User's Guide

HP 86120A Multi-Wavelength Meter

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PACKARD

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other agencies.

Safety Symbols

The following safety symbols are used throughout this manual. Familiarize yourself with each of the symbols and its meaning before operating this instrument.

CAUTION   The *caution* sign denotes a hazard to the instrument. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

WARNING   **The *warning* sign denotes a life-threatening hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.**

|	
⚠	The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.
☢	The laser radiation symbol. This warning symbol is marked on products which have a laser output.
∿	This symbol denotes that the instrument uses alternating current.
| ▬	These symbols denotes that the power supply is turned on.
○ ▢	These symbols denotes that the power supply is turned off.
$C\epsilon$	The CE mark is a registered trademark of the European Community.
ISM1-A	This text denotes that the instrument is an Industrial Scientific and Medical Group 1 Class A product.
CSA	The CSA mark is a registered trademark of the Canadian Standards Association.

The HP 86120A—At a Glance

The HP 86120A Multi-Wavelength Meter measures the wavelength and optical power of laser light in the 700-1650 nm wavelength range. Because the HP 86120A simultaneously measures multiple laser lines, you can characterize wavelength-division-multiplexed (WDM) systems and the multiple lines of Fabry-Perot lasers.

Characterize laser lines easily
With the HP 86120A you can quickly and easily measure any of the following parameters:

- Peak wavelength and power
- Average wavelength
- Total optical power
- Laser line separation
- Laser drift (*wavelength and power*)
- Signal-to-noise ratios *(unmodulated lasers)*
- Coherence length

In addition to these measurements, a "power bar" is displayed that shows power changes like a traditional analog meter. You can see the power bar shown in the following figure of the HP 86120A's display.
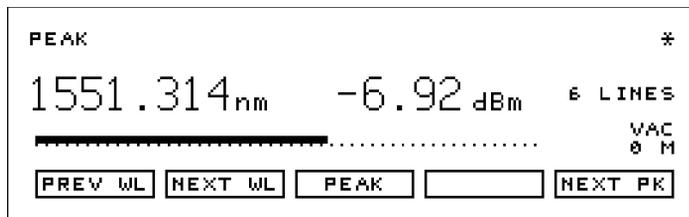
peakwl

CAUTION   The HP 86120A's input circuitry can be damaged when *total* input power levels exceed +18 dBm. To prevent input damage, this specified level must not be exceeded.

Print measurement results
You can get hardcopy results of your measurements by connecting a printer to the rear-panel PARALLEL PRINTER PORT connector.

Program the instrument for automatic measurements
The HP 86120A offers an extensive set of HP-IB programming commands. These commands allow you to perform automated measurements on manufacturing production lines and remote sites. Chapters 3 and 4 provide all the information you'll need to know in order to program the HP 86120A.

Display wavelengths as if measured in vacuum or standard air
Although all measurements are made in air, displayed results are corrected for air dispersion to accurately show wavelength values in vacuum or in "standard air." To ensure accurate wavelength measurements, make sure that you enter the elevation from which you will be making measurements as described in Chapter 1, "Getting Started".

Measurement accuracy—it's up to you!

Fiber-optic connectors are easily damaged when connected to dirty or damaged cables and accessories. The HP 86120A's front-panel INPUT connector is no exception. When you use improper cleaning and handling techniques, you risk expensive instrument repairs, damaged cables, and compromised measurements.

Before you connect any fiber-optic cable to the HP 86120A, refer to "Cleaning Connections for Accurate Measurements" on page 2-38.

General Safety Considerations

This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

WARNING   **If this instrument is not used as specified, the protection provided by the equipment could be impaired. This instrument must be used in a normal condition (in which all means for protection are intact) only.**

WARNING   **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

Printing History

HP Part Number	Edition	Date
86120-90001	First	March 1996

Typographical Conventions

The following conventions are used in this book.

Formatting	Information
key type	Keys or text located on the keyboard or instrument.
softkey type	Key names that are displayed on the instrument's screen.
display type	Words or characters displayed on the computer's screen or instrument's display.
user type	Words or characters that you type or enter.
emphasis type	Words or characters that emphasize some point or that are used as place holders for text that you type.

Warranty

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.

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

Hewlett-Packard warrants that its software and firmware designated by Hewlett-Packard for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error-free.

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

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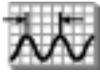
Contents

Contents

Contents

Contents

1

Getting Started

Getting Started

The instructions in this chapter show you how to install your HP 86120A. You should be able to finish these procedures in about ten to twenty minutes. After you've completed this chapter, continue with Chapter 2, "Making Measurements".

Refer to Chapter 6, "Specifications and Regulatory Information" for information on operating conditions such as temperature.

If you should ever need to clean the cabinet, use a damp cloth only.

WARNING   **This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.**

CAUTION   This product has autoranging line voltage input. Be sure the supply voltage is within the specified range.

CAUTION   When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4°C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

CAUTION   This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2, per IEC 1010 and 664 respectively.

Contents

Measurement accuracy—it's up to you!

Fiber-optic connectors are easily damaged when connected to dirty or damaged cables and accessories. The HP 86120A's front-panel INPUT connector is no exception. When you use improper cleaning and handling techniques, you risk expensive instrument repairs, damaged cables, and compromised measurements.

Before you connect any fiber-optic cable to the HP 86120A, refer to "Cleaning Connections for Accurate Measurements" on page 2-38.

Step 1. Inspect the Shipment

1. Verify that all system components ordered have arrived by comparing the shipping forms to the original purchase order. Inspect all shipping containers.

   If your shipment is damaged or incomplete, save the packing materials and notify both the shipping carrier and the nearest Hewlett-Packard sales and Service office. HP will arrange for repair or replacement of damaged or incomplete shipments without waiting for a settlement from the transportation company. Notify the HP customer engineer of any problems.

2. Make sure that the serial number and options listed on the instrument's rear-panel label match the serial number and options listed on the shipping document. The following figure is an example of the rear-panel serial number label:

```
        Hewlett-Packard
            86120A
            SN 001
      Lightwave Operation
      Santa Rosa, CA 95403
  Made in USA of domestic And foreign components
```
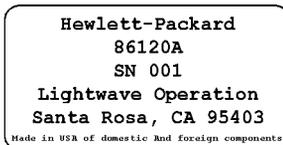
Table 1-1. Options and Accessories Available for the HP 86120A

Item	Quantity	HP Part Number
Option 010 Delete FC/PC connector	—	—
Option 022 Replace flat physical contact interface with angled physical contact interface	—	—
Option 900 Great Britain power cord	1	8120-1703
Option 901 Australia, New Zealand, China power cord	1	8120-0696
Option 902 European power cord	1	8120-1692
Option 906 Switzerland power cord	1	8120-2296
Option 912 Denmark power cord	1	8120-2957
Option 917 India, South Africa power cord	1	8120-4600
Option 918 Japanese power cord	1	8120-4754
Option 919 Israel power cord	1	8120-5181
Option UK5 Protective soft carrying case	1	—
Option UK6 Commercial calibration certificate with calibration data	1	—
Option AXE Rack mount kit with handles	1	86120-60031
Option IX4 Rack mount kit without handles	1	86120-60030
Option OB2 Additional user's manual	1	86120-90001
Option 412 Add 10 dB external attenuator (FC/PC interface connector)	1	—

Step 2. Check the Fuse

1. Locate the line-input connector on the instrument's rear panel.

2. Disconnect the line-power cable if it is connected.

3. Use a small flat-blade screwdriver to open the pull-out fuse drawer.

fusedr
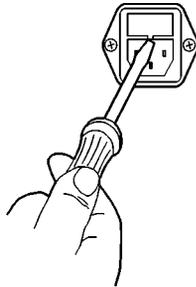
4. Verify that the value of the line-voltage fuse in the pull-out drawer is correct. The recommended fuse is an IEC 127 5×20 mm, 6.3A, 250 V, HP part number 2110-0703.

   Notice that an extra fuse is provided in a drawer located on the fuse holder.

WARNING   **For continued protection against fire hazard, replace line fuse only with same type and ratings, (type T 6.3A/250V for 100/240V operation). The use of other fuses or materials is prohibited.**

Step 3. Connect the Line-Power Cable

WARNING **This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.**

CAUTION Always use the three-prong AC power cord supplied with this instrument. Failure to ensure adequate earth grounding by not using this cord may cause instrument damage.

CAUTION *Do not* connect ac power until you have verified the line voltage is correct as described in the following paragraphs. Damage to the equipment could result.

CAUTION This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range.

1. Verify that the line power meets the requirements shown in the following table.

Line Power Requirements

Power:	115 VAC: 110 VA MAX. / 60 WATTS MAX. / 1.1 A MAX. 230 VAC: 150 VA MAX. / 70 WATTS MAX. / 0.6 A MAX.
Voltage	nominal: 115 VAC / 230 VAC range 115 VAC: 90-132 V range 230 VAC: 198-254 V
Frequency	nominals: 50 Hz / 60 Hz range: 47-63 Hz

2. Connect the line-power cord to the instrument's rear-panel connector.

3. Connect the other end of the line-power cord to the power receptacle.

Various power cables are available to connect the HP 86120A to ac power outlets unique to specific geographic areas. The cable appropriate for the area to which the HP 86120A is originally shipped is included with the unit. The cable shipped with the instrument also has a right-angle connector so that the HP 86120A can be used while sitting on its rear feet. You can order additional ac power cables for use in different geographic areas. Refer to "AC Line-Power Cords" on page 7-19.

Step 4. Connect a Printer

The HP 86120A can print hardcopies of measurement results on a printer. The output is ASCII text. If you don't have a printer, continue with "Step 5. Turn on the HP 86120A" on page 1-10.

- Using a standard parallel printer cable, connect the printer to the HP 86120A's rear-panel PARALLEL PRINTER PORT connector.

Step 5. Turn on the HP 86120A

1. Press the front-panel LINE key. After approximately 20 seconds, the display should look similar to the following figure:

   The front-panel LINE switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument.

```
┌─────────────────────────────────────────────┐
│ PEAK                                      *   │
│                                               │
│ NO SIGNAL                        0   LINES    │
│                                        VAC    │
│                                        0  M   │
│  ┌────────┐ ┌────────┐ ┌──────┐ ┌────────┐ ┌────────┐ │
│  │        │ │        │ │ PEAK │ │        │ │        │ │
│  └────────┘ └────────┘ └──────┘ └────────┘ └────────┘ │
└─────────────────────────────────────────────┘
```
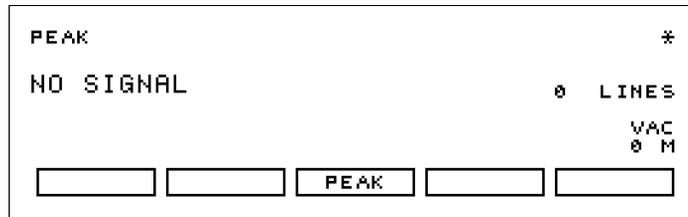
2. If the HP 86120A fails to turn on properly, consider the following possibilities:

   • Is the line fuse good?

   • Does the line socket have power?

   • Is it plugged into the proper ac power source?

If the instrument still fails, return it to Hewlett-Packard for repair. Refer to "Returning the Instrument for Service" on page 1-15.

Instrument firmware version

When the instrument is first turned on, the display briefly shows the instrument's firmware version number. In the unlikely event that you have a problem with the HP 86120A, you may need to indicate this number when communicating with Hewlett Packard.

There is no output laser aperture

The HP 86120A does not have an output laser aperture. However, light less than 1 nw escapes out of the front-panel OPTICAL INPUT connector. Operator maintenance or precautions are not necessary to maintain safety. No controls, adjustments, or performance of procedures result in hazardous radiation exposure.
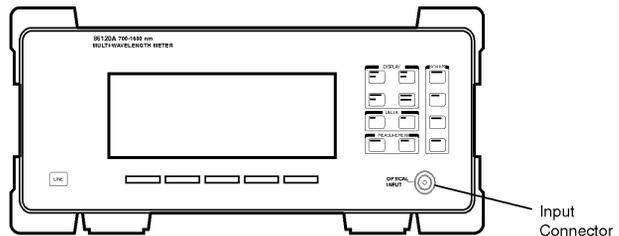
Step 6. Enter Your Elevation

In order for your HP 86120A to accurately measure wavelengths and meet its published specifications, you must enter the elevation where you will be performing your measurements.

1. Press the Setup key.

2. Press the *CAL* softkey.

3. Press *ELEV*.

4. Use the ⬆ and ⬇ softkeys to enter the elevation in meters. Entries jump in 500 meter steps from 0 m to 5000 m.

   The elevation value selected with the softkeys must be within 250 meters of the actual elevation.

5. Press *RETURN* to complete the entry.

Converting feet to meters

If you know your elevation in feet, you can convert this value to meters by using the following equation:

$$m = \frac{ft}{3.281}$$

Step 7. Select Medium for Wavelength Values

Because wavelength varies with the material that the light passes through, the HP 86120A offers wavelength measurements in two mediums: vacuum and standard air.

1. Press the Setup key.

2. Press the *CAL* softkey.

3. Make the following selection:

   • Press *VACUUM* for wavelength readings in a vacuum.

   • Press *STD AIR* for wavelength readings in standard air.

4. Press *RETURN* to complete the entry.

Definition of standard air

Standard air is defined to have the following characteristics:

Barometric pressure: 760 torr
Temperature: 15°C
Relative humidity: 0%

Step 8. Turn Off Wavelength Limiting

After the Preset key is pressed, the input wavelength range is limited to measuring lasers between 1200 nm and 1650 nm. You can easily expand the input range to the full 700 nm to 1650 nm range with the following steps:

1. Press the Preset key.

2. Press the Setup key.

3. Press *MORE* and then *WL LIM*.

4. Press *LIM OFF* to remove the limits on wavelength range.

    All responses in the full 700 nm to 1650 nm range are now displayed.

Returning the Instrument for Service

The instructions in this section show you how to properly package the instrument for return to a Hewlett-Packard service office. For a list of offices, refer to "Hewlett-Packard Sales and Service Offices" on page 7-20.

If the instrument is still under warranty or is covered by an HP maintenance contract, it will be repaired under the terms of the warranty or contract (the warranty is at the front of this manual). If the instrument is no longer under warranty or is not covered by an HP maintenance plan, Hewlett-Packard will notify you of the cost of the repair after examining the unit.

When an instrument is returned to a Hewlett-Packard service office for servicing, it must be adequately packaged and have a complete description of the failure symptoms attached.

When describing the failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as instrument failure settings, data related to instrument failure, and error messages) along with the instrument being returned.

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the HP service office repair and return your instrument as quickly as possible.

Preparing the instrument for shipping

1. Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem. The following information should be returned with the instrument.

   - Type of service required.
   - Date instrument was returned for repair.
   - Description of the problem:
     - Whether problem is constant or intermittent.
     - Whether instrument is temperature-sensitive.
     - Whether instrument is vibration-sensitive.
     - Instrument settings required to reproduce the problem.
     - Error codes.
     - Performance data.
   - Company name and return address.
   - Name and phone number of technical contact person.
   - Model number of returned instrument.
   - Full serial number of returned instrument.
   - List of any accessories returned with instrument.

2. Cover all front or rear-panel connectors that were originally covered when you first received the instrument.

CAUTION Cover electrical connectors to protect sensitive components from electrostatic damage. Cover optical connectors to protect them from damage due to physical contact or dust.

CAUTION Instrument damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

3. Pack the instrument in the original shipping containers. Original materials are available through any Hewlett-Packard office. Or, use the following guidelines:

   - Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.

   - For instruments weighing less than 54 kg (120 lb), use a double-walled,

corrugated cardboard carton of 159 kg (350 lb) test strength.

- The carton must be large enough to allow 3 to 4 inches on all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.

- Surround the equipment with 3 to 4 inches of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (antistatic) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.

4. Seal the carton with strong nylon adhesive tape.

5. Mark the carton "FRAGILE, HANDLE WITH CARE".

6. Retain copies of all shipping papers.

2

Making Measurements
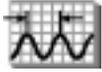
Making Measurements

In this chapter, you'll learn how to make a variety of fast, accurate measurements. As you perform these measurements, keep in mind the following points:

- 700 nm to 1650 nm maximum input wavelength range

  The range is normally limited from 1200 nm to 1650 nm. To use the full range, refer to "Measuring lasers between 700 nm and 1200 nm" on page 2-7 and to "To use the full wavelength range" on page 2-9.

- +10 dBm maximum total displayed input power

- Laser linewidths assumed to be less than 10 GHz

- If you change the elevation where you will be using your HP 86120A, refer to "Calibrating Measurements" on page 2-34.

- Press the green Preset key to return the HP 86120A to its default state.

CAUTION   Do not exceed +18 dBm source power. The HP 86120A's input circuitry can be damaged when total input power exceeds 18 dBm. You can measure power levels that are greater by adding attenuation and entering a power offset as described in "To measure total power exceeding 10 dBm" on page 2-33.

Contents

Measuring Wavelength and Power

This section gives you step-by-step instructions for measuring peak wavelength, average wavelength, peak power, and total input power. There are three display modes:

- Peak wavelength
- List-by-wavelength *or* power
- Average wavelength and total power

The figure on this page shows the peak wavelength mode. The figure on the next page shows the list-by-wavelength display mode where the signals are displayed in order from shortest to longest wavelengths. In either mode, the HP 86120A can measure up to 100 laser lines simultaneously.

Displayed Laser
Line has the
Greatest Power   Wavelength   Power   Measurement
Acquisition

Number of
Laser Lines
Found

PEAK   *

1551.314nm   3.07 dBm   6 LINES
PWR OFS
VAC
Power Bar   500 M

PREV WL   NEXT WL   PEAK   NEXT PK

Power Offset
Applied

Elevation
Calibration
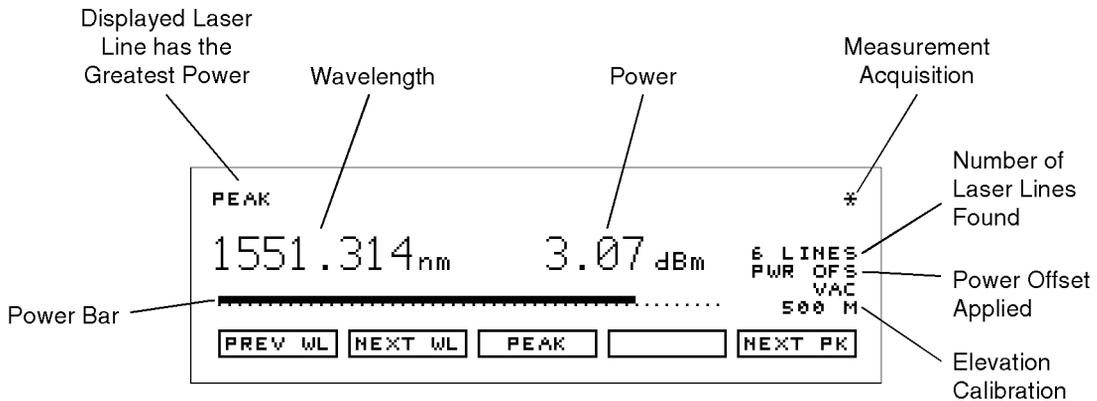
peakwl2

Display after "Peak WL" key pressed

Peak WL mode displays one signal

When Peak WL is pressed, the display shows the largest amplitude line in the spectrum. The word PEAK is shown on the screen. If multiple laser lines are present at the input, the number of lines located will be shown along the right side of the screen.

In addition to the digital readouts, there is a power bar. It provides a convenient analog "meter movement" for tuning laser power.

Although the Peak WL mode shows one signal at a time, softkeys are provided that allow you to scroll through and display all the measured laser lines. You can scroll through the list according to the wavelengths or powers measured.

List by WL or Power modes display multiple lines simultaneously

In the list-by-wavelength or list-by-power modes, the measurements of five laser lines can be displayed at any one time. Use the ✿ and ✿ softkeys to move the cursor ↔ through the list of signals; the list can contain up to 100 entries. Press the SELECT key, and the display changes to peak wavelength mode with the signal at the cursor displayed.

Annotation in the upper right corner of the display indicates whether the signals are ordered according to wavelength (BY WL) or power (BY PWR). The cursor shows the currently selected laser line. As you scroll through the responses, the current position of the selection cursor is shown along the screen's right side.

Laser Line
Selection Cursor   Power Bars

Position of
Selection
Cursor in List

```
1546.495nm    -10.76dBm ━━━━.....              *
1548.084       -9.46    ━━━━ .....        BY  WL
1549.698       -7.81    ━━━━ .....       5 OF  6
1551.314   ↔  -6.92    ━━━━━.....           VAC
1552.933      -10.30    ━━━━━ .....          0 M
    ┌───────┐ ┌───────┐ ┌───────┐ ┌───────┐ ┌───────┐
    │   ✿   │ │   ✿   │ │ PEAK  │ │       │ │SELECT │
    └───────┘ └───────┘ └───────┘ └───────┘ └───────┘
```

Medium for
λ Values

Softkeys
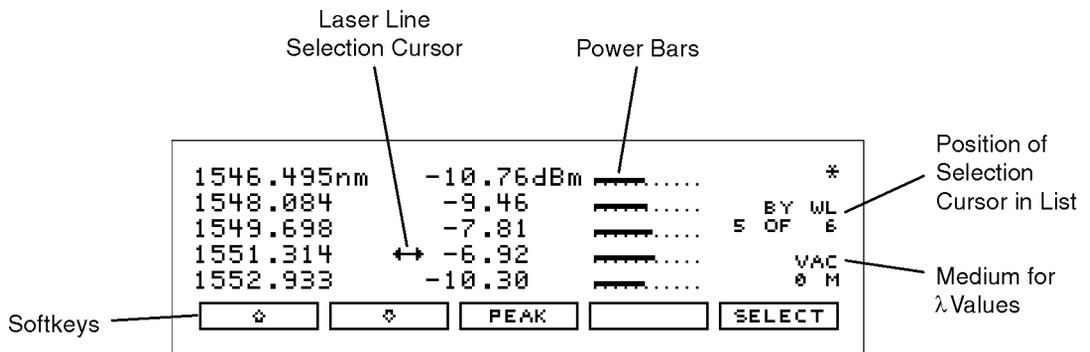
listwl

Display after "List by WL" key pressed

Also notice that power bars graphically show the relative power levels between laser lines.

Total power and average wavelength can be measured
In the third available display mode, the HP 86120A displays the average wavelength as shown in the following figure. The displayed power level is the total input power to the instrument. It is the sum of the powers of each laser line; it is *not* a measure of the average power level of the laser lines.
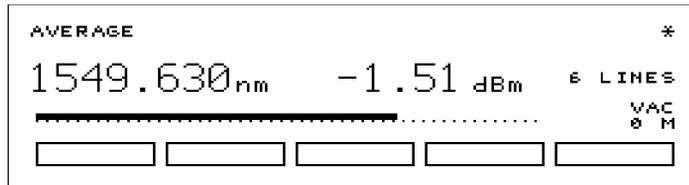
The following equation shows how individual wavelengths of laser lines are summed together to obtain the average wavelength value:.

$$\lambda_{avg} = \frac{\displaystyle\sum_{i=1}^{n} P_i \, \lambda_i}{\displaystyle\sum_{i=1}^{n} P_i}$$

where,
n is the number of laser lines included in the average.
P_i is the peak power of an individual laser line. Power units are in Watts (linear).

The following equation shows how individual powers of laser lines are summed together to obtain the total power value:

$$P_{total} = \sum_{i=1}^{n} P_i$$

where,
> n is the number of laser lines included in the measurement.
> P_i is the peak power of an individual laser line. Power units are in Watts (linear).

Measuring lasers between 700 nm and 1200 nm

After the Preset key is pressed, the input wavelength range is limited to measuring lasers between 1200 nm and 1650 nm. This prevents the accidental display of spurious signals that may not exist. You can easily expand the input range to the full 700 nm to 1650 nm range, however you should learn how to identify spurious signals.

Spurious signals below 1200 nm may be displayed whenever low-power laser lines (power levels near the HP 86120A's specified sensitivity) are present at the input. For example, a low-power laser line at 1550 nm has a second harmonic line at 775 nm. If this second harmonic is above the peak threshold level relative to the fundamental line, it is considered a peak. Its displayed power level may be *greater* than that of the fundamental because the amplitude correction at 775 nm is much greater (by about 15 dB) than that at 1550 nm (the interferometer is less sensitive at 775 nm).

You can also avoid displaying this second harmonic line by reducing the peak threshold below its preset value. Because the peak threshold level is used to determine which signals are to be displayed *before* amplitude corrections are applied, the harmonic will be eliminated. Refer to "Defining Laser-Line Peaks" on page 2-13.

In order to use the full wavelength range, refer to "To use the full wavelength range" on page 2-9.

To display peak wavelength and power

1. Connect the fiber-optic cable to the front-panel OPTICAL INPUT connector.

2. To display the peak wavelength and power, do one of the following:

   • Press the green Preset key.

   • Press *Peak WL*.

3. To move the cursor to view other signals, press:

   • *PREV WL* to select next (previous) shorter wavelength.

   • *NEXT WL* to select next longer wavelength.

   • *PEAK* to signal with greatest power.

   • *PREV PK* to select next lower power signal.

   • *NEXT PK* to select next higher power signal.

To display multiple laser lines

1. Connect the fiber-optic cable to the front-panel OPTICAL INPUT connector.

2. Press the green Preset key.

3. Press *List by WL* to display the laser lines from the shortest wavelength to the longest wavelength.

4. Press *List by Power* to display the laser lines in order of decreasing amplitudes.

To display average wavelength and total power

• Press the Avg WL key.

To use the full wavelength range

1. Press the Setup key.

2. Press *MORE* and then *WL LIM*.

3. Press *LIM OFF* to remove the limits on wavelength range. All responses in the full 700 nm to 1650 nm range are now displayed.

To control the power bar

1. Press the Setup key.

2. Press *MORE* and then *PWR BAR*.

3. Press *BAR ON* to display the power bar, and press *BAR OFF* to hide the power bar display.

Changing the Units and Measurement Rate

Change the displayed units
As described later in this section, it's easy to change the wavelength and amplitude units. You can choose between the following units:

Table 2-1. Available Units

Wavelength	Power
nm	dBm
cm^{-1}	mW
THz	μW

You can speed up the measurement rate
Under normal operation, the HP 86120A makes a measurement and displays the results about once every 1.25 seconds. It is in this normal update mode that maximum accuracy and wavelength resolution are achieved. However, should a faster update be desired, for example when real-time feedback is required to tune a laser to its designated channel, the HP 86120A can be set to update approximately four times per second. This reduces both wavelength resolution and accuracy but can be beneficial in some applications.

When *FAST* update is selected, one less digit of resolution is displayed. Also, if multiple wavelengths are present, these individual responses, with the reduced resolution, may no longer be recognized.

Select continuous or single measurements
The HP 86120A continuously measures the input spectrum at the front-panel OPTICAL INPUT connector. Whenever measurements are being acquired, an asterisk (*) is displayed in the display's upper right corner. When you switch between normal and fast update modes the rate that the asterisk blinks changes.

You can specify that the instrument perform a measurement only when the front-panel Single key is pressed. This is the single-acquisition measurement mode, and it is useful for capturing and preserving data. After capturing the data, you can display it using many of the procedures included in this chapter. You can return to continuous measurement mode at any time by pressing the Cont key.

To change the units of measure

1. Press Setup.

2. Press the *UNITS* softkey.

3. Press *WL* and select one of the following units. Then, press *RETURN* to complete your selection:

   - *NM* for nanometers

   - *THZ* for terahertz

   - CM^{-1} for wave number

4. Press *POWER* and select one of the following units:

   - *DBM* for decibels relative to a milliwatt

   - *MW* for milliwatts

   - *UW* for microwatts

To select single measurement acquisition

- Press the Single key.

To increase measurement speed

1. Press the Setup key.

2. Press the *UPDATE* softkey.

3. Select either *NORMAL* or *FAST*.

Defining Laser-Line Peaks

The HP 86120A uses two rules to identify valid laser-line peaks. Understanding these rules is essential to getting the most from your measurements. For example, these rules allow you to "hide" AM modulation sidebands or locate laser lines with small amplitudes.

In order to identify a laser line, the laser-line must meet *both* of the following rules:

- Power must be greater than the power established by the *peak threshold limit*

- Power must rise and then fall by at least the *peak excursion* value

In addition, the input wavelength range can be limited as described in this section.

Peak threshold limit
The peak threshold limit is set by subtracting the peak threshold value from the power of the largest laser line. So, if the largest laser line is 2 dBm and the peak threshold value is 10 dB, the peak threshold limit is –8 dBm (*–8 dBm = 2 dBm – 10 dB*). You can set the peak threshold value between 0 to 40 dB.

The peak threshold's default value is 10 dB. This ensures that any modulated signals being measured are not confused with their AM sidebands. For unmodulated lasers, or Fabry-Perot lasers, it may be desirable to increase this threshold to look for responses that are more than 10 dB from the peak.

Peak threshold can be used to suppress spurious signals. For example, a laser that is amplitude modulated in the audio frequency range can cause spurious wavelengths to be displayed below and above the correct wavelength. The power of these spurious wavelengths is below that of the correct wavelength. These spurious signals can be eliminated by decreasing Peak threshold from its Preset value.

Peak excursion

The peak excursion defines the rise and fall in amplitude that must take place in order for a laser line to be recognized. The rise and fall can be out of the noise, or in the case of two closely spaced signals, out of the filter skirts of the adjacent signal. The peak excursion's default value is 15 dB. Any laser line that rises by 15 dB and then falls by 15 dB passes the rule. You can set the peak excursion value from 1 to 30 dB.

Examples of valid and invalid signals

In the following figure, three laser lines are identified: responses ①, ③, and ④. Response ② is not identified because it is below the peak threshold. The portion of each signal that is within the peak excursion limits is shown in bold lines.

Because of the peak excursion rule, responses ④ and ⑤ are identified as one laser line—the minimum point between ④ and ⑤ does not drop to the peak excursion limit. This response has the highest power shown which is peak ④.

Whenever the peak threshold limit or peak excursion value is changed, the new limits are applied to the current displayed measurements even if the instrument is in the Single measurement mode.
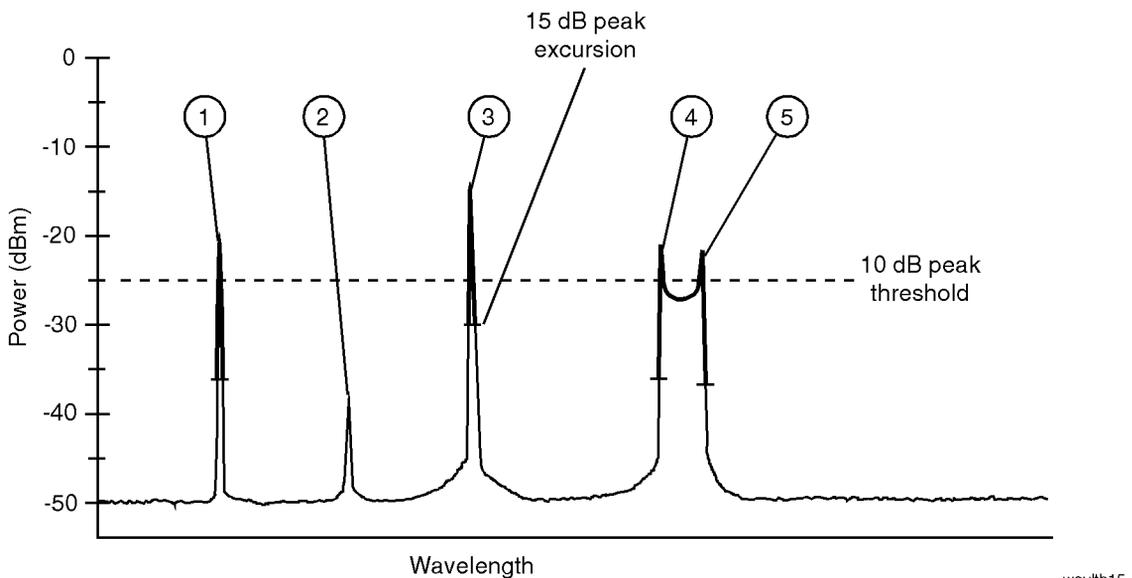
wavlth15

The following figure shows the same laser lines as the previous figure, but the peak-excursion value has been changed from 15 to 3 dB. Four laser lines are now identified with responses ④ and ⑤ identified as two distinct laser lines.

Limiting the input wavelength range

The HP 86120A's preset condition limits the wavelength measurement range from 1200 nm to 1650 nm. You can expand the wavelength range to cover the entire 700 nm to 1650 nm range. Although wavelength range limiting reduces the number of laser lines found, its main purpose is to eliminate the identification of second harmonic distortion products as described in the following sidebar. To set the wavelength range, refer to "To use the full wavelength range" on page 2-9.

wavlth3
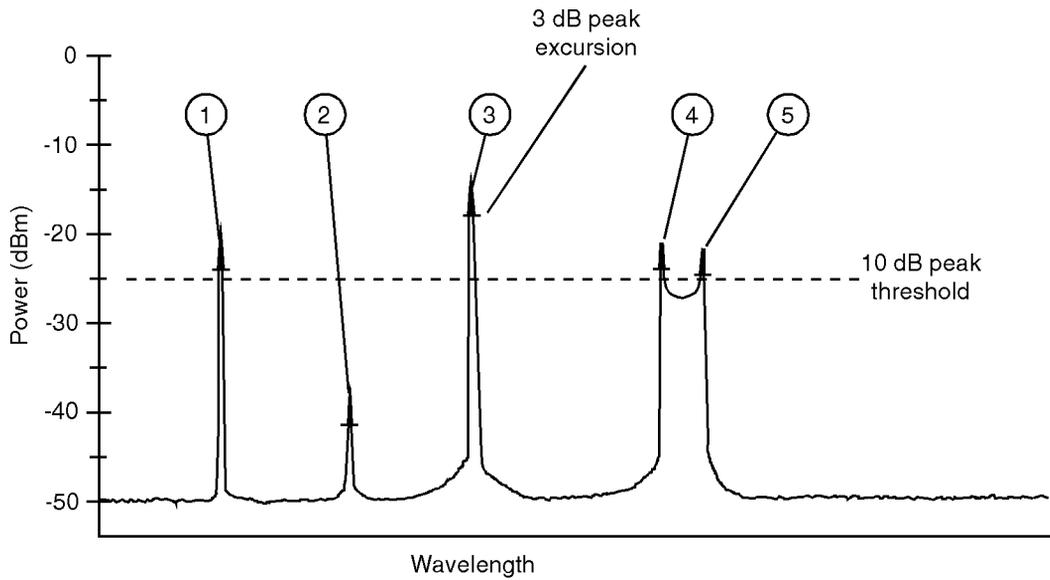
Distortion caused by low-power laser lines

Low-power laser lines (power level near the HP 86120A's specified sensitivity) may be accompanied by second harmonic (or other) distortion. For example, a low-power laser line at 1550 nm has a second harmonic line at 775 nm. If this second harmonic is above the peak threshold level relative to the fundamental line, it is considered a peak. Its displayed power level may be *greater* than that of the fundamental because the amplitude correction at 775 nm is much greater (by about 15 dB) than that at 1550 nm (the interferometer is less sensitive at 775 nm).

To avoid displaying this second harmonic line, limit the input wavelength range from 1200 nm to 1650 nm as described in "To use the full wavelength range" on page 2-9.

Or, reduce the peak threshold below its preset value. Because the peak threshold level is used to determine which signals are to be displayed *before* amplitude corrections are applied, the harmonic will be eliminated.

To define laser-line peaks

1. Press the Setup key.

2. Press *MORE* and then *THRSHLD*.

3. Press *PX EXC*, and enter the peak excursion value. Use the ✚ softkey to select the digit that requires editing. Use the ⬥ and ⬦ softkeys to change the value.

   The peak excursion value can range from 1 to 30 dB. The default value is 15 dB.

4. Press *RETURN*.

5. Press *PK THLD* and then enter the peak threshold value.

   The peak threshold value can range from 0 to 40 dB. Setting this value to 0 dB ensures that only the peak wavelength is identified. The default value is 10 dB.

Pressing the green PRESET key changes the peak excursion and peak threshold values to their default settings. It also turns wavelength range limiting on. Turning the HP 86120A's power off and then on does not change these settings.

> **If too many lines are identified**
>
> If the following message is displayed, too many laser lines have been identified:
>
>   E15 MAX NUMBER OF SIGNALS FOUND
>
> The maximum number of laser lines that the instrument can measure is 100. If this message appears, decrease the peak threshold value or increase the peak excursion value.

Measuring Laser Separation

It is often important to measure the wavelength and power separation between multiple laser lines. This is especially true in wavelength-division-multiplexed (WDM) systems where channel spacing must be adhered to. The HP 86120A can display the wavelength and amplitude of any laser line relative to another. In fact, the following types of relative measurements can be made compared to the reference:

- Relative wavelength, absolute power
- Relative power, absolute wavelength
- Relative wavelength and power

For example, suppose that you want to measure separation on a system having the spectrum shown in the following figure.
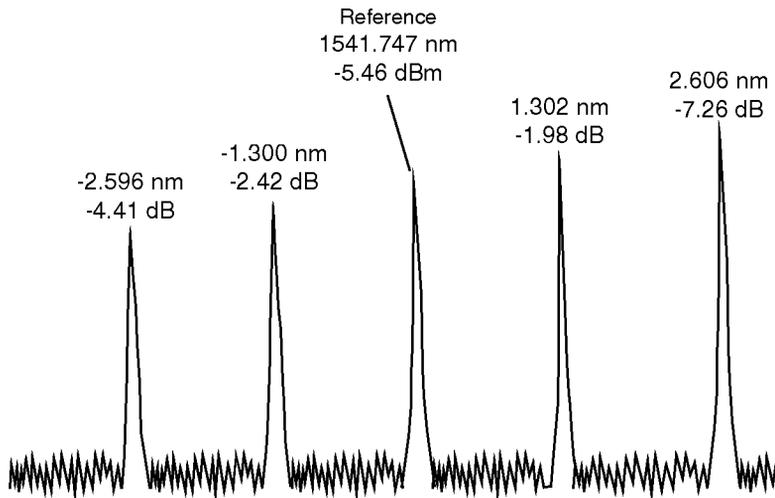
peaks

The HP 86120A displays separation on this spectrum as shown in the following figure. Notice that the 1541.747 nm laser line is selected as the reference. It is shown in absolute units. The wavelengths and powers of the remaining responses are shown relative to this reference. For example, the first response is 2.596 nm below the reference.

```
    -2.596nm       -4.41dB    ▬▬▬.....        *
    -1.300         -2.42dB    ▬▬▬.....    ΔWL/PWR
  1541.747      ↔ -5.46dBm  ▬▬▬....     BY  WL
     1.302         -1.98dB    ▬▬▬.....    6  OF  8
     2.606         -7.26dB    ▬▬▬......
                                           VAC
  ┌────────┐ ┌────────┐ ┌─────────┐ ┌────────┐ ┌──────┐   0  M
  │   ♧    │ │   ♧    │ │ SELECT  │ │ RESET  │ │ EXIT │
  └────────┘ └────────┘ └─────────┘ └────────┘ └──────┘
```
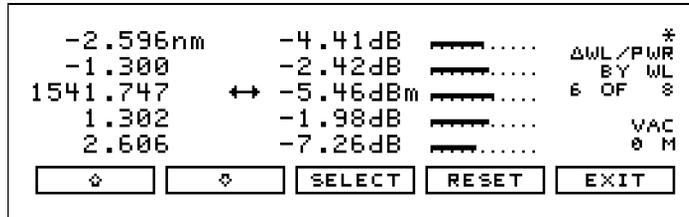
To determine channel spacing, simply read the relative wavelength measurement of the laser lines immediately preceding and following the reference. Use the ♧ , ♧ , and *SELECT* softkeys to change the reference laser line and read the channel spacing between each channel.

You can use relative power measurements to measure flatness (pre-emphasis) in a WDM system. Simply select one carrier as the reference and measure the remaining carriers relative to the reference level. The power differences represent the system flatness.

Press *RESET* to turn off the delta calculations so that all responses are shown in absolute wavelength and powers.

To measure channel separation

1. Press the front-panel Preset key.

2. Press List by WL.

3. Press the Delta On key.

   Use the Off key to turn off the measurement.

4. Select the type of separation to observe:

   • Δ *WL* displays channel separation.

   • Δ *WL* / Δ *PWR* displays both channel separation and differences in power.

5. Use the ⬆ and ⬇ softkeys to select the reference laser line.

6. Press *SELECT*.

   Press *SELECT* anytime to select a new reference. Press *RESET* anytime to turn off the delta calculation.

To measure flatness

1. Press the front-panel Preset key.

2. Press List by Power.

   This lists the input signals by power with the largest response listed first.

3. Press the Delta On key.

4. Select Δ *PWR*.

5. Use the ⬆ and ⬇ softkeys to select the first laser line.

6. Press *SELECT*.

7. Since the largest power signal is the reference, the relative power measurements for the other responses shows system flatness.

Measuring Laser Drift

In this section, you'll learn how the HP 86120A can be used to monitor drift (changes to a laser's wavelength and amplitude over time). Drift is measured simultaneously for every laser line that is identified at the input. The HP 86120A keeps track of each laser line's initial, current, minimum, and maximum values and displays their differences relative to itself. This allows the HP 86120A to be used for laser transmitter evaluation, burn-in, or development. In addition, you can monitor system performance over time, temperature, or other condition.

The following display shows power and wavelength drift measured on five laser lines. The DRIFT annotation, item ①, tells you that drift measurements are being performed. The current relative drift values for wavelength and power are shown in items ② and ③ respectively. Item ④ indicates the absolute reference values for the laser line indicated by the cursor ↔. The reference values are measured before the measurement starts.
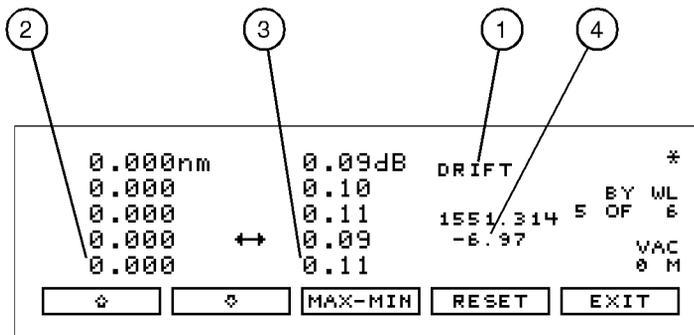
drift

You can restart the drift measurement at any time by pressing the *RESET* softkey. All minimum and maximum values are reset to the reference values, and the HP 86120A begins to monitor drift from the current laser line values. Move the cursor up and down the listing to see the reference wavelength and power of each laser line.

If measurement updating stops or the values become blanked

If, in the middle of a measurement, the number of laser lines present changes, the measurement stops until the original number of lines returns. You'll notice that a *CLEAR* softkey appears and one of the following message is displayed:

```
E46 NUM LINES < NUM REFS
E47 NUM LINES > NUM REFS
```

To view the data measured before the conditions changed, press CLEAR and then MAX-MIN. Notice that the measurement acquisition is changed from continuous to single.

To restart testing, press CLEAR, the CONT key, and then RESET to use the new number of lines as the reference. Pressing CONT restarts continuous measurement acquisition. Or, you can restore the original number of lines on the input so that the drift measurement can continue.

To measure drift

1. Press the front-panel Preset key.

2. Press Peak WL, List by WL, or List by Power to select the display style for observing drift.

3. Press Appl's and then *DRIFT*.

   Pressing *DRIFT* sets the current laser-line values as the reference from which to compare all drift.

4. Press *MAX-MIN* for the desired type of drift measurement as described in the following paragraphs:

   | MAX-MIN | Display shows the current values of laser lines relative to the wavelength and power values measured when the test was begun or the *RESET* softkey was pressed. |

   MAX-MIN   Display shows the current values of laser lines relative to the wavelength and power values measured when the test was begun or the *RESET* softkey was pressed.

   MAX-MIN   Display shows absolute maximum values since the drift measurement was started. This measurement gives the *longest* wavelength and *greatest* power measured. The laser line of interest may have since drifted to a lesser value. Note that the maximum wavelength and maximum power may not have occurred simultaneously.

   MAX-**MIN**   Display shows absolute minimum values since the drift measurement was started. This measurement gives the *shortest* wavelength and *smallest* power measured. The laser line of interest may have since drifted to a greater value. Note that the minimum wavelength and minimum power may not have occurred simultaneously.

   MAX-MIN   Display shows the *total* drift from the reference since the drift measurement was started. Values represent the minimum wavelength and power drift values subtracted from the maximum drift values.

5. In the List by WL and List by Power displays, use the ✿ and ✿ softkeys to view the reference values (wavelength and power values of each laser line before the test was started).

   During the measurement, you can change the display mode to Peak WL, List by WL, List by Power, or Avg WL. When List by WL or List by Power is selected, the signal list is sorted by reference values and not by the current, maximum,

or minimum values.

To restart the drift measurements, press *RESET*. This resets the reference values.

Measuring Signal-to-Noise Ratios

Signal-to-noise measurements provide a direct indication of system performance. Signal-to-noise measurements are especially important in WDM systems because there is a direct relation between signal-to-noise and bit error rate. The HP 86120A displays signal-to-noise measurements in the third column. For example, the selected signal in the following figure has a signal-to-noise ratio of 23.4 dB/nm.

Signal to Noise   Noise Bandwidth   Auto
Measurements   Indicator   Mode

```
1546.494nm     -10.78dBm 17.9dB S/N AUTO  *
1548.084        -9.45    19.6 1NM   BY WL
1549.698        -7.79    23.0    5 OF  6
1551.314    ↔  -6.94    23.4
1552.932       -10.30    18.7        VAC
                                      0 M
┌────────┐ ┌────────┐ ┌──────┐ ┌──────┐ ┌──────┐
│   ☼    │ │   ☼    │ │ PEAK │ │WL REF│ │ EXIT │
└────────┘ └────────┘ └──────┘ └──────┘ └──────┘
```
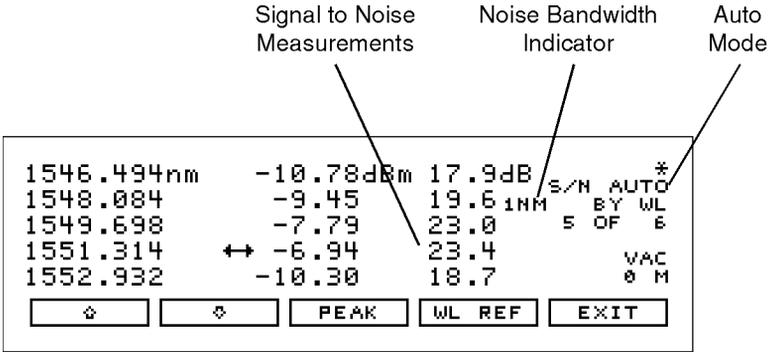
snr

Understanding how measurements are made is critical
During a signal-to-noise measurement, the absolute power of the carrier, in dBm, is compared to the absolute power of the noise at the carrier wavelength. See the following figure. The noise power at the carrier must be determined by interpolation because the carrier, in most cases, can not or should not be turned off.

You can select one of two methods used to determine the wavelength where the noise is measured: automatic interpolation or a user-entered wavelength. In the figure above, notice that "S/N AUTO" is displayed to indicate that automatic interpolation is selected.

Measuring Signal-to-Noise Ratios

P~laser line~

Noise value at
user-entered
wavelength

Interpolated
noise value
using automatic
mode

peak
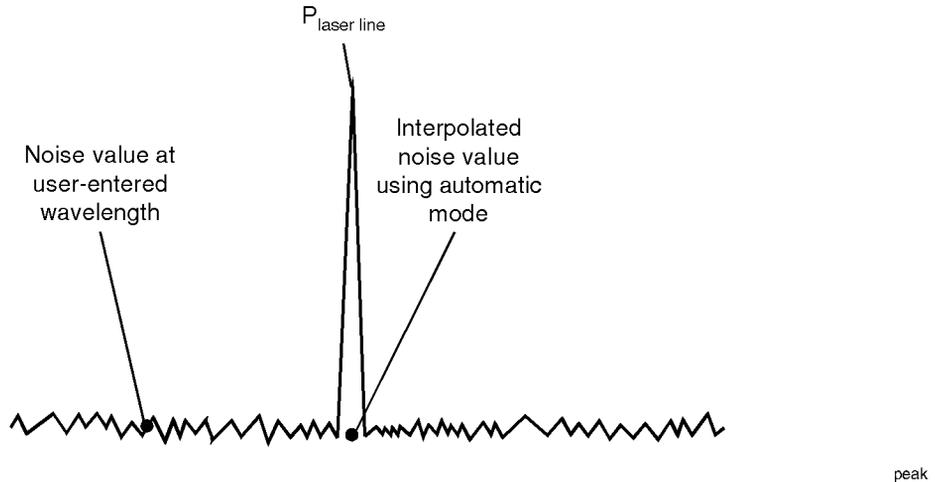
Location of noise measurements

Automatic interpolation

When the signal-to-noise "auto" function is selected, the HP 86120A first
determines the proximity of any adjacent signal. If the next closest signal is
≤200 GHz (approximately 1.6 nm at 1550 nm) away from the signal of interest,
then the noise power is measured half way between the two channels and an
equal distance to the other side of the signal of interest. See points P_{n1} and
P_{n2} in the following figure.

If the closest signal is more than 200 GHz from the signal of interest, or if there
is no other signals present, then the noise power is measured at 100 GHz on
either side of the signal of interest. The two measured noise power levels are
then averaged to estimate the noise power level at the signal wavelength. The
noise power measurements use linear interpolation to estimate the noise
power level at the signal of interest's wavelength.
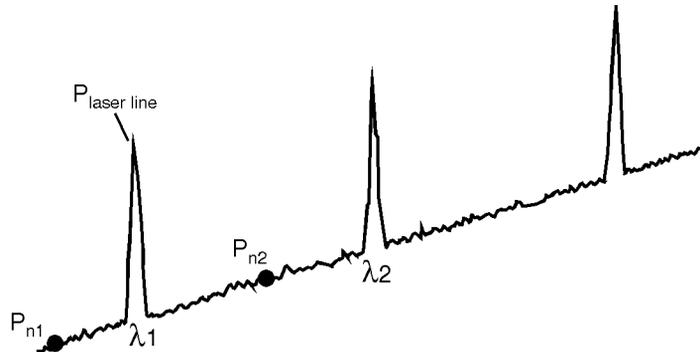
sun

Automatic interpolation

User-entered wavelength
When the signal-to-noise "user" function is selected, the HP 86120A uses only one wavelength to measure the noise power for all signals. This wavelength is set by the user and all signals are compared to the noise level at this wavelength to determine their corresponding signal-to-noise ratios

Noise bandwidth affects measurement
When measuring noise power, the HP 86120A must account for the noise bandwidth used during the measurement. Because noise bandwidth varies with measurement bandwidth (a wide bandwidth allows more noise to the HP 86120A's detector than a narrow bandwidth), the HP 86120A normalizes all noise power measurements to a bandwidth of 1 nm. The annotation 1 nm is displayed to show that the noise bandwidth is being normalized to a 1 nm bandwidth.

Repetitive data formats

The HP 86120A signal-to-noise application works best when the laser being tested is not modulated, or modulated with non-repetitive data formats. With repetitive data formats, such as PRBS data and SONET formats, there is significant low-frequency amplitude modulation of the laser. This modulation raises the noise floor of the HP 86120A significantly. The signal-to-noise measured can be limited to about 15 dB while measuring lasers modulated by repetitive data formats.

To measure signal-to-noise

1. Press the front-panel Preset key.

2. Press List by WL.

3. Press Appl's and then *S/N*.

4. To select the wavelength reference for measuring the noise, do the following steps:

   a. Press *WL REF*, and

      • press *AUTO* to let the instrument interpolate the wavelength,

        or

      • press *USER* to select the last wavelength manually entered.

   b. If you chose *USER*, you can specify the wavelength by pressing *USER WL*. Use the ✛ softkey to select the digit that requires editing. Use the ✿ and ✿ softkeys to change the value.

   c. Press *RETURN*.

5. While the signal-to-noise measurements are displayed, you can press *PEAK* anytime to select the signal with the highest power.

Measuring Coherence Length

Coherence length is a measure of the distance over which a laser's light retains the phase relationships of its spectrum. The HP 86120A measures coherence length of Fabry-Perot semiconductor diode lasers. The HP 86120A cannot measure coherence length of light emitting diodes (LEDs) or distributed feedback (DFB) lasers.

When you select coherence length measurements, the HP 86120A displays the following four values:

• Coherence length (Lc)

• Round trip optical length of diode laser cavity (2nLd)

• Alpha factor

• Beta factor

Coherence length in the region of 1 mm to 200 mm can be measured. The following figure shows a coherence length measurement.

```
COHERENCE LENGTH                          *
           Lc =   9.6 mm           BY WL
          2nLᴅ =1.491 mm          5 OF  6
         alpha =0.984                 VAC
          beta =0.061                 0 M
 [        ] [        ] [        ] [        ] [ EXIT ]
```

Coherence length (L_c)

The interferogram of the laser being tested is sampled and the envelope of the interferogram is found. This envelope has peaks (regions of high fringe visibility) at zero optical path delay and at delays equal to multiples of the laser cavity round-trip optical length. This is shown in the following figure of the interferogram envelope:

The amplitudes of the peaks decreases exponentially from the largest peak at
zero path delay. The exponential decay constant is defined as the coherence
length, Lc. The curve that connects the tops of the envelope peaks is given by
the following equation:

$$decay\ curve\ =\ e^{-\frac{OPD}{L_c}}$$

OPD is the optical path delay and Lc is the coherence length. Thus, at an opti-
cal path delay equal to the coherence length, the envelope peaks are down to
$1/e$ of their value at zero path delay peak. All envelope peaks found are used
to determine the exponential decay constant (coherence length) using a least
squares fit.

Round trip optical length of diode laser cavity (2nLd)
The average optical path delay spacing of the envelope peaks is measured.
This is equal to the diode laser cavity round trip optical length, 2nLd.

Alpha factor
The alpha factor is defined as the height of the first envelope peak away from
zero path delay relative to the height of the envelope peak at zero path delay.
The alpha factor is always between 0 and 1.

The *smaller* the alpha factor, the shorter the coherence length.

$$Alpha\,factor\ =\ \frac{V_A}{V_o}$$

Beta factor

The beta factor is defined as the height of the fringe visibility envelope mid-way between the zero optical path delay peak and the next peak relative to the height of the envelope peak at zero path delay. The beta factor is always between 0 and 1.

The *smaller* the beta factor, the more longitudinal modes (wavelengths) the laser has.

$$Beta\,factor\ =\ \frac{V_B}{V_o}$$

To measure coherence length

1. Press the front-panel Preset key.

2. Press Appl's and then *COH LEN*.

Measuring Modulated Lasers

A laser that is amplitude modulated at low frequencies (for example, modulated in the audio frequency range) can cause spurious wavelengths to be displayed below and above the correct wavelength. The power of these spurious wavelengths is below that of the correct wavelength. These spurious signals can be eliminated by decreasing the peak threshold. Refer to "Defining Laser-Line Peaks" on page 2-13. Even when the laser is amplitude modulated, the correct wavelength and power is displayed.

A laser modulated at high frequency (in the RF or microwave range) can also cause spurious wavelengths to be displayed, especially when the modulation is of a repetitive nature such as that of PRBS or SONET digital formats. In general, no spurious wavelengths will be displayed using preset instrument conditions. The preset condition includes peak excursion, peak threshold, and wavelength range limiting. However, increasing peak threshold can cause spurious wavelengths to be displayed. To control the wavelength range, refer to "To use the full wavelength range" on page 2-9.

Even when the laser being tested is modulated with repetitive formats, the carrier's correct wavelength and power is displayed; the wavelength and power of the spurious sidebands are incorrect.

Measuring Total Power Greater than 10 dBm

The maximum total power that can be measured by the HP 86120A is 10 dBm. However, with the addition of an external attenuator, more power can be applied. This may be necessary at the transmit end of a wavelength-division-multiplexed system where large signal levels are present. By entering an amplitude offset equal to the amount of attenuation at the instrument's input, accurate amplitude measurements are shown on the display. Additional amplification can also be accounted for.

To measure total power exceeding 10 dBm

The maximum total input power that can be applied to the HP 86120A before damage occurs is 18 dBm. The maximum total input power that can be measured is 10 dBm.

1. Connect an optical attenuator between the front-panel OPTICAL INPUT connector and the fiber-optic cable.

   The attenuator must reduce the total input power to the HP 86120A so that it is below +10 dBm.

2. Press *Setup*, *CAL*, and then *PWR OFS*.

   Notice that the PWR OFS annotation appears on the screen to indicate an offset is applied.

3. Use the ✦ softkey to select the digit that requires editing.

4. Use the ✿ and ✿ softkeys to change the value.

Power offset values are added to the display power readings. For example, if you placed a 10 dB attenuator on the front-panel connector, enter a power offset value of +10 dB. Negative values can also be entered if you connect an amplifier instead of an attenuator.

Calibrating Measurements

The wavelength of light changes depending on the material that the light is passing through. To display meaningful wavelength measurements, the HP 86120A performs two steps:

1. Measures the wavelength in air.

2. Converts the wavelength to show values in either a vacuum or "standard air".

For example, a laser line with a wavelength of 1550.000 nm in a vacuum would have a wavelength in standard air of 1549.577 nm.

Because all measurements made inside the HP 86120A are performed in air, the density of air, due to elevation, affects the wavelength results. You must calibrate the HP 86120A by entering the elevation. Elevations from 0 to 5000 meters can be entered. The elevation correction is immediately applied to the current measurement even if the instrument is in the single measurement acquisition mode.

Annotation on the display shows the current calibration elevation in meters and whether the wavelength measurements are shown for a vacuum (VAC) or standard air (STD AIR).

If you select frequency instead of wavelength measurements, switching between vacuum and standard air will not affect the measurement results. This is because the frequency of an optical signal does not change in different mediums—only the wavelength changes.

Definition of standard air

Standard air is defined to have the following characteristics:

> Barometric pressure: 760 torr
> Temperature: 15°C
> Relative humidity: 0%

To enter the elevation

1. Press the Setup key.

2. Press the *CAL* softkey.

3. Press *ELEV*.

4. Use the ⬆ and ⬇ softkeys to enter the elevation in meters. Entries jump in 500 meter steps from 0 m to 5000 m.

   In order for the HP 86120A to meet its published specifications, the elevation value selected with the softkeys must be within 250 meters of the actual elevation.

5. Press *RETURN* to complete the entry.

Converting feet to meters

If you know your elevation in feet, you can convert this value to meters by using the following equation:

$$m = \frac{ft}{3.281}$$

To select the medium for light

1. Press the Setup key.

2. Press the *CAL* softkey, and make the following selection:

   • Press *VACUUM* for wavelengths in a vacuum.

   • Press *STD AIR* for wavelengths in standard air.

3. Press *RETURN* to complete the entry.

Printing Measurement Results

Measurement results can be sent directly to a printer. Simply connect a compatible printer to the rear-panel PARALLEL PRINTER PORT connector. The output is ASCII text. An example of a compatible printer is an Hewlett-Packard's LaserJet series printer. Be sure to use a parallel printer cable to connect the printer.

The printer output is not a copy of the display. Rather, it is a listing of all signals present at the input (up to 100). The measurement values printed depend on the settings of the instrument when the Print key is pressed.

The following is an example of a typical printout:

```
HP 86120A SER US36151025
Firmware Ver. 1.000
List By Wavelength
8 Lines
Power Offset 0.0 dB
Vacuum
Elevation 0 Meters
Update Normal
Peak Excursion 15 dB
Peak Threshold 10 dB

Input
Wavelength  Power
----------- ----------
1280.384nm  -16.97dBm
1281.473     -13.14
1282.569     -13.92
1283.651     -13.34
1284.752     -11.69
1285.840      -8.11
1286.944     -10.38
1288.034     -14.65
```

To create a hardcopy

1. Connect the printer to the HP 86120A's rear-panel PARALLEL PRINTER PORT connector.

2. Press Print.

   You can use the *ABORT* and *CONT* softkey to stop and restart a print job that is in progress.

Cleaning Connections for Accurate Measurements

Accurate and repeatable measurements require clean connections. Use the following guidelines to achieve the best possible performance when making measurements on a fiber-optic system:

- Keep connectors covered when not in use.

- Use dry connections whenever possible.

- Use the cleaning methods described in this section.

- Use care in handling all fiber-optic connectors.

- When inserting a fiber-optic connector into a front-panel adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter.

Because of the small size of cores used in optical fibers, care must be used to ensure good connections. Poor connections result from core misalignment, air gaps, damaged fiber ends, contamination, and improper use and removal of index-matching compounds.

Use dry connections. Dry connectors are easier to clean and to keep clean. Dry connections can be used with physically contacting connectors (for example, Diamond HMS-10/HP, FC/PC, DIN, and ST). If a dry connection has 40 dB return loss or better, making a wet connection will probably not improve (and can degrade) performance.

CAUTION Hewlett-Packard strongly recommends that index matching compounds *not* be applied to their instruments and accessories. Some compounds, such as gels, may be difficult to remove and can contain damaging particulates. If you think the use of such compounds is necessary, refer to the compound manufacturer for information on application and cleaning procedures.

Table 2-2. Cleaning Accessories

Item	HP Part Number
Isopropyl alcohol	8500-5344
Cotton swabs	8520-0023
Small foam swabs	9300-1223
Compressed dust remover (non-residue)	8500-5262

Table 2-3. Dust Caps Provided with Lightwave Instruments

Item	HP Part Number
Laser shutter cap	08145-64521
FC/PC dust cap	08154-44102
Biconic dust cap	08154-44105
DIN dust cap	5040-9364
HMS10/HP dust cap	5040-9361
ST dust cap	5040-9366

Inspecting Fiber-Optic Cables

Consistent measurements with your lightwave equipment are a good indication that you have good connections. However, you may wish to know the insertion loss and/or return loss of your lightwave cables or accessories. If you test your cables and accessories for insertion loss and return loss upon receipt, and retain the measured data for comparison, you will be able to tell in the future if any degradation has occurred.

Connector (or insertion) loss is one important performance characteristic of a lightwave connector. Typical values are less than 0.5 dB of loss, and sometimes as little as 0.1 dB of loss with high performance connectors. Return loss is another important factor. It is a measure of reflection: the less reflection the better (the larger the return loss, the smaller the reflection). The best physically contacting connectors have return losses better than 50 dB, although 30 to 40 dB is more common.

Visual inspection of fiber ends

Although it is not necessary, visual inspection of fiber ends can be helpful. Contamination or imperfections on the cable end face can be detected as well as cracks or chips in the fiber itself. Use a microscope (100X to 200X magnification) to inspect the entire end face for contamination, raised metal, or dents in the metal as well as any other imperfections. Inspect the fiber for cracks and chips. Visible imperfections not touching the fiber core may not affect performance (unless the imperfections keep the fibers from contacting).

To clean a non-lensed connector

CAUTION Do not use any type of foam swab to clean optical fiber ends. Foam swabs can leave filmy deposits on fiber ends that can degrade performance.

1. Apply isopropyl alcohol to a clean lint-free cotton swab or lens paper.

   Cotton swabs can be used as long as no cotton fibers remain on the fiber end after cleaning.

2. Before cleaning the fiber end, clean the ferrules and other parts of the connector.

3. Apply isopropyl alcohol to a new clean lint-free cotton swab or lens paper.

4. Clean the fiber end with the swab or lens paper. Move the swab or lens paper back and forth across the fiber end several times.

   Some amount of wiping or mild scrubbing of the fiber end can help remove particles when application of alcohol alone will not remove them. This technique can remove or displace particles smaller than one micron.

5. Immediately dry the fiber end with a clean, dry, lint-free cotton swab or lens paper.

6. Blow across the connector end face from a distance of 6 to 8 inches using filtered, dry, compressed air. Aim the compressed air at a shallow angle to the fiber end face.

   Nitrogen gas or compressed dust remover can also be used.

CAUTION   Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

7. As soon as the connector is dry, connect or cover it for later use.

To clean an adapter

1. Apply isopropyl alcohol to a clean foam swab.

    Cotton swabs can be used as long as no cotton fibers remain after cleaning. The foam swabs listed in this section's introduction are small enough to fit into adapters.

    Although foam swabs can leave filmy deposits, these deposits are very thin, and the risk of other contamination buildup on the inside of adapters greatly outweighs the risk of contamination by foam swabs.

2. Clean the adapter with the foam swab.

3. Dry the inside of the adapter with a clean, dry, foam swab.

4. Blow through the adapter using filtered, dry, compressed air.

    Nitrogen gas or compressed dust remover can also be used.

CAUTION   Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

To test insertion loss and return loss

To test insertion loss, use an appropriate lightwave source and a compatible lightwave receiver to test insertion loss. Examples of test equipment configurations include the following equipment:

• HP 71450B/51B/52B optical spectrum analyzers with Option 002 built-in

white light source.

- HP 8702 or HP 8703 lightwave component analyzer system

- HP 83420 lightwave test set with an HP 8510 network analyzer

- HP 8153 lightwave multimeter with a source and power sensor module

To test return loss, use an appropriate lightwave source, a lightwave receiver, and lightwave coupler to test return loss. Examples of test equipment configurations include the following equipment:

- HP 8703 lightwave component analyzer

- HP 8702 analyzer with the appropriate source, receiver, and lightwave coupler

- HP 8504 precision reflectometer

- HP 8153 lightwave multimeter with a source and power sensor module in conjunction with a lightwave coupler

- HP 81554SM dual source and HP 81534A return loss module

3

Programming

HP-IB Programming

This chapter explains how to program the HP 86120A. The programming syntax conforms to the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation and to the Standard Commands for Programmable Instruments (SCPI).

Where to begin…

- If you are unfamiliar with the rules governing SCPI command syntax, refer to "Reviewing SCPI Syntax Rules" on page 3-23.

- To learn how to correctly begin your programs, refer to "Addressing and Initializing the Instrument" on page 3-4.

- To learn which commands to use and how to use them, refer to "Making Measurements" on page 3-6.

- To learn to read the instrument's status registers, refer to "Monitoring the Instrument" on page 3-16.

The programming examples for individual commands in this manual are written in HP BASIC 6.0 for an HP 9000 Series 200/300 Controller.

Contents

Addressing and Initializing the Instrument

The HP 86120A's HP-IB address is configured at the factory to a value of 20. You must set the output and input functions of your programming language to send the commands to this address. You can change the HP-IB address from the front panel as described in "To change the HP-IB address" on page 3-5.

Remote mode and front-panel lockout

Whenever the instrument is controlled by a computer, the Remote message is displayed on the instrument's screen and the softkey menu is blanked except for the *LOCAL* softkey. This softkey can be pressed by the user to restore front panel control of the instrument.

You can specify a local lockout mode that prevents the *LOCAL* softkey from being displayed. If the instrument is in local lockout mode, all the softkeys may be blanked. For example, if the instrument is first placed in local lockout mode and then placed in remote mode, no softkeys are displayed.

Consult the documentation for your programming environment to determine which commands are used to put an instrument in the remote and local lock-out modes. These are not HP 86120A commands; they control HP-IB control lines and do not send any characters to the HP 86120A.

Initialize the instrument at start of every program

It is good practice to initialize the instrument at the start of every program. This ensures that the bus and all appropriate interfaces are in a known state. HP BASIC provides a CLEAR command which clears the interface buffer and also resets the instrument's parser. (The parser is the program that reads the instructions that you send.) Whenever the instrument is under remote programming control, it should be in the single measurement acquisition mode. This is automatically accomplished when the *RST common command is used. The *RST command initializes the instrument to a preset state:

```
CLEAR 720
OUTPUT 720;"*RST"
```

Notice in the example above, that the commands are sent to an instrument address of 720. This indicates address 20 on an interface with select code 7. Pressing the green Preset key does not change the HP-IB address.

Set single acquisition mode
An advantage of using the *RST command is that it sets the HP 86120A into the single measurement acquisition mode. Because the READ and MEASure data queries expect this mode, their proper operation is ensured.

Establish the wavelength range
At the start of each program, be sure to establish the input wavelength range using the HP 86120A's :CALCulate2:WLIMit command. Setting this command to on enables the full wavelength range of the instrument. If you are measuring signals between 1200 nm and 1650 nm, use this command to ensure that spurious second harmonic peaks are not identified. Refer to "WLIMit[:STATe]" on page 4-35. Refer also to "Limiting the input wavelength range" on page 2-15.
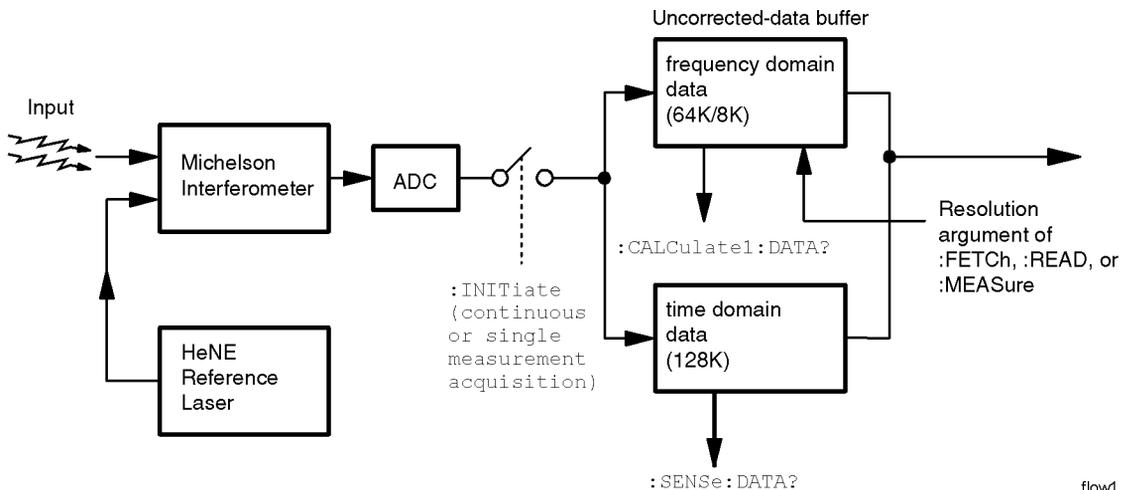
To change the HP-IB address

1. Press the Setup key.

2. Press *MORE* and then *HP-IB*.

3. Use the ⬙ and ⬙ softkeys to change the HP-IB address.

4. Press *RETURN*.

Making Measurements

Making measurements remotely involves changing the HP 86120A's settings, performing a measurement, and then returning the data to the computer. The simplified block diagram of the HP 86120A shown here lists some of the available programming commands. Each command is placed next to the instrument section it configures or queries data from.

Notice that there are two buffers from which data can be queried: an uncorrected data buffer and a corrected data buffer. With each scan of the input wavelength range, the analog-to-digital converter loads 65,536 data values into the uncorrected data buffer. This is considered to be one "measurement". A fast-update measurement mode is available for quicker measurement acquisi-

Uncorrected-data buffer

Input

Michelson
Interferometer

ADC

frequency domain
data
(64K/8K)

Resolution
argument of
:FETCh, :READ, or
:MEASure

`:CALCulate1:DATA?`

`:INITiate
(continuous
or single
measurement
acquisition)`

time domain
data
(128K)

HeNE
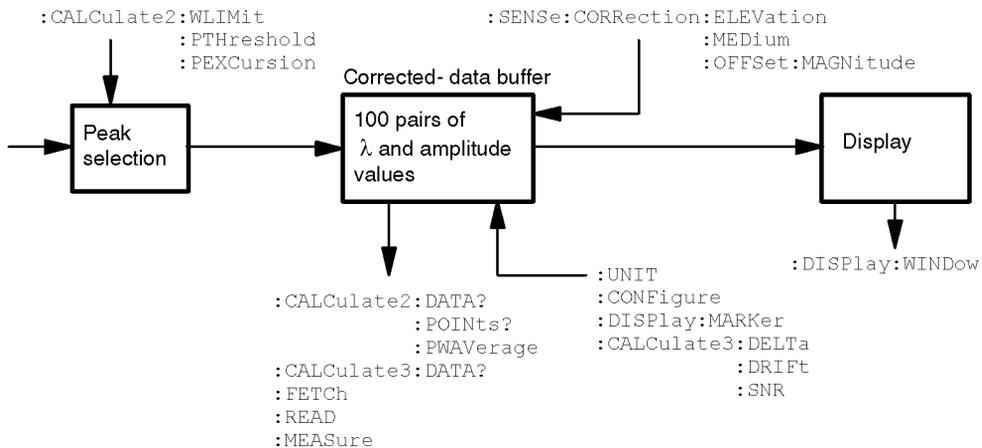Reference
Laser

`:SENSe:DATA?`

flow1

tion. But, because only 8,192 data values are collected in fast-update measurement mode, the ability to resolve closely spaced signals is reduced.

After collecting the uncorrected data, the HP 86120A searches the data for the first 100 peak responses. (Searching starts at 1700 nm and progresses towards 700 nm). These peak values are then placed into the corrected data buffer. Each peak value consists of an amplitude and wavelength measurement. Amplitude and wavelength correction factors are applied to this data.

For a listing of the programming commands (including a cross reference to front-panel keys), refer to the following tables:

```
:CALCulate2:WLIMit              :SENSe:CORRection:ELEVation
         :PTHreshold                            :MEDium
         :PEXCursion                            :OFFSet:MAGNitude
```

Corrected- data buffer

```
Peak           100 pairs of        Display
selection      λ and amplitude
               values
```

```
:DISPlay:WINDow

:CALCulate2:DATA?      :UNIT
         :POINts?      :CONFigure
         :PWAVerage    :DISPlay:MARKer
:CALCulate3:DATA?      :CALCulate3:DELTa
:FETCh                          :DRIFt
:READ                           :SNR
:MEASure
```

flow2

Commands are grouped in subsystems

The HP 86120A commands are grouped in the following subsystems. You'll find a description of each command in Chapter 4, "Programming Commands".

Subsystem	Purpose of Commands
Measurement Instructions	Perform frequency, wavelength, wavenumber, and coherence length measurements.
CALCulate1	Queries *uncorrected* frequency-spectrum data.
CALCulate2	Queries *corrected* peak data.
CALCulate3	Performs delta, drift, and signal-to-noise measurements.
DISPlay	Applies markers and displays power bars.
HCOPy	Print measurement results.
SENSe	Sets elevation-correction values, selects readings for air or vacuum, and enters amplitude offsets. Queries time-domain values of the input data.
STATus	Queries instrument status registers.
SYSTem	Presets HP 86120A and queries error messages.
TRIGger	Stops current measurement. Acquires new measurement data. Also used to select single or continuous acquisition of measurement data.
UNIT	Sets the amplitude units to watts or dBm.

Table 3-1 on page 3-9 shows the kinds of measurements that the HP 86120A can perform and the associated programming commands used to return that data. In some cases, there is more than one method that can be used to obtain the desired data. Refer to Chapter 4, "Programming Commands" for the correct syntax for these commands.

Table 3-1. Commands for Capturing Data

Desired Measurement	Command to Configure Measurement (partial listing)	Command to Query Data
Wavelength (nm)	CONFigure, FETCh, READ, and MEASure	MEASure:ARRay:POWer:WAVelength?
Frequency (THz)	CONFigure, FETCh, READ, and MEASure	MEASure:ARRay:POWer:FREQuency?
Wavenumber (m^{-1})	CONFigure, FETCh, READ, and MEASure	MEASure:ARRay:POWer:WNUMber?
Coherence Length (m)	CONFigure, FETCh, READ, and MEASure	FETCh, READ, or MEASure
Power (W, dBm)	CONFigure, FETCh, READ, and MEASure	MEASure:ARRay:POWer?
Average Wavelength, Wavenumber, or Frequency	CALCulate2:PWAVerage:STATe	CALCulate2:DATA?
Total Power (W, dBm)	CALCulate2:PWAVerage:STATe	CALCulate2:DATA?
Laser-Line Separation	CALCulate3:DELTa:REFerence	CALCulate3:DATA?
Laser-Line Drift	CALCulate3:DRIFt:STATe	CALCulate3:DATA?
Signal-to-Noise Ratio	CALCulate3:SNR:STATe	CALCulate3:DATA?
Time-Domain Data	CALCulate1:TRANsform:FREQuency:POINts	SENSe:DATA?
Corrected Frequency Domain Data	CALCulate1:TRANsform:FREQuency:POINts	CALCulate2:DATA?
Uncorrected Frequency Domain Data	CALCulate1:TRANsform:FREQuency:POINts	CALCulate1:DATA?

Measurement instructions give quick results

The easiest way to measure wavelength, frequency, power, or coherence length is to use the MEASure command. The MEASure command is one of four measurement instructions: MEASure, READ, FETCh, and CONFigure. The syntax for measurement instructions is documented in "Measurement Instructions" on page 4-14.

Each measurement instruction has an argument that controls the measurement update rate. This is equivalent to using the *NORMAL* and *FAST* softkeys.

:MEASure command
MEASure configures the HP 86120A, captures new data, and queries the data all in one step. For example, to measure the longest wavelength, send the following command:

```
:MEASure:SCALar:POWer:WAVelength? MAX
```

Table 3-2. The Different Forms of MEASure

Desired Measurement Data	Use this MEASure Query	Display Format
Power (W, dBm)	:MEASure:ARRay:POWer?	List by Power
	:MEASure:SCALar:POWer?	single wavelength mode
Frequency (Hz)	:MEASure:ARRay:POWer:FREQuency?	List by WL *(frequency)*
	:MEASure:SCALar:POWer:FREQuency?	single wavelength mode
Wavelength (m)	MEASure:ARRay:POWer:WAVelength?	List by WL
	MEASure:SCALar:POWer:WAVelength?	single wavelength mode
Wavenumber (m^{-1})	:MEASure:ARRay:POWer:WNUMber?	List by WL
	:MEASure:SCALar:POWer:WNUMber?	single wavelength mode
Coherence Length (m)	:MEASure:LENGth:COHerence?	coherence length

Specifying SCALar places the display in the single wavelength format and returns a single value to the computer. Specifying ARRay places the display in the List by Power or List by WL modes; an array of data is returned to the computer.

A common programming error is to send the :MEASure command when the instrument is in the continuous measurement acquisition mode. Because :MEASure contains an :INIT:IMM command, which expects the single measurement acquisition mode, an error is generated, and the INIT command is ignored.

:READ command

The READ command works like the MEASure command except that it does not configure the instrument's settings. You can use the CONFigure command to configure the instrument for a particular measurement without returning any data.

The MEASure and READ commands are identical to combining the following commands:

Command	Equivalent Commands
:MEASure	:ABORt;:CONFigure;:READ
:READ	:ABORt;:INITiate:IMMediate;:FETCh

A common programming error is to send the :READ command when the instrument is in the continuous measurement acquisition mode. Because :READ contains an :INIT:IMM command, which expects the single measurement acquisition mode, an error is generated, and the INIT command is ignored.

:FETCh command

The FETCh command returns data from previously performed measurements; it does not initiate the collection of new data. Because FETCh does not configure the instrument or acquire new input data, you can use FETCh repeatedly on the same set of acquired data. For example, use two FETCh commands to return wavelength and then power values for the same measurement. This is shown in the following program fragment:

```
OUTPUT 720;":INIT:CONT OFF;"
OUTPUT 720;":CONF:ARR:POW MAX"
OUTPUT 720;":INIT:IMM"
OUTPUT 720;":FETC:ARR:POW?"
ENTER 720:powers$
OUTPUT 720;":FETC:ARR:POW:WAV?"
ENTER 720:wavelengths$
```

In the example above, the data in the power and wavelength arrays are returned in the same order so that powers can be matched to wavelengths.

Also, because new data is not collected, FETCh is especially useful when characterizing transient data.

FETCh does not reconfigure the display. For example, if the display is in the Peak WL mode, sending :FETCh:ARRay does not configure the display to the List by WL even though an array of data is returned to the computer.

A common programming error occurs when the :FETCh command is used after an *RST command. This generates error number –230, "Data corrupt or stale". In this instance, you must send :INIT:IMM after the *RST command and before :FETCh command to capture a new array of measurement data.

:CONFigure command

The CONFigure command changes measurement settings without taking a measurement. The instrument is placed in the List by WL, List by Ampl, Peak WL display, or in the coherence length application.

CONFigure can be queried. The query returns the last configuration setup by the CONFigure command. The instrument returns a string which is the last instrument function sent by a CONFigure command or MEASure query. The returned string is in the short command form. Use caution when using this query, because if any instrument settings were changed since the last CONFigure command or MEASure query these changes may not be included in the returned string.

For example, if the last CONFigure command was

```
:CONFigure:SCALar:POWer:WAVelength 1300NM, MAX
```

a CONFigure? query would return a string that is similar to the following line:

```
"POW:WAV 1.300000e-6,0.01"
```

The *1300NM* and *resolution* values track the actual instrument settings and input signals. Notice that the quotation marks are part of the returned string.

Return single or multiple measurement values

You can specify whether FETCh, READ, or MEASure returns a single value (SCALar) or multiple values (ARRay). The example the following command specifies SCALar data which returns a single value.

```
:MEASure:SCALar:POWer:WAVelength? MAX
```

ARRay and the SCPI standard

According to the SCPI command reference, ARRay command causes an instrument to take multiple measurements. (A <size> parameter indicates the number of measurements to take.) However, the HP 86120A's ARRay command refers to the measurements performed for one measurement sweep; this results in an array of measured signals. Because the <size> parameter does not apply, any <size> parameter sent will be ignored by the instrument. No syntax error will be generated if a <size> parameter is sent.

Always force the HP 86120A to wait for non-sequential commands

The HP 86120A normally processes its remote programming commands sequentially. The instrument waits until the actions specified by a particular command are completely finished before reading and executing the next command. However, there are a few non-sequential commands where this is not true. Non-sequential commands do *not* finish executing before the next command is interpreted.

The following is a list of the HP 86120A's non-sequential commands:

    :CALCulate1:TRANsform:FREQuency:POINTs
    :CALCulate2:PEXCursion
    :CALCulate2:PTHReshold
    :CALCulate2:WLIMit:STATe
    :CALCulate3:SNR:AUTO
    :SENSe:CORRection:ELEVation
    :INITiate:CONTinuous
    :INITiate[:IMMediate]

The following additional commands are also non-sequential commands if CALCulate3:SNR:AUTO is set to OFF:

    :CALCulate3:REFerence:FREQuency
    :CALCulate3:REFerence:WAVelength
    :CALCulate3:REFerence:WNUMber

The benefit of non-sequential commands is that, in some situations, they can reduce the overall execution times of programs. For example, you can set the peak excursion, peak threshold, and elevation and use a *WAI command at the end to save time. However, non-sequential commands can also be a source of annoying errors. Always use the *OPC query or *WAI command with the non-sequential commands to ensure that your programs execute properly.

For example, suppose that you wanted to set the elevation correction value and then send an :INIT:IMM command. The following programming fragment results in an error *–213 "Init ignored"*. This occurs because the :ELEVation command causes the recalculation of the data which is like sending the :INIT:IMM command. When the actual :INIT:IMM is sent, the error occurs because the command is already in progress.

```
OUTPUT 720;":INIT:IMM"
OUTPUT 720;":SENSe:CORRection:ELEVation 1000"
OUTPUT 720;":INIT:IMM"
```

Use an *OPC? query to ensure that the :ELEVation command has completed as shown in the following lines:

```
OUTPUT 720;":INIT:IMM"
OUTPUT 720;":SENSe:CORRection:ELEVation 1000"
OUTPUT 720;"*OPC?"
ENTER 720;Response$
OUTPUT 720;":INIT:IMM"
```

Or, the *WAI command could be used:

```
OUTPUT 720;":INIT:IMM"
OUTPUT 720;":SENSe:CORRection:ELEVation 1000"
OUTPUT 720;"*WAI?"
OUTPUT 720;":INIT:IMM"
```

The format of returned data

Measurements are returned as strings
All measurement values are returned from the HP 86120A as ASCII strings.
When an array is returned, the individual values are separated by the comma
character.

Determine the number of data points
When a FETCh, READ, or MEASure command is used (with ARRay speci-
fied), the first returned value indicates the total number of measurement val-
ues returned in the query.

If you use the:CALCulate1:DATA?, :CALCulate2:DATA?, or
:CALCulate3:DATA? queries to query data, send the :POINts? query first to
determine the number of values returned in the string. The string does not
contain a first value which specifies the string length. This is shown in the fol-
lowing example:

```
OUTPUT 720;":CALCulate1:POINts?"
ENTER 720;Length
OUTPUT 720;":CALCulate1:DATA?"
ENTER 720;Result$
```

Data can be corrected for elevation and vacuum
Normally, the HP 86120A provides measurement values calculated for condi-
tions in air at sea level. Use the :SENSe:CORRection:ELEVation command to
compensate for air dispersion. Altitudes up to 5000 meters can be entered.
Use the :SENSe:CORRection:MEDium command to switch to readings in a
vacuum.

Amplitude units
The default amplitude units are dBm. If you need measurements in watts, use
the :UNIT:POWer command. When the HP 86120A is turned on, the amplitude
units are automatically set to the units used before the instrument was last
turned off.

Monitoring the Instrument

Almost every program that you write will need to monitor the HP 86120A for its operating status. This includes querying execution or command errors and determining whether or not measurements have been completed. Several status registers and queues are provided to accomplish these tasks.

In this section, you'll learn how to enable and read these registers. In addition to the information in this section, you should review the commands documented in "Common Commands" on page 4-4 and "STATus Subsystem" on page 4-66.

Status registers

The HP 86120A provides four registers which you can query to monitor the instrument's condition. These registers allow you to determine the following items:

- Status of an operation
- Availability of the measured data
- Reliability of the measured data

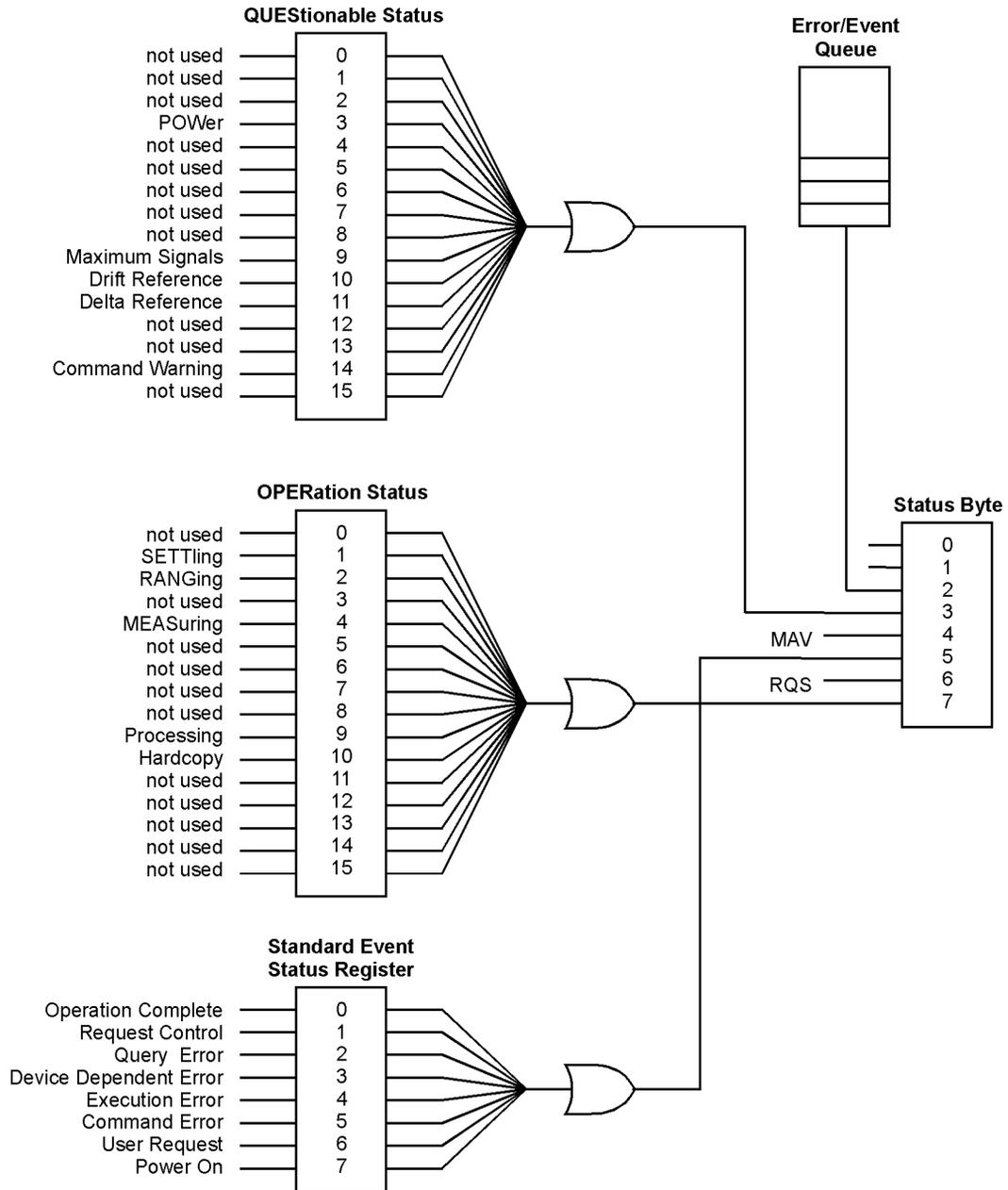All three registers are shown in the figure on the following page and have the following uses:

Register	Definition
Status Byte	Monitors the status of the other three registers.
Standard Event Status	This is the standard IEEE 488.2 register. Contains bits which indicate the status of the other two registers.
OPERation Status	Contains bits that report on the instrument's normal operation.
QUEStionable Status	Contains bits that report on the condition of the signal.

Status Byte register
The Status Byte Register contains summary bits that monitor activity in the other status registers and queues. The Status Byte Register's bits are set and cleared by the presence and absence of a summary bit from other registers or queues. Notice in the following figure that the bits in the Standard Event Status, OPERation status, and QUEStionable status registers are "or'd" to control a bit in the Status Byte Register.

If a bit in the Status Byte Register goes high, you can query the value of the source register to determine the cause.

QUEStionable Status

not used	0
not used	1
not used	2
POWer	3
not used	4
not used	5
not used	6
not used	7
not used	8
Maximum Signals	9
Drift Reference	10
Delta Reference	11
not used	12
not used	13
Command Warning	14
not used	15

Error/Event Queue

OPERation Status

not used	0
SETTling	1
RANGing	2
not used	3
MEASuring	4
not used	5
not used	6
not used	7
not used	8
Processing	9
Hardcopy	10
not used	11
not used	12
not used	13
not used	14
not used	15

Status Byte

	0
	1
	2
	3
MAV	4
	5
RQS	6
	7

Standard Event Status Register

Operation Complete	0
Request Control	1
Query Error	2
Device Dependent Error	3
Execution Error	4
Command Error	5
User Request	6
Power On	7

status

The Status Byte Register can be read using either the *STB? common command or the HP-IB serial poll command. Both commands return the decimal-weighted sum of all set bits in the register. The difference between the two methods is that the serial poll command reads bit 6 as the Request Service (RQS) bit and clears the bit which clears the SRQ interrupt. The *STB? command reads bit 6 as the Master Summary Status (MSS) and does not clear the bit or have any affect on the SRQ interrupt. The value returned is the total bit weights of all of the bits that are set at the present time.

OPERation Status and QUEStionable Status registers

You can query the value of the OPERation Status and QUEStionable Status registers using commands in the STATus subsystem.

The STATus subsystem also has transition filter software which give you the ability to select the logic transitions which set bits in the OPERation Status and QUEStionable Status registers. For example, you can define the POWer bit of the QUEStionable Status register to report an event when the condition transitions from false to true. This is a positive transition. You can also specify a negative transition where the bit is set when the condition transitions from true to false.

Table 3-3. Bits in Operation Status Register

Bit	Definition
0	*not used*
1	*SETTling* - indicating that the instrument is waiting for the motor to reach the proper position before beginning data acquisition.
2	*RANGing* - indicating the the instrument is currently gain ranging.
3	*not used*
4	*MEASuring* - indicating that the instrument is making a measurement.
5 through 8	*not used*
9	*Processing* - indicating that the instrument is currently processing the data acquired.
10	*Hardcopy* - indicating that the instrument is currently printing the data to the parallel port
11 through 16	*not used*

Table 3-4. Bits in Questionable Status Register

Bit	Definition
0, 1, and 2	*not used*
3	*POWer* - indicating that the instrument is measuring too high of a power.
3 through 8	not used
9	*Maximum signals* - indicating that the instrument has found the maximum number of signals.
10	*Drift Reference* - indicating that the number of reference signals is different from the current number of input signals.
11	*Delta Reference* - indicating that there is no delta reference signal.
12 through 13	not used
14	*Command Warning* - indicating that the instrument has received some extra unexpected parameters for one of the measurement functions.
15	*not used*

Standard Event Status register

The Standard Event Status Register monitors the following instrument status events:

- OPC - Operation Complete
- RQC - Request Control
- QYE - Query Error
- DDE - Device Dependent Error
- EXE - Execution Error
- CME - Command Error
- URQ - User Request
- PON - Power On

When one of these events occur, the event sets the corresponding bit in the register. If the bits are enabled in the Standard Event Status Enable Register, the bits set in this register generate a summary bit to set bit 5 (ESB) in the Status Byte Register.

The contents of the Standard Event Status Register can be read and the register cleared by sending the *ESR? query. The value returned is the total bit weights of all of the bits that are set at the present time.

Enabling register bits with masks

Several masks are available which you can use to enable or disable individual bits in each register. For example, you can disable the Hardcopy bit in the OPERation Status Register so that even though it goes high, it can never set the summary bit in the status byte high.

Use the *SRE common command to set or query the mask for the Status Byte Register.

The masks for the OPERation Status and QUEStionable Status registers are set and queried using the STATus subsystem's ENABle commands.

Use the *ESE common command to set or query the mask for the Standard Event Status Register.

The *CLS common command clears all event registers and all queues except the output queue. If *CLS is sent immediately following a program message terminator, the output queue is also cleared. In addition, the request for the *OPC bit is also cleared.

For example, suppose your application requires an interrupt whenever any type of error occurs. The error related bits in the Standard Event Status Register are bits 2 through 5. The sum of the decimal weights of these bits is 60. Therefore, you can enable any of these bits to generate the summary bit by sending the `*ESE 60` command.

Whenever an error occurs, it sets one of these bits in the Standard Event Status Register. Because the bits are all enabled, a summary bit is generated to set bit 5 in the Status Byte Register.

If bit 5 (ESB) in the Status Byte Register is enabled (via the *SRE command), an SRQ service request interrupt is sent to the external computer.

Standard Event Status Register bits that are not enabled still respond to their corresponding conditions (that is, they are set if the corresponding event occurs). However, because they are not enabled, they do not generate a summary bit to the Status Byte Register.

Queues

There are two queues in the instrument: the output queue and the error queue. The values in the output queue and the error queue can be queried.

Output queue
The output queue stores the instrument responses that are generated by certain commands and queries that you send to the instrument. The output queue generates the Message Available summary bit when the output queue contains one or more bytes. This summary bit sets the MAV bit (bit 4) in the Status Byte Register. The method used to read the Output Queue depends upon the programming language and environment. For example, with HP Basic, the output queue may be read using the ENTER statement.

Error queue
As errors are detected, they are placed in an error queue. Instrument specific errors are indicated by positive values. General errors have negative values. You can clear the error queue by reading its contents, sending the *CLS command, or by cycling the instrument's power.

The error queue is first in, first out. If the error queue overflows, the last error in the queue is replaced with error -350, "Queue overflow." Any time the queue overflows, the least recent errors remain in the queue, and the most recent error is discarded. The length of the instrument's error queue is 30 (29 positions for the error messages, and 1 position for the "Queue overflow" message).

The error queue is read with the SYSTEM:ERROR? query. Executing this query reads and removes the oldest error from the head of the queue, which opens a position at the tail of the queue for a new error. When all the errors have been read from the queue, subsequent error queries return 0, "No error."

For more information on reading the error queue, refer to "ERRor" on page 4-72. For a list of errors messages, refer to "Error Messages" on page 7-12.

Reviewing SCPI Syntax Rules

The HP 86120A's programming commands comply with the SCPI standard. In this section, you'll learn the correct syntax for forming and sending HP 86120A command strings. For more detailed information regarding the HP-IB, the IEEE 488.2 standard, or the SCPI standard, refer to the following books:

Hewlett-Packard Company. *Tutorial Description of Hewlett-Packard Interface Bus,* 1987.

Hewlett-Packard Company. *SCPI—Standard Commands for Programmable Instruments,* 1995.

International Institute of Electrical and Electronics Engineers. *IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation.* New York, NY, 1987.

International Institute of Electrical and Electronics Engineers. *IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols and Common commands For Use with ANSI/IEEE Std 488.1-1987.* New York, NY, 1987.

Types of commands
The HP 86120A responds to three types of commands:

- Common commands
- Measurement instructions
- Subsystem commands

All of these commands are documented in Chapter 4, "Programming Commands". The common commands are defined by IEEE 488.2. These commands control some functions that are common to all IEEE 488.2 instruments. Common command headers consist of only a single mnemonic preceded by an asterisk. The standard SCPI commands are the commands required for compatibility with SCPI. Measurement instructions are those commands which are specific to the control of the instrument. Measurement instructions are compound headers consisting of two or more mnemonics.

SCPI command are grouped in subsytems

In accordance with IEEE 488.2, the instrument's commands are grouped into "subsystems." Commands in each subsystem perform similar tasks. The following subsystems are provided:

Measurement Instructions
Calculate1 Subsystem
Calculate2 Subsystem
Calculate3 Subsystem
Display Subsystem
Hcopy Subsystem
Sense Subsystem
Status Subsystem
System Subsystem
Trigger Subsystem
Unit Subsystem

Sending a command

It's easy to send a command to the instrument. Simply create a command string from the commands listed in this book, and place the string in your program language's output statement. For commands other than common commands, include a colon before the subsystem name. For example, the following string places the cursor on the peak laser line and returns the power level of this peak:

```
OUTPUT 720;":MEAS:SCAL:POW? MAX"
```

Use either short or long forms

Commands and queries may be sent in either long form (complete spelling) or short form (abbreviated spelling). The description of each command in this manual shows both versions; the extra characters for the long form are shown in lowercase. The following is a long form of a command:

```
OUTPUT 720;":MEASure:SCALar:POWer? MAXimum"
```

And this is the short form of the same command:

```
OUTPUT 720;":MEAS:SCAL:POW? MAX"
```

Programs written in long form are easily read and are almost self-documenting. Using short form commands conserves the amount of controller memory needed for program storage and reduces the amount of I/O activity.

The rules for creating short forms from the long form is as follows:

The mnemonic is the first four characters of the keyword unless *the fourth character is a vowel, in which case the mnemonic is the first three characters of the keyword.*

This rule is *not* used if the length of the keyword is exactly four characters.

Table 3-5. Examples of Short Forms

Long Form	Equivalent Short Form
ROUTE	ROUT
LAYER	LAY
SYSTEM	SYST
ERROR	ERR

You can use upper or lowercase letters
Program headers can be sent using any combination of uppercase or lowercase ASCII characters. Instrument responses, however, are always returned in uppercase.

Combine commands in the same subsystem
You can combine commands from the same subsystem provided that they are both on the same level in the subsystem's hierarchy. Simply separate the commands with a semi-colon (;). For example, the following two lines,

```
OUTPUT 720;":CALC2:PEXC 12"
OUTPUT 720;":CALC2:PTHR 20"
```

can be combined into one line:

```
OUTPUT 720;":CALC2:PEXC 12;PTHR 20"
```

The semicolon separates the two functions.

Combine commands from different subsystems
You can send commands and program queries from different subsystems on the same line. Simply precede the new subsystem by a semicolon followed by a colon. In the following example, the colon and semicolon pair before DISP allows you to send a command from another subsystem.

```
OUTPUT 720;":CALC2:PEXC 12;:DISP:WIND:GRAP:STAT OFF"
```

Sending common commands

If a subsystem has been selected and a common command is received by the instrument, the instrument remains in the selected subsystem. For example, if the program message

```
"DISPLAY:MARK:MAX:LEFT;*CLS;DISP:MARK:MAX:RIGH"
```

is received by the instrument, the Display subsystem remains selected.

If some other type of command is received within a program message, you must reenter the original subsystem after the command.

Adding parameters to a command

Many commands have parameters that specify an option. Use a space character to separate the parameter from the command as shown in the following line:

```
OUTPUT 720;":INIT:CONT ON"
```

Separate multiple parameters with a comma (,). Spaces can be added around the commas to improve readability.

```
OUTPUT 720;":MEAS:SCAL:POW:FREQ? 1300, MAX"
```

White space

White space is defined to be one or more characters from the ASCII set of 0 through 32 decimal, excluding 10 (NL). White space is usually optional, and can be used to increase the readability of a program.

Numbers

All numbers are expected to be strings of ASCII characters. Thus, when sending the number 9, you would send a byte representing the ASCII code for the character "9" (which is 57). A three-digit number like 102 would take up three bytes (ASCII codes 49, 48, and 50). This is taken care of automatically when you include the entire instruction in a string. Several representations of a number are possible. For example, the following numbers are all equal:

    28
    0.28E2
    280E-1
    28000m
    0.028K
    28E-3K

If a measurement cannot be made, no response is given and an error is placed into the error queue. For example,

```
*RST
FETCh:POW?
```

will timeout the controller and place a *Data stale or corrupt* error ino the error queue.

Table 3-6. Suffix Multipliers

Multiplier	Mnemonic
1E18	EX
1E15	PE
1E12	T
1E9	G
1E6	MA
1E3	K
1E-3	M
1E-6	U
1E-9	N
1E-12	P
1E-15	F
1E-18	A

Program message terminator
The string of instructions sent to the instrument are executed after the instruction terminator is received. The terminator may be either a new-line (NL) character, the End-Or-Identify (EOI) line asserted, or a combination of the two. All three ways are equivalent. Asserting the EOI sets the EOI control line low on the last byte of the data message. The NL character is an ASCII linefeed (decimal 10). The NL terminator has the same function as an EOS (End Of String) and EOT (End Of Text) terminator.

Querying data

Data is requested from the instrument using a query. Queries can be used to find out how the instrument is currently configured. They are also used to get results of measurements made by the instrument, with the query actually activating the measurement. String responses are returned as upper-case letters.

Queries usually take the form of a command followed by a question mark (?). After receiving a query, the instrument places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. For example, the query

```
OUTPUT 720;":CALCULATE2:POINTS?"
```

places the number of points in the data set in the output queue. In HP BASIC, the controller input statement:

```
ENTER 720;Range
```

passes the value across the bus to the controller and places it in the variable Range. A newline character is appended to the response.

Sending another command or query before reading the result of a query causes the output queue to be cleared and the current response to be lost. This also generates an error in the error queue.

The output of the instrument may be numeric or character data depending on what is queried. Refer to the specific commands for the formats and types of data returned from queries.

You can send multiple queries to the instrument within a single program message, but you must also read them back within a single program message. This can be accomplished by either reading them back into a string variable or into multiple numeric variables. When you read the result of multiple queries into string variables, each response is separated by a semicolon.

Example Programs

The following example programs are provided in this section:

These programs are provided to give you examples of using HP 86120A remote programming commands in typical applications. They are not meant to teach general programming techniques or provide ready-to-use solutions. They should allow you to see how measurements are performed and how to return data to the computer.

All of the examples are written in the HP BASIC programming language.

Many subroutines are repeated in the examples
The first five example programs contain several common subroutines. These routines, along with one function, are described in the rest of this introduction. The descriptions are listed in the general order that the subroutines are called in the programs.

Error_msg subroutine
This function is found in examples 2, 3, 4, and 5. It displays an error message on the computer's screen explaining the reason that the program's execution stopped.

Set_ese subroutine
The subroutine sets the enable mask for the event status register to a value of 52. This allows bits 2, 4, and 5 to be set whenever a query error (QYE), execution error (EXE), or command error (CME) respectively occurs. All this is accomplished using the *ESE common command.

The Err_mngmt subroutine is used to actually read the value of the event sta-
tus register. Examples 1 through 5 call this subroutine.

FNIdentity function

When this function is called, it resets the instrument and queries the instru-
ment's identification string which is displayed on the the computer's screen by
the calling function. To accomplish this task, the FNIdentity function uses the
*RST, *OPC?, and *IDN? common commands. This function is called from
examples 1 through 5.

Err_mngmt subroutine

This subroutine checks to make sure that no errors have set bits in the event
status register and that there are no errors in the queue. Exiting this subrou-
tine is only possible if no errors have occurred. Notice that the logic test in the
subroutine tests for the same event status register bits enabled by the Set_ese
subroutine: BIT(Cme,5), BIT(Cme,4), BIT(Cme,2).

This subroutine is called in examples 1 through 5. However, it is modified in
examples 3, 4, and 5 to allow it to indicate the last programming command
that was sent to the instrument before an error occurred. This is accomplished
by adding an optional argument string.

Cmd_opc subroutine

The Cmd_opc subroutine, found in examples 3, 4, and 5, pauses the program
until a non-sequential command has finished executing on the HP 86120A. It
uses the *OPC? query.

For more information on non-sequential commands, refer to "Always force the
HP 86120A to wait for non-sequential commands" on page 3-13.

Tempo subroutine

This subroutine, which is only found in example 3, pauses the program for a
few seconds while the HP 86120A measures the drift on a laser. The argument
in the example sets the pause for 10 seconds.

Example 1. Measure a DFB laser

This program measures the power and wavelength of a DFB laser. It first sets the HP 86120A in the single-acquisition measurement mode. Then, it triggers the HP 86120A with the MEASure command to capture measurement data of the input spectrum. Because the data is stored in the instrument's memory, it can be queried as needed.

Refer to the introduction to this section for a description of each subroutine that is contained in this program.

```
COM /Instrument/ @Mwm
ASSIGN @Mwm TO 720

Set_ese
PRINT USING "37A,33A";"Multi-Wavelength Meter Identity is :
";FNIdentity$
OUTPUT @Mwm;":INIT:CONT OFF"
ON TIMEOUT 7,5 CALL Err_mngmt
OUTPUT @Mwm;":MEAS:SCAL:POW:WAV?"
ENTER @Mwm;Current_wl
OUTPUT @Mwm;":FETC:SCAL:POW?"
ENTER @Mwm;Current_pwr
OFF TIMEOUT
PRINT USING "20A,4D.3D,3A,19A,M2D.2D,4A";"The wavelength is :
";Current_wl /1.0E-9;" nm";" with a power of : ";Current_pwr;"
dBm"
END

Err_mngmt:SUB Err_mngmt
   COM /Instrument/ @Mwm
   DIM Err_msg$[255]
   INTEGER Cme
   CLEAR 7
   REPEAT !
      OUTPUT @Mwm;"*ESR?"
      ENTER @Mwm;Cme
      OUTPUT @Mwm;":SYST:ERR?"
      ENTER @Mwm;Err_msg$
      PRINT Err_msg$
   UNTIL NOT BIT(Cme,2) AND NOT BIT(Cme,4) AND NOT BIT(Cme,5)
   AND POS(Err_msg$,"+0")
Subend:SUBEND

Set_ese:SUB Set_ese
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;"*ESE ";IVAL("00110100",2)
SUBEND

Identity:DEF FNIdentity$;
   COM /Instrument/ @MwmV
   DIM Identity$[50]
   Identity$=""
   OUTPUT @Mwm;"*RST"
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done
   OUTPUT @Mwm;"*IDN?"
   ENTER @Mwm;Identity$
   RETURN Identity$
FNEND
```

Example 2. Measure a Fabry Perot laser

This program measures the multiple laser lines of a Fabry Perot laser. It measures both the power and wavelengths of each line. First, the program sets the HP 86120A in the single-acquisition measurement mode. Then, it triggers the HP 86120A with the MEASure command to capture measurement data of the input spectrum. Because the data is stored in the instrument's memory, it can be queried as needed.

Refer to the introduction to this section for a description of each subroutine that is contained in this program.

```
COM /Instrument/ @Mwm
ASSIGN @Mwm TO 720
ON ERROR GOTO Error_msg,
Set_ese
PRINT USING "37A,33A";"Multi-Wavelength Meter Identity is :
";FNIdentity$

OUTPUT @Mwm;":INIT:CONT OFF"
ON TIMEOUT 7,5 CALL Err_mngmt
OUTPUT @Mwm;":MEAS:ARR:POW:WAV?"
ENTER @Mwm USING "#,K";Nb_wl
ALLOCATE Current_wl(1:Nb_wl)
ENTER @Mwm USING "#,K";Current_wl(*)
OUTPUT @Mwm;":FETC:ARR:POW?"
ENTER @Mwm USING "#,K";Nb_wl
ALLOCATE Current_pwr(1:Nb_wl)
ENTER @Mwm USING "#,K";Current_pwr(*)
FOR I=1 TO Nb_wl
   PRINT USING "22A,2D,6A,4D.2DE,4A,S2D.2D,3A";"The wavelength
   number ";Current_wl(I);" at ";Current_pwr(I);"dBm"
NEXT I
OFF TIMEOUT
STOP

Error_msg:
   PRINT "the prgm is aborted due to : ";ERRM$
END
```

```
Err_mngmt:SUB Err_mngmt
   COM /Instrument/ @Mwm
   DIM Err_msg$[255]
   INTEGER Cme
   CLEAR 7
   REPEAT
      OUTPUT @Mwm; "*ESR?"
      ENTER @Mwm;Cme
      OUTPUT @Mwm; ":SYST:ERR?"
      ENTER @Mwm;Err_msg$
      PRINT Err_msg$
   UNTIL NOT BIT(Cme,2) AND NOT BIT(Cme,4) AND NOT BIT(Cme,5)
   AND Err$,"+0")
Subend:SUBEND

Set_ese:SUB Set_ese
   COM /Instrument/ @Mwm
   OUTPUT @Mwm; "*ESE";IVAL("00110100",2)
SUBEND

Identity:DEF FNIdentity$;
   COM /Instrument/ @Mwm
   DIM Identity$[50]
   Identity$=""
   OUTPUT @Mwm;"*RST"
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done
   OUTPUT @Mwm;"*IDN?"
   ENTER @Mwm;Identity$
   RETURN Identity$
FNEND
```

Example 3. Measure a Fabry Perot laser's drift

This program measures the drift of a Fabry Perot laser. It measures drift in both power and wavelength of each line. First, the program sets the HP 86120A in the continuous-acquisition measurement mode. Then, it measures drift using commands from the CALCulate3 subsystem.

Notice the use of the Tempo subroutine to pause the program for 10 seconds while the HP 86120A measures the drift on the laser.

The use of the Err_mngmt subroutine is optional. Refer to the introduction to this section for a description of each subroutine that is contained in this program.

```
COM /Instrument/ @Mwm
ASSIGN @Mwm TO 720
DIM Key$[1]
ON ERROR GOTO Error_msg
Set_ese
PRINT USING "37A,33A";"Multi-Wavelength Meter Identity is: "
;FNIdentity$
ON TIMEOUT 7,5 CALL Err_mngmt
Cmd_opc("*RST")
Cmd_opc(":INIT:CONT ON")
Cmd_opc(":CONF:ARR:POW:WAV")

! Turn on the drift calculation

Cmd_opc(":CALC3:DRIF:STAT ON")
Err_mngmt(":CALC3:DRIF:STAT ON")

! Turn off all drift states

Cmd_opc(":CALC3:DRIF:PRES")
Err_mngmt(":CALC3:DRIF:PRES")

! Turn on drift reference state

Cmd_opc(":CALC3:DRIF:REF:STAT ON")
Err_mngmt(":CALC3:DRIF:REF:STAT ON")

! Query the number of data points

OUTPUT @Mwm;":CALC3:POIN?"
ENTER @Mwm USING "#,K";Nb_pt
ALLOCATE Current_ref_wl(1:Nb_pt)
ALLOCATE Current_ref_pwr(1:Nb_pt)
```

```
! Query reference wavelengths and powers

OUTPUT @Mwm;":CALC3:DATA? WAV"
ENTER @Mwm USING "#,K";Current_ref_wl(*)
OUTPUT @Mwm;":CALC3:DATA? POW"
ENTER @Mwm USING "#,K";Current_ref_pwr(*)

! Turn off drift reference state

Cmd_opc(":CALC3:DRIF:REF:STAT OFF")
Err_mngmt(":CALC3:DRIF:REF:STAT OFF")

! Turn on drift max min calculation

Cmd_opc(":CALC3:DRIF:DIFF:STAT ON")
Err_mngmt(":CALC3:DRIF:DIFF:STAT ON")

Tempo(10)

ALLOCATE Current_diff_wl(1:Nb_pt)
ALLOCATE Current_diff_pw(1:Nb_pt)

! Query drift wavelengths and powers

OUTPUT @Mwm;":CALC3:DATA? WAV"
ENTER @Mwm USING "#,K";Current_diff_wl(*)
OUTPUT @Mwm;":CALC3:DATA? POW"
ENTER @Mwm USING "#,K";Current_diff_pw(*)
OFF TIMEOUT
FOR I=1 TO Nb_pt
   PRINT USING
   "18A,2D,6A,M4D.2DE,3A,21A,MDD.3DE,3A";"Wavelength number "
   ;I;" is : ";Current_ref_wl(I);"  m";"  with a drift from :
   ";Current_diff_wl(I);"  m"
   PRINT USING "28A,SDD.2DE,4A,20A,MDD.3DE,3A,/";"it has a
   power level of
   : ";Current_ref_pwr(I);" dBm";" with a drift from :
   ";Current_diff_pw(I);" dB";
NEXT I
STOP

Error_msg: !
   PRINT "The program is aborted due to : ";ERRM$
END
```

```
Err_mngmt:SUB Err_mngmt(OPTIONAL Cmd_msg$)
   COM /Instrument/ @Mwmt
   DIM Err_msg$[255]
   INTEGER Cme
   CLEAR @Mwm
   REPEAT
      OUTPUT @Mwm;"*ESR?"
      ENTER @Mwm;Cme
      OUTPUT @Mwm;":SYST:ERR?"
      ENTER @Mwm;Err_msg$
      IF NPAR>0 AND NOT POS(Err_msg$,"+0") THEN PRINT "This
      command ";Cmd_msg$;" makes the following error :"
      IF NOT POS(Err_msg$,"+0") THEN PRINT Err_msg$
   UNTIL NOT BIT(Cme,2) AND NOT BIT(Cme,4) AND NOT BIT(Cme,5)
   AND POS(Err_msg$,"+0")
Subend:SUBEND

Set_ese:SUB Set_ese
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;"*ESE ";IVAL("00110100",2)
SUBEND

Identity:DEF FNIdentity$;
   COM /Instrument/ @Mwm
   DIM Identity$[50]
   Identity$=""
   OUTPUT @Mwm;"*RST"
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done
   OUTPUT @Mwm;"*IDN?"
   ENTER @Mwm;Identity$
   RETURN Identity$
FNEND

Cmd_opc:SUB Cmd_opc(Set_cmd$)
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;Set_cmd$
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done$
SUBEND

Tempo:SUB Tempo(Temp)
   FOR I=Temp TO 0 STEP -1)
      DISP "Waiting for ";VAL$(I);" sec . . . "
      WAIT 1
   NEXT I
   DISP ""
SUBEND
```

Example 4. Measure laser-line separation

This program measures the line separations on a Fabry Perot laser. It measures separation (delta) between power and wavelength of each line using commands from the CALCulate3 subsystem.

Refer to the introduction to this section for a description of each subroutine that is contained in this program.

```
COM /Instrument/ @Mwm
ASSIGN @Mwm TO 720
DIM Key$[1]
ON ERROR GOTO Error_msg
Set_ese
PRINT USING "37A,33A";"Multi-Wavelength Meter Identity is :
";FNIdentity$
ON TIMEOUT 7,5 CALL Err_mngmt
Cmd_opc("*RST")

! Change to list-by-wavelength display

Cmd_opc(":CONF:ARR:POW:WAV")

! Trigger and wait for one measurement

Cmd_opc(":INIT")
Cmd_opc("*WAI")

! Turn on delta mode

Cmd_opc(":CALC3:DELT:WPOW:STAT ON")

! Set first wavelength as reference

Cmd_opc(":CALC3:DELT:REF:WAV MIN")

! Query number of data points

OUTPUT @Mwm;":CALC3:POIN?"
ENTER @Mwm USING "#,K";Nb_pt
ALLOCATE Delta_wl(1:Nb_pt)
ALLOCATE Delta_pwr(1:Nb_pt)

! Query wavelengths and powers

OUTPUT @Mwm;":CALC3:DATA? WAV"
ENTER @Mwm;Delta_wl(*)
OUTPUT @Mwm;":CALC3:DATA? POW"
ENTER @Mwm;Delta_pwr(*)
```

```
OFF TIMEOUT
FOR I=1 TO Nb_pt-1
   PRINT USING "6A,2D,17A,M4D.3D,31A,S2D.2D,4A";"Line :";I;"
   wavelength is : ";(Delta_wl(I)+((NOT I=1)*Delta_wl(1)))/
   1.0E-9;" nm. Absolute line level is  : ";Delta_pwr(I)+(NOT
   I=1)*Delta_pwr(1);" dBm"
   PRINT USING "17A,2D,6A,M4D.3D,23A,2D,6A,S2D.2D,3A";"Delta Wl
   to line ",I+1," is : ";(Delta_wl(I+1)-(NOT I=1)*Delta_wl(I))/
   1.E-9;" nm, Delta Pwr to line ",I+1," is :
   ";(I=1)*(Delta_pwr(I+1))+(NOT I=1)*(Delta_pwr(I+1)-
   Delta_pwr(I));" dB"
NEXT I
PRINT USING "6A,2D,17A,M4D.3D,31A,S2D.2D,4A";"Line : ";I;"
wavelength is : ";(Delta_wl(1)+Delta_wl(Nb_pt))/1.0E-9;" nm.
Absolute line level is  : ";Delta_pwr(1)+Delta_pwr(Nb_pt);" dBm"
STOP
Error_msg: !
   PRINT "The program is aborted due to : ";ERRM$
END

Err_mngmt:SUB Err_mngmt(OPTIONAL Cmd_msg$)
   COM /Instrument/ @Mwmt
   DIM Err_msg$[255]
   INTEGER Cme
   CLEAR @Mwm
   REPEAT
      OUTPUT @Mwm;"*ESR?"
      ENTER @Mwm;Cme
      OUTPUT @Mwm;":SYST:ERR?"
      ENTER @Mwm;Err_msg$
      IF NPAR>0 AND NOT POS(Err_msg$,"+0") THEN PRINT "This
      command ";Cmd_msg$;" makes the following error :"
      IF NOT POS(Err_msg$,"+0") THEN PRINT Err_msg$
   UNTIL NOT BIT(Cme,2) AND NOT BIT(Cme,4) AND NOT BIT(Cme,5)
   AND POS(Err_msg$,"+0")
Subend:SUBEND

Set_ese:SUB Set_ese
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;"*ESE ";IVAL("00110100",2)
SUBEND

Identity:DEF FNIdentity$;
   COM /Instrument/ @Mwm
   DIM Identity$[33]
   Identity$=""
   OUTPUT @Mwm;"*RST"
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done
   OUTPUT @Mwm;"*IDN?"
   ENTER @Mwm;Identity$
   RETURN Identity$
FNEND
```

```
Cmd_opc:SUB Cmd_opc(Set_cmd$)
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;Set_cmd$
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done$
SUBEND
```

Example 5. Measure signal-to-noise ratio

This program measures signal-to-noise ratios on a Fabry Perot laser. It measures the ratio for each line using commands from the CALCulate3 subsystem.

Refer to the introduction to this section for a description of each subroutine that is contained in this program.

```
COM /Instrument/ @Mwm
ASSIGN @Mwm TO 720
DIM Key$[1]
ON ERROR GOTO Error_msg,
Set_ese
PRINT USING "37A,33A";"Multi-Wavelength Meter Identity is :
";FNIdentity$
ON TIMEOUT 7,5 CALL Err_mngmt
Cmd_opc("*RST")
OUTPUT @Mwm;":MEAS:ARR:POW:WAV?"
ENTER @Mwm USING "#,K";Nb_pt
ALLOCATE Current_wl(1:Nb_pt)
ENTER @Mwm USING "#,K";Current_wl(*)
OUTPUT @Mwm;":FETC:ARR:POW?"
ENTER @Mwm USING "#,K";Nb_pt
ALLOCATE Current_pwr(1:Nb_pt)
ENTER @Mwm USING "#,K";Current_pwr(*)

! Turn signal-to-noise ratio on

Cmd_opc(":CALC3:SNR:STAT ON")
Err_mngmt(":CALC3:SNR:STAT ON")

! Set first wavelength as noise reference

Cmd_opc(":CALC3:SNR:REF:WAV MIN")
Err_mngmt(":CALC3:SNR:REF:WAV MIN")

! Query number of data points

OUTPUT @Mwm;":CALC3:POIN?"
ENTER @Mwm USING "#,K";Nb_pt
ALLOCATE Snr_pwr(1:Nb_pt)

! Query signal-to-noise values

OUTPUT @Mwm;":CALC3:DATA? POW"
ENTER @Mwm;Snr_pwr(*)
OFF TIMEOUT
```

```
FOR I=1 TO Nb_pt
   PRINT USING "7A,2D,17A,M4D.3D,25A,S2D.2D,22A,2D.2D,3A";"Line
   : ";I;" wavelength is : ";Current_wl(I)/1.0E-9;" nm, absolute
   level is : ";Current_pwr(I);" dBm, with a SNR of :
   ";Snr_pwr(I);" dB"
NEXT I
STOP

Error_msg: !
   PRINT "The program is aborted due to : ";ERRM$
END

Err_mngmt:SUB Err_mngmt(OPTIONAL Cmd_msg$)
   COM /Instrument/ @Mwmt
   DIM Err_msg$[255]
   INTEGER Cme
   CLEAR @Mwm
   REPEAT !
      OUTPUT @Mwm;"*ESR?"
      ENTER @Mwm;Cme
      OUTPUT @Mwm;":SYST:ERR?"
      ENTER @Mwm;Err_msg$
      IF NPAR>0 AND NOT POS(Err_msg$,"+0") THEN PRINT "This
      command ";Cmd_msg$;" makes the following error :"
      IF NOT POS(Err_msg$,"+0") THEN PRINT Err_msg$
   UNTIL NOT BIT(Cme,2) AND NOT BIT(Cme,4) AND NOT BIT(Cme,5)
   AND POS(Err_msg$,"+0")
Subend:SUBEND

Set_ese:SUB Set_ese
   COM /Instrument/ @Mwm
   OUTPUT @Mwm;"*ESE ";IVAL("00110100",2)
SUBEND

Identity:DEF FNIdentity$;
   COM /Instrument/ @Mwm
   DIM Identity$[50]
   Identity$=""
   OUTPUT @Mwm;"*RST"
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done
   OUTPUT @Mwm;"*IDN?"
   ENTER @Mwm;Identity$
   RETURN Identity$
FNEND

Cmd_opc:SUB Cmd_opc(Set_cmd$)
   COM /Instrument/ @Mwmd
   OUTPUT @Mwm;Set_cmd$
   OUTPUT @Mwm;"*OPC?"
   ENTER @Mwm;Opc_done$
SUBEND
```

Example 6. Increase a source's wavelength accuracy

This example program uses the HP 86120A to increase the absolute wavelength accuracy of HP 8167A, HP 8168B, and HP 8168C Tunable Laser Sources. Essentially, the HP 86120A's accuracy is transferred to the tunable laser source. The absolute accuracy of the tunable laser source is increased from <±0.1 nm to <±0.005 nm which is the HP 86120A's absolute accuracy (at 1550 nm).

In order to run this program, the tunable laser source's firmware must support the automatic alignment command, WAVEACT.

The program uses the following measurement algorithm:

> Identify and initialize the HP 86120A and tunable laser source
> Ask user for desired wavelength
> Set wavelength of tunable laser source
> Turn tunable laser source's output on
> Enter loop
> > Measure wavelength
> > Compare wavelength to desired wavelength
> > Realign tunable laser source's wavelength
> > Check if wavelength changed from last pass
> Repeat until (delta wavelength < 0.0015 nm *or* wavelength is stable)

```
COM Current_wl,Diff_wl.Target_wl,Previous_diff,Diff_diff
Current_wl=0
Diff_wl=0
Target_wl=0
Previous_diff=O
Diff_diff=0

ASSIGN @Tls TO 724
ASSIGN @Mwm TO 720

! Initialize instrument

DIM  Identity$[50]
Identity$=""
OUTPUT @Tls;"*CLS"
OUTPUT @Tls;"*IDN?"
ENTER @TLS;identity$
PRINT "TLS IS A ";identity$
OUTPUT @Mwm;"*RST"
OUTPUT @Mwm;"*CLS"
OUTPUT @Mwm;"*IDN?"
ENTER @Mwm;Identity$
PRINT "MWM IS A ";identity$

! Ask user for desired wavelength

INPUT "What wavelength (nm)do you wish to have",Target_wl
Target_wl=Target_wl*1.OE-9
PRINT "the target wavelength is : ";Target_wl

! Set wavelength of tunable laser source

OUTPUT @Tls; ":WAVE ";VAL$(Target_wl)
OUTPUT @Tls; ":OUTP ON"

! Enter realignment loop

REPEAT
   OUTPUT @Mwm;":MEAS:SCAL:POW:WAV?"
   ENTER @Mwm;Current_wl
   PRINT "The current wavelength is : ";VAL$(Current_wl)
   Diff_wl=PROUND(ABS(Target_wl-Current_wl),-16)
   PRINT "Diff between target & Current is (+ or -) :
   ";VAL$(Diff_wl)
   OUTPUT @Tls;":WAVEACT ";VAL$(Current_wl)
   Diff_diff=PROUND(ABS(Diff_wl-Previous_diff),-16)
   PRINT "differential difference between two turn :
   ";VAL$(Diff_diff)
   Previous_diff=Diff_wl
UNTIL (Diff_wl<1.5*1.0E-12) OR (Diff_diff=0)
END
```

Lists of Commands

Table 3-7. Programming Commands (1 of 5)

Command	Description	Code
Codes: S indicates a standard SCPI command. I indicates an instrument specific command.		
Common Commands		
*CLS	Clears all event registers and the error queue.	
*ESE	Sets the bits in the standard-event status enable register	
*ESR?	Queries value standard-event status register.	
*IDN?	Queries instrument model number and firmware version.	
*OPC	Sets operation complete bit of the standard-event status register	
*RST	Resets instrument.	
*SRE	Sets bits in service-request enable register	
*STB	Queries value of status byte	
*TRG	Triggers acquisition of measurement data.	
*TST?	Performs an instrument self test	
*WAI	Causes instrument to finish processing current command before continuing.	
Measurement Instructions		
:CONFigure	Configures instrument for wavelength, wavenumber, frequency, power, and coherence length measurements.	I
:FETCh	Queries wavelength, wavenumber, frequency, power, and coherence length measurements that have already been captured.	I
:MEASure	Configures, measures, and queries wavelength, wavenumber, frequency, power, and coherence length measurements.	I
:READ	Measures and queries wavelength, wavenumber, frequency, power, and coherence length measurements.	I

Table 3-7. Programming Commands (2 of 5)

Command	Description	Code
Codes: S indicates a standard SCPI command. I indicates an instrument specific command.		
CALCulate1 Subsystem		
:CALCulate1:DATA?	Queries the uncorrected frequency-spectrum data of the input signal.	S
:CALCulate1:TRANsform:FREQuency:POINts?	Sets and queries the number of points in the data set.	S
CALCulate2 Subsystem		
:CALCulate2:DATA?	Queries the corrected frequency-spectrum data of the input signal.	S
:CALCulate2:PEXCursion	Sets the peak excursion limit.	I
:CALCulate2:POINts?	Queries the number of points in the data set.	I
:CALCulate2:PTHReshold	Sets the peak threshold limit.	I
:CALCulate2:PWAVerage[:STATe]?	Places the instrument in the average-wavelength mode. Data queries return the power-weighted average frequency, wavelength, or wavenumber or total power.	I
:CALCulate2:WLIMit[:STATe]	Limits input wavelength range of the HP 86120A.	I
CALCulate3 Subsystem		
:CALCulate3:DATA?	Queries the data resulting from delta, drift, and signal-to-noise measurements.	S
:CALCulate3:DELTa:POWer[:STATe]	Turns the delta power measurement mode on and off.	I
:CALCulate3:DELTa:REFerence:FREQuency	Selects the signal to be used as the reference for the DELTa calculations.	I
:CALCulate3:DELTa:REFerence:POWer?	Queries the power level of the reference signal.	I
:CALCulate3:DELTa:REFerence[:WAVelength]	Selects the signal to be used as the reference for the DELTa calculations.	I
:CALCulate3:DELTa:REFerence:WNUMber	Selects the signal to be used as the reference for the DELTa calculations.	I
:CALCulate3:DELTa:WAVelength[:STATe]	Turns the delta wavelength measurement mode on and off.	I
:CALCulate3:DELTa:WPOWer[:STATe]	Turns the delta wavelength and power measurement mode on and off.	I
:CALCulate3:DRIFt:DIFFerence[:STATe]	Sets the drift calculation to subtract the minimum values measured from the maximum values measured.	I

Table 3-7. Programming Commands (3 of 5)

Command	Description	Code
Codes: S indicates a standard SCPI command. I indicates an instrument specific command.		
:CALCulate3:DRIFt:MAXimum[:STATe]	Sets the drift calculation to return the maximum power (frequency) values measured.	I
:CALCulate3:DRIFt:MINimum[:STATe]	Sets the drift calculation to return the minimum power (frequency) values measured.	I
:CALCulate3:DRIFt:PRESet	Turns off all the drift states for DIFFerence, MAXimum, MINimum, and REFerence.	I
:CALCulate3:DRIFt:REFerence:RESet	Places the current list of signals into the reference list.	I
:CALCulate3:DRIFt:REFerence[:STATe]	Turns the drift state on and off so that CALC3:DATA? will return the reference signal list.	I
:CALCulate3:DRIFt[:STATe]	Turns the drift measurement calculation on and off.	I
:CALCulate3:POINts?	Queries the number of points in the data set.	I
:CALCulate3:SNR:AUTO	Selects the internal or externally entered frequency value for the noise measurement reference in the SNR calculation.	I
:CALCulate3:SNR:REFerence:FREQuency	Sets the frequency used for the noise measurement reference in the SNR calculation.	I
:CALCulate3:SNR:REFerence[:WAVelength]	Sets the wavelength used for the noise measurement reference in the SNR calculation.	I
:CALCulate3:SNR:REFerence:WNUMber	Sets the wave number used for the noise measurement reference in the SNR calculation.	I
:CALCulate3:SNR[:STATe]	Turns the SNR calculation on and off.	I
DISPlay Subsystem		
:DISPlay:MARKer:MAXimum	Sets the marker to the signal with the largest power.	I
:DISPlay:MARKer:MAXimum:LEFT	Moves marker to signal with the next lower wavelength or frequency.	I
:DISPlay:MARKer:MAXimum:NEXT	Moves the marker to the signal with the closest power level just below the power level of the signal at the current marker position.	I
:DISPlay:MARKer:MAXimum:PREVious	Moves the marker to the signal with the closest power level just above the power level of the signal at the current marker position.	I
:DISPlay:MARKer:MAXimum:RIGHt	Moves marker to the next higher wavelength or frequency.	I
:DISPlay[:WINDow]:GRAPhics:STATe	Turns the instrument display of the power bars on and off.	S

Table 3-7. Programming Commands (4 of 5)

Command	Description	Code
Codes: S indicates a standard SCPI command. I indicates an instrument specific command.		
HCOPy Subsystem		
:HCOPy:IMMediate	Starts a printout.	S
SENSe Subsystem		
:SENSe:CORRection:ELEVation	Sets the elevation value used by the instrument to compensate for air dispersion.	I
:SENSe:CORRection:OFFSet:MAGNitude	Sets the power offset value used by the instrument.	S
:SENSe:CORRection:MEDium	Sets the instrument to return the wavelength reading in a vacuum when the parameter is on. Parameters are VAC and AIR.	I
:SENSe:DATA?	Queries the time domain samples of the input signal.	I
STATus Subsystem		
:STATus:{OPERation | QUEStionable}:CONDition?	Returns the value for the condition register for the node.	S
:STATus:{OPERation | QUEStionable}:EVENt?	Returns the value of the event register for the node.	S
:STATus:{OPERation | QUEStionable}:ENABle	Sets the enable register.	S
:STATus:{OPERation | QUEStionable}:PTRansition	Sets the positive transition filter register.	S
:STATus:{OPERation | QUEStionable}:NTRansition	Sets the negative transition filter register.	S
:STATus:PRESet	Presets the enable registers for all status nodes.	S
SYSTem Subsystem		
:SYSTem:ERRor?	Queries an error from the error queue.	S
:SYSTem:HELP:HEADers?	Queries an ASCII listing of all HP 86120A remote commands.	I
:SYSTem:PRESet	Performs the equivalent of a front-panel PRESET key press.	S
:SYSTem:VERSion	Queries the version of SCPI with which this instrument is compliant.	S

Table 3-7. Programming Commands (5 of 5)

Command	Description	Code
Codes: S indicates a standard SCPI command. I indicates an instrument specific command.		
TRIGger Subsystem		
:ABORt	Stops the current measurement sequence.	S
:INITiate:IMMediate	Places the instrument into the initiated state and initiates a new measurement sequence.	S
:INITiate:CONTinuous	Sets the instrument for single or continuous measurement.	S
UNIT Subsystem		
:UNIT[:POWer]	Sets the power units to watts (linear) or dBm (logarithmic).	S

Table 3-8. Keys Versus Commands (1 of 3)

Key	Equivalent Command
Δ PWR	:CALCulate3:DELTa:POWer[:STATe]
Δ WL	:CALCulate3:DELTa:WAVelength[:STATe]
Δ WL/PWR	:CALCulate3:DELTa:WPOWer[:STATe]
Appl's	*See* COH LEN, DRIFT, *and* S/N
AUTO	:CALCulate3:SNR:AUTO ON
Avg WL	:CALCulate2:PWAVerage[:STATe]
BAR OFF	:DISPlay[:WINDow]:GRAPhics:STATe
BAR ON	:DISPlay[:WINDow]:GRAPhics:STATe
CAL	*See* ELEV, PWR OFS, STD AIR, *and* VACUUM
CM-1	:MEASure:ARRay:POWer:WNUMber
COH LEN	:MEASure:LENGth:COHerence:CLENgth
Cont	:INITiate:CONTinuous ON
DBM	UNIT:POWer
DRIFT	:CALCulate3:DRIFt[:STATe]
ELEV	:SENSe:CORRection:ELEVation
EXIT	none
FAST	*See* UPDATE
HP-IB	none
LIM OFF	:CALCulate2:WLIMit[:STATe] OFF
LIM ON	:CALCulate2:WLIMit[:STATe] ON
List by Power	:CONFigure:ARRay:POWer
List by WL	:MEASure:ARRay:POWer:WAVelength
MAX-MIN	:CALCulate3:DRIFt:MINimum[:STATe] *and* :CALCulate3:DRIFt:MAXimum[:STATe]
MW	UNIT:POWer

Table 3-8. Keys Versus Commands (2 of 3)

Key	Equivalent Command
NEXT PK	:DISPlay:MARKer:MAXimum:NEXT
NEXT WL	:DISPlay:MARKer:MAXimum:RIGHt
NM	:MEASure:ARRay:POWer:WAVelength
NORMAL	*See* UPDATE
OFF	:CALCulate3:DELTa:POWer[:STATe]
ON	:CALCulate3:DELTa:POWer[:STATe]
PEAK	:DISPlay:MARKer:MAXimum
Peak WL	*See* NEXT PK, NEXT WL, PEAK, PREV PK, *and* PREV WL
PK EXC	:CALCulate2:PEXCursion
PK THLD	:CALCulate2:PTHReshold
POWER	:UNIT:POWer
Preset	:SYSTem:PRESet
PREV PK	:DISPlay:MARKer:MAXimum:PREVious
PREV WL	:DISPlay:MARKer:MAXimum:LEFT
Print	:HCOPy:IMMediate
PWR BAR	*See* BAR ON *and* BAR OFF
PWR OFF	:SENSe:CORRection:OFFSet:MAGNitude
RESET	:CALCulate3:DRIFt:REFerence:RESet
S/N	:CALCulate3:SNR:STATe
SELECT	:CONFigure:POWer
Setup	*See* CAL, UNITS, *and* UPDATE
Single	:INITiate:CONTinuous OFF
STD AIR	:SENSe:CORRection:MEDium AIR
THRSHLD	*See* PK EXC *and* PK THLD

Table 3-8. Keys Versus Commands (3 of 3)

Key	Equivalent Command
THZ	:MEASure:ARRay:POWer:FREQuency
UNITS	:UNIT:POWer
UPDATE	Measurement Instructions and :CALCulate1:TRANsform:FREQuency:POINts
USER	:CALCulate3:SNR:AUTO OFF
USER WL	:CALCulate3:SNR:REFerence[:WAVelength]
UW	UNIT:POWer
VACUUM	:SENSe:CORRection:MEDium VACuum
WL	*See* CM, NM, *and* THZ
WL LIM	CALCulate2:WLIMit[:STATe]
WL REF	*See* AUTO, USER, *and* USER WL

4

Programming Commands

◄■HP-IB► Programming Commands

This chapter is the reference for all HP 86120A programming commands. Commands are organized by subsystem.

Table 4-1. Notation Conventions and Definitions

Convention	Description
< >	Angle brackets indicate values entered by the programmer.
|	"Or" indicates a choice of one element from a list.
[ ]	Square brackets indicate that the enclosed items are optional.
{ }	When several items are enclosed by braces, one, and only one of these elements must be selected.
<integer>	An ASCII string representing an integer. This is defined by the IEEE 488.2 <NR1> format.
<real>	An ASCII string representing a real number. This is defined by the IEEE 488.2 <NR2> or <NRf> formats.

Contents

Common Commands

Common commands are defined by the IEEE 488.2 standard. They control generic device functions which could be common among many different types of instruments. Common commands can be received and processed by the instrument whether they are sent over the HP-IB as separate program messages or within other program messages.

*CLS

The *CLS (clear status) command clears all the event status registers summarized in the status byte register.

Syntax   `*CLS`

Description   With the exception of the output queue, all queues that are summarized in the status byte register are emptied. The error queue is also emptied. Neither the event status enable register, nor the service request enable register are affected by this command.

After the *CLS command, the instrument is left in the idle state. The command does not alter the instrument setting. *OPC and *OPC? actions are cancelled.

This command cannot be issued as a query.

*ESE

The *ESE (event status enable) command sets the bits in the event status enable register and enables the corresponding bits in the event status register.

Syntax

```
*ESE <integer>
*ESE?
```

<integer> is an mask from 0 to 255.

Description

The event status enable register contains a mask value for the bits to be enabled in the event status register. A bit set to one (1) in the event status enable register enables the corresponding bit in the event status register to set the event summary bit in the status byte register. A zero (0) disables the bit. Refer to the following table for information about the event status enable register bits, bit weights, and what each bit masks. The event status enable register is cleared at power-on. The *RST and *CLS commands do not change the register. The *ESE? query returns the value of the event status enable register.

Table 4-2. Event Status Enable Register

Bit[a]	Bit Weight	Enables
7	128	PON – Power On
6	64	Not Used
5	32	CME – Command Error
4	16	EXE – Execution Error
3	8	DDE – Device Dependent Error
2	4	QYE – Query Error
1	2	Not Used
0	1	OPC – Operation Complete

a. A high enables the event status register bit.

Query Response

<integer> is an mask from 0 to 255.

Example

`OUTPUT 720;"*ESE 32"`

In this example, the *ESE 32 command enables CME (event summary bit) bit 5 of the event status enable register. Therefore, when an incorrect programming command is received, the CME (command error bit) in the status byte register is set.

*ESR?

The *ESR (event status register) query returns the value of the event status register.

Syntax   `*ESR?`

Description   When you read the standard event status register, the value returned is the total of the bit weights of all of the bits that are set to one at the time you read the byte. The following table shows each bit in the event status register and its bit weight. The register is cleared when it is read.

Table 4-3. Standard Event Status Register

Bit	Bit Weight	Condition
7	128	PON – Power On
6	64	Not Used
5	32	CME – Command Error
4	16	EXE – Execution Error
3	8	DDE – Device Dependent Error
2	4	QYE – Query Error
1	2	Not Used
0	1	OPC – Operation Complete

Query Response $<integer>$ ranges from 0 to 255.

Example   OUTPUT 720;"*ESR?"
                     ENTER 720;Event
                     PRINT Event

*IDN?

The *IDN? (identification number) query returns a string value which identi-
fies the instrument type and firmware version.

Syntax   *IDN?

Description   An *IDN? query must be the last query in a program message. Any queries
                     after the *IDN? query in a program message are ignored.

                     The maximum length of the identification string is 50 bytes.

Query Response   The following identification string is returned. The last entry in the string is
                     the firmware version number; this value may vary between instruments.

                     HEWLETT-PACKARD, 86120A, 0, 1.000

Example   DIM Id$[50]
                     OUTPUT 720;"*IDN?"
                     ENTER 720;Id$
                     PRINT Id$

*OPC

The *OPC (operation complete) command sets the operation complete bit in
the event status register when all pending device operations have finished.

Syntax   *OPC
                     *OPC?

Description   The *OPC? query places an ASCII "1" in the output queue when all pending
                     device operations have finished.

This command is useful when the computer is sending commands to other instruments. The computer can poll the event status register to check when the HP 86120A has completed the operation. Use the *OPC? query to ensure all operations have completed before continuing the program. By following a command with an *OPC? query and an ENTER statement, the program will pause until the response (ASCII "1") is returned by the instrument.

Be sure the computer's timeout limit is at least two seconds, since some of the HP 86120A commands take approximately one second to complete.

Query Response   1

Example   OUTPUT 720;"*OPC?"
                        ENTER 720;Op$

*RST

The *RST (reset) command returns the HP 86120A to a known condition.

Syntax   *RST

Description   For a listing of reset conditions, refer to the following table. This command cannot be issued as a query. Since this command places the instrument in single measurement acquisition mode, any current data is marked as invalid and a measurement query such as :FETCh? results in error number –230, "Data corrupt or stale". You must initiate a new sweep with :INIT:IMM before you can use the :FETCh command.

Table 4-4. Conditions Set by *RST Reset

Item	Setting
Display mode	single wavelength
Wavelength range limiting	on
Measurement acquisition	single
Wavelength calibration	vacuum
Elevation correction value	0 meters
Wavelength units	nm
Amplitude units	dBm
Amplitude offset	0 dB
Peak threshold	10 dB
Peak excursion	15 dB
Number of uncorrected data points	34123
Power-bar display	on
Delta Measurements:	
Δ power	off
Δ wavelength	off
Δ wavelength and power	off
reference signal position	700 nm
Drift measurements	off
Signal-to-Noise Measurements:	
measurement	off
reference frequency	193.4144 THz
reference wavelength	1550 nm in vacuum

*SRE

The *SRE (service request enable) command sets the bits in the service request enable register.

Syntax
```
*SRE <integer>
*SRE?
```

<integer> is defined as an integer mask from 0 to 255.

Description
The service request enable register contains a mask value for the bits to be enabled in the status byte register. A bit set to one in the service request enable register enables the corresponding bit in the status byte register to generate a service request. A zero disables the bit. The following table lists the bits in the service request enable register and what they mask.

The service request enable register is cleared when the instrument is turned on. The *RST and *CLS commands do not change the register. The *SRE? query returns the value of the service request enable register.

Table 4-5. Service Request Enable Register

Bit[a]	Bit Weight	Enables
7	128	Not Used
6	64	Not Used
5	32	Event Status Bit (ESB)
4	16	Message Available (MAV)
3	8	Not Used
2	4	Error queue status
1	2	Not Used
0	1	Not Used

a. High enables the status byte register bit.

Query Response
<integer> from 0 to 63 for 128 to 191.

Example   OUTPUT 720;"*SRE 32"

In this example, the command enables ESB (event summary) bit 5 in the status byte register to generate a service request.

*STB?

The *STB (status byte) query returns the current value of the instrument's status byte.

Syntax   *STB?

Description   The master summary status (MSS) bit 6 indicates whether or not the device has at least one reason for requesting service. When you read the status byte register, the value returned is the total of the bit weights of all of the bits set to one at the time you read the byte. The following table shows each bit in the status byte register and its bit weight. The *STB? query does not affect the contents of the status byte register.

Table 4-6. Status Byte Register

Bit	Bit Weight	Condition
7	128	Not Used
6	64	Master Summary Status (MSS)
5	32	Event Status Bit (ESB)
4	16	Message Available (MAV)
3	8	Not Used
2	4	Error queue status
1	2	Not Used
0	1	Not Used

Query Response $<integer>$ from 0 to 255.

Example   OUTPUT 720;"*STB?"
                       ENTER 720;Value
                       PRINT Value

*TRG

The *TRG (trigger) command is identical to the group execute trigger (GET)
message or RUN command.

Syntax   *TRG

Description   This command acquires data according to the current settings. This command
                       cannot be issued as a query. If a measurement is already in progress, a trigger
                       is ignored, and an error is generated.

Example   The following example starts the data acquisition according to the current set-
                       tings.

                       OUTPUT 720;"*TRG"

*TST?

The *TST (test) query starts a self-test on the instrument.

Syntax   *TST?

Description   The result of the test is placed in the output queue. A zero indicates the test
                       passed and a non-zero value indicates the test failed. The instrument will ini-
                       tiate a measurement and check for any hardware errors after the measure-
                       ment is complete.

Query Response   *<integer>*

Example   OUTPUT 720;"*TST?"
                       ENTER 720;Result
                       PRINT Result

*WAI

The *WAI command prevents the instrument from executing any further commands until the current command has finished executing.

Syntax   `*WAI`

Description   All pending operations are completed during the wait period. This command cannot be issued as a query.

Measurement Instructions

Use the measurement instructions documented in this section to perform measurements and return the desired results to the computer. Four basic measurement instructions are used: CONFigure, FETCh, READ, and MEASure. Because the command trees for each of these four basic measurement instructions are identical, only the MEASure tree is documented.

To perform a measurement, append to the measurement instruction a POWer or LENGth function. The POWer functions select power, frequency, wavelength, or wave number measurements. Use the LENGth functions to configure the instrument to measure coherence length. The instrument measures the coherence length in the time domain by rectifying and low-pass filtering the interferogram. The resulting waveform is then curve fit into a decaying exponential. Refer to "Measuring Coherence Length" on page 2-29.

When the :SCALar command is used, data for a single measurement value is returned. When the :ARRay command is used, multiple data values are returned.

The **MEASure** measurement instruction always acquires new measurement data. In order to obtain both wavelength and power values from the same measurement data, use two FETCh commands. This is shown in the following program fragment:

```
OUTPUT 720;":INIT:CONT OFF;"
OUTPUT 720;":CONF:ARR:POW MAX"
OUTPUT 720;":INIT:IMM"
OUTPUT 720;":FETC:ARR:POW?"
ENTER 720:powers$
OUTPUT 720;":FETC:ARR:POW:WAV?"
ENTER 720:wavelengths$
```

In the example above, the data in the power and wavelength arrays are returned in the same order so that powers can be matched to wavelengths. You can also send a **MEASure** command followed by a FETCh command.

The commands in this subsystem have the following command hierarchy:

```
{:MEASure | :READ[?] | :FETCh[?] | :CONFigure[?]}
    {:ARRay | [:SCALar] }
        :POWer[?]
            :FREQuency[?]
            :WAVelength[?]
            :WNUMber[?]
    [SCALar]:LENGth
        :COHerence
            :ALPHa?
            :BETA?
            [:CLENgth]?
            :DELay?
```

MEASure{:ARRay | [:SCALar]} :POWer?

Returns amplitude values.

Syntax   :POWer? [<expected_value>[,<resolution>]]

Used With	<expected_value>	<resolution>
SCALar	optional	ignored
ARRay	ignored	ignored

Description   When used with a :SCALar command, a single value is returned. The display is placed in the single-wavelength mode, and the marker is placed on the signal having a power level that is closest to the *expected_value* parameter.

When used with an :ARRay command, an array of amplitudes is returned. The display is placed in the list-by-power mode.

Returned values are in the current power units. Wavelength units are not affected.

CONFigure command

When this function is used with the CONFigure command, the query question mark character "?" *must not* be included in the string. However, the FETCh, READ, and MEASure command are queries and require the question mark. Refer to the examples for this command.

< expected_value >   MAXimum   Displays the highest power signal
Constants

MINimum   Displays the lowest power signal

DEFault   Displays the signal at the current marker position

Examples	`:CONF:ARR:POW`
	`:FETC:ARR:POW?`
	`:READ:ARR:POW?`
	`:MEAS:ARR:POW?`
	`:CONF:SCAL:POW –10 dBm`
	`:FETC:SCAL:POW? MAX`
	`:READ:SCAL:POW? MIN`
	`:MEAS:SCAL:POW? DEF`

Query Response   The following line is an example of a returned string when :MEAS:SCAL:POW? MAX is sent:

`–5.88346500E+000`

If six laser lines are located and :MEAS:ARR:POW? is sent, the following string could be returned. Notice that the first returned number indicates the number of laser-line values returned in the query. The measurement units are in dBm.

```
6,–1.37444400E+001,–1.10996100E+001,–9.62396600E+000,
–7.94024500E+000,–7.01303200E+000,–1.04536200E+001
```

MEASure{:ARRay | [:SCALar]} :POWer:FREQuency

Returns frequency values.

Syntax   :POWer:FREQuency? [<expected_value>[,<resolution>]]

Used With	<expected_value>	<resolution>
SCALar	optional	optional
ARRay	ignored[a]	optional

a. Although ignored, this argument must be present if the resolution argument is specified.

Description   When used with a :SCALar command, a single value is returned. The display is placed in the single-wavelength mode, and the marker is placed on the signal having a frequency that is closest to the *<expected_value>* parameter. Default units for *<expected_value>* parameter is in Hz. When used with an :ARRay command, an array of frequencies is returned. The display is placed in the list-by-wavelength mode.

The *<resolution>* parameter sets the resolution of the measurement. It is a unitless number whose value will be limited to either 0.01 or 0.001 (whichever is closer). MAXimum resolution is equivalent to the FAST measurement update mode. MINimum resolution is equivalent to the NORMAL measurement update mode.

Returned values are in Hz (display is in THz). Power units are not affected.

CONFigure command

When this function is used with the CONFigure command, the query question mark character "?" *must not* be included in the string. However, the FETCh, READ, and MEASure command are queries and require the question mark. Refer to the examples for this command.

**< expected_value >
Constants**

MAXimum	The highest frequency signal
MINimum	The lowest frequency signal
DEFault	The current marker position

< resolution >	MAXimum	0.01 resolution (fast update)
Constants	MINimum	0.001 resolution (normal)
	DEFault	Current resolution

Examples

```
:CONF:ARR:POW:FREQ DEF MIN
:FETC:ARR:POW:FREQ? DEF MAX
:READ:ARR:POW:FREQ?
:MEAS:ARR:POW:FREQ?

:CONF:SCAL:POW:FREQ 230.8THZ, MAX
:FETC:SCAL:POW:FREQ? 230.8THZ, MIN
:READ:SCAL:POW:FREQ? 230.8THZ
:MEAS:SCAL:POW:FREQ? 230.8THZ
```

Query Response The following line is an example of a returned string when
:MEAS:SCAL:POW:FREQ? MAX is sent:

```
+1.94055176E+014
```

If six laser lines are located and :MEAS:ARR:POW:FREQ? is sent, the following string is an example of the returned data. Notice that the first returned number indicates the number of laser-line values returned in the query.

```
6,+1.94055100E+014,+1.93854100E+014,+1.93653000E+014,+1.934520
00E+014,+1.93250900E+014,+1.93050000E+014
```

MEASure{:ARRay | [:SCALar]} :POWer:WAVelength

Returns wavelength values.

Syntax   :POWer:WAVelength? [<expected_value>[,<resolution>]]

Used With	<expected_value>	<resolution>
SCALar	optional	optional
ARRay	ignored[a]	optional

a. Although ignored, this argument must be present if the resolution argument is specified.

Description   When used with a :SCALar command, a single value is returned. The display is placed in the single-wavelength mode, and the marker is placed on the signal having a wavelength that is closest to the *<expected_value>* parameter. Default units for *<expected_value>* parameter is in meters.

When used with an :ARRay command, an array of wavelengths is returned. The display is placed in the list-by-wavelength mode.

The *<resolution>* parameter sets the resolution of the measurement. It is a unitless number whose value will be limited to either 0.01 or 0.001 (whichever is closer).

Returned values are in meters. Displayed units are nanometers. Power units are not affected.

CONFigure command

When this function is used with the CONFigure command, the query question mark character "?" *must not* be included in the string. However, the FETCh, READ, and MEASure command are queries and require the question mark. Refer to the examples for this command.

< expected_value >   MAXimum   The highest wavelength signal
Constants
                MINimum   The lowest wavelength signal

                DEFault   The current marker position

4-20

< resolution >	MAXimum	0.01 resolution (fast update)
Constants	MINimum	0.001 resolution (normal)
	DEFault	Current resolution

Examples
```
:CONF:ARR:POW:WAV DEF MAX
:FETC:ARR:POW:WAV? DEF MIN
:READ:ARR:POW:WAV?
:MEAS:ARR:POW:WAV?

:CONF:SCAL:POW:WAV 1300NM, MAX
:FETC:SCAL:POW:WAV? 1300NM, MIN
:READ:SCAL:POW:WAV? 1300NM
:MEAS:SCAL:POW:WAV? 1300NM
```

Query Response   The following line is an example of a returned string when
:MEAS:SCAL:POW:WAV? MAX is sent:

```
+1.5529258E-006
```

If six laser lines are located and :MEAS:ARR:POW:WAV? is sent, the following
string could be returned. Notice that the first returned number indicates the
number of laser-line values returned in the query.

```
6,+1.54488100E-006,+1.54648400E-006,+1.54809000E-
006,+1.54969900E-006,+1.55131100E-006,+1.55292600E-006
```

MEASure{:ARRay | [:SCALar]} :POWer:WNUMber

Returns a wave number value.

Syntax   :POWer:WNUMber? [<expected_value>[,<resolution>]]

Used With	<expected_value>	<resolution>
SCALar	optional	optional
ARRay	ignored[a]	optional

a. Although ignored, this argument must be present if the resolution argument is specified.

Description   When used with a :SCALar command, a single value is returned. The display is placed in the single-wavelength mode, and the marker is placed on the signal having a wave number that is closest to the *<expected_value>* parameter. Default units for *<expected_value>* parameter is in m^{-1}.

When used with an :ARRay command, an array of wave number is returned. The display is placed in the list-by-wavelength mode.

The *<resolution>* parameter sets the resolution of the measurement. It is a unitless number whose value will be limited to either 0.01 or 0.001 (whichever is closer).

Returned values are in inverse meters. Displayed units are inverse centimeters. Power units are not affected.

CONFigure command

When this function is used with the CONFigure command, the query question mark character "?" *must not* be included in the string. However, the FETCh, READ, and MEASure command are queries and require the question mark. Refer to the examples for this command.

< expected_value >
Constants

MAXimum	The laser line having the largest wave number
MINimum	The laser line having the smallest wave number
DEFault	The current marker position

< resolution >	MAXimum	0.01 resolution (fast update)
Constants	MINimum	0.001 resolution (normal)
	DEFault	Current resolution

Examples
```
:CONF:ARR:POW:WNUM DEF MAX
:FETC:ARR:POW:WNUM? DEF MIN
:READ:ARR:POW:WNUM?
:MEAS:ARR:POW:WNUM?
:CONF:SCAL:POW:WNUM 6451, MAX
:FETC:SCAL:POW:WNUM? 6451, MIN
:READ:SCAL:POW:WNUM? 6451
:MEAS:SCAL:POW:WNUM? 6451
```

Query Response   If the :MEAS:SCAL:POW:WNUM? 6451 command is sent, and a 1550 nm laser
line is present, the following response would be returned to the computer:

```
+6.45286262E+005
```

Notice that the returned units are m^{-1}. If six laser lines are measured and
:MEAS:ARR:POW:WNUM? is sent, the following response is returned. Notice
that the first returned number indicates the number of laser-line values
returned in the query.

```
6,+6.47298400E+005,+6.46627900E+005,+6.45957000E+005,+6.452863
00E+005,+6.44615600E+005,+6.43945300E+005
```

MEASure[:SCALar]:LENGth:COHerence:ALPHa?

Queries the alpha constant.

Syntax   :LENGth:COHerence:ALPHa?

Attribute Summary   Query Only

Description   The alpha constant is a unitless ratio.

MEASure[:SCALar]:LENGth:COHerence:BETA?

Queries the beta constant.

Syntax   :LENGth:COHerence:BETA?

Attribute Summary   Query Only

Description   The beta constant is a unitless ratio.

MEASure[:SCALar]:LENGth:COHerence[:CLENgth]?

Queries the coherence length of the input signal in meters.

Syntax   :LENGth:COHerence:CLENgth?

Attribute Summary   Query Only

MEASure[:SCALar]:LENGth:COHerence:DELay?

Queries the round-trip path delay in the laser chip.

Syntax   :LENGth:COHerence:DELay?

Attribute Summary   Query Only

Description   The units of the returned value are in meters.

CALCulate1 Subsystem

Use the CALCulate1 commands to query *uncorrected* frequency-spectrum data. In *NORMAL* measurement update mode, 34,123 values are returned. If the HP 86120A is set for *FAST* measurement update mode (low resolution), 4,268 values are returned.

The commands in this subsystem have the following command hierarchy:

```
:CALCulate1
    :DATA?
    :TRANsform
        :FREQuency
            :POINts
```

DATA?

Queries *uncorrected* frequency-spectrum data of the input laser line.

Syntax   :CALCulate1:DATA?

Attribute Summary   Preset State: not affected
                            SCPI Compliance: standard
                            Query Only

Description   The returned values are in squared Watts (linear) units. No amplitude or fre-
                          quency correction is applied to the values. To obtain the logarithmic result,
                          multiply five times the logarithm of the returned values.

                          Be prepared to process a large amount of data when this query is sent. The
                          amount of data returned depends on the measurement update state of the
                          instrument which can be set using the :CALCulate1:TRANsform:FRE-
                          Quency:POINts command or the resolution argument of an instrument func-
                          tion. Refer to "Measurement Instructions" on page 4-14.

                          When *NORMAL* measurement update is specified, over 580 kilobytes of data
                          (34,123 values) can be returned to the computer. When *FAST* measurement
                          update is specified, over 72 kilobytes of data (4,268 values) can be returned.

                          The following string is a typical example of the first few returned values:

```
+4.02646500E+001,+6.78125100E+001,+6.17986600E+001,+4.26768200
E+001,+4.80245300E+001,+3.10491300E+001,+1.13409400E+001,+5.07
832500E+001,+2.77746200E+001,+3.89150500E+001,+3.50217600E+001
,+7.34649800E-001,+5.64983800E+000,
```

                          Notice that only measurement values are returned to the computer. There is
                          no first value that indicates the number of values contained in the string as
                          there is, for example, with the FETCh, READ, and MEASure commands. Use
                          the :CALCulate1:TRANsform:FREQuency:POINTs command to query the
                          number of points the :CALC1:DATA? returns.

                          When *NORMAL* measurement mode is selected, the uncorrected frequency
                          domain data consists of 64K (65,536) values. Only the frequency domain data
                          corresponding to 700-1650 nm wavelength (in vacuum) is returned (34,123
                          values). In *FAST* measurement mode, the data consists of 16K (8,192) values of
                          which 4,268 values are returned.

The frequency spacing between values is uniform and is equal to the reference laser frequency (473.6127 THz) divided by 64K, or 7.226756 GHz. Note the spacing between values is not uniform in wavelength units. The values returned are in ascending optical frequency.

The first value of the uncorrected frequency data corresponds to an optical frequency of 181.6879 THz (1650.041 nm). The last value of the uncorrected frequency data corresponds to an optical frequency of 428.2793 THz (699.993 nm). For example, a laser line peak located at the 1,500th returned value has an optical frequency of:

$$frequency \ = \ 181.6879 \ THz + 1,499(7.226756 \ GHz)$$

$$= \ 192.5208 \ THz$$

or, 1557.195 nm (in vacuum).

When *FAST* measurement mode is selected, the uncorrected frequency domain data consists of 16K (8,192) values. The frequency spacing between elements is uniform and is equal to the reference laser frequency (473.6127 THz) divided by 16K, or 57.81405 GHz. Note the spacing between values is not uniform in wavelength units. The values returned are in ascending optical frequency. Only the frequency domain data corresponding to 700-1650 nm wavelength (in vacuum) is returned (4,268 values). The first value of the uncorrected frequency data corresponds to an optical frequency of 181.652 THz (1650.37 nm). The last value of the uncorrected frequency data corresponds to an optical frequency of 428.344 THz (699.89 nm). For example, a laser line peak located at the 200th returned value has an optical frequency of:

$$frequency \ = \ 181.652 \ THz + 199(57.81405 \ GHz)$$

$$= \ 193.157 \ THz$$

or, 1551.07 nm (in vacuum).

If your program is aborted or interrupted after sending this query, the HP 86120A continues to process the data but does not place it in the output buffer. Because of the amount of data processed, the instrument will not respond to any new commands in its input buffer for up to 20 seconds.

TRANsform:FREQuency:POINts

Sets the size of the fast fourier transform (FFT) performed by the instrument.

Syntax

`:CALCulate1:TRANsform:FREQuency:POINts{?| {<integer> | MINimum | MAXimum}}`

<integer> Sets FFT size. Must be either 34123 or 4268. Other values result in an error.

Constant	Description
MINimum	4,268
MAXimum	34,123

Attribute Summary

Non-sequential command
Preset State: array size set to 34,123
*RST State: 34,123
SCPI Compliance: instrument specific

Description

A *NORMAL* updated display corresponds to an FFT size of 34,123. A *FAST* updated display corresponds to an FFT size of 4,268. These values are a sub-set of the uncorrected-data buffer shown in the figure that is located in "Making Measurements" on page 3-6. Changing the number of points causes the instrument to reprocess the current set of data.

The query form of the command returns the number of points in the data set. This is the number of measurement points that will be returned by the CALC1:DATA? query.

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

Query Response   For normal update:

+34123

For fast update:

+4268

CALCulate2 Subsystem

Use the CALCulate2 commands to query *corrected* values frequency-spectrum data.

The commands in this subsystem have the following command hierarchy:

```
:CALCulate2
    :DATA?
    :PEXCursion
    :POINts?
    :PTHReshold
    :PWAVerage
        [:STATe]
    :WLIMit
        [:STATe]
```

DATA?

Queries the corrected peak data of the input laser line.

Syntax

:CALCulate2:DATA? {FREQuency | POWer | WAVelength | WNUMber}

Constant	Description
FREQuency	Queries the array of laser-line frequencies after the peak search is completed. If :CALC2:PWAV:STAT is on, the power-weighted average frequency is returned.
POWer	Queries the array of laser-line powers after the peak search is completed. If :CALC2:PWAV:STAT is on, the total input power is returned.
WAVelength	Queries the array of laser-line wavelengths after the peak search is completed. If :CALC2:PWAV:STAT is on, the power-weighted average wavelength is returned.
WNUMber	Queries the array of laser-line wave numbers after the peak search is completed. If :CALC2:PWAV:STAT is on, the power-weighted average wave number is returned.

Attribute Summary

Preset State: not affected
SCPI Compliance: standard
Query Only

Description

Use the CALC2:POIN? query to determine the number of points the CALC2:DATA? query will return. The following string is a typical example of the first few returned values returned when WAVelength is specified:

```
+1.54488600E-006,+1.54649100E-006,+1.54808300E-
006,+1.54969600E-006,+1.55131200E-006,+1.55293000E-006
```

This next string resulted by specifying the WNUMber argument:

```
+6.47296600E+005,+6.46625000E+005,+6.45959900E+005,+6.45287500
E+005,+6.44615500E+005,+6.43943900E+005
```

Notice that only measurement values are returned to the computer. There is no first value that indicates the number of values contained in the string as there is, for example, with the FETCh, READ, and MEASure commands.

When there is no input signal, the POWer query returns –200 dBm; the WAVe-length query returns 100 nm (1.0E–7).

PEXCursion

Sets the peak excursion limit used by the HP 86120A to determine valid laser line peaks.

Syntax

:CALCulate2:PEXCursion{?| {<integer> | MINimum | MAXimum | DEFault}}

<integer> represents logarithmic units in dB. Valid range is 1 to 30 dB.

Constant	Description
MINimum	1 dB
MAXimum	30 dB
DEFault	15 dB

Attribute Summary

Non-sequential command
Preset State: 15 dB
*RST State: 15 dB
SCPI Compliance: instrument specific

Description

A laser line is identified as a valid peak if its amplitude is greater than the peak excursion plus the amplitudes of the closest local minima on either side of the peak. This command works in conjunction with the peak threshold setting. Refer to "PTHReshold" on page 4-33. Changing the peak excursion limit causes the instrument to reprocess the current set of data. Refer also to "Defining Laser-Line Peaks" on page 2-13.

The query response is the current value. For example, if the current value is set to 15 dB, the following value is returned:

15

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information..

POINts?

Queries the number of points in the data set.

Syntax :CALCulate2:POINts?

Attribute Summary Preset State: unaffected
*RST State: unaffected
SCPI Compliance: instrument specific
Query Only

Description This is the number of points that will be returned by the CALC2:DATA? query.

Query Response For example, if six laser lines are located:

+6

PTHReshold

Sets the peak threshold limit used by the instrument to determine valid laser line peaks.

Syntax :CALCulate2:PTHReshold{?| {<integer> | MINimum | MAXimum | DEFault}}

<integer> represents logarithmic units in dB. Valid range is 0 to 40.

Constant	Value
MINimum	0 dB
MAXimum	40 dB
DEFault	10 dB

Attribute Summary

Non-sequential command
Preset State: 10 dB
*RST State: 10 dB
SCPI Compliance: instrument specific

Description

A laser line is identified as a valid peak if its amplitude is above the maximum amplitude minus the peak threshold value. The subtraction is done in dB units. This setting works in conjunction with the peak excursion setting to determine which responses are located. Refer to "PEXCursion" on page 4-32. Changing the peak threshold limit causes the instrument to reprocess the current set of data. Refer also to "Defining Laser-Line Peaks" on page 2-13.

The query response is the current value. For example, if the current value is set to 15 dB, the following value is returned:

15

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

PWAVerage[:STATe]

Places the instrument in the power-weighted average mode.

Syntax

:CALCulate2:PWAVerage[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary

Preset State: off
*RST State: off

Description   When the state is on, the CALC2:DATA? POW query returns the total power and the CALC2:DATA? WAV, FREQ, or WNUM query returns the power-weighted average wavelength, frequency, or wave number values.

Turning power-weighted average mode on while making delta, coherence length, or signal-to-noise measurements results in a "–221 Settings conflict" error.

WLIMit[:STATe]

Limits input wavelength range of the HP 86120A.

Syntax   :CALCulate2:WLIMit[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Non-sequential command
Preset State: on
*RST State: on
SCPI Compliance: instrument specific

Description   When this function is on, the HP 86120A has an input range of 1200 nm to 1650 nm. When this function is off, the instrument displays peaks over the full wavelength range. If you are measuring signals between 1200 nm and 1650 nm, set this function on to avoid identifying spurious second harmonic peaks.

Whenever the HP 86120A receives this command, it reprocesses the data and performs a new peak search.

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

CALCulate3 Subsystem

Use the CALCulate3 commands to perform delta, drift, and signal-to-noise measurements. To select a measurement, use one of the following STATe commands:

CALC3:DELT:POW:STAT   *(delta power)*
CALC3:DELT:WAV:STAT   *(delta wavelength)*
CALC3:DELT:WPOW:STAT   *(delta power and wavelength)*
CALC3:DRIF:STAT   *(drift)*
CALC3:SNR:STAT   *(signal-to-noise ratios)*

If you select a drift measurement, you can additionally select one of the following additional states:

CALC3:DRIF:DIFF:STAT   *(difference)*
CALC3:DRIF:MAX:STAT   *(maximum drift)*
CALC3:DRIF:MIN:STAT   *(minimum drift)*
CALC3:DRIF:REF:STAT   *(drift reference values)*

The :CALCulate3:DRIFt:PRESet command turns off the minimum, maximum, difference, and reference states but leaves the drift state on.

Attempting to turn more than one state on at a time results in a "–221 Settings Conflict" error.

The *RST and SYSTem:PRESet commands turns all calculations off.

The commands in this subsystem have the following command hierarchy:

```
:CALCulate3
    :DATA?
    :DELTa
        :POWer
            [:STATe]
        :PRESet
        :REFerence
            :FREQuency
            :POWer?
            [:WAVelength]
            :WNUMber
        :WAVelength
            [:STATe]
        :WPOWer
            [:STATe]
    :DRIFt
        :DIFFerence
            [:STATe]
        :MAXimum
            [:STATe]
        :MINimum
            [:STATe]
        :PRESet
        :REFerence
            :RESet
            [:STATe]
        [:STATe]
    :POINts?
    :SNR
        :AUTO
        :REFerence
            :FREQuency
            [:WAVelength]
            :WNUMber
        [:STATe]
```

DATA?

Queries the data resulting from delta, drift, and signal-to-noise measurements.

Syntax :CALCulate3:DATA? {POWer | FREQuency | WAVelength | WNUMber}

Argument	Description
POWer	Queries the array of laser-line powers after the calculation is completed.
FREQuency	Queries the array of laser-line frequencies after the calculation is completed.
WAVelength	Queries the array of laser-line wavelengths after the calculation is completed.
WNUMber	Queries the array of laser-line wave numbers after the calculation is completed.

Attribute Summary Preset State: not affected
SCPI Compliance: standard
Query Only

Description The data returned by the query depends upon which calculation state is on. If no calculation state is on, an error is generated. The returned data is comma delimited. The following string is a typical example of six values returned when POWer is specified from a delta power measurement:

```
-7.42833100E+000,-1.00087200E+000,-2.52121400E+000,
-3.41918900E+000,-3.80437200E+000,-6.36282900E+000
```

Notice that only measurement values are returned to the computer. There is no first value that indicates the number of values contained in the string as there is, for example, with the FETCh, READ, and MEASure commands. Use the CALC3:POIN? query to determine the number of points the CALC3:DATA? query returns.

DELTa:POWer[:STATe]

Turns the delta-power measurement mode on and off.

Syntax   :CALCulate3:DELTa:POWer[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
                    *RST State: off
                    SCPI Compliance: instrument specific

Description   When this state is on, the power of the reference laser line is subtracted from
                    the power values of all laser lines except the reference.

                    The power data returned by the CALC3:DATA? query is the array of laser line
                    power levels normalized to the power level of the reference laser line. The
                    power of the reference laser line is returned as an absolute power (unnormal-
                    ized). The frequency data returned is the array of absolute frequency values.

                    Note

                    Only one STATe command can be turned on at any one time. Attempting to turn more
                    than one state on at a time results in a "−221 Settings Conflict" error. Refer to
                    "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measure-
                    ments.

DELTa:PRESet

Turns off all delta measurement states.

Syntax   :CALCulate3:DELTa:PRESet

Attribute Summary   Preset State: not affected
                    *RST State: not affected
                    SCPI Compliance: instrument specific
                    Command Only

DELTa:REFerence:FREQuency

Selects the reference laser line for DELTa calculations.

Syntax   :CALCulate3:DELTa:REFerence:FREQuency{?| {<real> | MINimum | MAXimum}}

<real> is a frequency value that is within the following limits:

Constant	Description
MINimum	181.6924 THz
MAXimum	428.6 THz

Attribute Summary   Preset State: 428.6 THz (700 nm)
*RST State:428.6 THz (700 nm)
SCPI Compliance: instrument specific

Description   The reference will be the laser line at the frequency closest to the frequency entered. Subsequent measurements will use the frequency closest to the reference frequency used for the previous measurement.

The query returns the reference laser line's frequency. The default units for the *<real>* parameter is in Hz.

DELTa:REFerence:POWer?

Queries the reference laser line's power level.

Syntax   :CALCulate3:DELTa:REFerence:POWer?

Attribute Summary   Preset State: not affected
*RST State: not affected
SCPI Compliance: instrument specific
Query Only

DELTa:REFerence[:WAVelength]

Selects the reference laser line for DELTa calculations.

Syntax   :CALCulate3:DELTa:REFerence[:WAVelength]{?| {<real> | MINimum | MAXimum}}

<real> is a wavelength value that is within the following limits:

Constant	Description
MINimum	700.0 nm
MAXimum	1650.0 nm

Attribute Summary   Preset State: 700 nm (428.6 THz)
*RST State: 700 nm (428.6 THz) laser line
SCPI Compliance: instrument specific

Description   The reference will be the laser line at the wavelength closest to the wavelength entered. Subsequent measurements will use the wavelength closest to the reference wavelength used for the previous measurement.

The query returns the current wavelength of the reference laser line. The default units for the *<real>* parameter is in meters.

DELTa:REFerence:WNUMber

Selects the reference laser line for delta calculations.

Syntax   :CALCulate3:DELTa:REFerence:WNUMber{?| {<real> | MINimum | MAXimum}}

<real> is a wave number value that is within the following limits:

Constant	Description
MINimum	6,061
MAXimum	14,286

Attribute Summary   Preset State: 14,286 cm^{-1} (700 nm)
                           *RST State: 14,286 cm^{-1} (700 nm)
                           SCPI Compliance: instrument specific

Description   The reference will be the laser line at the wave number closest to the wave number entered. Subsequent measurements will use the wave number closest to the reference wave number used for the previous measurement.

                           The query returns the current wave number of the reference laser line. The default units for the *<real>* parameter is in m^{-1}.

DELTa:WAVelength[:STATe]

Turns the delta wavelength measurement mode on and off.

Syntax   `:CALCulate3:DELTa:WAVelength[:STATe]{?| {ON | OFF | 1 | 0}}`

Attribute Summary   Preset State: off
                           *RST State: off
                           SCPI Compliance: instrument specific

Description   When on, the wavelength of the reference laser line is subtracted from the wavelength values of all laser lines except the reference.

                           For the CALC3:DATA? query, the power data returned is the array of absolute powers measured for each laser line. The frequency data is the array of frequency values normalized to the frequency of the reference laser line. The frequency of the reference laser line is returned as an absolute frequency (unnormalized).

> **Note**
>
> Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "–221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DELTa:WPOWer[:STATe]

Turns the delta wavelength and power measurement mode on and off.

Syntax   :CALCulate3:DELTa:WPOWer[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
*RST State: off
SCPI Compliance: instrument specific

Description   When on, the wavelength of the reference laser line is subtracted from the wavelength values of all laser lines except the reference. The power value of the reference is subtracted from the power values of all laser lines except the reference.

For the CALC3:DATA? query, the power data returned is the array of powers normalized to the power of the reference laser line. The power of the reference laser line is returned as an absolute power (unnormalized).

The frequency data is the array of frequency values normalized to the frequency of the reference laser line. The frequency of the reference laser line is returned as an absolute frequency (unnormalized).

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "−221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DRIFt:DIFFerence[:STATe]

Sets the drift calculation to subtract the minimum values measured from the maximum values measured.

Syntax   :CALCulate3:DRIFt:DIFFerence[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
                     *RST State: off
                     SCPI Compliance: instrument specific

Description   Use the CALC3:DRIF:PRES command to turn off all the drift states before turning on this state. The CALC3:DATA? query returns the maximum power and frequency minus the minimum power and frequency.

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "–221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DRIFt:MAXimum[:STATe]

Sets the drift calculation to return the maximum power and frequency values measured.

Syntax   :CALCulate3:DRIFt:MAXimum[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
                     *RST State: off
                     SCPI Compliance: instrument specific

Description   Use the CALC3:DRIF:PRES command to turn off all the drift states before turning on this state. The CALC3:DATA? query returns the maximum power and frequency.

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "−221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DRIFt:MINimum[:STATe]

Sets the drift calculation to return the minimum power and frequency values measured.

Syntax   :CALCulate3:DRIFt:MINimum[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
*RST State: off
SCPI Compliance: instrument specific

Description   Use the CALC3:DRIF:PRES command to turn off all the drift states before turning on this state. The CALC3:DATA? query returns the minimum power or frequency.

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "−221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DRIFt:PRESet

Turns off all the drift states for DIFFerence, MAXimum, MINimum, and REFerence.

Syntax   :CALCulate3:DRIFt:PRESet

Attribute Summary   Preset State: unaffected by
                          *RST State: unaffected by
                          SCPI Compliance: instrument specific
                          Command Only

Description   This command allows the CALC3:DATA? query to return the difference
                          between the current measurement and the reference.

DRIFt:REFerence:RESet

Places the current list of laser lines into the reference list.

Syntax   :CALCulate3:DRIFt:REFerence:RESet

Attribute Summary   Preset State: unaffected by
                          *RST State: unaffected by
                          SCPI Compliance: instrument specific
                          Command Only

DRIFt:REFerence[:STATe]

Turns on and off the drift reference state.

Syntax   :CALCulate3:DRIFt:REFerence[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
                               *RST State: off
                               SCPI Compliance: instrument specific

Description   When this command is set to on, the CALC3:DATA? command returns the reference laser lines. Use the CALC3:DRIF:PRES command to turn off all the drift states before turning on the drift reference state.

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "–221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selecting measurements.

DRIFt[:STATe]

Turns on and off the drift measurement calculation.

Syntax   :CALCulate3:DRIFt[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
                               *RST State: off
                               SCPI Compliance: instrument specific

Description   When the drift mode is first turned on, the current list of laser lines is placed into the reference. All subsequent measurements take the new data, subtract the reference data, and display the differences in wavelengths and powers.

                               The CALC3:DATA? query returns the power and frequency of the current measurement minus the power and frequency of the reference.

Note

Only one STATe command can be turned on at any one time. Attempting to turn more than one state on at a time results in a "–221 Settings Conflict" error. Refer to "CALCulate3 Subsystem" on page 4-36 for additional information on selectingmeasurements.

POINts?

Queries the number of points in the data set.

Syntax   :CALCulate3:POINts?

Attribute Summary   Preset State: unaffected by
                        RST State: unaffected by
                        SCPI Compliance: instrument specific
                        Query Only

Description   The value returned is the number of points returned by the CALC3:DATA? query.

SNR:AUTO

Selects the reference frequency value for measuring noise in the signal-to-noise calculation.

Syntax   :CALCulate3:SNR:AUTO{?| {ON | OFF | 1 | 0}}

Constant	Description
ON	Selects internally generated reference frequency.
OFF	Selects user-entered reference frequency.

Attribute Summary   Preset State: on
                          *RST State: on
                          SCPI Compliance: instrument specific

Description   The command argument allows you to select either an internally generated or
                          a user-entered frequency reference for measuring the noise. This value can
                          either be internally generated or a user-entered frequency.

                          To enter a value to use as the reference, use the SNR:REFerence:FREQuency,
                          SNR:REFerence:WAVelength, and SNR:REFerence:WNUMber commands.

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the
time to complete before sending any more commands to the instrument. Refer to
"Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for
more information.

SNR:REFerence:FREQuency

Enters a frequency that can be used for the noise measurement reference in
signal-to-noise calculations.

Syntax   :CALCulate3:SNR:REFerence:FREQuency{?| {<real> | MINimum |
                          MAXimum}}

                          <real> is a frequency value that is within the following limits:

Constant	Description
MINimum	428.2749 THz
MAXimum	181.6924 THz

Attribute Summary   Preset State: unaffected by
                          *RST State: 193.4144 THz (1550.0 nm in a vacuum).
                          SCPI Compliance: instrument specific

Description   After entering this value, use the SNR:AUTO command to configure the
                          instrument to use this value in subsequent signal-to-noise calculations.

The default units for the *<real>* parameter is Hz.

SNR:REFerence[:WAVelength]

Sets the wavelength used for the noise measurement reference in the signal-to-noise calculation.

Syntax   :CALCulate3:SNR:REFerence[:WAVelength]{?| {<real> | MINimum | MAXyimum}}

<real> is a wavelength value that is within the following limits:

Constant	Description
MINimum	700.0 nm
MAXimum	1650.0 nm

Attribute Summary   Preset State: unaffected by
*RST State: 1550.0 nm in a vacuum.
SCPI Compliance: instrument specific

Description   After entering this value, use the SNR:AUTO command to configure the instrument to use this value in subsequent signal-to-noise calculations. The number entered is converted internally to the corresponding frequency.

The default units for the *<real>* parameter is meters.

SNR:REFerence:WNUMber

Sets the wave number used for the noise measurement reference in the signal-to-noise calculation.

Syntax   :CALCulate3:SNR:REFerence:WNUMber{?| {<real> | MINimum | MAXimum}}

<real> is a wave number value that is within the following limits:

Constant	Description
MINimum	6060 (1650 nm)
MAXimum	14286 (700 nm)

Attribute Summary   Preset State: unaffected by
*RST State: 1550.0 nm in a vacuum.
SCPI Compliance: instrument specific

Description   After entering this value, use the SNR:AUTO command to configure the
instrument to use this value in subsequent signal-to-noise calculations. The
wave number entered is converted internally to the corresponding frequency.

The default units for the *<real>* parameter is m^{-1}.

SNR[:STATe]

Turns the signal-to-noise calculation on and off.

Syntax   :CALCulate3:SNR[:STATe]{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: off
*RST State: off
SCPI Compliance: instrument specific

Note

Only one STATe command can be turned on at any one time. Attempting to turn more
than one state on at a time results in a "–221 Settings Conflict" error. Refer to
"CALCulate3 Subsystem" on page 4-36 for additional information on selecting measure-
ments.

CONFigure Measurement Instruction

For information on the CONFigure measurement instruction, refer to "Measurement Instructions" on page 4-14.

DISPlay Subsystem

The commands in this subsystem have the following command hierarchy:

```
:DISPlay
    :MARKer:
        :MAXimum
            :LEFT
            :NEXT
            :PREVious
            :RIGHt
    [:WINDow]
        :GRAPhics
            :STATe
```

MARKer:MAXimum

Sets the marker to the laser line that has the maximum power.

Syntax   :DISPlay:MARKer:MAXimum

Attribute Summary   Preset State: marker set to maximum-power laser line
                    *RST State: marker set to maximum-power laser line
                    SCPI Compliance: instrument specific
                    Command Only

MARKer:MAXimum:LEFT

Moves the marker left to the next laser line.

Syntax   :DISPlay:MARKer:MAXimum:LEFT

Attribute Summary   Preset State: marker set to maximum-power laser line
                    *RST State: marker set to maximum-power laser line
                    SCPI Compliance: instrument specific
                    Command Only

Description   Moves the marker from the current marker position to the next laser line having the following characteristic:

• shorter wavelength
• lower frequency
• lower wave number

If the display is in the List by Ampl mode, it will be changed to List by WL before the marker is moved.

MARKer:MAXimum:NEXT

Moves the marker to the laser line with the next lower power level.

Syntax   :DISPlay:MARKer:MAXimum:NEXT

Attribute Summary   Preset State: marker set to maximum-power laser line
*RST State: marker set to maximum-power laser line
SCPI Compliance: instrument specifid
Command Only

Description   If the display is in the List by WL mode, it will be changed to List by Ampl before
the marker is moved.

MARKer:MAXimum:PREVious

Moves the marker to the laser line that has the next higher power level.

Syntax   :DISPlay:MARKer:MAXimum:PREVious

Attribute Summary   Preset State: marker set to maximum-power laser line
*RST State: marker set to maximum-power laser line
SCPI Compliance: instrument specific
Command Only

Description   If the display is in the List by WL mode, it will be changed to List by Ampl before
the marker is moved.

MARKer:MAXimum:RIGHt

Moves the marker right to the next laser line.

Syntax   :DISPlay:MARKer:MAXimum:RIGHt

Attribute Summary   Preset State: marker set to maximum-power laser line
                    *RST State: marker set to maximum-power laser line
                    SCPI Compliance: instrument specific
                    Command Only

Description   Moves the marker from the current marker position to the next laser line hav-
                    ing the following characteristic:

- longer wavelength
- higher frequency
- higher wave number

If the display is in the List by Ampl mode, it will be changed to List by WL before
the marker is moved.

[WINDow]:GRAPhics:STATe

Turns on and off the display of the power bars.

Syntax   :DISPlay[:WINDow]:GRAPhics:STATe{?| {ON | OFF | 1 | 0}}

Attribute Summary   Preset State: on
                    *RST State: on
                    SCPI Compliance: standard

Description   Specifying on displays the power bars in all modes except the drift and signal-
                    to-noise modes. Specifying off prevents the display of power bars for all instru-
                    ment modes.

FETCh Measurement Instruction

For information on the FETCh measurement instruction, refer to "Measurement Instructions" on page 4-14.

HCOPy Subsystem

Use the command in this subsystem to print the displayed measurement results to a printer. This subsystem has the following command hierarchy:

:HCOPy
　　[:IMMediate]

[:IMMediate]

Prints measurement results on a printer.

Syntax　　　　　　　　:HCOPy:IMMediate

Attribute Summary　　　Preset State: none
　　　　　　　　　　　　*RST State: none
　　　　　　　　　　　　SCPI Compliance: standard
　　　　　　　　　　　　Command Only

Description　　　　　　Connect the printer to the HP 86120A's rear-panel PARALLEL PRINTER PORT connector. The output to the printer is ASCII text.

MEASure Measurement Instruction

For information on the MEASure measurement instruction, refer to "Measurement Instructions" on page 4-14.

READ Measurement Instruction

For information on the READ measurement instruction, refer to "Measurement Instructions" on page 4-14.

SENSe Subsystem

Use the SENSe commands to correct measurement results for elevation above sea level and to select between measurements in air or vacuum. You can also enter an amplitude offset. The commands in this subsystem have the following command hierarchy:

```
[:SENSe]
    :CORRection
        :ELEVations
        :MEDium
        :OFFSet
            [:MAGNitude]
    :DATA?
```

CORRection:ELEVation

Sets the elevation value used by the instrument to compensate for air dispersion.

Syntax   :SENSe:CORRection:ELEVation{?| {<integer> | MINimum | MAXimum}}

<integer> is the altitude in meters.

Constant	Description
MINimum	0 m
MAXimum	5000 m

Attribute Summar   Non-sequential command
Preset State: unaffected by
*RST sets this value to the minimum.
SCPI Compliance: instrument specific

Description   Changing the elevation value causes the current data to be reprocessed.

Querry Response   The query form returns the current elevation setting as shown in the following example:

+1500

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

CORRection:MEDium

Sets the HP 86120A to return wavelength readings in a vacuum or standard air.

Syntax   `:SENSe:CORRection:MEDium{?| {AIR | VACuum}}`

Argument	Description
AIR	Selects wavelength values in standard air.
VACuum	Selects wavelength values in a vacuum.

Attribute Summary   Preset State: VAC
*RST State: VAC
SCPI Compliance: instrument specific

Description   Standard air is defined to have the following characteristics:

Barometric pressure: 760 torr
Temperature: 15°C
Relative humidity: 0%

CORRection:OFFSet[:MAGNitude]

Enters an offset for amplitude values.

Syntax   `:SENSe:CORRection:OFFSet:MAGNitude{?| {<real> | MINimum | MAXimum}}`

<real> is the logarithmic units in dB.

Constant	Description
MINimum	–40.0 dB
MAXimum	40.0 dB

Attribute Summary

Preset State: 0.0
*RST State: 0.0
SCPI Compliance: standard

Querry Response

The query form returns the current offset setting as shown in the following example:

`+5.00000000E+000`

DATA?

Queries the time domain samples of the input laser line.

Syntax

`:SENSe:DATA?`

Attribute Summary

Preset State: none
SCPI Compliance: instrument specific
Query Only

Description

Be prepared to process a large amount of data when this query is sent. The amount of data returned depends on the measurement update state of the instrument which is set using the resolution argument of an instrument function. Refer to "Measurement Instructions" on page 4-14.

When *NORMAL* measurement update is specified, over 2,200 kilobytes of data (128K values) can be returned to the computer. When *FAST* measurement update is specified, over 250 kilobytes of data (16K values) can be returned.

The floating point values are scaled from 1.000 to 1.999 (1 + 1023/1024). Amplitude values are not calibrated.

The input laser line(s) generate an interference pattern on the photodetector as a function of the Michelson interferometer optical path delay. The time domain data is sampled at uniform optical path delay increments of half the reference laser wavelength, or 0.316495 microns. When *NORMAL* measurement update is selected, the first data value is sampled at –20.74 mm optical path delay, and the last value is sampled at +20.74 mm optical path delay. When FAST measurement update is selected, the first data value is sampled at

+2.59 mm optical path delay, and the last value is sampled at –2.59 mm optical path delay. The data value that corresponds to zero optical path delay is approximately, but not exactly, located in the center of the time domain data.

If your program is aborted or interrupted after sending this query, the HP 86120A continues to process the data but does not place it in the output buffer. Because of the amount of data processed, the instrument will not respond to any new commands in its input buffer for 30 or 40 seconds.

Query Response   The following string shows an example of the first few measurements returned by this query.

```
+1.51367200E+000,+1.51855500E+000,+1.49902300E+000,+1.47949200
E+000,+1.50488300E+000,+1.53320300E+000,+1.50097700E+000,+1.47
265600E+000,+1.50293000E+000,+1.50781300E+000,+1.51171900E+000
,+1.48242200E+000,+1.50097700E+000,+1.51855500E+000,+1.5068360
0E+000,+1.48632800E+000,+1.50488300E+000
```

Notice that only values are returned to the computer. There is no first value that indicates the number of values contained in the string as there is, for example, with the FETCh, READ, and MEASure commands.

STATus Subsystem

Use the commands in this subsystem to control the HP 86120A's status-reporting structures. These structures provide registers that you can use to determine if certain events have occurred.

The commands in this subsystem have the following command hierarchy:

```
:STATus
    :OPERation
        :CONDition?
        :ENABle
        [:EVENt]?
        :PTRansition
        :NTRansition
    :PRESet
    :QUEStionable
        :CONDition?
        :ENABle
        [:EVENt]?
        :PTRansition
        :NTRansition
```

{OPERation | QUEStionable}:CONDition?

Queries the value of the questionable or operation condition register.

Syntax   :STATus:{OPERation | QUEStionable}:CONDition?

Query Response   0 to 32767

Attribute Summary   Preset State: none
                           *RST State: none
                           SCPI Compliance: standard
                           Query Only

Description   Use this command to read the value of the OPERation Status or QUEStionable
                     Status registers. Refer to "Monitoring the Instrument" on page 3-16.

Example   OUTPUT 720;":STATUS:OPERATION:CONDITION?"

{OPERation | QUEStionable}:ENABle

Sets the enable mask for the questionable or operation event register.

Syntax   :STATus:{OPERation | QUEStionable}:ENABle{?| <value>}

                    <integer> an interger from 0 to 65535.

Attribute Summary   Preset State: none
                           *RST State: none
                           SCPI Compliance: standard

Description   The enable mask selects which conditions in the event register cause the sum-
                     mary bit in the status byte to be set. If a bit in the enable mask is set true and
                     the corresponding event occurs, the summary bit (bit 3 for the questionable
                     status or bit 7 for the operation status) in the status byte will be set.

Example   OUTPUT 720;":STATUS:QUESTIONABLE:ENABLE 1024"

Query Response   When queried, the largest value that can be returned is 65535. This is because
                     the most-significant register bit cannot be set true.

{OPERation | QUEStionable}[:EVENt]

Queries the contents of the questionable or operation event registers.

Syntax   :STATus:{OPERation | QUEStionable}:EVENt?

Query Response   0 to 32767

Attribute Summary   Preset State: none
                         *RST State: none
                         SCPI Compliance: standard
                         Query Only

Description   The response will be a number from 0 to 32767 indicating which bits are set.
                     Reading the register clears the register.

Example   OUTPUT 720;":STATUS:OPERATION:EVENT?"

{OPERation | QUEStionable}:NTRansition

Selects bits in the event register which can be set by negative transitions of
the corresponding bits in the condition register.

Syntax   :STATus:OPERation:NTRansition{?| *<integer>}*

                     <integer> an interger from 0 to 65535.

Attribute Summary   Preset State: none
                               *RST State: none
                               SCPI Compliance: standard

Description   Changes in the state of a condition register bit causes the associated OPERa-
                               tion Status or QUEStionable Status register bit to be set. This command allows
                               you to select a negative bit transition to trigger an event to be recognized. A
                               negative transition is defined to occur whenever the selected bit changes
                               states from a 1 to a 0. You can enter any value from 0 to 65535.

                               When queried, the largest value that can be returned is 32767. This is because
                               the most-significant register bit cannot be set true.

Example   OUTPUT 720;":STATUS:OPER:NTRansition 16"

{OPERation | QUEStionable}:PTRansition

Selects bits in the event register which can be set by positive transitions of the
corresponding bits in the condition register.

Syntax   :STATus:OPERation:PTRansition{?| <*integer*>}

                               <*integer*> an interger from 0 to 65535.

Attribute Summary   Preset State: none
                               *RST State: none
                               SCPI Compliance: standard

Description   Changes in the state of a condition register bit causes the associated OPERa-
                               tion Status or QUEStionable Status event register bit to be set. This command
                               allows you to select a positive bit transition to trigger an event to be recog-
                               nized. A positive transition is defined to occur whenever the selected bit
                               changes states from a 0 to a 1. You can enter any value from 0 to 65535.

                               When queried, the largest value that can be returned is 32767. This is because
                               the most-significant register bit cannot be set true.

Example   OUTPUT 720;":STATUS:OPER:PTRansition 16"

PRESet

Presets the enable registers and the PTRansition and NTRansition filters.

Syntax   :STATus:PRESet

Attribute Summary   Preset State: none
*RST State: none
SCPI Compliance: standard
Command Only

Description   The PRESet command is defined by SCPI to affect the enable register. If you
want to clear all event registers and queues, use the *CLS command.

Table 4-7. Preset Values

Status Node	Preset Value
Operation enable register	0
Questionable enable register	0
PTRansition filters	32767
NTRansition filters	0

Example   OUTPUT 720;":STATUS:PRESET"

SYSTem Subsystem

The commands in this subsystem have the following command hierarchy:

```
:SYSTem
    :ERRor?
    :HELP
        :HEADers?
    :PRESet
    :VERSion?
```

ERRor

Queries an error from the error queue.

Syntax   :SYSTem:ERRor?

Attribute Summary   Preset State: none
*RST State: none
SCPI Compliance: standard
Query Only

Description   The HP 86120A has a 30 entry error queue. The queue is a first-in, first-out
buffer. Repeatedly sending the query :SYSTEM:ERROR? returns the error
numbers and descriptions in the order in which they occur until the queue is
empty. Any further queries returns +0, "No errors" until another error
occurs.

For a complete list of error messages, refer to "Error Messages" on page 7-12.

Query Response   <value>, <string>

<value> is an integer. *<string>* is the text of the error message. The following
is an example of a response:

-113,"Undefined header"

Example   DIM Error$[250]
OUTPUT 720;":SYSTEM:ERROR?"
ENTER 720;Error$
PRINT Error$

HELP:HEADers?

Queries a listing of all the remote programming commands available for the HP 86120A.

Syntax   :SYSTem:HELP:HEADers?

Attribute Summary   Preset State: none
                        *RST State: none
                        SCPI Compliance: instrument specific
                        Query Only

Description   The returned ASCII string of commands is in the IEEE 488.2 arbitrary-block data format. The first line indicates the total number of bytes returned to the computer. That is, the # character is followed by one digit which indicates how many of the following digits convey the byte count. The next digits give the actual byte count. For example, in the listing below, 4010 bytes are indicated in the file.

Each command in the listing is separated by a linefeed character.

The following is an example of the first few lines and last few lines returned in the string. The term *nquery* indicates that a command cannot be sent as a query. The tirm *qonly* indicates that a command can only be sent as a query.

```
#44010
:ABORt/nquery/
:CALCulate:DATA?/qonly/
:CALCulate:TRANsform:FREQuency:POINts
:CALCulate1:DATA?/qonly/
:CALCulate1:TRANsform:FREQuency:POINts
:CALCulate2:DATA?/qonly/
.
.
.
*IDN?/qonly/
*OPC
*RST/nquery/
*SRE
*STB?/qonly/
*TRG/nquery/
*TST?/qonly/
*WAI/nquery/
```

PRESet

Performs the equivalent of pressing the front-panel PRESET key.

Syntax   :SYSTem:PRESet

Attribute Summary   Preset State: none
                        *RST State: none
                        SCPI Compliance: standard
                        Command Only

Description   The instrument state is set according to the settings shown in the following
                        table.

Table 4-8. Instrument Conditions

Item	Settings after Preset Key Pressed	Settings after Power Turned On
Display mode	single wavelength	last state[a]
Wavelength range limiting	on	last state
Measurement acquisition	continuous	last state
Wavelength calibration	vacuum	last state
Elevation correction value	not affected	last state
Wavelength units	nm	last state
Amplitude units	dBm	last state
Power offset	0 dB	last state
Peak threshold	10 dB	last state
Peak excursion	15 dB	last state
Measurement speed	normal	last state
Drift measurements	off	off
Delta Measurements:		
Δ power	off	off
Δ wavelength	off	off
reference signal position	700 nm	700 nm
Signal-to-Noise Measurements		
measurement	off	off
user frequency	193.4144 THz	last state
user wavelength	1550 nm in vacuum	last state
HP-IB address	not affected	last state
Power-bar display	on	last state

a. The term "last state" refers to the last setting that this parameter was in before the instrument power was turned off.

VERSion

Queries the version of SCPI that the HP 86120A complies with.

Syntax   :SYSTem:VERSion

Attribute Summary   Preset State: none
                          *RST State: none
                          SCPI Compliance: standard
                          Query Only

Description   The SCPI version used in the HP 86120A is 1995.0.

Table 4-9. SCPI Version Numbers

SCPI Version	Instrument Serial Prefix
1995.0	US3545 and above

TRIGger Subsystem

The SCPI definition defines the TRIGger subsystem to include ABORt, ARM, INITiate, and TRIGger commands. The HP 86120A has no ARM or TRIGger commands.

The commands in this subsystem have the following command hierarchy:

ABORt
INITiate
   :CONTinuous
   [:IMMediate]

ABORt

Halts the current measurement sequence and places the instrument in the idle state.

Syntax   :ABORt

Attribute Summary   Preset State: not affected
                          SCPI Compliance: standard
                          Command Only

Description   If the instrument is configured for continuous measurements, a new measurement sequence will begin. Otherwise, the instrument stays in the idle state until a new measurement is initiated.

INITiate:CONTinuous

Selects single or continuous measurement acquisition.

Syntax   :INITiate:CONTinuous{?| {ON | OFF | 1 | 0}}

Attribute Summary   Non-sequential command
                          Preset State: on
                          *RST State: off
                          SCPI Compliance: standard

Description   When on is specified, the instrument continuously measures the input spectrum.

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

INITiate[:IMMediate]

Initiates a new measurement sequence.

Syntax   :INITiate:IMMediate

Attribute Summary   Non-sequential command
Preset State: none
SCPI Compliance: standard
Command Only

Non-sequential command

Always use an *OPC? query or a *WAI command to ensure that this command has the time to complete before sending any more commands to the instrument. Refer to "Always force the HP 86120A to wait for non-sequential commands" on page 3-13 for more information.

UNIT Subsystem

The only command provided in this subsystem is the POWer command as shown in the following command hierarchy:

:UNIT
   [:POWer]

[:POWer]

Sets the power units to watts (linear) or dBm (logarithmic).

Syntax   :UNIT[:POWer]{?| {W | DBM}}

Attribute Summary   Preset State: dBm
                    *RST State: dBm
                    SCPI Compliance: standard

5

Servicing

Servicing

In this chapter, you'll find information on troubleshooting, performance testing, and replacing parts in the instrument. There are no adjustments required for the HP 86120A.

Safety first!

Before servicing the HP 86120A, familiarize yourself with the safety markings on the instrument and the safety instructions in this manual. This instrument has been manufactured and tested according to international safety standards. To ensure safe operation of the instrument and the personal safety of the user and service personnel, the cautions and warnings in this manual must be heeded. Refer to the summary of safety considerations at the front of this manual.

WARNING **These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.**

WARNING **The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

WARNING **The power cord is connected to internal capacitors that may remain live for five seconds after disconnecting the plug from its power supply.**

WARNING **This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord) The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.**

WARNING	**For continued protection against fire hazard, replace line fuse only with same type and ratings, (type T 6.3A/250V for 100/240V operation). The use of other fuses or materials is prohibited.**

General Information

Whenever you contact Hewlett-Packard about your HP 86120A, have the complete serial number and option designation available. This will ensure you obtain accurate service information.

- Refer to Table 5-1 on page 5-6 for a list of service tools.

- Refer to Table 5-2 on page 5-7 for a list of internal labels.

- Refer to Table 5-3 on page 5-8 for the location of each instrument assembly.

- Refer to Table 5-4 on page 5-10 for the location of each cable.

Clean the cabinet using a damp cloth only.

Protect againt ESD damage
Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. Refer to "Electrostatic Discharge Information" on page 5-12 for more information on preventing ESD.

WARNING   **To avoid exposure to the laser path of a CLASS IIIa LASER PRODUCT, do not open the A1A1, A1A2, or A1A3 assemblies. There are no serviceable components inside. Laser paths outside of the A1A1, A1A2, or A1A3 assemblies do not require precautions to maintain safety.**
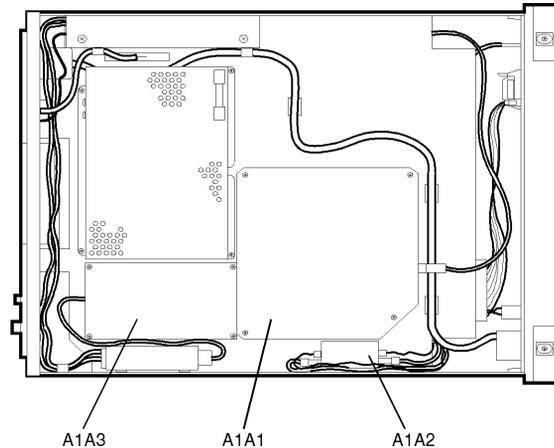
A1A3   A1A1   A1A2

servopt

CAUTION   Do not disturb any of the screws on the A1A1, A1A2, or A1A3 assemblies. Loosening or tightening these screws destroys the amplitude and wavelength calibration so that the HP 86120A no longer meets its published specifications. If the position of these screws is changed, return the instrument to Hewlett Packard for service.

Table 5-1. Required Tools

Tool	HP Part Number
Small Pozidriv screwdriver	8710-0899
Wire cutter	8710-0012
Long-nose pliers	8710-1107
5.5 mm nut driver	8710-1220
7 mm nut driver	8710-1217
TORX T-10 driver	8710-1623
TORX T-10 key, right angle (Options AXE & IX4)	8710-1657
TORX T-15 driver	8710-1622
4 mm hex key	8710-1755

Table 5-2. Internal Labels

CAUTION VISIBLE LASER RADIATION WHEN OPEN. DO NOT STARE DIRECTLY INTO BEAM OR VIEW WITH OPTICAL INSTRUMENTS 1 mW 633 nm CLASS IIIA LASER PRODUCT	This label warns you that removing the A1A1 Interferometer Assembly's cover exposes the beam of a CLASS IIIA LASER PRODUCT. *Never* remove this cover.
WARNING **HIGH** **VOLTAGE**	This label warns you that high voltage circuits are located beneath the A1A3 Laser Assembly's cover. *Never* remove this cover.
ATTENTION-WARNING To prevent shock, after unplugging the laser high voltage connector, ground the two contacts of the male connector simultaneously to discharge the plasma tube.	This label warns you about disconnecting the high-voltage connector to the A1A3 Laser Assembly. Be sure to properly discharge the connector as described in the procedure "To replace the A1 Optical Block Assembly" on page 5-32 or "To replace the A3 High Voltage Power Supply Assembly" on page 5-37.
WARNING HAZARDOUS VOLTAGE	This label warns you of hazardous voltages associated with the A3 High Voltage Power Supply Assembly.
⚠ ⚠ CAUTION PRODUCT WARRANTY WILL BE VOID IF THIS COVER REMOVED	This label has to purposes. First, it warns you that the instrument's warranty will be voided if the cover on the A1A1 Interferometer Assembly is disturbed. Second, if the cover is disturbed, the label will be damaged to indicate the tampering. *Never* remove this cover.
Hewlett-Packard 86120A-600010 SN 001 Lightwave Operation Santa Rosa, CA 95403 Made in USA of domestic And foreign components	This label provides the HP part number and serial number for the A1A1 Interferometer Assembly.
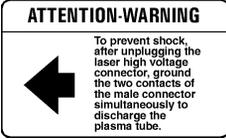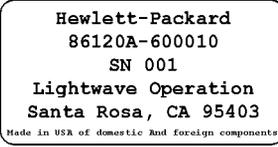
Table 5-3. Major Assemblies

Reference Designator	Description
A1	Optical Block Assembly
A1A1	Interferometer. Part of A1.
A1A2	Detector. Part of A1.
A1A3	Laser. Part of A1.
A2	Power Supply Board Assembly
A3	High Voltage Power Supply Assembly
A4	Digital Signal Processing Board Assembly
A5	Main Board Assembly
A6	Front-Panel Assembly, includes A6A2. Does not include A6A1.
A6A1	Display Assembly (includes printed-circuit board)
A6A2	Flexible keypads
B1	Fan Assembly
FL1	Line-Module Filter. Part of W12.

A3   A6A2

Top View

A6

A2

A6A1

A1A3

A1A1   A1A2

Bottom View

A5   FL1

B1

A4
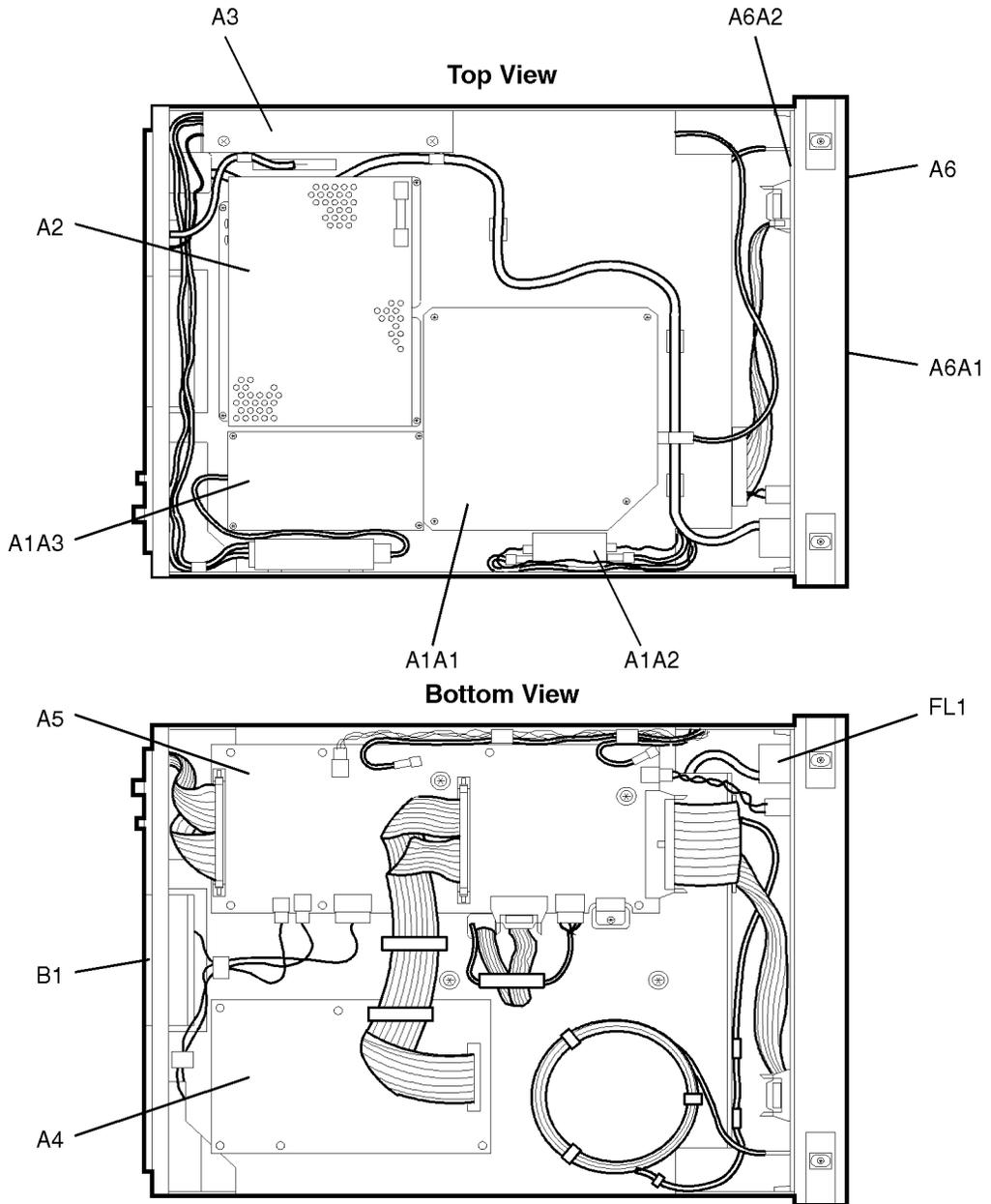
rpmajor

Table 5-4. Cable Assemblies

Reference Designator	Description
W1	Input Fiber Optic Cable
W2	Front-Panel Ribbon Cable
W3	Display Power Cable
W4	SMB Cable, 260 mm long
W5	SMB Cable, 310 mm long
W6	Detector Bias Cable
W7	Main Bus Cable
W8	Part of B1.
W9	Digital Signal Processing Ribbon Cable
W10	Control Cable for A1 Assembly.
W11	Control Cable for A1 Assembly.
W12	Line Switch Cable (includes FL1)
W13	Power Harness Cable

Top View

W13　　　　　　　　　　W12　　　　　W1

Bottom View

W13　　W6　　W5　　　　　W10　　W4　W11

W7

W8

W3

W2

W9

W1
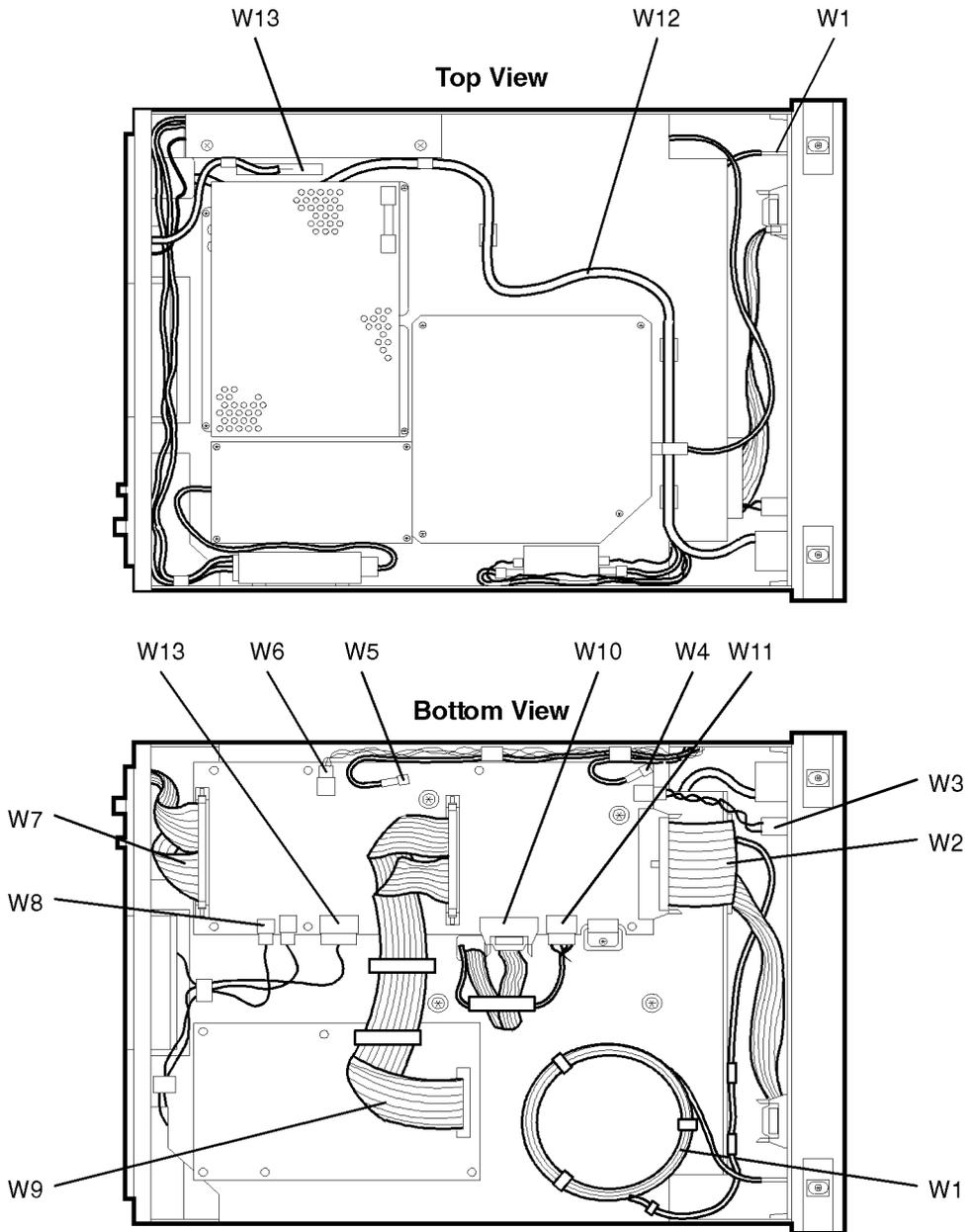
rpcable

Electrostatic Discharge Information

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on electronic assemblies should be performed at a static-safe work station. The following figure shows an example of a static-safe work station using two types of ESD protection:

• Conductive table-mat and wrist-strap combination.

• Conductive floor-mat and heel-strap combination.
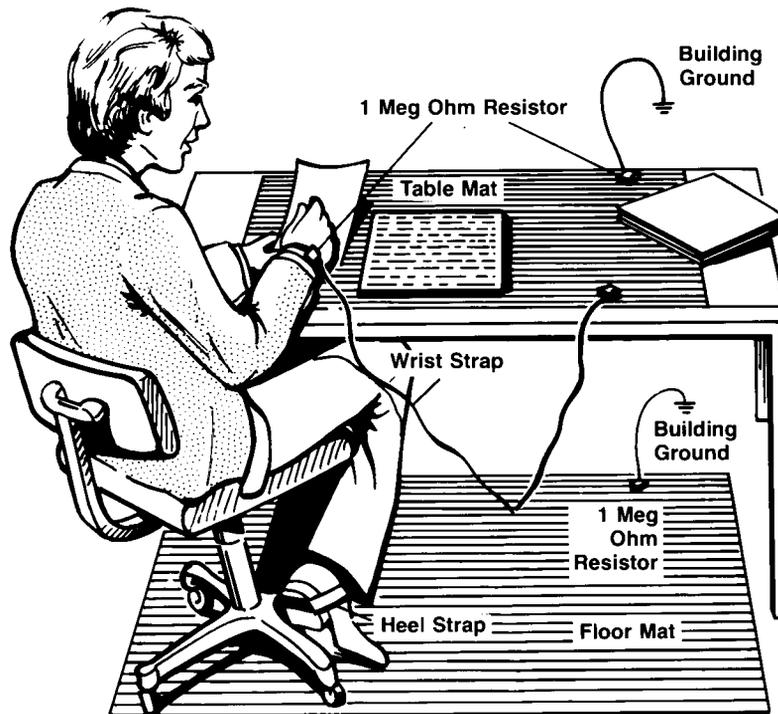
Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone.

To ensure user safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Refer to Table 5-5 on page 5-13 for information on ordering static-safe accessories.

WARNING   **These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.**

Reducing ESD Damage

The following suggestions may help reduce ESD damage that occurs during testing and servicing operations.

• Personnel should be grounded with a resistor-isolated wrist strap before re-moving any assembly from the unit.

• Be sure all instruments are properly earth-grounded to prevent a buildup of static charge.

Table 5-5. Static-Safe Accessories

HP Part Number	Description
9300-0797	3M static control mat 0.6 m × 1.2 m (2 ft× 4 ft) and 4.6 cm (15 ft) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.)
9300-0980	Wrist-strap cord 1.5 m (5 ft)
9300-1383	Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection.
9300-1169	ESD heel-strap (reusable 6 to 12 months).

Troubleshooting

WARNING   **The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

WARNING   **The power cord is connected to internal capacitors that may remain live for five seconds after disconnecting the plug from its power supply.**

The A2 Power Supply Board Assembly generates four voltages of which three are used in the instrument: +5.2V, +15V and –15V. These voltages are connected to the A5 Main Board Assembly at A5J6 and then distributed to the instrument's various circuits and assemblies.

The A1 Optical Block Assembly contains a Michelson interferometer and a reference HeNe laser.

The A5 Main Board Assembly provides motor control, analog-to-digital conversion, signal processing, and power supply distribution. The motor control includes the motor drive and encoder counter for the motor located in the A1 Optical Block Assembly. Because these motor controls are interactive, isolating the malfunction to one of these circuits is best done by substituting known good A1 or A5 assemblies.

The troubleshooting procedures in this section refer to the connector jacks on the A5 Main Board Assembly. The following figure shows the location of each of these jacks.

Bottom View

J14   J13   J10   J11   J1   J12   J2

J6

J9   J3

J7   J4

J8   J5
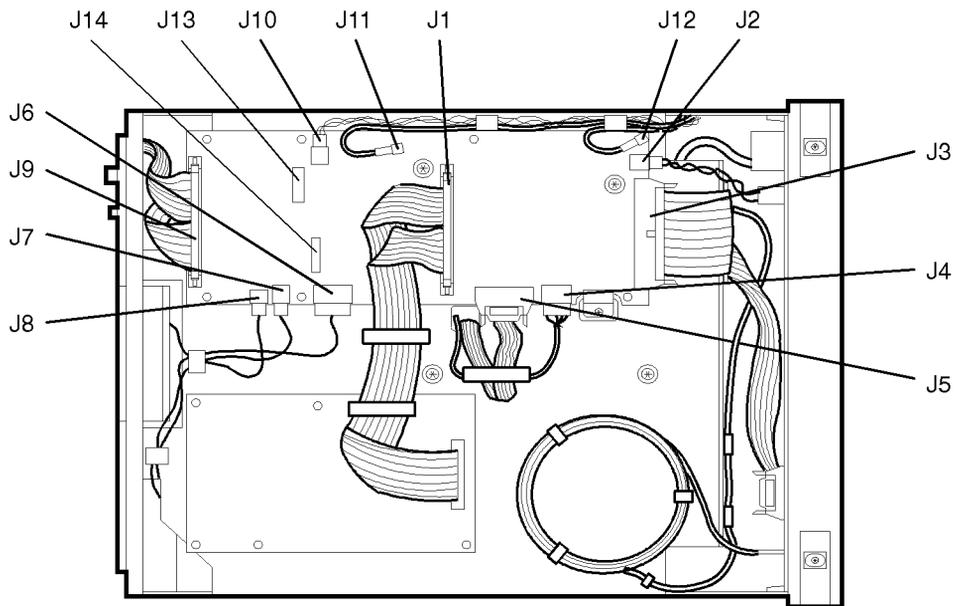
A5 Assembly Jacks

If a general problem occurs

1. Test the power supply voltages as described in "To check the power supply voltages" on page 5-17.

2. Test the A1 Optical Block Assembly as described in "To check the A1 Optical Block Assembly" on page 5-18.

3. If the instrument does not display a signal's power or wavelength, the A4 or A5 assembly is faulty.

If the display is blank

1. Measure the +5.2V supply to the A6A1 Display Assembly at A5J2.

2. If the voltage is incorrect, refer to "To check the power supply voltages" on page 5-17.

3. Check the W2 ribbon cable connections.

If random symbols are displayed

1. Test the power supply voltages as described in "To check the power supply voltages" on page 5-17.

2. If the voltages are correct, the A5 Main Board Assembly is probably faulty.

If the front-panel keys don't work

- If only one key does not function, there is probably a bad contact. Replace the A6 Front Panel Assembly.

- If several keys do not function, suspect ribbon cable W2 or the A5 Main Board Assembly.

If the fan doesn't run

- Measure the +12V supply at A5J8 pin 4.

  Power for the fan, B1, is supplied through two resistors on the A5 assembly which drop the +15V supply to +12V.

To check the power supply voltages

1. Measure the following voltages:

   On the following wires located at the A2 Power Supply Board Assembly's 13-pin connector:

   - Yellow wires: +5.2V
   - Red wires: +15V
   - Violet wire: –15V
   - Black wires: ground

   On the A5 Main Board Assembly:

   - A5J1 pins 13 and 15: +5.2V
   - A5J1 pins 1 and 3: –15V
   - Large resistor's lead located next to A5J7 and A5J8: +15V

2. If no voltages are detected, check that the ac line voltage is present at the A2 Power Supply Board Assembly's 3-pin connector. Measure the line voltage across the white/gray/red wire and the gray wire.

   - If the ac line voltage is present, check the 5A fuse on the A2 Power Supply Board Assembly.

   - If no voltage is present, check the 6.3A fuse in the rear-panel's line module FL1. Refer to "To check the line-power fuse" on page 5-19.

3. Measure the +5V supply to the A4 assembly at A5J1.

4. Measure the +5V supply to the A6 Front Panel Assembly at A5J2.

To check the A1 Optical Block Assembly

This procedure tests the output from the two photodetectors in the A1 assembly.

1. Measure the voltage at A5J7 pin 1. It should measure +13V.

   This voltage is for the A1 assembly's reference laser. It is generated from +15V by a voltage-dropping resistor.

2. Measure the +15V, +5V, and –15V supplies at A5J5.

   These voltages power the A1 assembly's encoder.

3. Measure the +15V and –15V supplies at A5J10.

   These voltages power the A1 assembly's detectors.

4. Disconnect any input signal from the instrument's OPTICAL INPUT connector.

5. Disconnect the SMB cable from A5J11, and connect the cable to an oscilloscope.

   This is the signal from the reference detector, and it should consist of sine wave bursts with the following approximate characteristics:

   Frequency: 5 MHz
   Burst rate: 4 per second
   Burst duration: 15 ms
   Amplitude: 1V p-p
   Voltage at lowest point: 0V

6. If there is no signal present, replace the A1 assembly.

7. Disconnect the SMB cable from A5J12, and connect the cable to the oscilloscope.

   This is the signal from the signal detector, and it should be close to 0V dc.

8. Connect a single frequency laser (such as a DFB laser) to the instrument's front-panel OPTICAL INPUT connector.

9. Set the laser's power to 1 mW (0 dBm).

10. Observe the signal on the oscilloscope. It should consist of sine-wave bursts

with the following approximate characteristics:

Burst rate: 4 per second
Burst duration: 15 ms
Amplitude: 1V p-p
Voltage at lowest point: 0V

The signal's amplitude level varies linearly with the laser's power.

11. If there is no signal present, replace the A1 assembly.

12. Reconnect the cables to A5J11 and A5J12.

To check the line-power fuse

1. Locate the line-input connector on the instrument's rear panel.

2. Disconnect the line-power cable if it is connected.

3. Use a small flat-blade screwdriver to open the pull-out fuse drawer.

fusedr
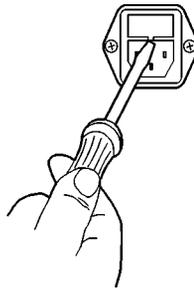
The recommended fuse is an IEC 127 5×20 mm, 6.3A, 250 V, HP part number 2110-0703. Notice that an extra fuse is provided in a drawer located on the fuse holder.

WARNING   **For continued protection against fire hazard, replace line fuse only with same type and ratings, (type T 6.3A/250V for 100/240V operation). The use of other fuses or materials is prohibited.**

Testing Performance

The procedures in this section test the HP 86120A's performance using the specifications listed in Chapter 6, "Specifications and Regulatory Information" as the performance standard. All of the tests are done manually without the aid of a computer. None of these tests require access to the interior of the instrument.

   Test 1. Absolute Wavelength Accuracy
   Test 2. Sensitivity
   Test 3. Polarization Dependence
   Test 4. Optical Input Return Loss
   Test 5. Amplitude Accuracy and Linearity

Allow the HP 86120A to warm up for 15 minutes before doing any of the performance tests.

Calibration Cycle
This instrument requires periodic verification of performance. The instrument should have a complete verification of specifications at least once every year.

Test 1. Absolute Wavelength Accuracy

Description Wavelength accuracy is verified using traceable light sources such as the following devices:

• Stable lasers
• Gas lamps
• HeNe gas lasers

CAUTION Do not exceed +18 dBm source power. The HP 86120A's input circuitry can be damaged when total input power exceeds 18 dBm.

Procedure Use three or four light standards that cover the HP 86120A's wavelength range. Connect the traceable sources to the HP 86120A and verify that the HP 86120A is reading the sources to within the absolute wavelength accuracy specification.

Test 2. Sensitivity

Description   Sensitivity is verified using the following devices:

- Optical power meter
- Optical attenuator
- 1310 nm and 1550 nm lasers (>0 dBm output power)

C A U T I O N   Do not exceed +18 dBm source power. The HP 86120A's input circuitry can be damaged when total input power exceeds 18 dBm.

Procedure   Perform the following procedure first using the 1310 nm laser and then repeat the steps using the 1550 nm laser.

1. Connect the laser's output to the optical attenuator's input.

2. Connect the optical attenuator's output to the optical power meter.

3. Adjust the attenuator for a reading of 0 dBm on the power meter. Record the attenuator's setting.

   Attenuation at 0 dBm: _____

4. Adjust the attenuator for a reading of –35 dBm on the power meter. Record the attenuator's setting.

   Attenuation at –35 dBm: _____

5. Disconnect the fiber-optic cable at the power meter's input and connect the cable to the HP 86120A being tested.

6. Reset the optical attenuator to the setting recorded in Step 3.

7. Read the power and wavelength measured on the HP 86120A, and compared them to the specifications listed in Chapter 6, "Specifications and Regulatory Information".

8. Reset the optical attenuator to the setting recorded in Step 4.

9. Read the power and wavelength measured on the HP 86120A, and compared them to the specifications listed in Chapter 6, "Specifications and Regulatory Information".

Test 3. Polarization Dependence

Description   Polarization Dependence is verified using the following devices:

- 1310 nm and 1550 nm DFB lasers
- Optical attenuator
- HP 11896A Polarization Controller

C A U T I O N   Do not exceed +18 dBm source power. The HP 86120A's input circuitry can be damaged when total input power exceeds 18 dBm.

Procedure   Perform the following procedure first using the 1310 nm laser and then repeat the steps using the 1550 nm laser.

1. Turn on the lasers and allow them to warm up.

2. Set the polarization controller to a scan rate of 5.

3. On the HP 86120A, press the Preset key.

4. Connect the laser's optical output to the polarization controller's optical input.

5. Connect the polarization controller's optical output to the HP 86120A being tested.

6. Set the polarization controller to autoscan.

7. On the HP 86120A, press Peak WL, Appl's, and then *DRIFT*. Press *MAX-MIN* so that both *MAX* and *MIN* in the softkey label are highlighted. The display shows the total drift since the drift measurement was started.

8. Wait five minutes, read the peak amplitude drift from the HP 86120A, and compare with the specification listed in Chapter 6, "Specifications and Regulatory Information".

Test 4. Optical Input Return Loss

Description

Input return loss is verified using the following devices:

- HP 8153A Lightwave Multimeter
- HP 81553SM 1550 nm Fabry-Perot laser, SM 9/125 μm Source Module
- HP 81534A Return Loss Model

Procedure: standard instruments *(flat contacting connectors)*

1. Turn the source module's output off.

2. Connect a single-mode patchcord between the source module's optical output and the return-loss module's INPUT SOURCE connector.

3. Set the return-loss module's wavelength to 1550 nm, and select an average time of 1 second.

4. Locate an HMS-10/HP/HRL to FC/PC patchcord. Connect the HMS-10/HP/HRL end of the patchcord to the return-loss module's OUTPUT connector. Terminate the other end of the cable.

5. Zero the return-loss module.

6. Turn on the source module.

7. Remove the termination from the cable, and leave the cable's free end uncovered.

8. The return-loss module measures the reflection reference (14.6 dB return loss of the patchcord's FC/PC connector in air).

9. Make a low-reflection termination in the HMS-10/HP/HRL to FC/PC patchcord. Do this by wrapping the cable 6 times around a 5 mm diameter mandrel.

10. The return-loss module measures the termination parameter.

11. Connect the HMS-10/HP/HRL to FC/PC patchcord to the HP 86120A's front panel OPTICAL INPUT connector.

12. The lightwave multimeter measures the return loss. Compare this measurement with the specification listed in Chapter 6, "Specifications and Regulatory Information".

Procedure: Option 022 instruments *(angled contacting connectors)*

1. Turn the source module's output off.

2. Connect a single-mode patchcord between the source module's optical output and the return-loss module's INPUT SOURCE connector.

3. Set the return-loss module's wavelength to 1550 nm, and select an average time of 1 second.

4. Locate an HMS-10/HP/HRL to FC/APC (angled FC) patchcord. Connect the HMS-10/HP/HRL end of the patchcord to the return-loss module's OUTPUT connector. Terminate the FC/APC end of the cable.

5. Zero the return-loss module.

6. Turn on the source module.

7. Remove the termination from the cable, and connect the FC/APC end of an FC/APC to FC/PC cable to the free end of this cable. Leave the cable's free end uncovered.

8. The return-loss module measures the reflection reference (14.6 dB return loss of the patchcord's FC/PC connector in air).

9. Disconnect the FC/APC to FC/PC cable.

10. Make a low-reflection termination in the HMS-10/HP/HRL to FC/APC patchcord. Do this by wrapping the cable 6 times around a 5 mm diameter mandrel.

11. The return-loss module measures the termination parameter.

12. Connect the HMS-10/HP/HRL to FC/APC patchcord to the HP 86120A's front panel OPTICAL INPUT connector.

13. The lightwave multimeter measures the return loss. Compare this measurement with the specification listed in Chapter 6, "Specifications and Regulatory Information".

FC/APC patchcord loss

The effect of having loss in the FC/APC patchcord 1 to 2 connector pair is to under measure the return loss by twice the FC/APC patchcord 1 to 2 loss. For example, if this connector pair loss is 0.5 dB, then the actual return loss caused by the 14.6 dB Fresnel reflection is 15.6 dB, but we enter 14.6 dB as an R value. Then, if the DUT return loss is exactly 40 dB below that of the 14.6 Fresnel reflection, the optical return loss module will display 53.6 dB because the 0.5 dB connector pair loss (seen twice) is removed. In reality, the return loss is 54.6 dB (exactly 40 dB below 14.6 dB), better than that displayed.

Test 5. Amplitude Accuracy and Linearity

Equipment

Amplitude linearityis performed using the following devices:

- 1550 nm DFB lasers
- Optical attenuator
- HP 11896A Polarization Controller
- Optical power meter

Procedure

Polarization sensitivity

To ensure measurement accuracy, minimize the movement of any fiber-optic cables during this procedure. Moving cables causes polarization changes which affect amplitude measurements.

---

1. Turn on the laser and allow it to warm up.

2. Connect the laser's output to the optical attenuator's input.

3. Connect the optical attenuator's output to the polarization controller's optical input.

4. Connect the polarization controller's optical output to the optical power meter.

5. Configure the optical power meter for 1550 nm.

6. Adjust the optical attenuator so that the power meter measures a power level of 0 dBm.

7. Enter the attenuator setting and the measured power level in the first row of Table 5-6 on page 5-29. Be sure to enter these values into the "Attenuator Settings" and "Power Meter Readings" columns.

8. Enter the measured power on the following line:

   Pwr: _____

9. Change the attenuator in 1 dB steps as shown in Table 5-6, and enter the attenuator settings and power measurements.

   After completing this step, the first two columns of the table should be completely filled in.

10. Disconnect the fiber-optic cable from the optical power meter and connect it to the HP 86120A's OPTICAL INPUT connector.

11. Set the optical attenuator for the value that you recorded in Step 8.

12. Place the polarization controller in the auto scan mode.

13. Press the HP 86120A's front-panel Preset key.

14. Press List by Power, Appl's, and then *DRIFT*.

15. After two minutes, stop the polarization controller's auto scan function.

16. Press the *MAX-MIN* softkey so that *MAX* is highlighted. Enter the maximum drift reading on the following line:

    maximum drift: _____

17. Press the *MAX-MIN* softkey so that *MIN* is highlighted. Enter the minimum drift reading on the following line:

    minimum drift: _____

18. Use the values recorded in Step 8, Step 16, and Step 17 to calculate the power-correction offset value as shown in the following equation:

$$ offset = \frac{minimum\ drift + maximum\ drift}{2} - Pwr $$

    Enter the calculate value on the following line:

    power-correction offset: _____

19. Change the attenuator to the settings shown in Table 5-6. For each setting, record the power measured on the HP 86120A.

    After completing this step, the table's column titled "HP 86120A Power Reading" should be completely filled in.

20. Calculate the "Linearity" value for each row in the table using the following equation:

$$ Linearity = Power\ Meter\ Reading - HP\ 86120A\ Power\ Reading - offset $$

21. Compare the linearity values with the specification listed in Chapter 6,
    "Specifications and Regulatory Information". The data may show multiple
    amplitude plateaus separated by small amplitude steps. This is *not* a
    problem as long as the amplitude steps are within the linearity specification.

Table 5-6. Linearity Data Values

Desired Power (dBm)	Attenuator Setting	Power Meter Reading	HP 86120A Power Reading	Linearity
0				
−1				
−2				
−3				
−4				
−5				
−6				
−7				
−8				
−9				
−10				
−11				
−12				
−13				
−14				
−15				
−16				
−17				
−18				
−19				
−20				

Replacing Instrument Assemblies

This section provides step-by-step procedures to remove and replace the major instrument assemblies. These include the following procedures:

To remove the instrument cover

1. Disconnect the power cord from the instrument.

2. Use a T-15 TORX driver to remove the two screws that attach the handle to the instrument.

3. Locate the two bumper feet attached to the rear panel.

4. Use a 4 mm hex key to remove the four bolts that secure the two bumper feet to the rear panel.

   Although the bumper feet are no longer attached to the instrument's frame, they are still attached to the instrument's cover.

CAUTION   Beneath the cover, located in the vicinity of the handle attachment screws, are two finger springs that reduce electro-magnetic interference (EMI). These springs can be damaged. Carefully perform the following steps to remove the cover without causing damage.

5. Use one hand to apply pressure to the opposite side of the cover from the side with the handle. Simultaneously pull on the instrument foot that is located on the handle side.

   This action relieves strain on the springs while removing the cover.

6. Slide the instrument cover assembly toward the rear of the instrument, and remove it from the instrument.

CAUTION   When replacing the cover, be careful to protect the instrument's cable assemblies and components from damage. Be sure to use extra caution to avoid damaging the EMI springs. If you damage an EMI spring, you can order a new one using HP part number 8160-0656. The part that is ordered with this number can be cut to provide 8 replacement springs.

7. Slide the cover assembly back onto the instrument chassis while applying pressure to the side of the cover that is opposite the handle attachment screws. Make sure that the cover seats firmly into the channel on the back side of the front casting.

   Gentle pressure ensures that the cover will not bind against the EMI screws. Make sure that the seam in the cover is located on the bottom of the instrument.

To replace the A1 Optical Block Assembly

WARNING **To avoid exposure to the laser path of a CLASS IIIa LASER PRODUCT, do not open the A1A1, A1A2, or A1A3 assemblies. There are no serviceable components inside the A1A1, A1A2, or A1A3 assemblies.**
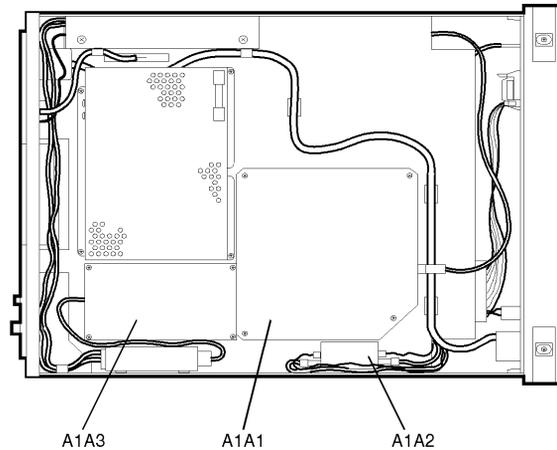
A1A3   A1A1   A1A2

servopt

CAUTION Do not disturb any of the screws on the A1A1, A1A2, or A1A3 assemblies. Loosening or tightening these screws destroys the amplitude and wavelength calibration so that the HP 86120A no longer meets its published specifications. If the position of these screws is changed, return the instrument to Hewlett Packard for service.

1. Remove the instrument cover as described in "To remove the instrument cover" on page 5-31.

2. Disconnect fiber-optic cable W1 from the A1 assembly. Use caution to avoid touching the cable's ferrule tip against the connector body.

Cable
Clips

W1
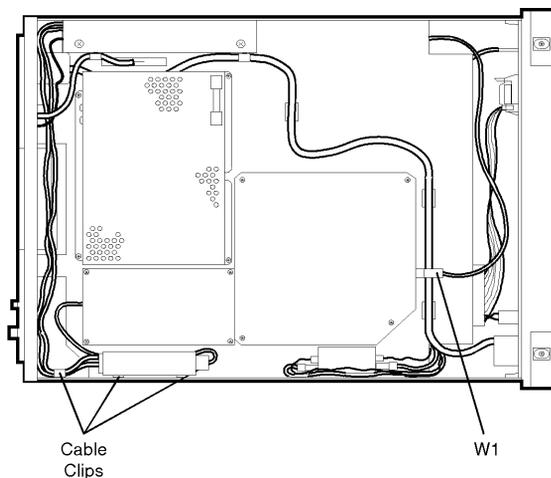
optblk1

3. Cover the free end of the cable W1 and the connector on the A1 assembly to protect them from damage.

WARNING **To prevent shock, do not cut or damage the high voltage cables when removing the cable ties in the following step.**

4. Cut and remove the three cable ties that secure the high voltage connector to the side panel. These clips are identified in the figure above.

5. Remove the two SMA cables and two twisted wire cables that attach to the A1A2 assembly shown in the following figure.

A1A2
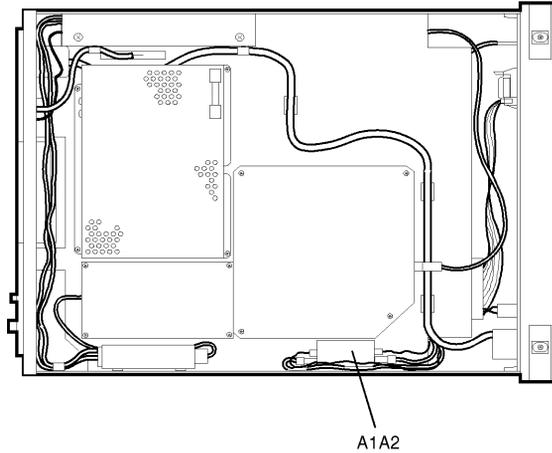
optblk2

WARNING   **To prevent shock, carefully unplug the laser's high-voltage connector as described in the next step. This cable remains energized long after the instrument has been disconnected from the power source. Immediately after unplugging the connector, ground the two contacts of the male connector simultaneously on the side of the instrument to discharge the plasma tube.**

6. Unplug the high-voltage connector shown in the following figure. Immediately after unplugging the connector, ground the two contacts of the male connector simultaneously on the side of the instrument to discharge the plasma tube.

Top View

High Voltage
Connector
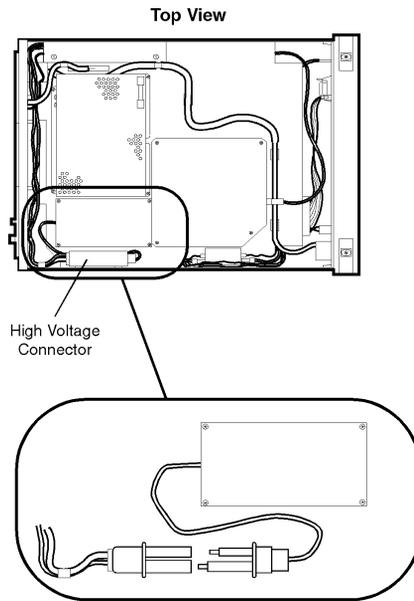
highvolt

7. Place the instrument on its left side so that the A1 assembly will not accidentally fall out of the instrument when the securing screws are removed.

8. Disconnect cables W4 and W10, shown in the following figure, from their connectors on the A5 Main Board Assembly. Free the cables from the cable clips.

optblk3
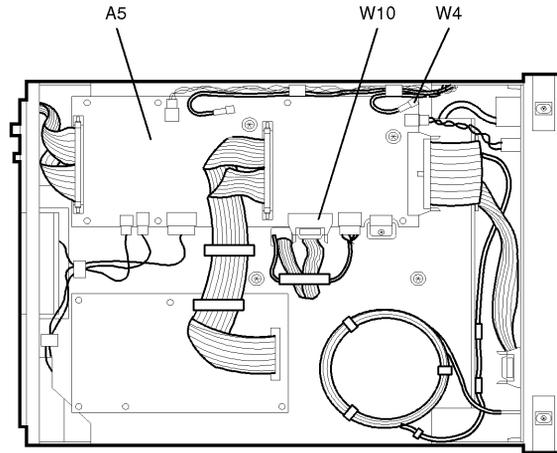
9. While holding the A1 assembly with one hand, use a T-15 TORX driver to remove the four screws that attach the A1 assembly to the instrument.

   When reinstalling the A1 assembly, torque these four screws to 20 in/lbs.

10. Gently remove the A1 assembly while feeding cables W4 and W10 through the hole in the sheet metal.

11. To install the A1 assembly, perform the steps in this procedure in reverse order.

To replace the A3 High Voltage Power Supply Assembly

WARNING   **To prevent shock, do not cut or damage the high voltage cables when removing the cable ties in the following step.**

1. Remove the instrument cover as described in "To remove the instrument cover" on page 5-31.

2. Cut and remove the three cable ties that secure the high voltage connector to the side panel.

3. Unplug the high voltage connector as described in the following warning message:

WARNING   **To prevent shock, carefully unplug the laser's high-voltage connector as described in the next step. This cable remains energized long after the instrument has been disconnected from the power source. Immediately after unplugging the connector, ground the two contacts of the male connector simultaneously on the side of the instrument to discharge the plasma tube.**

4. Unplug the high-voltage connector shown in the following figure. Immediately after unplugging the connector, ground the two contacts of the male connector simultaneously on the side of the instrument to discharge the plasma tube.

Top View

High Voltage
Connector
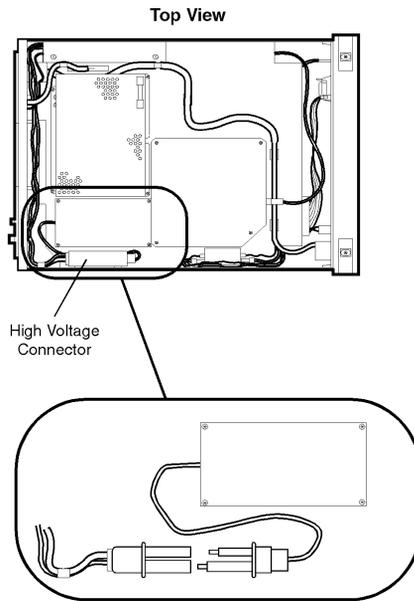
highvolt

5. Place the instrument on its left side.

6. Cut and remove the cable ties that secure the high voltage connector cable
    to the fan assembly.

7. Cut and remove the cable ties that secure cable W13.

8. Disconnect W13 from the A5 Main Board Assembly.

W13
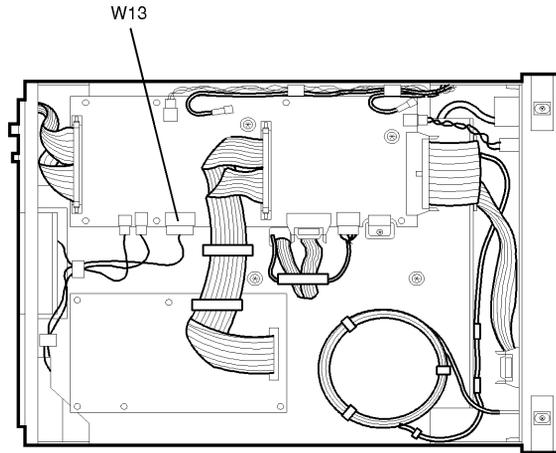
optblk5

9. Use a T-10 TORX driver to remove the four screws that attach the A3 assembly to the instrument's side panel.

Four
Screws
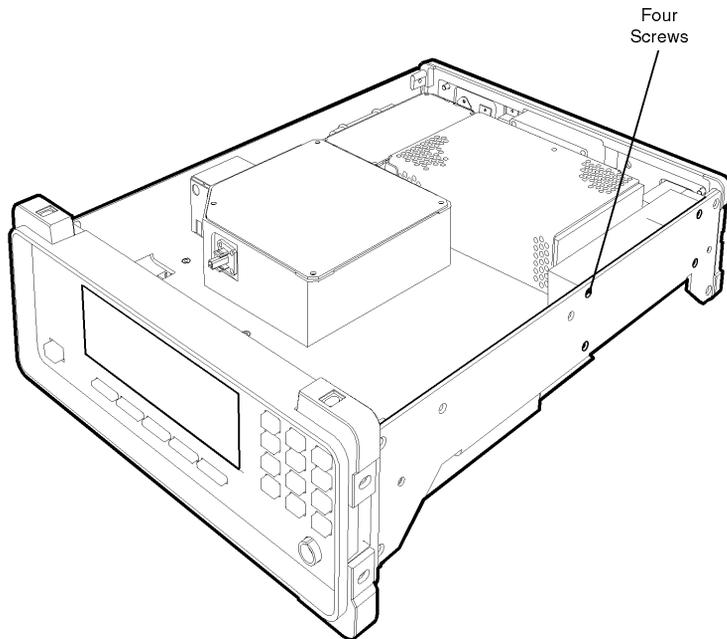
optblk4

10. To install the A3 assembly, perform the steps in this procedure in reverse order.

To replace a cable clip

Cable clips are used throughout the instrument to attach cables to sheet-metal housings. They attach with self-adhesive bonds.

1. Remove the old clip.

2. Remove any remaining glue.

3. Clean the surface using isopropyl alcohol.

4. Remove the paper backing from the bottom of the new clamp.

5. Press the clamp firmly onto the surface.

To replace line filter assembly FL1

Although replacing FL1 is straightforward, be sure to observe the following points:

- Tighten the screws (item 12 shown in Table 5-10 on page 5-52) that attach FL1 to 6 in-lbs. Do not use the recommended torque for M3 screws. Over tightening these screws will damage line filter's flange.

- Observe the following warning about correct wire attachment. The wire color codes in the figure refer to the following cable colors:

  54 green/yellow
  98 white/gray
  918 white/brown/gray

WARNING   **Be sure to solder the wires to FL1 in the correct positions as shown in the following figure. Failure to attach these wires correctly could result in damage to the instrument and injury to the user.**
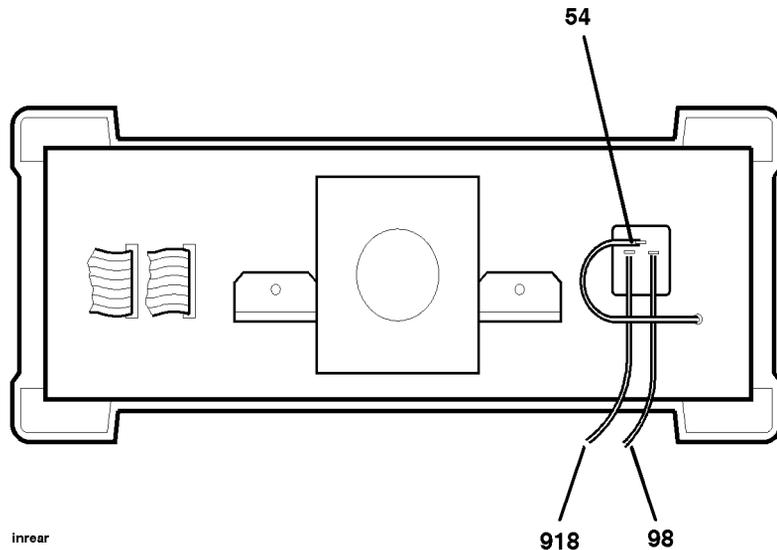
Replaceable Parts

In this section, you'll find figures that identify each mechanical and electrical assembly in the instrument. A Hewlett-Packard part number is provided for each available part. The following identification figures are provided:

Part ordering information

To order an assembly or mechanical part, quote the Hewlett-Packard part number, and indicate the quantity required. To order a part that is not listed, include the following information with the order:

- HP 86120A model number

- HP 86120A serial number

- Description of where the part is located, what it looks like, and its function (if known)

- Quantity needed

Parts can be ordered by addressing the order to the nearest Hewlett-Packard office. Customers within the USA can also use either the direct mail-order system or the direct phone-order system described below. The direct phone-order system has a toll-free phone number available.

Direct mail-order system
Within the USA, Hewlett-Packard can supply parts through a direct mail-order system. Advantages of using the system are as follows:

- Direct ordering and shipment from Hewlett-Packard

- No maximum or minimum on any mail order. (There is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing.)

- Prepaid transportation. (There is a small handling charge for each order.)

- No invoices

To provide these advantages, a check or money order must accompany each order. Mail-order forms and specific ordering information are available through your local HP office.

Direct phone-order system
The toll-free phone number, (800) 227-8164, is available Monday through Friday, 6 am to 5 pm (Pacific time). Regular orders have a 4-day delivery time.

Table 5-7. Major Assemblies

Reference Designator	HP Part Number	Description
A1	86120-60010 86120-69010	Optical Block Assembly. Includes A1A1, A1A2, and A1A3. Optical Block Assembly *(exchange)*
A1A1	—	Interferometer. Part of A1. Can not be ordered separately.
A1A2	—	Detector. Part of A1. Can not be ordered separately.
A1A3	—	Laser. Part of A1. Can not be ordered separately.
A2	0950-2293	Power Supply Board Assembly
A3	0950-3024	High Voltage Power Supply Assembly
A4	1150-5006	Digital Signal Processing Board Assembly
A5	86120-60011 86120-69011	Main Board Assembly Main Board Assembly *(exchange)*
A6	86120-60025 86120-69025	Front-Panel Assembly, includes A6A2. Does not include A6A1. Front-Panel Assembly, includes A6A2. Does not include A6A1. *(exchange)*
A6A1	2090-0292	Display Assembly (includes printed-circuit board)
A6A2	86120-40001	Flexible keypads. Pulls apart along groove into two separate pads.
B1	5063-0243	Fan Assembly
FL1	9135-0270	Line-Module Filter. Also part of W12.
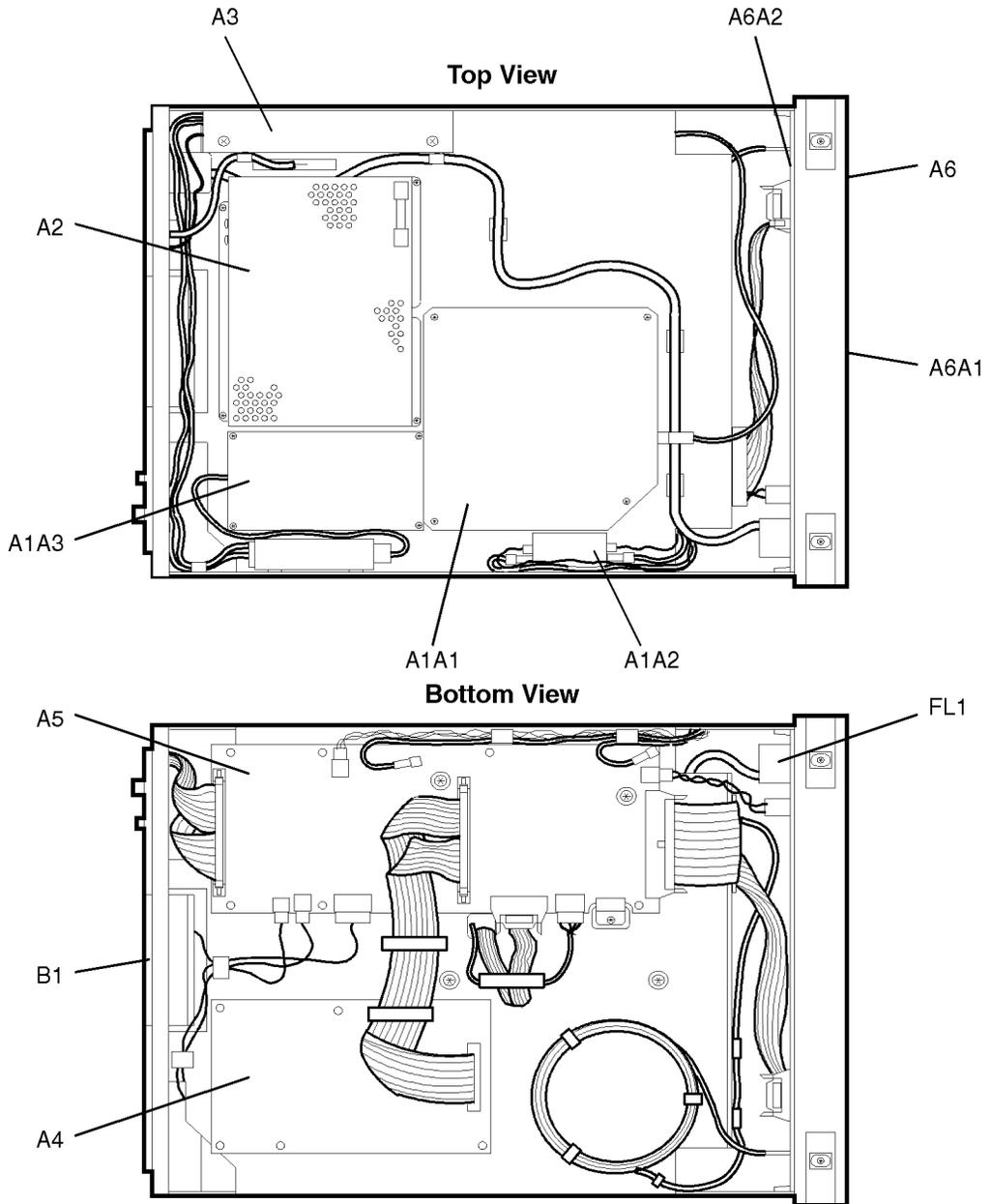
rpmajor

Table 5-8. Cable Assemblies

Reference Designator	HP Part Number	Description
W1	08169-67608 81685-67688	Input Fiber Optic Cable Input Fiber Optic Cable *(Option 022 angled input fiber)*
W2	86120-60019	Front-Panel Ribbon Cable
W3	86120-60023	Display Power Cable
W4	8120-5020	SMB Cable, 260 mm long
W5	8120-5021	SMB Cable, 310 mm long
W6	86120-60024	Detector Bias Cable
W7	86120-60020	Main Bus Cable
W8	—	Part of B1. Not separately orderable.
W9	86120-60018	Digital Signal Processing Ribbon Cable
W10	—	Control Cable for A1 Assembly. Can not be ordered separately.
W11	—	Control Cable for A1 Assembly. Can not be ordered separately.
W12	86120-60021	Line Switch Cable (includes FL1)
W13	86120-60022	Power Harness Cable

Top View

Bottom View
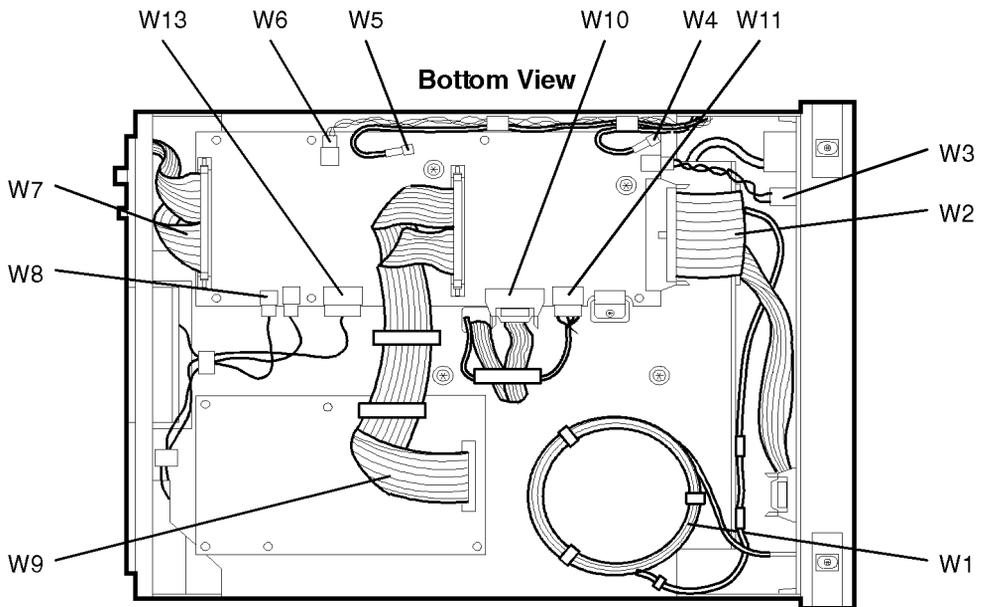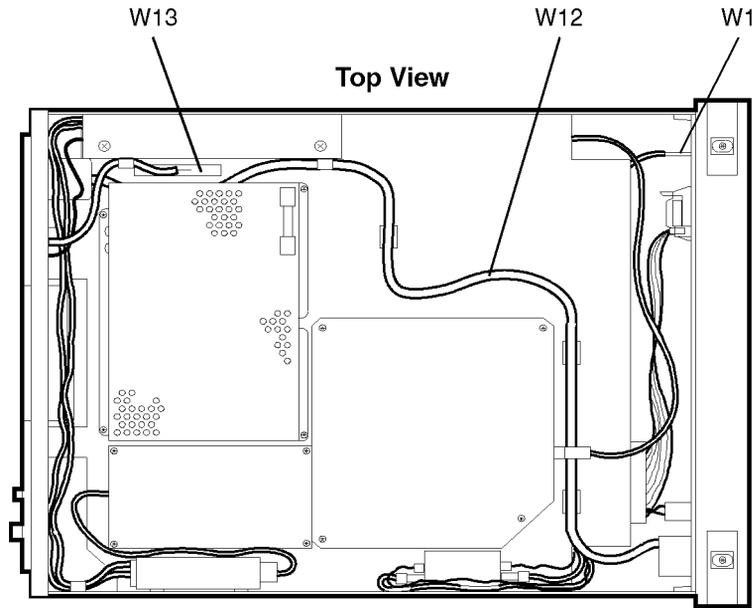
rpcable

Table 5-9. Front-Panel Parts

Item	HP Part Number	Qty	Description
1	08703-20098	1	Universal fiber-optic connector
2	0535-0031	12	Nut-hex with lock washer, M3 x 0.5, 2.4 mm thick
3	0515-0664	1	Screw, TORX T10 Pan Head, M3 x 0.5, 12 mm long
4	0515-0374	7	Screw, TORX T10 Pan Head, M3 x 0.5, 10 mm long
5	86120-20007	1	Front frame
6	0515-0373	1	Screw, TORX T10 Pan Head, M3 x 0.5, 10 mm long
7	0515-0372	4	Screw, TORX T10 Pan Head, M3 x 0.5, 8 mm long
8	0510-1386	6	Retainer, push on, 11.5 mm
9	5041-1682	1	LINE key. Part of W12
10	0515-0430	8	Screw with washer, TORX T10 Pan Head, M3 x 0.5, 6 mm long
11	5041-8928	4	Front frame bumper
12	4040-2331	1	Filter mesh window
13	86120-00005	1	Front panel faceplate

(6 places)

Display
Window

(1 place)

rpfrtpr
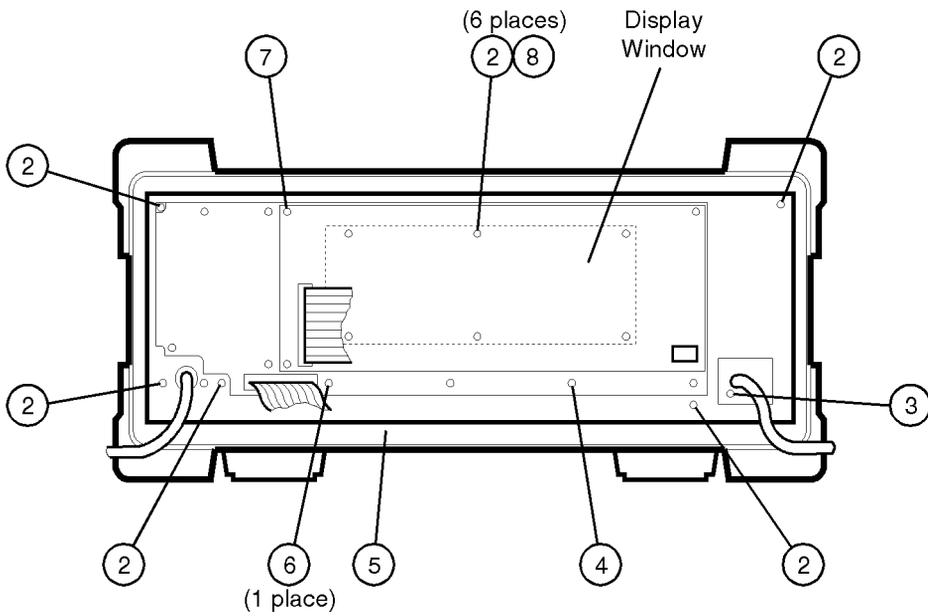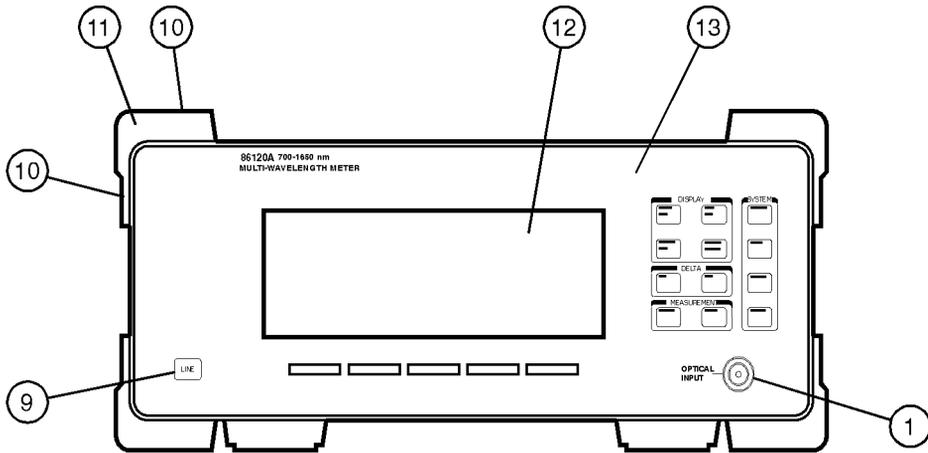
Table 5-10. Rear-Panel Parts

Item	HP Part Number	Qty	Description
1	—	1	HP-IB connector. Part of W7
2	—	1	Parallel port connector. Part of W7
3	2190-0034	2	Washer, lock, HLCL No. 8 0.168 in ID
4	0380-0644	2	Standoff, hex, 0.255 in long, 6-32 thread
5	2190-0584	2	Washer, lock, HLCL 3.0mm, 3.1 mm ID, 6.2 mm OD
6	1251-7812	2	Jackscrew
7	0360-0269	1	Terminal solder lug
8	0535-0082	5	Nut-hex with lock washer, M4 x 0.7, 3.2 mm thick
9	0535-0082	4	Nut-hex with lock washer, M4 x 0.7, 3.2 mm thick
10	0515-0382	2	Screw with washer, TORX T15 Pan Head, M4 x 0.7, 12 mm long
11	2110-0703	1	Fuse. 6.3A 250V
12	0515-2032	2	Screw, TORX T10 Flat Head, M3 x 0.5, 8 mm long
13	3050-0894	4	Washer, flat, 5.0mm, 5.4 mm ID, 9.85 mm OD
14	2190-0587	4	Washer, lock, HLCL 5.0mm, 5.1 mm ID, 9.2 mm OD
15	0515-1218	4	Screw, socket head cap (hex recess), M5 x 0.8, 40 mm long
16	5041-8929	2	Foot rear
17	86120-20008	1	Rear frame
18	3160-0309	1	Fan grille
19	0515-0383	4	Screw, TORX T15 Pan Head, M4 x 0.7, 16 mm long

rprea
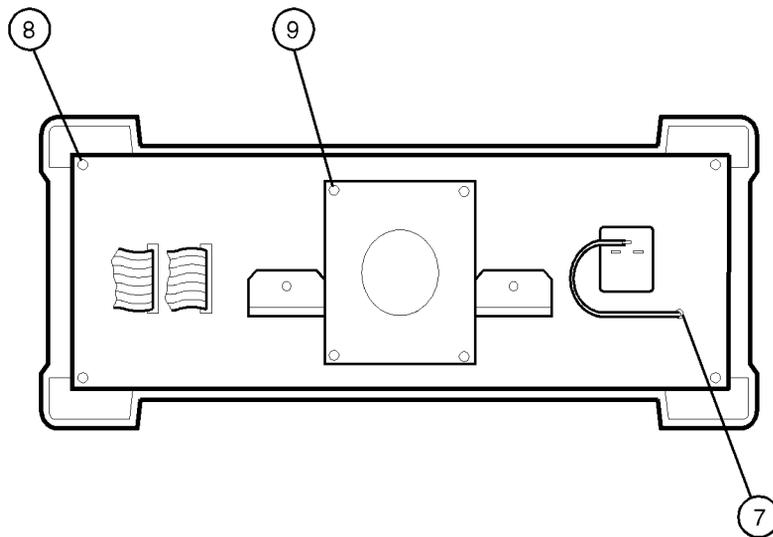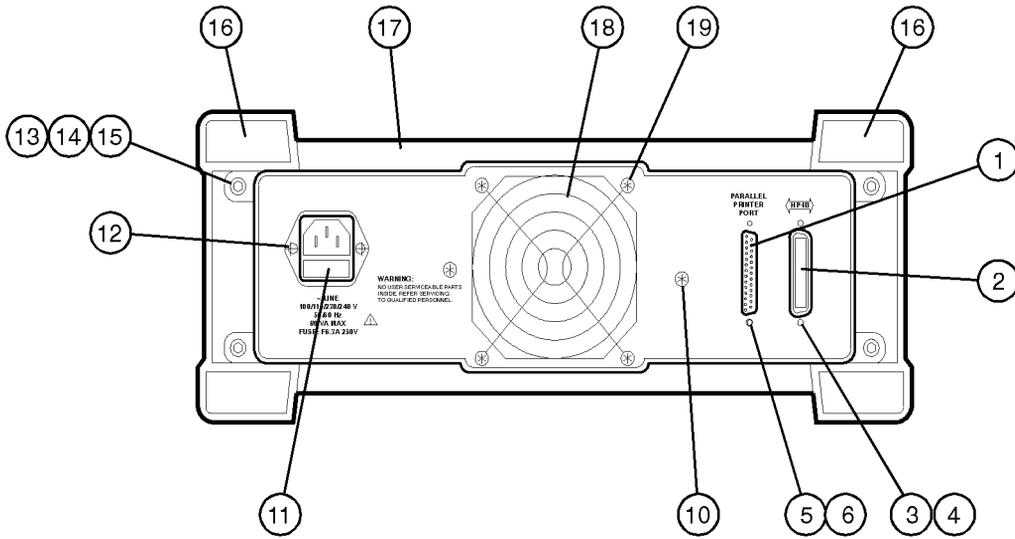
Table 5-11. Top View Parts

Item	HP Part Number	Qty	Description
1	1400-0968	2	Cable clip, 0.75 in x 0.75 in
2	1400-0755	3	Component clip 0.75 in x 0.75 in
3	1400-1328	2	Cable mount, 1 in x 1 in
4	1400-2136	1	Cable mount, 0.75 in x 0.75 in
5	0515-0372	4	Screw, TORX T10 Pan Head, M3 x 0.5, 8 mm long
6	86120-00011	1	Shield for A2 Power Supply
7	0515-0380	4	Screw, TORX T15 Pan Head, M4 x 0.7,10 mm long

rpto
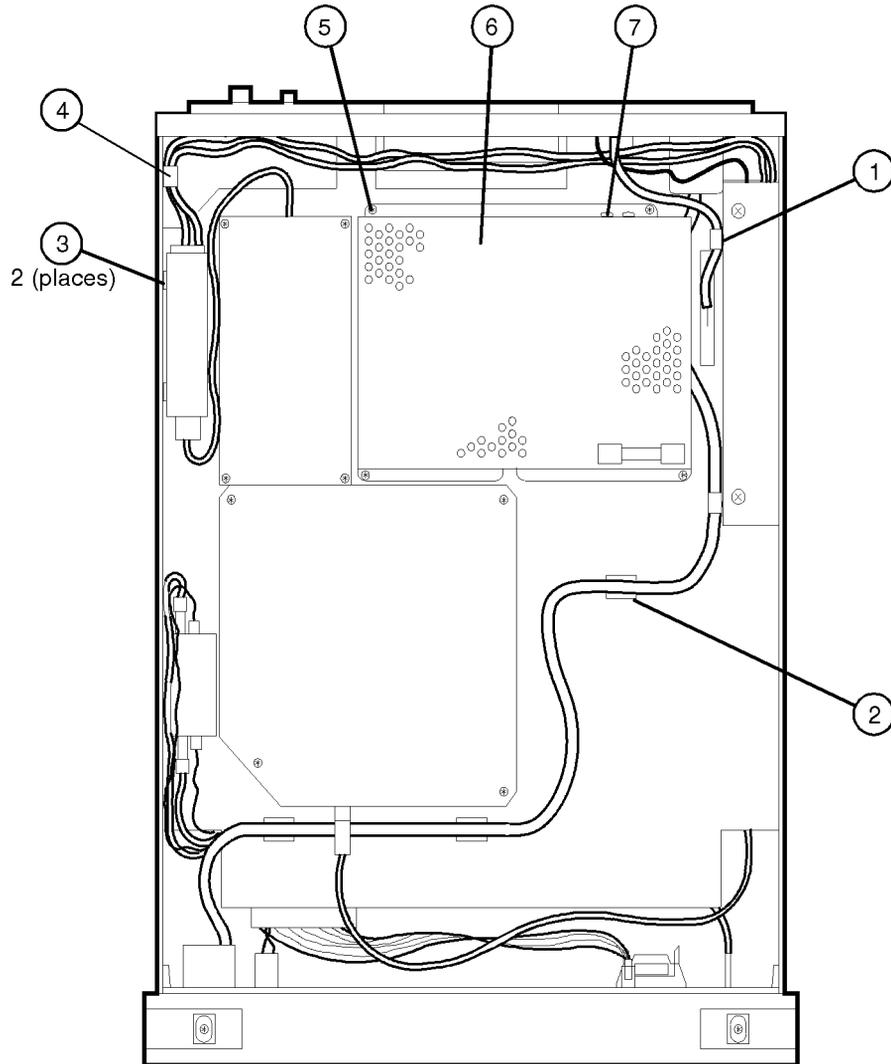
Table 5-12. Bottom View Parts

Item	HP Part Number	Qty	Description
1	1400-1439	2	Cable clip
2	0515-0372	1	Screw, TORX T10 Pan Head, M3 x 0.5, 8 mm long
3	0515-0430	8	Screw, TORX T10 Pan Head, M3 x 0.5, 6 mm long
4	86120-20018	1	Heatsink
5	0400-0387	4	Rubber grommet
6	86120-20009	4	Standoff
7	3050-1415	4	Flat Washer M4.0
8	0515-0456	4	Screw, TORX T15 Pan Head, M4 x 0.7, 20 mm long
9	1400-1582	3	Cable clip, 11 mm x 16 mm
10	1400-1594	3	Cable clip, 0.99 in x 0.99 in
11	86120-00004	1	Main deck sheet-metal assembly
12	0515-0372	6	Screw, TORX T10 Pan Head, M3 x 0.5, 8 mm long
13	1400-2132	4	Cable clip, 2.75 in x 0.5 in
14	1400-2136	1	Cable clip, 0.75 in x 0.75 in
15	0515-0372	8	Screw, TORX T10 Pan Head, M3 x 0.5, 8 mm long
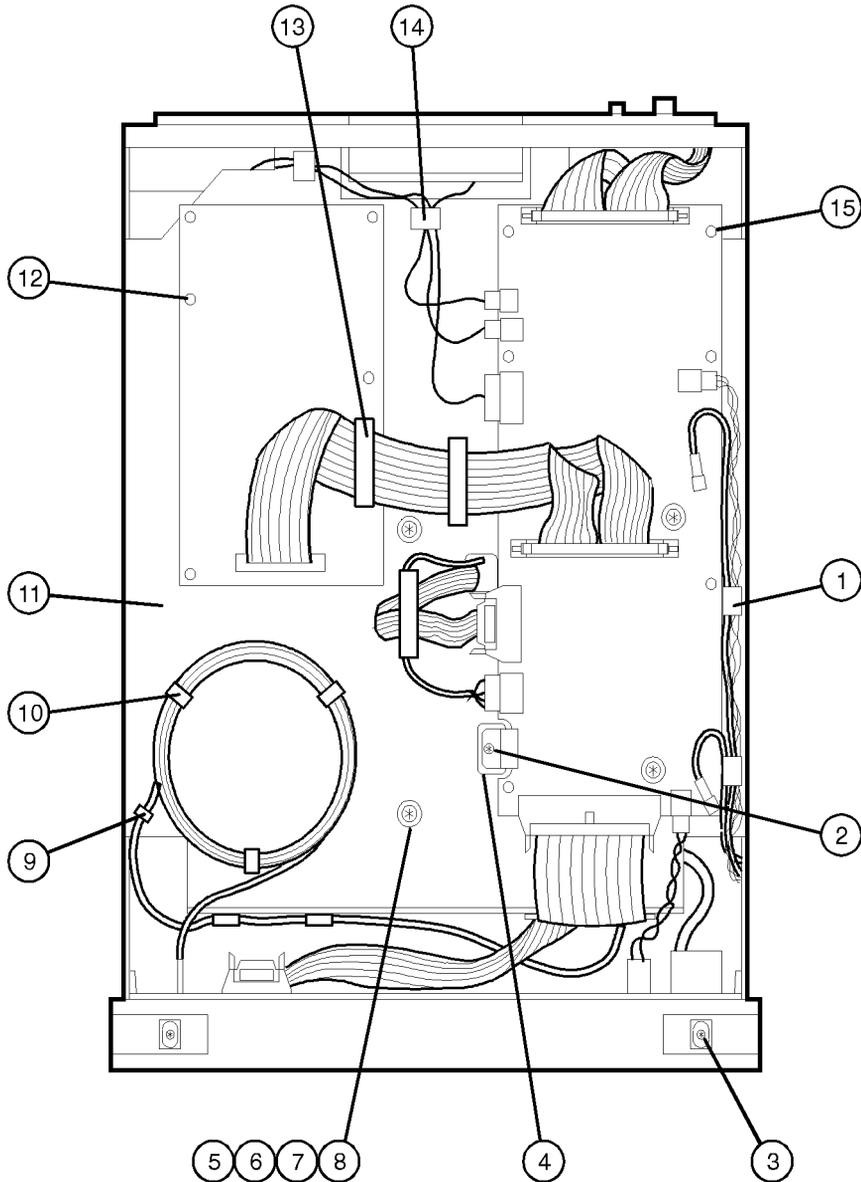
rpbottom

Table 5-13. Side View Parts

Item	HP Part Number	Qty	Description
1	0515-1102	4	Screw, TORX T10 Flat Head, M3 x 0.5, 8 mm long
2	0515-2086	8	Screw, TORX T15 Flat Head, M4 x 0.7, 7 mm long
3	0515-0430	8	Screw with washer, TORX T10 Pan Head, M3 x 0.5, 6 mm long
4	5041-8928	4	Front frame bumper

(4 places)
①

②
(4 places
per side)

④   ③
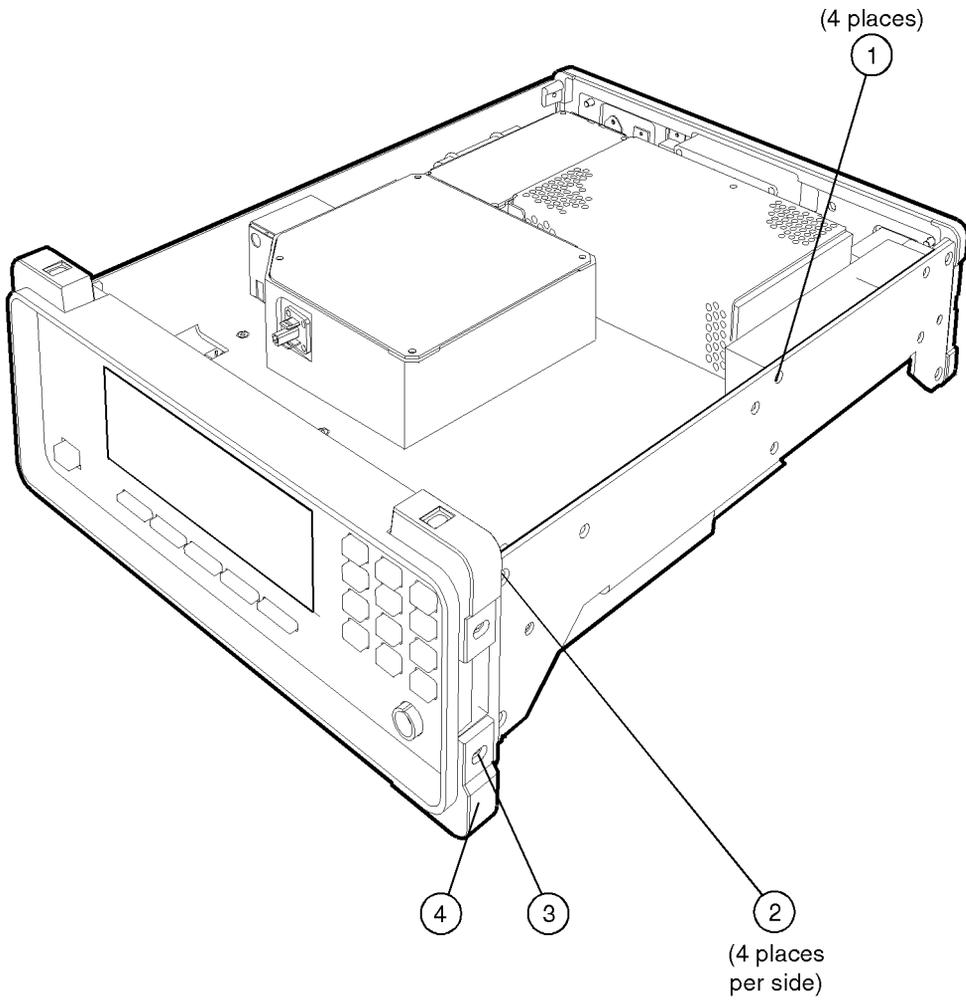
rpside

Table 5-14. Instrument Cover Parts

Item	HP Part Number	Qty	Description
1	0515-0380	2	Screw, TORX T15 Pan Head, M4 x 0.7,10 mm long
2	0515-1227	6	Screw, TORX T10 Flat Head, M3 x 0.5, 6 mm long
3	01650-47701	2	Molded feet
4	1460-1345	2	Spring leg
5	08590-40005	2	Plastic spacer for rear foot
6	5041-8929	2	Foot rear
7	86120-00007	1	Instrument Cover
8	0340-1505	1	Insulator
—	86120-60028	1	Handle Assembly *(not shown in drawing)*

rpinscvr

6
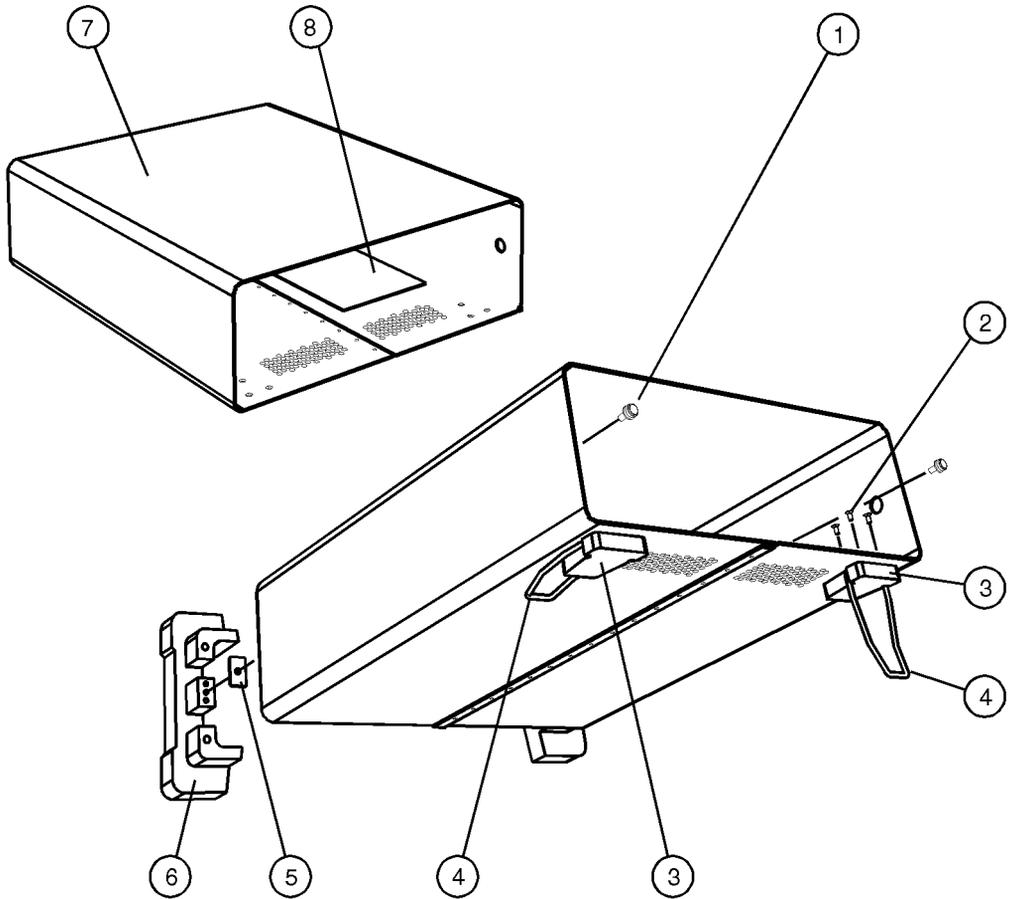
Specifications and Regulatory Information

Specifications and Regulatory Information

This chapter lists specification and characteristics of the instrument. The distinction between these terms is described as follows:

- Specifications describe warranted performance over the temperature range 0°C to +55°C and relative humidity <95% (unless otherwise noted). All specifications apply after the instrument's temperature has been stabilized after 15 minutes of continuous operation.

- *Characteristics* provide useful information by giving functional, but non-warranted, performance parameters. *Characteristics are printed in italics.*

Calibration Cycle

This instrument requires periodic verification of performance. The instrument should have a complete verification of specifications at least once every year.

Contents

Definition of Terms

Wavelength

Range refers to the allowable wavelength range of the optical input signal.

Absolute accuracy indicates the maximum wavelength error over the allowed environmental conditions. The wavelength accuracy is based on fundamental physical constants, which are absolute standards not requiring traceability to artifacts kept at national standards laboratories. Four He-Ne gas lasers are used. First, there is an internal 632.991 nm-vacuum (473.6127 THz) reference laser[1]. To verify absolute wavelength accuracy, three external lasers are measured during manufacturing with these wavelengths:

730.685 nm, or 410.2896 THz[2]
1152.591 nm, or 260.1032 THz[3]
1523.488 nm, or 196.7804 THz[3]

Differential Accuracy indicates the maximum wavelength error in measuring the wavelength difference between two signals that are simultaneously present.

Minimum Resolvable Separation indicates the minimum wavelength separation of two laser lines required to measure each wavelength simultaneously. Two laser lines closer in wavelength than the minimum resolvable separation are not resolved and one average wavelength is displayed.

Display Resolution indicates the minimum incremental change in displayed wavelength.

1. Obarski, G. E. 1990. "Wavelength Measurement System for Optical Fiber Communications" *NIST Technical Note 1336* (February): 18. Take the average of the two frequencies straddling gain center.
2. Moore, C. E. 1971. "Atomic Energy Levels as Derived from the Analysis of Optical Spectra: Vol. 1" *NSRDS-NBS 35, Vol. 1 (COM-72-51282)* (December): 77.
3. D. A. Jennings, F. R. Peterson, and K. M. Evenson. 1979. "Frequency measurement of the 260-THz (1.15 micron) He-Ne laser" *Optics Letters Vol. 4, No. 5* (May): 129-130.

Amplitude

Calibration Accuracy indicates the maximum power calibration error at the specified wavelengths over the allowed environmental conditions. The amplitude calibration acccuracy is tracable to a National Institute of Standards and Technology (NIST) calibrated optical power meter. NIST is the national standards laboratory of the United States.

Flatness refers to the maximum amplitude error in a measurement between two lines that are separated in wavelength by no more than the specified amount.

Linearity indicates the maximum power error in measuring the change in power of one laser line.

Polarization Dependence indicates the maximum displayed power variation as the polarization of the input signal is varied.

Display Resolution indicates the minimum incremental change in displayed power.

Sensitivity

Sensitivity is defined as the minimum power level of a single laser-line input to measure wavelength and power accurately. A laser line with less than the minimum power may be measured but with reduced wavelength and power accuracy. For multiple laser-lines input, sensitivity may be limited by total input power.

Selectivity

Selectivity indicates the ability to measure the wavelength and power of a weak laser line in the proximity of a specified stronger laser line and separated by the specified amount.

Input Power

Maximum displayed level indicates the maximum total input power (total of all laser lines present) to accurately measure wavelength and power.

Maximum safe input power indicates the maximum total input power (total of all laser lines present) to avoid permanent optical damage to the instrument.

Maximum Number of Lines Input

Maximum number of lines input is the maximum number of displayed lines. If more than 100 lines are input, only the 100 longest wavelength lines are displayed.

Input Return Loss

Input Return Loss indicates the optical power reflected back to the user's fiber cable relative to the input power. It is limited by the return loss of the front-panel connector, and assumes the user's connector is good.

Measurement Cycle Time   *Measurement cycle time* refers to the cycle time when measuring wavelength and power of laser lines. Specific advanced applications may require longer cycle times.

Specifications

Each laser line is assumed to have a widewith (including modulation side-bands) of less than 10 GHz. All specifications apply when the instrument is in NORMAL UPDATE mode unless noted.

Wavelength

Range	700-1650 nm (182-428 THz)
Absolute accuracy (lines separated by ≥30 GHz)	±3 ppm (±0.005 nm at 1550 nm, ±0.004 nm at 1310 nm)
Differential accuracy *(characteristic)*	*±2 ppm*
Minimum resolvable separation[a] *(characteristic)*	*20 GHz (0.16 nm at 1550 nm, 0.11 nm at 1300 nm)*
Display resolution	0.001 nm, normal update mode
	0.01 nm, fast update mode

a. Signals of equal amplitude. For lines that are separated by less than 30 GHz, wavelength accuracy is reduced.

Amplitude

Calibration accuracy at calibration wavelengths ±30 nm	
1310 and 1550 nm	±0.5 dB
780 nm (characteristic)	*±0.5 dB*
Flatness, ±30 nm from any wavelength	
1200-1600 nm *(characteristic)*	*±0.2 dB*
700-1650 nm *(characteristic)*	*±0.5 dB*
Linearity, 1200 nm to 1600 nm, lines above −20 dBm	±0.3 dB
Polarization dependence	
1200-1600 nm	±0.5 dB
700-1650 nm *(characteristic)*	*±1.0 dB*
Display resolution	0.01 dB

Sensitivity

700-900 nm, single line input	−20 dBm
900-1200 nm, single line input	−25 dBm
1200-1600 nm, single line input[a]	−35 dBm
1600-1650 nm, single line input[a]	−30 dBm
700-1650 nm, multiple lines input *(characteristic)*	*30 dB below total input power, but not less than single line input sensitivity.*

a. Spurious free from +10 dBm to −20 dBm

Selectivity

Two lines input separated by ≥100 GHz *(characteristic)*	*25 dB*
Two lines input separated by ≥30 GHz *(characteristic)*	*10 dB*
Input Power	
Maximum displayed level (sum of all lines)	+10 dBm
Maximum safe input level (sum of all lines)	+18 dBm
Maximum Number of Laser Lines Input	100

Input Return Loss

With flat contacting connectors	35 dB
With angled contacting connectors (Option 022)	50 dB

Measurement Cycle Time

Normal update mode *(characteristic)*	*1.25 s (0.8 measurements-per-second)*
Fast update mode *(characteristic)*	*0.25 s (4 measurement-per-second)*

Measurement Applications

Signal-to-Noise *(characteristic)*	*>25 dB (1 nm noise bandwidth), lines above −20 dBm*
Coherence Length *(characteristic)*	Fabry-Perot lasers, 1 to 200 mm coherence length, accuracy ±5%, 0.75s cycle time

Operating Specifications

Use	indoor
Power:	115 VAC: 110 VA MAX. / 60 WATTS MAX. / 1.1 A MAX. 230 VAC: 150 VA MAX. / 70 WATTS MAX. / 0.6 A MAX.
Voltage	nominal: 115 VAC / 230 VAC range 115 VAC: 90-132 V range 230 VAC: 198-254 V
Frequency	nominals: 50 Hz / 60 Hz range: 47-63 Hz
Altitude	Up to 15,000 feet (4,572 meters)
Operating temperature	0°C to +55°C
Maximum relative humidity	80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C
Weight	8.5 kg (19 lb)
Dimensions (H x W x D)	140 x 340 x 465 mm (5.5 x 13.4 x 18.3 in)

Regulatory Information

- Laser Classification: This product contains an FDA Laser Class I (IEC Laser Class 1) laser.

- This product complies with 21 CFR 1040.10 and 1040.11.

Notice for Germany: Noise Declaration

Acoustic Noise Emission	Geraeuschemission
LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
per ISO 7779	nach DIN 45635 t.19

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Hewlett-Packard Co.

Manufacturer's Address: 1400 Fountaingrove Parkway
                                  Santa Rosa, CA 95403-1799
                                  USA

declares that the product:

   Product Name: Multi-Wavelength Meter

   Model Number: HP 86120A

   Product Options: This declaration covers all options of the above product.

conforms to the following Product specifications:

   Safety: IEC 1010-1:1990+A1 / EN 61010-1:1993
             CAN/CSA-C22.2 No. 1010.1-92

   EMC: CISPR 11:1990/EN 55011:1991 Group 1, Class A
             IEC 801-2:1984/EN 50082-1:1992 4 kV CD, 8 kV AD
             IEC 801-3:1984/EN 50082-1:1992 3 V/m, 27-500 MHz
             IEC 801-4:1988/EN 50082-1:1992 0.5 kV Sig. Lines, 1 kV Power Lines

             IEC 1000-3-2:1995 / EN 61000-3-2:1995
             IEC 1000-3-3:1994 / EN 61000-3-3:1994

Supplementary Information:

These products herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Santa Rosa, California, USA   1/22/96

Dixon Browder/Quality Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department ZQ/Standards Europe, Herrenberger Strasse 130, D-71034 Böblingen, Germany (FAX: +49-7031-14-3143)

Regulatory Information
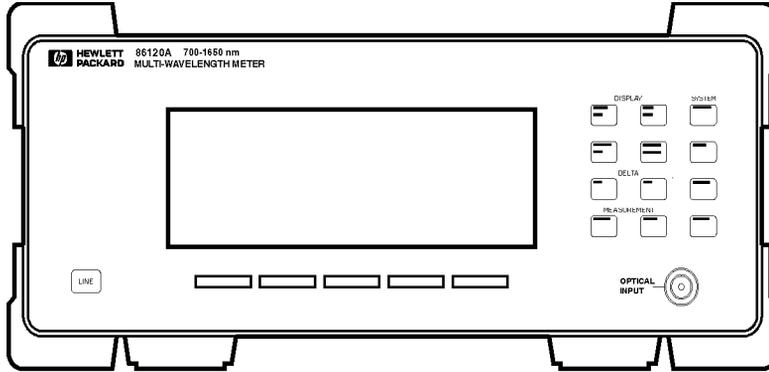
frntview

Front view of instrument
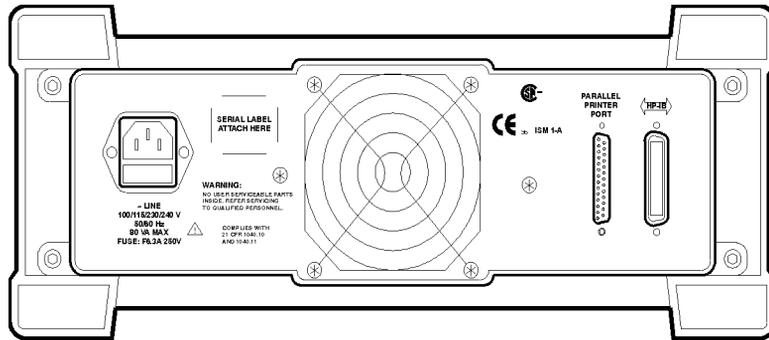
rearview

Rear new of instrument

7

Reference

Reference

Instrument Preset Conditions

Table 7-1. Instrument Conditions (1 of 2)

Item	Settings after Preset Key Pressed	Settings after Power Turned On
Display mode	single wavelength	last state[a]
Wavelength range limiting	on	last state
Measurement acquisition	continuous	last state
Wavelength calibration	vacuum	last state
Elevation correction value	not affected	last state
Wavelength units	nm	last state
Amplitude units	dBm	last state
Power offset	0 dB	last state
Peak threshold	10 dB	last state
Peak excursion	15 dB	last state
Measurement speed	normal	last state
Drift measurements	off	off
Delta Measurements:		
Δ power	off	off
Δ wavelength	off	off
Signal-to-Noise Measurements		
measurement	off	off
user frequency	193.4144 THz	last state
user wavelength	1550 nm in vacuum	last state

Table 7-1. Instrument Conditions (2 of 2)

Item	Settings after Preset Key Pressed	Settings after Power Turned On
HP-IB address	not affected	last state
Power-bar display	on	last state

a. The term "last state" refers to the last setting that this parameter was in before the instrument power was turned off.

Menu Maps

This section provides menu maps for the HP 86120A softkeys. The maps show which softkeys are displayed after pressing a front-panel key; they show the relationship between softkeys. The softkeys in these maps are aligned vertically instead of horizontally as on the actual display. This was done to conserve space and to make the maps easier to interpret.

Appl's Menu

Appl's

S/N
DRIFT
COH LEN

RETURN

PEAK
WL REF
EXIT

AUTO
USER
USER WL

RETURN

CANCEL
RETURN

MAX-MIN
RESET
EXIT

EXIT

mappls

Display Avg WL Menu

There is no menu associated with this key.

Measurement Cont Menu

There is no menu associated with this key.

Display List by Power Menu

List by
Power

↑
↓
PEAK

SELECT
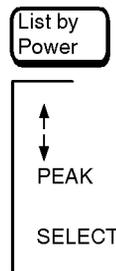
mlistpwr

Display List by WL Menu


```
List by
WL
  ↕
PEAK

SELECT
```

mlistwl

Delta On Menu


```
On

Δ WL ─────────►      ↕
Δ PWR ────────►
Δ WL/PWR ─────►   SELECT
                  RESET
RETURN            EXIT
```

mon

Delta Off Menu

```
┌─────────┐
│ Off     │
└─────────┘
     │
     ▲
     ▼
   PEAK

   SELECT
```
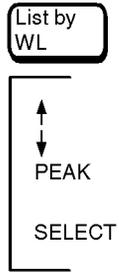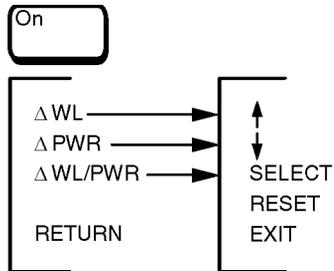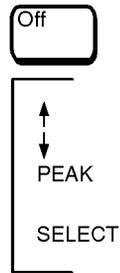
moff

Display Peak WL and System Preset Menus

```
┌─────────┐
│ Preset  │
└─────────┘

┌─────────┐
│ Peak WL │
└─────────┘
     │
   PREV WL
   NEXT WL
   PEAK
   PREV PK
   NEXT PK
```

mpreset

Measurement Single Menu

There is no menu associated with this key.

System Print Menu

```
┌─────────┐
│ Print   │
└─────────┘
    │
   CONT
    │
    │
  ABORT
    │
```

mprint

System Setup Menu
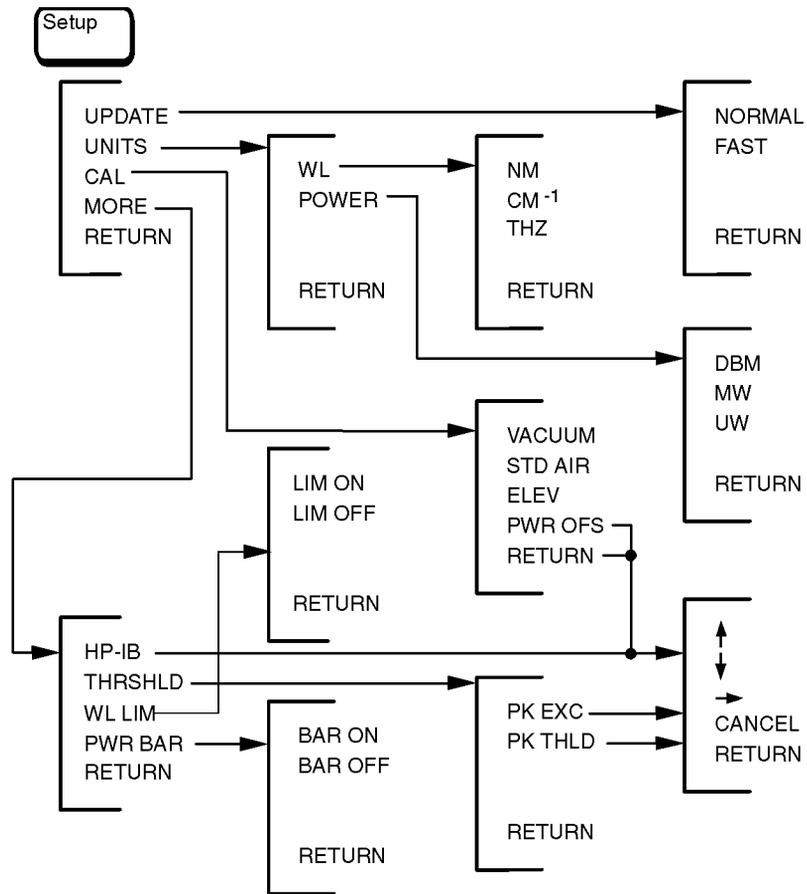
msetup

Error Messages

In this section, you'll find all the error messages that the HP 86120A can display on its screen. lists all instrument-specific errors. lists general SCPI errors.

Table 7-2. Instrument Specific Error Messages (1 of 3)

Error Number	Error Message
1	BAD CHECKSUM FROM MOTOR
2	MOTOR COMMUNICATION PROBLEM
3	MOTOR NOT MOVING
4	MOTOR INDEX PULSE NOT FOUND
5	MOTOR CHIP SET INIT FAILED
6	MOTOR COMMUTATION FAILURE
7	MOTOR NOT SETTLED
8	MOTOR DID NOT STOP
9	MOTOR MOTION ERROR
10	MOTOR POSITION LIMIT FAILED
11	MOTOR POSITION WRAP FAILED
12	POWER LEVEL TOO HIGH
13	DATA DOWNLOAD PROBLEM
14	DATA ACQUISITION PROBLEM
15	MAX NUMBER OF SIGNALS FOUND
16	MOTOR INTERRUPT RECEIVED

Table 7-2. Instrument Specific Error Messages (2 of 3)

Error Number	Error Message
17	ROM BYTE UNERASED
18	ROM WRITE OPERATION FAILED
19	ROM DEFECTIVE
20	ROM DATA INVALID
21	ROM VERSION INCOMPATIBLE
22	ROM POLLING LIMITED OUT
23	INPUT OUT OF RANGE
24	BAD CAL ROM DATA
25	BAD CAL ROM DATA
26	BAD CAL ROM DATA
27	BAD CAL ROM DATA
28	BAD CAL ROM DATA
29	BAD CAL ROM DATA
30	NVSRAM WRITE OPERATION FAILED
31	SOFTWARE INITIALIZATION FAIL
32	HARDWARE INITIALIZATION FAIL
33	INITIALIZATION TIMEOUT
34	BATTERY FAILED
36	TOO MANY ERRORS
37	FUNCTION NOT YET IMPLEMENTED
38	PRINTER OFF LINE
39	PRINTER OUT OF PAPER
40	PRINTER ERROR DETECTED

Table 7-2. Instrument Specific Error Messages (3 of 3)

Error Number	Error Message
41	PRINTER TIMED OUT
42	PRINTOUT WAS ABORTED
43	NOT ALLOWED IN COH LEN
44	NOT ALLOWED IN S/N
45	UNKNOWN KEYPRESS
46	NUM LINES < NUM REFS
47	NUM LINES > NUM REFS
48	NO REFERENCE SIGNAL
49	UNKNOWN ERROR

Table 7-3. General SCPI Error Messages (1 of 3)

Error Number	Desription
+0	"No errors"
−100	"Command error (unknown command)"
−101	"Invalid character"
−102	"Syntax error"
−103	"Invalid separator"
−104	"Data type error"
−105	"GET not allowed"
−108	"Parameter not allowed"
−109	"Missing parameter"
−112	"Program mnemonic too long"
−113	"Undefined header"
−120	"Numeric data error"
−121	"Invalid character in number"
−123	"Exponent too large"
−124	"Too many digits"
−128	"Numeric data not allowed"
−131	"Invalid suffix"
−134	"Suffix too long"
−138	"Suffix not allowed"
−141	"Invalid character data"
−148	"Character data not allowed"
−150	"String data error"
−151	"Invalid string data"

Table 7-3. General SCPI Error Messages (2 of 3)

Error Number	Desription
−158	"String data not allowed"
−161	"Invalid block data"
−168	"Block data not allowed"
−170	"Expression error"
−171	"Invalid expression"
−178	"Expression data not allowed"
−200	"Execution error"
−211	"Trigger ignored" Caused by sending the *TRG command when the instrument is already taking a measurement or when the instrument is in continuous measurement mode.
−213	"Init ignored" Caused by sending an INIT:IMM, READ, or MEASure command while a measurement is already in progress or while the instrument is in continuous measurement mode.
−221	"Settings conflict" Caused by trying to set the instrument to a state that is not allowed. For example, turning on drift maximum and drift minimum state simultaneously or turning on SNR state while drift or delta state is on.
−222	"Data out of range"
−223	"Too much data"
−224	"Illegal parameter value"
− 230	"Data corrupt or stale" Caused by trying to query measurement data immediately after a *RST command. For example, sending *RST; FETCh or sending *RST; :CALC2:DATA? pow.
−232	"Data questionable" Caused by sending a resolution value in one of the measurement functions that is outside the intrument's range.
−273	"Illegal macro label"

Table 7-3. General SCPI Error Messages (3 of 3)

Error Number	Desription
–310	"System error"
–321	"Out of memory"
–350	"Too many errors"
–400	"Query error"
–410	"Query INTERRUPTED"
–420	"Query UNTERMINATED"
–430	"Query DEADLOCKED"
–440	"Query UNTERMINATED after indef resp" Query was unterminated after an indefinite response.

Front-Panel Fiber-Optic Adapters

The FC/PC adapter is the standard adapter supplied with the instrument.
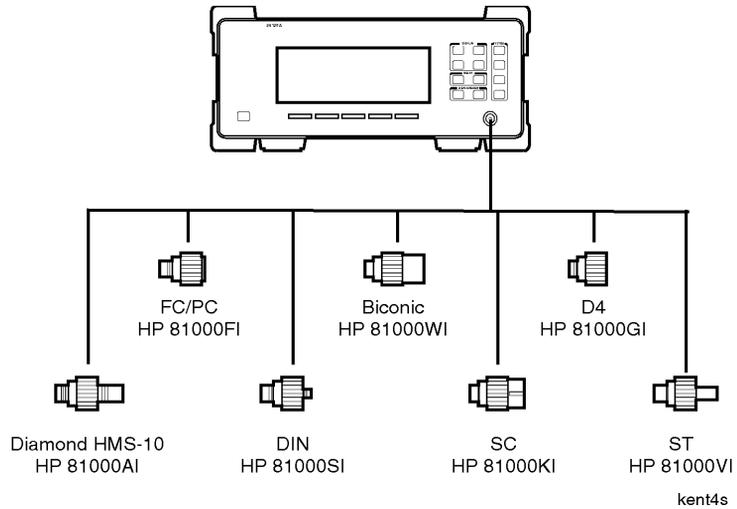
AC Line-Power Cords

PLUG TYPE **	CABLE HP PART NUMBER	PLUG DESCRIPTION	CABLE LENGTH CM (INCHES)	CABLE COLOR	FOR USE IN COUNTRY
250V E L N	8120-1351 8120-1703	Straight* BS1363A 90□	229 (90) 229 (90)	Mint Gray Mint Gray	Great Britain, Cyprus, Nigeria, Singapore, Zimbabwe
250V E L N	8120-1369 8120-0696	Straight* NZSS198/ ASC112 90□	201 (79) 221 (87)	Gray Gray	Argentina, Australia, New Zealand, Mainland China
250V E N L	8120-1689 8120-1692	Straight* CEE7-Y11 90□	201 (79) 201 (79)	Mint Gray Mint Gray	East and West Europe, Central African Republic, United Arab Republic (unpolarized in many nations)
125V E N L	8120-1348 8120-1538	Straight* NEMA5-15P 90□	203 (80) 203 (80)	Black Black	United States, Canada, Japan (100V or 200V), Brazil, Colombia, Mexico, Philippines, Saudia Arabia, Taiwan
	8120-1378 8120-4753 8120-1521 8120-4754	Straight* NEMA5-15P Straight 90□ 90□	203 (80) 230 (90) 203 (80) 230 (90)	Jade Gray Jade Gray Jade Gray Jade Gray	
250V E N L	8120-5182 8120-5181	Straight* NEMA5-15P 90□	200 (78) 200 (78)	Jade Gray Jade Gray Jade Gray Jade Gray	Israel
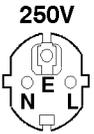
* Part number for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable, including plug.
** E = Earth Ground: L = Line: N = Neutral.

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Index

Index

Index

Index

Index

Index

Index

Index