User's Guide

HP 8167A/8D/8E/8F
Tunable Laser Source

SERIAL NUMBERS

This guide applies to the 8167A, 8168D, 8168E and 8168F tunable laser sources.

HEWLETT PACKARD

Notices

Subject Matter

The information in this document is subject to change without notice.

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Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Printing History

New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide between editions. The date on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your Hewlett-Packard representative.

Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year (8167A and 8168D) or three years (8168E and 8168F) from date of shipment. During the warranty period, HP will, at its option, either repair or replace products that prove to be defective.

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

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, 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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Certification

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.

Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, NIST (formerly the United States National Bureau of Standards, NBS) to the extent allowed by the Institutes's calibration facility, and to the calibration facilities of other International Standards Organization members.

ISO 9001 Certification

Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

General This is a Safety Class 1 instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

Operation - Before applying power Comply with the installation section. Additionally, the following shall be observed:

- Do not remove instrument covers when operating.
- Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.
- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.
- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Be aware that energy at many points may, if contacted, result in personal injury.
- Any adjustments, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when unavoidable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an enviroment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Be aware that capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Safety Symbols

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Caution, risk of electric shock.

Frame or chassis terminal.

Protective conductor terminal.

Hazardous laser radiation.

Warning

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, 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.

Caution

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

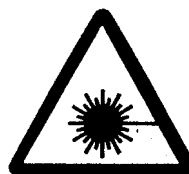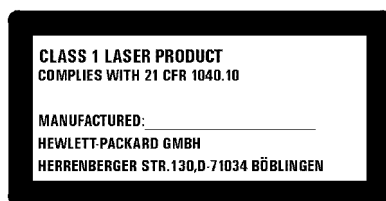# Initial Safety Information for the Tunable Laser Source

The Specifications for these instruments are as follows:

	HP 8167A	HP 8168D	HP 8168E	HP 8168F
Laser Type	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP
Laser Class				
According to 21 CFR 1040.10 (USA)	1	1	1	IIIb
According to IEC 825-1 (Non-USA) EN 60825-1 Europe	3A	3A	3A	3A
Permissible Output Power (CW)	<1.6mW	<1.6mW	<1.6mW	<9.9mW
Beam Diameter	9μm	9μm	9μm	9μm
Numerical Aperture	0.1	0.1	0.1	0.1
Wavelength	1280-1330nm	1490-1565nm	1475-1575nm	1450-1590nm

Note   **USA**

CLASS 1 LASER PRODUCT
COMPLIES WITH 21 CFR 1040.10

MANUFACTURED:
HEWLETT-PACKARD GMBH
HERRENBERGER STR.130,D-71034 BÖBLINGEN

The laser safety warning labels are fixed on the instrument (except the 8168F, see label below).

DANGER

INVISIBLE LASER RADIATION
AVOID DIRECT EXPOSURE TO BEAM

MAX. OUTPUT POWER: 3.3 mW, CW
WAVELENGTH RANGE: 1400 nm to 1620 nm
CLASS IIIb LASER PRODUCT
COMPLIES WITH 21 CFR 1040.10

HEWLETT-PACKARD GMBH
HERRENBERGER STR. 130
D-71034 BÖBLINGEN

MANUFACTURED: _____ JAN 1996

AVOID EXPOSURE
Laser radiation
is emitted
from this aperture

Class IIIb stickers, required for 8168F in USA only

Caution

The use of optical instruments with this product will increase eye hazard.

Note

Non-USA

LASER RADIATION
DO NOT STARE INTO BEAM OR VIEW
DIRECTLY WITH OPTICAL INSTRUMENTS
CLASS 3A LASER PRODUCT
(IEC 825-1:1993; EN 60825-1:1994)

A sheet of laser safety warning labels are included with the instrument. You *MUST* stick the labels in the local language onto the outside of the instrument, in a position where they are clearly visible to anyone using the instrument.

You *MUST* return instruments with malfunctioning laser boxes to an HP Service Center for repair and calibration.

The instrument has built in safety circuitry that will disable the optical output in the case of a fault condition.

Warning	Use of controls or adjustments or performance of procedures other than those specified for the laser source may result in hazardous radiation exposure.

Warning	Refer Servicing only to qualified and authorized personnel.

Warning	Do not enable the laser when there is no fiber attached to the optical output connector.
	The optical output connector is at the bottom right of the instrument front panel.
	The laser is enabled by pressing the gray button beside the optical output connector on the front panel. The laser is enabled when the green LED on the front panel of the instrument is lit.

Warning	Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.
	The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

Sicherheitsinformation für Laser Quellen

Die Spezifikationen für die Geräte sind wie folgt:

	HP 8167A	HP 8168D	HP 8168E	HP8168F
Laser Typ	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP
Laser Klasse Gemäß IEC 825-1 (EN60825-1 Europa)	3A	3A	3A	3A
Zulässige Ausgangsleistung	<1.6mW	<1.6mW	<1.6mW	<9.9mW
Strahldurchmesser	9μm	9μm	9μm	9μm
Numerische Apertur	0.1	0.1	0.1	0.1
Wellenlänge	1280-1330nm	1490-1565nm	1470-1575nm	1450-1590nm

Hinweis

LASERSTRAHLUNG
NICHT IN DEN STRAHL BLICKEN
AUCH NICHT MIT OPTISCHEN INSTRUMENTEN
LASERKLASSE 3A
(IEC 825-1:1993; EN 60825-1:1994)

Ein Blatt mit Laser Warnaufklebern ist jedem Gerät beigefügt. Die Aufkleber müssen in der Landessprache, für den Anwender gut sichtbar, an der Außenseite des Gerätes angebracht werden.

Geräte mit defekten Laser müssen zur Reparatur oder zur Kalibration an ein HP Service Büro geschickt werden.

Das Gerät hat eine eingebaute Sicherheitsschaltung, die den Laserausgang im Falle einer Störung abschaltet.

Warnung   **Bedienung, Abgleicharbeiten oder die Durchführung von Tests, die nicht im Handbuch angegeben sind, können zum Austritt gefährlicher Strahlung führen.**

Warnung	Reparaturarbeiten dürfen nur von qualifiziertem und bevollmächtigtem Personal durchgeführt werden.

Warnung	Laser nicht ohne angeschlossenes Glasfaserkabel einschalten.
	Der optische Ausgang befindet sich am unteren rechten Teil der Frontplatte. Mit dem danebenliegenden grauen Druckschalter wird der Laser ein- bzw. ausgeschaltet. Bei eingeschaltetem Laser leuchtet eine grüne LED an der Frontplatte des Einschubes.

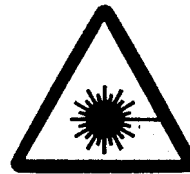| Warnung	Wenn der Laser eingeschaltet ist, darf unter keinen Umständen in das Ende des optischen Kabels oder in den Laserausgang am Gerät geschaut werden.
	Der Laserstrahl ist für das menschliche Auge unsichtbar, kann aber das Sehvermögen ernsthaft verletzen.

Informations et Consignes de Sécurité Relatives à l'Utilisation des Lasers.

Les Spécifications de l'appareil sont les Suivantes:

	HP 8167A	HP 8168D	HP 8168E	HP8168F
Type du Laser	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP	Fabry Perot-Laser InGaAsP
Classe du Laser				
Conforme au IEC 825-1 (EN 60825-1 Europe)	3A	3A	3A	3A
Permit Puissance de Sortie	<1.6mW	<1.6mW	<1.6mW	<9.9mW
Diamètre du Faisceau	9μm	9μm	9μm	9μm
Ouverture Numérique	0.1	0.1	0.1	0.1
Longueur d'Onde	1280-1330nm	1490-1565nm	1475-1575nm	1450-1590nm

Remarque

RAYONNEMENT LASER
NE PAS REGARDER FIXMENT LE RAYON
NI LE REGARDER DIRECTEMENT
AVEC DES APPAREILS OPTIQUES
(IEC 825-1:1993; EN 60825-1:1994)

Les étiquettes de sécurité sont incluses dans l'appareil. Il est obligatoire de coller une étiquette en langage local à l'éxterieur de l'appareil de telle sorte qu'elle soit parfaitement visible par l'utilisateur.

Il est recommandé de fixer l'étiquette de sécurité sur la partie infèrieure gauche de la face avant de l'appereil.

En cas de mauvais fonctionnement du laser, celui doit être renvoyé imperativement accompagné de l'appareil dans un centre de maintenance Hewlett-Packard ou agréé Hewlett-Packard pour réparation et calibration.

L'appareil comporte un système de sécurité mettant hors service la sortie optique en cas de mauvais fonctionnement du laser.

Attention	**L'utilisation du laser en dehors de ses limites de performances et des procédures définies par HP peut conduire à une exposition aux radiations dangereuse pour l'utilisateur.**

Attention	**Seul le personnel autorisé par HP est qualifié pour intervenir sur le laser.**

Attention	**Ne pas mettre le laser sous tension sans s'être assuré qu'une fibre optique est bien fixée sur le connecteur.**
	Le connecteur de sortie optique est situé au bas de la face avant de l'appareil.
	La mise en service du laser s'effectue par la pression du bouton gris situé à coté de la sortie optique au bas de la face avant de l'appareil. L'illumination de la LED verte indique que le laser est en activité.

Attention	**Ne tentez en aucun cas de regarder l'extrémité de la fibre optique attachée au connecteur lorsque le laser est en activité.**
	Bien que la lumière émise par le laser ne soit pas visible elle peut cependant être dangereuse pour la vue.

Introduction

This guide is arranged into four categories:

- Getting Started
  This section gives an introduction to the instrument, and aims to make the instrument familiar to you: Chapter 1.

- Local Control
  This is the information on how to control the instrument from the front panel: Chapters 2 and 3.

- Remote Control
  This is the information on how to control the instrument over the HP-IB. This is made of general information for using the HP-IB, a command reference, and some programming examples.: Chapters 4, 5, and 6.

- Additional Information
  This is supporting information of a non-operational nature. This contains installation information, accessories, specifications, function tests, cleaning procedures, and error codes: Appendices A through G.

Attenuator Some information in this manual applies only to the tunable laser source with the built in optical attenuator (option 003). This paragraph is marked the way that all the passages which only apply to the attenuator option are marked in this manual.

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Getting Started

This chapter gives you basic information on how you can operate the tunable laser source from the front panel.

What is a Tunable Laser Source?

A tunable laser source is a laser source for which the wavelength is not fixed. The Hewlett-Packard tunable laser sources also allow you to set the output power, and to choose between continuous wave or modulated output power.

Note   The single greatest factor affecting the performance of the tunable laser source, as with all fiber optic measurements, is the cleanliness of the connectors. Ensure that your connectors are always clean. For cleaning instructions, see Appendix E.

1

A description of the Front Panel

Figure 1-1. The Tunable Laser Source Front Panel

A softkey is a key whose function changes depending on the keys that you have pressed before. The function of a softkey is shown on the display above the softkey.

The memory card drive allows you to load replacement, or additional, software to increase the capabilities of your tunable laser source.

There are six function keys. These allow you

■ to set the wavelength, or to perform a wavelength sweep.

■ to set the output power,

■ to save the wavelength and output power setting,

■ to check or change the system configuration: to test the instrument, to switch off the laser and display, to change the HP-IB Address, to select whether the internal modulation signal is available at the Modulation Output constantly, or only when the power is being output, or to get information about the instrument and the software revision,

■ to get help information (see "Getting Help" in the next section of this chapter), or

■ to perform an auxiliary application such as examine the power characteristic, or to set the instrument for maximum power output.

The numeric keypad, the cursor keys, and the modify knob are used to edit parameters.

The modulation output gives a TTL level signal of the same frequency as the internal modulating signal.

The modulation input allows you to input a signal to modulate the power of the optical output.

The analog output gives a dc-signal proportional to the output power. The relationship between this voltage level and the output power is not calibrated, but is approximately 1mV for each 1μW.

At the back of the 8168F, you also have a Remote Interlock Connector. This is to protect the user from injury. If the short-circuit at this BNC connector is opened, the laser is switched off immediately and cannot be switched on until it is closed again.

Starting the 8168F

When you turn on the 8168F, the instrument is locked. This is to prevent unauthorized persons from using this Laser Safety Class IIIb instrument. The Starting screen for the 8168F is shown below:

```
                    [ Secure ]
         Instrument is locked.



  Unlock
```

Figure 1-2. Starting Screen for the 8168F

If you have not set a new password, you also see the message:
`default pwd: 8168, please change it!`. This message appears in the "Secure" screen until you set a new password (see "Secure" in Chapter 3).

To unlock the instrument, press `Unlock`. You see the following screen:

```
          [ Secure: Unlock Instrument ]
      Enter password to unlock:     ----



                                            Cancel
```

Figure 1-3. "Secure: Unlock Instrument" Screen

Enter the 4-figure password using the DATA keys. The default password is 8168,
although you can change this from the AUX menu (see "Secure" in Chapter 3).

When you enter the correct password, the instrument is unlocked, and you see
the following screen:

```
                   [ Secure ]
         Instrument is unlocked.



    Lock            ChngPwd            Exit
```

Figure 1-4. "Secure" Screen

Press `Exit`, or any of the function keys, to view the main screen.

Getting Help

Press (HELP) to get help.

When you press this key, the first help screen is displayed, this is either the last
screen that was used, or the screen with the limit values for the parameters.

Figure 1-5. A Summary of the Help Hard- and Softkeys

Press `Search` to get the help topics menu.

Figure 1-6. The Help Topics Menu

Choose a topic using ↑ and ↓, or the Modify Knob. Press `Select`, or (ENTER) to get the information.

Press `Close` to close the help topics menu without selecting a topic.

Many of the help texts are longer than one screen. You move between screens of information using ↑ and ↓.

Changing the Value of a Parameter

What follows is a description of the various methods of changing the value of parameters on the tunable laser source. Examples in which actual parameter values are changed are given with the parameter descriptions.

1

Making Big Changes to a Parameter

If you are changing the value of a parameter completely, you can directly type in the value on the keypad, and press (ENTER).

Example   To change the output power from 200μW to 1025μW.

1. Press (OUTPUT POWER). The cursor moves to P on the right hand side of the display.

$$\lambda: 1540.000\text{nm} \qquad \underline{P}: \quad 200\mu\text{W}$$

2. Type the new value for the output power on the numeric keypad.

$$\lambda: 1540.000\text{nm} \qquad P: 1025\underline{\mu}\text{W}$$

3. Press (ENTER) to end the editing.

Making a Small Change to a Parameter

For small changes to a parameter use (EDIT), or the Modify Knob.

Select the parameter and then:

1. Press (EDIT), (⇐). (⇒), or turn the Modify Knob slightly. If you start with Modify Knob the cursor moves to the digit that was most recently changed. If no digit was changed before, or if you started with another key, the cursor moves to the position of the most significant digit of the parameter.

2. If you want to move the cursor and select another digit to edit, use (⇐) and (⇒).

3. Enter the new value for the digit at the cursor on the keypad, or by turning the Modify Knob. If you have entered the value from the keypad, the cursor moves to the next digit.

4. Repeat steps 2 and 3 to continue editing the value.

5. When you have finished editing the value, press (ENTER). The edited value becomes the new value of the parameter.

Example   To change the wavelength from 1540.000nm to 1542.500nm.

1. Press (WAVELENGTH). The cursor moves to λ on the left hand side of the display.

$$\underline{\lambda}:1540.000nm \qquad P: 200\mu W$$

2. Press (EDIT). The cursor moves to the most significant digit of the wavelength value.

$$\lambda:\underline{1}540.000nm \qquad P: 200\mu W$$

3. Press (⇒) three times to move to the cursor to the units digit. Press (2) on the numeric keypad. The units digit changes, and the cursor moves to the next digit.

$$\lambda:1542.\underline{0}00nm \qquad P: 200\mu W$$

4. Press (5) on the numeric keypad, to change the tenths digit. Press (ENTER) to end the editing.

$$\underline{\lambda}:1542.500nm \qquad P: 200\mu W$$

Setting a Parameter to its Default Value

There is a default softkey that you can use to set a parameter to its default value.

1. Press (EDIT).

2. Press `Default`.

If You Make a Mistake

If you make a mistake while you are editing a parameter, you can cancel the editing, and get the previous value for the parameter back by pressing `Cancel`.

Alternatively, you can press `Clear` and type in the parameter again.

1

If the Parameter Will Not Change

If, when you press (ENTER) after editing, the tunable laser source returns immediately to the previous value for the parameter, then the value you tried to enter is outside the calibrated range. Press (HELP), and select the Input Limits help topic to see the calibrated range.

A Sample Session

There are two short tasks in this sample session. The first is to measure the power of a modulated signal at a single wavelength, and then a wavelength characteristic at a fixed power.

The sample session is written for an HP 8168E/F Tunable Laser Source, and an HP 8153A Lightwave Multimeter with an HP 81532A Power Sensor (It is assumed that the power sensor is inserted in channel A). To perform the sample session as described here, you also need a connector interface for the multimeter (for example, an HP 81000AI), and a patchcord (if you are using the HP 81000AI, then a Diamond HMS-10/HP/HRL to Diamond HMS-10/HP patchcord, HP 81109AC).

These same procedures are repeated in "Example 3 - Measuring the Power of a Modulated Signal" in Chapter 6 and "Example 4 - Measuring a Wavelength Characteristic" in Chapter 6, where they are performed using the HP-IB.

Measuring the Power of a Modulated Signal

We want to measure the power of a 1540nm signal, modulated by a 100kHz square wave, at 500μW.

1. Make sure that all your connectors and connector interfaces are clean.

2. Make sure that the Optical Output on the laser source is not Active.

3. Connect the output of the laser source to the input of the power sensor (as shown in the figure below). Make sure that the connector with the orange strain-relief sleeve is connected to the tunable laser source (the orange sleeve indicates an angled connector).

Figure 1-7. Connecting the Instruments for the Sample Session

Typically, you would connect a component to test between the tunable laser source and the power meter.

4. Make sure that both instruments are powered up.

Note	Normally you also need to be sure that the instruments are properly warmed up before using the source, or making any measurements. Here, because the measurements are not critical, it is okay to proceed immediately to the next step.

Setting the Wavelength

5. On the tunable laser source:

   a. Press (WAVELENGTH).

   b. Make sure that you are setting the wavelength directly.
      (Press nm/GHz if necessary until there is only one parameter (λ) shown on the left side of the display).

   c. Press (EDIT) and then Default to set the wavelength to 1540.000nm.

6. On the multimeter set the wavelength for the power sensor to 1540.0nm, set the measurement averaging time to 1s
   ((Chan)→A; (Mode)→MEAS; (Param)→λ→1540.0nm; (Param)→T→1s).

Setting the Modulated Power

7. On the tunable laser source:

a. Press `OUTPUT POWER`.

b. Make sure that you have a modulated signal selected
   (Press `Mod/CW` if necessary until there are two parameters (`POWER` and
   `FREQ`) shown on the right side of the display).

c. Make sure that `POWER` is selected
   (the label of the selected parameter is displayed in inverse, press `Power`
   if it is not selected).

d. Make sure that the power is being shown in μWatts
   (if necessary, press `W/dBm` to change the units).

e. Type 500 on the keypad and press `ENTER`.

8. On the multimeter, make sure that Watts are selected and that the
   instrument is autoranging
   (`dBm/W`$\rightarrow$W; `Auto`$\rightarrow$`AUTO`).

9. On the tunable laser source:

a. Press `Freq`.

b. Type in 100 on the keypad.

c. Make sure that the units are set to kHz
   (If necessary, press `Hz/kHz` to change the units).

d. Press `ENTER`.

```
 ┌──────────────────────────────────────────┐
 │                      POWER :    500 uW    │
 │  λ:1540.000nm FREQ    :   100 kHz         │
 │                                           │
 └──────────────────────────────────────────┘
 ┌────────┐┌────────┐┌────────┐┌────────┐┌────────┐
 │        ││        ││λ-sweep ││ Power  ││ Mod/CW │
 └────────┘└────────┘└────────┘└────────┘└────────┘
```

Figure 1-8.
Tunable Laser Source Display after Setting Up Wavelength and Power

10. Press the button beside the Optical Output, the green LED should be lit to
    indicate that the laser is now active.

You should notice that the power reading on the multimeter is approximately half the value set on the laser source. This is because the output is modulated by a square wave with a 50% duty cycle.

Measuring a Wavelength Characteristic

For the second part, we assume that the instruments are in the state given after the first task (see Figure 1-8).

We now want to measure the wavelength characteristic by measuring the power at 1nm steps between 1535nm and 1545nm, at the highest power level possible that is available over the full sweep range.

11. On the laser source, press `Mod/CW` to return the laser source to CW operation.

Setting Up the Wavelength Sweep

12. On the laser source:

   a. Press `WAVELENGTH`,and then `λ-Sweep` .

   b. Type in 1535 on the keypad and press `ENTER` to set the start wavelength for the sweep.

   c. Type in 1545 on the keypad and press `ENTER` to set the stop wavelength for the sweep.

   d. Type in 1 on the keypad and press `ENTER` to set the size of the wavelength step for the sweep.

start   1535.000 nm
stop   1545.000 nm
step   1.000 nm   P: 500 μW

↑   ↓   Pmax→P   Manual   Auto

Figure 1-9.
Tunable Laser Source Display during Setting Up for the Wavelength Sweep

e. Press ↓ to skip over the dwell parameter.

f. Type in 1 on the keypad and press (ENTER) to set the number of times that the sweep is to be performed.

13. On the laser source, press `Pmax→P` to set the output power to the highest value that can be maintained for the full sweep range.

14. On the power meter:

a. Set λ to 1535nm
((Param)→λ→1535.0nm).

b. Make sure that the parameter cursor is in the units position (that is, at the second "5").

Performing the Wavelength Characteristic Measurement

15. Make sure that the laser source is still active.

16. On the laser source, press `Manual`.

17. Read the value for the power at 1535nm on the multimeter.

18. Repeat the following steps at each wavelength in the sweep range

a. On the laser source, press `Next`.

b. On the multimeter, increment λ (press (⬆)).

c. Read the value for the power at the wavelength on the multimeter.

19. On the laser source, press `Stop` to end the sweep.

This procedure can be used in practice to measure the wavelength characteristic of a component.

2

Setting Wavelength and Power

This chapter describes how to set the wavelength and the power of the output.

A Summary of the Wavelength and Output Power Hard- and Softkeys

Figure 2-1.
A Summary of the additional Output Power Softkeys for the
Attenuator Option

Setting the Wavelength

There are three ways to set the wavelength of the tunable laser source.

- You can set the wavelength (λ) directly,

- You can set the wavelength from a base wavelength and an offset in the frequency domain, or

- You can set a range of wavelengths for the instrument to "sweep"

  Press (WAVELENGTH) to select the wavelength parameter.

  Use nm/GHz to select how you set the wavelength.

  Use λ-Sweep to perform a wavelength sweep.

Setting the Wavelength Directly

You can set the wavelength directly if the display looks like this:

λ:1540.000nm   P: 200 µW

| nm/GHz | | λ–sweep | | |

Figure 2-2. Setting the Wavelength Directly

Press (WAVELENGTH) and nm/GHz as necessary to get this display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

Example   To set the wavelength to 1505.500nm (on an HP 8168E/F)

1. Press (WAVELENGTH)
2. Press nm/GHz , if necessary, until the display looks as shown in Figure 2-2
3. Type in 1505.5 on the numeric keypad, and press (ENTER).

Setting a Relative Wavelength

You use a relative wavelength for heterodyning, for example, when you are measuring the linewidth of DFB (distributed feedback) lasers.

You can set a relative wavelength if the display looks like this:

Figure 2-3. Setting a Relative Wavelength

Press (WAVELENGTH) and nm/GHz as necessary to get to this display.

The output wavelength (λ) is set from the base wavelength (λ_0) and the frequency offset (df). The formula for calculating the output wavelength is:

$$\lambda = \frac{c}{(\lambda_0)df + c}\lambda_0$$

where c is the speed of light in a vacuum ($2.998 \times 10^8 ms^{-1}$).

You can edit only the value of *df* directly. See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

Changing the Base Wavelength

If you want to change λ_0,

1. set λ to the value to which you want to set the base wavelength (by calculating *df*, or by setting the wavelength directly) and then

2. press $\lambda \rightarrow \lambda_0$.

Example Set the base wavelength to 1540.000nm, and then set df, so that the output wavelength is 1507.5nm (on an HP 8168E/F)

1. Press (WAVELENGTH).
2. Press nm/GHz until the screen looks as shown in Figure 2-2 (that is, to set the wavelength *directly*).
3. Press (EDIT) and then Default .
4. Press nm/GHz , to set a relative wavelength.
5. Press $\lambda \rightarrow \lambda_0$

The base wavelength is now set.

6. Calculate the value for df

$$df = \frac{c}{\lambda} - \frac{c}{\lambda_0} = \frac{2.998E8}{1507.500E-9} - \frac{2.998E8}{1540.000E-9} = 4196.980GHz$$

7. Type in the value for df (4197.0) on the numeric keypad, and press (ENTER).
8. Because of inaccuracies in the value taken for the speed of light, this gives a λ value of 1507.499nm. Use the Modify Knob to edit the value for df to get $\lambda = 1507.5$nm

Performing a Wavelength Sweep

You can perform a wavelength sweep when the screen looks like this

Figure 2-4. Setting Up for a Wavelength Sweep

Press (WAVELENGTH) and λ-Sweep as necessary to get this display.

Setting the Wavelength Sweep

There are five parameters for the wavelength sweep,

- `start`, the wavelength with which the sweep begins,

- `stop`, the wavelength at which the sweep ends,

- `step`, the size of the change in wavelength for each step,

- `dwell`, the amount of time spent at the wavelength during each step, and

- `cycles`, the number of times the sweep is repeated.

Figure 2-5. The Parameters for a Wavelength Sweep

You move from one parameter to the next, using ↑ and ↓, the Modify Knob, or (ENTER). Only three of the parameters can be displayed at a time, you scroll the other parameters onto the display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

Setting the Maximum Power for the Sweep Range

`Pmax→P` sets the power to the maximum for the selected sweep range. Alternatively, you can set a power level in the way described in "Setting the Power".

| Note | If coherence control is enabled, and the uncal power level cannot be exceeded for the full wavelength range chosen, the wavelength range is reduced as necessary. |

Executing an Automatic Sweep

You can perform an automatic sweep if you press `Auto` after setting up the sweep parameters, or if you press `Cont` during a manual sweep.

Press `Pause` to interrupt the sweep. The instrument switches to a manual sweep (see "Performing a Manual Sweep").

Press `Stop` to end the sweep.

Example

Set the instrument to sweep the range 1495nm to 1555nm, three times, in 1nm steps, stopping for half a second at each wavelength, at the highest power level available at all wavelengths.

1. Press (WAVELENGTH) and then `λ-Sweep`.
2. Make sure you are at the `start` parameter.
3. Type in 1495 and then (ENTER), to set the start wavelength.
4. Type in 1555 and then (ENTER), to set the stop wavelength.
5. Type in 1 and then (ENTER), to set the step size.
6. Type in 0.5 and then (ENTER), to set the dwell time.
7. Type in 3 and then (ENTER), to set the number of cycles.
8. Press `Pmax→P`, to set the power.
9. Enable the optical output, if necessary.
10. Press `Auto`, to run the application.

Performing a Manual Sweep

You can perform a manual sweep if you press `Manual` after setting up the sweep parameters, or if you press `Pause` during an automatic sweep. During a manual sweep the display looks as follows:

λ:1547.000nm   P: 200 μW
SWEEP: MANUAL

| Prev | Next | | Cont | Stop |

Figure 2-6. Performing a Manual Sweep

Press `Next` to move on to the next wavelength step.

Press `Prev` to move back to the previous wavelength step.

Press `Cont` to continue with an automatic sweep, from the current wavelength.

Press `Stop` to end the sweep.

Setting the Power

The laser output can be either

■ a continuous wave (CW), fixed-amplitude signal,

■ a modulated signal, or

■ a signal with increased linewidth (coherence control).

Attenuator If you have the built in attenuator, there are two power modes for both the fixed-amplitude, the modulated, and the increased linewidth signals. You can either

■ specify the output power (Power Mode), or

■ specify the laser power and the attenuation (Attenuation Mode).

The two modes are separate, the values set in one mode do not affect the values set in the other.

Press (OUTPUT POWER) to select the output power parameter. Use `Mod/CW` to choose CW, modulated, or coherence control.

Attenuator If you have the optional attenuator installed, use `PowMode` to choose between Power Mode (specifying the output power) and Attenuation Mode (specifying the laser power and attenuation).

Setting the Output Power of a CW Signal

You can set the output power of a CW signal if the display looks like this:

λ:1540.000nm   P: 200 µW

| W/dBm | | λ-sweep | | Mod/CW |

Figure 2-7. Setting the Output Power of a CW Signal

Press (OUTPUT POWER), `Mod/CW` and `CW` as necessary to get to this display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

You can change the units by pressing `W/dBm` .

Attenuator	If you have the optional attenuator installed, you may need to press `PowMode` to get the display shown above.

Setting Power and Attenuation

Attenuator	If you have the optional attenuator installed, you can also set the output power by setting first the laser output power, and then setting the amount of attenuation.
	Press `PowMode` from the screen shown in Figure 2-7 to change to the Attenuation Mode.
	Press `Att` to select the attenuation parameter. Press `Pref` to select the laser output power.

What is Excessive Power?

An `EXCESSIVE` message indicates that the value you have set for the output power is larger than the laser diode is capable of producing at this wavelength. The instrument sets the output power as high as possible; it is this actual output power that is shown as part of the `EXCESSIVE` message.

Note	If the chosen value is simultaneously too low for the coherence control, if you are also using this, the `EXCESSIVE` is shortened to `EXC`.

The Analog Output

The Analog Output, on the front panel of the instrument, outputs a dc level that is proportional to the laser output power. The relationship between this voltage level and the output power is not calibrated, but is approximately 1mV for each 1μW.

Attenuator   If you have the optional attenuator installed, the Analog Output signal depends on the power mode you have chosen.

In Power Mode the laser output power, and therefore the Analog Output signal, is not linearly proportional to the output power. This is because the actual output optical power is derived by the optimum combination of the laser output power and the attenuation.

In Attenuation Mode the relationship between the Pref and the voltage level is approximately 1.35mV for each 1μW. (The difference between this value and that of the tunable laser source without the attenuator is due to the insertion loss of the attenuator). This value is only proportional to the output power if the attenuation remains constant. Here, the attenuator adds a constant offset to the voltage level.

Example   To set the power to -10dBm.

1. Press (OUTPUT POWER).
2. Press Mod/CW , and CW if necessary, so that the display looks as shown in Figure 2-7.
3. Press W/dBm , if necessary, so that the power is displayed in dBm.
4. Type -10 on the numeric keypad, and press (ENTER).

Setting a Modulated Signal

There are two ways of modulating the amplitude of the optical output.

■ Using the internal modulation, and

■ using external modulation.

Using the Internal Modulation

The internal modulating source is a square wave with a 50% duty-cycle. You can set both the amplitude and the frequency of this signal. The amplitude is set by the power parameter. This is the maximum output power of the output signal; at the minimum, nothing is output.

Figure 2-8. The Modulated Signal

Setting the Output Power of a Modulated Signal

You can set the output power of a modulated signal if the display looks like this:

Figure 2-9. Setting the Output Power of an Internally Modulated Signal

Press `OUTPUT POWER`, `Mod/CW`, and `Int` as necessary to get to this display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

You can change the units by pressing `W/dBm`.

The notes above about excessive power, and the analog output apply also to the power of a modulated signal.

Setting the Frequency of a Modulated Signal

You can also set the frequency of a modulated signal from the display shown above. Press `Freq` to select the parameter. See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

You can change the units by pressing `Hz/kHz` while you are editing the value. The new units come into effect when you press `ENTER`.

The Modulation Output

The Modulation Output on the front panel outputs a version of the modulating signal that has the same frequency and phase as the modulating signal, but has a fixed, TTL-level amplitude. You can use this to synchronize your external measuring equipment to the tunable laser source.

To allow for your possible sychronization requirements, there are two ways in which the signal can be output. Either the signal is combined with the laser-ready signal, so that the output is kept low when there is no optical signal being output (for example, while the laser is settling after a change of wavelength). Or the modulation signal is output all the time. This is set by the (System) `MODOUT` parameter (see "Setting the Modulation Output" in Chapter 3).

Example   Set the frequency of the modulated output to 300Hz.

1. Press (OUTPUT POWER).
2. Press `Mod/CW`, and `Int` if necessary, so that the display looks as shown in Figure 2-9.
3. Press `Freq`.
4. Type 300 on the numeric keypad.
5. Press `Hz/kHz`, if necessary, to set the units to Hz, and press (ENTER).

Using External Modulation

The external modulating source can be any signal of up to $5V_{pp}$. A $5V_{pp}$ signal causes 15% modulation of the power of the optical output signal.

Figure 2-10. External Modulation and Output Power

Setting the Output Power of a Modulated Signal

You can set the output power of a modulated signal if the display looks like this:

```
                          POWER :  -7.0 dBm
λ:1540.000nm  External Mod.
```
```
| W/dBm |  | λ-sweep |  | Mod/CW |
```

Figure 2-11. Setting the Output Power of an Externally Modulated Signal

Press (OUTPUT POWER), Mod/CW , and Ext as necessary to get to this display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

You can change the units by pressing W/dBm .

The notes above about excessive power, and the analog output apply also to the power of a modulated signal.

The Modulation Input

The Modulation Input on the front panel is where you input your modulating signal.

Using Coherence Control

Enabling the coherence control increases the linewidth of the optical output signal to between 50 and 500MHz (typically). This drastically reduces interference effects and therefore improves the power stability in sensitive test setups.

Setting the Output Power of a Coherence Control Signal

You can set the output power of a coherence controlled signal if the display looks like this:

```
                            POWER :  -7.0 dBm
λ:1540.000nm  Coherence Ctrl
```

```
┌─────────┬──────────┬──────────┬────────┐
│  W/dBm  │          │ λ-sweep  │ Mod/CW │
└─────────┴──────────┴──────────┴────────┘
```

Figure 2-12. Setting the Output Power of a Coherence Controlled Signal

Press (OUTPUT POWER), Mod/CW, and CohCtrl as necessary to get to this display.

See "Changing the Value of a Parameter" in Chapter 1 if you need details on how to edit parameters.

You can change the units by pressing W/dBm.

The notes above about excessive power, and the analog output apply also to the power of a coherence controlled signal.

The Coherence Control Uncal Power

At any particular wavelength, coherence control is only available with the specified linewidth, above a level known as the Coherence Control Uncalibrated Power, and below the Maximum Power level (that is, in the area between the two curves in the diagram). The message CC UNCAL indicates that the laser power is not high enough to provide the specified linewidth. The linewidth is still broadened.

Figure 2-13.
The Coherence Control Uncalibrated Power and the Maximum Power Level

3

Other Functions

This chapter describes how to save and recall measurement settings for the tunable laser source, and how to use the system functions of the instrument.

Storing and Recalling Instrument Settings

The (SETTING) key gives you access to the instrument settings displays. These displays look as follows:

Figure 3-1. User Setting Number 1

There are seven settings:

Attenuator When you have the optional attenuator installed, then the setting also includes the laser output power (Pref), the attenuation (Att), and the power mode (PowMode, or AttMode).

■ the Actual Setting, which is the setting being used by the instrument,

■ the Default Setting, and

■ five user settings.

Note	The Default Setting does *not* contain λ-Sweep information. All other settings contain this information, although it is not shown on the display.

Figure 3-2. Summary of the Setting Hard- and Softkeys

Use `Prev` and `Next` to move between the different setting displays.

Press `Default` to reset the Actual Setting to default values.

Press `Recall` to recall the Default Setting, or the currently displayed user setting for use as the Actual Setting (overwriting the Actual Setting).

Press `Store` to store the Actual Setting to the currently displayed user setting (overwriting the user setting).

Using the System Utilities

Press (SYSTEM) to access configuration information for the tunable laser source. You get the following screen:

```
HPIB#:  24          Time:  11:29

ModOut: Frq&Rdy     Date:  03/01/93
```
```
StandBy | HPIB | ModOut | Info | More
```

Figure 3-3. The System Screen

Figure 3-4. Summary of the System Hard- and Softkeys

There are not enough function keys under the display for all the system functions, therefore they have been divided into two sections. You change from one section to the other by pressing the `More` Softkey.

Switching the Instrument into Stand-By

Increasing the Lifetime of the Display

Normally the display is on at all times. If you want to switch off the display (and the laser), but keep the instrument running (for example, to prevent

display burn-in, but to keep the heat chamber up to temperature), press
StandBy (you may have to press More to get to this softkey).

While the instrument is in standby mode the laser is switched off, and the word
standby is flashed on the screen. Press any key to reactivate the instrument.

Setting the HP-IB Address

Press HPIB to select the parameter for setting the HPIB address (you may have
to press More to get to this softkey).

See "Changing the Value of a Parameter" in Chapter 1 if you need details on
how to edit parameters.

The default HP-IB address is 24.

Setting the Modulation Output

Press MODOUT to toggle the modulation output (you may have to press More to
get to this softkey). The two possible values are

- FRQ&RDY, where the modulation signal is combined with the laser-ready
  signal, so that the output is kept low when there is no optical signal being
  output (for example, while the laser is settling after a change of wavelength),
  and
- FRQ, where the modulation signal is output all the time.

Getting Information about the Instrument

Press Info for information on the firmware revision, serial number and the
date of the last calibration of your instrument (you may have to press More to
get to this softkey).

Setting the Date and Time

Press Date to set the date (you may have to press More to get to this softkey).
You can type in the six numbers for the date directly from the numeric keypad,
or you can use the arrow keys and the numeric keypad to edit the date. The
date is changed when you press the (Enter) key.

The date is in the format month/day/year.

You cannot use the Modify Knob for editing the date.

Press `Time` to set the time (you may have to press `More` to get to this softkey). You can type in the four numbers for the time directly from the numeric keypad, or you can use the arrow keys and the numeric keypad to edit the time. The time is changed when you press the (Enter) key.

The time is in the format hours:minutes.

You cannot use the Modify Knob for editing the time.

Performing a Selftest

Press `SelfTst` to start the internal instrument self-test. The instrument performs a full self-test, indicating after each test, the test that has just been performed, and the result (`passed` or `failed`):

μP1 Board	indicates the test of the first microprocessor board.
μP2 Board	indicates the test of the second microprocessor board.
Cal. Data	is the test of the calibration data, which is stored in the instrument.
HW-Interface	tests the hardware interface.
ADC	is the test of the analog to digital converter.
Laser Board	tests the laser driver board.
Motor 1	tests the first of the two motors used to control the tuning of the laser.
Motor 2	tests the second of the two motors used to control the tuning of the laser.

Attenuator Motor 3   tests the motor used to control the attenuation.

When the test is completed, the message `Selftest.... ... passed` is shown on the display. If the instrument fails a selftest, the end of the test is signalled by three short beeps and the message `Selftest .... ... failed` is displayed. Even if the instrument fails the selftest, it will continue to operate as far as possible.

Auxiliary Functions

There are four or five auxiliary functions, accessed by (AUX):

- `Pmax(λ)` , the power characteristic (maximum power as a function of the wavelength),

- `→ Peak` , the setting for maximum output power,

- `PACT` , the Passive Component Test,

- `Realign` , Automatic Realignment, and

- `Secure` , the instrument lock (8168F only).

| Pmax(λ) | ->Peak | PACT | Realign | |

Figure 3-5. Auxiliary Functions (8167A, 8168D/E)

| Pmax(λ) | ->Peak | PACT | Realign | Secure |

Figure 3-6. Auxiliary Functions (8168F)

Viewing the Power as a Function of Wavelength

Press `Pmax(λ)` to get the graph of the maximum power as a function of the wavelength. This graph is drawn from the calibration data for the instrument. You can view the graph for the continuous wave power as a function of the wavelength if you make sure that the CW is selected for the output power. If coherence control is enabled, you will also be able to see the coherence control

uncal power level. Similarly, to view the maximum power for a modulated signal, you must make sure that Mod is selected.

There is a cursor on this graph, and the values for the wavelength position of this cursor, and the maximum power that can be output at this wavelength are given at the right of the display. If coherence control is enabled, the value for the minimum power that you should select is also given here.

You can move the cursor with the Modify Knob, or the (⇐), and the (⇒) keys.

Setting the Peak Power

The peak power is the highest power that the instrument can deliver. To set the output for peak power, press → Peak. This changes the wavelength to the lowest wavelength at which the peak power can be achieved, and sets the power to this peak value.

Passive Component Test (PACT)

See separate manual 08168-91051.

Automatic Realignment

Press Realign to request automatic realignment. This realigns the laser cavity after Laser Protection. You should use Automatic Realignment if you have already tried reactivating the laser and reducing the power, and this has been unsuccessful.

You should not use Automatic Realignment when the laser is stabilizing.

Automatic Realignment is available on all 8168D/E/F models, but only 8167A models with serial numbers greater than 3424G00176.

After pressing Realign , you get the following message:

```
Laser will be active while realigning.
Please disconnect any device from
output to avoid damage.
Realignment will take approx tt minutes
```

where tt is the approximate time that Realignment will take. This will be roughly 15 minutes, although actual time taken depends on the wavelength range of the instrument.

Press the `Start` softkey. The message `Running` is flashed in the Display window. The Display also shows the estimated time before realignment is complete. The extreme right softkey offers you the chance to abort, and may be pressed at any time.

```
┌───                [Auto Realignment]                ───┐
│                                                         │
│      Running                                            │
│                                                         │
│      Estimated time:       tt    min                    │
└─────────────────────────────────────────────────────────┘

┌─────────┐┌─────────┐┌─────────┐┌─────────┐┌─────────┐
│         ││         ││         ││         ││  Abort  │
└─────────┘└─────────┘└─────────┘└─────────┘└─────────┘
```

Figure 3-7. Auto Realignment

After realignment, one of the following messages appears in the Display window:

`Abort by user` – you have pressed the `Abort` softkey during realignment. The laser cavity has not been realigned.

`A power down interrupted Auto Realignment at a critical moment` – Automatic Realignment has been interrupted by a power down. The laser cavity has not been realigned. Continue by pressing the `Realign` or `Exit` softkey.

`Realignment OK` – the laser cavity has been realigned successfully with laser protection occurring for at most 1 wavelength point over the tuning range.

`No improvement` – the laser cavity has been realigned, but laser protection has occurred for more than 1 wavelength point over the tuning range. It is still safe to continue.

`Realignment impossible, contact service` – the laser cavity cannot be realigned because of a serious error. This error is unlikely to be directly concerned with realignment. Contact service and do not continue.

`Not allowed during stabilizing` – you tried to `Start` an operation while stabilizing when the working temperature is too low. Please wait until it has stabilized. See "Stabilizing" in Appendix A for more information.

`Stabilizing occurred try again later` – the instrument has resumed stabilizing. Realignment is not possible at present.

Secure

Press `Secure` to lock the instrument. This is to prevent unauthorized persons from using this Laser Safety Class IIIb instrument (8168F only). When you press `Secure`, you see the following screen:

```
                          [ Secure ]
            Instrument is unlocked.



    ┌──────────┐┌──────────┐┌──────────┐┌──────────┐┌──────────┐
    │   Lock   ││          ││  ChngPwd ││          ││   Exit   │
    └──────────┘└──────────┘└──────────┘└──────────┘└──────────┘
```

Figure 3-8. "Secure" screen

You may also see the message `default pwd: 8168, please change it!`. If you see this message, your password is still 8168 (the default). To prevent unauthorized persons using the instrument, you should change the password (see below).

The "Secure" screen offers you the following facilities:

- `Lock` : lock the instrument,

- `ChngPwd` : change the password,

- `Exit` : return to the main screen.

Lock the Instrument

When you press `Lock`, you see the following screen:

```
              [ Secure: Lock Instrument ]

          Enter password to lock:      ----



   |          | |          | |          | |          | | Cancel   |
```

Figure 3-9. "Secure: Lock Instrument" screen

To lock the screen, you enter the 4-figure password using the DATA keys. The
default password is 8168, but this can be changed by pressing `ChngPwd` from
the "Secure" screen (see below).

When you enter the correct password, you see the following screen:

```
                        [ Secure ]

          Instrument is locked.



   | Unlock   | |          | |          | |          | |          |
```

Figure 3-10. "Secure" screen - instrument is locked

The laser is switched off as soon as the instrument is locked.

Press `Unlock` to unlock the instrument. You get the following screen:

```
              [ Secure: Unlock Instrument ]

          Enter password to unlock:      ----



   |          | |          | |          | |          | | Cancel   |
```

Figure 3-11. "Secure: Unlock Instrument" screen

Enter the correct password to return to the "Secure" screen (Figure 3-8)

Change the Password

Press ChngPwd from the "Secure" screen. You see the following screen:

```
                   [ Secure: Change Password ]
 _____         _____
|          Enter actual password:        ----         |
|                                                      |
|                                                      |
|_____|

 _____  _____  _____  _____  _____
|            ||            ||            ||            ||  Cancel  |
 ------------  ------------  ------------  ------------  ----------
```

Figure 3-12. "Secure: Change Password" screen

Enter the 4-figure password, using the DATA keys. If you have not changed the password before, the default is 8168. When you enter the password correctly, you get the following screen:

```
                   [ Secure: Change Password ]
 _____         _____
|          Enter new password:           ----         |
|                                                      |
|                                                      |
|_____|

 _____  _____  _____  _____  _____
|            ||            ||            ||            ||  Cancel  |
 ------------  ------------  ------------  ------------  ----------
```

Figure 3-13.
"Secure: Change Password": Enter new password

Enter a new 4-figure password. You will be asked to verify this number:

```
                   [ Secure: Change Password ]
 _____         _____
|          Enter new password again:    ----          |
|                                                      |
|                                                      |
|_____|

 _____  _____  _____  _____  _____
|            ||            ||            ||            ||  Cancel  |
 ------------  ------------  ------------  ------------  ----------
```

Figure 3-14.
"Secure: Change Password": Enter new password again

When you enter the same number again, the password is changed and you return to the "Secure" screen (Figure 3-8). This new password is used to lock the instrument (see above), and you must enter it when you turn on the machine (see "Starting the 8168F" in Chapter 1).

If you forget your password, please contact Hewlett-Packard.

3

4

Programming the Tunable Laser Source

This chapter gives general information on how to control the tunable laser source remotely. Descriptions for the actual commands for the tunable laser source are given in the following chapters. The information in these chapters is specific to the tunable laser source, and assumes that you are already familiar with programming the HP-IB.

HP-IB Interface

The interface used by the tunable laser source is the HP-IB (Hewlett-Packard Interface Bus).

This is the interface used for communication between a controller and an external device, such as the tunable laser source. The HP-IB conforms to IEEE standard 488-1978, ANSI standard MC 1.1 and IEC recommendation 625-1.

If you are not familiar with the HP-IB, then refer to the following books:

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

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

■ The 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

To obtain a copy of either of these last two documents, write to:
The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street
New York, NY 10017
USA.

In addition, the commands not from the IEEE-488.2 standard, are defined according to the Standard Commands for Programmable Instruments (SCPI). For an introduction to SCPI, and SCPI programming techniques, refer to the following documents:

■ Hewlett-Packard Press (Addison-Wesley Publishing Company, Inc.). *A Beginners Guide to SCPI*. Barry Eppler. 1991.

■ The SCPI Consortium. *Standard Commands for Programmable Instruments*. Published periodically by various publishers. To obtain a copy of this manual, contact your Hewlett-Packard representative.

The tunable laser source interfaces to the HP-IB as defined by the IEEE Standards 488.1 and 488.2. The table shows the interface functional subset that the tunable laser source implements.

Table 4-1. HP-IB Capabilities

Mnemonic	Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker; serial poll; unaddressed to talk if addressed to listen
L4	Basic listener; unaddressed to listen if addressed to talk; no listen only
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT0	No device trigger capability
C0	No controller capability (Controller capability to be implemented)

Setting the HP-IB Address

You can only set the HP-IB address from the front panel. See "Setting the HP-IB Address" in Chapter 3.

The default HP-IB address is 24.

Returning the Instrument to Local Control

If the instrument has been operated in remote the only key you can use is `Local`. This key returns the instrument to local control. `Local` does not operate if local lockout has been enabled.

How the Tunable Laser Source Receives and Transmits Messages

The tunable laser source exchanges messages using an input and an output queue. Error messages are kept in a separate error queue.

How the Input Queue Works

The input queue is a FIFO queue (first-in first-out). Incoming bytes are stored in the input queue as follows:

1. Receiving a byte:

    a. Clears the output queue.

    b. Clears Bit 7 (MSB).

2. No modification is made inside strings or binary blocks. Outside strings and binary blocks, the following modifications are made:

    a. Lower-case characters are converted to upper-case.

    b. The characters 00_{16} to 09_{16} and $0B_{16}$ to $1F_{16}$ are converted to spaces (20_{16}).

    c. Two or more blanks are truncated to one.

3. An EOI (End Or Identify) sent with any character is put into the input queue as the character followed by a line feed (LF, $0A_{16}$). If EOI is sent with a LF, only one LF is put into the input queue.

4. The parser starts if the LF character is received or if the input queue is full.

Clearing the Input Queue

Switching the power off, or sending a Device Interface Clear signal, causes commands that are in the input queue, but have not been executed to be lost.

The Output Queue

The output queue contains responses to query messages. The tunable laser source transmits any data from the output queue when a controller addresses the instrument as a talker.

Each response message ends with a carriage return (CR, $0D_{16}$) and a LF ($0A_{16}$), with EOI = TRUE. If no query is received, or if the query has an error, the output queue remains empty.

The Message Available bit (MAV, bit 4) is set in the Status Byte register whenever there is data in the output queue.

The Error Queue

The error queue is 30 errors long. It is a FIFO queue (first-in first-out). That is, the first error read is the oldest error to have occurred. A new error is only put into the queue if it is not already in it.

If more than 29 errors are put into the queue, the message '-350 <Queue Overflow>' is placed as the last message in the queue.

Some Notes about Programming and Syntax Diagram Conventions

A program message is a message containing commands or queries that you send to the tunable laser source. The following are a few points about program messages:

■ You can use either upper-case or lower-case characters.

■ You can send several commands in a single message. Each command must be separated from the next one by a semicolon (;).

■ You end a program message with a line feed (LF) character, or any character sent with End-Or-Identify (EOI).

■ You can use any valid number/unit combination.

   Example   1500nm, 1.5μm and 1.5e-6m are all equivalent.

   If you do not specify a unit, then the default unit is assumed. The default unit for the commands are given with command description in the next chapter.

Short Form and Long Form

The instrument accepts messages in short or long forms. For example, the message `:STATUS:OPERATION:ENABLE 768` is in long form, the short form of this message is `:STAT:OPER:ENAB 768`.

In this manual the messages are written in a combination of upper and lower case. Upper case characters are used for the short form of the message. For example, the above command would be written `:STATus:OPERation:ENABle`.

The first colon can be left out for the first command or query in your message. That is, the example given above could also be sent as `STAT:OPER:ENAB 768`.

Command and Query Syntax

All characters not between angled brackets must be sent exactly as shown.

The characters between angled brackets (< ... >) indicate the kind of data that you should send, or that you get in a response. You do not type the angled brackets in the actual message. Descriptions of these items follow the syntax description. The most common of these are:

string   is ascii data. A string is contained between a " at the start and the end, or a ' at the start and the end.

value   is numeric data in integer (12), decimal (34.5) or exponential format (67.8E-9).

wsp   is a white space.

Other kinds of data are described as required.

The characters between square brackets ([...]) show optional information that you can include with the message.

The bar (|) shows an either-or choice of data, for example, $a|b$ means either a or b, but not both simultaneously.

Extra spaces are ignored; they can be inserted to improve readability.

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Remote Commands

This chapter gives a list of the HP 8167A/8D/8E/8F Remote commands, for use with the HP-IB.

In the remote command descriptions the parts given in upper-case characters must be given. The parts in lower-case characters can also be given, but they are optional.

Units

The units and all the allowed mnemonics are given in the table below.

Table 5-1. Units and Allowed Mnemonics

Unit	Default	Allowed Mnemonics
deciBel/1mW	DBM	DBM, DBMW
Hertz	HZ	HZ, KHZ, MAHZ, GHZ, THZ
meter	M	PM, NM, UM, MM, M
Watt	Watt	PW, NW, UW, MW, W

Where units are specified with a command, only the Default is shown, by the full range of mnemonics can be used.

Command Summary

Table 5-2. Common Command Summary

Command	Parameter/Response	Min	Max	Function
*CLS				Clear Status Command
*ESE	<value>	0	255	Standard Event Status Enable Command
*ESE?	<value>	0	255	Standard Event Status Enable Query
*ESR?	<value>	0	255	Standard Event Status Register Query
*IDN?	<string>			Identification Query
*OPC				Operation Complete Command
*OPC?	<value>			Operation Complete Query
*OPT?	<string>			Options Query
*RCL	<location>	0	5	Recall Instrument Setting
*RST				Reset Command
*SAV	<location>	1	5	Save Instrument Setting
*SRE	<value>	0	255	Service Request Enable Command
*SRE?	<value>	0	255	Service Request Enable Query
*STB?	<value>	0	255	Read Status Byte Query
*TST?	<value>	0	65535	Self Test Query
*WAI				Wait Command

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Table 5-3. Command List

Command	Parameter Response	Unit	Min	Max	Default	Notes
:DISPlay						
:ENABle	OFF|ON|0|1				1	
:ENABle?	0|1					
:LOCK	OFF|ON|0|1, <value>					password
:LOCK?	0|1					
:OUTPut						
[:STATe]	OFF|ON|0|1				0	
[:STATe]?	0|1					
[:SOURce]						
:AM						
:INTernal						
:FREQuency	<value>|MIN|DEF|MAX	HZ	250	300 000	80 000	
:FREQuency?	<value>	HZ				
MIN|DEF|MAX	<value>	HZ				
:SOURce	INT|INT1|INT2|EXT|0|1|2				0	
:SOURce?	0|1|2					
:STATe	OFF|ON|0|1				0	
:STATe?	0|1					
[:SOURce]						
:MODout	FRQ|FRQ&RDY|0|1					
[:SOURce]						
:MODout?	0|1					
[:SOURce]						
:POWer						
:ATTenuation	<value>|MIN|DEF|MAX	[DB]	40.0dBm†	0.0dBm†	0.0dBm	
:ATTenuation?	<value>	DB				
MIN|DEF|MAX	<value>	DB				
:AUTO	OFF|ON|0|1				0	
:AUTO?	0|1					
:DARK	OFF|ON|0|1				0	
:DARK?	0|1					
[:LEVel]						
[:IMMediate]						
[:AMPlitude]	<value>|MIN|DEF|MAX	DBM	-10dBm†	-4dBm†	-7.0dBm	
		W	100μW†	398μW†	200μW	
		Attenuator Option				
		DBM	-50dBm†	-5.5dBm†	-7.0dBm	
		W	10nW†	300μW†	200μW	
[:AMPlitude]?	<value>	DBM, W				
MIN|DEF|MAX	<value>	DBM, W				
:UNIT	DBM|DBMW|W				DBM	
:UNIT?	DBM|W					

Table 5-3. Command List (continued)

Command	Parameter Response	Unit	Min	Max	Default	Notes
[:SOURce]						
:WAVElength						
[:CW|:FIXED]	\<value\>|MIN|DEF|MAX	M				
			HP 8167A			
			1280nm[†]	1330nm[†]	1310nm	
			HP 8168D			
			1490nm[†]	1565nm[†]	1540nm	
			HP 8168E			
			1475nm[†]	1575nm[†]	1540nm	
			HP 8168F			
			1450nm[†]	1590nm[†]	1540nm	
[:CW|:FIXED]?	\<value\>	M				
MIN|DEF|MAX	\<value\>	M				
:REFerence?	\<value\>					
:DISPlay						
:FREQuency	\<value\>					
:FREQuency?	\<value\>					
:STATus						
:OPERation						
[:EVENt]?	\<value\>					
:CONDition?	\<value\>					
:ENABle	\<value\>					
:ENABle?	\<value\>					
:NTRansition	\<value\>					
:NTRansition?	\<value\>					
:PTRansition	\<value\>					
:PTRansition?	\<value\>					
:QUEStionable						
[:EVENt]?	\<value\>					
:CONDition?	\<value\>					
:ENABle	\<value\>					
:ENABle?	\<value\>					
:NTRansition	\<value\>					
:NTRansition?	\<value\>					
:PTRansition	\<value\>					
:PTRansition?	\<value\>					
:PRESet						

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Table 5-3. Command List (continued)

Command	Parameter Response	Unit	Min	Max	Default	Notes
:SYSTem						
:DATe	<value>,<value>,<value>					Year,Month,Day
:DATe?	<value>/<value>/<value>					Year/Month/Day
:ERRor?	<value>		-32768	32767		
:TIMe	<value>,<value>,<value>					Hour,Minute,Second
:TIMe?	<value>:<value>:<value>					Hour:Minute:Second
:TRACe						
:CATalog?	<string>					trace_names
:POINts?						
<trace_name>	<value>					the number of points
[:DATa]?						
<trace_name>	<value>,<value>, ...					X- and Y-value for each point
WAVEACT	<value>					Wavelength in meters

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† These are specified minimum and maximum values. Actual values depend on the calibration of the instrument.

The Common Commands

The IEEE 488.2 standard has a list of reserved commands, called common commands. These are the commands that start with an asterisk. Some of these commands must be implemented by any instrument using the standard, others are optional. The tunable laser source implements all the necessary commands, and some optional ones. This chapter describes the implemented commands.

Common Status Information

There are four registers for the common status information. Two of these are status-registers and two are enable-registers. These registers conform to the *IEEE Standard 488.2-1987*. You can find further descriptions of these registers under " *ESE", " *ESR?", " *SRE", and " *STB?".

The following figure shows how the registers are organized.

Figure 5-1. Common Status Registers

*The questionable and operation status trees are described in ":STATus Commands".

Note	Unused bits in any of the registers return 0 when you read them.

SRQ, The Service Request

A service request (SRQ) occurs when a bit in the Status Byte register goes from $0 \rightarrow 1$ AND the corresponding bit in the Service Request Enable Mask is set.

The Request Service (RQS) bit is set to 1 at the same time that the SRQ is caused. This bit can only be reset by reading it by a serial poll. The RQS bit is

not affected by the condition that caused the SRQ. The serial poll command transfers the value of the Status Byte register to a variable.

*CLS

Syntax   *CLS

Definition The *CLS command clears the following:

- Error queue

- Standard event status register (ESR)

- Status byte register (STB)

After the *CLS command the instrument is left waiting for the next command. The instrument setting is unaltered by the command, though *OPC/*OPC? actions are canceled.

If the *CLS command occurs directly after a program message terminator, the output queue and MAV, bit 4, in the status byte register are cleared, and if condition bits 2-0 of the status byte register are zero, MSS, bit 6 of the status byte register is also zero.

Example   OUTPUT 724;"*CLS"

*ESE

Syntax   *ESE <wsp><value>
                $0 \leq value \leq 255$

Definition The *ESE command sets bits in the standard event status enable register (ESE) that enable the corresponding bits in the standard event status register (ESR).

The register is cleared:

- At power-on

- By sending a value of zero

The register is not changed by the *RST and *CLS commands.

BIT	MNEMONIC	BIT VALUE
7	Power On	128
6	User Request	64
5	Command Error	32
4	Execution Error	16
3	Device Dependent Error	8
2	Query Error	4
1	Request Control	2
0	Operation Complete	1

The Event Status Enable Register

*ESE?

The standard event status enable query returns the contents of the standard event status enable register.

Example   OUTPUT 724;"*ESE 21"

OUTPUT 724;"*ESE?"
ENTER 724; A$

*ESR?

Syntax   *ESR?

Definition   The standard event status register query returns the contents of the standard event status register. The register is cleared after being read.

$0 \le contents \le 255$

BITS	MNEMONICS	BIT VALUE
7	Power On	128
6	User Request	64
5	Command Error	32
4	Execution Error	16
3	Device Dependent Error	8
2	Query Error	4
1	Request Control	2
0	Operation Control	1

The Standard Event Status Register

Example `OUTPUT 724;"*ESR?"`
`ENTER 724; A$`

*IDN?

Syntax `*IDN?`

Definition The identification query commands the instrument to identify itself over the interface.

Response: `HEWLETT-PACKARD, HP8167A, mmmmmmmmmmm, n.n.n`

`HEWLETT-PACKARD`: manufacturer

`HP8167A` or `HP8168D` or `HP8168E` or `HP8168F`: instrument model number

`mmmmmmmmmmm`: serial number (not supplied)

`n.n.n`: firmware revision level

Example `DIM A$ [100]`
`OUTPUT 724;"*IDN?"`
`ENTER 724; A$`

*OPC

Syntax   *OPC

Definition   The instrument parses and executes all program message units in the input queue and sets the operation complete bit in the standard event status register (ESR). This command can be used to avoid filling the input queue before the previous commands have finished executing.

*OPC?

This query causes all the program messages in the input queue to be parsed and executed. Once it has completed it places an ASCII '1' in the output queue. There is a short delay between interpreting the command and putting the '1' in the queue.

Example   OUTPUT 724;"*CLS;*ESE 1;*SRE 32"
OUTPUT 724;"*OPC"

OUTPUT 724;"*CLS;*ESE 1;*SRE 32"
OUTPUT 724;"*OPC?"
ENTER 724;A$

*OPT?

Syntax   *OPT?

Definition   This query returns a string with the options installed in the tunable laser source.

If the Passive Component Test software is available, the first position in the option string is Passive Component Test. If it is not available, the first position returns 0.

If the optional attenuator is installed, the third position in the option string is ATTENUATOR. If it is not installed, the third position returns 0.

If Coherence Control is available, the fourth position in the option string is COHERENCE CONTROL. If it is not available, the fourth position returns 0.

Example   OUTPUT 724;"*OPT?"
ENTER 724;A$

*RCL

Syntax   *RCL <wsp> <location>

0 ≤ location ≤ 5

Definition   An instrument setting from the internal RAM is made the actual instrument setting.

You can recall user settings from locations 1-5. See "*SAV".
Location 0 contains the default setting, which is the same as that obtained by *RST.

Example   OUTPUT 724;"*RCL 3"

*RST

Syntax   *RST

Definition   The reset setting (default setting) stored in ROM is made the actual setting.

Instrument state: the instrument is placed in the idle state awaiting a command.

The following are not changed:

■ HP-IB (interface) state

■ Instrument interface address

■ Output queue

■ Service request enable register (SRE)

■ Standard event status enable register (ESE)

The commands and parameters of the reset state are listed in the following table.

Table 5-4. Reset State (Default Setting)

Parameter	Reset Value			
	HP 8167A	HP 8168D	HP 8168E	HP8168F
Wavelength	1310nm	1540nm	1540nm	1540nm
df	0GHz			
Display Mode	nm			
Power	minimum*			
Power/Attenuation Mode	Power			
Unit (Power)	μW			
Modulation Timing	External			
Modulation Status	Off			

*The minimum value is determined, individually for each instrument at calibration.

Example   OUTPUT 724;"*RST"

*SAV

Syntax   *SAV <wsp> <location>

1 ≤ location ≤ 5

Definition   The instrument setting is stored in RAM. You can store settings in locations 1-5. The scope of the saved setting is identical with the scope of the standard setting described in "*RST".

Example   OUTPUT 724;"*SAV 3"

*SRE

Syntax   *SRE <wsp> <value>

0 ≤ value ≤ 255

Definition   The service request enable command sets bits in the service request enable register that enable the corresponding status byte register bits.

The register is cleared:

■ At power-on

■ By sending a value of zero.

The register is not changed by the *RST and *CLS commands.

BITS	MNEMONICS	BIT VALUE
7	Operation Status	128
6	Request Status	64
5	Event Status Byte	32
4	Message Available	16
3	Questionable Status	8
2	Not used	0
1	Not used	0
0	Not used	0

The Service Request Enable Register

Note

Bit 6 cannot be masked.

*SRE?

The service request enable query returns the contents of the service request enable register.

Example   OUTPUT 724;"*SRE 48"

OUTPUT 724;"*SRE?"
ENTER 724; A$

*STB?

Syntax   *STB?

Definition   The read status byte query returns the contents of the status byte register.

$0 \leq contents \leq 255$

BITS	MNEMONICS	BIT VALUE
7	Operation Status	128
6	Request Service	64
5	Event Status Byte	32
4	Message Available	16
3	Questionable Status	8
2	Not used	0
1	Not used	0
0	Not used	0

The Status Byte Register

Example   OUTPUT 724;"*STB?"
ENTER 724; A$

*TST?

Syntax   *TST?

Definition   The self-test query commands the instrument to perform a self-test and place the results of the test in the output queue.

Returned value: $0 \leq$ value ≤ 65535. This value is the sum of the results for the individual tests

BITS	MNEMONICS	BIT VALUE
15	μP1 Board	32768
14	μP2 Board	16384
13	Battery Test	8192
6	Motor 3 (Opt. 003)	64
5	Motor 2	32
4	Motor 1	16
3	Laser Control Board	8
2	Analog to Digital Conv.	4
1	Hardware Interface	2
0	Calibration Data	1

The Self Test Results

So 16 would mean that Motor 1 had failed, 18 would mean that Motor 1 had failed, and so had the hardware interface. A value of zero indicates no errors.

If the self-test fails, the results are also put in the error queue. It is recommended that you read self-test results from the error queue. Explanations for the non-zero results of the self-test are given in Appendix F.

No further commands are allowed while the test is running.

The instrument is returned to the setting that was active at the time the self-test query was processed.

The self-test does not require operator interaction beyond sending the *TST? query.

Example

```
OUTPUT 724;"*TST?"
ENTER 724; A$
```

*WAI

Syntax   `*WAI`

Definition   The wait-to-continue command prevents the instrument from executing any further commands, all pending operations are completed. There is a delay of approximately 0.1 seconds between the completion of the final operation and the parsing of the next command.

Example   `OUTPUT 724;"*WAI"`

:DISPlay Commands

:DISPlay:ENABle

Syntax   `:DISPlay:ENABle <wsp> OFF|ON|O|1`

Description   This command enables or disables the front panel display.

Set the state to `OFF` or `O` to switch the display off, set the state to `ON` or `1` to switch the display on. The default is for the display to be on.

:DISPlay:ENABle?

Syntax   `:DISPlay:ENABle?`

Description   The query returns the current state of the display.

A returned value of `O` indicates that the display is off. A returned value of `1` indicates that the display is on.

Example   `OUTPUT 724;":DISP:ENAB ON"`

`OUTPUT 724;":DISP:ENAB?"`
`ENTER 724;A$`

:LOCK Commands

:LOCK

Syntax   :LOCK <wsp> OFF|ON|0|1 , <value>

Description   This command switches the lock off and on.

Set the state to OFF or 0 to switch the lock off. Set the state to ON or 1 to switch the lock on. The laser is switched off immediately when the instrument is locked.

<value> is the four-figure password.

:LOCK?

Syntax   :LOCK?

Description   The query returns the current state of the lock.

A returned value of 0 indicates that the lock is off. A returned value of 1 indicates that the lock is on.

Example   OUTPUT 724;":LOCK ON, 8168"

OUTPUT 724;":LOCK?"
ENTER 724;A$

:OUTPut Commands

:OUTPut[:STATe]

Syntax   :OUTPut[:STATe] <wsp> OFF|ON|0|1

Description   This command switches the laser current off and on.

Laser light emerges only when the current is on. Set the state to OFF or 0 to switch the laser current off, set the state to ON or 1 to switch the laser current on. The default is for the laser current to be off.

:OUTPut[:STATe]?

Syntax   `:OUTPut[:STATe]?`

Description The query returns the current state of the laser current.

A returned value of 0 indicates that the laser current is off. A returned value of 1 indicates that the laser current is on.

Example   `OUTPUT 724;":OUTP ON"`

`OUTPUT 724;":OUTP?"`
`ENTER 724;A$`

[:SOURce] Commands

[:SOURce]:AM:INTernal:FREQuency

Syntax   `[:SOURce]:AM:INTernal:FREQuency <wsp>`
`<value>|MIN|DEF|MAX`

Description This command sets the frequency of the amplitude modulation of the laser output.

The frequency can be set in the range 250Hz to 300kHz. You can set to the minimum, default or maximum programmable values by sending `MIN`, `DEF`, or `MAX`, respectively, instead of the value.

The default units are `HZ`, though `KHZ`, `MAHZ`, `GHZ`, `THZ` can alternatively be specified.

The resolution of the frequency is given in the table below:

Range (Hz)	Resolution (Hz)
250 ... 999	1
1 000 ... 9 990	10
10 000 ... 99 900	100
100 000 ... 300 000	1000

[:SOURce]:AM:INTernal:FREQuency?

Syntax   [:SOURce]:AM:INTernal:FREQuency? [MIN|DEF|MAX]

Description   This query returns the frequency of the amplitude modulation, as a floating point number in Hertz. If you specify MIN, DEF, or MAX with the query, it will return, respectively, the minimum, default, or maximum modulation frequency.

Example   OUTPUT 724;":AM:INT:FREQ 40.4KHZ"
                OUTPUT 724;":AM:STAT ON"

                OUTPUT 724;":AM:INT:FREQ?"
                ENTER 724;A$

[:SOURce]:AM:SOURce

Syntax   [:SOURce]:AM:SOURce <wsp> INT|INT1|INT2|EXT|0|1|2

Description   This command chooses the type or source of the modulation of the laser output.

                Set the source to INT, INT1 or 0 to select internal modulation, set the source to INT2 or 1 to select coherence control, or set the source to EXT or 2 to select external modulation. The default is for internal modulation to be selected.

Modulation Input   When external modulation is selected, the signal is modulated according to the signal applied to the modulation input on the front panel of the instrument. The maximum signal that can be applied is $5V_{pp}$, which results in 15% modulation of the optical output.

[:SOURce]:AM:SOURce?

Syntax   [:SOURce]:AM:SOURce?

Description   The query returns the current state of modulation.

                A returned value of 0 indicates that internal modulation is selected. A returned value of 1 indicates that coherence control is selected, 2 indicates that external modulation is selected.

Example   OUTPUT 724;":AM:SOUR ON"

                OUTPUT 724;":AM:SOUR?"
                ENTER 724;A$

[:SOURce]:AM:STATe

Syntax	[:SOURce]:AM:STATe <wsp> OFF|ON|0|1
Description	This command enables and disables amplitude modulation of the laser output.
	Set the state to OFF or 0 to disable modulation, set the state to ON or 1 to enable modulation. The default is for the modulation to be disabled.
Modulation Output	When the internal modulation is selected, the Modulation Output on the front panel outputs a version of the modulating signal that has the same frequency and phase as the modulating signal, but has a fixed, TTL-level amplitude. You can use this to synchronize your external measuring equipment to the tunable laser source.
	To allow for your possible synchronization requirements, there are two ways in which the signal can be output. Either the signal is combined with the laser-ready signal, so that the output is kept low when there is no optical signal being output (for example, while the laser is settling after a change of wavelength). Or the modulation signal is output all the time. This is set by the :SOURCE:MODOUT command (see "[:SOURCE]:MODOUT").

[:SOURce]:AM:STATe?

Syntax	[:SOURce]:AM:STATe?
Description	The query returns the current state of modulation.
	A returned value of 0 indicates that modulation is disabled. A returned value of 1 indicates that modulation is enabled.
Example	OUTPUT 724;":AM:STAT ON"
	OUTPUT 724;":AM:STAT?" ENTER 724;A$

[:SOURCE]:MODOUT

Note   This command does not confirm to the SCPI standard.

Syntax   `[:SOURCE]:MODOUT FRQ|FRQRDY|0|1`

Description This command sets the modulation output. The two possible
                 values are

- `FRQ` or 0, where the modulation signal is output all the time,
  and
- `FRQRDY` or 1, where the modulation signal is combined with
  the laser-ready signal, so that the output is kept low when
  there is no optical signal being output (for example, while the
  laser is settling after a change of wavelength).

[:SOURCE]:MODOUT?

Note   This command does not confirm to the SCPI standard.

Syntax   `[:SOURCE]:MODOUT?`

Description This queries the mode of the modulation output. The two
                 possible values are

- 0, where the modulation signal is output all the time, and
- 1, where the modulation signal is combined with the
  laser-ready signal, so that the output is kept low when there
  is no optical signal being output (for example, while the laser
  is settling after a change of wavelength).

[:SOURce]:POWer:ATTenuation

Attenuator	Syntax	[:SOURce]:POWer:ATTenuation <wsp> <value>|MIN|DEF|MAX
	Description	This command sets the level of attenuation of an inbuilt optional attenuator, if this is installed.

The specified range for the attenuation is 0.00dB to 40.00dB. You can set to the minimum, default or maximum programmable values by sending `MIN`, `DEF`, or `MAX`, respectively, instead of the value.

The resolution of the attenuation is specified to be 0.1dB. The actual resolution of the attenuator is better than this (typically 0.04dB). To allow you access to this resolution, you can specify the attenuation to two decimal places with the HP-IB command.

You need to be in the Attenuation Mode (see "[:SOURce]:POWer:ATTenuation:AUTO") for this value to have an affect. The output power is a combination of this value and the laser output power (see "[:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude]").

In this respect, this command does not confirm to the SCPI standard. The SCPI standard requires that entering an explicit value for the attenuation switches the attenuation mode `OFF`.

The default units are `DB`.

[:SOURce]:POWer:ATTenuation?

Attenuator	Syntax	[:SOURce]:POWer:ATTenuation? [MIN|DEF|MAX]
	Description	This query returns the attenuation level of the optional attenuator if this has been installed.

The value returned is applies
only to the attenuation mode (see
"[:SOURce]:POWer:ATTenuation:AUTO?").

If you specify MIN, DEF, or MAX with the query,
it will return, respectively, the minimum,
default, or maximum amplitude level.

Example   `OUTPUT 724;":POW:ATT:AUTO OFF"`
`OUTPUT 724;":POW 200UW OUTPUT`
`724;":POW:ATT 22.32DB"`

`OUTPUT 724;":POW:ATT?" ENTER 724;A$`

[:SOURce]:POWer:ATTenuation:AUTO

Attenuator   **Syntax**   `[:SOURce]:POWer:ATTenuation:AUTO <wsp>`   5
`OFF|ON|0|1`

Description   This command selects Power or Attenuation
Mode. In Power Mode, you specify the output
power. In Attenuation Mode, you must
specify both the laser output power, and the
attenuation level.

Use `ON` or `1` to select Power Mode.

Use `OFF` or `0` to select Attenuation Mode

[:SOURce]:POWer:ATTenuation:AUTO?

Attenuator   **Syntax**   `[:SOURce]:POWer:ATTenuation:AUTO?`

Description   This query returns whether the instrument is in
Power Mode, or Attenuation Mode.

1 indicates Power Mode.

0 indicates Attenuation Mode

[:SOURce]:POWer:ATTenuation:DARK

Note	This command does not confirm to the SCPI standard.	

Attenuator	**Syntax**	`[:SOURce]:POWer:ATTenuation:DARK OFF|ON|0|1`
	Description	Use `ON` or 1 to set the attenuator to the "dark" position. This blocks all light from the laser. You can use this as an alternative to disabling the laser, the advantage of doing this is that you avoid the laser rise time.
		This command is available in Attenuation Mode Only.

[:SOURce]:POWer:ATTenuation:DARK?

Note	This command does not confirm to the SCPI standard.	

Attenuator	**Syntax**	`[:SOURce]:POWer:ATTenuation:DARK? 0|1`
	Description	This query returns whether the attenuator is in the "dark" position (where all light is blocked by the laser) or not. If the attenuator is in the dark position, 1 is returned.
	Example	`OUTPUT 724;":POW:ATT:DARK ON"`
		`OUTPUT 724;":POW:ATT:DARK?" ENTER 724;A$`

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude]

Syntax [:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude] <wsp>
<value>|MIN|DEF|MAX

Description This command sets the power of the laser output.

The specified range for the amplitude is -10dBm to -4dBm,
or 100μW to 398μW. You can set to the minimum, default or
maximum programmable values by sending MIN, DEF, or MAX,
respectively, instead of the value.

Attenuator If you have the optional attenuator installed, the range is
-50dBm to -5.5dBm, or 10nW to 300μW.

If you are using the Attenuation Mode (see
"[:SOURce]:POWer:ATTenuation:AUTO"), then this
value sets the laser output power, which is not the same as the
output power. The output power is a combination of this value
and the attenuation (see "[:SOURce]:POWer:ATTenuation").

The values for the output power that you set in the Power
Mode, and the laser output power that you set in the
Attenuation Mode, are stored and used independently.

Note The instrument may not be able to output a signal
with the maximum programmable power, it will
output a signal with the maximum power. Use the
[:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude]? query to
find out the power being output.

The default units are DBM, or W, depending on the unit selected
by the [:SOURce]:POWer:UNIT command. Independently of the
chosen default unit, you can also specify the unit to be used as
DBM, DBMW, PW, NW, UW, MW or W.

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude]?

Syntax [:SOURce]:POWer[:LEVel][:IMMediate][:AMPlitude]?
[MIN|DEF|MAX]

Description This query returns the amplitude level of the output power. The
value returned is the actual amplitude that is output, which

may be different from the value set for the output. If these two figures are not the same, it is indicated in the STATus:OPERation register.

Attenuator If you have the optional attenuator installed, the value returned for the power is dependent on whether you are in power or attenuation mode (see "[:SOURce]:POWer:ATTenuation:AUTO?"). If you are in power mode, the value returned is the output power. If you are in attenuation mode, the value returned is the laser output power, and you must also use the attenuation value to calculate the output power (see "[:SOURce]:POWer:ATTenuation?").

If you specify `MIN`, `DEF`, or `MAX` with the query, it will return, respectively, the minimum, default, or maximum amplitude level.

Example   OUTPUT 724;":POW:UNIT DBM"
            OUTPUT 724;":POW? MAX"
            ENTER 724;A$ OUTPUT 724;":POW ",A$

[:SOURce]:POWer:UNIT

Syntax   [:SOURce]:POWer:UNIT <wsp> DBM|DBMW|Watt

Description This command sets the power units. Set the units to dBm by sending `DBM` or `DBMW`. Set the units to watts by sending `W`. The default units are dBm.

[:SOURce]:POWer:UNIT?

Syntax   [:SOURce]:POWer:UNIT?

Description The query returns the units currently being used. The response is either 0 for dBm or dBmW, or 2 for Watts.

Example   OUTPUT 724;":POW:UNIT DBM"

            OUTPUT 724;":POW:UNIT?"
            ENTER 724;A$

[:SOURce]:WAVElength[:CW|:FIXED]

Syntax   [:SOURce]:WAVElength[:CW|:FIXED] <wsp>
<value>|MIN|DEF|MAX

Description This command sets the absolute wavelength of the output. The default units for the wavelength are meters.

The specified range for the wavelength is given in the table below.

Table 5-5. Specified Wavelength range

Min	Max	Default
HP 8167A		
1280nm	1330nm	1310nm
HP 8168D		
1490nm	1565nm	1540nm
HP 8168E		
1475nm	1575nm	1540nm
HP 8168F		
1450nm	1590nm	1540nm

The programmable range is larger than this. The programmable range is set individually for each instrument when it is calibrated during production. You can set the wavelength to the maximum, default or minimum wavelength by sending MIN, DEF, or MAX, respectively, instead of the value.

The default units are M, though PM, NM, UM, MM can alternatively be specified.

[:SOURce]:WAVElength[:CW|:FIXED]?

Syntax   [:SOURce]:WAVElength[:CW|:FIXED]? [MIN|DEF|MAX]

Description The query returns the current wavelength in meters. If you specify MIN, DEF, or MAX with the query, it will return, respectively, the minimum, default, or maximum wavelength.

Example   `OUTPUT 724;":WAVE:REF:STAT OFF"`
                `OUTPUT 724;":WAVE 1542E-9"`

                `OUTPUT 724;":WAVE?"`
                `ENTER 724;A$`

[:SOURce]:WAVElength:REFerence?

Syntax   `[:SOURce]:WAVElength:REFerence?`

Description   The query returns the reference wavelength (λ_0) in meters.

Example   `OUTPUT 724;":WAVE:REF?"`
                `ENTER 724;A$`

[:SOURce]:WAVElength:REFerence:DISPlay

Syntax   `[:SOURce]:WAVElength:REFerence:DISPlay`

Description   This command sets the reference wavelength to the value of the output wavelength ($\lambda \rightarrow \lambda_0$).

Example   `OUTPUT 724;":WAVE:REF:DISP"`

[:SOURce]:WAVElength:FREQuency

Syntax   `[:SOURce]:WAVElength:FREQuency <wsp> <value>`

Description   This command sets the frequency difference used to calculate a relative wavelength. The output wavelength is made up of the reference wavelength and this frequency difference. The default units for the frequency are Hertz. The output wavelength (λ) is set from the base wavelength (λ_0) and the frequency offset (df). The formula for calculating the output wavelength is:

$$\lambda = \frac{c}{(\lambda_0)df + c}\lambda_0$$

where c is the speed of light in a vacuum ($2.998 \times 10^8 \text{ms}^{-1}$).

[:SOURce]:WAVElength:FREQuency?

Syntax   `[:SOURce]:WAVElength:FREQuency?`

Description   The query returns the frequency difference in Hertz.

Example   OUTPUT 724;":WAVE:FREQ 11E9"

OUTPUT 724;":WAVE:FREQ?"
ENTER 724;A$

:STATus Commands

Each node of the status circuitry has five registers:

- A condition register (CONDition), which contains the current status.This register is updated continuously. It is not changed by having its contents read.

- A positive transition register (PTRansition), which, when enabled, puts a 1 into the event register, when the corresponding bit in the condition register goes from 0 to 1.

   The power-up condition for this register is for all the bits to be disabled.

- A negative transition register (NTRansition), which, when enabled, puts a 1 into the event register, when the corresponding bit in the condition register goes from 1 to 0.

   The power-up condition for this register is for all the bits to be disabled.

- The event register (EVENt), which contains the output from the transition registers. The contents of this register are cleared when it is read.

- The enable register (ENABle), which enables changes in the event register to affect the Status Byte.

The status registers for the tunable laser source are organized as shown:

Figure 5-2. The Status Registers

The OPERation branch of the status registers indicates things that can happen during normal operation. The QUEStionable branch indicates error conditions.

:STATus:OPERation:CONDition?

Syntax   :STATus:OPERation:CONDition?

Description   This query reads the contents of the OPERation:CONDition register. Only two bits of the condition register are used:

- Bit 8, which is 1 when the output power that you set exceeds what the laser is capable of producing.

- Bit 9, which is 1 while the instrument is performing its power-up initialization.

Example   OUTPUT 724;":STAT:OPER:COND?"
ENTER 724;A$

:STATus:OPERation:ENABle

Syntax   :STATus:OPERation:ENABle <wsp> <value>

Description   This command sets the bits in the ENABle register that enable the contents of the EVENt register to affect the Status Byte (STB). Setting a bit in this register to 1 enables the corresponding bit in the EVENt register to affect bit 7 of the Status Byte.

:STATus:OPERation:ENABle?

Syntax   :STATus:OPERation:ENABle?

Description   This query returns the current contents of the OPERation:ENABle register.

Example   OUTPUT 724;":STAT:OPER:ENAB 768"

                 OUTPUT 724;":STAT:OPER:ENAB?"
                 ENTER 724;A$

:STATus:OPERation[:EVENt]?

Syntax   :STATus:OPERation[:EVENt]?

Description   This query reads the contents of the OPERation:EVENt register. Only two bits of the event register are used (whether these bits contain information depends on the transition register configuration):

- Bit 8, which can reflect the excessive state (when the output power that you set exceeds what the laser is capable of producing).

- Bit 9, which can reflect the initializing state (the instrument is performing its power-up initialization).

Example   OUTPUT 724;":STAT:OPER:PTR 768"
                 OUTPUT 724;":STAT:OPER:COND?"
                 ENTER 724;A$

:STATus:OPERation:NTRansition

Syntax   :STATus:OPERation:NTRansition <wsp> <value>

Description   This command sets the bits in the NTRansition register. Setting a bit in this register enables a negative transition (1→0) in the corresponding bit in the CONDition register to set the bit in the EVENt register.

:STATus:OPERation:NTRansition?

Syntax   :STATus:OPERation:NTRansition?

Description   This query returns the current contents of the OPERation:NTRansition register.

Example   OUTPUT 724;":STAT:OPER:NTR 768"

                  OUTPUT 724;":STAT:OPER:NTR?"
                  ENTER 724;A$

:STATus:OPERation:PTRansition

Syntax   :STATus:OPERation:PTRansition <wsp> <value>

Description   This command sets the bits in the PTRansition register. Setting a bit in this register enables a positive transition (0→1) in the corresponding bit in the CONDition register to set the bit in the EVENt register.

:STATus:OPERation:PTRansition?

Syntax   :STATus:OPERation:PTRansition?

Description   This query returns the current contents of the OPERation:PTRansition register.

Example   OUTPUT 724;":STAT:OPER:PTR 768"

                  OUTPUT 724;":STAT:OPER:PTR?"
                  ENTER 724;A$

:STATus:QUEStionable:CONDition?

Syntax   :STATus:QUEStionable:CONDition?

Description   This query reads the contents of the QUEStionable:CONDition
                    register. Only three bits of the condition register are used:

- Bit 7, which is 1 when coherence control has been activated
  and the chosen power level is too low (that is, below the
  Coherence Control Uncalibrated Power for that wavelength).

- Bit 9, which is 1 when the temperature in the laser heat
  chamber is out of range (stabilizing).

- Bit 10, which is 1 when the output has been switched off to
  protect the laser diode.

Example   OUTPUT 724;":STAT:QUES:COND?"
                    ENTER 724;A$

:STATus:QUEStionable:ENABle

Syntax   :STATus:QUEStionable:ENABle <wsp> <value>

Description   This command sets the bits in the ENABle register that
                    enable the contents of the EVENt register to affect the Status
                    Byte (STB). Setting a bit in this register to 1 enables the
                    corresponding bit in the EVENt register to affect bit 3 of the
                    Status Byte.

:STATus:QUEStionable:ENABle?

Syntax   :STATus:QUEStionable:ENABle?

Description   This query returns the current contents of the
                    QUEStionable:ENABle register.

Example   OUTPUT 724;":STAT:QUES:ENAB 1536"

                    OUTPUT 724;":STAT:QUES:ENAB?"
                    ENTER 724;A$

:STATus:QUEStionable[:EVENt]?

Syntax   :STATus:QUEStionable[:EVENt]?

Description   This query reads the contents of the QUEStionable:EVENt register. Only three bits of the event register are used (whether these bits contain information depends on the transition register configuration):

■ Bit 7, which is 1 when coherence control has been activated and the chosen power level is too low (that is, below the Coherence Control Uncalibrated Power for that wavelength).

■ Bit 9, which can reflect that the temperature in the laser heat chamber is out of range (stabilizing).

■ Bit 10, which can reflect that the output has been switched off to protect the laser diode.

Example   OUTPUT 724;":STAT:QUES:PTR 1536"
OUTPUT 724;":STAT:QUES:COND?"
ENTER 724;A$

:STATus:QUEStionable:NTRansition

Syntax   :STATus:QUEStionable:NTRansition <wsp> <value>

Description   This command sets the bits in the NTRansition register. Setting a bit in this register enables a negative transition (1→0) in the corresponding bit in the CONDition register to set the bit in the EVENt register.

:STATus:QUEStionable:NTRansition?

Syntax   :STATus:QUEStionable:NTRansition?

Description   This query returns the current contents of the QUEStionable:NTRansition register.

Example   OUTPUT 724;":STAT:QUES:NTR 768"

OUTPUT 724;":STAT:QUES:NTR?"
ENTER 724;A$

:STATus:QUEStionable:PTRansition

Syntax   :STATus:QUEStionable:PTRansition <wsp> <value>

Description   This command sets the bits in the PTRansition register. Setting a bit in this register enables a positive transition $(0{\rightarrow}1)$ in the corresponding bit in the CONDition register to set the bit in the EVENt register.

:STATus:QUEStionable:PTRansition?

Syntax   :STATus:QUEStionable:PTRansition?

Description   This query returns the current contents of the QUEStionable:PTRansition register.

Example   OUTPUT 724;":STAT:QUES:PTR 1536"

              OUTPUT 724;":STAT:QUES:PTR?"
              ENTER 724;A$

:STATus:PRESet

Syntax   :STATus:PRESet

Description   This command presets all the enable registers and transition filters for both the OPERation and QUEStionable nodes.

        ■ All the bits in the ENABle registers are set to 0

        ■ All the bits in the PTRansition registers are set to 1

        ■ All the bits in the NTRansition registers are set to 0

Example   OUTPUT 724;":STAT:PRES"

:SYSTem Commands

:SYSTem:DATe

Syntax   :SYSTem:DATe <wsp> <value>,<value>,<value>

where

- the first value is the year (two or four digits),
- the second value is the month, and
- the third value is the day.

Description   This command sets the date.

:SYSTem:DATe?

Syntax   :SYSTem:DATe?

Description   This query returns the current date in the format YY/MM/DD, where YY is the year, MM is the month, and DD is the day.

Example   OUTPUT 724;":STAT:DAT 93,3,15"

:SYSTem:ERRor?

Syntax   :SYSTem:ERRor?

Description   This query returns the next error from the error queue (see "The Error Queue" in Chapter 4). Each error has the error code and a short description of the error, separated by a comma, for example 0, "No error". Error codes are numbers in the range -32768 and +32767. Negative error numbers are defined by the SCPI standard. Positive error numbers are device dependent. The errors are listed in Appendix F

Example   OUTPUT 724;":SYST:ERR?"
                 ENTER 724;A$

:SYSTem:TIMe

Syntax :SYSTem:TIMe \<wsp\> \<value\>,\<value\>,\<value\>

where

- the first value is the hour,
- the second value is the minute, and
- the third value is the seconds.

Description This command sets the time.

:SYSTem:TIMe?

Syntax :SYSTem:TIMe?

Description This query returns the current time in the format HH:MM:SS, where HH is the hour, MM is the minute, and SS is the seconds.

Example OUTPUT 724;":SYST:TIM 16,15,00"

:TRACe Commands

:TRACe:CATalog?

Syntax :TRACe:CATalog?

Description This query returns a string with a list of the traces stored in the instrument. At the moment, this is only CC_UNCAL.

Note The trace for the maximum power trace is not available using :TRACe commands because of the large number of data points. Use the :POWer? MAX query to get data points for particular wavelengths.

Example OUTPUT 724;":TRAC:CAT?"
ENTER 724; A$

:TRACe:POINts? <trace_name>

Syntax   :TRACe:POINts?

Description This query returns the number of data points that are in the trace. Each data point is described by an x- and a y-value.

Example   OUTPUT 724;":TRAC:POIN? CC_UNCAL"
                ENTER 724;A$

:TRACe[:DATa]? <trace_name>

Syntax   :TRACe[:DATa]?

Description This query returns the trace data for the named trace. The information is returned as a string with the values separated by commas (,). The values are grouped into data points. Each data point has an x-value and a y-value. The x-values are given in meters, the y-values are given in Watts.

Example   OUTPUT 724;":TRAC? CC_UNCAL"
                ENTER 724;A$

Other Commands

WAVEACT

Syntax   WAVEACT <wsp> <value>

                where

                ■ <value> is the wavelength. If no units are specified, <value> is taken to be in meters.

Description This command allows the Tunable Laser Source to adjust the wavelength at least ±1pm of the wavelength meter reading.

Note   The accuracy of WAVEACT is dependent on the wavemeter specification.

                It is only as exact as the Wavelength meter.

Set <value> to the actual wavelength measured with a wavelength meter. Repeat the call to `WAVEACT` until the new wavelength is accurate enough, or will not get any better.

When `WAVEACT` is active, you see the message `EXT. λ REF.` at the bottom left of the Tunable Laser Source Screen.

You cannot call `WAVEACT` with a value that would set the Tunable Laser Source to a wavelength that is not in its wavelength range.
For example, suppose the current wavelength is at the lower wavelength limit of, say, 1480.000 nm. Calling `WAVEACT` with a different value would cause the wavelength to be corrected to be outside the valid range.
So, after `WAVEACT 1480.009`, the Tunable Laser Source will attempt to set a new wavelength of 1479.991 nm, which is outside the wavelength limits.

Note	It is advisable not to call `WAVEACT` with modulation or coherence control on.

`WAVEACT` is not available on HP 8167A models with serial numbers lower than 3424Gxxxxx, or on any HP 8168A models.

For an example of the use of `WAVEACT`, see "Example 5 - Increased Tuning Linearity" in Chapter 6.

Example `WAVEACT 1541nm`

6

Programming Examples

This chapter gives some programming examples. The language used for the programming is BASIC 5.1 Language System used on HP 9000 Series 200/300 computers. Example 5 also gives an equivalent listing in C.

These programming examples do not cover the full command set for the instrument. They are intended only as an introduction to the method of programming the instrument. The programming examples use the HP-IB.

6

Example 1 - Checking Communication

Function

This program sends a queries, and displays the reply.

Listing

```
10    !-----------------------------
20    !
30    ! HP 8167A/8D/8E/8F Programming Example 1
40    !
50    ! A Simple Communications Check
60    !
70    !-----------------------------
80    !
90    ! Definitions and initializations
100   !
110   Tls=724
```
This statement sets the address of the tunable laser source. The first 7 is to access the HP-IB card in the controller, the 24 is the HP-IB address of the tunable laser source
```
120   DIM String$[50]
130   !
140   CLEAR SCREEN
150   PRINT TABXY(5,10);"Programming Example 1, Simple Communications"
160   !
170   ! Send an IDN query to the TLS and get the TLS Identification
180   !
190   OUTPUT Tls;"*IDN?"
200   ENTER Tls;String$
210   PRINT TABXY(10,12);"Identification : ";String$
```
The *IDN? query gets the identification of the tunable laser source.
```
220   !
230   END
```

Example 2 - Status Registers and Queues

Example 2 - Status Registers and Queues

Function

This program sends a commands and queries typed in by the user. The contents of the status byte and the standard event status register are displayed. These registers are updated for each new command, and each time a Service ReQuest (SRQ) occurs. The number of the most recent error, and the most recent contents of the output queue is also displayed.

Listing

```
10      !---------------------------------------------------
20      !
30      ! HP 8167A/8D/8E/8F Programming Example 2
40      !
50      ! Status Structure, and a useful self learning tool
60      !
70      !---------------------------------------------------
80      !
90      ! Declarations and initializations
100     !
110     INTEGER Value,Bit,Quot,Xpos,Ypos
120     DIM Inp$[100]
130     DIM A$[300]
140     Tls=724
150     ON INTR 7 GOSUB Pmm_srq
160     !
170     ! Mask the registers
180     !
190     OUTPUT Tls;"*SRE 248;*ESE 255"
```

The *SRE 248 command enables bits 7 (Operation Status Summary), 5 (ESB), 4 (MAV), and 3 (Questionable Status Summary) in the status byte (bit 6 (SRQ) cannot be disabled in this register).
The *ESE 255 command enables all of the bits in the Event Status Register.

```
200     !
210     ! Set up the screen
220     !
230     CLEAR SCREEN
240     PRINT TABXY(40,3);"Status Byte"
250     PRINT TABXY(4,1);"  OPS SRQ ESB MAV QUE"
260     PRINT TABXY(4,2);" +---+---+---+---+---+---+---+---+"
270     PRINT TABXY(4,3);" :   :   :   :   :   :   :   :   :"
280     PRINT TABXY(4,4);" +---+---+---+---+---+---+---+---+"
290     PRINT TABXY(4,5);"            ^"
```

Example 2 - Status Registers and Queues

```
300    PRINT TABXY(4,6);"               :"
310    PRINT TABXY(4,7);" +------------------------------+"
320    PRINT TABXY(4,8);" :           OR                 :"
330    PRINT TABXY(4,9);" +------------------------------+"
340    PRINT TABXY(4,10);"   ^    ^    ^    ^    ^    ^    ^    ^"
350    PRINT TABXY(4,11);" +---+---+---+---+---+---+---+---+"
360    PRINT TABXY(4,12);" :   :   :   :   :   :   :   :   :"
370    PRINT TABXY(4,13);" +---+---+---+---+---+---+---+---+"
380    PRINT TABXY(4,14);"  PON URQ CME EXE DDE QYE RQC OPC"
390    PRINT TABXY(40,12);"Standard Event Status Register"
400    PRINT TABXY(4,16);"Last Command :"
410    PRINT TABXY(4,17);"Last Error   :"
420    PRINT TABXY(4,18);"Output Queue :"
430    !
440    ! Start the program loop and enable the interrupt for the errors
450    !
460    Ende=0
470    GOSUB Pmm_srq
480    ENABLE INTR 7;2
490    !
500    ! The Central Loop
510    !
520    REPEAT
530      INPUT "Command ?  ",Inp$
540      GOSUB Pmm_srq
550      OUTPUT Tls;Inp$
560      PRINT TABXY(21,16);"                                          "
570      PRINT TABXY(21,16);Inp$
580      WAIT 1.0
590    UNTIL Ende=1
600    GOTO 1380
610    !
620    !---------------------------------------------------------------
630 Pmm_srq: ! Interrupt Handling Subroutine to display the status, and the
640    ! error and output queues
650    !---------------------------------------------------------------
660    !
670    ! Get the value for the Status Byte
680    !
690    Value=SPOLL(Tls)
700    !
710    ! Initialize and start the display of the registers
720    !
730    PRINT TABXY(21,17);"                                          "
740    PRINT TABXY(21,18);"                                          "
750    Ypos=3
```

Example 2 - Status Registers and Queues

```
760    FOR Z=0 TO 1
770      Bit=128
780      Xpos=7
790      !
800      ! Do it for each bit
810      !
820      REPEAT
830        Quot=Value DIV Bit
840        !
850        ! If the bit is set then display 1
860        !
870        IF Quot>0 THEN
880          PRINT TABXY(Xpos,Ypos);"1"
890          Value=Value-Bit
900          !
910          ! If MAV is set, then get and display the output queue contents
920          !
930          IF Z=0 THEN
940            IF Bit=16 THEN
950              ENTER Tls;A$
960              PRINT TABXY(21,18);A$
970            END IF
980          END IF
990          !
1000         ! If the bit is not set, then display 0
1010         !
1020       ELSE
1030         PRINT TABXY(Xpos,Ypos);"0"
1040       END IF
1050       !
1060       ! Set up for the next iteration
1070       !
1080       Bit=Bit DIV 2
1090       Xpos=Xpos+4
1100     UNTIL Bit=0
1110     !
1120     ! Now that the status byte is displayed, get the Standard Events
1130     ! Status Register
1140     !
1150     OUTPUT Tls;"*ESR?"
1160     ENTER Tls;Value
1170     !
1180     ! Set up to display the ESR
1190     !
1200     Ypos=12
1210   NEXT Z
```

Example 2 - Status Registers and Queues

```
1220  !
1230  ! Read and display any messages in the error queue
1240  !
1250  REPEAT
1260    OUTPUT Tls;"SYSTEM:ERROR?"
1270    ENTER Tls;Value,A$
```
The SYSTEM:ERROR? query gets the number of the last error in the error queue.
```
1280    IF Value<>0 THEN PRINT TABXY(21,17);Value,A$
1290  UNTIL Value=0
1300  !
1310  ! Clear the Status structure and reenable the interrupt before returning
1320  !
1330  OUTPUT Tls;"*CLS"
1340  ENABLE INTR 7
1350  !
1360  RETURN
1370  !
1380  END
```

6

Example 3 - Measuring the Power of a Modulated Signal

Example 3 - Measuring the Power of a Modulated Signal

Function

This program performs the same sequence as the first part of the sample session given in chapter 1. That is, to measure the power of 1540nm signal, modulated by a 100kHz square wave, at 500μWatts.

Requirements

The sample session is written for an HP 8168E/F Tunable Laser Source, and an HP 8153A Lightwave Multimeter with an HP 81532A Power Sensor (It is assumed that the power sensor is inserted in channel A). To perform the sample session as described here, you also need a connector interface for the multimeter (for example, an HP 81000AI), and a patchcord (if you are using the HP 81000AI, then a Diamond HMS-10/HP/HRL to Diamond HMS-10/HP patchcord, HP 81109AC).

Setting Up the Equipment

1. Make sure that all your connectors, and connector interfaces are clean.

2. Make sure that the Optical Output on the laser source is not Active.

3. Connect the output of the laser source to the input of the power sensor (as shown in the figure below). Make sure that the connector with the orange strain-relief sleeve is connected to the tunable laser source (the orange sleeve indicates an angled connector).

Example 3 - Measuring the Power of a Modulated Signal

Figure 6-1. Connecting the Instruments for the Sample Session

Typically, you would connect a component to test between the tunable laser source and the power meter.

4. Make sure that both instruments are powered up.

Note	Normally you also need to be sure that the instruments are properly warmed up before using the source, or making any measurements. In this case, because the measurements are not critical, it is acceptable to proceed immediately to the next step.

Listing

```
10    !----------------------------------------
20    !
30    ! Programming Example 3
40    !
50    ! Measuring the Power of a Modulated Signal
60    !
70    !----------------------------------------
80    !
90    ! Definitions and Initializations
100   !
110   Tls=724
120   Mm=722
130   !
140   Wavel=1.540E-6
150   Oppwr=5.00E-4
160   Opfrq=1.00E+5
170   !
180   ! Set the multimeter to measure in Watts, with an averaging time of 1s,
```

Example 3 - Measuring the Power of a Modulated Signal

```
190   ! and to autorange
200   !
210   OUTPUT Mm;"sense1:power:unit W;atime 1s;range:auto on"
220   !
230   CLEAR SCREEN
240   PRINT TABXY(2,2);"Programming example 3: Measuring the power of a Modulated Signal"
250   !
260   ! Set up the power on the tunable laser source, and on the meter
270   !
280   OUTPUT Tls;"wavelength ";Wavel
290   OUTPUT Mm;"sense1:power:wavelength ";Wavel
300   !
310   ! Set the modulated power on the TLS
320   !
330   OUTPUT Tls;"power:unit W;:power ";Oppwr
340   OUTPUT Tls;"am:state on;internal:frequency ";Opfrq
350   !
360   ! Switch on the optical output of the TLS
370   ! Read the value from the multimeter, and display it
380   !
390   OUTPUT Tls;"output on"
400   WAIT 3
```
Let everything settle before making a reading
```
410   OUTPUT Mm;"read1:power?"
420   ENTER Mm;A
430   PRINT TABXY(4,4);"The power read is";A*1E6;"uW"
440   !
450   END
```

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Example 4 - Measuring a Wavelength Characteristic

Function

This program performs the same sequence as the second part of the sample session given in chapter 1. That is, to measure a wavelength characteristic.

The requirements and the setting up are as described in Example 3.

Listing

```
10    !-------------------------------------
20    !
30    ! HP 8168E/F Programming Example 4
40    !
50    ! Measuring a Wavelength Characteristic
60    !
70    !-------------------------------------
80    !
90    ! Definitions and Initializations
100   !
110   Tls=724
120   Mm=722
130   !
140   Startw=1.535E-6
150   Stopw=1.545E-6
160   Stepw=1.E-9
170   !
180   ! Initialize the two instruments
190   !
200   OUTPUT Tls;"power:unit W;:am:state off"
210   OUTPUT Mm;"sense1:power:unit W;atime 1s;range:auto:on"
220   !
230   CLEAR SCREEN
240   PRINT TABXY(2,2);"Programming Example 4: Measuring a Wavelength Characteristic"
250   PRINT
260   PRINT
270   !
280   ! Find the maximum power for the full range
290   !
300   OUTPUT Tls;"power max"
```
We set the power to the absolute maximum for the instrument
```
310   OUTPUT Tls;"power? max"
320   ENTER Tls;Maxpower
330   Wavel=Startw
340   REPEAT
```

Example 4 - Measuring a Wavelength Characteristic

```
350     OUTPUT Tls;"Wavelength ";Wavel
360     OUTPUT Tls;"power?"
370     Enter Tls;Power
```
This reads back the actual (maximum) power that is being output
```
380     IF Power<Maxpower THEN Maxpower=Power
```
We want to find the lowest maximum power
```
390     Wavel=Wavel+Stepw
400   UNTIL Wavel>Stopw+(Stepw/2)
```
*We check for the end this way because these are floating point numbers, and they may not fulfill an
end condition exactly*
```
410   OUTPUT Tls;"power ";Maxpower
420   !
430   ! Switch on the laser source
440   !
450   OUTPUT Tls;"output on"
460   WAIT 2
470   !
480   ! Measure the power over the range
490   !
500   Wavel=Startw
510   REPEAT
520     OUTPUT Tls;"Wavelength ";Wavel
530     OUTPUT Mm;"sense1:power:wavelength ";Wavel
540     WAIT 1
550     OUTPUT Mm;"read1:power?"
560     ENTER Mm;A
570     PRINT "The power read at";Wavel*1.E+9;"nm is";A*1.E+6;"uW"
580     Wavel=Wavel+Stepw
590   UNTIL Wavel>Stopw+(Stepw/2)
600   !
610   END
```

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Example 5 - Increased Tuning Linearity

Function

This example shows how you can increase the Tuning Linearity, using the HP-IB command `WAVEACT`. Figure 6-2 shows the measurement setup.

Figure 6-2. Measurement setup for Increased Tuning Linearity

The tunable laser source and wavelength meter are initialized. The TLS is then programmed to the first wavelength of the sweep: for example, 1550.000 nm.

The actual wavelength is read from the wavelength meter, which might be 1550.018 nm. The difference between the measured and programmed values is

Example 5 - Increased Tuning Linearity

18 pm, which is larger than the 1 pm tolerance allowed in this example. The measured wavelength reading is therefore sent to the TLS using the HP-IB command WAVEACT.

The TLS will now detune itself to reduce the difference. The new wavelength is read with the wavelength meter, and the correction loop repeated until the difference is reduced to the allowed tolerance. Once the correct wavelength is achieved, the receiver can be read.

This process is repeated for each wavelength in the sweep (Figure 6-3).

Figure 6-3.
Flow chart describing Increased Tuning Linearity program.

In this example, the allowed wavelength difference is 1 pm, that is the minimum achievable on the TLS. This will typically take several cycles through the correction loop. Allowing a larger tolerance will reduce the average number of correction cycles and overall test time.

Example 5 - Increased Tuning Linearity

The program also exits the loop after ten tries, regardless of the wavelength difference. If the TLS does not reach the desired tolerance within ten tries, there is a problem in the system. It is most likely that the tolerance has been set at a smaller value than that of the stability (noise) of the wavelength meter. This must be avoided, since the tunable laser will be chasing a moving number, which will waste time without improving performance.

Any wavelength meter of sufficient accuracy, linearity, and stability can be used.

Basic Listing

```
1      ! This program first sets the targeted wavelength
2      ! It then enters in a loop until the Targeted wavelength
3      ! is close enough to the targeted one.
4      ! This program uses the HP 86120A multi-wavelength meter
10     COM Elevat,Start_wl,Stop_wl,Step_wl,Allow_diff,Numb_tries
20     COM Target_wl,Current_wl,Diff_wl,Loop_count
30     !
40     !
50     Start_wl=1550
60     Stop_wl=1555
70     Step_wl=.001
80     Allow_diff=.001
90     Numb_tries=10
100    !
110    Target_wl=0
120    Current_wl=0
130    Diff_wl=0
140    !
150    ASSIGN @Tls TO 724
160    ASSIGN @Mwm TO 720
170    !
180    OUTPUT @Tls;"*CLS"
190    OUTPUT @Tls;"*RST"
200    !
210    OUTPUT @Mwm;"*CLS"
220    OUTPUT @Mwm;"*RST"
230    OUTPUT @Mwm;"SENSE:CORR:ELEV 2000"
240    !
250    OUTPUT @Tls;"OUTP ON"
260    !
270    !
280    FOR I=Start_wl TO Stop_wl STEP Step_wl
290    !
300      PRINT ""
```

Example 5 - Increased Tuning Linearity

```
310    PRINT "Target = ";I;" NM"
320  !
330    Target_wl=I*1.0E-9
340  !
350    OUTPUT @Tls;":WAVE";Target_wl
360    OUTPUT @Tls;"*OPC?"
370    ENTER @Tls;Ready
380  !
390   Loop_count=0
400  !
410    LOOP
420      OUTPUT @Mwm;":MEAS:SCAL:POW:WAV?
430      ENTER @Mwm;Current_wl
440      Diff_wl=Current_wl-Target_wl
450      PRINT "Current =";Current_wl*1.0E+9,"Diff
=";PROUND(Diff_wl*1.E+9,-4)
460    EXIT IF ABS(Diff_wl)<(Allow_diff+.0005)*1.0E-9 OR
Loop_count=Numb_tries
470      OUTPUT @Tls;":WAVEACT ";Current_wl
480      Loop_count=Loop_count+1
490    END LOOP
500  !
510  !  (Read the receiver at this point)
520  !
530   NEXT I
540  !
550   END
```

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Example 5 - Increased Tuning Linearity

Table 6-1. Program Description: Increased Tuning Linearity

Line No.	Description
10 to 20	Dimension, and make common all variables.
50 to 90	Start, stop and step size are set here for the sweep range. Allow_diff is the tolerance for wavelength correction. All wavelength values entered in nm here. Numb_tries is the maximum number of times through the correction loop.
110 to 130	Set working variables to zero.
150 to 160	Tls (HP 8168E/F tunable laser source) is at HP-IB address 24, and the Mwm (HP 86120A multi-wavelength meter) is at HP-IB address 20.
180 to 220	*CLS (clear status byte) and *RST (reset to default settings) the Tls and Mwm. *RST is important for the Mwm because it must be in single trigger mode for line 420 to work (single trigger is the default mode).
230	For accuracy, the elevation must be sent to the Mwm in meters. The default is 0 m, so this line can be omitted if used at sea level.
250	Enable the output of the Tls.
280	Start of the FOR .. NEXT loop for the wavelength sweep. Start, stop and step values set in lines 50 to 70. End of this loop is line 530.
300 to 310	Optional. Prints a blank line and then the programmed or "target" wavelength.
330	Convert the target wavelength in nm to meters, which is the default unit on the Tls and Mwm.
350	Program the Tls with the "target" wavelength.
360 to 370	The Tls must be settled (have finished tuning) before being read by the Mwm. The Tls will not respond to *OPC? (operation complete) until it is settled.
390	Reset the correction loop counter.
410	The start of the wavelength correction loop. The loop ends at line 490.
420	This triggers a single wavelength measurement on the Mwm.
430	Enter the measured wavelength in the variable Current_wl.
440	Calculate the wavelength difference between Current_wl (measured by the Mwm) and Target_wl (to which the Tls is set). This is the wavelength error.
450	Optional. Print the current (measured) wavelength (converted back to nm) and the difference wavelength (the error, converted to nm and rounded to four digits).
460	The correction loop is exited if either the Diff_wl (wavelength difference or error) is less than or equal to that set as Allow_diff (in line 80), or if this loop has been repeated Numb_tries (set in line 90) times. It is necessary to take the absolute value of Diff_wl for the comparison. One half pm is added to Allow_diff, and < is used as a way to accomplish < or = conditional. This avoids noise problems of less than 1 pm.
470	This is the special command to send the wavelength measured by the Mwm to the Tls for wavelength. correction. The Tls internally compares this measured wavelength with the programmed wavelength (of line 350) and attempts to correct it's output wavelength.
480	Increments the loop counter by 1.
490	End of the correction loop.
510	The Tls is corrected at this point. Put commands to read the receiver (power meter, *OSA , and so on) here.
530	End of the wavelength sweep loop.

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Example 5 - Increased Tuning Linearity

C Listing

```
/*-----------------------------------------------------------------------*
 *
 * File: set_wave.c
 *
 * Notes:
 *
 * o You have to include <math.h>, <your_hpib_interface.h> to use
 *   these functions.
 *
 * o There is no error handling shown here.
 *
 * o Instruments are not initialized here.
 *
 * o Maybe you should wait until your instruments have completed
 *   their operations. (e.g. Wait for OPC on HP 8167/68)
 *
 * o In this example we use the hpib library SICL
 *   (Standard Instrument Control Library);
 *   used commands:
 *   - iopen       open an instrument              (like fopen)
 *   - iclose      close an instrument             (like fclose)
 *   - iprintf     send a message to an instrument      (like fprintf)
 *   - iscanf      get a message from an instrument     (like fscanf)
 *   - ipromptf    a combination of iprintf and iscanf
 *   the type INST is an instrument handle          (like FILE)
 *
 * o to compile we use the command
 *     cc -Aa -o set_wave set_wave.c -lsicl -lm
 *
 *
 *
 *-----------------------------------------------------------------------*/

#include <stdlib.h>
#include <stdio.h>
#include <math.h>
#include <sicl.h>                                  /* for our hpib library */

int    SetExactWvl   (double theWvl);              /* function prototypes  */
double GetWavelength (INST theInstrument);

/*-----------------------------------------------------------------------*/
int main (int argc, char **argv)
/*-----------------------------------------------------------------------*/
{
  double theWvl;
```

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Example 5 - Increased Tuning Linearity

```
   if (argc != 2)
     exit(-1);

   sscanf(argv[1], "%lf", &theWvl);

   return (SetExactWvl (theWvl));
}

/*-------------------------------------------------------------------------*/
int SetExactWvl (double theWvl)
/*-------------------------------------------------------------------------*/
{
                                          /* open the instruments:          */
   INST laserSource = iopen("hpib,24");   /* laser source at hpib address 24 */
   INST waveMeter   = iopen("hpib,06");   /* wave meter at hpib address 6    */

   int  trialCnt;
   int  trialMax = 10;

   double actWvl;
   double diffWvlMax = 1.5e-12;                                  /* 1.5 pm */

   iprintf (laserSource, "WAVE %lg\n", theWvl);       /* set the wavelength */
   iprintf (laserSource, "OUTP ON\n");                /* turn the laser on  */

   for (trialCnt = 0; trialCnt < trialMax; trialCnt++)
    {
      actWvl = GetWavelength (waveMeter);              /* read the wavelength */

      if (fabs(actWvl - theWvl) < diffWvlMax)       /* break if near enough */
        break;

      iprintf (laserSource, "WAVEACT %lg\n", actWvl);/* tell the laser source */
                                                     /* the actual wavelength */
    }

   iclose (laserSource);                             /* close the instruments */
   iclose (waveMeter);

   return trialCnt;
}

/*-------------------------------------------------------------------------*/
double GetWavelength (INST theInstrument)
/*-------------------------------------------------------------------------*/
{
   double actualWvl;
```

Example 5 - Increased Tuning Linearity

```
                        /* With this cryptic command we get the wavelength  */
                        /* from an ADVANTEST TQ8325 wavelength meter         */

    ipromptf (theInstrument, "H0D0M0A1E\n","%lf", &actualWvl);

    return (actualWvl);
}
```

A

Installation

This appendix provides installation instructions for the tunable laser source. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage, and shipment.

Safety Considerations

The Model tunable laser source is a Class 1 instrument (that is, an instrument with an exposed metal chassis directly connected to earth via the power supply cable). The symbol used to show a protective earth terminal in the instrument is ⏚ .

Before operation, you should review the instrument and manual, including the red safety page, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, you should keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

The Function Test gives a procedure for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Hewlett-Packard office.

Warning	To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

AC Line Power Supply Requirements

The tunable laser source can operate from any single-phase AC power source that supplies between 100V and 240V at a frequency in the range from 50 to 60Hz. The maximum power consumption is 360VA with all options installed.

Line Power Cable

According to international safety standards, this instrument has a three wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure A-1 for the part numbers of the power cables available.

A

Australia	Denmark	Europe	Great Britain
8120-1369	8120-2956	8120-1689	8120-1351

South Africa	Switzerland	United States
8120-4211	8120-2104	8120-1378

Figure A-1. Line Power Cables - Plug Identification

Warning	To avoid the possibility of injury or death, you must observe the following precautions before switching on the instrument.

- If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the Common terminal connects to the earthed pole of the power source.

- Insert the power cable plug only into a socket outlet provided with a protective earth contact. Do not negate this protective action by the using an extension cord without a protective conductor.

- Before switching on the instrument, the protective earth terminal of the instrument must be connected to a protective conductor. You can do this by using the power cord supplied with the instrument.

- Do not interrupt the protective earth connection.

The following work should be carried out by a qualified electrician. All local electrical codes must be strictly observed. If the plug on the cable does not fit the power outlet, or if the cable is to be attached to a terminal block, cut the cable at the plug end and rewire it.

The color coding used in the cable depends on the cable supplied. If you are connecting a new plug, it should meet the local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications).

- Ground connection.

- Cable clamp.

The AC power requirements are summarized on the rear panel of the instrument.

A

Figure A-2. Rear Panel Markings

Changing the Battery

This instrument contains a lithium battery. Changing the battery should be carried out only by a qualified electrician or by HP service personnel. There is a danger of explosion if the battery is incorrectly replaced. Replace only with the same or an equivalent type (HP part number 1420-0298). Discard used batteries according to local regulations.

Changing the Fuse

There are two fuses in this instrument. Both of the fuses are T4.0A/250V time-lag (HP Part No. 2110-0014). The fuse holder is at the rear of the instrument, below the line power connector. To change a fuse,

1. Release the fuse holder: use the blade of a flat-headed screwdriver to depress the catch at the top of the holder and then pull the holder out a little.

Figure A-3. Releasing the Fuse Holder

2. Pull the fuse holder out of the instrument.

Figure A-4. The Fuse Holder

3. Check and change the fuses as necessary.

4. Place the fuse holder back in the instrument, and push it until the catch clicks back into place.

A

Operating and Storage Environment

The following summarizes the tunable laser source operating environment ranges. In order for the tunable laser source to meet specifications, the operating environment must be within these limits.

Warning   **The tunable laser source is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.**

Temperature

The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.

The storage and operating temperature for the tunable laser source are given in the table below.

Table A-1. Temperature

	Operating Range	Storage Range
Specified	10°C to 35°C	-40°C to 70°C

Humidity

The operating humidity for the tunable laser source is 15% to 95% from 10°C to 35°C.

Instrument Positioning and Cooling

The tunable laser source has a cooling fan mounted internally. Mount or position the instrument upright and horizontally so that air can circulate through it freely. When operating the tunable laser source, choose a location that provides at least 75mm (3inches) of clearance at the rear, and at least 25mm (1inch) of clearance at each side. Failure to provide adequate air clearance may result in excessive internal temperature, reducing instrument reliability.

A

Figure A-5. Correct Positioning of the Tunable Laser Source

Switching on the Tunable Laser Source

When you switch on the tunable laser source it goes through three start-up phases

1. Self test,

2. Initializing, and

3. Stabilizing.

Self test

This is the same self test as described in "Performing a Selftest" in Chapter 3.

Initializing

Initializing takes a minute or two. During this time, the instrument performs a self test. The first test is of the memory; while this is being done, all the elements on the display are turned on. If the instrument fails the memory test, this display will start blinking. After this, the rest of the self test is performed. The test being performed is shown on the display.

A

Stabilizing

Stabilizing is the process of heating up the heat chamber to its operating temperature (55±1°C). The length of time taken depends on how warm the heat chamber is when the instrument is first switched on. Under normal (laboratory) conditions, this takes approximately one hour. The percentage of operating temperature that has been reached is displayed as part of the STABILIZING message that is shown at the top of the screen during the process. The instrument only meets specifications while the heat chamber is at the operating temperature.

If you try to set a power level which cannot be supplied during the stabilizing, then the AVAILABLE message is displayed with the maximum power that is available.

Note	If the value is simultaneously too low for the coherence control, if you are also using this, the AVAILABLE is shortened to AVA.

Stabilizing during Operation

The instrument will maintain the heat chamber within the operating limits (54°C→56°C) if you are using the instrument in a normal laboratory environment. If you are using the tunable laser source in either an extremely warm, or an extremely cold environment, the STABILIZING message may appear from time to time as the instrument tries to get back to the operating temperature. The stabilizing level should not decrease beyond 95%.

In an extreme case, the STABILIZING message will appear and the percentage value will decrease below 95%, and possibly keep decreasing. In this case you should switch off the instrument, and let it cool down completely before powering it up again.

Signal Outputs.

There are two signal outputs on the front panel of the tunable laser source.

■ One of these is the Modulation Output, which outputs the internal signal used to modulate the optical output. This is a squarewave signal with 50% duty cycle, and is at TTL levels (see "Setting the Modulation Output" in Chapter 3 and "[:SOURCE]:MODOUT" in Chapter 5 for more information).

■ The other is the analog output, which outputs a voltage level proportional to the power of the output laser signal. The relationship between this voltage level and the output power is not calibrated, but is approximately 1mV for each 1μW.

Caution	The maximum external voltages that can be applied to the outputs of this instrument are ±10V.

Optical Output

Caution	If the optical termination on your instrument is angled, you can only use cables with angled connectors with the instrument.

A

See "Connector Interfaces and Other Accessories" in Appendix B for further details on connector interfaces and accessories.

Option 007	If you have an instrument with a polarization maintaining fiber (PMF), the PMF will be automatically aligned and maintain the state of polarization..
	The fiber is of Panda type, with T_E mode in the slow axis in line with the connector key.

Figure A-6. PMF Output

HP-IB Interface

You can connect your HP-IB interface into a star network, a linear network, or a combination star and linear network. The limitations imposed on this network are as follows:

- The total cable length cannot exceed 20 meters
- The maximum cable length per device is 2 meters
- No more than 15 devices may be interconnected on one bus.

Connector

The following figure shows the connector and pin assignments.

Connector Part Number: 1251-0293

Figure A-7. HP-IB Connector

Caution	HP products delivered now are equipped with connectors having ISO metric- threaded lock screws and stud mounts (ISO M3.5×0.6) that are black in color. Earlier connectors may have lock screws and stud mounts with imperial-threaded lock screws and stud mounts (6-32 UNC) that have a shiny nickel finish.

Caution	■ It is recommended that you do not stack more than three connectors, one on top of the other. ■ Hand-tighten the connector lock screws. Do not use a screwdriver.

HP-IB Logic Levels

The tunable laser source HP-IB lines use standard TTL logic, as follows:

■ True = Low = digital ground or 0Vdc to 0.4Vdc

■ False = High = open or 2.5Vdc to 5Vdc

All HP-IB lines have LOW assertion states. High states are held at 3.0Vdc by pull-ups within the instrument. When a line functions as an input, it requires approximately 3.2mA to pull it low through a closure to digital ground. When a line functions as an output, it will sink up to 48mA in the low state and approximately 0.6mA in the high state.

Note	The HP-IB line screens are not isolated from ground.

Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

Return Shipments to HP

If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be reusable, but the Hewlett-Packard Sales/Service Office will provide information and recommendation on materials to be used if the original packing is no longer available or reusable. General instructions for repackaging are as follows:

1. Wrap instrument in heavy paper or plastic.

2. Use strong shipping container. A double wall carton made of 350-pound test material is adequate.

3. Use enough shock absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.

4. Seal shipping container securely.

5. Mark shipping container FRAGILE to encourage careful handling.

6. In any correspondence, refer to instrument by model number and serial number.

B

Accessories

Mainframe

Mainframe Description	Model No.
Tunable Laser Source 1280nm to 1330nm	HP 8167A
Tunable Laser Source 1490nm to 1565nm	HP 8168D
Tunable Laser Source 1470nm to 1580nm	HP 8168E
Tunable Laser Source 1450nm to 1590nm	HP 8168F
Handle Kit	Option 1CN
Rack Kit	Option 1CM
(Additional) Operating and Programming Manual	Option 0B2

Options

Figure B-1. Tunable Laser Source Options Overview

Option 003:

Built-in optical attenuator with 40dB attenuation range, cannot be combined with option 007.

Option 003 is not available for the 8168D.

Option 007:

Polarization maintaining fiber, Panda-type, for straight or angled connector types (depending on the connector option selected), cannot be combined with option 003 or 023.

Option 007 is availablr for all models.

Connector Interfaces and Other Accessories

The tunable laser source is supplied with one of three connector interface options.

- Option 021 with a straight contact connector
- Option 022 with an angled contact connector

■ Option 023 with a Diamond HMS-10/HP/HRL angled, non-contact connector. Cannot be combined with option 007.

Option 023 is not available for the 8168D.

Option 021, Straight Contact Connector. If you want to use straight connectors (such as FC/PC, Diamond HMS-10, DIN, Biconic, SC, ST, or D4) to connect to the instrument, you must

1. attach your connector interface (see the list of connector interfaces below) to the interface adapter,

2. then connect your cable.

Figure B-2. Tunable Laser Source Option 021 Configuration

| Connector Interface | |
Description	Model No.
Biconic	HP 81000WI
D4	HP 81000GI
Diamond HMS-10	HP 81000AI
DIN 47256	HP 81000SI
FC/PC	HP 81000FI
SC	HP 81000KI
ST	HP 81000VI

Option 022, Angled Contact Connector. If you want to use angled contact connectors (such as FC/APC, Diamond HRL-10, DIN, or SC/APC) to connect to the instrument, you must

1. attach your connector interface (see the list of connector interfaces below) to the interface adapter,

2. then connect your cable.

B

Figure B-3. Tunable Laser Source Option 022 Configuration

Connector Interface	
Description	Model No.
DIN 47256-4108	HP 81000SI
FC/APC	HP 81000FI
SC/APC	HP 81000KI

Option 023, Diamond HMS-10/HRL Angled, Non-Contact Connector. The instrument as it is delivered with this option can only be used with cables with Diamond HMS-10/HP/HRL angled connectors. To connect angled connectors (such as FC/APC, DIN 47256-4108, Radiall, and so on), use the appropriate patchcord.

If you want to use straight connectors (such as FC/PC, Diamond HMS-10, DIN, Biconic, SC, ST, or D4) to connect to the instrument, you must

1. replace the HMS-10 connector interface with an interface adapter (HP 81000UI),

2. attach your connector interface (see the list of connector interfaces below) to the interface adapter,

3. then connect your cable.

Figure B-4. Tunable Laser Source Option 023 Configuration

Cables with Angled Connectors

Description	Model No.
Diamond HMS-10/HP/HRL - Bare Fiber	HP 81102BC
Diamond HMS-10/HP/HRL - Diamond HMS-10/HP/HRL	HP 81102AC
Diamond HMS-10/HP/HRL - Diamond HMS-10/HP	HP 81109AC
Diamond HMS-10/HP/HRL - DIN 47256-4108	HP 81102SC
Diamond HMS-10/HP/HRL - FC/APC	HP 81102PC
Diamond HMS-10/HP/HRL - Radiall	HP 81102DC

Interface Adapter	
Description	**Model No.**
Interface Adapter	HP 81000UI

HP-IB Cables and Adapters

The HP-IB connector is compatible with the connectors on the following cables and adapters.

- HP-IB Cable, 10833A, 1 m (3.3 ft.)

- HP-IB Cable, 10833B, 2 m (6.6 ft.)

- HP-IB Cable, 10833C, 4 m (13.2 ft.)

- HP-IB Cable, 10833D, 0.5 m (1.6 ft.)

- HP-IB Adapter, 10834A, 2.3 cm extender.

B

C

Specifications

Definition of Terms

Absolute wavelength accuracy:
The maximum difference between the actual wavelength and the displayed wavelength of the TLS. Wavelength is defined as wavelength in vacuum.
Conditions: constant power level, temperature within operating temperature range, coherence control off.
Measurement with wavelength meter.

Linewidth:
The 3 dB width of the optical spectrum, expressed in Hertz.
Conditions: temperature within operating temperature range, coherence control off.
Measurement with heterodyning technique: the output of the laser under test is mixed with another laser of the same type on a wide bandwidth photodetector. The electrical noise spectrum of the photodetector current is measured with HP lightwave signal analyzer.

Maximum specified output power:
The maximum output power specified at a specific wavelength.

Measurement at the end of a patchcord.

Figure C-1.
Maximum Specified Output Power for 8168D, E and F (without options)

Minimum output power:
The minimum output power for which the specifications apply.

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Output power:	The maximum output power for the specified TLS tuning range. *Conditions:* temperature within operating temperature range. *Measurement* with power meter at the end of a single-mode fiber patchcord.
Peak power:	The highest optical power within specified wavelength range.
Polarization extinction ratio:	The ratio of optical power in the slow axis of the polarization-maintaining fiber to optical power in the fast axis within a specified wavelength range. *Conditions:* only for TLS with polarization maintaining fiber, TE mode in slow axis and oriented in line with connector key. *Measurement* with rotatable polarizer at the end of a polarization-maintaining patchcord, with polarizer orientations for the fast and slow axes kept fixed while changing the wavelength.
Power flatness:	When changing the wavelength and measuring the differences between actual and displayed power levels, the power flatness is ± half the span between the maximum and the minimum value of all differences relative to the mean power. *Conditions:* uninterrupted line voltage, constant power setting, temperature within ±1 K. *Measurement* with optical power meter.
Power linearity:	When changing the power level and measuring the differences between actual and displayed power levels, the power linearity is ± half the span between the maximum and the minimum value of all differences. *Conditions:* uninterrupted TLS line voltage, constant wavelength- and power level settings, temperature within ±1 K. *Measurement* with optical power meter.
Power repeatability:	The random uncertainty in reproducing the power level after changing and re-setting the power level or wavelength. The power repeatability is ± half the span between the maximum and the minimum value of all differences relative to the mean power. *Conditions:* uninterrupted TLS line voltage, constant wavelength, temperature within ±1 K. *Measurement* with optical power meter.
Power stability:	The change of the power level during a given time span, expressed as ± half the span of power changes relative to the mean power. *Conditions:* uninterrupted TLS line voltage, constant wavelength- and power level settings, temperature within ±1 K, time span as specified. *Measurement* with optical power meter.

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Relative intensity noise (RIN):	The square of the RMS optical power amplitude divided by the measurement bandwidth and the square of the average optical power, expressed in dB/Hz. *Conditions:* coherence control off, temperature within operating temperature range, frequency range 0.1 to 6 GHz. *Measurement* with HP lightwave signal analyzer.
Relative wavelength accuracy:	When randomly changing the wavelength and measuring the differences between the actual and displayed wavelengths, the relative wavelength accuracy is $\pm$ half the span between the maximum and the minimum value of all differences. *Conditions:* uninterrupted TLS line voltage, constant power level, temperature within operating temperature range, coherence control off. *Measurement* with wavelength meter.
Sidemode suppression ratio:	The ratio of average signal power to the optical power of the highest sidemode within a distance from 0.1 to 6 GHz to the signal's optical frequency, expressed in dB. *Conditions:* at a specified output power and wavelength range, temperature within operating temperature range, coherence control off. *Measurement* with HP lightwave signal analyzer using heterodyning method.
Source spontaneous emission:	The ratio of spontaneous emission power in 0.1 nm bandwidth to signal power within a ± 2 nm window around the signal wavelength, at $\rightarrow$ maximum specified output power, expressed in dB per 0.1 nm. *Conditions:* at maximum specified output power, temperature within operating temperature range, coherence control off. *Measurement* with optical spectrum analyzer at 0.1 nm resolution bandwidth.
Wavelength range:	The range of wavelengths for which the specifications apply.
Wavelength repeatability:	The uncertainty in reproducing the wavelength after detuning and re-setting the wavelength. The wavelength repeatability is $\pm$ half the span between the maximum and the minimum value of all changes. *Conditions:* uninterrupted TLS line voltage, constant power level, temperature within operating temperature range, coherence control off. *Measurement* with wavelength meter.
Wavelength resolution:	The smallest possible displayed wavelength increment / decrement.
Wavelength stability:	The change of wavelength during a given time span, expressed as $\pm$ half the span between the maximum and the minimum wavelengths. *Conditions:* uninterrupted TLS line voltage, constant wavelength- and power level settings, coherence control off, temperature within ± 1 K, time span as specified. *Measurement* with wavelength meter

C

Performance Specifications

Specifications describe the instrument's warranted performance. They are
measured at the end of a 2m long patchcord and are valid for the output power
and the wavelength ranges stated below.
Supplementary performance characteristics describe the instrument's
non-warranted typical performance.

	HP 8167A	HP 8168D	HP 8168E	HP 8168F
Wavelength Range	1280nm to 1330nm	1490nm to 1565nm	1475nm to 1575nm	1450nm to 1590nm
Absolute Wavelength Accuracy, typ[1]	±0.1nm	±0.2nm	±0.1nm	
Relative Wavelength Accuracy	±0.035nm, typ ±0.001nm[2]	±0.1nm	±0.035nm, typ ±0.001nm[2]	±0.035nm (1475-1575nm) ±0.050nm (1450-1590nm), typ ±0.001nm[2]
Wavelength Resolution	0.001nm, 170MHz at 1300nm	0.1nm	0.001nm, 125MHz at 1550nm	
Wavelength Stability (typ over 1 hour at constant temperature)	<±100MHz	±1GHz	<±100MHz	
Wavelength Repeatability	±0.035nm, typ ±0.001nm[2]	±0.1nm	±0.035nm, typ ±0.001nm[2]	±0.035nm (1475-1575nm) ±0.050nm (1450-1590nm), typ ±0.001nm[2]
Sidemode Suppression Ratio, typ[3]	>40dB (1280-1330nm at -7dBm)	n/a	>40dB (1500-1570nm at 0dBm)	>50dB (1475-1575nm at 1dBm)
Source Spontaneous Emission[4]	<-40dB/0.1nm	<-40dB/0.1nm (1500-1565nm) <-35dB/0.1nm (1490-1565nm)	<-45dB/0.1nm (1500-1570nm) <-35dB/0.1nm (1475-1575nm)	<-55dB/0.1nm (1520-1570nm) <-45dB/0.1nm (1475-1575nm) <-35dB/0.1nm (1450-1590nm)
Relative Intensity Noise (RIN), typ	<-145dB/Hz			
Linewidth (typ), coherence control off	100kHz			
Effective Linewidth (typ), coherence control on[5]	50-500MHz	30-500MHz (1500-1565nm)	50 to 500MHz (1500-1570nm)	50 to 500 MHz (1475-1575nm)

[1] Measured with a wavelength meter in a vacuum.
[2] Performance when controlled with appropriate wavelength meter.
[3] Measured by heterodyning method at specified output power (without options).
[4] Measured with optical spectrum analyzer at 0.1nm resolution bandwidth.
[5] At power levels larger than CC uncal value.

	HP 8167A	HP 8168D	HP 8168E	HP 8168F
Tuning Speed (typ for a 1/10/100nm step)[6] [7]	200ms/300ms/2s			
with #003[8]	250ms/300ms/2s	*n/a*	250ms/300ms/2s	
Output Power [9]	-3dBm peak typ	>-3dBm peak typ	>+1dBm peak typ	>+8dBm peak typ
	>-4dBm (over full wavelength range)	>-4dBm (1500-1565nm)	>0dBm (1500-1570nm)	>+7dBm (1520-1570nm)
		>-10dBm (1490-1565nm)	>-10dBm (1475-1575nm)	>1dBm (1475-1575nm)
				>-7dBm (1450-1590nm)
for #023[8]	reduce by 1dB	*n/a*	reduce by 1dB	
for #003[8]	reduce by 1.5dB	*n/a*	reduce by 1.5dB	
for #007[8]	reduce by 1dB	reduce by 1dB	reduce by 1dB	
for #023 and #003[8]	reduce by 2.5dB	*n/a*	reduce by 2.5dB	
Minimum Output Power	-10dBm			-7dBm
with #003[8]	-50dBm	*n/a*	-50dBm	-47dBm
Power Linearity	±0.1dB			±0.1dB[10]
with #003[8]	±0.3dB	*n/a*	±0.3dB	±0.3dB[10]
Power Stability (over 1 hour)	±0.03dB (typ ±0.01dB)			
Power Repeatability (typ)	±0.04dB			±0.04dB[10]
Power Flatness versus Wavelength	±0.1dB	±0.2dB	±0.1dB	±0.1dB[10] (1475-1575nm)
		typ ±0.1dB		±0.2dB[10] (1450-1590nm)
with #003[8]	±0.2dB	*n/a*	±0.2dB	±0.2dB[10] (1475-1575nm)
				±0.3dB[10] (1450-1590nm)

[6] Applicable for CW operation.
[7] The Tuning Speed increases when Modulation is on.
[8] Listed options are described in the Supplementary Performance Characteristics
[9] The Maximum power is lower when Modulation is on.
[10] For power settings below -3dBm (with option 003:P_{REF} <-3dBm, independent of attenuator setting, or power setting below -43dBm), the values shown may increase by up to 5 times.

Supplementary Performance Characteristics

Characteristics

- Output isolation (typ): 50dB
- Return loss (typ): 60dB (except option 021).

Operating Modes

Internal Modulation

Modulation frequency: 250Hz to 300kHz (squarewave)

Duty cycle: 50% fixed

Modulation depth: 100% (on/off)

Modulation output: TTL reference signal. Max power reduced by 1dB.

External modulation

Modulation frequency: 200kHz to 20MHz (at 3dB optical bandwidth, typ)

Modulation depth (max, typ): $\pm15\%$

Coherence Control

Effective linewidth of 50 to 500Mhz typ (30-500MHz typ for HP 8168D).

For measurements on components with 2m long patchcords and connectors with 14dB return loss, the effective linewidth results in a typical power stability of $<\pm0.025$dB ($<\pm0.1$dB for HP8168D) over 1 minute by drastically reducing interference effects in the test setup.

General

Polarization maintaining fiber

Fiber type: Panda

Orientation T_E mode in slow axis, in line with connector key.

Polarization Extinction Ratio: >15dB for HP 8167A and HP 8168D over the full wavelength range; >15dB for HP 8168E/F between 1490 and 1575nm, (>12dB over the full wavelength range).

HP-IB Interface

HP-IB Interface function code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC2, DT0, C0

Passive Component Test Software

Files and data can be stored on memory cards according to PCMCIA type 1, standard PCMCIA 1.0/JEIDA 4.0. Type 1 cards are 3.3mm thick. Recommended card capacity 512kByte.

Laser Class

HP8167A, HP8168D/E: Class 1 according to FDA 21 CFR 1040.10, Class 3A according to IEC 825-1 (1993).

HP 8168F: Class IIIb according to FDA 21 CFR 1040.10, Class 3A according to IEC 825-1 (1993).

Analog output: provides output voltage proportional to optical output power (except #003).

Recalibration period: 1 year (2 years for models with a Serial Number of 3426G00176 and over).

Warm-up time: typically <1 hour, can be used with reduced power in this phase.

Environmental

Altitude: up to 4,600m (15,000 feet).

Storage temperature: -40°C to +70°C

Operating temperature: 10°C to 35°C

Humidity: <95%R.H. (10°C to 35°C)

Installation Category (IEC 664): II

Pollution Degree (IEC 664): 2

Specifications are valid at non-condensing conditions.

Power: 100 to 240V_{rms}, ±10%. 260VA maximum.

Dimensions: 145mm H, 426mm W, 545mm D (5.8"×16.9"×21.6")

Weight: net 18kg (40lbs), shipping 21kg (46lbs).

Listed options

Option 003: built-in attenuator

Option 007: polarization maintaining Panda fiber

Option 021: straight contact output connector

Option 023: angled non-contact output connector

Other Specifications

Acoustic Noise Emission:

For ambient temperature up to 30°C
L_p = 40.2dB(A)
L_w = 4.8 Bel
Typical operator position,
normal operation.

Data are results from type tests per ISO 7779
(EN 27779).

Geräuschemissionswerte:

Bei einer Umgebungstemperatur bis 30°C
L_p = 40.2dB(A)
L_w = 4.8 Bel
am Arbeitsplatz,
normaler Betrieb.

Die Angabe ist das Ergebnis einer Typprüfung
gemäß ISO 7779 (EN 27779).

Declaration of Conformity

Manufacturer: Hewlett-Packard GmbH
Böblingen Instruments Division
Herrenberger Straße 130
D-71034 Böblingen
Germany

We declare that the product

Product Name: Tunable Laser Source
Model Numbers: **HP8167A**
HP8168D, HP8168E, HP8168F
Options: All

conforms to the following standards

Safety: IEC 1010-1:1990 incl. Addendum 1:1992, EN 61010:1993
IEC 825-1:1993, EN 60825-1:1994

EMC: EN 55011:1991/CISPR 11, Group 1 Class B
EN 50082-1:1992

IEC 801-2:1991	ESD	4kV cd, 8kV ad
IEC 801-3:1992	Radiated Immunity	3 V/m
IEC 801-4:1988	Fast Transients	0.5 kV, 1 kV

Supplementary Information:

The product herewith complies with the requirements of the
* Low Voltage Directive (73/23/EEC) and the
* EMC Directive (89/336/EEC).
The system also conforms to other standards not listed here. If you need information on conformance to a particular standard, please contact your local Hewlett-Packard Sales and Service Office.
This system was tested in a typical configuration with HP systems.

Böblingen, 19 February 1996   Hans Baisch
BID Regulations Consultant

D

Performance Tests

Introduction

The procedures in this section test the optical performance of the instrument. The complete specifications to which the HP 8167A/8D/8E/8F is tested are given in Appendix C. All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to tests using the Diamond HMS-10/HP connector.

Equipment Required

The equipment required for the performance test is listed in the table below. Any equipment which satisfies the critical specifications of the equipment given in the table, may be substituted for the recommended models.

Equipment Required

Instrument	Description	#021	#022	#023
HP 71452B #E14[1]	Optical Spectrum Analyzer	1	1	1
HP 8153A	Lightwave Multimeter	1	1	1
HP 81532A	Power Sensor Module	1	1	1
HP 86120A	Multi-Wavelength Meter	1	1	1
HP 81000AI	Diamond HMS-10 Connector Interface	3	2	2
HP 81000SI	DIN 47256 Connector Interface		1	
HP 81000UM	Universal Through Adapter	1	1	
HP 81109AC	Diamond HMS-10/HP/HRL - Diamond HMS-10/HP Patchcord	2	1	1
HP 81102SC	Diamond HMS-10/HP/HRL - DIN 47250-4108		1	1
HP 81102AC	Diamond HMS-10/HP/HRL - Diamond HMS-10/HP/HRL			1

additional for 8168F (max power test only):

Instrument	Description	#021	#022	#023
HP 81533B	Optical Head Interface Module	1	1	1
HP 81525A	Optical Head	1	1	1
or 81524A	Optical **and** 81001FF, 10dB filter	1	1	1
HP 81000AA	Diamond HMS-10 Connector	1	1	1

[1] replaces older model HP71450A #009.

Test Record

Results of the performance test may be tabulated on the Test Record provided
at the end of the test procedures. It is recommended that you fill out the Test
Record and refer to it while doing the test. Since the test limits and setup
information are printed on the Test Record for easy reference, the record can
also be used as an abbreviated test procedure (if you are already familiar with
the test procedures). The Test Record can also be used as a permanent record
and may be reproduced without written permission from Hewlett-Packard.

Test Failure

If the HP8167A/8D/8E/8F fails any performance test, return the instrument to the nearest Hewlett-Packard Sales/Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument which are certified. These specifications, listed in Appendix C, are the performance standards or limits against which the HP 8167A/8D/8E/8F can be tested. The specifications also list some supplemental characteristics of the HP 8167A/8D/8E/8F. Supplemental characteristics should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supercede any that were previously published.

General ■ Make sure that all fiber connectors are clean

■ Turn the instruments on, enable the laser and allow the instruments to warm up until STABILIZING is no longer shown on the display.

Wavelength Tests

Connect the TLS (DUT) to the Wavelength Meter as shown in Figure D-1.

Note The connector housings for the patchcord cannot be screwed fully onto the wavelength meter.

This does not affect the wavelength measurements.

Figure D-1. Test Setup for the Wavelength Tests

Relative Wavelength Accuracy

1. Set the wavelength meter:

   a. Press SYSTEM (Preset).

   b. Press DISPLAY (Peak WL).

   c. Press DELTA (OFF).

   d. Press MEASUREMENT (Cont).

2. Set the TLS :

   a. Switch off Coherence Control.

   b. Set the output power to -10dBm (8168F to -7dBm), activate laser output.

3. Set the wavelength on the TLS to:

HP 8167A	1280nm
HP 8168D	1490nm
HP 8168E	1475nm
HP 8168F	1450nm

4. Note the displayed wavelength of the wavelength meter in the test report.

5. Increase wavelength setting on TLS by the steps shown in the test report.

6. Repeat list item 4 and list item 5 up to

HP 8167A	1330nm
HP 8168D	1565nm
HP 8168E	1575nm
HP 8168F	1590nm

7. Repeat list item 3 to list item 6 another 4 times.

8. From each of the repetitions of the measurements, pick the maximum and minimum deviations, and note these values in the test report.

9. Pick the largest Maximum Deviation, and note it as the Largest Maximum Deviation in the test report.

10. Pick the smallest Minimum Deviation, and note it as the Smallest Minimum Deviation in the test report.

11. Calculate the Relative Wavelength Accuracy

D

Wavelength Repeatability

1. Set the wavelength meter:

   a. Press SYSTEM (Preset).

   b. Press DISPLAY (Peak WL).

   c. Press DELTA (OFF).

   d. Press MEASUREMENT (Cont).

2. Set the TLS (DUT)

   a. Switch off Coherence Control.

   b. Set the output power to -10dBm (8168F to -7dBm), activate laser output.

   c. Set the wavelength to

HP 8167A	1330nm
HP 8168D	1565nm
HP 8168E	1575nm
HP 8168F	1575nm

3. Set the TLS to any wavelength in its range and note it in the test record.

4. Set the TLS back to the wavelength setup in list item 3 and wait a few seconds.

5. Measure the wavelength with the Wavelength Meter and note the result in test record.

6. Repeat list item 3 to list item 5 with different wavelength settings on the TLS 4 times.

7. Set the wavelength of the 8168F to 1595nm and repeat steps list item 3 to list item 6.

Power Tests

General   ■ Make sure that a second module or a blank insert is installed
in the second slot of the HP 8153A Mainframe.

■ Turn the instruments on, enable the laser and allow the
instruments to warm up until STABILIZING is no longer on the
display.

Maximum Output Power

Note   Absolute Power Accuracy is not specified.
The result of the measurement below is greatly influenced by
the quality and the matching of the used interconnections.

1. Set up the equipment as shown

   HP   as shown in Figure D-2
   8167A/68D,E
   HP 8168F   as shown in Figure D-3

D

Figure D-2.
Test Setup for the Maximum Output Power Test (except HP 8168F)

Figure D-3.
Test Setup for the Maximum Output Power Test (HP 8168F only)

Note	Instead of the HP81525A, an HP81524A can be used in conjunction with an HP81001FF 10dB filter. In this case, an HP81010BL lens is recommended.

2. Set the Power Meter

   a. Select Auto Range.

   b. Select averaging time 500ms.

    c. Select display in dBm.

3. Set the TLS

    a. Set the power to maximum possible value:

       i. Press (Output Power).

       ii. Use the Modify knob to increase the displayed value to the maximum.

    b. Set the wavelength to

HP 8167A	1280nm
HP 8168D	1490nm
HP 8168E	1475nm
HP 8168F	1450nm

    c. Activate the laser output.

Note

The laser output is limited to its maximum possible value at this wavelength, the display will probably show `excessive: P = x.yy `μ`W`

---

4. Measure the output power with the 8153A and note the result for this wavelength in the test report.

5. Increase the wavelength on the TLS as shown in the test report.

6. Increase the wavelength on the 8153A by the same amount that you have increased the wavelength the TLS.

7. Repeat list item 4 to list item 6 until the end of the wavelength range of the TLS is reached.

Power Linearity

1. Set up the equipment as shown in Figure D-4 (HP 8167A, 8168D,E,F).

Figure D-4.
Test Setup for the Power Tests (except Maximum Output Power)

2. Set the TLS

    a. Set the wavelength to

    HP 8167A   1310nm
    HP 8168D,E,F   1540nm

    b. Set the power to

	without attenuator	with attenuator
8167A	-5dBm	-6.5dBm
8168D	-5dBm	n/a
8168E	-1dBm	-2.5dBm
8168F	+1dBm	0.0dBm

    c. Make sure the optical output is inactive.

3. Set the Power Meter

    a. Zero the 8153A

    b. Select Auto Range

    c. Select averaging time 500ms

    d. Select display in dB

    e. Set the wavelength to

       HP 8167A   1310nm
       HP 8168D,E,F 1540nm

4. Activate the optical output.

5. Measure the output power with the Power Meter

6. Press (DISP->REF)

7. Change the power setting on the TLS to the next value listed in the test report and measure the power again.
Note the displayed value on the Power Meter as "Relative Power of actual setting".

8. Calculate the "Power Linearity at current setting" as
"Relative Power of current setting" + "Power Reduction from start condition"

9. Repeat list item 7 to list item 8 for all power levels listed the test report.

10. Check the calculated values of the Power Linearity of the various settings for the maximum and minimum values and note these in the test report.

11. Calculate the difference for the maximum and minimum values of the Power Linearity of the various settings as Final Power Linearity

Example

Power Linearity
(HP 8167A without attenuator)

	Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
			+	=
start:	-5.0dBm	REF	0.0dB	0.00dB
	-5.5dBm	*-0.55*dB	0.5dB	*-0.05*dB
	-6.0dBm	*-1.01*dB	1.0dB	*-0.01*dB
	-6.5dBm	*-1.47*dB	1.5dB	*+0.03*dB
	-7.0dBm	*-2.03*dB	2.0dB	*-0.03*dB
	-7.5dBm	*-2.52*dB	2.5dB	*-0.02*dB
	-8.0dBm	*-2.94*dB	3.0dB	*+0.06*dB
	-8.5dBm	*-3.52*dB	3.5dB	*-0.02*dB
	-9.0dBm	*-4.03*dB	4.0dB	*-0.03*dB
	-9.5dBm	*-4.54*dB	4.5dB	*-0.04*dB
	-10.0dBm	*-4.98*dB	5.0dB	*+0.02*dB

Maximum Power Linearity at current setting   *+0.06*dB

Minimum Power Linearity at current setting   *-0.05*dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity) *0.11*dBpp
Specification 0.2dBpp

Power Flatness over Wavelength

1. Set up the equipment as shown in Figure D-4 (HP 8167A, 8168D,E,F).

2. Set the TLS

    a. Set the power to:

	#023	#003	#023 + #003		#007
8167A	-4dBm	-5dBm	-5.5dBm	-6.5dBm	-5dBm
8168D	-4dBm	n/a	n/a	n/a	-5dBm
8168E	0dBm	-1dBm	-1.5dBm	-2.5dBm	-1dBm
8168F	+1dBm	0dBm	-0.5dBm	-2.5dBm	0dBm

    b. Set the wavelength to

        HP 8167A   1280nm
        HP 8168D   1500nm
        HP 8168E   1500nm
        HP 8168F   1475nm

3. Set the Power Meter

    a. Select Auto Range.

    b. Select averaging time 500ms.

    c. Select display in dB.

    d. Set the wavelength to

        HP 8167A   1280nm
        HP 8168D   1500nm
        HP 8168E   1500nm
        HP 8168F   1475nm

    e. Set `DISP->REF`

4. Increase the wavelength on the TLS and on the Power Meter by the steps
listed in the test record. Measure the output power.
Note the result in the test record

5. repeat list item 4 for the wavelength settings given in the test record.

6. From the measurement results calculate the difference between the
maximum and minimum deviation from REF and note the result as Flatness.

Power Stability

1. Set up the equipment as shown in Figure D-4 (HP 8167A, 8168D,E,F).

2. Set the TLS

    a. Set the wavelength to

    HP 8167A   1310nm
    HP 8168D,E,F   1540nm

    b. Set the power to high power

	#023	#003	#023+#003		#007
8167A	-4dBm	-5dBm	-5.5dBm	-6.5dBm	-5dBm
8168D	-4dBm	n/a	n/a	n/a	-5dBm
8168E	0dBm	-1dBm	-1.5dBm	-2.5dBm	-1dBm
8168F	+1dBm	+1dBm	+1dBm	+1dBm	0dBm

    c. Deactivate the laser output.

3. Set the Power Meter

    a. Zero the 8153A.

    b. Select Auto Range.

    c. Select averaging time 500ms.

    d. Select display in dB.

    e. Set the wavelength to

    HP 8167A   1310nm
    HP 8168D,E,F   1540nm

    f. Set 8153A to Logging, T_Total = 1 hour:

        i. Press (Menu).

        ii. Press (Record) to get STABILITY.

        iii. Press (Edit) to get T_TOTAL and modify the display until it shows 01:00:00.

        iv. Press (Edit).

4. Activate the optical output of the laser source, and wait 1 minute.

5. On the power meter, press (Exec).
Display will show RUNNING (blinking) a few moments then show the remaining time. When logging time is over the display will show STABILITY.

6. Get the results

   a. Press (More) to get SHOW.

   b. Press (Edit) to get MAXIMUM.
      Note the value in the test record.

   c. Press (Next) to get MINIMUM.
      Note the value in the test record.

   d. Press (Edit), and (Mode) to return to normal operation.

7. Calculate the Stability as the difference between the maximum and the minimum.

8. Set the TLS to low output power:

	#003	
8167A	-10dBm	-50dBm
8168D	-10 dBm	n/a
8168E	-10dBm	-50dBm
8168F	-7dBm	-47dBm

9. Repeat list item 5 to list item 7 and note the results in the test report.

Source Spontaneous Emission

1. Connect the TLS (DUT) to the wavelength meter as shown in Figure D-5.

Figure D-5. Test Setup for the Source Spontaneous Emission Test

2. Set the Optical Spectrum Analyzer

   a. Set the Span to 4nm, Resolution Bandwidth to 0.1nm and the Sensitivity to -60dBm.
      (Waveln -> SPAN ->{4} -> nm -> BW.SWP -> {0.1} -> nm; Amptd -> SENS Man -> {-60} -> dBm)

   b. Set the wavelength to the wavelength of the TLS.
      (Waveln -> {xxxx.000} -> nm)

3. Set the TLS:

   a. Set the power to high power

	#023	**#003**	**#023 + #003**
8167A	-4dBm	-5dBm	-5.5dBm	-6.5dBm
8168D,E,F	as stated in the test report		

4. On the spectrum analyzer, set the Marker to the highest peak and select delta. (Marker -> HIGHEST PEAK -> DELTA)

5. Using the MODIFY knob move the second marker to the highest peak of the displayed side modes and note the delta between the 2 markers in the test report.

6. Repeat list item 4 to list item 5 within the wavelength range of the TLS in 10nm steps.

Performance Test for the HP 8167A

Test Facility:

_____	Report No. _____
_____	Date _____
_____	Customer _____
_____	Tested By _____

Model   HP 8167A Tunable Laser Source

Serial No.   _____   Ambient temperature _____ °C

Options   _____   Relative humidity   _____ %

Firmware Rev.   _____   Line frequency   _____ Hz

Special Notes:

_____

_____

_____

_____

_____

_____

_____

D

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter with	HP 8153A		
2.	Sensor Module	HP 81532A		
3a.	Optical Spectrum Analyzer	HP 71452B		
3b.	Optical Spectrum Analyzer	HP 70950A		
3c	OSA Display	HP 70004A		
4.	Wavelength Meter	_____		
5a.	Connector Interface (×2)	HP 81000AI		
5b.	Connector Interface (#021)	HP 81000AI		
6.	Connector Interface (#022)	HP 81000SI		
7.	Universal Through Adapter (#021, #022)	HP 81000UM		
8a.	High Return Loss Cable	HP 81109AC		
8b.	High Return Loss Cable (#021)	HP 81109AC		
9.	High Return Loss Cable	HP 81102SC		
10.	_____	_____	_____	_____
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____
15.	_____	_____	_____	_____

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
1	1280.000nm	_____nm	_____nm		
	1290.000nm	_____nm	_____nm		
	1300.000nm	_____nm	_____nm		
	1310.000nm	_____nm	_____nm		
	1320.000nm	_____nm	_____nm		
	1330.000nm	_____nm	_____nm	_____nm	_____nm
2	1280.000nm	_____nm	_____nm		
	1290.000nm	_____nm	_____nm		
	1300.000nm	_____nm	_____nm		
	1310.000nm	_____nm	_____nm		
	1320.000nm	_____nm	_____nm		
	1330.000nm	_____nm	_____nm	_____nm	_____nm
3	1280.000nm	_____nm	_____nm		
	1290.000nm	_____nm	_____nm		
	1300.000nm	_____nm	_____nm		
	1310.000nm	_____nm	_____nm		
	1320.000nm	_____nm	_____nm		
	1330.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
4	1280.000nm	_____nm	_____nm		
	1290.000nm	_____nm	_____nm		
	1300.000nm	_____nm	_____nm		
	1310.000nm	_____nm	_____nm		
	1320.000nm	_____nm	_____nm		
	1330.000nm	_____nm	_____nm	_____nm	_____nm
5	1280.000nm	_____nm	_____nm		
	1290.000nm	_____nm	_____nm		
	1300.000nm	_____nm	_____nm		
	1310.000nm	_____nm	_____nm		
	1320.000nm	_____nm	_____nm		
	1330.000nm	_____nm	_____nm	_____nm	_____nm

Largest Maximum Deviation _____nm

Smallest Minimum Deviation _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation) _____nm
Specification   0.07nm

Measurement Uncertainty   ±0.01nm

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Wavelength Repeatability

Description 1330.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from _____nm to REF	1329.965nm	_____nm	1330.035nm	
from _____nm to REF	1329.965nm	_____nm	1330.035nm	
from _____nm to REF	1329.965nm	_____nm	1330.035nm	
from _____nm to REF	1329.965nm	_____nm	1330.035nm	
from _____nm to REF	1329.965nm	_____nm	1330.035nm	

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Maximum Power Test

Wavelength		Minimum Spec			Result	Measurement Uncertainty
		#007				±0.30dB
option	std	#023	#003	#023+#003		
		(circle the appropriate)				
1280nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1290nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1300nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1310nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1320nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1330nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Power Linearity
(HP 8167A without attenuator)

	Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
			+	=
start:	-5.0dBm	REF	0.0dB	0.00dB
	-5.5dBm	_____dB	0.5dB	_____dB
	-6.0dBm	_____dB	1.0dB	_____dB
	-6.5dBm	_____dB	1.5dB	_____dB
	-7.0dBm	_____dB	2.0dB	_____dB
	-7.5dBm	_____dB	2.5dB	_____dB
	-8.0dBm	_____dB	3.0dB	_____dB
	-8.5dBm	_____dB	3.5dB	_____dB
	-9.0dBm	_____dB	4.0dB	_____dB
	-9.5dBm	_____dB	4.5dB	_____dB
	-10.0dBm	_____dB	5.0dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
Specification   0.2dBpp

Measurement Uncertainty   ±0.05dB

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Power Linearity
(HP 8167A with attenuator)

Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=
start: -6.5dBm	REF	0.0dB	0.00dB
-10.0dBm	_____dB	3.5dB	_____dB
-15.0dBm	_____dB	8.5dB	_____dB
-20.0dBm	_____dB	13.5dB	_____dB
-25.0dBm	_____dB	18.5dB	_____dB
-30.0dBm	_____dB	23.5dB	_____dB
-35.0dBm	_____dB	28.5dB	_____dB
-40.0dBm	_____dB	33.5dB	_____dB
-45.0dBm	_____dB	38.5dB	_____dB
-50.0dBm	_____dB	43.5dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp

Specification   0.6dBpp

Measurement Uncertainty   ±0.05dB

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Power Flatness versus Wavelength
Wavelength   Deviation
1280nm   0.00 (start value, REF)

1290nm   _____dB

1300nm   _____dB

1310nm   _____dB

1320nm   _____dB

1330nm   _____dB

                   Maximum deviation   _____dB

                   Minimum deviation   _____dB

                   Flatness
(= Maximum - Minimum deviation)   _____dBpp
Specification 0.2dBpp without #003
0.4dBpp with #003

Measurement Uncertainty   ±0.07dB

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Power Stability

High power		**Low power**	
Maximum deviation	_____dB	Maximum deviation	_____dB
Minimum deviation	_____dB	Minimum deviation	_____dB

Power Stability		**Power Stability**	
(= Max - Min deviation)	_____dBpp	(= Max - Min deviation)	_____dBpp
Specification	0.06dBpp	Specification	0.06dBpp

Measurement Uncertainty ±0.02dB

Performance Test for the HP 8167A

Model HP 8167A Tunable Laser Source   Report No._____   Date_____

Source Spontaneous Emission

Wavelength	Maximum Spec	Result	Measurement Uncertainty
			±1.20dB
1280nm	-40dB	_____dB	
1290nm	-40dB	_____dB	
1300nm	-40dB	_____dB	
1310nm	-40dB	_____dB	
1320nm	-40dB	_____dB	
1330nm	-40dB	_____dB	

D

Performance Test for the HP 8168D

Test Facility:

_____	Report No. _____
_____	Date _____
_____	Customer _____
_____	Tested By _____

Model   HP 8168D Tunable Laser Source

Serial No.   _____   Ambient temperature _____ °C

Options   _____   Relative humidity   _____ %

Firmware Rev. _____   Line frequency   _____ Hz

Special Notes:

_____

_____

_____

_____

_____

_____

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter with	HP 8153A		
2.	Sensor Module	HP 81532A		
3a.	Optical Spectrum Analyzer	HP 71452B		
3b.	Optical Spectrum Analyzer	HP 70950A		
3c.	OSA Display	HP 70004A		
4.	Wavelength Meter	_____		
5a.	Connector Interface (×2)	HP 81000AI		
5b.	Connector Interface (#021)	HP 81000AI		
6.	Connector Interface (#022)	HP 81000SI		
7.	Universal Through Adapter (#021, #022)	HP 81000UM		
8a.	High Return Loss Cable	HP 81109AC		
8b.	High Return Loss Cable (#021)	HP 81109AC		
9.	High Return Loss Cable	HP 81102SC		
10.	_____	_____	_____	_____
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____
15.	_____	_____	_____	_____

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
1	1490.000nm	_____nm	_____nm		
	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm
2	1490.000nm	_____nm	_____nm		
	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
3	1490.000nm	_____nm	_____nm		
	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm
4	1490.000nm	_____nm	_____nm		
	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
5	1490.000nm	_____nm	_____nm		
	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

Largest Maximum Deviation   _____nm

Smallest Minimum Deviation   _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation)   _____nm
Specification   0.2nm

Measurement Uncertainty   ±0.01nm

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Wavelength Repeatability

Description 1565.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from _____nm to REF	1564.965nm	_____nm	1565.035nm	
from _____nm to REF	1564.965nm	_____nm	1565.035nm	
from _____nm to REF	1564.965nm	_____nm	1565.035nm	
from _____nm to REF	1564.965nm	_____nm	1565.035nm	
from _____nm to REF	1564.965nm	_____nm	1565.035nm	

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Maximum Power Test

Wavelength	Minimum Spec		Result	Measurement Uncertainty
				±0.30dB
option:	std	#007		
	(circle the appropriate)			
1490nm	-10.0dBm	-11.0dBm	_____ dBm	
1500nm	-4.0dBm	-5.0dBm	_____ dBm	
1510nm	-4.0dBm	-5.0dBm	_____ dBm	
1520nm	-4.0dBm	-5.0dBm	_____ dBm	
1530nm	-4.0dBm	-5.0dBm	_____ dBm	
1540nm	-4.0dBm	-5.0dBm	_____ dBm	
1550nm	-4.0dBm	-5.0dBm	_____ dBm	
1560nm	-4.0dBm	-5.0dBm	_____ dBm	
1565nm	-4.0dBm	-5.0dBm	_____ dBm	

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Power Linearity

(HP 8168D) Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=
start: -5.0dBm	REF	0.0dB	0.00dB
-5.5dBm	_____dB	0.5dB	_____dB
-6.0dBm	_____dB	1.0dB	_____dB
-6.5dBm	_____dB	1.5dB	_____dB
-7.0dBm	_____dB	2.0dB	_____dB
-7.5dBm	_____dB	2.5dB	_____dB
-8.0dBm	_____dB	3.0dB	_____dB
-8.5dBm	_____dB	3.5dB	_____dB
-9.0dBm	_____dB	4.0dB	_____dB
-9.5dBm	_____dB	4.5dB	_____dB
-10.0dBm	_____dB	5.0dB	_____dB

Maximum Power Linearity at current setting _____dB

Minimum Power Linearity at current setting _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity) _____dBpp
Specification   0.2dBpp

Measurement Uncertainty   ±0.05dB

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Power Flatness versus Wavelength
 Wavelength   Deviation
 1500nm   0.00 (start value, REF)

 1510nm   _____dB

 1520nm   _____dB

 1530nm   _____dB

 1540nm   _____dB

 1550nm   _____dB

 1560nm   _____dB

 1565nm   _____dB

                Maximum deviation   _____dB

                Minimum deviation   _____dB

Flatness
(= Maximum - Minimum deviation)   _____dBpp
                      Specification   0.4dBpp
                                  0.2dBpp typical

        Measurement Uncertainty   ±0.07dB

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Power Stability

High power		Low power	
Maximum deviation	_____dB	Maximum deviation	_____dB
Minimum deviation	_____dB	Minimum deviation	_____dB

Power Stability		**Power Stability**	
(= Max - Min deviation)	_____dBpp	(= Max - Min deviation)	_____dBpp
Specification	0.06dBpp	Specification	0.06dBpp

Measurement Uncertainty ±0.02dB

Performance Test for the HP 8168D

Model HP 8168D Tunable Laser Source   Report No._____   Date_____

Source Spontaneous Emission

Wavelength	Output Power		Maximum Spec	Result	Measurement Uncertainty
option:		#007			±1.20dB
	(circle the appropriate)				
1490nm	-10.0dBm	-11.0dBm	-35dB	_____dB	
1500nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1510nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1520nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1530nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1540nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1550nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1560nm	-4.0dBm	-5.0dBm	-40dB	_____dB	
1565nm	-4.0dBm	-5.0dBm	-40dB	_____dB	

Performance Test for the HP 8168E

Test Facility:

——————————————————— Report No. ———————————————

——————————————————— Date ———————————————

——————————————————— Customer ———————————————

——————————————————— Tested By ———————————————

Model   HP 8168E Tunable Laser Source

Serial No.   ———————————   Ambient temperature ———— °C

Options   ———————————   Relative humidity ———— %

Firmware Rev. ———————————   Line frequency ———— Hz

Special Notes:

———

———

———

———

———

———

———

D

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter with	HP 8153A		
2.	Sensor Module	HP 81532A		
3a.	Optical Spectrum Analyzer	HP 71452B		
3b.	Optical Spectrum Analyzer	HP 70950A		
3c.	OSA Display	HP 70004A		
4.	Wavelength Meter	_____		
5a.	Connector Interface (×2)	HP 81000AI		
5b.	Connector Interface (#021)	HP 81000AI		
6.	Connector Interface (#022)	HP 81000SI		
7.	Universal Through Adapter (#021, #022)	HP 81000UM		
8a.	High Return Loss Cable	HP 81109AC		
8b.	High Return Loss Cable (#021)	HP 81109AC		
9.	High Return Loss Cable	HP 81102SC		
10a.	Optical Head Interfacer Module	HP 81533B		
10b	Optical Head	HP 81525A		
10c	Diamond HMS-10 Connector	HP 81000AA		
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
1	1475.000nm	_____nm	_____nm		
	1485.000nm	_____nm	_____nm		
	1495.000nm	_____nm	_____nm		
	1505.000nm	_____nm	_____nm		
	1515.000nm	_____nm	_____nm		
	1525.000nm	_____nm	_____nm		
	1535.000nm	_____nm	_____nm		
	1545.000nm	_____nm	_____nm		
	1555.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm		
	1575.000nm	_____nm	_____nm	_____nm	_____nm
2	1475.000nm	_____nm	_____nm		
	1485.000nm	_____nm	_____nm		
	1495.000nm	_____nm	_____nm		
	1505.000nm	_____nm	_____nm		
	1515.000nm	_____nm	_____nm		
	1525.000nm	_____nm	_____nm		
	1535.000nm	_____nm	_____nm		
	1545.000nm	_____nm	_____nm		
	1555.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm		
	1575.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
3	1475.000nm	_____nm	_____nm		
	1485.000nm	_____nm	_____nm		
	1495.000nm	_____nm	_____nm		
	1505.000nm	_____nm	_____nm		
	1515.000nm	_____nm	_____nm		
	1525.000nm	_____nm	_____nm		
	1535.000nm	_____nm	_____nm		
	1545.000nm	_____nm	_____nm		
	1555.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm		
	1575.000nm	_____nm	_____nm	_____nm	_____nm
4	1475.000nm	_____nm	_____nm		
	1485.000nm	_____nm	_____nm		
	1495.000nm	_____nm	_____nm		
	1505.000nm	_____nm	_____nm		
	1515.000nm	_____nm	_____nm		
	1525.000nm	_____nm	_____nm		
	1535.000nm	_____nm	_____nm		
	1545.000nm	_____nm	_____nm		
	1555.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm		
	1575.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
5	1475.000nm	_____nm	_____nm		
	1485.000nm	_____nm	_____nm		
	1495.000nm	_____nm	_____nm		
	1505.000nm	_____nm	_____nm		
	1515.000nm	_____nm	_____nm		
	1525.000nm	_____nm	_____nm		
	1535.000nm	_____nm	_____nm		
	1545.000nm	_____nm	_____nm		
	1555.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm		
	1575.000nm	_____nm	_____nm	_____nm	_____nm

Range 1475 to 1575nm   Largest Maximum Deviation _____nm

Smallest Minimum Deviation   _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation) _____nm
Specification   0.07nm

Measurement Uncertainty   ± 0.01nm

D

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No.＿＿＿＿   Date＿＿＿＿＿＿＿

Wavelength Repeatability

Description 1575.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from ＿＿＿＿＿nm to REF	1574.965nm	＿＿＿＿＿nm	1575.035nm	
from ＿＿＿＿＿nm to REF	1574.965nm	＿＿＿＿＿nm	1575.035nm	
from ＿＿＿＿＿nm to REF	1574.965nm	＿＿＿＿＿nm	1575.035nm	
from ＿＿＿＿＿nm to REF	1574.965nm	＿＿＿＿＿nm	1575.035nm	
from ＿＿＿＿＿nm to REF	1574.965nm	＿＿＿＿＿nm	1575.035nm	

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Maximum Power Test

Wavelength	Minimum Spec				Result	Measurement Uncertainty
		#007				±0.30dB
option:		#023	#003	#023+#003		
(circle the appropriate)						
1475nm	-10.0dBm	-11.0dBm	-11.5dBm	-12.5dBm	_____dBm	
1480nm	-10.0dBm	-11.0dBm	-11.5dBm	-12.5dBm	_____dBm	
1490nm	-10.0dBm	-11.0dBm	-11.5dBm	-12.5dBm	_____dBm	
1500nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1510nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1520nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1530nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1540nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1550nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1560nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1570nm	0dBm	-1.0dBm	-1.5dBm	-2.5dBm	_____dBm	
1575nm	-10.0dBm	-11.0dBm	-11.5dBm	-12.5dBm	_____dBm	

D

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Power Linearity
(HP 8168E without attenuator)

	Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=	
start:	-1.0dBm	REF	0.0dB	0.00dB
	-1.5dBm	_____dB	0.5dB	_____dB
	-2.0dBm	_____dB	1.0dB	_____dB
	-2.5dBm	_____dB	1.5dB	_____dB
	-3.0dBm	_____dB	2.0dB	_____dB
	-3.5dBm	_____dB	2.5dB	_____dB
	-4.0dBm	_____dB	3.0dB	_____dB
	-4.5dBm	_____dB	3.5dB	_____dB
	-5.0dBm	_____dB	4.0dB	_____dB
	-5.5dBm	_____dB	4.5dB	_____dB
	-6.0dBm	_____dB	5.0dB	_____dB
	-6.5dBm	_____dB	5.5dB	_____dB
	-7.0dBm	_____dB	6.0dB	_____dB
	-7.5dBm	_____dB	6.5dB	_____dB
	-8.0dBm	_____dB	7.0dB	_____dB
	-8.5dBm	_____dB	7.5dB	_____dB
	-9.0dBm	_____dB	8.0dB	_____dB
	-9.5dBm	_____dB	8.5dB	_____dB
	-10.0dBm	_____dB	9.0dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
Specification   0.2dBpp

Measurement Uncertainty   ±0.05dB

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Power Linearity
(HP 8168E with attenuator)

Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=
start: -2.5dBm	REF	0.0dB	0.00dB
-10.0dBm	_____dB	7.5dB	_____dB
-15.0dBm	_____dB	12.5dB	_____dB
-20.0dBm	_____dB	17.5dB	_____dB
-25.0dBm	_____dB	22.5dB	_____dB
-30.0dBm	_____dB	27.5dB	_____dB
-35.0dBm	_____dB	32.5dB	_____dB
-40.0dBm	_____dB	37.5dB	_____dB
-45.0dBm	_____dB	42.5dB	_____dB
-50.0dBm	_____dB	47.5dB	_____dB

Maximum Power Linearity at current setting _____dB

Minimum Power Linearity at current setting _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
Specification   0.6dBpp

Measurement Uncertainty   ±0.05dB

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Power Flatness versus Wavelength
  Wavelength   Deviation

  1500nm   0.00 (start value, REF)

  1510nm   _____dB

  1520nm   _____dB

  1530nm   _____dB

  1540nm   _____dB

  1550nm   _____dB

  1560nm   _____dB

  1570nm   _____dB

               Maximum deviation   _____dB

               Minimum deviation   _____dB

                   Flatness
(= Maximum - Minimum deviation)   _____dBpp
              Specification 0.2dBpp without #003
                         0.4dBpp with #003

      Measurement Uncertainty   ±0.07dB

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Power Stability

High power		**Low power**	
Maximum deviation	_____dB	Maximum deviation	_____dB
Minimum deviation	_____dB	Minimum deviation	_____dB

Power Stability		**Power Stability**	
(= Max - Min deviation)	_____dBpp	(= Max - Min deviation)	_____dBpp
Specification	0.06dBpp	Specification	0.06dBpp

Measurement Uncertainty ±0.02dB

Performance Test for the HP 8168E

Model HP 8168E Tunable Laser Source   Report No._____   Date_____

Source Spontaneous Emission

Wavelength	Output Power #007 option: #023	#003	#023 + #003 (circle the appropriate)	Maximum Spec	Result	Measurement Uncertainty ±1.20dB
1475m	-10.0dBm	-11.0dBm	-11.5dBm -12.5dBm	-35dB	_____dB	
1480nm	-10.0dBm	-11.0dBm	-11.5dBm -12.5dBm	-35dB	_____dB	
1490nm	-10.0dBm	-11.0dBm	-11.5dBm -12.5dBm	-35dB	_____dB	
1500nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1510nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1520nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1530nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1540nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1550nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1560nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1570nm	0dBm	-1.0dBm	-1.5dBm -2.5dBm	-45dB	_____dB	
1575nm	-10.0dBm	-11.0dBm	-11.5dBm -12.5dBm	-35dB	_____dB	

Performance Test for the HP 8168F

Test Facility:

_____   Report No. _____

_____   Date   _____

_____   Customer   _____

_____   Tested By   _____

Model   HP 8168F Tunable Laser Source

Serial No.   _____   Ambient temperature _____ °C

Options   _____   Relative humidity   _____ %

Firmware Rev.   _____   Line frequency   _____ Hz

Special Notes:

_____

_____

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_____

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D

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter with	HP 8153A		
2.	Sensor Module	HP 81532A		
3a.	Optical Spectrum Analyzer	HP 71452B		
3b.	Optical Spectrum Analyzer	HP 70950A		
3c.	OSA Display	HP 70004A		
4.	Wavelength Meter	_____		
5a.	Connector Interface (×2)	HP 81000AI		
5b.	Connector Interface (#021)	HP 81000AI		
6.	Connector Interface (#022)	HP 81000SI		
7.	Universal Through Adapter (#021, #022)	HP 81000UM		
8a.	High Return Loss Cable	HP 81109AC		
8b.	High Return Loss Cable (#021)	HP 81109AC		
9.	High Return Loss Cable	HP 81102SC		
10a.	Optical Head Interfacer Module	HP 81533B		
10b	Optical Head	HP 81525A or HP81524A		
10c	Diamond HMS-10 Connector	HP 81000AA		
11.	_____	_____	_____	_____
12.	_____	_____	_____	_____
13.	_____	_____	_____	_____
14.	_____	_____	_____	_____

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value		Maximum Deviation	Minimum Deviation
1	1450.000nm	_____nm	_____nm			
	1460.000nm	_____nm	_____nm			
	1475.000nm	_____nm	_____nm			
	1490.000nm	_____nm	_____nm			
	1500.000nm	_____nm	_____nm			
	1510.000nm	_____nm	_____nm			
	1520.000nm	_____nm	_____nm			
	1530.000nm	_____nm	_____nm			
	1540.000nm	_____nm	_____nm			
	1550.000nm	_____nm	_____nm			
	1560.000nm	_____nm	_____nm			
	1575.000nm	_____nm	_____nm	1475 to 1575nm	_____nm	_____nm
	1580.000nm	_____nm	_____nm			
	1590.000nm	_____nm	_____nm	1450 to 1590nm	_____nm	_____nm

D

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value		Maximum Deviation	Minimum Deviation
2	1450.000nm	_____nm	_____nm			
	1460.000nm	_____nm	_____nm			
	1475.000nm	_____nm	_____nm			
	1490.000nm	_____nm	_____nm			
	1500.000nm	_____nm	_____nm			
	1510.000nm	_____nm	_____nm			
	1520.000nm	_____nm	_____nm			
	1530.000nm	_____nm	_____nm			
	1540.000nm	_____nm	_____nm			
	1550.000nm	_____nm	_____nm			
	1560.000nm	_____nm	_____nm			
	1575.000nm	_____nm	_____nm	1475 to 1575nm	_____nm	_____nm
	1580.000nm	_____nm	_____nm			
	1590.000nm	_____nm	_____nm	1450 to 1590nm	_____nm	_____nm

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value		Maximum Deviation	Minimum Deviation
3	1450.000nm	_____nm	_____nm			
	1460.000nm	_____nm	_____nm			
	1475.000nm	_____nm	_____nm			
	1490.000nm	_____nm	_____nm			
	1500.000nm	_____nm	_____nm			
	1510.000nm	_____nm	_____nm			
	1520.000nm	_____nm	_____nm			
	1530.000nm	_____nm	_____nm			
	1540.000nm	_____nm	_____nm			
	1550.000nm	_____nm	_____nm			
	1560.000nm	_____nm	_____nm			
	1575.000nm	_____nm	_____nm	1475 to 1575nm	_____nm	_____nm
	1580.000nm	_____nm	_____nm			
	1590.000nm	_____nm	_____nm	1450 to 1590nm	_____nm	_____nm

D

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value		Maximum Deviation	Minimum Deviation
4	1450.000nm	_____nm	_____nm			
	1460.000nm	_____nm	_____nm			
	1475.000nm	_____nm	_____nm			
	1490.000nm	_____nm	_____nm			
	1500.000nm	_____nm	_____nm			
	1510.000nm	_____nm	_____nm			
	1520.000nm	_____nm	_____nm			
	1530.000nm	_____nm	_____nm			
	1540.000nm	_____nm	_____nm			
	1550.000nm	_____nm	_____nm			
	1560.000nm	_____nm	_____nm			
	1575.000nm	_____nm	_____nm	1475 to 1575nm	_____nm	_____nm
	1580.000nm	_____nm	_____nm			
	1590.000nm	_____nm	_____nm	1450 to 1590nm	_____nm	_____nm

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value		Maximum Deviation	Minimum Deviation
5	1450.000nm	_____nm	_____nm			
	1460.000nm	_____nm	_____nm			
	1475.000nm	_____nm	_____nm			
	1490.000nm	_____nm	_____nm			
	1500.000nm	_____nm	_____nm			
	1510.000nm	_____nm	_____nm			
	1520.000nm	_____nm	_____nm			
	1530.000nm	_____nm	_____nm			
	1540.000nm	_____nm	_____nm			
	1550.000nm	_____nm	_____nm			
	1560.000nm	_____nm	_____nm			
	1575.000nm	_____nm	_____nm	1475 to 1575nm	_____nm	_____nm
	1580.000nm	_____nm	_____nm			
	1590.000nm	_____nm	_____nm	1450 to 1590nm	_____nm	_____nm

Range 1475 to 1575nm   Largest Maximum Deviation _____nm

Smallest Minimum Deviation   _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation) _____nm
Specification   0.07nm

Range 1450 to 1590nm   Largest Maximum Deviation _____nm

Smallest Minimum Deviation   _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation) _____nm
Specification   0.10nm

Measurement Uncertainty ± 0.01nm

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Wavelength Repeatability

Description 1575.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from _____nm to REF	1574.965nm	_____nm	1575.035nm	
from _____nm to REF	1574.965nm	_____nm	1575.035nm	
from _____nm to REF	1574.965nm	_____nm	1575.035nm	
from _____nm to REF	1574.965nm	_____nm	1575.035nm	
from _____nm to REF	1574.965nm	_____nm	1575.035nm	

Wavelength Repeatability

Description 1590.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from _____nm to REF	1594.950nm	_____nm	1595.050nm	
from _____nm to REF	1594.950nm	_____nm	1595.050nm	
from _____nm to REF	1594.950nm	_____nm	1595.050nm	
from _____nm to REF	1594.950nm	_____nm	1595.050nm	
from _____nm to REF	1594.950nm	_____nm	1595.050nm	

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Maximum Power Test

Wavelength	Minimum Spec #007			Result	Measurement Uncertainty ±0.30dB
option:	#023	#003	#023+#003		
(circle the appropriate)					
1450nm	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	_____dBm
1460nm	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	_____dBm
1475nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1480nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1490nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1500nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1510nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1520nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1530nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1540nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1550nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1560nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1570nm	+7.0dBm	+6.0dBm	+5.5dBm	+4.5dBm	_____dBm
1575nm	+1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	_____dBm
1580nm	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	_____dBm
1590nm	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	_____dBm

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Power Linearity
(HP 8168F without attenuator)

	Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=	
start:	+1.0dBm	REF	0.0dB	0.00dB
	0.0dBm	_____dB	1.0dB	_____dB
	-1.0dBm	_____dB	2.0dB	_____dB
	-2.0dBm	_____dB	3.0dB	_____dB
	-3.0dBm	_____dB	4.0dB	_____dB
	-4.0dBm	_____dB	5.0dB	_____dB
	-5.0dBm	_____dB	6.0dB	_____dB
	-6.0dBm	_____dB	7.0dB	_____dB
	-7.0dBm	_____dB	8.0dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
Specification   0.2dBpp

Measurement Uncertainty   ±0.05dB

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Power Linearity
 (HP 8168F with attenuator)

	Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
		+	=	
start:	0.0dBm	REF dB	0.0dB	0.00 dB
	-5.0dBm	_____dB	5.0dB	_____dB
	-10.0dBm	_____dB	10.0dB	_____dB
	-15.0dBm	_____dB	15.0dB	_____dB
	-20.0dBm	_____dB	20.0dB	_____dB
	-25.0dBm	_____dB	25.0dB	_____dB
	-30.0dBm	_____dB	30.0dB	_____dB
	-35.0dBm	_____dB	35.0dB	_____dB
	-40.0dBm	_____dB	40.0dB	_____dB
	-47.0dBm	_____dB	47.0dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
Specification   0.6dBpp

Measurement Uncertainty   ±0.05dB

D

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Power Flatness versus Wavelength
  Wavelength   Deviation

  1475nm   0.00 (start value, REF)

  1480nm   _____dB

  1490nm   _____dB

  1500nm   _____dB

  1510nm   _____dB

  1520nm   _____dB

  1530nm   _____dB

  1540nm   _____dB

  1550nm   _____dB

  1560nm   _____dB

  1570nm   _____dB

  1575nm   _____dB

                Maximum deviation   _____dB

                Minimum deviation   _____dB

                        Flatness
(= Maximum - Minimum deviation)   _____dBpp
                    Specification 0.2dBpp without #003
                                   0.4dBpp with #003

            Measurement Uncertainty   ±0.07dB

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No.＿＿＿＿   Date＿＿＿＿＿＿＿＿＿＿

Power Stability

High power   **Low power**

Maximum deviation   ＿＿＿＿＿dB   Maximum deviation   ＿＿＿＿＿dB

Minimum deviation   ＿＿＿＿＿dB   Minimum deviation   ＿＿＿＿＿dB

Power Stability   **Power Stability**
(= Max - Min deviation)   ＿＿＿＿＿dBpp   (= Max - Min deviation) ＿＿＿＿＿dBpp
Specification   0.06dBpp   Specification   0.06dBpp

Measurement Uncertainty ±0.02dB

Performance Test for the HP 8168F

Model HP 8168F Tunable Laser Source   Report No._____   Date_____

Source Spontaneous Emission

Wavelength	Output Power #007			Maximum Spec	Result	Measurement Uncertainty ±1.20dB
option:	#023	#003	#023 + #003			
	(circle the appropriate)					
1450m	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	-35dB	_____dB
1460m	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	-35dB	_____dB
1475m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1480m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1490m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1500m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1510m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1520m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1530m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1540m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1550m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1560m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1570m	+ 7.0dBm	+ 6.0dBm	+ 5.5dBm	+ 4.5dBm	-55dB	_____dB
1575m	+ 1.0dBm	0.0dBm	-0.5dBm	-1.5dBm	-45dB	_____dB
1580m	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	-35dB	_____dB
1590m	-7.0dBm	-8.0dBm	-8.5dBm	-9.5dBm	-35dB	_____dB

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Cleaning Procedures

The Cleaning Kit

A full cleaning kit contains the following items:

Isopropyl alcohol This is usually available from pharmaceutical suppliers or chemists.

If possible, use alcohol supplied for medical purposes, rather than impure alcohol or alcohol with additives.

Caution
Do not use other solvents as some can damage plastic materials and claddings. For example, Acetone dissolves the adhesives used in fiber optic devices.

Warning
Never drink this alcohol as this can lead to blindness or other serious damage to your health.

Cotton-swabs Use swabs such as Q-tips or other cotton-swabs. These are typically available from local distributors of medical or hygiene products (such as supermarkets or pharmacies).

Note If you are cleaning connector interfaces or adapters, the diameter of the cotton swab is important. Cotton swabs for babies normally have a smaller diameter.

Caution

- Do not use foam swabs, as these can leave filmy deposits on the surface you are cleaning.
- Store your cotton-swabs carefully and never reuse them. Dust and dirt from the air or from previous cleaning, can scratch or dirty your optical device.

Soft-tissues These are available from most stores and distributors of medical and hygiene products (such as supermarkets or pharmacies).

Use multi-layer tissues made from non-recycled cellulose. These are more absorbent and softer than other types and they do not scratch the surface of your device.

Caution
Store your soft-tissues carefully and never reuse them, as dust and dirt from the air or from previous cleaning can scratch and dirty your optical device.

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Pipe-cleaner   This is available from tobacco shops.

Ensure that the bristles of the pipe-cleaner are soft, so that they do not scratch your device during cleaning.

Caution
Store your pipe-cleaners carefully and never reuse them as dust and dirt from the air or from previous cleaning can scratch and dirty your optical device.

Compressed Air   This is available from laboratory suppliers.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If you do not, it can lead to filmy deposits or scratches.

When using compressed air from a can,

- Hold the can upright. A slant can cause propellant to escape with the compressed air and dirty your optical device.
- Spray the first couple of seconds into the air, as the first stream of compressed air can contain condensation or propellant. Any condensation produces a filmy deposit.

If you are using compressed air from a can, you should select one with a CFC-free propellant, for the sake of the environment.

Other Cleaning Tools

To examine devices you also require:

Microscope Select a microscope with a magnification range of between 50X and 300X. These should be available from photographic stores or laboratory suppliers.

Ensure that the light source of the microscope is flexible. This helps you to examine your device closely and from different angles.

A microscope allows you to determine the type of dirt on your device and its extent. Then you can choose the correct cleaning procedure and later to examine the results of cleaning. With a microscope you can also determine if your optical device is scratched.

Ultrasonic bath This is typically available from photographic stores or laboratory suppliers.

An ultrasonic bath very gently removes greasy and other stubborn dirt from optical devices.

Only use an ultrasonic bath with isopropyl alcohol, as other solvents can damage or dirty your optical device.

Warm water and liquid soap Use water only if you are sure that your optical device will not corrode or be damaged. Do not use hot water, as this can lead to mechanical stress that can damage your optical device. Ensure that your liquid soap has no abrasive properties or perfume in it, as these can scratch or damage your optical device. Do not use normal washing-up liquid, as it can leave behind an iridescent film.

Premoistened cleaning wipes These are available from HP. The part number is HP 92193N (80 Wipes per box). These are tissues that are moistened with isopropyl alcohol.

Polymer film This is typically available from professional photographic stores or laboratory suppliers.

Polymer film is very gentle on optical surfaces and is particularly good for cleaning extremely sensitive devices such as mirrors.

Infrared sensor card This is typically available from laboratory suppliers.

With this card you can qualitatively check the uniformity of your emitted laser light, because when the laser light is projected onto the sensor card it becomes visible.

Lens Cleaning Paper Some lens cleaning papers and cleaning kits available, for example, in photographic stores are not suitable for cleaning fiber optic devices. To be sure, please ask the salesperson or the manufacturer.

E Preserving Connectors

Listed below are some hints on how to keep your connectors in the best possible condition.

Making Connections
Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

Dust Caps and Shutter Caps
Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Keep the caps on the equipment always when it is not in use.

All of Hewlett-Packard's lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your Hewlett-Packard sales office.

Immersion Oil and Other Index Matching Compounds
Where it is possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

Cleaning Procedures

If you are unsure about the correct cleaning procedure for your device or if you are unsure whether the procedure given here is suitable for your device, check with the manufacturer or sales distributor, or try the procedure on a dummy or test device first.

In general, *whenever possible use physically contacting connectors, and dry connections*. Fiber connectors may be used dry or wet. Dry means without index matching compound. If there is a need to use an index matching compound, use only HP index matching oil (part number 8500-4922). Clean the connectors, interfaces and bushings carefully each time after use.

Warning	**Make sure to disable all sources when you are cleaning any optical interfaces.**
	Under no circumstances look into the end of an optical cable attached to the optical output when the device is operational.
	The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

Cleaning Cable Connectors

Cleaning connectors is difficult as the core diameter of a singlemode fiber is only about 9μm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by skilled personnel, and as a last resort as it wears out your connector.

Warning	**Never look into the end of an optical cable that is connected to an active source.**

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure

1. Clean the connector by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the connector:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the connector by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

An Alternative Procedure

The better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1. Hold the tip of the connector in the bath for at least three minutes.
2. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Cleaning Connector Adapters

Caution

Some adapters have an anti-reflection coating on the back to reduce back reflection. This coating is extremely sensitive to solvents and mechanical abrasion. Extra care is needed when cleaning these adapters.

Preferred Procedure

1. Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the adapter:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the adapter by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

Cleaning Connector Interfaces

Caution

■ Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the interface.
■ Do not use pipe-cleaners on optical head adapters, as the hard core of normal pipe cleaners can damage the bottom of an adapter.

Preferred Procedure

1. Clean the interface by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2. Then clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface:

1. Moisten a new pipe-cleaner with isopropyl alcohol.
2. Clean the interface by pushing and pulling the pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
3. Moisten a new cotton-swab with isopropyl alcohol.
4. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
5. Using a new, dry pipe-cleaner, and a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.
6. Blow away any remaining lint with compressed air.

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Cleaning Bare Fiber Adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

Caution
Never use any kind of solvent when cleaning a bare fiber adapter as

- Solvents can damage the foam inside some adapters.
- They can deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure   Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt   Use this procedure particularly when there is greasy dirt on the adapter:

Caution
Be careful when using pipe-cleaners, as the core and the bristles of the pipe-cleaner are hard and can damage the adapter.

1. Clean the adapter by pushing and pulling a new, dry pipe-cleaner into the opening. Rotate the pipe-cleaner slowly as you do this.
2. Clean the adapter by rubbing a new, dry cotton-swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Cleaning Bare Fiber Ends

Bare fiber ends are often used for splices or, together with other optical components, to create a parallel beam. The end of a fiber can often be scratched. You make a new cleave. To do this:

1. Strip off the cladding.
2. Take a new soft-tissue and moisten it with isopropyl alcohol.
3. Carefully clean the bare fiber with this tissue.
4. Make your cleave and immediately insert the fiber into your bare fiber adapter in order to protect the surface from dirt.

Cleaning Lenses

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little alcohol as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure

1. Clean the lens by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the lens:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the lens by rubbing the cotton-swab over the surface using a small circular movement.
3. Using a new, dry cotton-swab remove the alcohol, any dissolved sediment and dust.
4. Blow away any remaining lint with compressed air.

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Cleaning Large Area Lenses and Mirrors

Caution
Some mirrors, such as those from a monochromator, are very soft and sensitive. Therefore, never touch them and do not use cleaning tools such as compressed air or polymer film.

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little liquid as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure

1. Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the lens:

Caution

■ Only use water if you are sure that your device does not corrode.
■ Do not use hot water as this can lead to mechanical stress, which can damage your device.
■ Make sure that your liquid soap has no abrasive properties or perfume in it, because they can scratch and damage your device.
■ Do not use normal washing-up liquid as sometimes an iridescent film remains.

1. Moisten the lens or the mirror with water.
2. Put a little liquid soap on the surface and gently spread the liquid over the whole area.
3. Wash off the emulsion with water, being careful to remove it all, as any remaining streaks can impair measurement accuracy.
4. Take a new, dry soft-tissue and remove the water, by rubbing gently over the surface using a small circular movement.
5. Blow away remaining lint with compressed air.

Alternative Procedure A

To clean lenses that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

1. Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.
2. Remove the film and any dirt with special adhesive tapes.

Alternative Procedure B

If your lens is sensitive to water then:

1. Moisten the lens or the mirror with isopropyl alcohol.
2. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3. Blow away remaining lint with compressed air.

Cleaning Fixed Connector Interfaces

A few instruments, such as the HP 8158B, have fixed connector interfaces. Generally, avoid cleaning this kind of interface, because it is difficult to remove any used alcohol or lint from the input of the optical block. Keep the dust caps on the interfaces unless it is in use.

If there is dust on the interface, try cleaning it using compressed air.

If there is fluid or greasy dirt on the interface then contact Hewlett-Packard, where trained personnel can open the instrument and do the cleaning. Never open the instrument to clean the optical block yourself, because the optical components can be easily scratched or misaligned.

Cleaning Optical Glass Plates

Some instruments, for example, the optical heads from Hewlett-Packard have an optical glass plate to protect the sensor. Clean this glass plate in the same way as optical lenses (see "Cleaning Lenses").

Cleaning Physical Contact Interfaces

Remove any connector interfaces from the optical output of the instrument before you start the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a singlemode fiber is only about 9μm. This generally means you cannot see streaks or scratches on the surface. To be certain of the degree of pollution on the surface of your interface and to check whether it has been removed after cleaning, you need a microscope.

Warning
Never look into an optical output, because this can seriously damage your eye sight.

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure
1. Clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt
Use this procedure particularly when there is greasy dirt on the interface:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

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Cleaning Recessed Lens Interfaces

Preferred Procedure

1. Blow away any dust or dirt with compressed air.

If this is not sufficient, then

1. Clean the interface by rubbing a new, dry cotton-swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure particularly when there is greasy dirt on the interface, and using the procedure for light dirt is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

1. Moisten a new cotton-swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton-swab over the surface using a small circular movement.
3. Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

Cleaning Fragile Optical Devices

Some optical devices, such as the HP 81000BR Reference Reflector, which has a gold plated surface, are very sensitive to mechanical stress or pressure. Do not use cotton-swabs, soft-tissues or other mechanical cleaning tools, as these can scratch or destroy the surface.

Preferred Procedure

1. Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

To clean devices that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

1. Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.
2. Remove the film and any dirt with special adhesive tapes.

Alternative Procedure

For these types of optical devices you can often use an ultrasonic bath with isopropyl alcohol. Only use the ultrasonic bath if you are sure that it won't cause any damage to the device.

1. Put the device into the bath for at least three minutes.
2. Blow away any remaining liquid with compressed air.

If there are any streaks or drying stains on the surface, repeat the cleaning procedure.

Cleaning Metal Filters or Attenuator Gratings

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This kind of device is extremely fragile. A misalignment of the grating leads to inaccurate measurements. Never touch the surface of the metal filter or attenuator grating. Be very careful when using or cleaning these devices. Do not use cotton-swabs or soft-tissues, as there is the danger that you cannot remove the lint and that the device will be destroyed by becoming mechanically distorted.

Preferred Procedure

1. Use compressed air at a distance and with low pressure to remove any dust or lint.

Procedure for Stubborn Dirt

Do not use an ultrasonic bath as this can damage your device.

Use this procedure particularly when there is greasy dirt on the device:

1. Put the optical device into a bath of isopropyl alcohol, and wait at least 10 minutes.
2. Remove the fluid using compressed air at some distance and with low pressure.

If there are any streaks or drying stains on the surface, repeat the whole cleaning procedure.

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Error Messages

Display Messages

AVA is the equivalent of **AVAILABLE** (see below), if Coherence Control is on or below Uncal level.

AVAILABLE indicates that the set value is too high for laser output while the instrument is warming up.

The value given in the message is the maximum power available.

CC UNCAL indicates that the set power value is too small to achieve full linewidth broadening.

EXC is the equivalent of **EXCESSIVE** (see below), if Coherence Control is on or below Uncal level.

EXCESSIVE indicates that the set value is greater than the laser can output at this wavelength.

The value given in the message (P =) is the actual power being output, the maximum power available at that wavelength.

INITIALIZING is displayed while the instrument is performing its internal initialization.

LASER PROTECTION indicates that the laser has been switched off to prevent damage to the laser diode.

Try, once or twice, to reenable the laser. If this does not work, try reducing the power, and then reenabling. If this does not work, press (AUX) Realign for Automatic Realignment. This will automatically realign the laser cavity. See "Automatic Realignment" in Chapter 3 for more information.

STABILIZING indicates that the laser heat chamber is not at operating temperature. It can take around 1 hour for the temperature to stabilize. The percentage value given as part of the message indicates how close the

instrument is to the operating temperature (100%). (See "Stabilizing" in
Appendix A for more detailed information about stabilizing.)

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HP-IB Messages

Instrument Specific Errors

These are error messages with positive error numbers. They indicate errors such as incompatible modes.

200 Not Attenuation Mode

This indicates that a command or query was received that cannot be executed or answered in Power Mode (see "[:SOURce]:POWer:ATTenuation:AUTO" in Chapter 5).

Command Errors

These are error messages in the range -100 to -199. They indicate that a syntax error has been detected by the parser in a command, such as incorrect data, incorrect commands, or misspelled or mistyped commands.

A command error is signaled by the command error bit (bit 5) in the event status register.

-100 Command error. This indicates that the parser has found a command error but cannot be more specific.

-101 Invalid character. The command contains an invalid or unrecognized character.

-102 Syntax error. The command or data could not be recognized.

-103 Invalid separator. The parser was expecting a separator (for example, a semicolon (;) between commands) but did not find one.

-104 Data type error. The parser was expecting one data type, but found another (for example, was expecting a string, but received numeric data).

-105 GET not allowed. A Group Execute Trigger was received within a program message (see IEEE 488.2, 7.7)

-108 Parameter not allowed. More parameters were received for a command than were expected.

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-109 Missing parameter. Fewer parameters were received than the command requires.

-110 Command header error. A command header is the mnemonic part of the command (the part not containing parameter information. This error indicates that the parser has found an error in the command header but cannot be more specific.

-111 Header separator error. A character that is not a valid header separator was encountered.

-112 Program mnemonic too long. The program mnemonic must be 12 characters or shorter.

-113 Undefined header. This header is not defined for use with the instrument.

-114 Header suffix out of range. The header contained an invalid character. This message sometimes occurs because the parser is trying to interpret a non-header as a header.

-120 Numeric data error. This error indicates that the parser has found an error in numeric data (including nondecimal numeric data) but cannot be more specific.

-121 Invalid character in number. An invalid character was found in numeric data (note, this may include and alphabetic character in a decimal data, or a "9" in octal data).

-123 Exponent too large. The exponent must be less than 32 000.

-124 Too many digits. The mantissa of a decimal number can have a maximum of 255 digits (leading zeros are not counted).

-128 Numeric data not allowed. Another data type was expected for this command.

-130 Suffix error. The suffix is the unit, and the unit multiplier for the data. This error indicates that the parser has found an error in the suffix but cannot be more specific.

-131 Invalid suffix. The suffix is incorrect or inappropriate.

-134 Suffix too long. A suffix can have a maximum of 12 characters.

-138 Suffix not allowed. A suffix was found where none is allowed.

-140 Character data error. This error indicates that the parser has found an error in character data but cannot be more specific.

-141 Invalid character data. The character data is incorrect or inappropriate.

-144 Character data too long. Character data can have a maximum of 12 characters.

-148 Character data not allowed. Character data was found where none is allowed.

-150 String data error. This error indicates that the parser has found an error in string data but cannot be more specific.

-151 Invalid string data. The string data is incorrect, (for example, an END message was received before the terminal quote character).

-158 String data not allowed. String data was found where none is allowed.

-160 Block data error. This error indicates that the parser has found an error in block data but cannot be more specific.

-161 Invalid block data. The block data is incorrect (for example, an END message was received before the length was satisfied).

-168 Block data not allowed. Block data was found where none is allowed.

Execution Errors

These are error messages in the range -200 to -299. They indicate that an execution error has been detected by the execution control block.

An execution error is signaled by the execution error bit (bit 4) in the event status register.

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-200 Execution error. This indicates that an execution error has occurred but the control block cannot be more specific.

-201 Invalid while in local. This command is invalid because it conflicts with the configuration under local control.

-202 Settings lost due to rtl. A local setting was lost when the instrument was changing from remote to local control, or from local to remote control.

-220 Parameter error. This indicates that a parameter error has occurred but the control block cannot be more specific.

-221 Settings conflict. A valid parameter was received, but could not be used during execution because of a conflict with the current state of the instrument.

-222 Data out of range. The data, though valid, was outside the range allowed by the instrument.

-223 Too much data. The block, expression, or string data was too long for the instrument to handle.

-224 Illegal parameter value. One value from a list of possible values was expected. The parameter received was not found in the list.

-240 Hardware error. Indicates that a command could not be executed due to a hardware error but the control block cannot be more specific.

-241 Hardware missing. Indicates that a command could not be executed because of missing instrument hardware.

F-6   Error Messages

Device-Specific Errors

These are error messages in the range -300 to -399, or between 1 and 32767. They indicate that an error has been detected that is specific to the operation of the tunable laser source.

A device-specific error is signaled by the device-specific error bit (bit 3) in the event status register.

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-300 Device-specific error. This indicates that a device-specific error has occurred. No more specific information is available.

-310 System error. An instrument system error has occurred.

-311 Memory error. A memory error has been detected.

-314 Save/recall memory lost. The nonvolatile data saved by the *SAV command has been lost.

-315 Configuration memory lost. The nonvolatile configuration data saved by the instrument has been lost.

-330 Self-test failed. Further information about the self-test failure is available by using *TST?.

-350 Queue overflow. The error queue has overflowed. This error is written to the last position in the queue, no further errors are recorded.

Query Errors

These are error messages in the range -400 to -499. They indicate that an error has been detected by the output queue control.

A device-specific error is signaled by the query error bit (bit 2) in the event status register.

-300 Query error. This indicates that a query error has occurred. No more specific information is available.

-410 Query INTERRUPTED. A condition occurred that interrupted the transmission of the response to a query (for example, a query followed by a DAB or a GET before the response was completely sent).

-420 Query UNTERMINATED. A condition occurred that interrupted the reception of a query (for example, the instrument was addressed to talk and an incomplete program message was received).

-430 Query DEADLOCKED. A condition causing a deadlocked query has occurred (for example, both the input and the output buffer are full and the device cannot continue).

-440 Query UNTERMINATED after indefinite response. Two queries were received in the same message. The error occurs on the second query if the first requests an indefinite response, and was already executed.

Backdating

Initial Safety Information for the Tunable Laser Source

The 8168F is in a higher Laser Class (IIIb) than the 8167A and the 8168D and E (all Class 1).

Earlier models

This manual can be also used for earlier tunable laser sources, that is, for HP 8167A models with serial number prefixes lower than 3424G, and for all versions of the HP 8168A.

However, these earlier models have the following features:

■ Only internal modulation is possible.

■ The `[:SOURce]:AM:SOURce` command and the `[:SOURce]:AM:SOURce?` query are not available.

■ The `CohCtrl Uncal` bit (Bit 7) in the questionable branch of the status registers is not used.

■ Option 007, the Polarization Maintaining Fiber is available.

Specifications

The specifications for the HP 8167A for serial number prefixes lower than 3424G differ as indicated below from those given in Appendix C.

Performance Specifications

Specifications describe the instrument's warranted performance. Supplementary performance characteristics describe the instrument's non-warranted typical performance.

	HP 8167A	HP 8168A
Relative Wavelength Accuracy (typ.) [1]	<±0.05nm (typ. ±0.02nm)	
Wavelength Repeatability [1]	±0.05nm (typ.:±0.02nm)	
Output Power		>-4dBm
for Option 003		>-5.5dBm
Power Stability (over 1h) [2]	<±0.05dB (typ. 0.01dB)	
[1] Measured with a wavemeter in air at constant temperature. [2] Measured with average optical power-meter at constant temperature.		

Supplementary Performance Characteristics

■ Output Isolation (typ.): 60dB

Performance Test for the HP 8168A

Test Facility:

_____   Report No. _____

_____   Date   _____

_____   Customer   _____

_____   Tested By   _____

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Model   HP 8168A Tunable Laser Source

Serial No.   _____   Ambient temperature _____ °C

Options   _____   Relative humidity   _____ %

Firmware Rev. _____   Line frequency   _____ Hz

Special Notes:

_____

_____

_____

_____

_____

_____

_____

Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Test Equipment Used:

	Description	Model No.	Trace No.	Cal. Due Date
1.	Lightwave Multimeter with	HP 8153A		
2.	Sensor Module	HP 81532A		
3a.	Optical Spectrum Analyzer	HP 70950A		
3b	OSA Display	HP 70004A		
4.	Wavelength Meter	Advantest TQ8325		
5a.	Connector Interface (×2)	HP 81000AI		
5b.	Connector Interface (#021)	HP 81000AI		
6.	Connector Interface (#022)	HP 81000SI		
7.	Universal Through Adapter (#021, #022)	HP 81000UM		
8a.	High Return Loss Cable	HP 81109AC		
8b.	High Return Loss Cable (#021)	HP 81109AC		
9.	High Return Loss Cable	HP 81102SC		
10.				
11.				
12.				
13.				
14.				
15.				

Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____ ; Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
1	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm
2	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____ ; Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
3	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm
4	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

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Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____ ; Date_____

Relative Wavelength Accuracy

Repetition	Wavelength Setting	Wavelength Measured	Deviation meas - set value	Maximum Deviation	Minimum Deviation
5	1500.000nm	_____nm	_____nm		
	1510.000nm	_____nm	_____nm		
	1520.000nm	_____nm	_____nm		
	1530.000nm	_____nm	_____nm		
	1540.000nm	_____nm	_____nm		
	1550.000nm	_____nm	_____nm		
	1560.000nm	_____nm	_____nm		
	1565.000nm	_____nm	_____nm	_____nm	_____nm

Largest Maximum Deviation   _____nm

Smallest Minimum Deviation   _____nm

Relative Wavelength Accuracy
(= Largest Maximum Deviation - Smallest Minimum Deviation)   _____nm
                                    Specification   0.10nm
                                                    0.04nm typical

                        Measurement Uncertainty   ±0.01nm

Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Wavelength Repeatability

Description 1565.000nm	Min Spec	Result REF	Max Spec	Measurement Uncertainty ±0.002nm
from _____nm to REF	1564.95nm	_____nm	1565.05nm	
from _____nm to REF	1564.95nm	_____nm	1565.05nm	
from _____nm to REF	1564.95nm	_____nm	1565.05nm	
from _____nm to REF	1564.95nm	_____nm	1565.05nm	
from _____nm to REF	1564.95nm	_____nm	1565.05nm	

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Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____   Date_____   _____

Maximum Power Test

Wavelength	Minimum Spec				Result	Measurement Uncertainty
						±0.30dB
option:	#023	#003	#023+#003			
	(circle the appropriate)					
1500nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1510nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1520nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1530nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1540nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1550nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1560nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	
1565nm	-4.0dBm	-5.0dBm	-5.5dBm	-6.5dBm	_____dBm	

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Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Power Linearity
  (HP 8168A without attenuator)

Power Setting at current setting	Relative Power from start	Power Reduction at current setting	Power Linearity
	plus	=	
start: -5.0dBm	REF	0.0dB	0.00dB
-5.5dBm	_____dB	0.5dB	_____dB
-6.0dBm	_____dB	1.0dB	_____dB
-6.5dBm	_____dB	1.5dB	_____dB
-7.0dBm	_____dB	2.0dB	_____dB
-7.5dBm	_____dB	2.5dB	_____dB
-8.0dBm	_____dB	3.0dB	_____dB
-8.5dBm	_____dB	3.5dB	_____dB
-9.0dBm	_____dB	4.0dB	_____dB
-9.5dBm	_____dB	4.5dB	_____dB
-10.0dBm	_____dB	5.0dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity) _____dBpp
Specification   0.2dBpp

Measurement Uncertainty   ±0.05dB

G-10   Backdating

Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Power Linearity
    (HP 8168A with attenuator)

	Power Setting at current setting	Relative Power from start plus	Power Reduction at current setting =	Power Linearity
start:	-6.5dBm	REF	0.0dB	0.00dB
	-10.0dBm	_____dB	3.5dB	_____dB
	-15.0dBm	_____dB	8.5dB	_____dB
	-20.0dBm	_____dB	13.5dB	_____dB
	-25.0dBm	_____dB	18.5dB	_____dB
	-30.0dBm	_____dB	23.5dB	_____dB
	-35.0dBm	_____dB	28.5dB	_____dB
	-40.0dBm	_____dB	33.5dB	_____dB
	-45.0dBm	_____dB	38.5dB	_____dB
	-50.0dBm	_____dB	43.5dB	_____dB

Maximum Power Linearity at current setting   _____dB

Minimum Power Linearity at current setting   _____dB

Final Power Linearity
(= Max Power Linearity - Min Power Linearity)   _____dBpp
                                    Specification   0.6dBpp

Measurement Uncertainty   ±0.05dB

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Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Power Flatness versus Wavelength

Wavelength   **Deviation**

1500nm   0.00 (start value, REF)

1510nm   _____dB

1520nm   _____dB

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1530nm   _____dB

1540nm   _____dB

1550nm   _____dB

1560nm   _____dB

1565nm   _____dB

Maximum deviation   _____dB

Minimum deviation   _____dB

Flatness
(= Maximum - Minimum deviation)   _____dBpp
Specification 0.2dBpp without #003
0.4dBpp with #003

Measurement Uncertainty   ±0.07dB

Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Power Stability

High power   **Low power**

Maximum deviation   _____dB   Maximum deviation   _____dB

Minimum deviation   _____dB   Minimum deviation   _____dB

Power Stability   **Power Stability**
(= Max - Min deviation)   _____dBpp   (= Max - Min deviation)   _____dBpp
Specification   0.1dBpp   Specification   0.1dBpp

Measurement Uncertainty ±0.02dB

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Performance Test for the HP 8168A

Model HP 8168A Tunable Laser Source   Report No._____   Date_____

Sidemode Suppression Ratio

Wavelength	Minimum Spec	Result	Measurement Uncertainty
			±1.20dB
1500nm	-40dB	_____dB	
1510nm	-40dB	_____dB	
1520nm	-40dB	_____dB	
1530nm	-40dB	_____dB	
1540nm	-40dB	_____dB	
1550nm	-40dB	_____dB	
1560nm	-40dB	_____dB	
1565nm	-40dB	_____dB	

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