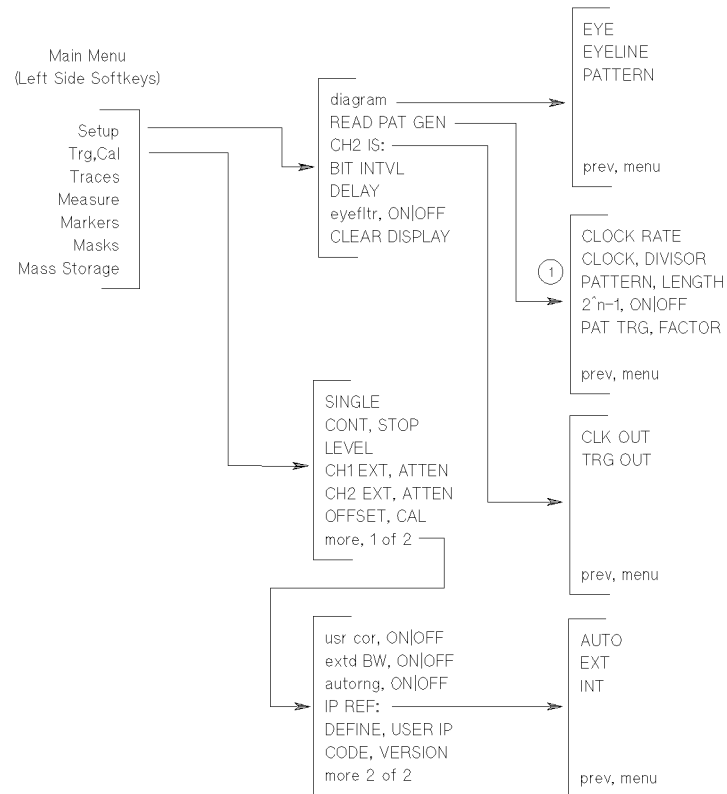
① Some of the keys in this menu may appear depending on the pattern generator and clock source configuration.

Setup and Trg, Cal Menus

Main Menu
(Left Side Softkeys)

Setup
Trg,Cal
Traces
Measure
Markers
Masks
Mass Storage

select:
display, ON|OFF
SCALE
REF, LEV|POS
AUTO, SCALE
persist
average

INFINIT
VARIABLE
COLOR, GRADING
MONO, GRADING
PERSIST, SWEEPS
OFF
prev, menu

EXTINCT, RATIO
MEASURE, EYE
r/f tim, ON|OFF
UPPER, THRSHLD
LOWER, THRSHLD
NUMBER, SAMPLES
OFF

average, ON|OFF
AVERAGE, SWEEPS

prev, menu

X1 (|)
X2 (|)
Y1 (– –)
Y2 (– –)
MARKERS, OFF

mask, setup
test ON|OFF
#errors, ON|OFF
#traces, ON|OFF
count, TRC|DOT
err trc, ON|OFF

default, masks
display, ON|OFF
MASK, ALIGN
MASK, MARGIN
msk mar, ON|OFF
CLEAR, MASKS
prev, menu

STM–1, OC–3
STM–4, OC–12
STM–16,OC–48

prev, menu

PREV, PAGE
NEXT, PAGE

LOAD, FILE
PURGE, FILE
SAVE, STATE
SAVE, MSK,LIM

ENTER, LINE
SELECT, CHAR
INSERT, REPLACE
SPACE
DELETE, CHAR
CLEAR, TO END
prev, menu

Traces, Measure, Markers, Masks, and Mass Storage Menus

Configuring the Analyzer

Select from eye, eyeline, and pattern modes

Use the Setup menu's `diagram` softkey to select from one of three measurement modes: eye, eyeline, and pattern.

Press to select eye,
eyeline, or pattern modes

Setup
menu

Setup

Trg,Cal

Traces

Measure

Markers

Masks

Mass
Storage

Tr1=Ch1
20 mV/div
48 mV ref

0 s   100.469 ps/div

Tr: 7

diagram
EYE

READ
PAT GEN

CH2 is:
CLK OUT

BIT
INTVL

DELAY

eyefltr
ON|OFF

CLEAR
DISPLAY
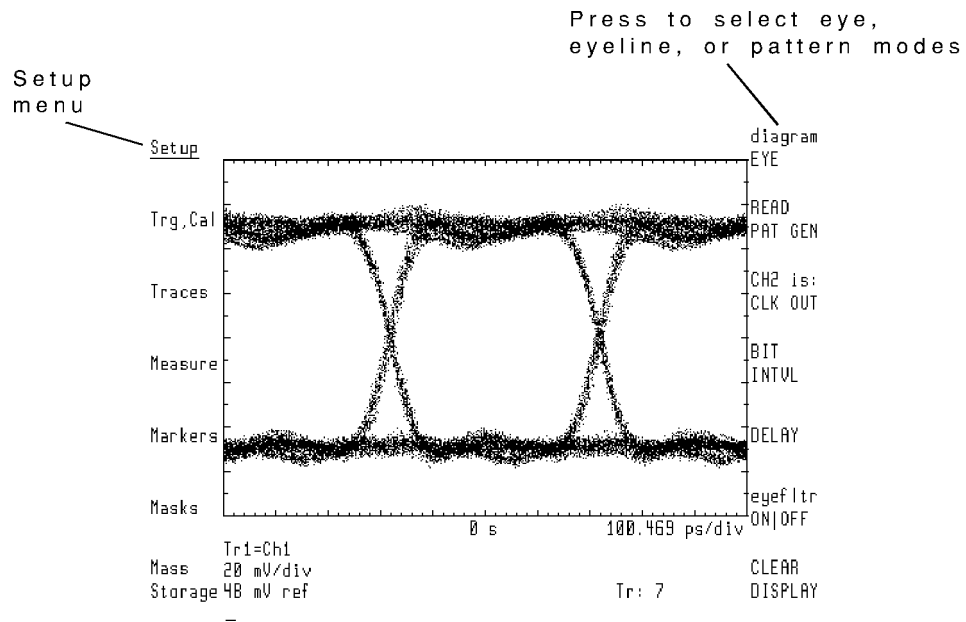
The following table shows the features available in each of the operating modes.

Features Available in Each Mode

	Eye Mode	Eyeline Mode	Pattern Mode
Eye Measurements	√		
Extinction Ratio Measurements	√	√	
Mask Testing	√	√	√
Display the Mask Error Trace		√	√
Improve Sensitivity Using Eye Filtering		√	√
40 GHz Extended Bandwidth		√	√
User Corrections		√	√
Display Data Pattern			√

Three sweep selections are available

The eye diagram analyzer can operate with single, continuous, or stopped sweeps. With continuous sweeps, sweeps occur as soon as the selected triggering conditions are met and repeat continuously as long as the trigger conditions are met.

Use the Trg,Cal menu to control the sweep and adjust the trigger level. The trigger source is entered in the Setup menu. The trigger level can be manually adjusted.
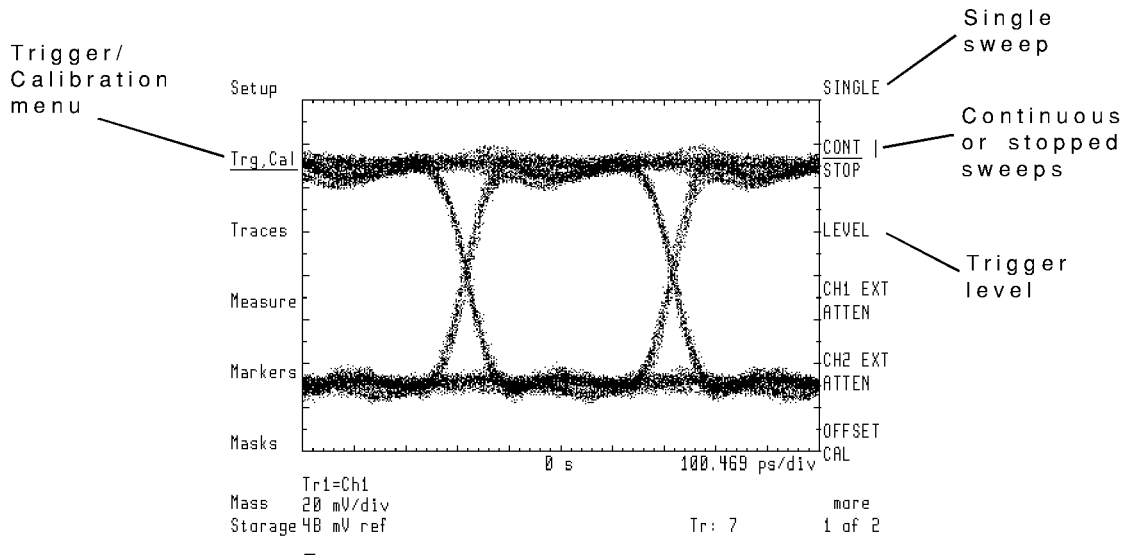
The source of the trigger reference is selected using the Setup menu's `CH2 is:` softkey. The following table shows the reference used when using an HP 7084X pattern generator.

	HP 7084X's Trigger Reference
Eye Mode	`CLOCK` [1] or `TRIGGER`
Eyeline Mode	`CLOCK`[1] or `TRIGGER`
Pattern Mode	`TRIGGER`

1 This connection provides faster trace updates.

You can redefine the [INSTR PRESET] key

The Trg,Cal menu's `DEFINE USER IP` softkey redefines the settings invoked by the [INSTR PRESET] key. Redefining the instrument preset can save valuable time when configuring for measurements.

Entering the pattern generator's settings

The Setup menu's `READ PAT GEN` softkey queries the HP 7084X pattern generator and HP 70311A clock source for the clock frequency, pattern length, and any divide ratios. In the case of alternate configurations, an appropriate submenu will be displayed for the parameters that require manual updating.

Note   A `READ PAT GEN` should be performed after changing pattern generator settings such as clock frequency or pattern length.

Selecting the 10 MHz reference on IP

Use the Trg,Cal menu's `IP REF` softkey to select the source of the 10 MHz reference on an [INSTR PRESET]. Choices are internal, external, or auto. With auto, the eye diagram automatically selects an external reference if it is present at the HP 70820A's rear-panel connector. Otherwise, the module's internal reference is selected.

Moving the measurement plane

Specifying an attenuation on channel 1 changes the measurement plane from the front-panel `RF INPUT 1` connector to include the indicated attenuation. Specifying any attenuation on channel 2 may be necessary to ensure proper triggering. Use the Trg,Cal menu's `CH1 EXT ATTEN` and `CH2 EXT ATTEN` softkeys to specify any external attenuation.

These softkeys can also be used to specify an optical-to-electrical responsivity conversion between the source and input channels. As a result, the display shows optical units referenced to the input of the optical-to-electrical converter. Channel and marker readouts change to watts/div. Also, the `CH1 EXT ATTEN` softkey changes to read `CH1 RSPVTY` (responsivity).

Additional features

The Trg,Cal menu's `autorng ON OFF` softkey turns on or off autoranging. When autoranging is activated, the eye diagram analyzer automatically selects the appropriate hardware gain and offset to maximize the signal at the analog-to-digital converter regardless of the input signal's amplitude.

In rare instances, you may need to know the revision number and date code of the eye diagram analyzer personality. Use the Trg,Cal menu's `CODE VERSION` softkey to display these values on the screen.

To select the mode

1. Press the left-side `Setup` softkey.

2. Press `diagram`.

3. Press `EYE`, `EYELINE`, or `PATTERN`.

To select single or continuous sweeps

1. Press the left-side `Trg,Cal` softkey.

2. Select one of the following sweep states:

   ■ Press `SINGLE` to select single sweeps. Each additional press of this softkey triggers another sweep.

   ■ Press `CONT STOP` so that `CONT` is underlined to select continuous sweeps.

   ■ Press `CONT STOP` so that `STOP` is underlined to stop the sweeps.

To select the trigger source

1. Press the left-side `Setup` softkey.

2. Press `CH2 is:`.

3. Press `CLK OUT` if the analyzer is in eye or eyeline modes.

4. Press `TRG OUT` if the analyzer is in pattern mode.

5. Press the left-side `Trg,Cal` softkey.

6. Press `CH2 EXT ATTEN`, and enter the value of any attenuator connected to channel 2.

   The default value is 6 dB.

To adjust the trigger level

1. Press the left-side `Traces` softkey in the eye diagram analyzer menus.

2. Press `select:` and then `TR2` to select trace two.

3. Press `display ON|OFF` until `ON` is underlined.

4. Press `AUTO-SCALE` to automatically scale the trigger trace.

5. Press the left-side `Trg,Cal` softkey.

6. Press `LEVEL`, and use the knob to position the trigger level indicator line so that it crosses an edge.

7. Press the left-side `Traces` softkey.

8. Press `display ON|OFF` so that `OFF` is underlined.

9. Press `select:`, and then `TR1`.

To enter the data signal type

1. Press the left-side `Setup` softkey.

2. If an HP 70841A/B pattern generator is used, press `READ PAT GEN`.

   The eye diagram analyzer reads the settings of the pattern generator.

3. If a non Hewlett-Packard pattern generator is used in place of an HP 70841A/B pattern generator, perform the following steps:

   a. Press `READ PAT GEN`.

   b. Press `CLOCK RATE`, and enter the rate of the clock signal.

   c. Press `CLOCK DIVISOR`, and enter the divisor for the clock signal.

      For example, when using a trigger or sync output, enter 16 if the clock signal is divided by 16.

   d. Press `PATTERN LENGTH`, and enter the pattern repetition length in bits or as the binary power depending on the position of the `2∧n-1 ON OFF` softkey. If the `2∧n-1 ON OFF` softkey is set to `ON`, binary powers are entered in the form $2^n - 1$. This makes it very easy to set the pattern length for PRBS sequences. When the `2∧n-1 ON OFF` softkey is set to `OFF`, the pattern length is entered directly in bits.

4. Press `PAT TRG FACTOR`, and enter the factor that relates how many repetitions of the pattern occur between trigger pulses.

   Frequently, 16 to 32 or more repetitions of the pattern occur between trigger pulses.

Note   When operating off a trigger or sync output with a divided clock frequency or a pattern trigger, be sure to set `CH2 is:` to `TRG OUT`.

---

5. Press `prev menu`.

6. If a clock source other than the HP 70311A is used, enter the precise clock frequency by pressing `CLOCK RATE`.

To move the measurement plane

1. Press the left-side `Trg,Cal` softkey.

2. Press `CH1 EXT ATTEN`, and enter the attenuation on the channel 1 input.

To change the (INSTR PRESET) key

1. Set the eye diagram analyzer to the desired settings.

2. Press the left-side `Trg,Cal` softkey.

3. Press `more 1 of 2`, `DEFINE USER IP`, and then `CONT`.

To restore the factory instrument preset

1. Press (MENU).

2. Press the left-side `page 1 of 2` softkey.

3. Press the left-side `States` softkey.

4. Press `more 1 of 2`, and then `preset: FAC|USR` so that `FAC` is underlined.

To select the 10 MHz reference on (INSTR PRESET)

The following steps set the source of the 10 MHz reference selected when (INSTR PRESET) is pressed.

1. Press the left-side `Trg,Cal` softkey.

2. Press `more 1 of 2`, `IP REF`, and then press one of the following selections:

   - `AUTO` so that the eye diagram analyzer automatically selects an external reference (if it is present) or the internal reference.

   - `EXT` to select the external reference.

   - `INT` to select the internal reference.

Controlling the Display

Control the number of bits displayed

The Setup menu's `BIT INTVL` softkey allows you to select the number of bits that will be displayed on the screen. The horizontal time scale automatically changes to the appropriate setting. Use `DELAY` to enter time delay. The amount of delay is entered in bits. Use this feature, in pattern mode, to view different portions of the PRBS waveform.

The amount of delay can be as much as 1000 times the time span. In addition, the eye diagram analyzer can view the trace before the trigger event. Negative time delay up to $\frac{-time\ span}{2}$ can be entered.

Measure in optical power units

The Trg,Cal menu's `CH1 EXT ATTEN` and `CH2 EXT ATTEN` softkeys allow you to specify any external attenuation or optical-to-electrical responsivity conversion between the source and input channels. Specifying an attenuation on channel 1 changes the measurement plane from the front-panel channel 1 connector to include the indicated attenuation. Specifying an optical-to-electrical responsivity displays optical units referenced to the input of the optical-to-electrical converter. Channel and marker readouts change to watts/div. Also, the `CH1 EXT ATTEN` softkey changes to read `CH1 RSPVTY` (responsivity).

Improve the sensitivity in eyeline mode

In eyeline mode, additional eye filtering can be applied to improve the measurement sensitivity. This can be an advantage when measuring extinction ratios on low-level signals. Use the `eyefltr ON OFF` softkey to apply the filter. When the pattern repetition frequency is greater than 10 MHz, internal filtering is applied that provides a 20 dB signal-to-noise improvement. For pattern repetition frequencies less than 10 MHz, software filtering is applied that allows variable signal-to-noise improvement versus sweep time.

Extend the bandwidth to 40 GHz

Use the `extd BW ON OFF` softkey to enable RF corrections which extend the measurement bandwidth of the eye diagram analyzer to 40 GHz. Extended bandwidth operation can be used in both eyeline and pattern modes, but not in eye mode.

Apply user corrections

User-corrections provide a convenient method for modifying the display of input signals. Some of the applications for user-corrections include the following:

- Filtering input signals to simulate the effects of circuit design.

- Compensating for frequency and phase response of external probes.

- Compensating for frequency and phase response of external test setups.

- Compensating for the frequency response of optical to electrical converters.

Several Bessel-Thomson software filters are included on the HP 70874A eye diagram analyzer's memory card. These filters can be applied as user corrections in the eyeline and pattern modes. (User corrections must be off in eye mode.) User correction files are identified by the prefix `a_` as shown in the following table. The files `AUTOST` and `HP70874` comprise the eye diagram analyzer program.

To learn more about these files and about creating and applying user corrections, refer to Chapter 7.

User Correction Files

File Name	File Data
a_bt248832	4th order Bessel-Thomson filter for 2.48832 Gbit/sec transmission.
a_bt_62208	4th order Bessel-Thomson filter for 622.08 Mbit/sec transmission.
a_bt_15552	4th order Bessel-Thomson filter for 155.52 Mbit/sec transmission.

To set the number of bits displayed

1. Press the left-side `Setup` softkey.

2. Press `BIT INTVL`, and enter the number of bits that you want displayed.

To add time delay

1. Press the left-side `Setup` softkey.

2. Press `DELAY`.

3. Use the numeric keypad to enter the amount of bits to be displayed.

To measure optical power units

1. Press the left-side `Trg,Cal` softkey.

2. Press `CH1 EXT ATTEN`, and enter the responsivity value in watts/div.

    Notice that the `CH1 EXT ATTEN` softkey changes to read `CH1 RSPVTY` (responsivity).

To improve sensitivity in eyeline mode

1. Press the left-side `Setup` softkey.

2. Use the `diagram` softkey to select either eyeline or pattern modes.

3. Press `eyefltr ON OFF` so that `ON` is underlined.

4. Turn the front-panel knob to adjust the amount of filtering applied.

To extend the measurement bandwidth

1. Press the left-side `Setup` softkey.

2. Press `diagram`.

3. Press either `EYELINE` or `PATTERN`.

    The extended 40 GHz bandwidth cannot be used in eye mode.

4. Press the left-side `Trg,Cal` softkey.

5. Press `more 1 of 2` and then `extd BW ON|OFF` so that `ON` is underlined.

To apply user corrections
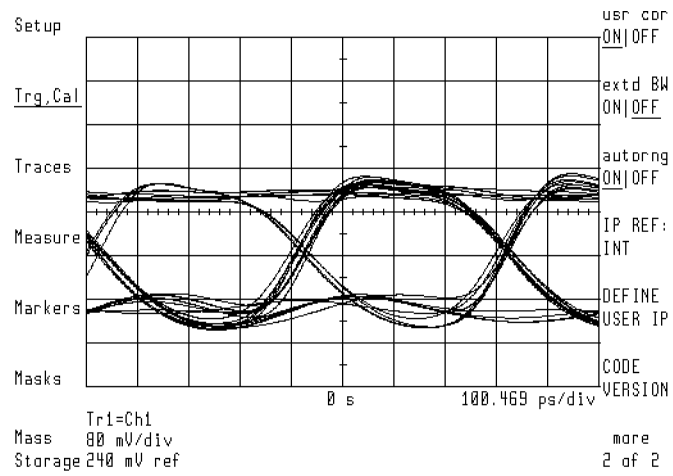
1. Place the HP 70874A eye diagram analyzer memory card in the front-panel card slot.

    The HP 70874A eye diagram analyzer must already be loaded into memory.

2. Press (USER) to display the eye diagram analyzer's menus.

3. Press the left-side `Setup` softkey.

4. Press `diagram`, and then select either `EYELINE` or `PATTERN`. User corrections can not be applied in eye mode.

5. Press the left-side `Mass Storage` softkey.

6. A catalog of the files contained on the memory card should be displayed as shown in the following figure.

7. Rotate the front-panel knob to highlight the desired file.

    User correction files are identified by the prefix `a_`.

8. Press `LOAD FILE`. The file is loaded when `user corrections loaded` is displayed on the screen.

9. Press the left-side `Trg,Cal` softkey.

10. Press `more 1 of 2` and then `usr cor ON|OFF` so that `ON` is underlined.

```
Setup                                        usr cor
                                             ON|OFF

Trg,Cal                                      extd BW
                                             ON|OFF

Traces                                       autorng
                                             ON|OFF

Measure                                      IP REF:
                                             INT

Markers                                      DEFINE
                                             USER IP

Masks                                        CODE
                          0 s     100.469 ps/div  VERSION
         Tr1=Ch1
Mass     80 mV/div                              more
Storage 240 mV ref                             2 of 2
         _
```

User corrections applied to the data.

Displaying Traces

Four traces can be displayed

The Traces menu's `select:` softkey allows you to display and control up to four traces. The scaling, reference positions, and reference levels of each trace can be separately adjusted. To automatically adjust the trace scale factor and reference level for optimum display, simply press `AUTO-SCALE`. Signals are autoscaled once when the softkey is pressed and not on a continual basis. If you change the amplitude of the signal, it will not be autoscaled.

During mask testing, trace 4 is reserved for the error trace.
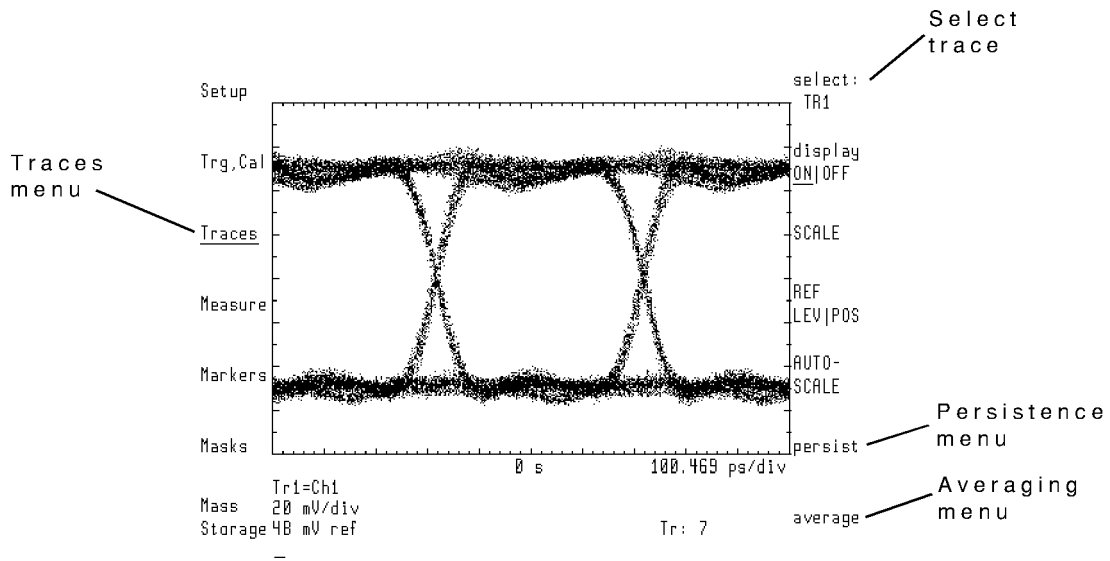
Each trace can be positioned and scaled

The selected trace can be positioned vertically on the display. This is accomplished using the `REF LEV|POS` softkey to enter both the reference position and reference level. The reference position (POS) is entered as a percentage of the vertical display. The top of the screen is 100%. The bottom of the screen is 0%. The reference level (REF LEV) is the amplitude value at the reference position.

Trace 1 can be averaged

The Traces menu's `average` softkey presents a menu used for controlling trace averaging. Trace averaging keeps a running average of the measurement values on each sweep. You can set the averaging count; its default value is 16. Trace averaging is only applied to trace 1.
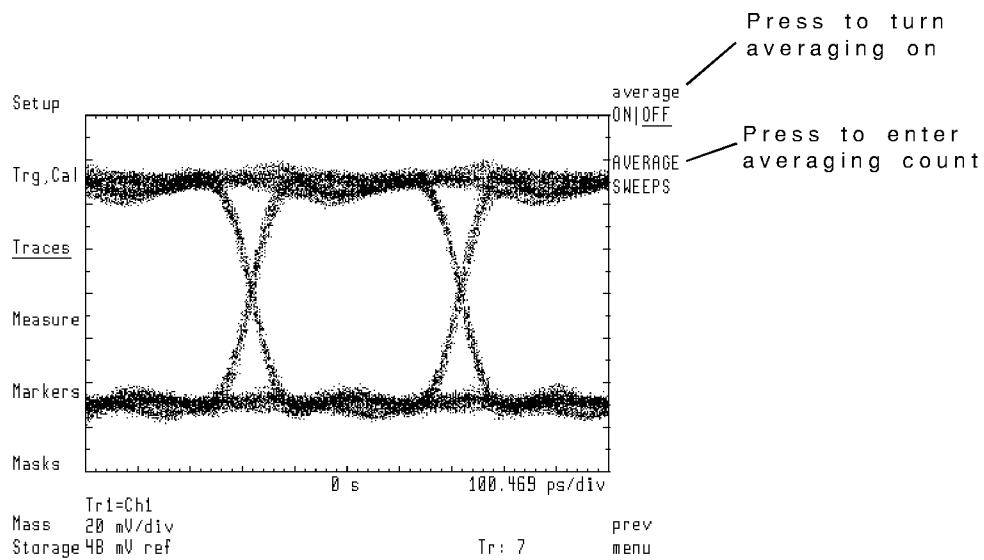
The averaging submenu.

Four persistence modes are available

The eye diagram analyzer offers four trace persistence selections. These selections are located under the Traces menu's `persist` softkey and include the following types:

- Infinite monochrome.
- Variable monochrome.
- Color grading.
- Monochrome grading.

Trace persistence works on all displayed traces regardless of which trace is selected.
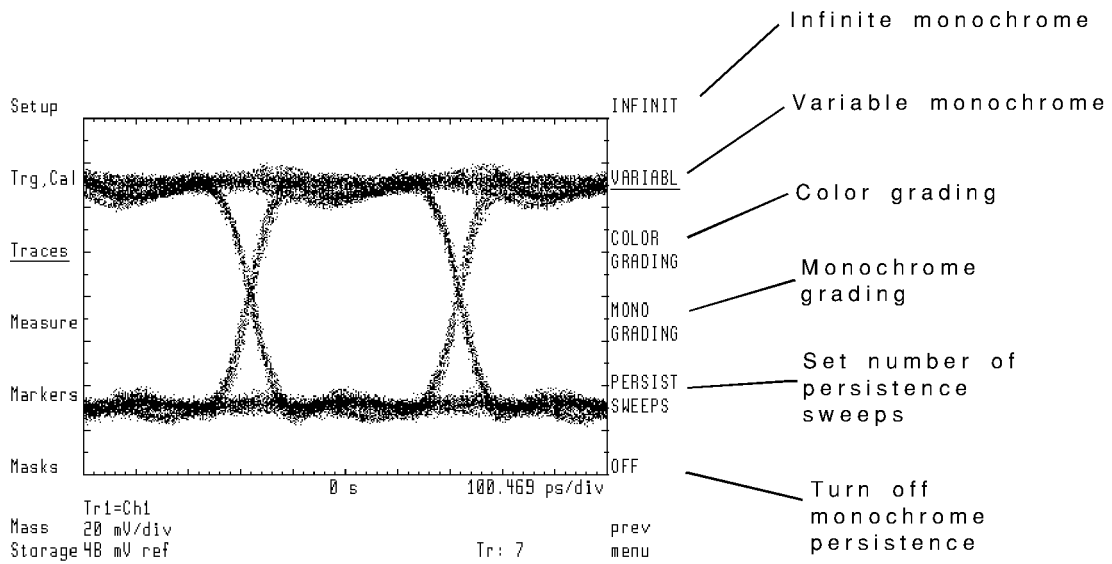
The persistence submenu.

Infinite monochrome persistence

With infinite monochrome persistence (INFINIT), traces accumulate on the display until persistence is turned off or the display is cleared using the Setup menu's CLEAR DISPLAY softkey. Press OFF to turn off infinite monochrome persistence.

Variable Monochrome persistence

With variable monochrome persistence (VARIABL), older traces become dimmer as new traces are acquired. Traces can be one of seven different brightness levels, with new traces being the brightest. After N number of sweeps (N is set with the PERSIST SWEEPS), every trace gets dimmer by one intensity level; traces already at the dimmest level disappear altogether. Lower values of N work best with this type of persistence, typically values of five through 10. Press OFF to turn off this persistence.

Color grading persistence

With color grading persistence (COLOR GRADING), the color of a displayed pixel is a function of how many times a trace dot falls on that particular pixel. There are 5 possible colors that a pixel can be. If a pixel has progressed to the highest color (yellow) before N PERSIST SWEEPS have occurred, it remains that color no matter how many more dots fall on it. After N PERSIST SWEEPS , the color grading acquisition stops. The following list shows the order of colors that a pixel can progress through:

1. green
2. cyan (light blue)
3. purple
4. rose
5. yellow

This persistence works best with high values of N, typically values of 50 through 100. No softkeys may be pressed in this mode until after EXIT GRADING is pressed.

Monochrome grading persistence

Monochrome grading persistence (MONO GRADING) works just like color grading except that a given pixel increases in intensity instead of color each time a dot falls on it. There are 15 different levels of intensity. EXIT GRADING must also be used in this mode to return to normal instrument operation.

To display a trace

1. Press the left-side Traces softkey.

2. Press select: and then press TR1 , TR2 , TR3 , or TR4 .

3. Press display ON OFF so that ON is underlined.

To scale and position a trace

1. Press the left-side `Traces` softkey.

2. Select from the following choices to scale and move the trace:

   - To automatically scale the selected trace, press `AUTO-SCALE`.

   - To manually set the scale, press `SCALE`. Use the front-panel knob or numeric keypad to change the displayed vertical scaling.

   - To move the trace's reference position, press `REF LEV|POS` so that `POS` is highlighted. Rotate the front-panel knob to change the position.

   - To change the reference level at the trace's reference position, press `REF LEV|POS` so that `LEV` is highlighted. Rotate the front-panel knob to change the level.

To apply persistence

1. Press the left-side `Traces` softkey.

2. Press the `persist` softkey.

3. Press `PERSIST SWEEPS` and select one of the following:

   - If variable persistence will be used, enter the number of sweeps taken before a trace decrements in brightness.

   - If grading persistence will be used, enter the number of sweeps taken until the grading display is stopped.

4. Press one of the four top right-side softkeys to select the persistence mode.

5. `INFINIT` and `VARIABLE` persistence can be stopped at any time by pressing `OFF`.

To average trace 1

1. Press the left-side `Traces` softkey.

2. Press the `average` softkey.

3. Press `AVERAGE SWEEPS`, and enter the number of sweeps used for the running average.

4. Press `average ON|OFF` so that `ON` is underlined.

Calibrating the Analyzer

Calibration compensates for dc offsets

An offset calibration routine is provided that allows the eye diagram analyzer to compensate channel 1 for any external or internal dc offsets. This ensures accurate measurements of the lasers's one and zero levels. For example, you can use the calibration to remove any offset that may be present in an optical-to-electrical converter. This is sometimes referred to as the "dark" level.

Calibrate IF for accuracy

The HP 70820A microwave transition analyzer module provides separate automatic IF calibration routines for channel 1 and channel 2. Each requires approximately 30 minutes to run. For optimum performance, you should perform the calibrations when at least one of the following is true:

■ The temperature has changed ±5° Centigrade since the last calibration was performed.

■ More than one week has passed since the last calibration.

■ Before any critical measurement.

Note	Allow the microwave transition analyzer module to warm up for at least one hour before performing a calibration.

To perform an offset calibration

■ Turn the laser off.

■ Press the left-side `Trg,Cal` softkey.

■ Press `OFFSET CAL`, and then `CONT`.

> The calibration takes about a minute to execute. When the calibration is finished, `DC NULL: done` is displayed.

■ Turn the laser on.

To calibrate the IF

1. Connect a low-loss cable between the front-panel CALIBRATOR OUTPUT and channel 1 connectors.

Calibrator
Output

PTA22
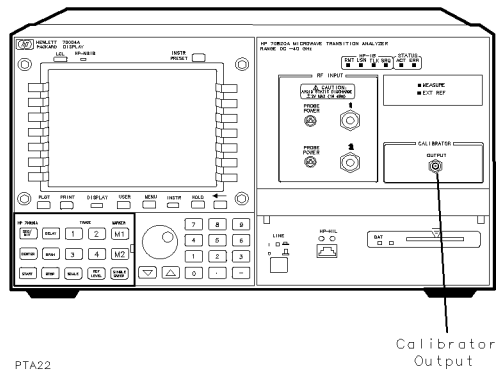
2. Press (MENU).

3. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

4. Press the `IF calib` softkey.

5. Press the `CAL CH1` softkey.

> The calibration routine takes about 30 minutes to complete.

6. Disconnect the cable from channel 1, and connect it to the channel 2 connector.

7. Repeat the above procedure for channel 2.

Performing Eye Diagram Measurements

To perform the automatic eye diagram measurements, use the measure menu. With the exception of extinction ratio, these measurements must be performed in eye mode. The following figure shows the measurement results on an eye diagram:

Automatic measurements

The Measure menu's top two softkeys, EXTINCT RATIO and MEASURE EYE start the desired measurements.
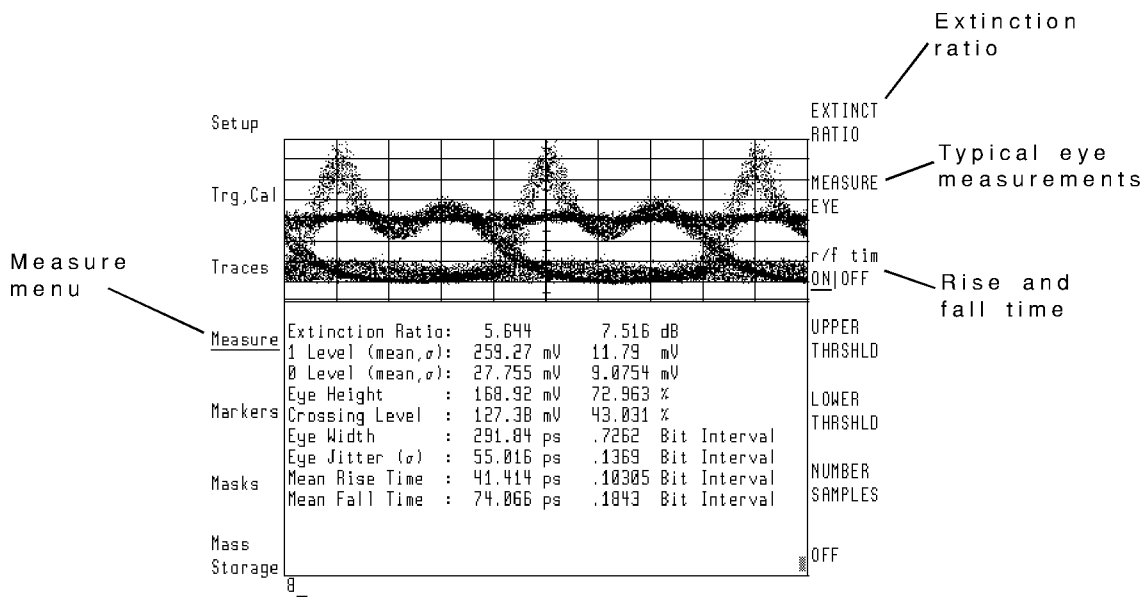
Use `EXTINCT RATIO` to automatically compute the extinction ratio in eye or eyeline modes. This measurement is a ratio of the most prevalent logical one level divided by the logical zero level over one bit interval. When making extinction ratio measurements in eyeline mode, the number of samples should be increased from the default of 1000 to approximately 20000. This insures that a number of traces are evaluated to compute the extinction ratio. Use the `NUMBER SAMPLES` softkey for this purpose.

`MEASURE EYE` initiates a number of automatic histogram measurements on an eye diagram.

Use `r/f tim ON OFF` to enable rise time and fall time measurements during the measure eye routine. This approximately doubles the measurement time. Use the `UPPER THRSHLD` and `LOWER THRSHLD` softkeys to set the upper and lower edges for rise time and fall time measurements. These softkeys define the amplitude level to be used for the upper and lower parts of an edge definition for the automatic measurement functions. The default upper threshold is 80%. The default lower threshold is 20%.

Measurement Definitions

Extinction Ratio

This measurement is the ratio of the most prevalent high level to the most prevalent low level over one bit interval. The measurement results are displayed in both linear and logarithmic (10 *log*) forms of the ratio.

The peaks of the histogram are used to set initial limits for the computation of the one and zero levels. The initial mean and sigma of the one level is based on histogram data above the relative 50% point of the peaks. The limits for the next evaluation of the histogram data are set to the initial mean plus-or-minus one sigma. The new mean and sigma for the one level is determined. This process iterates several times until the sigma becomes small and the mean converges on the most prevalent one level. The determination of the most prevalent zero level is based on the same algorithm, except the initial mean and sigma of the zero level are based on histogram data below the relative 50% point of the peaks.

1 Level (mean, σ)

This measurement is the mean and sigma of the one level determined from a 20% window of a bit interval centered in the middle of the bit.

0 Level (mean, σ)

This measurement is the mean and sigma of the zero level determined from a 20% window of a bit interval centered in the middle of the bit.

Eye Height

This measurement is the difference between the mean minus-three sigma of the one level and the mean plus-three sigma of the zero level.

Crossing Level

This measurement is the amplitude that the one level and zero level cross. It also expresses the level as a percentage of the mean one level and mean zero level difference.

Eye Width

This measurement is the eye width determined from the bit period and the eye jitter. On the eye, the edges are defined to be the left crossing point plus-three sigma and the right crossing point minus-three sigma.

Eye Jitter (σ)	This measurement is the sigma of a horizontal histogram at the crossing point.
Mean Rise Time	This measurement is the mean time interval between a horizontal histogram centered at the lower threshold point and a horizontal histogram centered at the upper threshold point on a rising edge of an eye diagram.
Mean Fall Time	This measurement is the mean time interval between a horizontal histogram centered at the upper threshold point and a horizontal histogram centered at the lower threshold point on a falling edge of an eye diagram.

To measure extinction ratio

1. Press the left-side `Setup` softkey.

2. Press `diagram` and then `EYE` or `EYELINE`.

3. Press the left-side `Measure` softkey.

4. If eyeline mode is used, press `NUMBER SAMPLES`. Use the front-panel knob to increase the number of samples to approximately 20000.

   This insures a valid sample (number of traces) are evaluated to compute the extinction ratio.

5. Press `EXTINCT RATIO`.

To measure the eye parameters

1. Press the left-side `Setup` softkey.

2. Press `diagram` and then `EYE`.

3. Press the left-side `Measure` softkey.

4. Press `MEASURE EYE` to begin the eye measurements.

5. To include rise and fall time measurements with the results, press `r/f tim ON OFF` so that `ON` is underlined.

6. To turn off the eye diagram measurements, press `OFF`.

Using Markers

Use this menu to activate the four available line markers: X1, X2, Y1, and Y2. Markers allow you to measure or compare portions of the displayed waveform. For example, you can use markers to measure the peak-to-peak difference in a laser's turn-on time as measured on the eye diagram's crossing point.

Use the front-panel knob or numeric keypad to position each displayed marker on the screen. Notice that the value at the marker is displayed on the top portion of the screen. To turn the markers off, simply press MARKERS OFF .

Marker positions

Marker separation

Markers menu

X1=-74.3474 ps X2=-44.2065 ps X(2-1)= 30.1408 ps

Setup

X2 adjust:
-44.206536 ps

Trg,Cal

Traces

Measure

Markers

Masks

Tr1=Ch1
Mass   100 mV/div
Storage 320 mV ref

0 s   40.188 ps/div

X1 (|)
TR1

X2 (|)
TR1

Y1 (--)
(off)

Y2 (--)
(off)

MARKERS
OFF
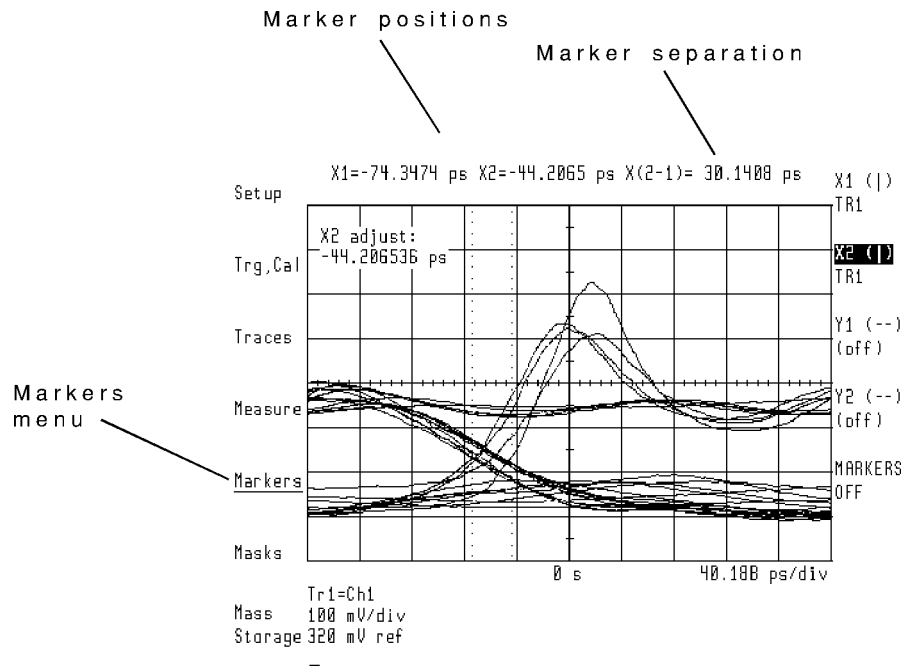
Applying Mask Testing

Use the Masks menu to display and control mask testing. Built in standard masks for the more common SONET/SDH transmission rates are provided. To learn how to create your own custom masks, refer to Chapter 6.

Test results are displayed

During mask testing, mask violations are displayed in the lower portion of the display. You can specify whether the mask errors are counted as trace errors or as the number of trace points or dots that violated the mask. You do this using the `count TRC|DOT` softkey.

Limit line 2 (L2)

Mask 1 (M1)

Limit line 3 (L3)

Error counts
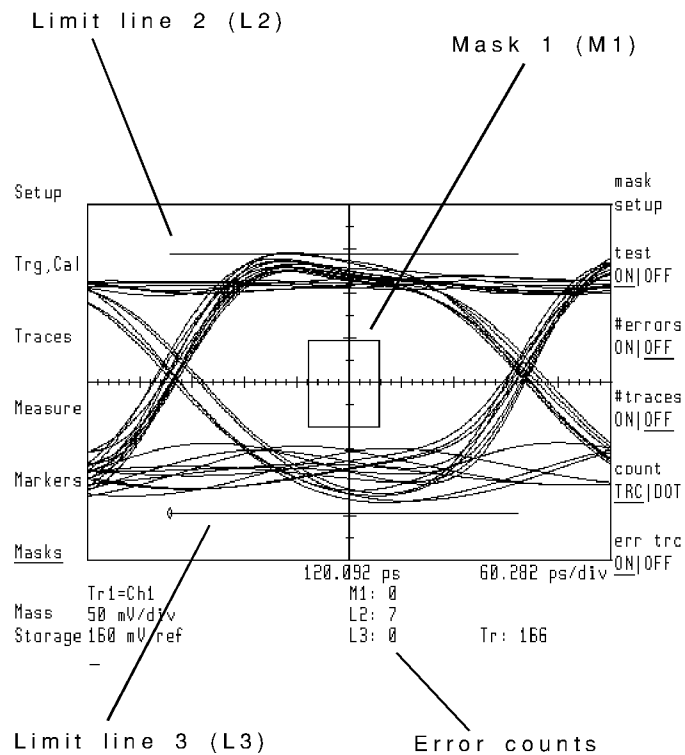
Automatic alignment scales the mask

The `MASK ALIGN` softkey, located under the Masks menu, automatically aligns and scales a default mask to the data per the SONET/SDH standards. This is accomplished using histograms and is best done in eye mode for faster and more evenly distributed data acquisition. Eye mode provides a more even statistical distribution of high and low data. This results in faster acquisition of the histogram data used to determine zero and one levels. The mask and limit lines adjust to fit the displayed data. To change the number of samples used for the histogram, use the `Measure` menu's `NUMBER SAMPLES` function.

Display the error trace

Use the `err trc ON OFF` softkey to display a trace that violates a mask. The screen is split with the error trace displayed in the lower half of the display. Trace four is allocated as the error trace.
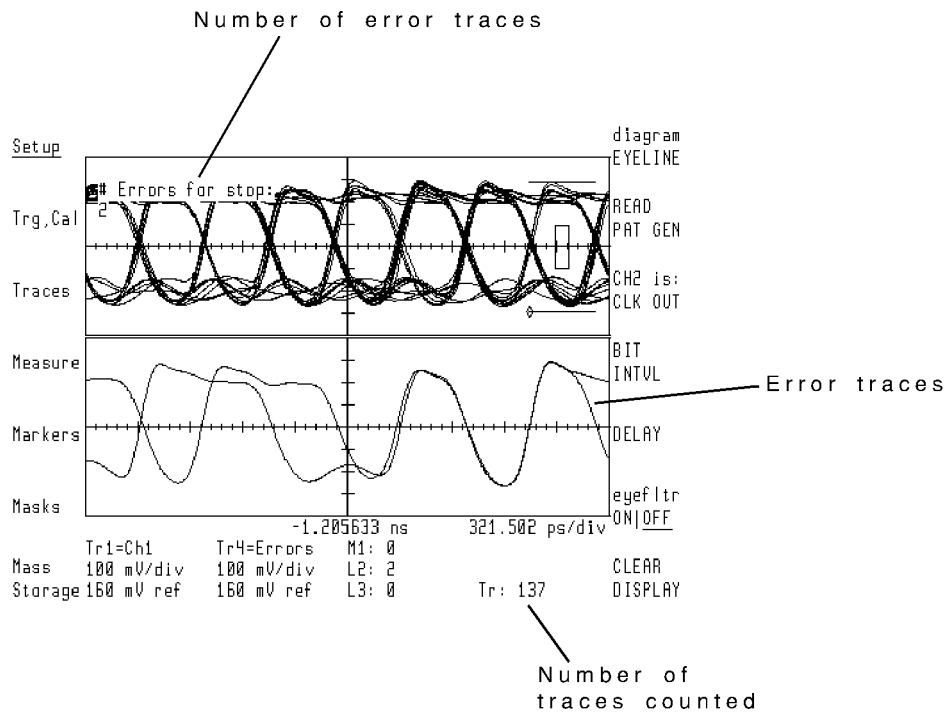
Mask margins tighten mask tests

Margins can be added to the mask/limit line tests. This margin is added as a percent of the mask. Zero percent margin corresponds to the default mask. One hundred percent margin corresponds to the mean of the histograms of the one and zero levels, and the crossing points.

Negative mask margins can also be implemented. These can be used to gain an idea of time severity of the encountered errors.
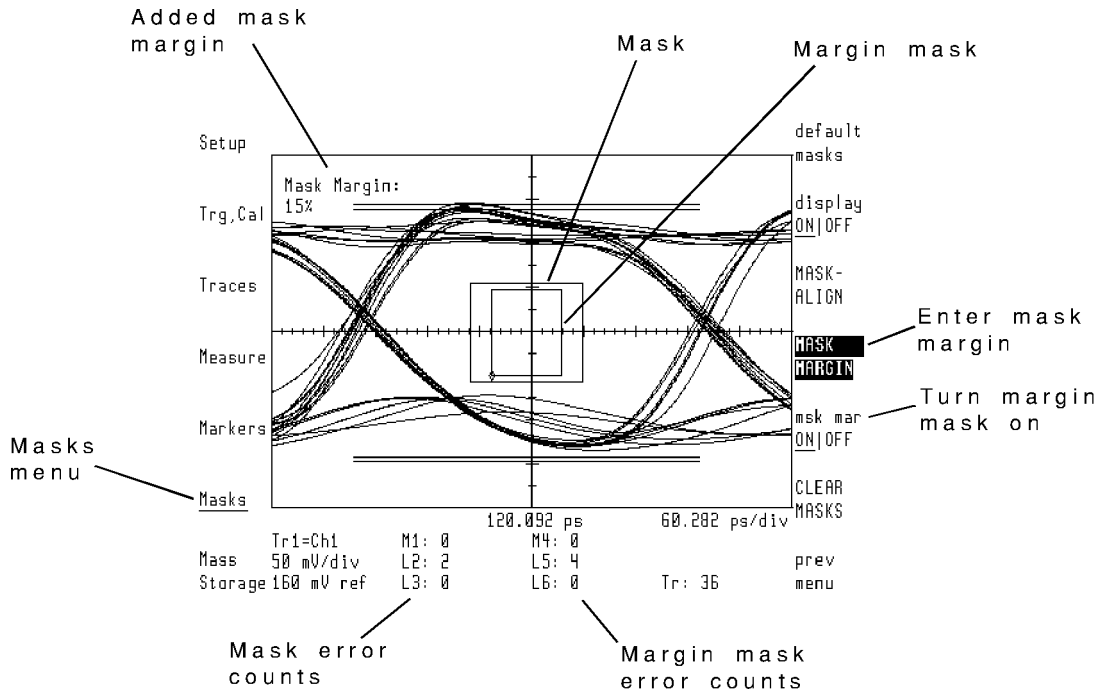
The mask setup submenu.

To display a SONET/SDH mask

1. Press the left-side `Masks` softkey.

2. Press `mask setup`.

3. Press `default masks`, and then press the softkey for the desired SONET mask.

4. Press `MASK ALIGN` to automatically align the mask to a displayed signal.

5. To add mask margins, perform the following steps:

   a. Press `MASK MARGIN`, and enter the percentage of needed margin.

   b. Press `msk mar ON|OFF` so the `ON` is underlined.

6. Press `prev menu`.

To begin mask testing

1. Press the left-side `Masks` softkey.

2. Display a mask as described in "To display a SONET/SDH mask" in this section.

3. To stop mask testing after N number of errors have occurred, perform the following:

   a. Press `#errors ON|OFF` so that `ON` is underlined.

   b. Enter the number of errors. The default value is infinite.

4. To stop mask testing after N number of traces have occurred, perform the following:

   a. Press `#traces ON|OFF` so that `ON` is underlined.

   b. Enter the number of traces. The default value is infinite.

5. Press `count TRC|DOT` to select whether the mask errors are being counted as a trace error or as the number of trace points or dots that violated the mask.

   If `TRC` is underlined, traces errors are being counted. If `DOT` is underlined, trace points are counted.

6. Press `test ON|OFF` so that `ON` is underlined.

To display the error trace

1. Display a mask and begin testing as described in this section.

2. Press `err trc ON|OFF` so that `ON` is underlined.

To remove all displayed masks

1. Press the left-side `Masks` softkey.

2. Press `mask setup` :

   ■ To temporarily prevent the display of a mask without removing it, press `display ON|OFF` so that `OFF` is underlined.

   ■ To remove the mask, press `CLEAR MASKS` .

Saving to Mass Storage

Using the Mass Storage menu, you can save and recall instrument states and mask/limit lines to a mass storage device. The mass storage device is normally a ROM card that has been inserted into the front-panel card slot. To learn how to select another mass-storage device, refer to Chapter 9.

Instrument states are files that restore the eye diagram analyzer to previously saved settings. Use instrument states to quickly return the eye diagram analyzer to an often used measurement configuration.

Mask/limit lines allow you to perform pass/fail testing. Refer to Chapter 2 for a tutorial on using the supplied mask/limit lines. Refer to Chapter 6 for information on creating your own custom mask/limit lines.

Instrument state files are identified by the file prefix "s_." Mask/limit line files are identified by the file prefix "m_."
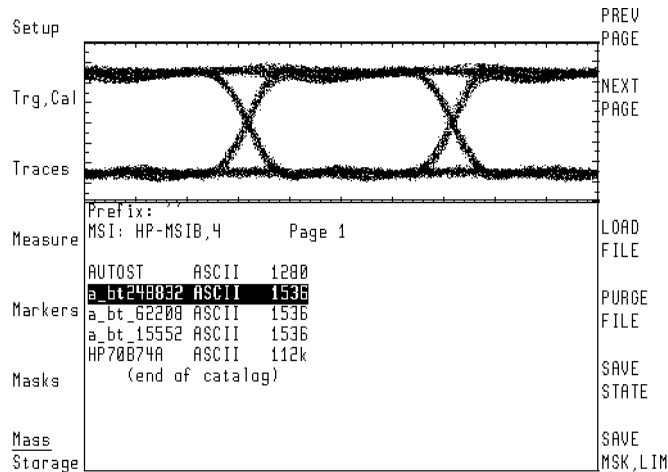
The Mass Storage Menu showing catalog of ROM card.

Insert the ROM card to avoid an error

Selecting the Mass Storage menu without first inserting a ROM card into the front-panel card slot results in the following displayed error message:

    6218 catalog open failed

If this happens, simply insert a card, and then press PREV PAGE .

As the figure on the previous page shows, the files stored on the card are automatically listed on the display. If the complete list does not fit on one screen, use the PREV PAGE and NEXT PAGE softkeys to view the complete list.

To save an instrument state

1. Set the eye diagram analyzer to the desired settings.

2. Insert a ROM card into the front-panel card slot.

3. Press the left-side Mass Storage softkey.

4. Press SAVE STATE .

To save a mask/limit line

1. Insert a ROM card into the front-panel card slot.

2. Press the left-side Mass Storage softkey.

3. Press SAVE MSK,LIM .

To load a state or mask/limit line

1. Insert a ROM card into the front-panel card slot.

2. Press the left-side Mass Storage softkey.

3. Rotate the front-panel knob to highlight the desired file.

    Instrument state files are identified by the file prefix "s_." Mask/limit line files are identified by the file prefix "m_."

4. Press LOAD FILE .

To erase a file

1. Insert a ROM card into the front-panel card slot.

2. Press the left-side Mass Storage softkey.

3. Rotate the front-panel knob to highlight the file you want to erase.

4. Press PURGE FILE .

Getting Prints of the Display

Often, it is important to get hard copies of the display for reports or records. The display can be printed on any Hewlett-Packard graphics printer. These printers support the Hewlett-Packard PCL printer language and include the following:

- ThinkJet
- PaintJet
- LaserJet

The printer must have an HP-IB interface.

Hard copies can be produced on a Hewlett-Packard plotter if the eye diagram analyzer is in pattern mode. Plots cannot be produced in eye or eyeline modes.

To get a print

1. Connect the printer to the display via an HP-IB cable.

   Be sure to connect the HP-IB to the display's connector and not to the connector on the HP 70820A microwave transition analyzer module.

2. The first time the printer is used, enter the printer type and address:

   a. Press the front-panel (DISPLAY) key.

   b. Press the `Hard Copy` softkey.

   c. Press the `printer address` softkey.

      ■ To configure the printer in talk/listen mode on the HP-IB, use the `HP-IB TLK/LSN` softkeys to enter the printer's address.

      ■ To configure the printer in listen only mode on the HP-IB, press the `HP-IB L ONLY` softkey.

      ■ To configure the printer via the HP-MSIB, enter its address using `HP-MSIB COLUMN` and `HP-MSIB ROW` softkeys.

   d. Press the front-panel ← softkey.

   e. Press the `printer config` softkey.

   f. Use the softkeys along the right side of the display to select the type of printer used.

   g. Press the front-panel ← softkey.

   h. Press the `copy options` softkey, and then press the `COPY IS PRT/PLT` softkey so that `PRT` is underlined.

   i. Press the front-panel (USER) key to return to the eye diagram analyzer's menu.

3. Press the front-panel (PRINT) key.

To get a plot

Note   Hard copies can be produced on an Hewlett-Packard plotter if the eye diagram analyzer is in pattern mode. Plots cannot be produced in eye or eyeline modes.

1. Connect the plotter to the display via an HP-IB cable.

   Be sure to connect the HP-IB to the display's connector and not to the connector on the HP 70820A microwave transition analyzer module.

2. The first time the plotter is used, enter the plotter type and address:

   a. Press the front-panel `DISPLAY` key.

   b. Press the `Hard Copy` softkey.

   c. Press the `plotter address` softkey.

   - To configure the plotter in talk/listen mode on the HP-IB, use the `HP-IB TLK/LSN` softkeys to enter the plotter's address.

   - To configure the plotter in listen only mode on the HP-IB, press the `HP-IB L ONLY` softkey.

   - To configure the plotter via the HP-MSIB, enter its address using `HP-MSIB COLUMN` and `HP-MSIB ROW` softkeys.

   d. Press the front-panel ← softkey.

   e. Press the `plotter config` softkey.

   f. Use the softkeys along the right side of the display to enter the plotter scaling points and select pen numbers.

   Normally, the scaling points do not need to be changed from the default values.

   g. Press the front-panel `←` key.

   h. Press the `copy options` softkey, and then press the `COPY IS PRT/PLT` softkey so that `PLT` is underlined.

   i. Press the front-panel `USER` key to return to the eye diagram analyzer's menu.

3. Press the front-panel `PLOT` key.

4

HP 70820A Menus

This chapter discusses the softkey menus for the HP 70820A microwave transition analyzer module. To learn about the eye diagram analyzer's menus, refer to Chapter 3. These menus provide additional features useful to running the eye diagram analyzer. The *HP 71500 Series Reference* contains menu maps, softkey definitions, and other important information.

If you intend to program the HP 70820A, refer to the *HP 71500 Series Programmer's Guide*. You'll find the preview feature that is discussed in this chapter very useful. It displays the corresponding programming command in response to most softkeys presses.

The remaining chapters of this book present features available through the HP 70820A menus.

(MENU)   This chapter documents features available with the HP 70820A menus. To access these menus, press (MENU). Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the (MENU) key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing (USER).

HP 70820A Features

Most front-panel controls are accessed via softkey menus. Softkeys are the seven buttons located on each side of the screen. The functions of softkeys change according to the menus displayed on the screen.

Sweep
control

Sweep
triggering

Control of
4 traces

Vertical
scale

Places
moveable
marker on
traces

Configuration

Leads to
6 remaining
menus

R TSE (hp)

Main

Trigger

Traces

Scale

Markers

Config

page
1 of 2

Tr1=Ch1
25 mV/div
0 V ref

0 s   10 ns/div
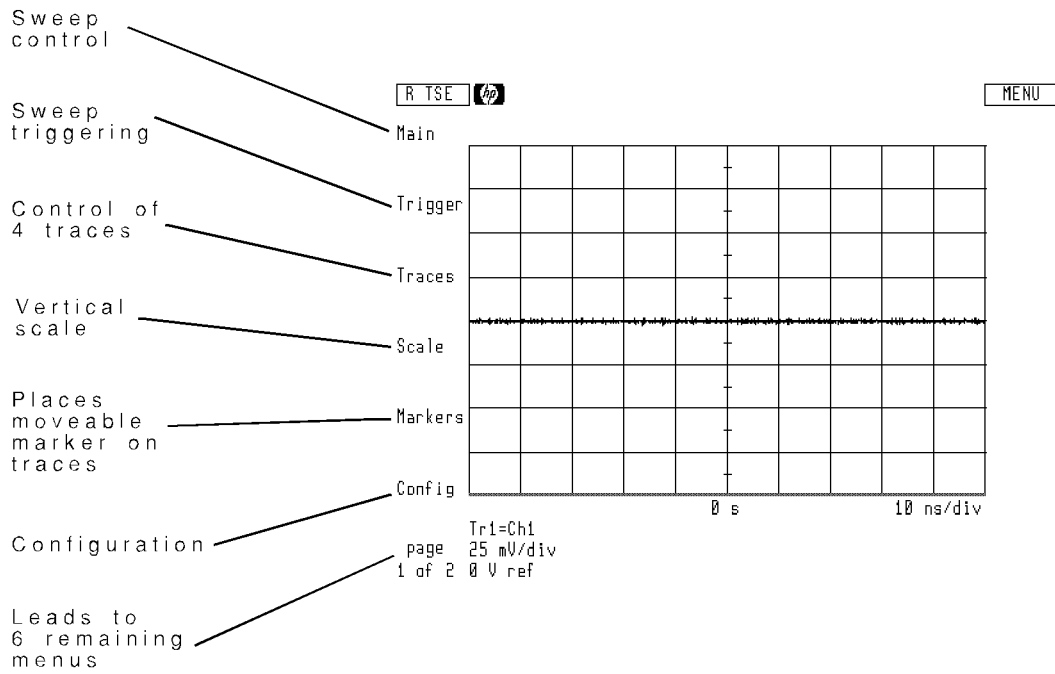
MENU

Page 1 of top level menus.

Left-side softkeys

Use the softkeys located on the left side of the display to access the twelve major menus. These softkeys are shown in two *pages*. Press the `page 1 of 2` to view the second page of softkeys. When the HP 70820A module first turns on, the Main menu is automatically selected.
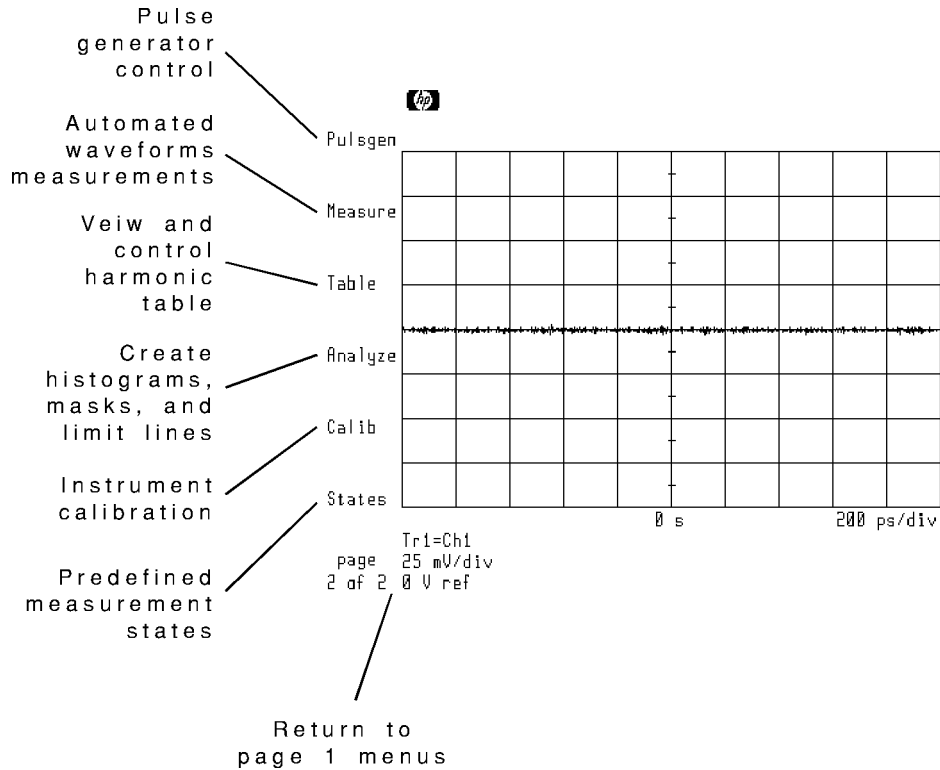
Page 2 of top level menus.

Measure fast amplitude and phase transitions

The HP 70820A module measures fast amplitude and phase transitions on continuous wave (CW) and modulated signals. Time, frequency, and power sweeps can be performed from dc to 40 GHz. The HP 70820A module triggers on the RF input signal.

During stimulus/response measurements, the HP 70820A module controls an RF source instrument's:

■ frequency

■ power

■ pulse modulator

Viewing repetitive and non-repetitive signals

Because of the sampling techniques employed by the HP 70820A, the HP 70820A module is optimized for viewing repetitive input signals. However, there is single-shot operation for viewing baseband and modulated non-repetitive signals having bandwidths up to 10 MHz. Pre-trigger data can also be viewed. An example of using the single shot operation is measuring the turn-on characteristics of a pulse modulator. Single shot operation uses a maximum sampling rate of 20 MHz.

For optimum performance

The HP 70820A module should be configured to:

■ Control the RF source over the communications bus.

■ Share the same frequency reference as the RF source.

Channels versus traces

The HP 70820A module has two input channels, four traces, and four trace memory registers. The figure on the following page shows the location of channels 1 and 2.

■ Channels are used to measure input signals.

■ Traces are used to display measurement results.

■ Trace memory registers can be used as a third channel.

To view HP 70820A menus

- Press (MENU).

To return to eye diagram analyzer

1. Press (USER).

2. If the eye diagram analyzer's menus are not displayed, load the program as explained in chapter 1.

3. An additional press of (USER) displays the menus for Instrument BASIC.

To preview programming commands

1. Press (MENU).

2. Press left-side `Config` softkey in the HP 70820A menu.

3. Press `more 1 of 3`.
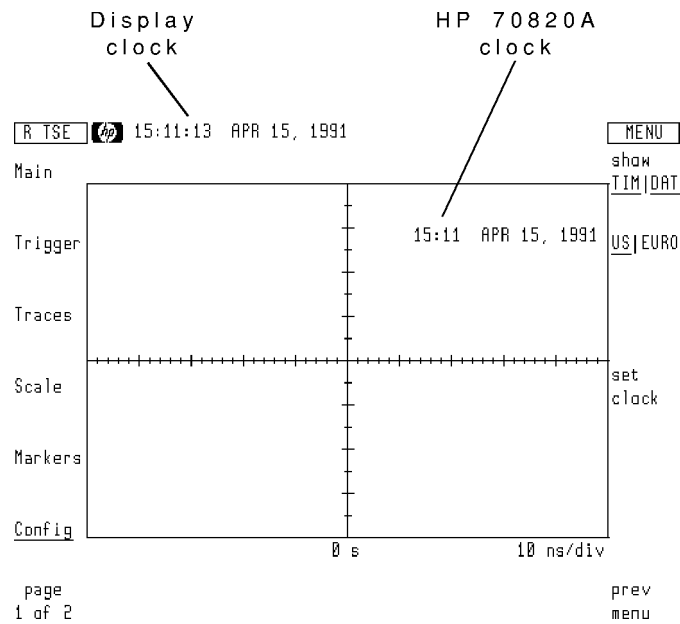
4. Press `preview ON|OFF` so that `ON` is underlined.

   As an example of the preview feature, press `persist ON|OFF`. Notice that the corresponding programming command `DISP:PERS 1024` is displayed at the bottom of the graticule.

To view the firmware date code

1. Press (MENU).

2. Press the left-side `Config` softkey.

3. Press `more 1 of 3` and then `more 2 of 3`.

4. Press `system`.

5. Press `ROM VERSION`.

Displaying the date and time

There are two clocks that can be displayed on the screen: the display's clock and the HP 70820A module's clock. You can control whether the clocks are displayed, the indicated time, and the display format. When the mainframe is turned on, the display sets the clock in the HP 70820A module. This causes both clocks to indicate the same time.

```
      Display                      HP 70820A
       clock                         clock
         |                             |
┌─────┐ ┌──┐                         ┌──────┐
│R TSE│ │hp│ 15:11:13  APR 15, 1991  │ MENU │
└─────┘ └──┘                         └──────┘
Main                                   show
      ┌──────────────────┬──────────────────┐ TIM|DAT
      │                  │                  │
Trigger                  │  15:11  APR 15, 1991 US|EURO
      │                  │                  │
Traces                   ┤                  │
      │                  │                  │
      ├─────────────────┼─────────────────┤
Scale │                  │                  │ set
      │                  │                  │ clock
      │                  │                  │
Markers                  ┤                  │
      │                  │                  │
Config│                  │                  │
      └──────────────────┴──────────────────┘
                        0 s          10 ns/div

 page                                  prev
 1 of 2                                menu
```

To control the HP 70820A's clock

1. Press `MENU`.

2. Press the left-side `Config` softkey.

3. Press `more 1 of 3` and then `clock`:

   ■ Press `show TIM|DAT` to display the time or date.

      A portion of the softkey label is underlined to indicate your selection. Both time and date can be displayed simultaneously.

   ■ Press the `US|EURO` to select US or European display format.

   ■ Press `set clock` to change the time or date.

      Enter the new value in the same format as displayed.

To control the display's clock

1. Press `DISPLAY` to show the display's menus.

2. Press the left-side `Misc` softkey.

3. Press `clock`:

   ■ Press `CLOCK DISPLAY` to turn the clock display on and off.

   ■ Press `US/EURO` to select US or European display format.

   ■ Press `set clock` to change the time or date.

      Enter the new value in the same format as displayed.

5

HP 70820A:
Trace Histograms

MENU   This chapter documents features available with the HP 70820A menus. To access these menus, press MENU. Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the MENU key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing USER.

The HP 70820A menus can perform statistical analysis on any displayed trace. After creating a vertical or horizontal histogram of the trace data, the display can show mean and standard deviation values of the histogram.

Generating Histograms

Histogram analysis is performed using the Histogram menu. (Press (MENU), the left-side page 1 of 2, Analyze, and then Histogm to enter the menu.) The HP 70820A menus perform vertical or horizontal histograms on any single trace.

You can control the number of samples taken, the window for valid data samples, and the sample bounds for calculating mean and standard deviations.
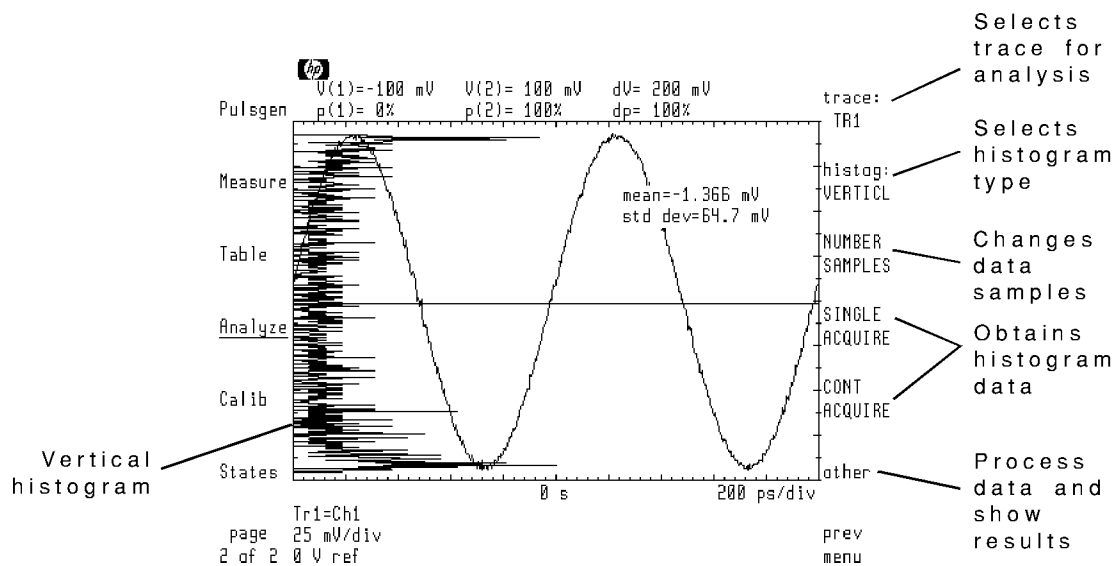
The Histogram menu

When generating histograms, you must perform the following basic steps:

1. Select a trace.
2. Select histogram type.
3. Enter the number of samples.
4. Set limits for acquired data.
5. Acquire the data.
6. Establish limits for statistical analysis.
7. View the mean and standard deviation.

Histogram data can be acquired once using the `SINGLE ACQUIRE` softkey or continuously updated using the `CONT ACQUIRE` softkey.

Horizontal histogram

Press `other` **for this additional menu**
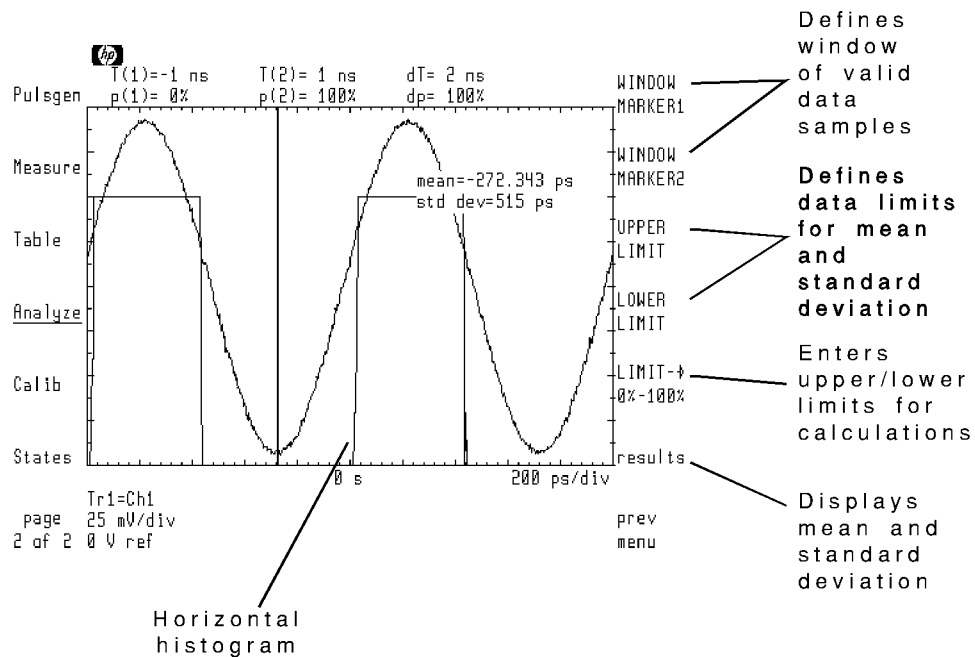
Tutorial: Creating a Vertical Histogram

This tutorial creates a vertical histogram on data taken from sine wave. However, the procedure works for any type of waveform.

Select the histogram type

1. Display a trace to perform statistical analysis on.

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `histogm` to enter the Histogram menu.

4. Press the `trace:` softkey, and select the trace to perform statistical analysis on.

5. Press the `histog:` softkey.

6. Press the `VERTICL HISTOGM` softkey so that the softkey text is underlined.

Acquire the data

7. Press `other`.

8. Use the `WINDOW MARKER1` and `WINDOW MARKER2` softkeys to define a window for taking histogram data.

   Notice that the values at the marker positions are indicated at the top of the display.
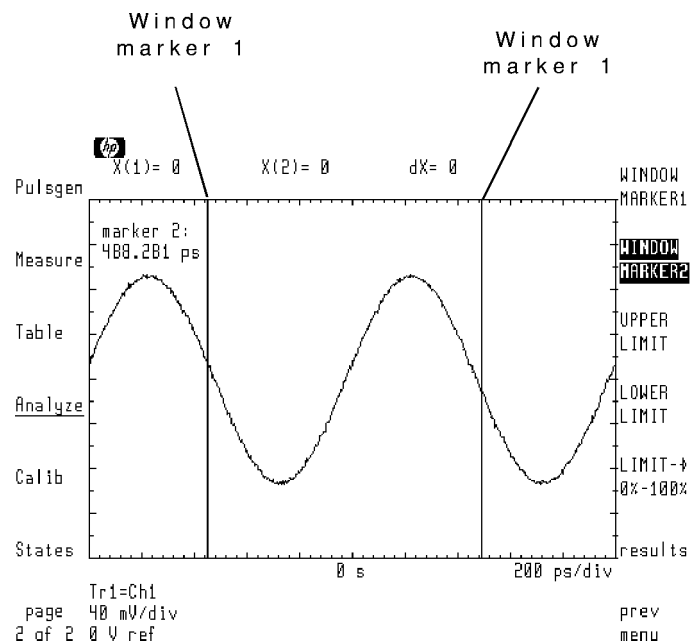
9. Press `prev menu` and then `NUMBER SAMPLES` softkeys. If desired, change the number of samples taken for the histogram.

   The default number of samples taken is 1000.

10. Press the `SINGLE ACQUIRE` softkey to draw the vertical histogram.

Data will be acquired once. To continually acquire and update the histogram, press `CONT ACQUIRE` instead.

```
                              (hp)
                     Pulsgen                                    trace:
                                                                TR1
                                                                histog:
                     Measure                                    VERTICL

                     Table                                      NUMBER
                                                                SAMPLES

                     Analyze                                    SINGLE
  Vertical                                                      ACQUIRE
  histogram
                     Calib                                      CONT
                                                                ACQUIRE

                     States                                     other
                                        0 s      200 ps/div
                     Tr1=Ch1
              page   40 mV/div                                  prev
              2 of 2  0 V ref                                   menu
```
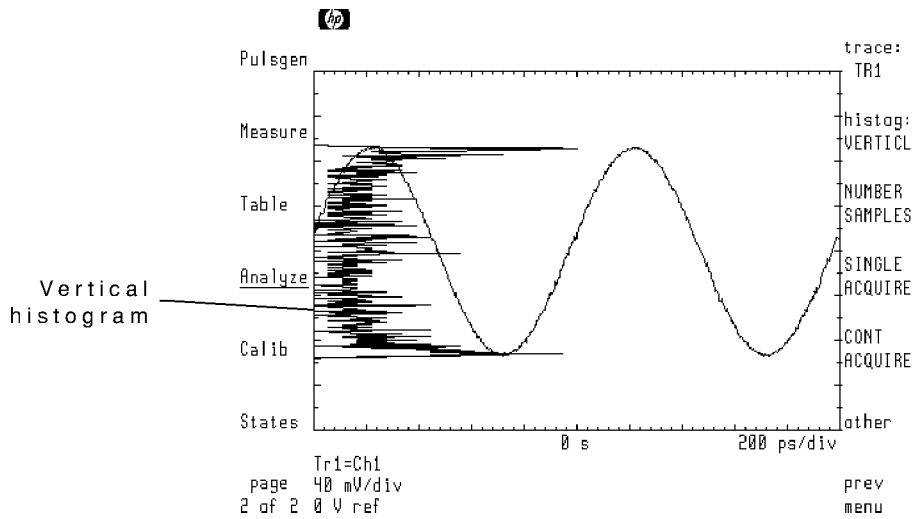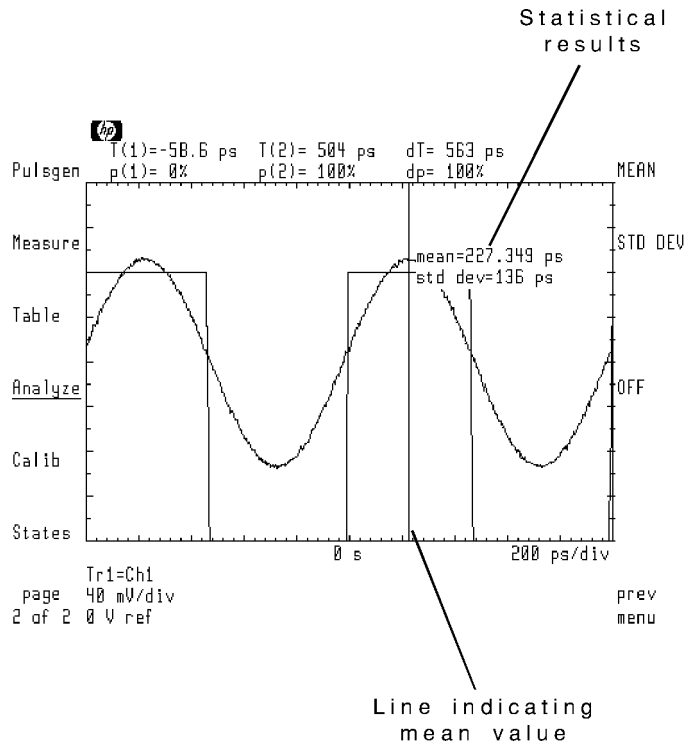
Perform statistical analysis

11. Press `other`.

12. The range of sample points used to calculate the mean and standard deviation is the full screen. If you desire to change these limits, perform the following:

    a. Use the `UPPER LIMIT` and `LOWER LIMIT` softkeys to enter the new limits.

       Notice that the values at the limit-line positions are indicated at the top of the display.

    b. Press the `LIMIT→ 0%-100%` softkey to enter the new upper limit and lower limit values for the calculations.

Upper limit line

Lower limit line

```
        V(1)=-103 mV    V(2)= 101 mV    dV= 204 mV      WINDOW
Pulsgen p(1)= 0%        p(2)= 100%      dp= 100%        MARKER1

        lower limit:                                    WINDOW
Measure -103.125 mV                                     MARKER2

Table                                                   UPPER
                                                        LIMIT

Analyze                                                 LOWER
                                                        LIMIT

Calib                                                   LIMIT-→
                                                        0%-100%

States                                                  results
                        0 s             200 ps/div
        Tr1=Ch1
page    40 mV/div                                       prev
2 of 2  0 V ref                                         menu
```
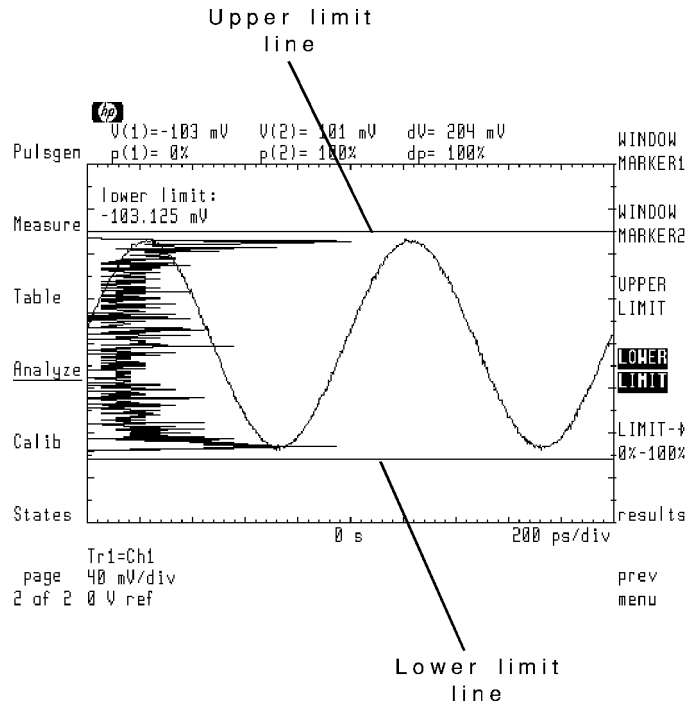
13. Press the `results` softkey.

14. Press the `MEAN` softkey to display a line indicating the location of the mean. The mean and standard deviation values are also indicated.

15. Press the `STD DEV` softkey to display a line indicating the location of the standard deviation.

Statistical
results

Line indicating
mean value
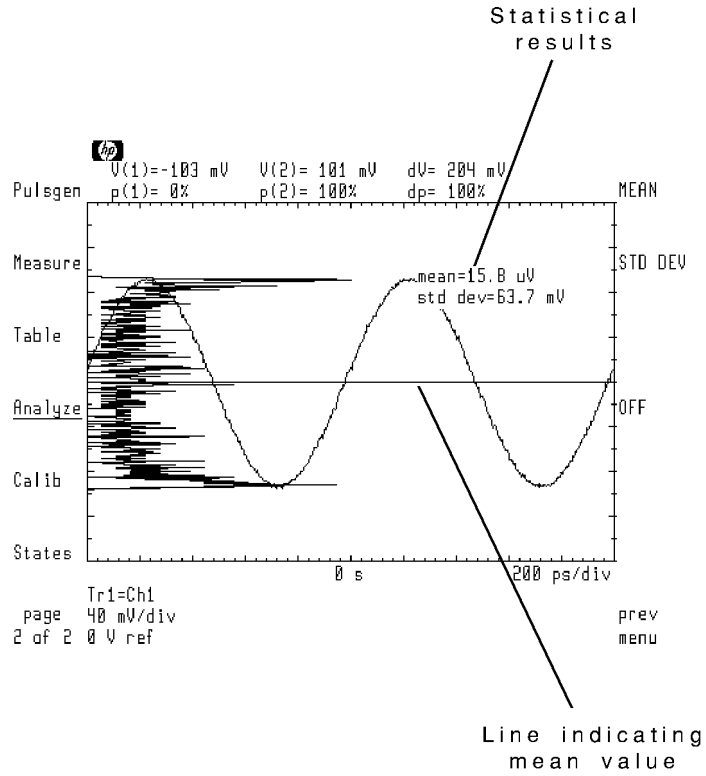
Tutorial: Creating a Horizontal Histogram

This tutorial creates a horizontal histogram on data taken from sine wave. However, the procedure works for any type of waveform.

Select the histogram type

1. Display a trace to perform statistical analysis on.

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `histogm` to enter the Histogram menu.

4. Press the `trace:` softkey, and select the trace to perform statistical analysis on.

5. Press the `histog:` softkey.

6. Press the `HORZNTL HISTOGM` softkey so that the softkey text is underlined.

Acquire the data

7. Press `other`.

8. Use the `WINDOW MARKER1` and `WINDOW MARKER2` softkeys to define a window for taking histogram data.

   Notice that the values at the marker positions are indicated at the top of the display.
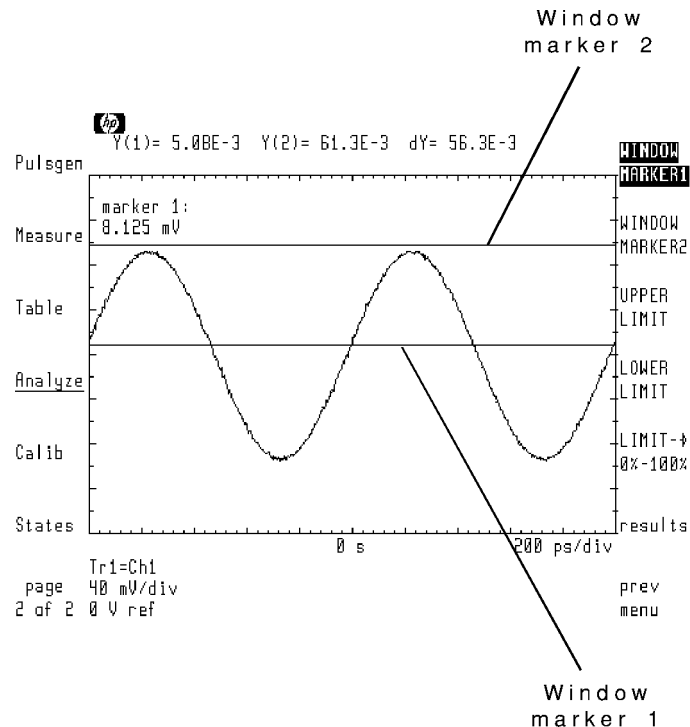
9. Press the `prev menu` and then `NUMBER SAMPLES` softkeys. If desired, change the number of samples taken for the histogram.

   The default number of samples taken is 1000.

10. Press the `SINGLE ACQUIRE` softkey to draw the vertical histogram.

    Data will be acquired once. To continuously acquire and update the histogram, press `CONT ACQUIRE` instead.

Horizontal histogram
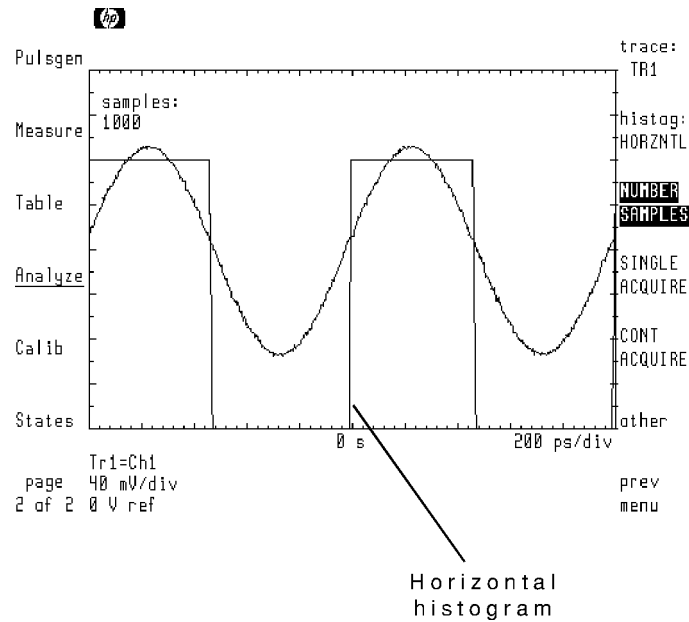
Perform statistical analysis

11. Press `other`.

12. Use the `UPPER LIMIT` and `LOWER LIMIT` softkeys to indicate the range of sample points used to calculate the mean and standard deviation.

Lower limit line   Upper limit line
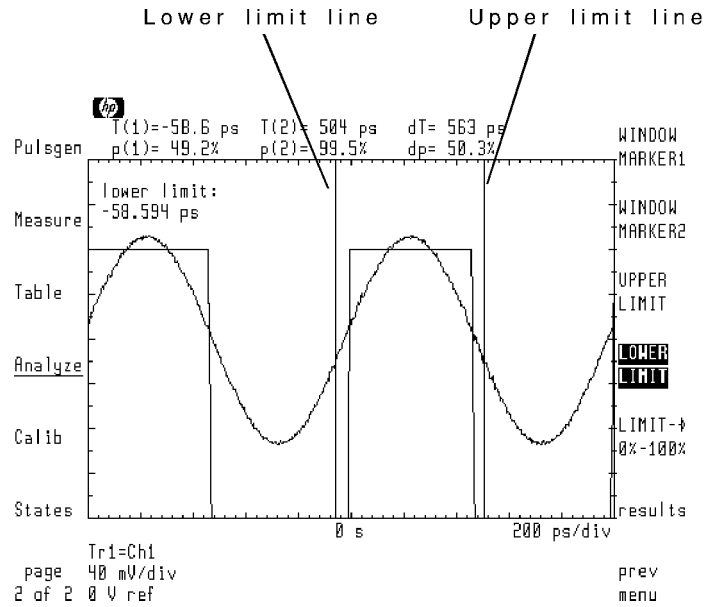
13. Press the `LIMIT→ 0%-100%` softkey to enter the upper limit and lower limit values for the calculations.

14. Press the `results` softkey.

15. Press the `MEAN` softkey to display a line indicating the location of the mean. The mean and standard deviation values are also indicated.

16. Press the `STD DEV` softkey to display a line indicating the location of the standard deviation.

Statistical
results

T(1)=-58.6 ps   T(2)= 504 ps   dT= 563 ps
p(1)= 0%   p(2)= 100%   dp= 100%

Pulsgen   MEAN

Measure   STD DEV

                        mean=227.349 ps
                        std dev=136 ps

Table

Analyze   OFF

Calib

States
            0 s   200 ps/div

        Tr1=Ch1
page   40 mV/div   prev
2 of 2 0 V ref   menu

Line indicating
mean value

6

HP 70820A:
Masks and Limit Lines

$\boxed{\text{MENU}}$ This chapter documents features available with the HP 70820A menus. To access these menus, press $\boxed{\text{MENU}}$. Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the $\boxed{\text{MENU}}$ key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing $\boxed{\text{USER}}$.

Masks and limit lines allow you to test the shape (time or frequency versus amplitude) of a displayed response. Masks are closed polygon shapes. Limit lines are lines. Traces or measurement points that penetrate a mask or cross a limit line result in testing errors.
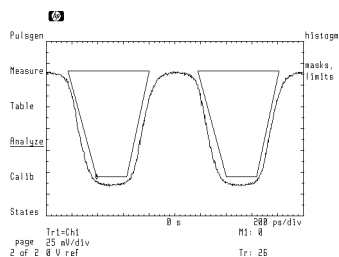
Two masks displayed on screen.
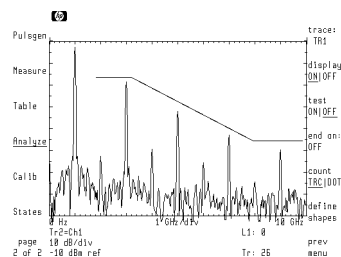
A limit line displayed on screen.

Because you can perform repetitive testing of response shapes, masks and limit lines are ideal for pass/fail testing on production lines. You create, save, recall, and edit limit lines using the `masks, limits` menu. Access this menu using the left-side `Analyze` softkey.

Since masks and limit lines are treated similarly, in this chapter, most references to masks applies equally to limit lines.

Creating Masks

The HP 70820A menus allow you to create and display up to eight limit lines and masks at one time. Five default mask/limit-line shapes are provided for your use:

1. Hexagon.
2. Square.
3. Equilateral triangle.
4. Inverted equilateral triangle.
5. Flat line.

You can stretch, shrink, or move any mask. Its also easy to add additional points or delete unneeded points from any shape. Both limit lines and masks can establish either upper or lower limits for a response.

To create a mask

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `masks, limits` and then `define shapes`.

4. Press `type:`. If you're going to create a mask, press `MASK`. If you're going to create a limit line, press `UPPER LIMIT` or `LOWER LIMIT`.

5. Press `default shapes` and select the shape that most closely matches the mask you need.

6. Press `edit`.

7. If multiple masks/limit lines are displayed, use the `SELECT` softkey to select the mask or limit line that is going to be edited.

8. Press (HOLD) so that `SELECT` is not highlighted.

   ■ To move a point:

      a. Press the (⇑) and (⇓) keys to select the point.

      b. Press `move X|Y`.

         Notice that the `X` and `Y` in the softkey label indicate the direction the selected point will move.

      c. Rotate the front-panel knob to move the point. (Or, use the numeric keypad.)

   ■ To add a point:

      a. Press the (⇑) and (⇓) keys to select a point.

         On masks, it is best to select the closest point counterclockwise from the one you intend to add.

      b. Press `ADD POINT` to add a point at the location of the currently selected point.

         This inserts a point between the point at the current location and the next point.

c. Press `move X|Y` to select the direction for moving the new point.

d. Rotate the front-panel knob to move the point.

■ To delete a point:

a. Press the ⇑ and ⇓ keys to select the point.

b. Press `DELETE POINT`.

9. Press `prev menu`.

10. Use the `scale X|Y` and `offset X|Y` softkeys to stretch, reduce, or move the mask.

To erase a mask

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `masks, limits` and then `define shapes`.

4. Press `edit`.

5. Press `SELECT`, and enter the number of the mask or limit line you need to erase.

6. Press `delete shapes`.

7. Press `DELETE CURRENT` to erase the mask.

8. You can erase all masks and limit lines by pressing `DELETE ALL`.

Testing Responses

Once you've created a mask or limit line, set the following conditions for testing:

- Trace to which testing is applied.

- Violations defined as traces or measurement points.

- Testing ends after a set number of errors.

- Testing ends after a set number of traces.

Use the `test ON|OFF` softkey to start testing. Testing stops whenever one of the following events occurs:

- A set number of trace sweeps.

- A set number of violations.

- `test ON|OFF` is set to `OFF`.

Numbers displayed at the bottom of the screen indicate the number of violations and trace sweeps that have occurred. The following figure shows a response that has violated a limit line three times on three sweeps.
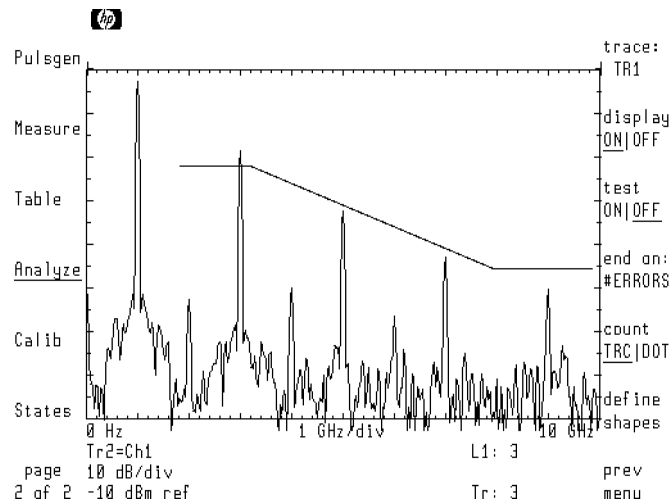
To start testing

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `masks, limits`.

4. Create a mask.

5. Press `trace:`, and select the trace for testing.

6. Use the `count TRC|DOT` softkey to indicate whether traces (`TRC`) or measurement point (`DOT`) violations are counted as errors.

7. Press `end on:`.

8. If you want testing to stop after a set number of errors, press `#Errors ON|OFF` so that `ON` is underlined. Enter the desired number of errors.

9. If you want testing to stop after a set number of traces, press `#Traces ON|OFF` so that `ON` is underlined. Enter the desired number of traces.

10. Press `test ON|OFF` so that `ON` is underlined to begin testing.

Saving, Recalling, and Cataloging Masks/Limit Line Files

Masks and limit lines can be saved in files and recalled for later use. This section shows you how to accomplish this task using the HP 70820A module's `mass storage` menu. (You can also save, recall, and erase mask/limit line files using the eye-diagram analyzer's `Mass Storage` menu.)

The files are saved to default memory. To select default memory, refer to "Selecting and Formatting Memory" in Chapter 9. Each file has a file name that consists of the prefix $m\_$ followed by a custom name that you enter. The prefix identifies the file as a mask or limit line.

Although eight masks or limit lines can be displayed at one time, only slope 1 is nonvolatile. All other masks are erased by turning the power off. Pressing (INSTR PRESET) does not erase the slopes.

```
Pulsgen                                              msi:
                                                     HP-MSIB
        ┌──────────────────────────────────────┐
Measure ┤                                       ├    ┤PREV
        │                                       │    ┤PAGE
        │                                       │
Table   │                                       │    ┤NEXT
        │                                       │    ┤PAGE
        ├──────────────────────────────────────┤
        │Prefix: ''                             │
Analyze │MSI: HP-MSIB,4        Page 1           │    LOAD
        │                                       │    FILE
        │ ▌m_Shape_1  ASCII   2560▐             │
        │  m_Shape_2  ASCII   2560              │
Calib   │     (end of catalog)                  │    save
        │                                       │
        │                                       │
States  │                                       │    more
        │                                       │
        │                                       │
  page  │                                       │    prev
 2 of 2 └──────────────────────────────────────┘    menu
```

Catalog of files in memory.

To save a mask/limit line file

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Analyze` softkeys.

3. Press `masks, limits`.

4. Create a mask using the mask limits menu.

5. Press the `States` softkey.

6. Press `more 1 of 2`, and then `mass storage`.

7. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in chapter 9.

8. Press `save`, `save misc`, and then `SAV MSK LIM`.

9. Use the softkeys, knob, numeric keypad, and step keys to create a file name.

10. Press `ENTER LINE` to save the file.

Note   An HP-IL keyboard is recommended to simplify the task of entering alphanumeric information. This keyboard plugs into the jack provided on the display's front panel. Order the keyboard using the following part numbers:

keyboard .... HP 46021A

HP-IL cable 46020-60001

Note   ■ Turn the front-panel knob to move the character-select cursor.
■ Press `SELECT CHAR` to enter a character at the character-select cursor.
■ Press the numeric keypad to enter numbers or a minus sign.
■ The `INSERT or . . .` softkey determines the action of the `SELECT CHAR` softkey. Choices are INSERT a character, REPLACE an existing character, or DELETE a character.
■ Press the (⇓) and (⇑) keys (beneath the front-panel knob) to move the command-entry cursor.
■ Use the `CLEAR TO END` softkey to remove characters from the command-entry cursor to the end of the command.

To recall a mask/limit line file

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in chapter 9.

5. Rotate the front-panel knob to select (highlight) the desired file.

6. Press `LOAD FILE`.

To erase a mask file/limit line file

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in chapter 9.

5. Press `more`.

6. Rotate the front-panel knob to select (highlight) the desired file.

7. Press `PURGE FILE` to erase the file.

To catalog files in memory

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in chapter 9.

7

HP 70820A:
User-Corrections

This chapter documents features available with the HP 70820A menus. To access these menus, press MENU. Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the MENU key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing USER.

User-corrections provide a convenient method for modifying the display of input signals. Some of the applications for user-corrections include the following:

■ Filtering input signals to simulate the effects of circuit design.

■ Compensating for frequency and phase response of external probes.

■ Compensating for frequency and phase response of external test setups.

■ Compensating for the frequency response of optical to electrical converters.

Note   User corrections can only be applied in eyeline and pattern modes. User corrections are turned off in eye mode.

Loading the Supplied Software Filters

Several Bessel-Thomson software filters are included on the HP 70874A eye diagram analyzer's memory card. These filters can be applied as user corrections in the eyeline and pattern modes. (User corrections must be off in eye mode.) User correction files are identified by the prefix a_ as shown in the following table. Two additional files on the card, AUTOST and HP70874, comprise the eye diagram analyzer program.

Supplied User Correction Files

File Name	File Data
a_bt248832	4th order Bessel-Thomson filter for 2.48832 Gbit/sec transmission.
a_bt_62208	4th order Bessel-Thomson filter for 622.08 Mbit/sec transmission.
a_bt_15552	4th order Bessel-Thomson filter for 155.52 Mbit/sec transmission.

To load a filter

1. Place the HP 70874A eye diagram analyzer memory card in the front-panel card slot.

   The HP 70874A eye diagram analyzer must already be loaded into memory.

2. Press (USER) to display the eye diagram analyzer's menus.

3. Press the left-side `Setup` softkey.

4. Press `diagram`, and then select either `EYELINE` or `PATTERN`. User corrections can not be applied in eye mode.

5. Press the left-side `Mass Storage` softkey.

6. A catalog of the files contained on the memory card should be displayed as shown in the following figure.

```
Setup                                              PREV
                                                   PAGE

Trg,Cal                                            NEXT
                                                   PAGE

Traces

           Prefix: ''
Measure    MSI: HP-MSIB,4        Page 1            LOAD
                                                   FILE
           AUTOST      ASCII     1280
           a_bt248832 ASCII     1536              PURGE
Markers    a_bt_62208 ASCII     1536              FILE
           a_bt_15552 ASCII     1536
           HP70874A    ASCII     112k
Masks          (end of catalog)                   SAVE
                                                   STATE

Mass                                               SAVE
Storage                                            MSK,LIM
```

7. Rotate the front-panel knob to highlight the desired file.

   User correction files are identified by the prefix `a_`.

8. Press `LOAD FILE`. The file is loaded when `user corrections loaded` is displayed on the screen.

9. Press the left-side `Trg,Cal` softkey.

10. Press `more 1 of 2` and then `usr cor ON|OFF` so that `ON` is underlined.

User corrections applied to the data.

Learning About User Corrections

To create and use your own user corrections, enter the User Correction menu. (This menu is located under the HP 70820A's Calib menu.) The microwave transition analyzer maintains two separate user-correction memories: one for channel 1 and one for channel 2. After entering the User Correction menu, the microwave transition analyzer displays user-correction data in the lower half of the screen. The screen's upper half remains dedicated to showing the normal display. Or, if the displayed trace is assigned to the data, the trace shows a graphical representation of the filter as the following figure shows. To learn how to assign a trace to user corrections, refer to "Viewing User-Correction Data" in this chapter.

```
Pulsgen                                                          CH1|CH2

Measure                                                          usr cor
                                                                 ON|OFF

Table                                                            SEL|EDT

                                             path to
Analyze       FREQ        MAGN       PHASE   next FREQ           SLOPE |
                                                                FLAT
           dc value     0.00 dB     0.00 deg   slope
          1.866240 GHz  -3.01 dB    0.00 deg   slope            INSERT
Calib     2.488320 GHz  -5.71 dB    0.00 deg   slope            LINE
          4.976640 GHz  -21.50 dB   0.00 deg   slope
          100.0000 GHz  -21.50 dB   0.00 deg

States                                                          other

 page                                                           prev
2 of 2                                                          menu
```
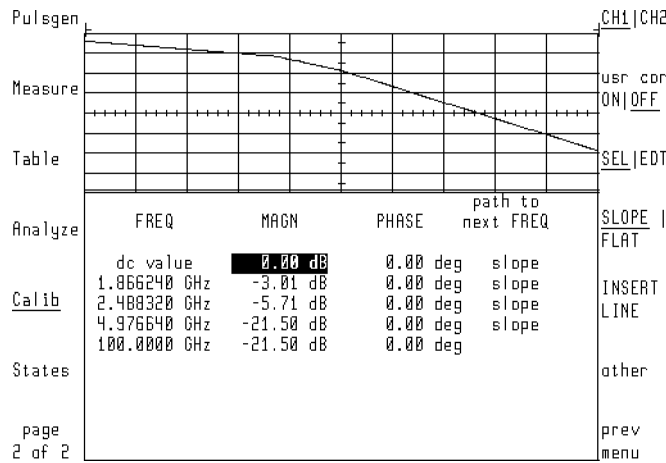
User Corrections.

User corrections always contain at least two default lines of data as shown in the following figure. While these two lines of data cannot be removed, you can modify their magnitude or phase values. New lines of data are easily added. Each line of data consists of FREQuency, MAGNitude, PHASE, and path to next FREQ fields. The path to next FREQ field determines how data is interpolated between two adjacent user correction frequency points. The path to the next user correction point can be a linear slope (this is the default), log slope, or flat line.
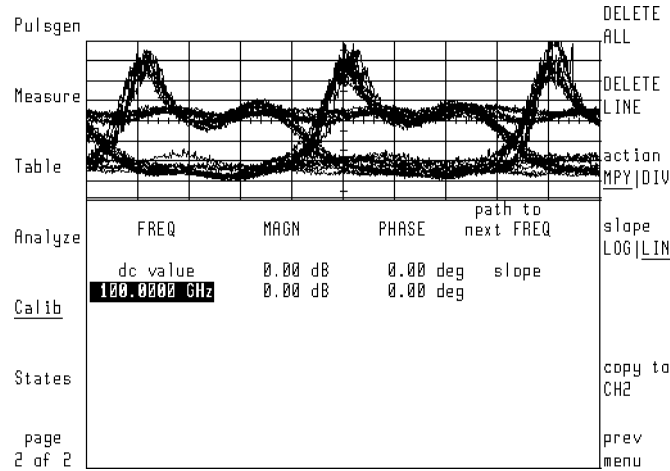
Default data

You enter user correction data using one of the following two methods:

■ manually using front-panel keys *or*

■ storing the results of a sweep to user correction memory

To enter the user correction menu

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

3. Press the `user corr` softkey to enter the User Correction menu.

To select a channel for user corrections

1. Enter the User Correction menu as explained in the preceding section.

2. To select channel 1, press the `CH1|CH2` softkey to underline `CH1`.

3. To select channel 2, press the `CH1|CH2` softkey to underline `CH2`.

To turn user corrections on and off

■ Using the `MENU` softkeys:

  1. Enter the User Correction menu.

  2. Press the `usr cor ON|OFF` softkey so that `ON` or `OFF` is underlined.

■ Using the `USER` softkeys:

  1. Press the left-side `Trg,Cal` softkey.

  2. Press `more 1 of 2` and then `usr cor ON|OFF` so that `ON` or `OFF` is underlined.

To delete a channel's user corrections

1. Enter the User Correction menu.

2. Use the `CH1|CH2` softkey to select the channel.

3. Press the `other` softkey.

4. Press the `DELETE ALL` softkey.

5. Press the `CONFIRM DEL ALL` softkey to delete all corrections, or press the `ABORT DEL ALL` to abort the deletion process.

Entering and Editing User Corrections

The User Correction menu provides softkeys for entering and editing lines of user-correction data. To view user-correction data graphically at the same time it is created, refer to "Viewing User-Correction Data" in this chapter.

The `SEL|EDT` softkey determines whether the front-panel knob and arrow keys select a field for editing the current field's data. New lines can be entered between the first and last lines. Refer to "To enter a line of data" in this section.

The microwave transition analyzer interpolates the data between adjacent points. Interpolation between the defined points can be either slope or flat line. If slope is selected, the `slope LOG|LIN` softkey determines whether slopes are linear or logarithmic. To locate this softkey, press `other` in the User Correction menu.

```
Pulsgen                                                    DELETE
                                                           ALL

Measure                                                    DELETE
                                                           LINE

Table                                                      action
                                                           MPY|DIV

                                           path to         slope
Analyze        FREQ        MAGN      PHASE  next FREQ       LOG|LIN

             dc value     0.00 dB    0.00 deg    slope
Calib       100.0000 GHz  0.00 dB    0.00 deg


States                                                     copy to
                                                           CH2

  page                                                     prev
 2 of 2                                                    menu
```
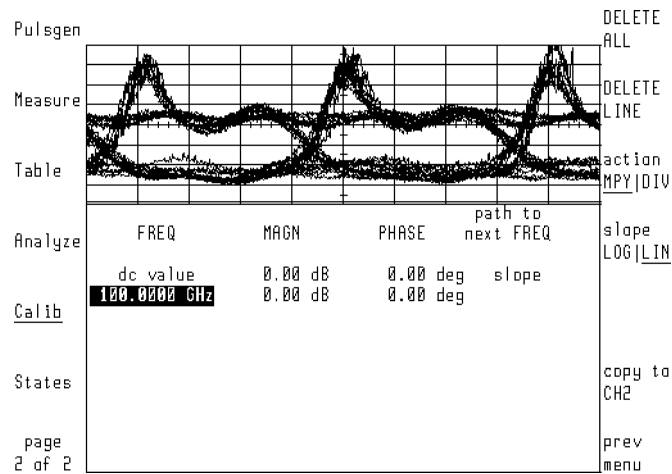
The following two figures show the effect of selecting linear slope and flat types. The trace graphically shows the filter. With the exception of the `path to next FREQ` field, the data in each filter is identical.

```
Pulsgen                                                    CH1|CH2

Measure                                                    usr cor
                                                           ON|OFF

Table                                                      SEL|EDT

                                              path to      SLOPE |
Analyze        FREQ        MAGN       PHASE   next FREQ     FLAT

            dc value     0.00 dB     0.00 deg   slope
            1.866240 GHz  -3.01 dB   0.00 deg   slope      INSERT
Calib       2.488320 GHz  -5.71 dB   0.00 deg   slope      LINE
            4.976640 GHz -21.50 dB   0.00 deg   slope
            100.0000 GHz -21.50 dB   0.00 deg

States                                                     other

   page                                                    prev
  2 of 2                                                   menu
```

```
Pulsgen                                                    CH1|CH2

Measure                                                    usr cor
                                                           ON|OFF

Table                                                      SEL|EDT

                                              path to      SLOPE |
Analyze        FREQ        MAGN       PHASE   next FREQ     FLAT

            dc value     0.00 dB     0.00 deg   flat
            1.866240 GHz  -3.01 dB   0.00 deg   flat       INSERT
Calib       2.488320 GHz  -5.71 dB   0.00 deg   flat       LINE
            4.976640 GHz -21.50 dB   0.00 deg   flat
            100.0000 GHz -21.50 dB   0.00 deg

States                                                     other

   page                                                    prev
  2 of 2                                                   menu
```

To enter a line of data

1. In the User Corrections menu, press the `SEL|EDT` softkey so that `SEL` is underlined.

2. New lines are added just above the highlighted line. Use the front-panel knob or arrow keys to highlight any field of the line which is to be below the new inserted line.

3. Press the `INSERT LINE` softkey.

To edit a line of data

1. In the User Corrections menu, use the front-panel knob or arrow keys to highlight a field in the line.

2. Press the `SEL|EDT` softkey so that `EDT` is underlined.

3. Use the front-panel knob, step keys, or numeric keypad to change the displayed value.

    If you are editing the `path to next FREQ` field, press the `SLOPE | FLAT` softkey to change the value.

To delete a line of data

1. In the User Corrections menu, press the `SEL|EDT` softkey so that `SEL` is underlined.

2. Use the front-panel knob or arrow keys to highlight any field in the line you wish to delete.

3. Press the `other` softkey.

4. Press the `DELETE LINE` softkey.

To select flat-line interpolation

1. In the User Corrections menu, press the `SEL|EDT` softkey so that `SEL` is underlined.

2. Use the front-panel knob or arrow keys to highlight the desired `path to next FREQ` field.

3. Press the `SLOPE | FLAT` softkey so that `FLAT` is underlined.

To select logarithmic slope interpolation

1. In the User Corrections menu, press the `other` softkey.

2. Press the `slope LOG|LIN` softkey so that `LOG` is underlined.

    For logarithmic interpolation to take effect, the `path to next FREQ` field in the lines of data must be set to slope.

To copy user correction to alternate channel

1. In the User Corrections menu, press the `other` softkey.

2. Press the `copy to CH2` softkey.

    If channel 2 data is selected the softkey reads `copy to CH1`.

Viewing User-Correction Data

This section explains how to assign user-correction data to a trace. This allows you to view the data graphically. Graphically displaying the data is especially helpful when you are designing a custom filter. When a trace is assigned to user correction data, the display's horizontal axis automatically changes to frequency. The technique used to control the frequency scale depends on the microwave transition analyzer's sweep mode.

Setting the frequency scale for frequency sweeps

When using a frequency sweep, the frequency scales of the microwave transition analyzer and the user-correction trace are identical. The start and stop frequencies are the same. This includes any frequency offset.

Setting the frequency scale for time sweeps

When the microwave transition analyzer is performing time sweeps, the frequency scale of any user-correction trace is related to the sweep time. The start frequency is set to 0 Hz. The stop frequency is determined by the seconds-per-division setting. To set the stop frequency, use the following formula to determine the seconds-per-division setting, then set the sweep time using the Main menu's `SEC/DIV` softkey.

$$seconds/division = \frac{trace\ length}{20\ F_{stop}}$$

where:

trace length is determined by pressing `TRACE POINTS` in the Configuration menu.

F_{stop} equals the desired stop frequency in hertz.

For example, to set the stop frequency to 5 GHz with 512 trace points, set the time scale to 5.12 ns per division.

It should be noted that this formula also determines the frequency scale of any time domain trace that has been formatted to the frequency domain using an FFT. The advantage of using a trace formatted using an FFT is that the displayed upper frequency limit can be higher than the available range of many RF sources.

To view user corrections

1. Press `MENU`.

2. Press the left-side `Traces` softkey to enter the Traces menu.

3. Select a trace, and then press the `input:` softkey.

4. Use the front-panel knob to scroll the menu bar to `UCORR1` as shown in the following figure.

   `UCORR1` sets the trace to user-correction data for channel 1. `UCORR2` sets the trace to user-correction data for channel 2.

```
Main        TR1 = UCORR1                              CH1

                  CH1                                 CH2
Trigger       2 = CH2
            3,4 = CH1/CH2
                  CH2/CH1
Traces            CH1/MEM1                            CH1/CH2
                  CH2/MEM2
                  TABLE
Scale         1 = UCORR1                              CH2/CH1
                  UCORR2
                  (CH1/CH2)/MEM1
                  -(CH1/CH2)/MEM3
Markers           2*MAGN(CH1/CH2)/(MAGN(MEM2)+MAGN(MEM3))   MEMx

Config                                                build
                                                     eqn

  page                                               RETURN
 1 of 2
```

5. Press the RETURN softkey.

6. Press the left-side Main softkey to enter the Main menu.

7. Set the frequency scale of the user-correction trace:

   ■ If the microwave transition analyzer is set for a frequency sweep, use the Main menu's START and STOP softkeys.

   ■ If the microwave transition analyzer is set for a time sweep, press the Main menu's SEC/DIV softkey, and enter the sweep time to set the stop frequency. The formula to determine the sweep time is provided at the beginning of this section.

8. Press the left-side Scale softkey to enter the Scale menu.

9. Press the REF LEV|POS softkey, and set the reference level to correctly position the trace on screen.

10. If needed, press the SCALE softkey, and change the vertical amplitude scale.

11. Press the left-side Calib softkey.

12. Press the user corr softkey.

    The user correction data is now displayed graphically above the data.

Pulsgen

Measure

Table

Analyze

Calib

States

page
2 of 2

	FREQ	MAGN	PHASE	path to next FREQ
dc value		0.00 dB	0.00 deg	slope
1.866240 GHz		-3.01 dB	0.00 deg	slope
2.488320 GHz		-5.71 dB	0.00 deg	slope
4.976640 GHz		-21.50 dB	0.00 deg	slope
100.0000 GHz		-21.50 dB	0.00 deg	

CH1|CH2

usr cor
ON|OFF

SEL|EDT

SLOPE |
FLAT

INSERT
LINE

other

prev
menu
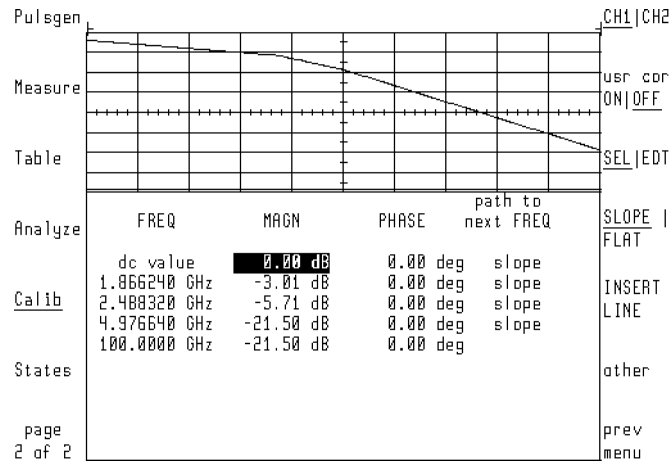
Saving, Recalling, and Cataloging
User-Correction Files

User-correction data can be saved in files and recalled for later use. This section shows you how to accomplish this task using the HP 70820A module's `mass storage` menu. (You can also save, recall, and erase user-correction files using the eye-diagram analyzer's `Mass Storage` menu.)

The files are saved to default memory. To select default memory, refer to "Selecting and Formatting Memory" in Chapter 9. Each file has a file name that consists of the prefix $a\_$ followed by a custom name that you enter. The prefix identifies the file as user-correction data.

Entering file names is made much easier if you have an HP 46021A keyboard and 46020-60001 keyboard cable.

To save a user-correction file

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2` and then `mass storage`.

4. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in Chapter 9.

5. Press `save`.

6. Press `SAVE USR COR`.

Note
- Turn the front-panel knob to move the character-select cursor.
- Press `SELECT CHAR` to enter a character at the character-select cursor.
- Press the numeric keypad to enter numbers or a minus sign.
- The `INSERT or . . .` softkey determines the action of the `SELECT CHAR` softkey. Choices are INSERT a character, REPLACE an existing character, or DELETE a character.
- Press the (⇓) and (⇑) keys (beneath the front-panel knob) to move the command-entry cursor.
- Use the `CLEAR TO END` softkey to remove characters from the command-entry cursor to the end of the command.

To recall a user-correction file

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Rotate the front-panel knob to select (highlight) the desired file.

5. Press `LOAD FILE`.

To erase a user-correction file

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in chapter 9.

5. Press `more`.

6. Rotate the front-panel knob to select (highlight) the desired file.

7. Press `PURGE FILE` to erase the file.

Tutorial: Constructing a Low-Pass Filter from a Transfer Function

This procedure builds a fourth order Bessel-Thomson filter characterizing SONET/SDH transmitters operating at 2.48832 Gbit/sec. The filter is loaded into channel 1 user-correction data. The user-correction data is based on the transfer function

$$H_{(p)} = \frac{105}{(105 + 105y + 45y^2 + 10y^3 + y^4).}$$

where:

$y = 2.1140p$
$p = j\omega/\omega_r$
$\omega_r = 1.5\pi f_0$
$f_0 = bit\ rate$

Note   This example of manually constructing a filter is useful as an example. To aid in the construction of 4th order Bessel Thomson filters at other frequencies, use the `MAKEFILT` program located on the `IBASIC UTILITIES FOR HP 71500 SERIES` memory card. This card is supplied with the eye diagram analyzer and has the part number 70820-10004.

Constructing the filter

For this example, $f_0 = 2.48832$ Gbit/sec.

1. Press `MENU` to display menus for the HP 70820A.

2. Press the left-side `Config` softkey.

3. Press `TRACE POINTS`, and enter a value of 256.

4. Press `more 1 of 3` and then `LINES DOTS` so that `LINES` is underlined.

5. Press the left-side `Main` softkey, and enter a `SEC/DIV` value of 803.75514 ps.

   This sets an appropriate frequency range for the filter frequency points by setting the span to $2/f_0$. This is 803.75514 ps for this example.

6. Press the left-side `Traces` softkey.

7. Press `select:`, `TR1`, and then `display ON OFF` so that `OFF` is underlined.

8. Press `select:`, `TR2`, `input:`, and then `build eqn`.

9. Press `CLR -> END`.

10. Press `SEL|EDT` so that `SEL` is underlined.

11. Turn the front-panel to highlight the j operand, and then press `INSERT`.

12. Using the technique shown in the previous step, finish constructing the trace equation shown in the following figure. Enter numbers using the front-panel numeric keypad.

```
Main        TR2 = 0*2.81856*FREQ/2.48832E9        SEL|EDT

Trigger        ()      IMAG()    CH1        (         DELETE
              AC()     INTEG()   CH2        )
            ANALY()    MAGN()    MEM1       [
            ATAN()     REAL()    MEM2                 --▶
Traces       DB()      SIGN()    MEM3       ]
             DC()      SQRT()    MEM4       E
            DEG()      SUM()     TR1        +
Scale       DFT()      TD()      TR3        -         ◀--
            DIFF()               TR4        *
            d/dx()               e          /
            EXPJ()               j          CHOP
Markers     FFT()                n          CONV      CLR▶END
            FM()                 PI         CORR
            IDFT()               TIME       MOD
Config      IFFT()     Fsig      FREQ       SHIFT     RETURN
                       Fcar      POWER      VS

 page                                                prev
 1 of 2                                              menu
```

13. Press RETURN.

14. Press select: and then TR3.

15. Press input: , build eqn , and then CLR -> END.

16. Press SEL|EDT so that SEL is underlined and build the trace equation shown in the following figure.

   Notice that the cursor has wrapped to the following line. Be sure to include the last two right parenthesis characters shown on the last line.

```
Main        TR3 = 105/(105+TR2*(105+TR2*(45+TR2*(10+TR2))   SEL|EDT
            ))

Trigger        ()      IMAG()    CH1        (         INSERT
              AC()     INTEG()   CH2        )
            ANALY()    MAGN()    MEM1       [
            ATAN()     REAL()    MEM2                 --▶
Traces       DB()      SIGN()    MEM3       ]
             DC()      SQRT()    MEM4       E
            DEG()      SUM()     TR1        +
Scale       DFT()      TD()      TR2        -         ◀--
            DIFF()               TR4        *
            d/dx()               e          /
            EXPJ()               j          CHOP
Markers     FFT()                n          CONV      CLR▶END
            FM()                 PI         CORR
            IDFT()               TIME       MOD
Config      IFFT()     Fsig      FREQ       SHIFT     RETURN
                       Fcar      POWER      VS

 page                                                prev
 1 of 2                                              menu
```

17. Press RETURN.

18. Press format: and then PHASE.

19. Press the left-side `Scale` softkey.

20. Press `AUTO-SCALE`.

21. Press the left-side `Markers` softkey.

22. Repeatedly press `M1 (↓)` until `TR3` is shown in the `M1 (↓)` softkey label.

23. Repeatedly press `M2 (↓)` until `TR3` is shown in the `M2 (↓)` softkey label.

24. Turn the front-panel knob to set the marker on 1.86224 GHz. (You can also enter the value using the numeric keypad.)

```
              M1(↓)   0 Hz                    0 deg           AUTO
       Main   M2(↑)   1.86624 GHz             -120.854 deg    DELAY

       Trigger                                                TIME
                                                             DELAY

       Traces                                                APERTUR

       Scale

       Markers

       Config

              -15.8008 GHz       3.173 GHz/div      15.9252 GHz
              Tr2=j*k*f/k    Tr3=k/(k+T2
       page   200E-3/div     90 deg/div                        more
       1 of 2 0 ref          0 deg ref                         2 of 2
```
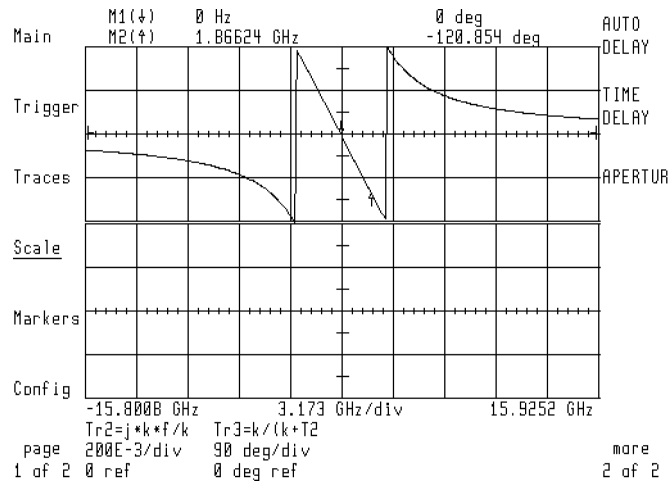
25. Press the left-side `Scale` softkey.

26. Press `more 1 of 2` and then `AUTO DELAY`.

27. Press the left-side `Traces` softkey.

28. Press `store trace` and then `to user correct`.

29. Press `adaptiv ON|OFF` so that `ON` is underlined.

30. Press `CHAN 1 USR COR`.

   The filter response is now stored in user corrections.

31. To view the response or to view the data, perform the following steps:

   a. Press the left-side `Traces` softkey.
   b. Press `select:` and then `TR2`.
   c. Press `display ON|OFF` so that `OFF` is underlined.
   d. Press `select:` and then `TR3`.
   e. Press `display ON|OFF` so that `OFF` is underlined.
   f. Press `select:` and then `TR1`.

g. Press `input:` , and then turn the front panel knob so that "UCORR1" is highlighted.

```
Main        TR1 = CH1                                              CH1

Trigger        1 = CH1                                             CH2
                   CH2
               4 = CH1/CH2
                   CH2/CH1
Traces             CH1/MEM1                                        CH1/CH2
                   CH2/MEM2
                   TABLE
Scale              UCORR1                                          CH2/CH1
                   UCORR2
                   (CH1/CH2)/MEM1
                   -(CH1/CH2)/MEM3
Markers            2*MAGN(CH1/CH2)/(MAGN(MEM2)+MAGN(MEM3))         MEMx
               2 = j*2.81856*FREQ/2.48832E9
               3 = 105/(105+TR2*(105+TR2*(45+TR2*(10+TR2)))       build
Config                                                            eqn

 page                                                            RETURN
1 of 2
```

h. Press `RETURN` .
i. Press the left-side `Scale` softkey.
j. Press `AUTO-SCALE` .
k. Press the left-side `page 1 of 2` and then `Calib` softkeys.
l. Press `user corr` .

```
Pulsgen                                                      CH1|CH2


Measure                                                      usr cor
                                                             ON|OFF

Table                                                        SEL|EDT

                                          path to
Analyze      FREQ        MAGN      PHASE   next FREQ          SLOPE |
                                                             FLAT
           dc value    0.00 dB    0.00 deg   slope
           dc value    0.00 dB    0.00 deg   slope           INSERT
Calib    124.4200 MHz  -0.01 dB   0.00 deg   slope           LINE
         248.8300 MHz  -0.05 dB  -0.02 deg   slope
         373.2500 MHz  -0.11 dB  -0.01 deg   slope
         497.6600 MHz  -0.19 dB  -0.03 deg   slope
States   622.0800 MHz  -0.31 dB  -0.05 deg   slope           other
         746.5000 MHz  -0.44 dB  -0.06 deg   slope
 page    870.9100 MHz  -0.61 dB  -0.06 deg   slope           prev
2 of 2   995.3300 MHz  -0.80 dB  -0.04 deg   slope           menu
```

32. To store the filter to a memory card, perform the following steps:

a. Press the left-side `States` softkey.
b. Press `more 1 of 2` and then `mass storage` .
c. If the mass-storage device needs to be selected, refer to "Selecting and Formatting Memory" in Chapter 9.
d. Press `save` .

e. Press `SAVE USR COR` .

33. To restore the instrument settings, press INSTR PRESET .

8

HP 70820A:
Calibration

[MENU]   This chapter documents features available with the HP 70820A menus. To access these menus, press [MENU]. Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the [MENU] key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing [USER].

Using the Calibration menu, you can perform the following tasks:

- matching delay between channels
- initiate an instrument self-test routine
- turn off RF correction
- calibrate the IF
- verify the calibrator signal

Introducing the Calibration Menu

The features documented in this chapter are located in the Calibration menu. The automatic IF calibrations documented in this chapter ensure accurate measurements using the eye diagram analyzer. RF correction data resides in nonvolatile instrument memory and does not need to be changed unless repairs have been made. The Calibration Menu's `user corr` softkey features are documented in Chapter 7.
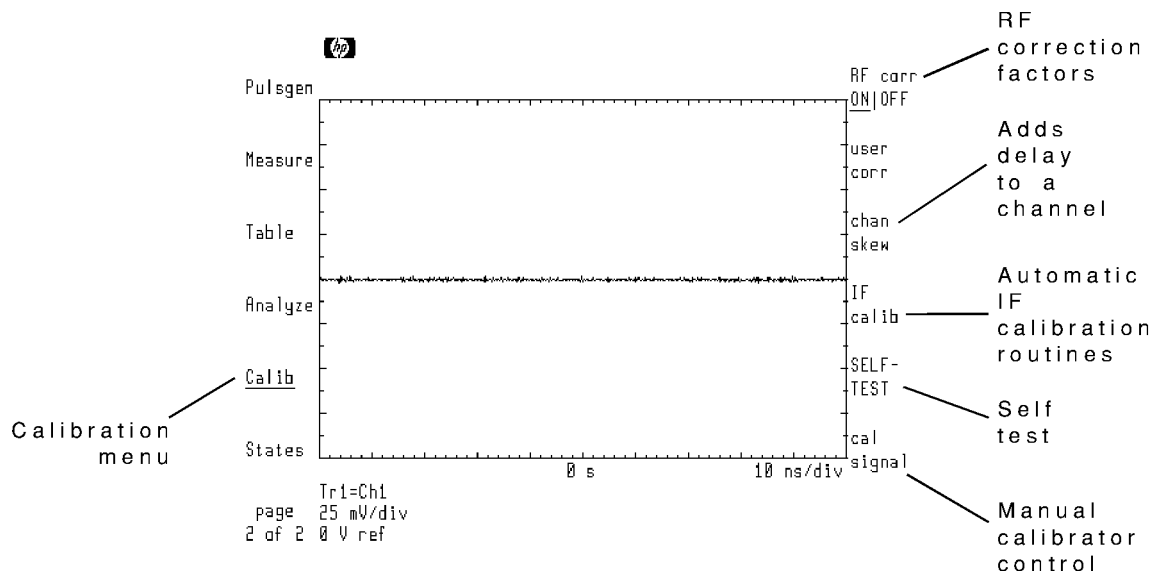
The Calibration menu

Turning Off RF Correction

The microwave transition analyzer module applies RF correction factors to all measurements. These correction factors are loaded at the factory into nonvolatile memory. You can prevent the use of RF correction factors during measurements.

Note   RF corrections can only be applied in eyeline and pattern modes. RF corrections must be off in eye mode.

To turn off RF correction

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

3. Press the `RF corr ON|OFF` softkey so that `OFF` is underlined.

Matching Delay Between Channels

Significant delays can occur between the signals on channel 1 and channel 2 when the electrical lengths of external cabling varies. This results in a phase offset between the two channels. The microwave transition analyzer module offers the capability to add delay to either channel 1 or channel 2.

The following figure shows added delay on channel 2.
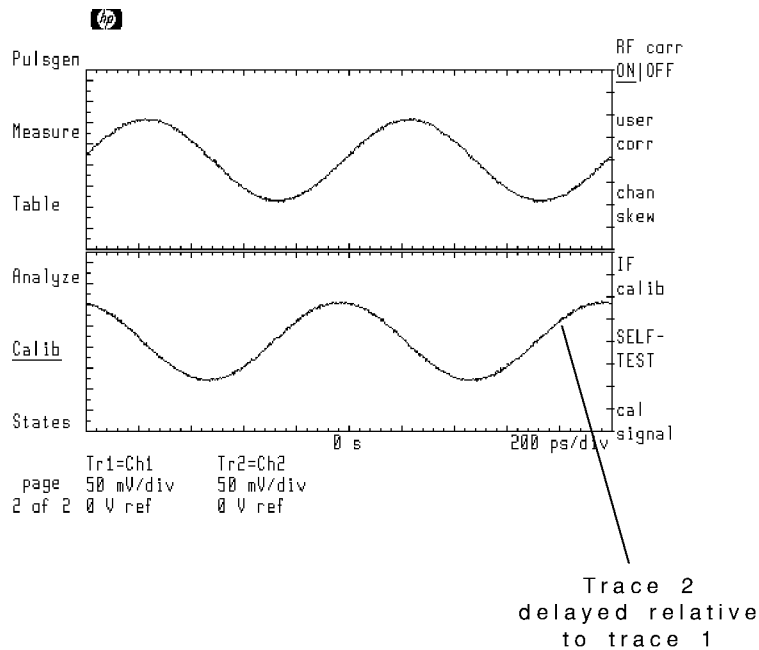
Use the `AUTO SKEW` softkey to automatically compensate the delay on channel 2. Automatic skewing assumes two equal phase signals input to channels 1 and 2. If measurements are to be performed at multiple frequencies, it is recommended that the `AUTO SKEW` function be performed first at a low frequency and then at higher frequencies to ensure better resolution.

Delay can be manually compensated using the `CHAN2 SKEW` softkey. For convenience, the `SEC/DIV` softkey is provided so that the time scale can be changed.

Added delay
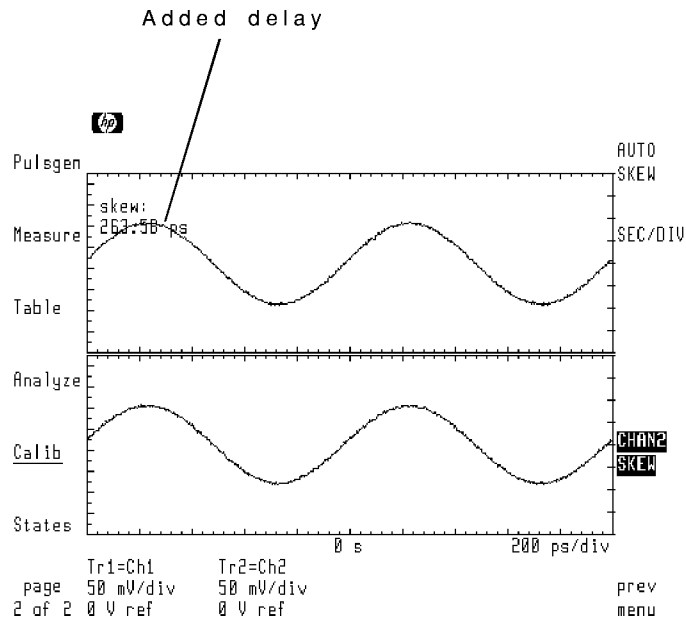
Trace 2 delay compensated

To delay a channel

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

3. Press the `chan skew` softkey.

4. Press `AUTO SKEW` to automatically compensate channel 2.

Calibrating the IF

The microwave transition analyzer module provides separate automatic IF calibration routines for channel 1 and channel 2. Each requires approximately 30 minutes to run. For optimum performance, you should perform the calibrations when at least one of the following is true:

■ The temperature has changed ±5° Centigrade since the last calibration was performed.

■ More than one week has passed since the last calibration.

■ Before any critical measurement.

Note   Allow the microwave transition analyzer module to warm up for at least one hour before performing a calibration.

To calibrate the IF

1. Connect a low-loss cable between the front-panel CALIBRATOR OUTPUT and channel 1 connectors.

PTA22
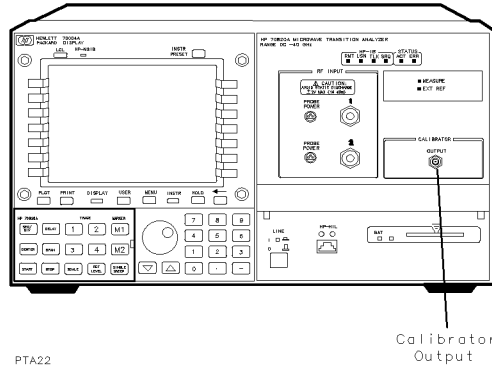
Calibrator
Output

2. Press MENU.

3. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

4. Press the `IF calib` softkey.

5. Press the `CAL CH1` softkey.

6. Press the `CAL CH1` softkey.

   The calibration routine takes about 30 minutes to complete.

7. Disconnect the cable from channel 1, and connect it to the channel 2 connector.

8. Repeat the above procedure for channel 2.

To view the last calibration date

1. Turn any displayed traces off to make viewing the calibration date easier.

2. Press MENU.

3. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

4. Press the `IF calib` softkey.

5. Press the `cal debug` softkey.

6. Press the `show` softkey.

7. Press the `CH1 CAL INFO` softkey to view when channel 1 was last calibrated.

8. Press the `CH2 CAL INFO` softkey to view when channel 2 was last calibrated.

Calibration date

Pulsgen   SHOW
                                                                     COR FFT

Measure   SHOW
                                                                     COR FIR

Table   SHOW
                                                                     CAL

CH1 cal stats...pg 1/6 (press key again for more)   CH1 CAL
Analyze   INFO
Last cal: 92/06/16
Miscel: rev 1.01+
gains std dev: 0.010219,0.010210,0.010147   CH2 CAL
Calib   0.007302,0.014763,0.028434   INFO
                  0.049626,0.046131,0.046148
delay retries=0, pnts=20, std err=0.020365
States

                              0 s   10 ns/div
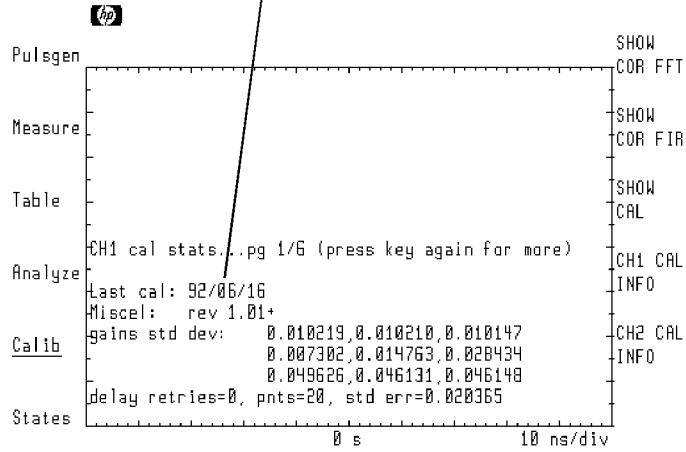
        page   prev
        2 of 2   menu

Viewing the Calibration Data

The ability to view the IF calibration data is mainly intended for service purposes. However, the procedures in this section show you how to view the data.

To view IF correction data traces

1. Press `MENU`.

2. Press the left-side `Traces` softkey to enter the Traces menu.

3. Turn on both trace 1 and trace 2. Set the input to trace 1 as channel 1. Set the input to trace 2 to channel 2.

4. Press the left-side `page 1 of 2` softkey.

5. Press the left-side `Calib` softkey to enter the Calibration menu.

6. Press the `IF calib`, `cal debug`, and then `show` softkeys.

7. Press the `SHOW COR FFT` or `SHOW COR FIR` softkeys to display the IF correction data for each channel.

8. Press the left-side `page 2 of 2` softkey.

9. Press the left-side `Scale` softkey to enter the Scale menu.

10. Select trace 1, and press the `AUTOSCALE` softkey. Select trace 2, and press the `AUTOSCALE` softkey.

Channel 1 data

Pulsgen

SHOW
COR FFT

Measure

SHOW
COR FIR

Table

SHOW
CAL

Analyze

CH1 CAL
INFO

Calib

CH2 CAL
INFO

States

0 Hz   883.25 kHz/div   8.83254 MHz
Tr1=Ch1   Tr2=Ch2
page   4 dB/div   1.9 dB/div   prev
2 of 2   11.2 dB ref   6.84 dB ref   menu

Channel 2 data
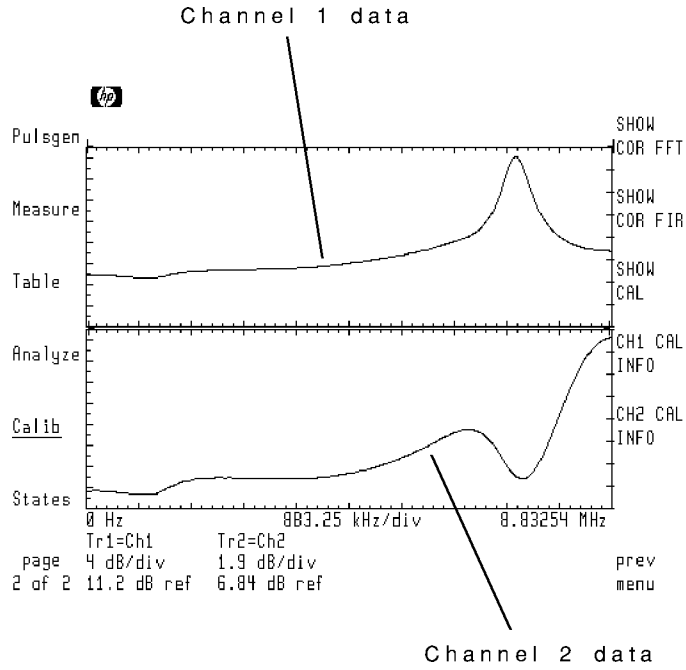
To view hardware response traces

1. Press `MENU`.

2. Press the left-side `Traces` softkey to enter the Traces menu.

3. Turn on both trace 1 and trace 2. Set the input to trace 1 as channel 1. Set the input to trace 2 to channel 2.

4. Press the left-side `page 1 of 2` softkey.

5. Press the left-side `Calib` softkey to enter the Calibration menu.

6. Press the `IF calib`, `cal debug`, and then `show` softkeys.

7. Press the `SHOW CAL` softkey to display the 100 kHz filter response of stage 0.

8. Press the left-side `page 2 of 2` softkey.

9. Press the left-side `Scale` softkey to enter the Scale menu.

10. Select trace 1, and press the `AUTOSCALE` softkey. Select trace 2, and press the `AUTOSCALE` softkey.

11. Press the left-side `page 1 of 2` softkey to re-enter the Calibration menu.

12. Press the `SHOW CAL` softkey.

13. Use the front-panel step keys to scroll through the various hardware responses.

Channel 1 data

Channel 2 data
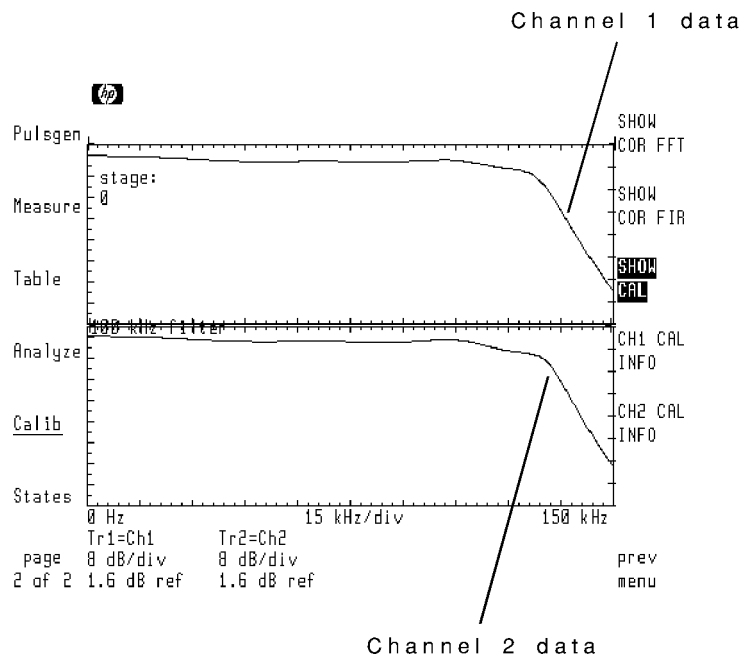
To view calibration data

1. Press (MENU).

2. Press `Traces` to enter the Traces menu.

3. Use the `select:` and `display ON OFF` softkeys to turn all displayed traces off.

    This makes viewing the calibration date easier.

4. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

5. Press the `IF calib`, `cal debug`, and then `show` softkeys.

6. Press the `CH1 CAL INFO` softkey to view the data for channel 1. Or, press the `CH2 CAL INFO` softkey to view the data for channel 2.

```
R TSE  [hp]                                              MENU

Pulsgen ┌─────────────────────────────────────────┐     SHOW
        │                                         │     COR FFT
        │                                         │
Measure │                                         │     SHOW
        │                                         │     COR FIR
        │                                         │
Table   ├                                         ┤     SHOW
        │                                         │     CAL
        │                                         │
Histogm ├ CH1 cal stats...pg 1/6 (press key again for more)│  CH1 CAL
        │                                         │     INFO
        ├ Last cal: 91/03/13                       │
        ├ Miscel:   rev 0.67                       │
Calib   ├ gains std dev:    0.012297,0.012431,0.012302│  CH2 CAL
        │                   0.006951,0.017942,0.039467│  INFO
        │                   0.074813,0.052565,0.053926│
States  └ delay retries=0, pnts=20, std err=0.021438 ┘
                                  0 s          10 ns/div

        page                                             prev
        2 of 2                                           menu
```
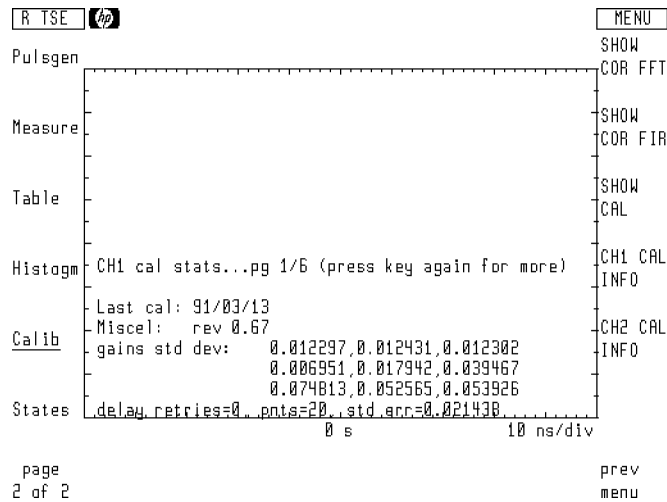
7. Repeatedly press the `CH1 CAL INFO` or `CH2 CAL INFO` softkey to view additional pages of information.

Performing a Self Test

You can initiate an automatic self-test routine that checks the internal condition of all major circuits. The self test takes approximately 30 seconds to run. (This routine automatically runs whenever the microwave transition analyzer is turned on.)

To perform the self test

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

3. Press the `SELF- TEST` softkey.

Controlling the Calibrator Signal

For verification purposes, the Calibrator Output signal can by manually controlled. This includes changing its amplitude and frequency. The signal has the following characteristics:

shape ....square wave
frequency ....153 Hz to 5 MHz
amplitude ....5 positions

The signal's amplitude can be set to one of five positions: 0 through 4. Zero represents the smallest available amplitude. Four represents the largest amplitude. These settings do not correlate to any specific amplitude and may vary between instruments.
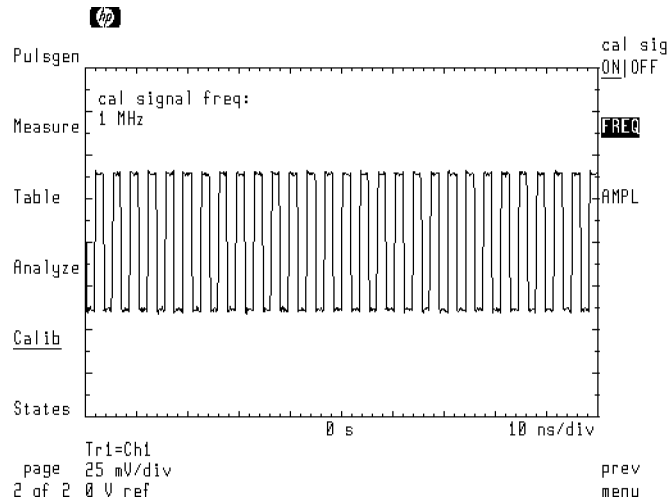
To turn the calibrator signal on

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `Calib` softkeys to enter the Calibration menu.

3. Press the `cal signal` softkey.

4. Press the `cal sig ON|OFF` softkey so that `ON` is underlined.

To change the calibrator frequency and amplitude

1. Press (MENU).

2. Press the left-side `Calib` softkey to enter the Calibration menu.

3. Press the `cal signal` softkey.

4. Press the `FREQ` softkey, and enter a frequency between 156 Hz and 5 MHz.

5. Press the AMPL softkey, and enter an amplitude setting between 0 and 4.

9

HP 70820A:
Memory Cards, Disks, and RAM

[MENU]   This chapter documents features available with the HP 70820A menus. To access these menus, press [MENU]. Refer to the *HP 71500 Series Reference* for definitions of all softkeys located under the [MENU] key. Provided that the HP 70874A Eye Diagram Analyzer personality is loaded, you can return to the eye diagram menus by pressing [USER].

The HP 70820A menus provide the ability to store data as files on the following media:

■ Memory cards

■ HP-IB Disk drive

■ Internal random-access memory (RAM) disk

Learning how to manage this memory is essential to obtaining the most benefit from your system. Memory cards are inserted into the front-panel card slot. RAM disks can be used as temporary storage for copying the contents of one memory card to another memory card.

The following list shows the types of data that can be saved as files:

 Traces
 Measurement states
 Histograms
 Masks
 Limit lines
 Calibrations
 User corrections
 User menus
 Downloadable programs (DLPs)

Selecting and Formatting Memory

When first turned on, the microwave transition analyzer module automatically selects the memory card as the mass-storage device. You can format memory and save, recall, erase, and list (catalog) files using the mass-storage menu located in the States menu.

Memory cards

Memory cards must be formatted before use. Formatting erases any previously stored files and initializes memory for storing data. RAM memory cards have a built-in battery to retain memory data. Data stored in the card remain as long as the card's battery has sufficient power. You should change the battery every two years using the procedure in this section.

On new cards, a special code is stamped on the card's side indicating the date it was installed. The first character is a digit that indicates the year. The next two characters are letters which represent the month. The forth character is a digit indicating the week. For example, 1OC3 indicates the battery was installed during the third week of October in 1991.

Note	If no card is inserted in the front-panel card slot, and you attempt to catalog a memory card, the display shows the message `catalog open failed`. Place a card in the card slot, and retry the operation.

RAM disks

RAM disks offer a convenient method of duplicating memory cards. Refer to "To duplicate a memory card" in this section. Up to 16 internal RAM disks can be created. (These are numbered 0 through 15.) The default size of each RAM disk is 32 kilobytes.

Use Instrument BASIC's `INITIALIZE` statement to create each disk. The following example creates RAM disk zero:

```
INITIALIZE ":MEMORY,0,0",128
```

The second integer, 0, determines the RAM disk number. The value 128 represents the size of the RAM disk in sectors. Each sector consists of 256 bytes. So, a value of 128 sectors creates a RAM disk of 32 kilobytes. A value of 512 sectors creates a RAM disk of 128 kilobytes.

Use the following command to create RAM disk 1 with a size of 128 kilobytes:

```
INITIALIZE ":MEMORY,0,1",512
```

Note   Because internal RAM is volatile, all RAM disks are deleted when the power is turned off. When this happens, all files are lost and each RAM disk must be recreated.

HP-IB Disk Drives

Measurement data and files can be saved on an external HP-IB disk drive. The disc drive must be a 3.5 inch, CS80 compatible, such as an HP 9122. To use the drive, you must connect it and enter its HP-IB address using (DISPLAY) menu softkeys. The procedure in this section shows you how to do this. You'll need to know the disk drive's HP-IB address, unit number, and volume number. The HP-IB address is represented by a digit from 1 through 7. The unit number indicates an individual slot in the disk drive. Although unit numbers can range from 0 through 9, they are typically 0 or 1. The volume number is used for hard disk drives. For reading diskettes, the volume number should be 0.

To use a memory card

1. Locate the arrow printed on one end of the card.

2. Insert the card with the arrow facing up into the front-panel card slot. The card's arrow should match the arrow printed above the card slot.

3. Press (DISPLAY) and then the left-side `Mass Storage` softkey.

4. Press `msi` and then `MEMORY CARD` .

5. Press (MENU) and then the left-side `page 1 of 2` and then `States` softkeys.

6. Press `more 1 of 2` , `mass storage` , and then `msi:` .

7. Press `HP-MSIB CARD` .

   If `6218 catalog open failed` is displayed, the card is not in the front-panel card slot. The HP-MSIB address for the card is the same address as the display's HPIB address and is normally set to 4. If the address is not correct, enter the correct address using the numeric keypad.

Caution   The following steps erase any files stored on the card.

---

8. If the memory card is new and needs to be formatted, perform the following steps:

   a. Press `prev menu` , `more` , and then `FORMAT` .

   b. Press `FORMAT as LIF` to use the LIF format or press `FORMAT as DOS` to use the DOS format.

To use an HP-IB disk drive

1. Connect the HP-IB disk drive to the HP 70004A Color Display using an HP-IB cable.

2. Determine or set the HP-IB address of the disk drive. Refer to the disk drive's user's manual for information on determining the disk drive's address.

3. Press `DISPLAY` and then the left-side `Mass Storage` softkey.

4. Press `msi` and then `HP-IB disk`.

5. Press `HP-IB ADDRESS`, and enter the disk drive's HP-IB address.

    This value is between 1 and 7.

6. Press `UNIT NUMBER`, and enter the disk drive's unit number.

    This number is typically a 0 or 1. Zero usually indicates the disk drive's left side slot.

7. Press `VOLUME NUMBER`, and enter the disk drive's volume number.

    The volume number should be left at the default value of zero for floppy disk drives.

8. Press `MENU` and then the left-side `page 1 of 2` and then `States` softkeys.

9. Press `more 1 of 2`, `mass storage`, and then `msi:`.

10. Press `HP-MSIB CARD`.

    Although card is selected, the display's `HP-IB disk` softkey pressed in step 4 redirected communications to the HP-IB disk drive.

To use an internal RAM disk

1. Press (USER) to invoke Instrument BASIC. (If the eye diagram personality is loaded, press (USER) twice.)

2. Enter an INITIALIZE statement to create a RAM disk. For example, enter the following BASIC statement:

        INITIALIZE ":MEMORY,0,0",128

3. Press (MENU) and then the left-side page 1 of 2 and States softkeys.

4. Press more 1 of 2 and then mass storage.

5. Press msi: and then MEMORY to select the internal RAM disk.

   The RAM disk number is shown on the screen. You can use the front-panel knob to change the RAM disk number.

To change a memory card's battery

The memory card's battery is a lithium commercial CMOS type, part number CR 2016.

Caution	The memory card should be installed when the battery is removed. If the battery is removed while the card is not installed, all data in the card will be lost. Store memory-card files on another device before changing the battery, when extra care is appropriate.
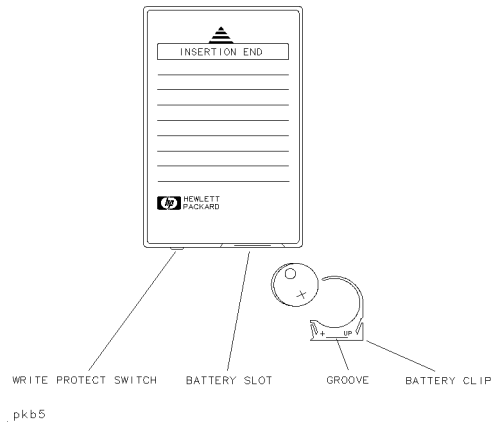
1. Install the memory card into the HP 70004A Display.

2. On the front edge of the card, locate the groove of the battery clip.

3. Gently pry the battery clip out of the card. The battery fits inside the clip.

4. Replace the battery, making sure the plus (+) sign on the battery is on the same side as the plus sign on the clip.

5. Insert the battery clip into the memory card, holding the clip as oriented in the figure. (Face the open edge of the clip toward the memory card's write-protect switch.)

6. Write on the card the date that the battery was replaced.

Working with Files

Files are identified by a prefix and a name. The eye diagram analyzer assigns a prefix according to the type of data as shown in the following table. You enter the file name. When cataloged, the file listings show the file's data type and size in bytes.

File Prefixes

File Type	File Prefix
Calibration data	c_
Histograms	h_
Instrument registers	r_
Instrument state	s_
Mask/Limit line	m_
Program	d_
Trace	t_
User corrections	a_
(USER) menu	k_

You can create additional prefix text for your file names. The text, appended to the standard prefixes, allows you to indicate files that have similar data. For example, the following figure shows a catalog of two mask files. Each file has an additional prefix of Shape. The additional prefix is appended regardless of the type of file you are saving.

The total length of your file name can not exceed 10 characters for LIF and 8 characters for DOS. This includes prefix and file name.

```
Pulsgen                                              msi:
                                                     HP-MSIB
          ┌──────────────────────────────────┐
Measure   ┤                                  ├      PREV
          ┤                                  ├      PAGE
          ┤                                  ├
Table     ┤                                  ├      NEXT
          ┤                                  ├      PAGE
          ┤──────────────────────────────────┤
          │Prefix: ''                         │
          │MSI: HP-MSIB,4        Page 1       │
Analyze   │                                   │     LOAD
          │                                   │     FILE
          │m_Shape_1  ASCII    2560           │
          │m_Shape_2  ASCII    2560           │
Calib     │   (end of catalog)                │     save
          │                                   │
          │                                   │
States    │                                   │     more
          │                                   │
   page   │                                   │     prev
  2 of 2  └──────────────────────────────────┘     menu
```

To duplicate a memory card

Instrument BASIC provides the ability to mass copy all the files from one memory card to another memory card. This allows you to easily reproduce copies without having to copy file one at a time. Use the following steps:

1. Refer to "To use a memory card" in this chapter to select the memory card for use.

2. Insert the memory card with the files into the front-panel card slot.

3. Press (USER). (If the eye diagram analyzer personality is loaded, press (USER) twice.)

4. Use a keyboard to enter the following Instrument BASIC commands. These commands initialize a RAM disc and copy the files from the card to the RAM disk. If you don't have a keyboard, Instrument BASIC has an editor for creating these commands. Refer to the *HP 71500 Series Instrument BASIC User's Guide*.

```
INITIALIZE ":MEMORY,0,0"
WILDCARDS DOS
COPY "*" TO ":MEMORY,0,0"
```

5. Remove the card from the card slot and insert a blank formatted card in the slot.

6. Issue the following Instrument BASIC command to copy the files from the RAM disk to the new card:

```
COPY "*:MEMORY,0,0" TO ":EXTERNAL,904"
```

To catalog all files

Use this procedure to catalog default memory. To select default memory, refer to "Selecting and Formatting Memory" in this chapter.

1. If you plan to catalog the files on a memory card, insert the card in the front-panel card slot.

2. Press (MENU).

3. Press the left-side `page 1 of 2` and then `States` softkeys.

4. Press `more 1 of 2` and then `mass storage`.

   Remember to insert the card before cataloging a memory card. If `6218 catalog open failed` is displayed, the card is missing. The HP-MSIB address for the card is the same address as the display's HPIB address and is normally set to 4. If the address is not correct, enter the correct address using the numeric keypad.

To save a file

Use this procedure to save a file in the default memory. To select default memory, refer to "Selecting and Formatting Memory" in this chapter.

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, `mass storage`, `save`, and then perform one of the following:

   ■ If your saving an instrument state, user-correction, or histogram, press the appropriate softkey.

   ■ If your saving a trace, press `save trace`. Select the trace and then use the `VEC|FMT` softkey to determine if the trace data is saved as complex data (VEC) or scalar data (FMT). Press `save`.

   ■ If your saving a channel calibration, mask, limit line, user-defined key, all recall registers, press `save misc` and then the appropriate softkey.

4. Enter the desired file name.

5. Press `ENTER LINE` to save the file.

Note   An HP-IL keyboard is recommended to simplify the task of entering alphanumeric information. This keyboard plugs into the jack provided on the display's front panel. Order the keyboard using the following part numbers:

keyboard .... HP 46021A

HP-IL cable 46020-60001

Note   ■ Turn the front-panel knob to move the character-select cursor.
    ■ Press `SELECT CHAR` to enter a character at the character-select cursor.
    ■ Press the numeric keypad to enter numbers or a minus sign.
    ■ The `INSERT or . . .` softkey determines the action of the `SELECT CHAR` softkey. Choices are INSERT a character, REPLACE an existing character, or DELETE a character.
    ■ Press the (⇓) and (⇑) keys (beneath the front-panel knob) to move the command-entry cursor.
    ■ Use the `CLEAR TO END` softkey to remove characters from the command-entry cursor to the end of the command.

To recall a file

Use this procedure to recall a file from the default memory. To select default memory, refer to "Selecting and Formatting Memory".

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Rotate the front-panel knob to select (highlight) the desired file.

5. Press `LOAD FILE`.

To erase a file

Use this procedure to erase a file in the default memory. To select default memory, refer to "Selecting and Formatting Memory" in this chapter.

1. Press `MENU`.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Press `more`.

5. Rotate the front-panel knob to select (highlight) the desired file.

6. Press `PURGE FILE` to erase the file.

To erase all files

Caution	This procedure erases all files stored in default memory.

1. Press ⌈MENU⌋.

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Press `more`.

5. Press `FORMAT` to erase all files in default memory.

To change the prefix

1. Press (MENU).

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Press `more`.

5. Press `CHANGE PREFIX`, and enter the desired text.

6. Press `ENTER LINE` to enter the prefix.

Note
- Turn the front-panel knob to move the character-select cursor.
- Press `SELECT CHAR` to enter a character at the character-select cursor.
- Press the numeric keypad to enter numbers or a minus sign.
- The `INSERT or . . .` softkey determines the action of the `SELECT CHAR` softkey. Choices are INSERT a character, REPLACE an existing character, or DELETE a character.
- Press the (⇓) and (⇑) keys (beneath the front-panel knob) to move the command-entry cursor.
- Use the `CLEAR TO END` softkey to remove characters from the command-entry cursor to the end of the command.

To erase a custom prefix

1. Press MENU .

2. Press the left-side `page 1 of 2` and then `States` softkeys.

3. Press `more 1 of 2`, and then `mass storage`.

4. Press `more`.

5. Press `CHANGE PREFIX`, and enter the desired text.

6. Repeatedly press the ⇓ step key until the cursor is located at the start of the custom text.

7. Press `CLEAR TO END`.

8. Press `ENTER LINE`.

10

Programming

Use variables to pass commands and data

Because the HP 70874A is an Instrument BASIC program, normal programming techniques are not employed. Instead, program control is achieved through manipulating three HP 70874A program variables: `Command`, `Param`, and `Response`. Strings and numbers are passed to these variables via two microwave transition analyzer commands:

PROG:STRing

PROG:NUMBer

The `Command` string variable directs the HP 70874A to perform an action. Twelve possible command strings are documented in this chapter: `ALIGN`, `BIT`, `CLEAR`, `DEFAULT`, `DELAY`, `DIAGRAM`, `EXTIN`, `MARGIN`, `MARMSK`, `MEAS`, `PERSIST`, `QUIT`.

Load the `Param` variable with a parameter for the selected `Command` variable string. Because execution begins immediately after `Command` is loaded, load `Param` before `Command`. `Param` is actually two variables with the same name; one is a string variable - the other is a numeric variable.

After execution of a command, the `Response` string variable contains any resulting query data. The following program show how to turn on infinite persistence. Notice how the `Param` variable is loaded before the `Command` variable.

```
OUTPUT @Mta;PROG:STR "Param","INF"
OUTPUT @Mta;PROG:STR "Command","PERSIST"
```

Use PROG:STR? to read response

The HP 70874A pauses execution after completion of each command. This provides a mechanism for synchronization between the issuance of a command and the retrieval of a response. In your controlling program, use the `PROG:WAIT?` query to indicate when the HP 70874A has paused. Then, retrieve the response using the `PROG:STR?` query. Use `PROG:STATe` to continue program execution. (Notice the lower case letter `e` in `PROG:STATe`. This indicates the this letter can be entered in either upper or lower case.)

The following example shows how to return the results of eye measurement. Notice that the MEAS command does not use the Param variable.

```
OUTPUT @Mta;PROG:STR "Command","MEAS"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

ALIGN

The ALIGN command string automatically aligns a mask to the eye.

Values of Program Variables

Variable	Data Type	Value
Command	string	ALIGN
Param	*There are no parameters for this command.*	
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Command","ALIGN"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

BIT

The BIT command string sets the instrument's time scale (seconds-per-division) to a value which corresponds to the number of bits specified in the Param variable.

Values of Program Variables

Variable	Data Type	Value
Command	string	BIT
Param	floating-point number	*example:* 3.5
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:NUMB "Param",3.5
OUTPUT @Mta;PROG:STR "Command","BIT"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

CLEAR

The CLEAR command string clears the display for persistence mode or error-trace mode. CLEAR also restarts any trace averaging.

Values of Program Variables

Variable	Data Type	Value
Command	string	CLEAR
Param	*There are no parameters for this command.*	
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Command","CLEAR"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

DEFAULT

The DEFAULT command string copies the default masks specified in the Param variable. Select a mask from the following types:

`STM-1`: default mask for STM-1.
`STM-4`: default mask for STM-4.
`STM-16`: default mask for STM-16.
`OC-3`: default mask for OC-3.
`OC-12`: default mask for OC-12.
`OC-48`: default mask for OC-48.

Values of Program Variables

Variable	Data Type	Value
Command	string	DEFAULT
Param	string	STM-1
		STM-4
		STM-16
		OC-3
		OC-12
		OC-48
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Param","STM-4"
OUTPUT @Mta;PROG:STR "Command","DEFAULT"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

DELAY

The DELAY command string sets the displayed delay value to the number of bits specified in the Param variable.

Values of Program Variables

Variable	Data Type	Value
Command	string	DELAY
Param	floating-point number	*For Example* 2.75
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:NUMB "Param",2.75
OUTPUT @Mta;PROG:STR "Command","DELAY"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

DIAGRAM

The DIAGRAM command string sets the diagram display to one of the following types specified in the Param variable:

- **EYE:** displays eye pattern. This is the standard display shown on digitizing oscilloscopes.

- **EYELINE:** displays a continuous line which shows the actual data value for the bit period.

- **PATTERN:** displays a continuous line like EYELINE, but for pattern trigger mode.

Values of Program Variables

Variable	Data Type	Value
Command	string	DIAGRAM
Param	string	EYE
		EYELINE
		PATTERN
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Param","EYELINE"
OUTPUT @Mta;PROG:STR "Command","DIAGRAM"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

EXTIN

The EXTIN command string performs an extinction ratio measurement. The Response variable is loaded with two floating-point numbers. The first number is the linear ratio. The second number is the logarithmic value.

Values of Program Variables

Variable	Data Type	Value
Command	string	EXTIN
Param	*There are no parameters for this command.*	
Response	string	*Two floating-point numbers.*

Example

```
OUTPUT @Mta;PROG:STR "Command","EXTIN"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

MARGIN

The MARGIN command string sets the margin percentage limit for margin mask testing. Load the Param variable with a floating-point number that specifies the percentage over standard mask to test. The range of margin is 0 to 100 percent.

Values of Program Variables

Variable	Data Type	Value
Command	string	MARGIN
Param	floating-point number	0 to 100% (*example:* 25.6)
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:NUMB "Param",25.6
OUTPUT @Mta;PROG:STR "Command","MARGIN"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

MARMSK

The MARMSK command string turns on or off margin mask testing.

Values of Program Variables

Variable	Data Type	Value
Command	string	MARMSK
Param	string	ON
		OFF
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Param","ON"
OUTPUT @Mta;PROG:STR "Command","MARMSK"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

MEAS

The MEAS command string performs the following eight measurements on the eye:

1. mean 1 level
2. mean 0 level
3. eye height
4. crossing level
5. eye width
6. eye jitter
7. mean rise time
8. mean fall time

The Response variable is loaded with eight floating-point numbers. Each number is the result of one of the eight measurements. The numbers are ordered according to the list shown above.

Values of Program Variables

Variable	Data Type	Value
Command	string	MEAS
Param	*There are no parameters for this command.*	
Response	string	*example:* 25.1 14.2 9.67 2.23 8.91 4.5 2.11 6.7

Example

```
OUTPUT @Mta;PROG:STR "Command","MEAS"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

PERSIST

The PERSIST command string controls persistence displays. Persistence modes are available via the standard microwave transition analyzer remote commands, however, special colormaps are necessary for proper display and are available only with Instrument BASIC.

Command parameters include INF, VAR, COLGRAD, MONOGRAD, and OFF. Each parameter has the following action:

- INF turns on infinite persistence mode.

- VAR turns on variable persistence mode.

- COLGRAD turns color graded persistence mode.

- MONOGRAD turns monochrome graded persistence mode.

- OFF turns persistence mode off.

Values of Program Variables

Variable	Data Type	Value
Command	string	PERSIST
Param	string	INF
		VAR
		COLGRAD
		MONOGRAD
		OFF
Response	string	DONE

Example

```
OUTPUT @Mta;PROG:STR "Param","COLGRAD"
OUTPUT @Mta;PROG:STR "Command","PERSIST"
OUTPUT @Mta;PROG:WAIT?
ENTER @Mta;A$
OUTPUT @Mta;PROG:STR? "Response"
ENTER @Mta;Response$
OUTPUT @Mta;PROG:STAT CONT
```

QUIT

The QUIT command string causes the Eye Diagram Personality to terminate. This command does not pause upon completion.

Values of Program Variables

Variable	Data Type	Value
Command	string	QUIT
Param	*There are no parameters for this command.*	
Response	*There is no response from this command.*	

Example

```
OUTPUT @Mta;PROG:STR "Command","QUIT"
```

11

Specifications and Characteristics

This chapter contains specifications and characteristics for the HP 71501A Eye Diagram
Analyzer.

Definitions of Terms

The distinction between specifications, *characteristics*, typical performance, and nominal
values is described as follows:

- Specifications describe warranted performance over the temperature range 0 °C to +55 °C
  (unless otherwise noted). All specifications apply after the instrument's temperature has
  been stabilized after 1 hour continuous operation and self-calibration routines have been
  run. Unless otherwise noted, corrected limits are given when specifications are subject to
  minimization with error-correction routines.

- *Characteristics* provide useful, but nonwarranted information about the functions and
  performance of the instrument. *Characteristics are printed in italics.*

- Typical Performance, where listed, is not *warranted*, but indicates performance which most
  units will exhibit.

- Nominal Value indicates the expected, but not *warranted*, value of the parameter.

Vertical Specifications

Bandwidth (−3 dB):	20 GHz (extended BW off)
	40 GHz (extended BW on)
dc accuracy (±5° C from cal):	the larger of ±2% of signal amplitude or $500 \mu V$
	the larger of ±1% of signal amplitude or $500 \mu V$ (typical)
Noise floor (at 1 GHz):	<1.4 mV$_{rms}$

Input Channel Specifications

Caution   Input channels RF INPUT 1 and RF INPUT 2 are dc coupled.

Operation input range: (including dc offset)	<±320 mV
Maximum safe input voltage without damage:	±2 V$_{pk-pk}$
Number of input channels:	2
Input connectors:[1]	2.4 mm (male)
Nominal input impedance:	50 Ω
Programmable dc offset:	±320 mV

1 Includes two 2.4 mm (f) to 3.5 mm (f) adapters.

Horizontal Specifications

Time scale range: (full scale is 10 divisions)	5 ps/div to 100 s/div
Delta time measurement accuracy:	1 ps or $< \dfrac{time\ span}{number\ of\ trace\ points}$ (whichever is larger)
Time delay in eye mode: (clock frequencies > 10 MHz)	$\dfrac{-time\ span}{2}$ to $(1000)(time\ span)$

Time delay in eyeline and pattern modes:
    Pattern repetition frequency >10 MHz:
    Pattern repetition frequency ≤10 MHz:
	
	 $\dfrac{-time\ span}{2}$ to $(1000)(time\ span)$
	
	 ±2 pattern repetition lengths

Time delay between channels:[1] (uncorrected)	<10 ps

1 Time delay between channels (up to ±20% of the time span) is correctable in software.

Trigger Specifications

Trigger sensitivity (dc - 40 GHz):	65 mV$_{\text{pk-pk}}$ (typical)
Jitter:	<2.5 ps $_{\text{rms}}$

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