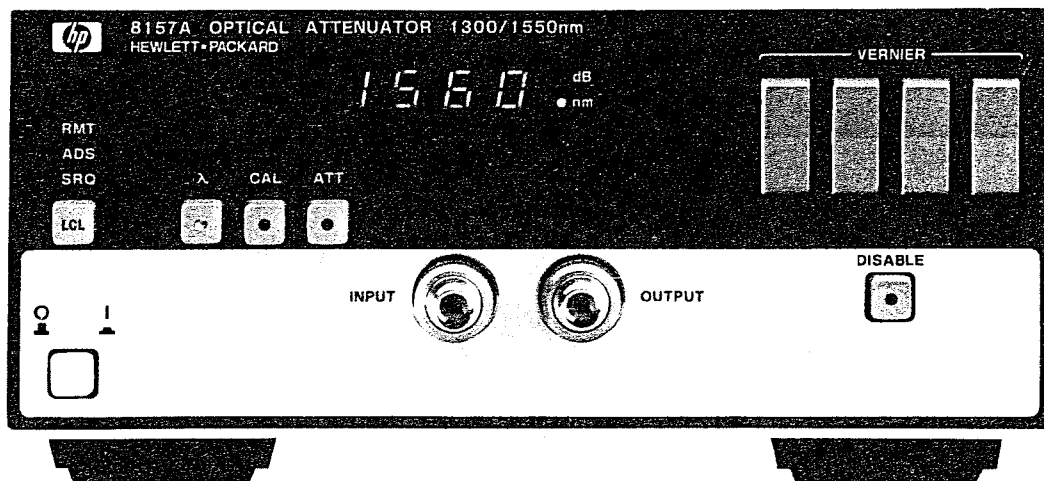


# HP 8157A OPTICAL ATTENUATOR





# **OPERATING AND PROGRAMMING MANUAL**

## **HP 8157A OPTICAL ATTENUATOR**

### **SERIAL NUMBERS**

This manual applies directly to instruments with serial number 2720G00101 and higher. Any change made in instruments having serial numbers higher than the above number will be found in a "Manual Changes" supplement supplied with this manual. Be sure to examine the supplement for changes which apply to your instrument and record these changes in the manual.

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

## WARRANTY

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

For warranty service or repair, this product must be returned to a service facility designated by 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, or software, or firmware will be uninterrupted or error free.

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*For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.*

## LIST OF EFFECTIVE PAGES

The List of Effective Pages gives the date of the most recent version of each page in the manual. To verify that your manual contains the most current information, check the dates printed at the bottom of each page with those listed below. The date on the bottom of each page reflects the edition or subsequent update in which that page was printed.

First Edition	October 1987
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Effective Pages	Date
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ALL	October 1987
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# PRINTING HISTORY

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The date on the title page and back cover of the manual only changes when a new edition is published. When an edition is reprinted, all the prior updates to the edition are incorporated. No information is incorporated into a new edition unless it appears in a prior update.

First Edition Printed

October 1987

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# SECTION I

## GENERAL INFORMATION

### 1.1 INTRODUCTION

This manual contains the information required to install, test, and operate the Hewlett-Packard Model HP 8157A Optical Attenuator.

### 1.2 SPECIFICATIONS

Specifications of the Model HP 8157A are given in Table I-1. These specifications are the performance standards or limits against which the instrument is tested. The specifications are measured with Diamond<sup>®</sup> HMS-10/HP (Opt.011) connector interfaces and Diamond<sup>®</sup> HMS-10/HP connectors.

### 1.3 SAFETY CONSIDERATIONS

The Model HP 8157A is a Safety Class 1 instrument (instrument with an exposed metal chassis that is directly connected to earth via the power supply cable). The symbol used to indicate a protective earth terminal in the instrument is  $\oplus$ .

Before operation, the instrument and manual, including the red safety page, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in a safe condition.

#### CAUTION

*Every time that you connect a fiber to the HP 8157A, CLEAN the connectors. This is because any dirt particles on the ferrule of the HP 8157A connector will effect the return loss of the instrument and could also lead to permanent damage of the optical block.*

*DO NOT use index matching gel on the HP 8157A connectors, as this could damage the instrument. If you must improve connections, use only immersion oils.*

#### Recommended Immersion Oils:

R.P. Cargille Laboratories, INC

Refractive Index Liquid, use one with the refractive index of glass.

Zeiss Immersion Oil

HP Part Number 6040-0648

#### CAUTION

*If you wish to use a DIN multimode connector on this instrument, screw the connector onto the HP 8157A's connector interface very softly, otherwise permanent damage can be caused to the ferrule of the HP 8157A.*

## 1.4 INSTRUMENTS COVERED BY THIS MANUAL

Each Model HP 8157A has a two-part serial number. The first 4 digits and the letter comprise the serial number prefix; the last 5 digits a sequential suffix which is unique to each Model HP 8157A. The contents of this manual apply directly to optical attenuators having serial numbers above 2720G00101

## 1.5 DESCRIPTION

The HP 8157A Optical Attenuator is precisely calibrated at 1300nm and 1550nm over the whole 60dB attenuation range. Because of the advanced optical system, including the lens design and coating, the attenuation can be easily corrected for other wavelengths in the respective ranges by simple entry of the desired wavelength into the instrument memory. This enables you to match the attenuator exactly to the center wavelength of your source, thus ensuring reliable measurement results. The following lists the features of the HP 8157A Optical Attenuator:

- designed for single-mode fibers
- full HP-IB programmability
- 60dB attenuation range, 0.01dB resolution and 0.04dB repeatability
- correction of attenuation between 1200nm and 1650nm

## 1.6 ACCESSORIES SUPPLIED

The Model HP 8157A is supplied complete with the following accessories:

Item	HP Part No.
T 800mA, 250Vac Fuse (100/120V)*	2110-0020
T 400mA, 250Vac Fuse (220/240V)*	2110-0340
Power Cord	see Figure 2-2

\* one fitted and one supplied

## 1.7 ACCESSORIES AVAILABLE

A number of interface cables are available for simplifying connection of the Model HP 8157A to various optical signal sources and receivers. For a list of these adapter cables and connectors, see the latest Ordering Guide. The following lists the company options available for the HP 8157A:

Option 907	Front Handle Kit
Option 908	Rack Flange Kit
Option 916	Additional Operating and Programming Manual
P/N 5061-9071	Bail Handle Kit

An additional accessory for the Model HP 8157A is the HP 15475A Cleaning Kit. This kit includes cleaning material (brush, tissue, tape, etc.) to clean optical surfaces such as connectors and is supplied in a plastic carrying case.

**Table 1-1. Specifications**

Specifications describe the instrument's warranted performance. They are measured with Diamond® HMS-10/HP connector interfaces (Opt.011) and Diamond® HMS-10/HP connectors, if not otherwise specified. The connectors must have Manufacturing Date Code 31-87 or higher to achieve the warranted return loss values.

**Optical Characteristics**

Specifications are measured at 1300nm and 1550nm using a CW laser diode source with constant output power and single-mode fibers with 9/125 μm (NA=0.1).

**Wavelength Range:**  
1200nm to 1650nm

**Attenuation Range (excl. insertion loss):** 60.00dB

**Insertion Loss (incl. both connectors)**

	HMS-10/HP Opt.011	FC/PC, DIN, ST Opts.012,013,014
worst case	< 4.0dB	< 6.0dB
typical	2.0dB	2.0dB

**Linearity:** ±0.20dB, typically 0.05dB

**Return Loss (incl. two Diamond® HMS-10/HP connector interfaces and a terminated fiber end\*):** >33dB

**Typical Return Loss (incl. two connector interfaces and a terminated fiber end\*):**

HMS-10/HP	PC	ST	DIN 47256	FC**
> 36dB	> 30dB	> 20dB	> 33dB	< 14dB

\* Far end of fiber connected to the output port is terminated reflection-free.

\*\* Note: FC is not a physical contact connector, therefore return loss is < 14dB.

**Repeatability (of attenuation after any parameter has been changed and reset):** < ±0.04dB

**Display**

Display Range: 0.00 to 64.00dB

Display Resolution: 0.01dB (min. step size)

## **Supplementary Performance Characteristics**

(Description of non-warranted typical performance parameters)

**Repeatability** (of attenuation after a max. of 6 matings of same connector pair): <0.2dB

### **Operating Modes**

Output disable: Optical signal path interrupted.

$\lambda$ : Entry of wavelength for automatic correction of attenuation using typical correction values

Att: Attenuation is displayed and can be varied

Cal: Entry of calibration factor to adjust display so that displayed value indicates actual power level at output connector of attenuator. Range:  $\pm 99.99$ dB

### **General**

Recalibration period: 1 year

No warm-up time required if previously stored within operating temperature range.

### **HP-IB Capability**

All modes and parameters can be programmed.

**Listen** (time for HP 8157A to receive, verify and execute a message).

Output disable/enable, attenuation,  $\lambda$ : < 20 to 550ms (depending on actual setting/programmed parameter)

Cal: < 5ms

**Talk** (time for HP 8157A to transmit a message).

Query commands: < 1ms/character

**HP-IB Interface Function Code:** SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0

### **Environmental**

Storage temperature: -40°C to +75°C

Operating temperature: 0°C to +55°C

Humidity: <95% R.H. from 0°C to 40°C

**Power:** 100/120/220/240Vrms, +5%, -10%, 90VA max., 48-400Hz

**Battery back-up** (for non-volatile memory): with instrument switched off all current modes and data will be maintained for at least 10 years after instrument delivery

**Dimensions:** 89mm H, 212.3mm W, 345mm D (3.5"x8.36"x13.6")

**Weight:** net 6.3 kg (13.9 lbs), shipping 10.6 kg (23.4 lbs)

For adapter cables and other accessories see latest Ordering Guide.

Data subject to change.

# SECTION II

## INSTALLATION

### 2.1 INTRODUCTION

This section provides installation instructions for the Model HP 8157A and its accessories. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage and shipment.

### 2.2 INITIAL INSPECTION

Inspect the shipping container for damage. If the container or cushioning is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been verified both mechanically and electrically.

Procedures for checking the optical operation are given in Section 4. 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. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement without waiting settlement.

### 2.3 PREPARATION FOR USE

#### **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.).*

*When operating the HP 8157A in the vertical position i.e. standing on the rear panel feet, care should be taken to ensure the instrument does not fall over and cause operator injury.*

### 2.4 Power Requirements

The instrument requires a power source of 100/120/220/240 Vrms (+10%, -5%) at a frequency of 48-400 Hz single phase. The maximum power consumption is 90 VA.

## 2.5 Line Voltage Selection

### CAUTION

*BEFORE SWITCHING ON THE INSTRUMENT, make sure that the instrument is set to the local line voltage.*

The switch is combined with the power line voltage receptacle on the rear panel. If it is necessary to change the setting, **THE POWER CORD MUST FIRST BE DISCONNECTED.** Then insert a screwdriver into the recess at the left-hand side of the assembly and prise open the cover. Figure 2-1 shows the main details of the assembly. To change the voltage setting, the selector must be removed and then replaced with the new setting value displayed. If necessary, change the fuse in accordance with the new voltage setting.

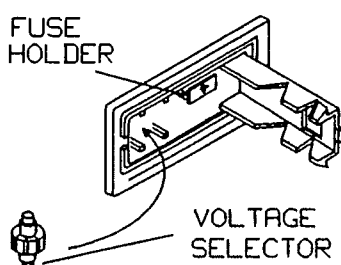


Figure 2-1. Line Voltage Switch Assembly.

VOLTAGE	100/120V	220/240V
FUSE	T 800mA, 250Vac	T 400mA, 250Vac

## 2.6 Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of the power cables available.

### WARNING

*To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on.*

- a) *If this instrument is to be energised via an autotransformer for voltage reduction, ensure that the Common terminal is connected to the grounded pole of the power source.*
- b) *The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.*
- c) *Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor. This is verified by using the power cord which is supplied with the instrument.*

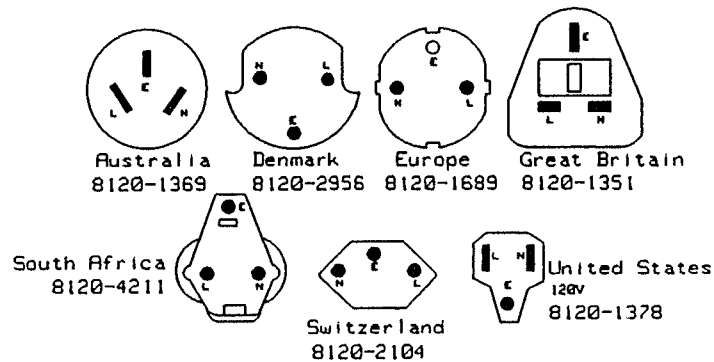


Figure 2-2. Power Cables - Plug Identification

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

The color coding used in the cable will depend on the cable supplied (see Figure 2-2). If a new plug is to be connected, it should meet local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications in Section 1).
- Ground connection.
- Cable clamp.

## 2.7 HP-IB Connector

The rear panel HP-IB connector (Fig 2-3), is compatible with the connector on Cable Assemblies 10833A, B, C and D. If a cable is to be locally manufactured, use connector male, HP part number 1251-0293.

## 2.8 HP-IB Logic Levels

The HP 8157A HP-IB lines use standard TTL logic, the levels being as follows:

True = Low = digital ground or 0V dc to 0.4V dc,

False = High = open or 2.5V dc to 5V dc.

All HP-IB lines have LOW assertion states. High states are held at 3.0V d.c. by pull-ups within the instrument. When a line functions as an input, approximately 3.2mA of current is required 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:** Isolation, the HP-IB line screens are not isolated from ground.

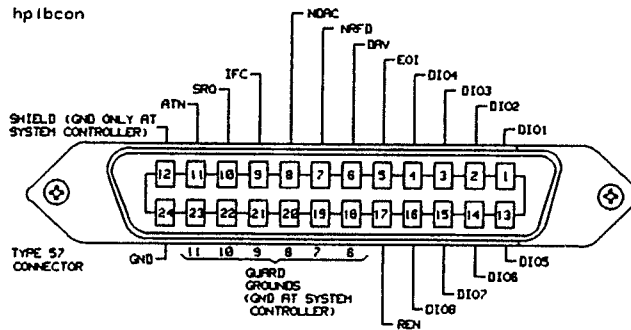


Figure 2-3. HB-IB Connector

## 2.9 OPERATING ENVIRONMENT

The operating temperature limits are 0°C to 55°C. The specifications also apply over this range.

## 2.10 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.



## 2.11 STORAGE AND SHIPMENT

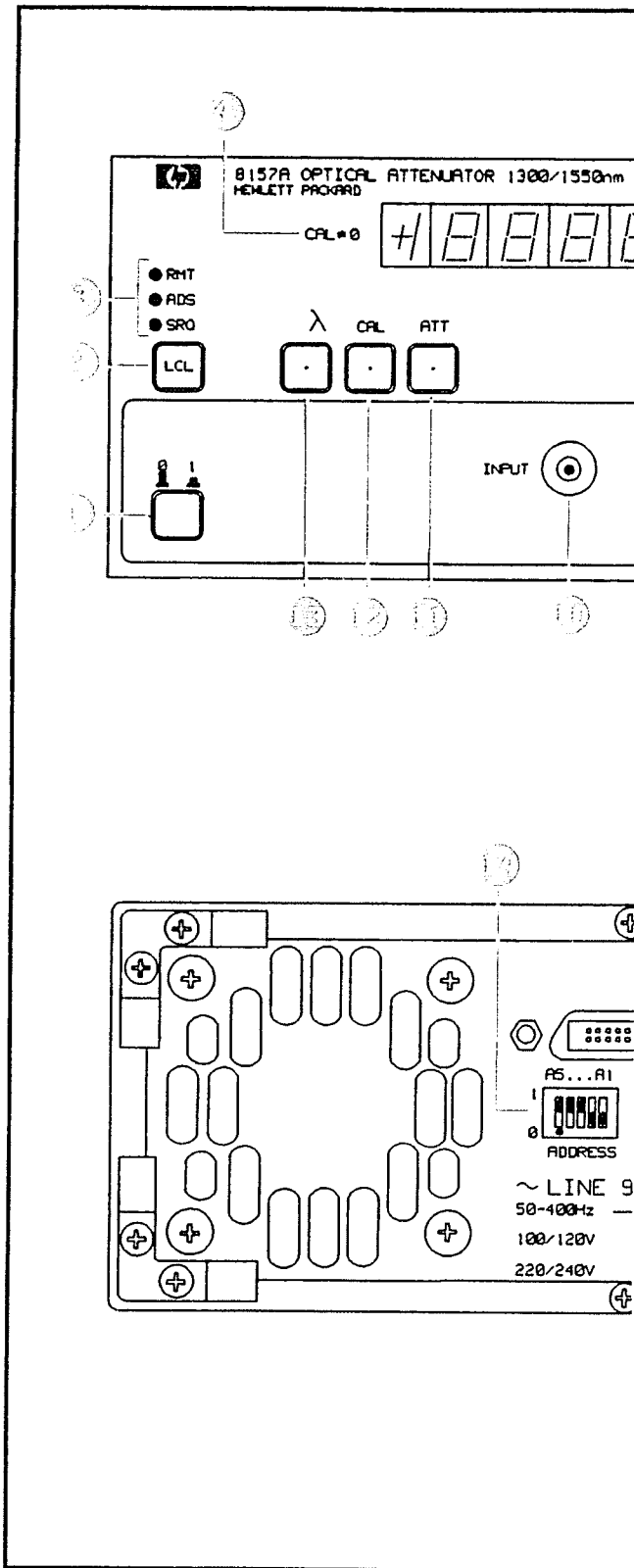
The instrument can be stored or shipped at temperatures between minus 40 deg C and plus 75 deg C. The instrument should be protected from temperature extremes which may cause condensation within it.

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 also provide information and recommendations on materials to be used if the original packing is no longer available or reusable. General instructions for repacking 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.

Figure 3-1. Front and Rear Panel (



# SECTION III

## OPERATING AND PROGRAMMING

### 3.1 INTRODUCTION

This section explains the functions of controls, indicators and connectors, as well as providing operating and programming information. Figure 3-1 provides a numbered illustration of the front and rear panel controls, and should be folded out when reading the description "Getting to Know Your Instrument " on the following pages. This description should be read before continuing with the more detailed operating information. Programming information is located at the end of this section.

### 3.2 SPECIAL OPERATING CONSIDERATIONS

The following points should be noted before applying power to the instrument:

- ➔ Read the safety summary at the beginning of this manual.
- ➔ Ensure that the VOLTAGE SELECTOR switch on the rear panel is set for operation at the local line voltage.

If any change is made to the setting of the VOLTAGE SELECTOR switch, the fuse must also be changed. Before making either of these changes, switch the instrument off and disconnect the power cord.

#### **WARNING**

##### How to Avoid Potential Exposure to Radiation

*When connecting the Model HP 8157A into the optical path between an optical source and optical receiver, complete the connection between the Model HP 8157A and receiver first. Then regarding the connection between Model HP 8157A and source, make the Model HP 8157A connection before the source connection. This avoids any potential exposure to radiation.*

### 3.3 OPERATORS CHECKS

The HP 8157A performs a self-test routine at power switch-on. At the start of this routine, all front panel LEDs should be momentarily lit. In the event of a fault being detected, an error code will be presented in the digital display. The error codes and required action are listed as follows:

- Keyboard test failed. Check that no key is stuck in pressed position.
- Exxx where xxx is a 3-digit number. Indicates a serious fault and instrument should be returned to the nearest Hewlett-Packard Service Office.

### 3.4 GETTING TO KNOW YOUR INSTRUMENT

The following should be read in conjunction with Figure 3-1 which can be folded out to aid understanding.

#### Frontpanel

1. LINE switch. Power on/off switch.
2. LCL key. This key returns the HP 8157A to local manual operation when the instrument is under program control. Note that this key is disabled when the LOCAL LOCKOUT command has been sent by the system controller to the instrument.
3. Program status LEDs. When illuminated, the following is indicated.
  - RMT: Indicates remote control. All front panel pushbuttons (except the LCL pushbutton) are disabled.
  - ADS: Indicates that the instrument is being addressed under program control, although the front panel pushbuttons may still be enabled depending on the status of the RMT LED.
  - SRQ: Indicates that a Service Request has been sent by the instrument to the controller.
4. CAL  $\neq$  0 LED. Indicates that a non-zero value is currently selected for the CAL factor (see description for CAL key 13). The difference between the **displayed** attenuation and **actual** attenuation = the CAL factor.
5. Digital display. Displays numerical value of currently selected parameter (wavelength, CAL-factor or attenuation).
6. Unit LEDs. Operate in conjunction with the digital display (6) to indicate the base units of the currently selected parameter.
7. VERNIER rocker keys. Used to vary parameter values.
8. DISABLE key. Used to enable/disable the optical output (10). When the key LED is illuminated, the optical output is disabled.
9. Connector for optical output.
10. Connector for optical input.
11. ATT key. Used to set the attenuation. When pressed, current attenuation is displayed and can be changed via VERNIER keys (8).
12. CAL key. Used to offset the **displayed** attenuation value (as set via key (12)). When pressed, current offset (CAL factor) is displayed and can be changed via VERNIER keys (8). **NOTE:** When CAL key is already active, i.e. key LED illuminated, holding the key down will display the insertion loss for the selected fiber mode.
13.  $\lambda$  key. Used for setting the wavelength. When pressed, the current wavelength is displayed and can be changed via VERNIER keys (8).

## Rearpanel

14. HP-IB address switch.
15. HP-IB connector.
16. LINE connector assembly (including VOLTAGE SELECTOR switch). A three-pronged receptacle to provide chassis ground through the power cable for operator protection.

## 3.5 SETTING THE ATTENUATION

### 3.6 Basic Considerations

When you press the ATTenuation key on the HP 8157A front panel, the displayed setting automatically takes into consideration:

- The operating wavelength of the optical input. (Selected by  $\lambda$  key 13).

Due to the fact that attenuation is dependent on **wavelength**, you must first set the HP 8157A to the operating wavelength of the optical input to ensure attenuation accuracy. To make sure that you obtain the optimum performance from your optical system, use the center wavelength of your source. This can be found, for example, on the heatsink at the rear of the HP8154B. To set the wavelength, press  $\lambda$  key (13) and the current setting will be displayed. You can then change this setting via VERNIER keys (7), and the HP 8157A adjusts the attenuating filters automatically.

#### NOTE

Although instrument operation is specified for wavelengths 1300nm and 1550nm the setting range is 1200nm to 1650nm. For any setting other than that specified, the attenuation is based on a wavelength correction factor which is **typically** interpolated from the specified values.

With wavelength selected, the HP 8157A now performs automatic correction for any attenuation settings you make via the ATT key (11).

### 3.7 Optimize The Display With The CAL Key

The CAL key can be used to change the displayed attenuation setting without a corresponding change in actual attenuation at the output. Two examples of how this would be useful are as follows:

1. Making relative settings. If you want the displayed attenuation to be referenced to 20 dB, then entering -20 dB via the CAL key will set 20 dB **actual** attenuation to be the 0 dB **displayed** setting.
2. Adjusting the displayed attenuation to take known external losses into account. Consider the typical setup shown in the following figure 3-2.

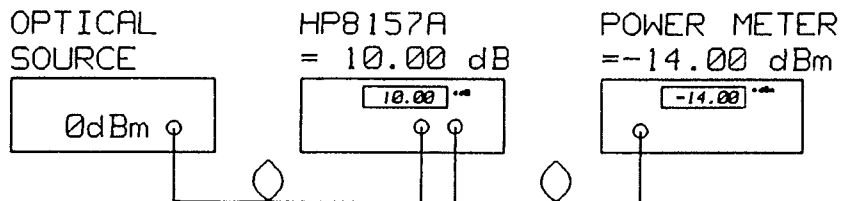


Figure 3-2.

Total attenuation from source to power meter is 14 dB, although the HP 8157A's displayed attenuation setting is 10 dB. There are therefore 4 dB external losses. By entering 4 dB via the CAL key, the displayed attenuation setting will change to 14 dB to include the 4 dB external losses, thus corresponding to power meter reading. Note that the CAL ≠ 0 LED is now illuminated. This informs you that the displayed attenuation has been corrected via the following formula to include the CAL factor:

$$\text{Actual attenuation} + \text{CAL factor} = \text{Displayed attenuation}$$

Substituting the values in the example gives the following:

$$10\text{dB} + 4\text{dB} = 14\text{dB}$$

## 3.8 PROGRAMMING

### 3.9 WHAT YOU NEED TO KNOW . . . .

Programming information in this section is restricted to HP 8157A specifics, and assumes that you have a working knowledge of HP-IB intrinsics. If you are not familiar with HP-IB, then refer to the following publications:

- HP Publication 5952-0156, "Tutorial Description of HP-IB"
- ANSI/IEEE-488-1978, "Digital Interface for Programmable Instrumentation" published by the Institute of Electrical and Electronic Engineers

For a complete list of the HP 8157A programming commands, refer to the pages at the end of this section.

### 3.10 . . . About The HP 8157A's HP-IB Capabilities

The HP 8157A interfaces to the HP-IB as defined by the IEEE Standard 488-1978. The interface functional subset which the HP 8157A implements is specified in Table 3-1.

Table 3-1. HP-IB Capabilities

MNEMONIC	INTERFACE FUNCTION NAME
SH1	SOURCE HANDSHAKE CAPABILITY
AH1	ACCEPTOR HANDSHAKE CAPABILITY
T6	BASIC TALKER, SERIAL POLL, UNADDRESSED IF MY LISTEN ADDRESS
L4	BASIC LISTENER, UNADDRESSED IF MY TALK ADDRESS
SR1	SERVICE REQUEST CAPABILITY
RL1	REMOTE/LOCAL CAPABILITY
PPO	NO PARALLEL POLL CAPABILITY
DC1	DEVICE CLEAR CAPABILITY
DT0	NO DEVICE TRIGGER CAPABILITY
CO	NO CONTROLLER CAPABILITY

### 3.11 . . . About Programming Examples in This Section

Programming examples are given in this section to aid explanation. These examples assume the following:

- an HP9000, Series 200 or 300 Computer is controller
- that BASIC is the programming language
- the HP 8157A is set to HP-IB address 28 (factory setting)

### 3.12 GETTING STARTED

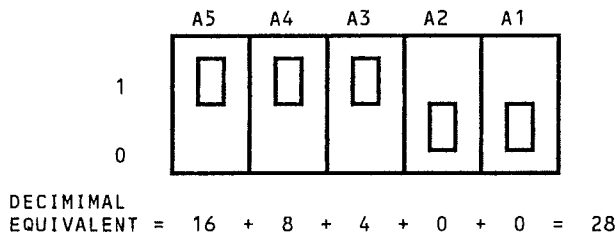
If this is the first time you are programming the HP 8157A, the following gives you a few simple tasks to carry out prior to detailed program development. The benefits are twofold in that it gets you started on programming the HP 8157A, at the same time checking remote operation of your instrument.

### 3.13 Setting the Address

Each instrument that you connect to the interface bus has a unique "address", and the HP 8157A is no different. The address used in a typical BASIC statement takes the form "7xx" where:

- 7 = the interface select code
- xx = the instrument address, which can be any integer from 00 to 30 (21 is usually reserved for the controller)

The HP 8157A is preset at the factory to address 28 as shown in the following illustration of the address switch (you can check this by pressing the front panel LCL key to display the address).



If you are satisfied with this address, then continue with the next task "Checking Remote Operation" (Note that all examples in this section assume the address is set to 28).

If you want to change the address, first ensure that the HP 8157A is in local mode and not addressed (i.e. the ADS and RMT LEDs (3) are not illuminated), then change the bit settings on rear panel address switch (16). Now press the front panel LCL key, and the new address will be activated and displayed.

### 3.14 Checking Remote Operation

You can now check remote operation using a few simple commands as follows:

```
10 DIM A$(7)
20 CLEAR 728
30 OUTPUT 728; "ATT 5.00 dB"
40 OUTPUT 728; "ATT?"
50 ENTER 728;A$
60 PRINT A$
70 END
```

- clears HP 8157A's input/output buffers
- sets attenuation to 5.00 dB
- interrogates attenuation setting
- transfers setting data to controller

The controller output should read " 5.00" which indicates that both the Listener and Talker functions of the HP 8157A are operating correctly.



### 3.15 SENDING DATA TO THE HP 8157A (LISTENER FUNCTION)

All the settings you can make via front panel switches can also be programmed via HP-IB. To aid explanation, consider the following programming example:

```
10 OUTPUT 728;"WVL 1300 NM;Cal 0dB;D0;Att 3.2dB"  
20 END
```

This sets the HP 8157A to a wavelength of 1300nm, attenuation 3.2dB, CAL factor 0.0dB and output ON. The points to note on the setting "string" are as follows:

- Each setting in the string must be terminated by a ";"
- Either upper or lower case may be selected (d0 is the same as D0)
- Any of 3 different data formats may be used. The following settings are equivalent and will be interpreted correctly:  
wvl 1300 nm      WVL 1.3 um      WVL 1300 e-09 m      WVL 1.3E-06
- If no unit is specified, then the default unit will be assumed. The default unit is **dB** for attenuation and CAL factor, and **meter** for wavelength

(A complete list of the setting commands is given at the end of this section).

### 3.16 RECEIVING DATA FROM THE HP 8157A (TALKER FUNCTION)

Just as you can program all HP 8157A settings via HP-IB, you can also interrogate all settings - either individually or as a complete set (learn string). The HP 8157A can also send data regarding installed firmware, error and status reports. (A complete list of the interrogating commands is given on the blue pages at the end of this section).

From the programming example given in the previous sub-section, the wavelength was set to 1300nm. If you now want to interrogate this setting, you could use the following simple program:

```
10 DIM A$[11]                -dimensions string A$ for 11 characters
20 OUTPUT 728;"WVL?"        -interrogates the wavelength setting
30 ENTER 728;A$             -transfer setting data to controller
40 DISP A$                  -displays the setting data. ( 0.1300E-05)
50 END
```

Depending on which setting is being interrogated, the length of the character string returned to the controller is 1 to 11 characters long. You can also interrogate the complete settings using a single command. The following provides an example:

```
10 DIM A$[56]
20 OUTPUT 728;"LRN?"
30 ENTER 728;A$
40 PRINT A$
50 END
```

The Model HP 8157A then returns its settings as a 56-character string to the controller. The setting sequence is always the same and listed as follows:

Fiber setting	4 characters
Output state	4 characters
SRQ mask	8 characters
CAL factor	12 characters
Attenuation	12 characters
Wavelength	16 characters

### 3.17 STATUS/ERROR REPORTING (TALKER FUNCTION)

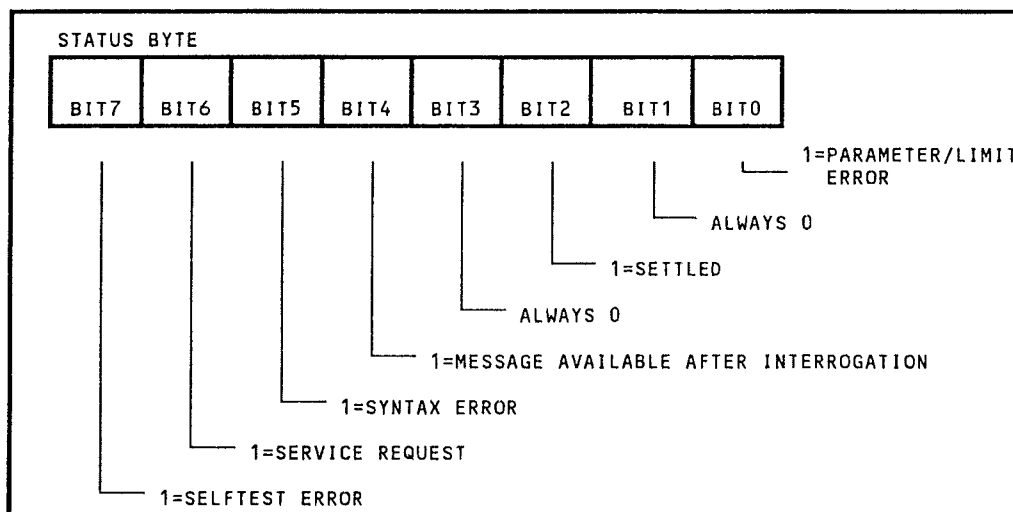
Another important feature of the HP 8157A is that you can program it to interrupt the controller when certain status/error conditions are met. The Require Service (SRQ) message is used to implement this feature and is independent of all other HP-IB activity. However, the HP 8157A **must be programmed** for the interrupt, via the SRQ mask, before the interrupt will take place. The possible interrupt conditions that can be programmed via the SRQ mask are listed as follows:

- Self-Test Error            If an error is detected by the self-test at power-on, or via the "TST?" command (e.g. OUTPUT 728;"TST?").
- Settled                    When the HP 8157A's hardware has settled to the new setting values. (Hardware Ready).
- Parameter Error            A wrong value has been set for a parameter.
- Message Available        When the HP 8157A is ready to respond to an interrogation command.
- Syntax Error              An invalid instruction has been sent.

These 6 interrupt conditions are monitored by an 8-bit Status Register, the content of this register being referred to as the Status Byte.

### 3.18 Status Register and Status Byte

The following shows which bit in the Status Register is allocated to which interrupt condition:



When an interrupt condition is true, the corresponding bit in the status Register is set to 1 - **independent of the SRQ mask setting**. However, an interrupt (SRQ) will only occur when the SRQ mask has been set for that condition. It is therefore possible for one or more bits of the Status Register to be true without the HP 8157A causing an interrupt - **because the SRQ mask has not been set for these bits**.

This is typically the case at power-on or after "Device Clear" - as the SRQ mask is then set to decimal 000 and all interrupts are disabled. If the HP 8157A is now serial polled or receives the "STB?" command, the decimal equivalent of the Status Byte is returned to the controller - but the Status Byte remains unchanged. To clear the Status Byte, the "CSB" (Clear Status Byte) command must be used. For example:

10	DIM A\$[7]	- Dimension of A-string
20	CLEAR 728	- Clears HP 8157A's I/O buffers; SRQ mask = 000
30	OUTPUT 728;"CSB"	- Clear Status Byte
40	OUTPUT 728;"wvl?"	- Interrogate wavelength setting.
50	S=SPOLL(728)	- Serial poll of HP 8157A
60	IF BIT(S,4) = 0 THEN GOTO 50	- Check Status Byte; if Bit 4=0,repeat Serial poll; if Bit 4=1, message available
70	ENTER 728;A\$	- Transfer wavelength setting to controller
80	PRINT A\$	- Print result
90	OUTPUT 728;"CSB"	- Clear Status Byte
100	END	

If the SRQ mask is set for certain conditions, and one of these conditions occur, bit 6 of the Status Register will go true ("1" state), the SRQ LED on the front panel will illuminate, and the HP-IB SRQ message will be sent. At this point, it will be necessary to address the HP 8157A as talker by using the Serial Poll command or "STB?" command:

10	A=SPOLL(728)	- Transfers Status Byte to variable "A"
20	PRINT A	
30	END	
	or	
10	OUTPUT 728;"STB?"	- Interrogates the Status Byte
20	ENTER 728;A	- Transfers the Status Byte to variable "A"
30	PRINT A	
40	END	

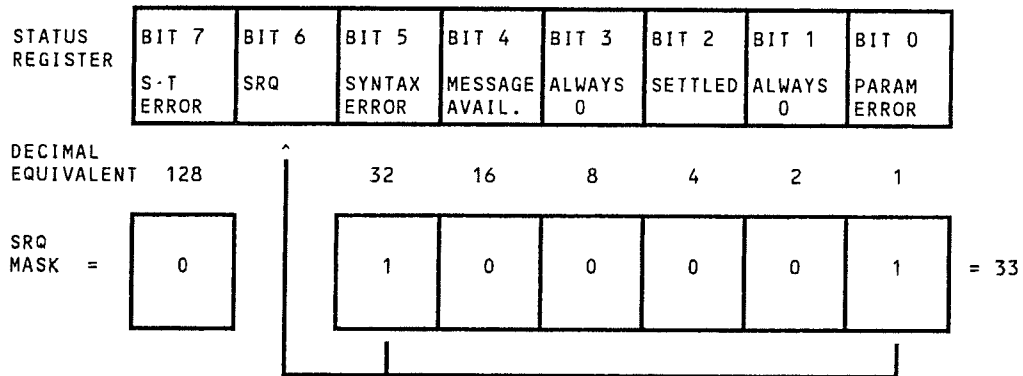
The Status Byte is returned to the controller as a decimal number which can be broken down into its 8 binary components to determine which bit has gone true. At the same time, the Status Register is cleared and SRQ set false.

#### NOTES

- Once SRQ is set true, the Status Byte remains unchanged until serial polled or interrogated via the "STB?" command. For any interrupt condition going true during this period, the corresponding bit in the Status Register will not be set. Instead, the "1" state will be held in HP 8157A memory and loaded into the Status Register after it is cleared e.g. by serial poll.
- For this reason, if several conditions are enabled by the SRQ mask and they all go true, only the condition that occurred first will have its bit set in the Status Register. The bit settings for the other conditions will be held in HP 8157A memory, and loaded simultaneously into the Status Register after it is cleared. If you have set more than one condition by the SRQ mask, therefore, your program should serial poll the HP 8157A twice to ensure that the Status Register is cleared and SRQ set false.

### 3.19 Setting the SRQ Mask

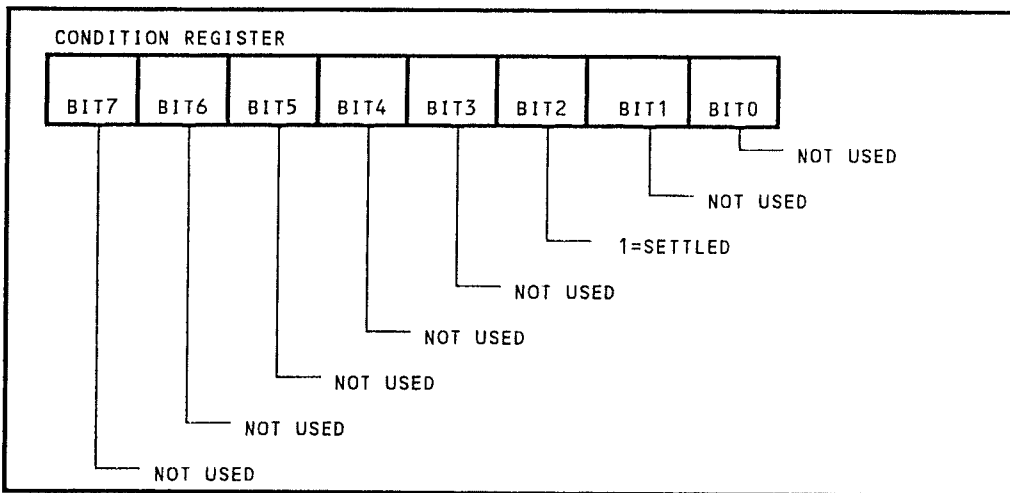
The SRQ mask can be set to mask bits 0-5 and bit 7 on the Status Register. Default mask value is 0 i.e. all interrupt conditions are disabled and no SRQ can be generated. To set the mask first determine which conditions you want to interrupt the controller, e.g., parameter error, syntax error, etc. Determine the decimal number (1-191) corresponding to those conditions. A "1" in the mask byte enables the corresponding interrupt condition. Then output the "SRE" instruction mnemonic followed by the decimal number. The following shows the Status Register and the SRQ mask set for bit 1 and bit 5, syntax error and parameter error. (OUTPUT 728;"SRE33").



### 3.20 Condition Register

Whereas the **Status Register** monitors events, i.e. when an interrupt condition occurs, a bit is set and remains set until the register is cleared, the **condition register** monitors the current status regarding "settled" and "attenuation > display".

The bit allocation in the condition register is as follows:



When the condition register is interrogated via the "CNB?" command, the contents are returned to the controller as a decimal number. This number can then be broken down into its binary components to determine which bit has been set to "1".



# HP 8157A COMMAND SUMMARY

## SETTINGS (LISTENER FUNCTION)

Parameter/Operation	Mnemonics	Data	Unit	Comment
Select Single-Mode Select Multimode	F F	1 2		These commands will be ignored, as always single-mode i.e. 1. Here due to compatability to HP 8158B.
Enable Output Disable Output	D D	0 1		
Set Wavelength	WVL	value	M MM UM NM	meter. Default if no unit defined millimeter micrometer nanometer
Set Attenuation	ATT	value	DB	Default is dB if no unit defined
Set CAL Factor	CAL	value	DB	Default is dB if no unit defined
Set SRQ Mask	SRE	value		value = decimal number (0-191). A "1" in the binary equivalent sets SRQ on this condition.
Clear Status Byte	CSB			Always clears Status Byte independent of SRQ state.
Clear Device	CLR			Clears all I/O buffers. Same as Universal Device Clear Command.

## INTERROGATING SETTINGS (TALKER FUNCTION)

Parameter/Operation	Mnemonics	Comment
Learn Mode	LRN?	Returns 56-character string detailing all settings.
Interrogate setting	F? WVL? CAL? ATT? D?	Always returns 1, i.e. single-mode. Returns 11-character string for $\lambda$ setting. Always in meters. Returns 7-character string for CAL factor. Always in dB. Returns 7-character string for attenuation setting. Always in dB. Returns integer (0 or 1) for output off/on.

## STATUS/ERROR REPORTING (TALKER FUNCTION)

Interrogation	Mnemonics	Comment
Status Byte	STB?	Returns 3-digit integer (000-191). With SRQ false, does not clear Status Byte.
Status Byte Mask	SRE?	Returns 3-digit integer (000-191)
Condition Byte	CNB?	Returns 2-digit integer (00-06)
Self-test	TST?	Executes self-test and returns 0 or 1 to indicate passed or failed
Error Number	ERR?	Returns 3-digit integer representing HP 8157A error code (details given in Service info). 000 means no error. An error code is only available if bit 7 (self-test) in the Status Byte has been set. Other error conditions in the Status Byte will not cause an error code. On readout, the error code is transferred to the 'Last Error Number' register.
Last Error Number	LERR?	Returns 3-digit integer for last active error. This is a destructive readout.
Operation Complete	OPC?	1 if no further command to interpret and execute in the input buffer. 0 if further commands in the input buffer.
Identifier	IDN?	Returns 40-character string identifying currently installed firmware and manufacturer model no.

## UNIVERSAL COMMANDS

Command	ASCII Character	Equivalent Forms		
		Binary	Octal	Decimal
Device Clear	DC <sub>4</sub>	00010100	024	20
Selected Device Clear	EOT	00000100	004	4

Both "CLEAR" commands clear all input/output buffers, reset SRQ mask to all disabled and SRQ to false, but have no effect on HP 8157A mode/parameter settings.



# SECTION IV

## PERFORMANCE TESTS

### 4.1 INTRODUCTION

The procedures in this section test the optical performance of the instrument. The complete specifications to which the HP 8157A is tested are given in Table 1-1. All tests can be performed without access to the interior of the instrument.

### 4.2 EQUIPMENT REQUIRED

Equipment required for the performance test is listed in Table 4-1. Recommended Test Equipment. Any equipment which satisfies the critical specifications given in the table may be substituted for recommended models.

Table 4-1. Recommended Test Equipment

Instrument/Accessory	Rec. Model	Critical Specification
Power Meter Standard	HP8152A HP81521B	Accuracy: < 2%, Dynamic Range >60dB. Accuracy (rel) <0.15dB
Lens Adapter	HP81010BL	
Connector Adapter	HP81000AA	
Single-Mode Fibers	HP81101AC 2 off	Date code 31-87 and higher.
Laser Source	HP8155A Opt.002/011	1300nm -3dBm into single-mode fiber
CW Laser Source	HP8155A Opt.003/011	1550nm -3dBm into single-mode fiber
OTDR	HP8145A Opt.002/011 or Opt.003/011	
Optical Attenuator	HP8158B Opt.002/011 or HP8157A Opt.011	
Single-Mode Fiber	≥0.5Km length with 2 Diamond HMS-10/HP connectors	
Connector Adapters	P/N 08154-61701 (Opt 011), if required	
Cleaning Kit	HP15475A	

### 4.3 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 familiar with test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Hewlett-Packard.

### 4.4 TEST FAILURE

If the HP 8157A fails any performance test, return the instrument to the nearest Hewlett-Packard Sales/Service Office for repair.

### 4.5 INSTRUMENTS SPECIFICATION

Specifications are the performance characteristics of the instrument which are certified. These specifications, listed in Table 1-1, are the performance standards or limits against which the HP 8157A can be tested. Table 1-1 also lists some supplementary characteristics of the HP 8157A and should be considered as additional information.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Bureau of Standards will be covered in a manual change supplement or revised manual. The specifications listed here supercede any previously published.

### 4.6 PERFORMANCE TEST

The performance tests given in this section are separated into Total Insertion Loss Test, Attenuation Accuracy Test, Attenuation Repeatability Test and Return Loss Test. Perform each step in the tests in the order they are given using the corresponding test equipment.

#### NOTE

Make sure that all optical connections of the test setups given in the procedure are dry and clean. For cleaning use accessory kit Model HP15475A. **DO NOT USE INDEX MATCHING GEL.**

The Optical Cables from the Laser Source to the HP 8157A and from the Attenuator to the Power Meter must be fixed on the table to ensure minimum cable movement during the tests.

*All tests and equipment mentioned in the Performance Test section refer to tests carried out with the Diamond<sup>®</sup> HMS-10/HP connectors with date codes 31-87 and higher.*

## 4.7 TOTAL INSERTION LOSS TEST

### Specification:

Insertion loss (including both connectors) < 4.0 dB with single-mode fiber 9  $\mu$ m.

### Equipment required:

#### 1300nm single-mode tests

HP8155A Opt.002/011 Laser Source with constant output power 1300nm wavelength.

Power Meter Standard with Optical Head, connector adapter and lens adapter for single-mode fiber. (8152A; 81521B; 81010BL; 81000AA)

Optical Cable (9  $\mu$ m) HP81101AC

Optical Cable (9  $\mu$ m) HP81101AC

#### 1550nm single-mode tests

HP8155A Opt.003/011 Laser Source with constant output power 1550nm wavelength.

Power Meter Standard with Optical Head, connector adapter and lens adapter for single-mode fiber. (8152A; 81521B; 81010BL; 81000AA)

Optical Cable (9  $\mu$ m) HP81101AC

Optical Cable (9  $\mu$ m) HP81101AC

Carry out the following TOTAL INSERTION LOSS test for 1300nm or 1550nm single-mode, using the equipment listed above.

1. Using the VERNIER rocker keys set the HP 8157A attenuation to 0000 dB.
2. Connect the equipment as shown in Figure 4-1

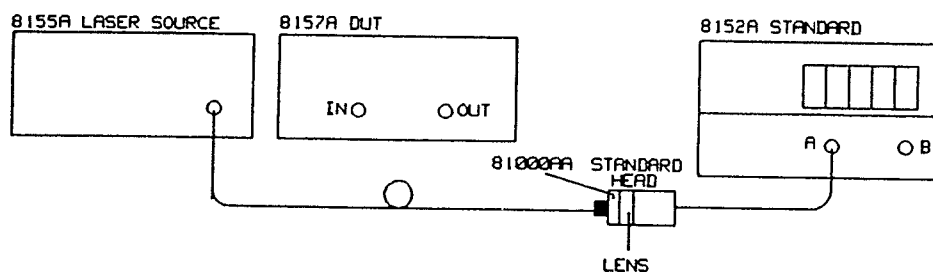


Figure 4-1. Reference Measurement Set-up

3. Set the Average Power Meter to Autorange. Display [dB].
4. Set DISPlay to REFerence on the power meter 8152A.

5. Connect the equipment as shown in Figure 4-2.

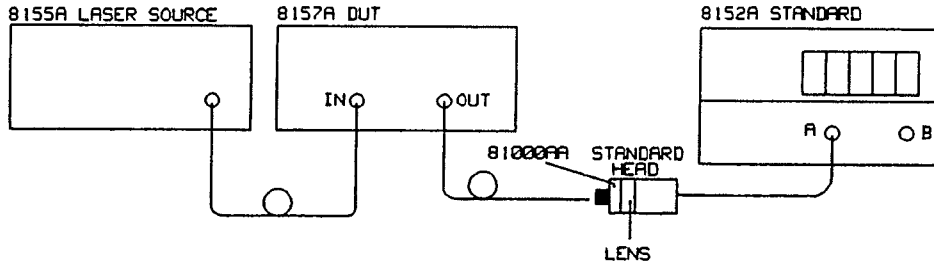


Figure 4-2. Total Insertion Loss Test Set-up

6. Enable the HP 8157A attenuator output and record the power meter reading (in dB) on the Test Record and check that it is within specifications.

## 4.8 ATTENUATION ACCURACY

### Specifications:

Linearity for single-mode,  $\pm 0.2$  dB.

### Equipment required:

#### 1300nm single-mode tests

HP8155A Opt.002/011 Laser Source with constant output power 1300nm wavelength.  
Power Meter Standard with Optical Head, connector adapter and lens adapter  
for single-mode fiber. (8152A; 81521B; 81010BL; 81000AA)  
Optical Cable (9  $\mu$ m) HP81101AC  
Optical Cable (9  $\mu$ m) HP81101AC

#### 1550nm single-mode tests

HP8155A Opt.003/011 Laser Source with constant output power 1550nm wavelength.  
Power Meter Standard with Optical Head, connector adapter and lens adapter  
for single-mode fiber. (8152A; 81521B; 81010BL; 81000AA)  
Optical Cable (9  $\mu$ m) HP81101AC  
Optical Cable (9  $\mu$ m) HP81101AC

Carry out the following ATTENUATION ACCURACY tests for 1300nm single-mode and 1550nm single-mode using the equipment listed above.

1. Set HP 8157A as follows:

$\lambda$  as required

CAL to 0.00 dB.

ATT to 0.00 dB

2. Connect equipment as shown in Figure 4-3.

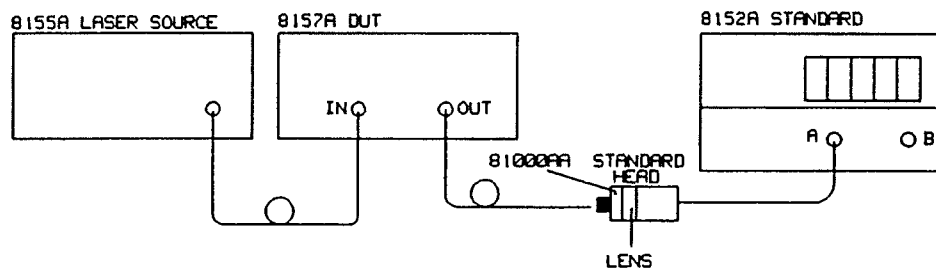


Figure 4-3. Attenuation Accuracy Test Set-up

3. Set HP 8157A output power level as 0.00 dB reference level on the Average Power Meter and check the following attenuation settings for  $\pm 0.2$  dB accuracy.

0.00 dB = Reference

1 dB	11 dB
2 dB	12 dB
3 dB	13 dB
4 dB	14 dB
5 dB	24 dB
6 dB	34 dB
7 dB	44 dB
8 dB	54 dB
9 dB	
10 dB	

## 4.9 ATTENUATOR REPEATABILITY

### Specifications:

Repeatability after any parameter has been changed and reset  $< \pm 0.04$  dB.

### Equipment required:

Use the same equipment, test set-up and HP 8157A settings as used for the ATTENUATION ACCURACY test (either for 1300nm or 1550nm wavelength).

1. Set the HP8157A attenuation to the values shown in step 3 and note the AVG Power Meter reading in the Test Record.
2. Set the HP8157A attenuation to any other value ( e.g.0.00dB ) and then back to the previous value. Note the AVG Power Meter reading in the Test Record and check that the second reading is within  $\pm 0.04$ dB of the first reading.
3. Repeat steps 1 and 2 for following attenuation settings:

5dB  
12dB  
24dB  
36dB  
48dB  
50dB  
53dB

## 4.10 ATTENUATOR RETURN LOSS

### Specifications:

Return Loss > 33 dB

### Equipment required:

#### Return Loss Test

HP8145A Optical Time Domain Reflectometer Opt.002/011 or Opt.003/011.

Single-Mode Fiber with 2 HMS10/HP Connectors( $\geq 0.5$ km)

HP8157A or HP8158B Opt.002/011 Attenuator

2 off HP81101AC Single-Mode Fibers

15475-68701 Adhesive Tape Kit (Part of HP15475A Cleaning Kit) to terminate the HP8157A output.

1. Make sure that all optical connectors are cleaned carefully.
2. Connect equipment as shown in Figure 4-4

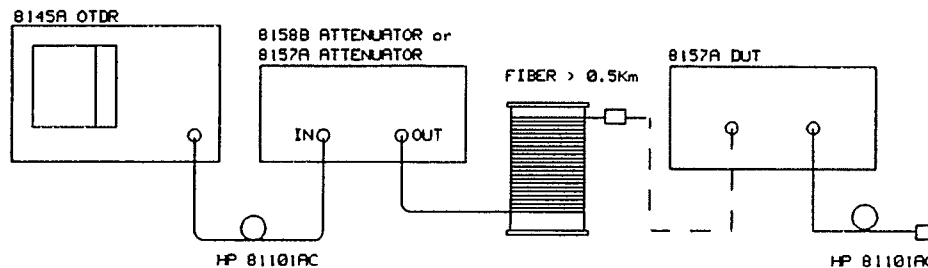


Figure 4-4. Return Loss Set-up

3. Set the 8158B (or HP 8157A) to min. attenuation and enable the output.
4. Set the HP8145A as follows:

Press RCL 0 ENTER and then START.

Select span and move the end-reflection of the connected fiber to the center of the screen.

Next press the center position softkey.

STOP measurement.

Change the HP8145A as follows:

vertical offset	to:	7dB
vertical scale	to:	2.5dB
span	to:	1Km
measurement mode	to:	fast refresh



5. Press MEASUREMENT START. The displayed end-reflection signal shows that the receiver is in saturation. Therefore increase the attenuation of the HP8158B (HP 8157A) until the displayed end-reflection shows only one peak which should be approx. one minor division below saturation.
6. Using vertical offset move the peak (fresnel reflection of 4%) to the upper graticule line as reference (14 dB).
7. Check the dynamic range by pressing the open fiber connector slightly against a piece of adhesive tape supplied with the HP15475A Cleaning Kit. The end-reflection signal should decrease by at least 5 divisions. If the end-reflection is higher, clean the connectors again.
8. Connect the open fiber connector to the input of the HP8157A DUT, set CAL and ATT to 0.00 and enable the output.
9. Terminate the output cable of the HP8157A DUT by pressing the open connector slightly against the piece of adhesive tape and check that the end-reflection decreases below to the center horizontal graticule line. Note the reading in dB, multiply by 2 and add 14 dB. Note the result in the Performance Test Record.

**NOTE:** The HP8145A OTDR displays the measurement results only for one way in the fiber, therefore the displayed results must be multiplied by 2. The measurement results are referenced to 14dB fresnel reflection which must be added.

# PERFORMANCE TEST RECORD FOR HP 8157A OPT.011

Hewlett-Packard Model 8157A

Test Performed By \_\_\_\_\_

Optical Attenuator

Date \_\_\_\_\_

Serial Number \_\_\_\_\_

Comments \_\_\_\_\_

## TOTAL INSERTION LOSS TEST

Test Conditions; 1300nm with single-mode fibers  
 1550nm with single-mode fibers  
 with Diamond HMS-10/HP connectors

Description	Test Pass Fail
1300nm with single-mode fibers < 4.0dB	
Output via 8157A (min. ATT.)	
Total Insertion Loss = _____ dB	_____
1550nm with single-mode fibers < 4.0dB	
Output via 8157A (min. ATT.)	
Total Insertion Loss = _____ dB	_____

# PERFORMANCE TEST RECORD FOR HP 8157A OPT.011

Hewlett-Packard Model 8157A

Test Performed By \_\_\_\_\_

Optical Attenuator

Date \_\_\_\_\_

Serial Number \_\_\_\_\_

Comments \_\_\_\_\_

## ATTENUATION ACCURACY TEST

Test Condition: 1300nm with single-mode fibers  
with Diamond HMS-10/HP connectors

Attenuation Setting	Power Meter Reading			Test Pass	Test Fail
	min.	act.	max.		
0 dB	0.00 dB Reference				
1 dB	0.8dB	_____ dB	1.2dB	_____	_____
2 dB	1.8dB	_____ dB	2.2dB	_____	_____
3 dB	2.8dB	_____ dB	3.2dB	_____	_____
4 dB	3.8dB	_____ dB	4.2dB	_____	_____
5 dB	4.8dB	_____ dB	5.2dB	_____	_____
6 dB	5.8dB	_____ dB	6.2dB	_____	_____
7 dB	6.8dB	_____ dB	7.2dB	_____	_____
8 dB	7.8dB	_____ dB	8.2dB	_____	_____
9 dB	8.8dB	_____ dB	9.2dB	_____	_____
10 dB	9.8dB	_____ dB	10.2dB	_____	_____
11 dB	10.8dB	_____ dB	11.2dB	_____	_____
12 dB	11.8dB	_____ dB	12.2dB	_____	_____
13 dB	12.8dB	_____ dB	1.2dB	_____	_____
24 dB	23.8dB	_____ dB	24.2dB	_____	_____
34 dB	33.8dB	_____ dB	34.2dB	_____	_____
44 dB	43.8dB	_____ dB	44.2dB	_____	_____
54 dB	53.8dB	_____ dB	54.2dB	_____	_____

# PERFORMANCE TEST RECORD FOR HP 8157A OPT.011

Hewlett-Packard Model 8157A

Test Performed By \_\_\_\_\_

Optical Attenuator

Date \_\_\_\_\_

Serial Number \_\_\_\_\_

Comments \_\_\_\_\_

## ATTENUATION ACCURACY TEST

Test Condition: 1550nm with single-mode fibers  
with Diamond HMS-10/HP connectors

Attenuation Setting	Power Meter Reading			Test Pass	Test Fail
	min.	act.	max.		
0 dB	0.00 dB Reference				
1 dB	0.8dB	_____ dB	1.2dB	_____	_____
2 dB	1.8dB	_____ dB	2.2dB	_____	_____
3 dB	2.8dB	_____ dB	3.2dB	_____	_____
4 dB	3.8dB	_____ dB	4.2dB	_____	_____
5 dB	4.8dB	_____ dB	5.2dB	_____	_____
6 dB	5.8dB	_____ dB	6.2dB	_____	_____
7 dB	6.8dB	_____ dB	7.2dB	_____	_____
8 dB	7.8dB	_____ dB	8.2dB	_____	_____
9 dB	8.8dB	_____ dB	9.2dB	_____	_____
10 dB	9.8dB	_____ dB	10.2dB	_____	_____
11 dB	10.8dB	_____ dB	11.2dB	_____	_____
12 dB	11.8dB	_____ dB	12.2dB	_____	_____
13 dB	12.8dB	_____ dB	1.2dB	_____	_____
24 dB	23.8dB	_____ dB	24.2dB	_____	_____
34 dB	33.8dB	_____ dB	34.2dB	_____	_____
44 dB	43.8dB	_____ dB	44.2dB	_____	_____
54 dB	53.8dB	_____ dB	54.2dB	_____	_____

# PERFORMANCE TEST RECORD FOR HP 8157A OPT.011

Hewlett-Packard Model 8157A	Test Performed By _____
Optical Attenuator	Date _____
Serial Number _____	Comments _____

## ATTENUATOR REPEATABILITY TEST

Test Condition: 1300nm or 1550nm with single-mode fibers  
with Diamond HMS-10/HP connectors

Attenuation Setting	Power Meter Reading 1	Power Meter Reading 2	Reading 1-2	Spec.	Test Pass	Test Fail
5 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____
12 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____
24 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____
36 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____
48 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____
53 dB	_____ dB	_____ dB	_____ dB	+/-0.04dB	_____	_____

# PERFORMANCE TEST RECORD FOR HP 8157A OPT.011

Hewlett-Packard Model 8157A

Test Performed By \_\_\_\_\_

Optical Attenuator

Date \_\_\_\_\_

Serial Number \_\_\_\_\_

Comments \_\_\_\_\_

## RETURN LOSS TEST

Test Condition: 1300nm or 1550nm with single-mode fibers  
with Diamond HMS-10/HP connectors

Specification

>33 dB

Actual Return Loss Measured

\_\_\_\_\_ dB

## Product Line Sales/Support Key

Key Product Line

A Analytical

CM Components

C Computer Systems

E Electronic Instruments & Measurement Systems

M Medical Products

P Personal Computation Products

\* Sales only for specific product line

\*\* Support only for specific product line

**IMPORTANT:** These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.

## HEADQUARTERS OFFICES

If there is no sales office listed for your area, contact one of these headquarters offices

### ASIA

Hewlett-Packard Asia Ltd  
47/F, 26 Harbour Rd.,  
Wanchai, HONG KONG  
G P O Box 863, Hong Kong  
Tel: 5-8330833  
Telex: 76793 HPA HX  
Cable: HPASIAL TD

### CANADA

Hewlett-Packard (Canada) Ltd  
6877 Goreway Drive  
MISSISSAUGA, Ontario L4V 1M8  
Tel: (416) 678-9430  
Telex: 069-8644

### EASTERN EUROPE

Hewlett-Packard Ges m b h  
Lieblgasse 1  
P O Box 72  
A-1222 VIENNA, Austria  
Tel: (222) 2500-0  
Telex: 13 4425 HEPA A

### NORTHERN EUROPE

Hewlett-Packard S A  
V D Hooplaan 241  
P O Box 999  
NL-118 LN 15 AMSTELVEEN  
The Netherlands  
Tel: 20 5479999  
Telex: 18919 hpner

### SOUTH EAST EUROPE

Hewlett-Packard S A  
World Trade Center  
110 Avenue Louis-Casai  
1215 Cointin, GENEVA, Switzerland  
Tel: (022) 98 96 51  
Telex: 27225 hpser  
Mail Address:  
P O Box  
CH-1217 Meyrin 1  
GENEVA  
Switzerland

### MIDDLE EAST AND CENTRAL AFRICA

Hewlett-Packard S A  
Middle East/Central  
Africa Sales H Q  
7 rue du Bois-du-Lan  
P O Box 364  
CH-1217 Meyrin 1  
GENEVA  
Switzerland  
Tel: (022) 83 12 12  
Telex: 27835 hmea ch  
Telefax: (022) 83 15 35

### UNITED KINGDOM

Hewlett-Packard Ltd  
Nine Mile Ride  
WOKINGHAM  
Berkshire, RG113LL  
Tel: 0344 773100  
Telex: 848805/8488 14/848912

### UNITED STATES OF AMERICA

Customer Information Center  
(800) 752-0900  
6:00 AM to 5 PM Pacific Time

### EASTERN USA

Hewlett-Packard Co  
4 Choke Cherry Road  
ROCKVILLE, MD 20850  
Tel: (301) 948-6370

### MIDWESTERN USA

Hewlett-Packard Co  
5201 Tollview Drive  
ROLLING MEADOWS, IL 60008  
Tel: (312) 255-9800

### SOUTHERN USA

Hewlett-Packard Co  
2000 South Park Place  
ATLANTA, GA 30339  
Tel: (404) 955-1500

### WESTERN USA

Hewlett-Packard Co  
5161 Lankershim Blvd  
NORTH HOLLYWOOD, CA 91601  
Tel: (818) 505-5600

### OTHER INTERNATIONAL AREAS

Hewlett-Packard Co  
Intercontinental Headquarters  
3495 Deer Creek Road  
PALO ALTO, CA 94304

Tel: (415) 857-1501  
Telex: 034-8300  
Cable: HEWPACK

### ALGERIA

Hewlett-Packard Trading S A  
Bureau de Liaison Alger  
Villa des Lions  
9 Hai Galloul  
DZ-BORDJ EL BAHRI  
Tel: 76 03 36  
Telex: 63343 dlion dz

### ANGOLA

Telectra Angola LDA  
Empresa Técnica de Equipamentos  
16 rue Cons Julio de Vilhema  
LUANDA  
Tel: 353 15,355 16  
Telex: 3134  
E, P

### ARGENTINA

Hewlett-Packard Argentina S A  
Montaneses 2140/50  
1428 BUENOS AIRES  
Tel: 541-11-1441  
Telex: 22796 HEW PAC-AR  
A, C, E, P  
Biotron S A C I M e I  
Av. Paso Colon 221, Piso 9  
1399 BUENOS AIRES  
Tel: 541-333-490,  
541-322-587

Telex: 17595 BIONAR  
M

Laboratorio Rodriguez  
Corswant S R L  
Misiones, 1156 - 1876  
Bernal, Oeste  
BUENOS AIRES

Tel: 252-3958, 252-4991  
A

Intermaco S R L  
Florida 537/71  
Galeria Jardin - Local 28  
1005 BUENOS AIRES

Tel: 393-4471/1928  
Telex: 22796 HEW PAC-AR  
P (Calculators)

Argentina Esanco S R L  
A/ASCO 2328  
1416 BUENOS AIRES

Tel: 541-58-1981, 541-59-2767  
Telex: 22796 HEW PAC-AR  
A

All Computers S A  
Montaneses 2140/50 5 Piso  
1428 BUENOS AIRES

Tel: 781-4030/4039/783-4886  
Telex: 18148 Ocm e  
P

### AUSTRALIA

Adelaide, South  
Australia Office  
Hewlett-Packard Australia Ltd  
153 Greenhill Road  
PARKSIDE, S A 5063  
Tel: 61-8-272-5911  
Telex: 82536  
Cable: HEWPARD Adelaide  
A\*, C, CM, E, P

### Brisbane, Queensland Office

Hewlett-Packard Australia Ltd  
10 Payne Road  
THE GAP, Queensland 4061  
Tel: 61-7-300-4133  
Telex: 42133  
Cable: HEWPARD Brisbane  
A, C, CM, E, M, P

### Canberra, Australia Capital Territory Office

Hewlett-Packard Australia Ltd  
Thynne Street, Fern Hill Park  
BRUCE, A C T 2617  
P O Box 257,  
JAMISON, A C T 2614  
Tel: 61-62-80-4244  
Telex: 62650  
Cable: HEWPARD Canberra  
C, CM, E, P

### Melbourne, Victoria Office

Hewlett-Packard Australia Ltd  
31-41 Joseph Street  
P O Box 221  
BLACKBURN, Victoria 3130  
Tel: 61-3-895-2895  
Telex: 31-024  
Cable: HEWPARD Melbourne  
A, C, CM, E, M, P

### Perth, Western Australia Office

Hewlett-Packard Australia Ltd  
Herdsmen Business Park  
CLAREMONT, W A 6010  
Tel: 61-9-383-2188  
Telex: 93859  
Cable: HEWPARD Perth  
C, CM, E, P

### Sydney, New South Wales Office

Hewlett-Packard Australia Ltd  
17-23 Talavera Road  
P O Box 308  
NORTH RYDE, N S W 2113  
Tel: 61-2-888-4444  
Telex: 21561  
Cable: HEWPARD Sydney  
A, C, CM, E, M, P

### AUSTRIA

Hewlett-Packard Ges m b h  
Verkaufsbuero Graz  
Grottenholstrasse 94  
A-8052 GRAZ  
Tel: 43-316-291-5660  
Telex: 312375  
C E

Hewlett-Packard Ges m b h  
Lieblgasse 1  
P O Box 72

A-1222 VIENNA  
Tel: 43-222-2500  
Telex: 134425 HEPA A  
A, C, CM, E, M, P

### BAHRAIN

Green Salon  
P O Box 557  
MANAMA  
Tel: 255503-250950  
Telex: 84419  
P

Wael Pharmacy

P O Box 648  
MANAMA  
Tel: 256123  
Telex: 8550 WAEI BN  
E, M

Zayani Computer Systems  
218 Shaik Mubarak Building  
Government Avenue  
P O Box 5918

MANAMA  
Tel: 276278  
Telex: 9015 plans bn  
P

### BELGIUM

Hewlett-Packard Belgium S A /N V  
Blvd de la Woluwe, 100  
Woluwedal  
B-1200 BRUSSELS  
Tel: (02) 32-2-761-31-11  
Telex: 23494 hewpac  
A, C, CM, E, M, P

### BERMUDA

Applied Computer Technologies  
Atlantic House Building  
P O Box HM 2091  
Par-La-Ville Road  
HAMILTON 5  
Tel: 295-1616  
Telex: 380 3589/ACT BA  
P

### BOLIVIA

Arrellano Ltda  
Av. 20 de Octubre #2125  
Casilla 1383

### LA PAZ

Tel: 368541  
M

### BRAZIL

Hewlett-Packard do Brasil S A  
Alameda Rio Negro, 750-I AND  
ALPHAVILLE  
06400 Barueri SP  
Tel: (011) 421 1311  
Telex: (011) 71351 HPBR BR  
Cable: HEWPACK Sao Paulo  
CM E

Hewlett-Packard do Brasil S A  
Praia de Botafogo 228-A-614  
6 AND -CONJ 601  
Edificio Argentina - Ala A  
22250 RIO DE JANEIRO, RJ  
Tel: (021) 552-6422  
Telex: 21905 HPBR BR  
Cable: HEWPACK Rio de Janeiro  
E

Van Den Cientifica Ltda  
Rua Jose Bonifacio, 458  
Todos os Santos  
20771 RIO DE JANEIRO, RJ  
Tel: (021) 593-8223  
Telex: 33487 EGLB BR  
A

ANAMED I C E I Ltda  
Rua Vergueiro, 360  
04012 SAO PAULO, SP  
Tel: (011) 572-1106  
Telex: 24720 HPBR BR  
M

Datatronix Electronica Ltda  
Av Pacaembu 746-C11  
SAO PAULO, SP  
Tel: (118) 260111  
CM

**BRUNEI**

Komputer Wisman Sdn Bhd  
G6, Chandrawaseh Cmplx,  
Jalan Tutong  
P O Box 1297,

**BANDAR SERI BEGAWAN**

**NEGARA BRUNI DARUSSALAM**  
Tel: 673-2-2000-70/26711  
C,E,P

**CAMEROON**

Beriac  
B P 23  
**DOUALA**  
Tel: 420153  
Telex: 5351  
C,P

**CANADA  
Alberta**

Hewlett-Packard (Canada) Ltd  
3030 3rd Avenue N E  
**CALGARY**, Alberta T2A 6T7  
Tel: (403) 235-3100  
A,C,CM,E\*,M,P\*

Hewlett-Packard (Canada) Ltd  
11120-178th Street  
**EDMONTON**, Alberta T5S 1P2  
Tel: (403) 486-6666  
A,C,CM,E,M,P

**British Columbia**

Hewlett-Packard (Canada) Ltd  
10691 Shellbridge Way

**RICHMOND**,  
British Columbia V6X 2W8  
Tel: (604) 270-2277  
Telex: 610-922-5059  
A,C,CM,E\*,M,P\*

Hewlett-Packard (Canada) Ltd  
121 - 3350 Douglas Street  
**VICTORIA**, British Columbia V8Z 3L1  
Tel: (604) 381-6616  
C

**Manitoba**

Hewlett-Packard (Canada) Ltd  
1825 Inkster Blvd  
**WINNIPEG**, Manitoba R2X 1R3  
Tel: (204) 694-2777  
A,C,CM,E,M,P\*

**New Brunswick**

Hewlett-Packard (Canada) Ltd  
814 Main Street  
**MONCTON**, New Brunswick E1C 1E6  
Tel: (506) 855-2841  
C

**Nova Scotia**

Hewlett-Packard (Canada) Ltd  
Suite 111  
900 Windmill Road  
**DARTMOUTH**, Nova Scotia B3B 1P7  
Tel: (902) 469-7820  
C,CM,E\*,M,P\*

**Ontario**

Hewlett-Packard (Canada) Ltd  
3325 N. Service Rd., Unit W03  
**BURLINGTON**, Ontario L7N 3G2  
Tel: (416) 335-8644  
C,M\*

Hewlett-Packard (Canada) Ltd.  
552 Newbold Street  
**LONDON**, Ontario N6E 2S5  
Tel: (519) 686-9181  
A,C,CM,E\*,M,P\*

Hewlett-Packard (Canada) Ltd.  
6877 Goreway Drive  
**MISSISSAUGA**, Ontario L4V 1M8  
Tel: (416) 678-9430  
Telex: 069-83644  
A,C,CM,E,M,P

Hewlett-Packard (Canada) Ltd.  
2670 Queensview Dr  
**OTTAWA**, Ontario K2B 8K1  
Tel: (613) 820-6483  
A,C,CM,E\*,M,P\*

**Quebec**

Hewlett-Packard (Canada) Ltd.  
17500 Trans Canada Highway  
South Service Road  
**KIRKLAND**, Quebec H9J 2X8  
Tel: (514) 697-4232  
Telex: 058-21521  
A,C,CM,E,M,P\*

Hewlett-Packard (Canada) Ltd.  
1150 rue Claire Fontaine  
**QUEBEC CITY**, Quebec G1R 5G4  
Tel: (418) 648-0726  
C

Hewlett-Packard (Canada) Ltd  
130 Robin Crescent  
**SASKATOON**, Saskatchewan S7L 6M7  
Tel: (306) 242-3702  
C

**CHILE**

ASC Ltda.  
Austria 2041  
**SANTIAGO**  
Tel: 223-5946, 223-6148  
Telex: 392-340192 ASC CK  
C,P

Jorge Calcagni y Cia  
Av. Italia 634 Santiago  
Casilla 16475  
**SANTIAGO 9**  
Tel: 9-011-562-222-0222  
Telex: 392440283 JCYCL CZ  
CM,E,M

Metrolab S A  
Monjitas 454 of 206  
**SANTIAGO**  
Tel: 395752, 398296  
Telex: 340866 METLAB CK  
A

Olympia (Chile) Ltda  
Av. Rodrigo de Araya 1045  
Casilla 256-V  
**SANTIAGO 21**  
Tel: 225-5044  
Telex: 340892 OLYMP  
Cable: Olympiachile Santiagochile  
C,P

**CHINA, People's  
Republic of**

China Hewlett-Packard Co., Ltd  
47/F China Resources Bldg  
26 Harbour Road  
**HONG KONG**  
Tel: 5-8330833  
Telex: 76793 HPA HX  
Cable: HP ASIA LTD  
A\*,M\*

China Hewlett-Packard Co., Ltd  
P O Box 9610, Beijing  
4th Floor, 2nd Watch Factory Main  
Shuang Yu Shou, Bei San Huan Road  
Hai Dian District  
**BEIJING**  
Tel: 33-1947 33-7426  
Telex: 22601 CTSHP CN  
Cable: 1920 Beijing  
A,C,CM,E,M,P

China Hewlett-Packard Co., Ltd  
CHP Shanghai Branch  
23/F Shanghai Union Building  
100 Yan An Rd. East  
**SHANG-HAI**  
Tel: 265550  
Telex: 33571 CHPSB CN  
Cable: 3416 Shanghai  
A,C,CM,E,M,P

**COLOMBIA**

Instrumentación  
H A. Langebaek & Kier S A  
Carrera 4A No 52A-26  
Apartado Aereo 6287  
**BOGOTA 1, D E**  
Tel: 212-1466  
Telex: 44400 INST CO  
Cable: AARIS Bogota  
CM,E,M  
Nefromedicas Ltda  
Calle 123 No. 9B-31  
Apartado Aereo 100-958  
**BOGOTA D E, 10**  
Tel: 213-5267, 213-1615  
Telex: 43415 HEGAS CO  
A

Compumundo  
Avenida 15 # 107-80  
**BOGOTA D E**  
Tel: 57-214-4458  
Telex: 39645466 MARCO  
P

Carvajal, S A  
Calle 29 Norte No. 6A-40  
Apartado Aereo 46  
**CALI**  
Tel: 9-011-57-3-621888  
Telex: 39655650 CUJCL CO  
C,E,P

**CONGO**

Seric-Congo  
B P 2105  
**BRAZZAVILLE**  
Tel: 815034  
Telex: 5262

**COSTA RICA**

Cientifica Costarricense S A  
Avenida 2, Calle 5  
San Pedro de Montes de Oca  
Apartado 10159  
**SAN JOSE**  
Tel: 9-011-506-243-820  
Telex: 3032367 GALGUR CR  
CM,E,M

O Fischel R Y Cia S A  
Apartados 434-10174  
**SAN JOSE**  
Tel: 23-72-44  
Telex: 2379  
Cable: OFIR  
A

**CYPRUS**

Telerexa Ltd.  
P O Box 1152  
Valentine House  
8 Stassandrou St.  
**NICOSIA**  
Tel: 45 628, 62 698  
Telex: 5845 tlrx cy  
E,M,P

**DENMARK**

Hewlett-Packard A/S  
Kongevejen 25  
DK-3460 BIRKEROD  
Tel: 45-02-81-6640  
Telex: 37409 hpas dk  
A,C,CM,E,M,P  
Hewlett-Packard A/S  
Roighedsvej 32  
DK-8240 RISSKOV, Aarhus  
Tel: 45-06-17-6000  
Telex: 37409 hpas dk  
C,E

**DOMINICAN REPUBLIC**

Microprog S A  
Juan Tomás Mejía y Cotes No. 60  
Arroyo Hondo  
**SANTO DOMINGO**  
Tel: 565-6268  
Telex: 4510 ARENTA DR (RCA)  
P

**ECUADOR**

CYEDE Cia. Ltda  
Avenida Eloy Alfaro 1749  
y Belgica  
Casilla 6423 CCI  
**QUITO**  
Tel: 9-011-593-2-450975  
Telex: 39322548 CYEDE ED  
E,P  
Medtronics  
Valladolid 524 Madrid  
P O 9171, **QUITO**  
Tel: 2-238-951  
Telex: 2298 ECUAME ED  
A

Hospitalar S A  
Robles 625  
Casilla 3590  
**QUITO**  
Tel: 545-250, 545-122  
Telex: 2485 HOSPTL ED  
Cable: HOSPITALAR-Quito  
M

Ecuador Overseas Agencies C A  
Calle 9 de Octubre #818  
P O Box 1296, Guayaquil  
**QUITO**  
Tel: 306022  
Telex: 3361 PBCGYE ED  
M

**EGYPT**

Sakrcro Enterprises  
P O Box 259  
**ALEXANDRIA**  
Tel: 802908, 808020, 805302  
Telex: 543333  
C

International Engineering Associates  
6 El Gamea Street  
Agouza  
**CAIRO**  
Tel: 71-21-68134-80-940  
Telex: 93830 IEA UN  
Cable: INTEGASSO  
E

Sakrcro Enterprises  
70 Mossadak Street  
Dokki, Giza  
**CAIRO**  
Tel: 706 440, 701 087  
Telex: 9337  
C

S S C Medical  
40 Gezerat El Arab Street  
Mohandessin  
**CAIRO**  
Tel: 803844, 805998, 810263  
Telex: 20503 SSC UN  
M\*

**EL SALVADOR**

IPESA de El Salvador S.A.  
29 Avenida Norte 1223  
**SAN SALVADOR**  
Tel: 9-011-503-266-858  
Telex: 301 20539 IPESA SAL  
A,C,CM,E,P

**ETHIOPIA**

Seric-Ethiopia  
P.O Box 2764  
**ADDIS ABABA**  
Tel: 185114  
Telex: 21150  
C,P

**FINLAND**

Hewlett-Packard Finland  
Field Oy  
Nittylanpolku IO  
00620 **HELSINKI**  
Tel: (90) 757-1011  
Telex: 122022 Field SF  
CM  
Hewlett-Packard Oy  
Plispankalliontie 17  
02200 **ESPOO**  
Tel: (90) 887-21  
Telex: 121563 HEWPA SF  
A, C, E, M, P

**FRANCE**

Hewlett-Packard France  
Z I. Mercure B  
Rue Berthelot  
13763 Les Milles Cedex  
**AIX-EN-PROVENCE**  
Tel: 33-42-59-4102  
Telex: 410770F  
A,C,E,M  
Hewlett-Packard France  
64, Rue Marchand Saillant  
F-61000 **ALENCON**  
Tel: (33) 29 04 42  
C\*\*  
Hewlett-Packard France  
Batiment Levitan  
2585, route de Grasse  
Bretelle Autoroute  
06600 **ANTIBES**  
Tel: (93) 74-59-19  
C



## FRANCE (Cont'd)

Hewlett-Packard France  
28 Rue de la République  
Boite Postale 503  
25026 BESANCON CEDEX, FRANCE  
Tel: (81) 83-16-22  
Telex: 361157  
C,E\*

Hewlett-Packard France  
ZA Kergaradec  
Rue Fernand Forest  
F-29239 GOUESNOU  
Tel: (98) 41-87-90  
E

Hewlett-Packard France  
Chemin des Mouilles  
Boite Postale 162  
69131 ECULLY Cedex (Lyon)  
Tel: 33-78-33-8125  
Telex: 310617F  
A,C,E,M,P\*

Hewlett-Packard France  
Parc d'activités du Bois Briard  
2 Avenue du Lac  
F-91040 EVRY Cedex  
Tel: 33 11/6077 9660  
Telex: 692315F  
C

Hewlett-Packard France  
Application Center  
5, avenue Raymond Chanas  
38320 EYBENS (Grenoble)  
Tel: (76) 62-57-98  
Telex: 980124 HP GRENOB EYBE  
C

Hewlett-Packard France  
Rue Fernand Forest  
Z A Kergaradec  
29239 GOUESNOU  
Tel: (98) 41-87-90

Hewlett-Packard France  
Parc Club des Tanneries  
Batiment B4  
4, Rue de la Faisanderie  
67381 LINCOLSHEIM  
(Strasbourg)  
Tel: (88) 76-15-00  
Telex: 890141F  
C,E\*,M\*,P\*

Hewlett-Packard France  
Centre d'affaires Paris-Nord  
Bâtiment Ampère  
Rue de la Commune de Paris  
Boite Postale 300  
93153 LE BLANC-MESNIL  
Tel: (1) 865-44-52  
Telex: 211032F  
C,E,M

Hewlett-Packard France  
Parc d'activités Cadéra  
Quartier Jean-Mermoz  
Avenue du Président JF Kennedy  
33700 MÉRIGNAC (Bordeaux)  
Tel: 33-56-34-0084  
Telex: 550105F  
C,E,M

Hewlett-Packard France  
3, Rue Graham Bell  
BP 5149  
57074 METZ Cedex  
Tel: (87) 36-13-31  
Telex: 860802F  
C,E

Hewlett-Packard France  
Miniparc-ZIRST  
Chemin du Vieux Chêne  
38240 MEYLAN (Grenoble)  
Tel: (76) 90-38-40  
980124 HP Grenoble  
C

Hewlett-Packard France  
Bureau vert du Bois Briard  
Cheman de la Garde  
- CP 212 212  
44085 NANTES Cedex  
Tel: (40) 50-32-22  
Telex: 711085F  
A,C,E,CM\*,P

Hewlett-Packard France  
125 Rue du Faubourg Bannier  
45000 ORLÉANS  
Tel: 33-38-62-2031  
E,P\*

Hewlett-Packard France  
Zone Industrielle de Courtaboeuf  
Avenue des Tropiques  
91947 LES ULIS Cedex (Orsay)  
Tel: 33-6-907 7825  
Telex: 600048F  
A,C,CM,E,M,P\*\*

Hewlett-Packard France  
15, Avenue de L'Amiral-Bruix  
75782 PARIS Cedex 16  
Tel: 33-15-02-1220  
Telex: 613663F  
C,P\*

Hewlett-Packard France  
242 Ter. Ave J Mermoz  
64000 PAU  
Tel: 33-59-80-3802  
Telex: 550365F  
C,E\*

Hewlett-Packard France  
6, Place Sainte Croix  
86000 POITIERS  
Tel: 33-49-41-2707  
Telex: 792335F  
C,E\*

Hewlett-Packard France  
47, Rue de Chativesle  
51100 REIMS  
Tel: 33-26-88-6919  
C,P\*

Hewlett-Packard France  
Parc d'activités de la Poterie  
Rue Louis Kerautel-Boimel  
35000 RENNES  
Tel: 33-99-51-4244  
Telex: 740912F  
A\*,C,E,M,P\*

Hewlett-Packard France  
98 Avenue de Bretagne  
76100 ROUEN  
Tel: 33-35-63-5766  
Telex: 770035F  
C,E

Hewlett-Packard France  
4, Rue Thomas-Mann  
Boite Postale 56  
67033 STRASBOURG Cedex  
Tel: (88) 28-56-46  
Telex: 890141F  
C,E,M,P\*

Hewlett-Packard France  
Le Péripole III  
3, Chemin du Pigeonnier de la Cèpière  
31081 TOULOUSE Cedex  
Tel: 33-61-40-1112  
Telex: 531639F  
A,C,E,M,P\*

Hewlett-Packard France  
Les Cardoulines  
Batiment B2  
Route des Dolines  
Parc d'activité de Valbonne  
Sophia Antipolis  
06560 VALBONNE (Nice)  
Tel: (93) 65-39-40  
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9, Rue Baudin  
26000 VALENCE  
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Parc d'activité des Prés  
1, Rue Papin Cedex  
59658 VILLENEUVE D'ASCO  
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C,E,M,P

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Parc d'activités Paris-Nord 11  
Boite Postale 60020  
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Tel: (1) 48 63 80 80  
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C,E,M,P\*

## GABON

Sho Gabon  
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Telex: 5230

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D-6380 BAD HOMBURG  
Tel: (06172) 400-0  
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A,C,E,M,P

Hewlett-Packard GmbH  
Geschäftsstelle  
Keithstrasse 2-4  
D-1000 BERLIN 30  
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Hewlett-Packard GmbH  
Verbindungsstelle Bonn  
Friedrich-Ebert-Allee 26  
5300 BONN  
Tel: (0228) 234001  
Telex: 8869421

Hewlett-Packard GmbH  
Vertriebszentrum Südwest  
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D-7030 BÖBLINGEN  
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Herrenberger Strasse 130  
D-7030 BÖBLINGEN  
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D-4600 DORTMUND-41  
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Geschäftsstelle  
Rosslauer Weg 2-4  
D-6800 MANNHEIM  
Tel: 49-0621-70-05-0  
Telex: 0462105 hpmhm  
A,C,E

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Geschäftsstelle  
Messerschmittstrasse 7  
D-7910 NEU ULM  
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Telex: 0712816 HP ULM-D  
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Emmericher Strasse 13  
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Berliner Strasse 111  
D-4030 RATINGEN 4  
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Postfach 1251  
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Halandri-ATHENS  
Greece  
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Telex: 221 286 HPHLGR  
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Telex: 215962 RKAR GR  
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Tel: 6474481/2  
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ATHENS 612  
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Hellamco  
P O Box 87528  
18507 PIRAEUS  
Tel: 4827049  
Telex: 241441  
A

## GUATEMALA

IPESA DE GUATEMALA  
Avenida Reforma 3-48, Zona 9  
GUATEMALA CITY  
Tel: 316627, 317853, 66471/5  
9-011-502-2-316627  
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**HONG KONG**

Hewlett-Packard Hong Kong, Ltd  
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5th Floor, Sun Hung Kai Centre  
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**HONG KONG**

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Telex: 74766 SCHMC HX  
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**ICELAND**

Hewlett-Packard Iceland  
Hoefdabakka 9  
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Telex: 46748 BERSAL IA  
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Jalan Kutai 24  
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Tel: 67118  
Telex: 31146 BERSAL SB  
Cable: BERSAL-SURABAYA  
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Al Mansoor City 9B/3/7  
BAGHDAD  
Tel: 551-49-73  
Telex: 212-455 HEPAIRAQ IK  
C

**IRELAND**

Hewlett-Packard Ireland Ltd  
Temple House, Temple Road  
Blackrock, Co. DUBLIN  
Tel: 88/333/99  
Telex: 30439  
C,E,P

Hewlett-Packard Ltd  
75 Belfast Rd, Carrickfergus  
Belfast BT38 8PH  
NORTHERN IRELAND  
Tel: 09603-67333  
Telex: 747626  
M

**ISRAEL**

Eldan Electronic Instrument Ltd  
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JERUSALEM 91000  
16, Ohaliav St.  
JERUSALEM 94467  
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Hewlett-Packard Italiana S.p.A  
Traversa 99C  
Via Giulio Petroni, 19  
I-70124 BARI  
Tel: (080) 41-07-44  
C,M

Hewlett-Packard Italiana S.p.A  
Via Emilia, 51/C  
I-40011 BOLOGNA Anzola Dell'Emilia  
Tel: 39-051-731061  
Telex: 511630  
C,E,M

Hewlett-Packard Italiana S.p.A  
Via Principe Nicola 43G/C  
I-95126 CATANIA  
Tel: (095) 37-10-87  
Telex: 970291  
C

Hewlett-Packard Italiana S.p.A  
Via G di Vittorio 10  
20094 CORSICO (Milano)  
Tel: 39-02-4408351  
Hewlett-Packard Italiana S.p.A  
Viale Brigata Bisagno 2  
16129 GENOVA  
Tel: 39-10-541141  
Telex: 215238

Hewlett-Packard Italiana S.p.A  
Viale G Modugno 33  
I-16156 GENOVA PEGLI  
Tel: (010) 68-37-07  
Telex: 215238  
C,E

Hewlett-Packard Italiana S.p.A  
Via G di Vittorio 9  
I-20063 CERNUSCO SUL  
NAVIGLIO  
(Milano)  
Tel: (02) 923691  
Telex: 334632  
A,C,CM,E,M,P

Hewlett-Packard Italiana S.p.A.  
Via Nuova Rivoltana 95  
20090 LIMITO (Milano)  
Tel: 02-92761

Hewlett-Packard Italiana S.p.A.  
Via Nuova San Rocco a  
Capodimonte, 62/A  
I-80131 NAPOLI  
Tel: (081) 7413544  
Telex: 710698  
A\*,C,E,M

Hewlett-Packard Italiana S.p.A.  
Via Orazio 16  
80122 NAPOLI  
Tel: (081) 7611444  
Telex: 710698

Hewlett-Packard Italiana S.p.A.  
Via Pellizzo 15  
35128 PADOVA  
Tel: 39-49-664-888  
Telex: 430315  
A,C,E,M

Hewlett-Packard Italiana S.p.A.  
Viale C. Pavese 340  
I-00144 ROMA EUR  
Tel: 39-65-48-31  
Telex: 610514  
A,C,E,M,P\*

Hewlett-Packard Italiana S.p.A.  
Via di Casellina 57/C  
500518 SCANDICCI-FIRENZE  
Tel: 39-55-753863  
C,E,M

Hewlett-Packard Italiana S.p.A.  
Corso Svizzera, 185  
I-10144 TORINO  
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Tel: 321227  
Telex: 22149  
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**JAPAN**

Yokogawa-Hewlett-Packard Ltd  
152-1, Onna  
ATSUGI, Kanagawa, 243  
Tel: (0462) 25-0031  
C,CM,E

Yokogawa-Hewlett-Packard Ltd  
Meiji-Seimei Bldg 6F  
3-1 Motochiba-Cho  
CHIBA, 280  
Tel: (0472) 25 7701  
C,E

Yokogawa-Hewlett-Packard Ltd  
Yasuda-Seimei Hiroshima Bldg  
6-11, Hon-dori, Naka-ku  
HIROSHIMA, 730  
Tel: (082) 241-0611

Yokogawa-Hewlett-Packard Ltd  
Towa Building  
2-2-3 Kaigan-dori, Chuo-ku  
KOBE, 650  
Tel: (078) 392-4791  
C,E

Yokogawa-Hewlett-Packard Ltd  
Kumagaya Asahi 82 Bldg  
3-4 Tsukuba  
KUMAGAYA, Saitama 360  
Tel: (0485) 24-6563  
C,CM,E

Yokogawa-Hewlett-Packard Ltd  
Asahi Shinbun Daiichi Seimei Bldg  
4-7, Hanabata-cho  
KUMAMOTO, 860  
Tel: 96-354-7311  
C,E

Yokogawa-Hewlett-Packard Ltd  
Shin-Kyoto Center Bldg.  
614, Higashi-Shiojiko-cho  
Karasuma-Nishiiru  
KYOTO, 600  
Tel: 075-343-0921  
C,E

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Mito Mitsui Bldg.  
1-4-73, Sanno-maru  
MITO, Ibaraki 310  
Tel: (0292) 25-7470  
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Yokogawa-Hewlett-Packard Ltd  
Meiji-Seimei Kokubun Bldg  
7-8 Kokubun, 1 Chome, Sendai  
MIYAGI, 980  
Tel: (0222) 25-1011  
C,E

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Gohda Bldg 2F  
1-2-10 Gohda Okaya-Shi  
Okaya-Shi  
NAGANO, 394  
Tel: (0266) 23 0851  
C,E

Yokogawa-Hewlett-Packard Ltd  
Nagoya Kokusai Center Building  
1-47-1, Nagano, Nakamura-ku  
NAGOYA, AICHI 450  
Tel: (052) 571-5171  
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Tel: (0486) 45-8031

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Yokogawa-Hewlett-Packard Ltd  
Chuo Bldg, 5-4-20 Nishi-Nakajima  
4-20 Nishinakajima, 5 Chome,  
Yodogawa-ku  
**OSAKA, 532**  
Tel: (06) 304-6021  
Telex: YHPOSA 523-3624  
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Tel: 0427 59-1311

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C,E

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Shinjuku-ku **TOKYO 163**  
Tel: 03-348-4611  
C,E,M

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Tel: (03) 349-1859  
Telex: J27584  
A

Yokogawa Hokushin Electric Corp  
9-32 Nokacho 2 Chome  
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Tel: (0422) 54-1111  
Telex: 02822-421 YEW MTK J  
A

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Utsunomiya Odori Building  
1-5 Odori, 2 Chome  
**UTSUNOMIYA, Tochigi 320**  
Tel: (0286) 33-1153  
C,E

Yokogawa-Hewlett-Packard Ltd  
Yasuda Seimei Nishiguchi Bldg  
30-4 Tsuruya-cho, 3 Chome  
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Tel: (045) 312-1252  
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P

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S A de C V  
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Fraccionamiento Loma Bonita 45060  
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Lomas de Chapultepec, 11000  
**MEXICO, D.F.**  
Tel: 520-9127  
P

Hewlett-Packard de Mexico,  
S A de C V  
Monte Pelvoux No 111  
Lomas de Chapultepec  
11000 **MEXICO, D.F.**  
Tel: 5-40-62-28 72-66, 50-25  
Telex: 17-74-507 HEWPACK MEX  
A,C,CM,E,M,P  
Hewlett-Packard De Mexico (Polanco)  
Avenida Ejercito Nacional #579  
2da y 3ra piso  
Colonia Granada 11560  
**MEXICO D.F.**  
Tel: 254-4433  
P

Hewlett-Packard de Mexico,  
S A de C V  
Czda del Valle  
409 Ote 4th Piso  
Colonia del Valle  
Municipio de Garza  
Garcia Nuevo Leon  
66220 **MONTERREY, Nuevo Leon**  
Tel: 83-78-42-40  
Telex: 382410 HPMY  
C

Infograficas y Sistemas  
del Noreste, S A  
Rio Orinoco #171 Oriente  
Despacho 2001  
Colonia Del Valle  
**MONTERREY**  
Tel: 559-4415 575-3837  
Telex: 483164  
A E

Hewlett-Packard de Mexico,  
S A de C V  
Blvd Independencia No 2000 Ote  
Col Estrella  
**TORREON, COAH**  
Tel: 171-18-21-99  
P

## MOROCCO

Etablissement Hubert Dolbeau & Fils  
81 rue Karatchi  
B P 11133  
**CASABLANCA**  
Tel: 3041-82, 3068-38  
Telex: 23051, 22822  
E

Gerep  
2, rue Agadir  
Boite Postale 156  
**CASABLANCA 01**  
Tel: 272093, 272095  
Telex: 23 739  
P

Sema-Maroc  
Dept Seric  
6, rue Lapebie  
**CASABLANCA**  
Tel: 260980  
Telex: 21641  
C,P

## NETHERLANDS

Hewlett-Packard Nederland B V  
Startbaan 16  
NL-1187 XR **AMSTELVEEN**  
P O Box 667  
NL-1180 AR **AMSTELVEEN**  
Tel: (020) 547-6911  
Telex: 13 216 HEPA NL  
A,C,CM,E,M,P  
Hewlett-Packard Nederland B V  
Bongerd 2  
P O Box 41  
NL 2900AA **CAPELLE A/D IJSSEL**  
Tel: 31-20-51-6444  
Telex: 21261 HEPAC NL  
C E

Hewlett-Packard Nederland B V  
Pastoor Petersstraat 134-136  
P O Box 2342  
NL 5600 CH **EINDHOVEN**  
Tel: 31-40-32-6911  
Telex: 51484 hepae nl  
C,E,P

## NEW ZEALAND

Hewlett-Packard (N Z ) Ltd  
5 Owens Road  
P O Box 26-189  
Epsom, **AUCKLAND**  
Tel: 64-9-687-159  
Cable: HEWPAK Auckland  
C,CM,E,P\*

Hewlett-Packard (N Z ) Ltd  
184-190 Willis Street  
**WELLINGTON**  
P O Box 9443  
Courtenay Place, **WELLINGTON 3**  
Tel: 64-4-887-199  
Cable: HEWPAK Wellington  
C,CM,E,P

Northrop Instruments & Systems Ltd  
369 Khyber Pass Road  
P O Box 8602  
**AUCKLAND**  
Tel: 794-091  
Telex: 60605  
A,M

Northrop Instruments & Systems Ltd  
110 Mandeville St.  
P O Box 8388  
**CHRISTCHURCH**  
Tel: 488-873  
Telex: 4203  
A,M

Northrop Instruments & Systems Ltd  
Sturdee House  
85-87 Ghuznee Street  
P O Box 2406  
**WELLINGTON**  
Tel: 850-091  
Telex: NZ 3380  
A,M

### **NIGERIA**

Elmeco Nigeria Ltd  
45 Saka Tirubu St  
Victoria Island  
**LAGOS**  
Tel: 61-98-94  
Telex: 20-117  
E

### **NORTHERN IRELAND** See United Kingdom

### **NORWAY**

Hewlett-Packard Norge A/S  
Folke Bernadottes vei 50  
P O Box 3558  
N-5033 FYLLINGSDALEN (Bergen)  
Tel: 0047/5/16 55 40  
Telex: 76621 hpnas n  
C,E,M

Hewlett-Packard Norge A/S  
Osterdalen 16-18  
P O Box 34  
N-1345 OEËSTERAAS  
Tel: 47-2-17-1180  
Telex: 76621 hpnas n  
A,C,CM,E,M,P

Hewlett-Packard Norge A/S  
Boehmergt 42  
Box 2470  
N-5037 SOLHEIMSVIK  
Tel: 0047/5/29 00 90

### **OMAN**

Khimji Ramdas  
P O Box 19  
**MUSCAT/SULTANATE OF OMAN**  
Tel: 795 901  
Telex: 3489 BROKER MB MUSCAT  
P

Suhail & Saud Bahwan

P O Box 169  
**MUSCAT/SULTANATE OF OMAN**  
Tel: 734 201-3  
Telex: 5274 BAHWAN MB  
E

Imlac LLC  
P O Box 9196  
**MINA AL FAHAL/SULTANATE OF OMAN**  
Tel: 70-77-27, 70-77-23  
Telex: 3865 Tawoos On  
A,C,M

### **PAKISTAN**

Mushko & Company Ltd  
Hcuse No 16, Street No 16  
Sector F-6/3  
**ISLAMABAD**  
Tel: 824545  
Telex: 54001 Muski Pk  
Cable: FEMUS Islamabad  
A,E,P\*

Mushko & Company Ltd  
Osman Chambers  
Abdullah Haroon Road  
**KARACHI 0302**  
Tel: 524131, 524132  
Telex: 2894 MUSKO PK  
Cable: COOPERATOR Karachi  
A,E,P\*

### **PANAMA**

Electronico Balboa, S A  
Calle Samuel Lewis, Ed Alfa  
Apartado 4929  
**PANAMA CITY**  
Tel: 9-011-507-636613  
Telex: 368 3483 ELECTRON PG  
C,M,E,M,P

### **PERU**

Cia Electro Médica S A  
Los Flamencos 145, Ofc 301/2  
San Isidro  
Casilla 1030  
**LIMA 1**  
Tel: 9-011-511-4-41325, 41-3705  
Telex: 39425257 PE PB SIS  
C,M,E,M,P  
**SAMS S A**  
Arenida Republica de Panama 3534  
San Isidro. **LIMA**  
Tel: 9-011-511-4-229332/413984/  
413226  
Telex: 39420450 PE LIBERTAD  
A,C,P

### **PHILIPPINES**

The Online Advanced Systems Corp  
2nd Floor, Electra House  
115-117 Esteban Street  
P O Box 1510  
Legaspi Village, Makati  
Metro **MANILA**  
Tel: 815-38-10 (up to 16)  
Telex: 63274 ONLINE PN  
A,C,E,M,P

### **PORTUGAL**

Mundinter Intercambio  
Mundial de Comércio S A R L  
Av Antonio Augusto Aguiar 138  
Apartado 2761  
**LISBON**  
Tel: (19) 53-21-31, 53-21-37  
Telex: 16691 munter p  
M

Soquimica  
Av da Liberdade, 220-2  
1298 **LISBOA** Codex  
Tel: 56-21-82  
Telex: 13316 SABASA  
A  
Telectra-Empresa Técnica de  
Equipamentos Eléctricos S A R L  
Rua Rodrigo da Fonseca 103  
P O Box 2531  
**LISBON 1**  
Tel: (19) 68-60-72  
Telex: 12598  
C,M,E

C P C S I  
Rua de Costa Cabral 575  
4200 **PORTO**  
Tel: 499174/495173  
Telex: 26054  
C,P

### **PUERTO RICO**

Hewlett-Packard Puerto Rico  
101 Muñoz Rivera Av  
Esu Calle Ochoa  
**HATO REY**, Puerto Rico 00918  
Tel: (809) 754-7800  
A,C,CM,M,E,P

### **QATAR**

Computer Arabia  
P O Box 2750  
**DOHA**  
Tel: 428555  
Telex: 4806 CHPARB  
P  
Nasser Trading & Contracting  
P O Box 1563  
**DOHA**  
Tel: 422170  
Telex: 4439 NASSER DH  
M

### **SAUDI ARABIA**

Modern Electronics Establishment  
Hewlett-Packard Division  
P O Box 281  
Thuobah  
**AL-KHOBAR 31952**  
Tel: 895-1760, 895-1764  
Telex: 671 106 HPMEEK SJ  
Cable: ELECTA AL-KHOBAR  
C,E,M

Modern Electronics Establishment  
Hewlett-Packard Division  
P O Box 1228  
Redec Plaza, 6th Floor  
**JEDDAH**  
Tel: 644 96 28  
Telex: 4027 12 FARNAS SJ  
Cable: ELECTA JEDDAH  
A,C,CM,E,M,P

Modern Electronics Establishment  
Hewlett-Packard Division  
P O Box 22015  
**RIYADH 11495**  
Tel: 491-97 15, 491-63 87  
Telex: 202049 MEERYD SJ  
C,E,M

Abdul Ghani El Ajou Corp  
P O Box 78  
**RIYADH**  
Tel: 40 41 717  
Telex: 200 932 EL AJOU  
P

### **SCOTLAND** See United Kingdom

### **SENEGAL**

Societe Hussein Ayad & Cie  
76, Avenue Georges Pompidou  
B P 305  
**DAKAR**  
Tel: 32339  
Cable: AYAD-Dakar  
E  
Moneger Distribution S A  
1, Rue Parent  
B P 148  
**DAKAR**  
Tel: 215 671  
Telex: 587  
P

Systeme Service Conseil (SSC)  
14, Avenue du Parachois  
**DAKAR ETOILE**  
Tel: 219976  
Telex: 577  
C,P

### **SINGAPORE**

Hewlett-Packard Singapore (Sales)  
Pte Ltd  
1150 Depot Road  
**SINGAPORE, 0410**  
Tel: 4731788  
Telex: 34209 HPSGSO RS  
Cable: HEWPACK, Singapore  
A,C,E,M,P  
Dynamar International Ltd.  
Unit 05-11 Block 6  
Kolam Ayer Industrial Estate  
**SINGAPORE 1334**  
Tel: 747-6188  
Telex: 26283 RS  
CM

### **SOUTH AFRICA**

Hewlett-Packard So Africa (Pty) Ltd.  
P O Box 120  
Howard Place, **CAPE PROVINCE**  
7450 South Africa  
Tel: 27 121153-7954  
Telex: 57-20006  
A,C,CM,E,M,P  
Hewlett-Packard So Africa (Pty) Ltd  
2nd Floor Juniper House  
92 Overport Drive  
**DURBAN 4067**  
Tel: 27-31-28-4178  
Telex: 6-22954  
C

Hewlett-Packard So Africa (Pty) Ltd  
Shop 6 Linton Arcade  
511 Cape Road  
Linton Grange  
**PORT ELIZABETH 6001**  
Tel: 27141130 1201  
Telex: 24-2916  
C

Hewlett-Packard So Africa (Pty) Ltd  
Fountain Center  
Kalkoen Str  
Monument Park Ext 2  
**PRETORIA 0105**  
Tel: (012) 45 5725  
Telex: 32163  
C,E

Hewlett-Packard So Africa (Pty) Ltd  
Private Bag Wendywood  
**SANDTON 2144**  
Tel: 27-11-802-5111, 27-11-802-5125  
Telex: 4-20877 SA  
Cable: HEWPACK Johannesburg  
A,C,CM,E,M,P

### **SPAIN**

Hewlett-Packard Española, S A  
Calle Entenza, 321  
**E-BARCELONA 29**  
Tel: 3/322 24 51, 321 73 54  
Telex: 52603 hpbee  
A,C,E,M,P  
Hewlett-Packard Española, S A  
Calle San Vicente S/N  
Edificio Albia II-7B  
48001 **BILBAO**  
Tel: 4/423 83 06  
A,C,E,M

Hewlett-Packard Española, S A  
C/ta N-VI, Km 16, 400  
Las Rozas  
**E-MADRID**  
Tel: (1) 637 00 11  
Telex: 23515 HPE  
C,M

Hewlett-Packard Española, S A  
Avda S Francisco Javier, S/N  
Planta 10 Edificio Sevilla 2  
**E-SEVILLA 5, SPAIN**  
Tel: 54/64 44 54  
Telex: 72933  
A,C,M,P

Hewlett-Packard Española, S A  
Isabel La Católica, 8  
**E-46004 VALENCIA**  
Tel: 34-6-361 1354  
Telex: 63435  
C,P

Hewlett-Packard Española, S A  
Av de Zugazarte, 8  
Las Arenas-Guecho  
**E-48930 VIZCAYA VIZCAYA**  
Tel: 34-423-83 06  
Telex: 33032

### **SWEDEN**

Hewlett-Packard Sverige AB  
Östra Tullgatan 3  
S-20011 **MALMÖ**  
Box 6132  
Tel: 46-40-702-70  
Telex: (854) 17886 (via Spånga office)  
C,P  
Hewlett-Packard Sverige AB  
Elementvagen 16  
S-7022 7 **ÖREBRO**  
Tel: 49-019-10-4820  
Telex: (854) 17886 (via Spånga office)  
C

Hewlett-Packard Sverige AB  
Skalholtsgatan 9, Kista  
P O Box 19  
S-16393 **SPÅNGA**  
Tel: (08) 750-2000  
Telex: (854) 17886  
Telefax: (08) 7527781  
A,C,CM,E,M,P  
Hewlett-Packard Sverige AB  
Box 266  
Topasgatan 1A  
S-42123 **VÄSTRA-FRÖLUNDA**  
(Gothenburg)  
Tel: 46-031-89-1000  
Telex: (854) 17886 (via Spånga office)  
A,C,CM,E,M,P

### **SUDAN**

Mediterranean Engineering  
& Trading Co Ltd  
P O Box 1025  
**KHARTOUM**  
Tel: 41184  
Telex: 24052  
C,P

### **SWITZERLAND**

Hewlett-Packard (Schweiz) AG  
Clarastrasse 12  
CH-4058 **BASEL**  
Tel: 41-61-33-5920  
A,C,E,P  
Hewlett-Packard (Schweiz) AG  
7, rue du Bois-du-Lan  
Case postale 365-1366  
CH-1217 **MEYRIN 1**  
Tel: (0041) 22-83-11-11  
Telex: 27333 HPAG CH  
A,C,CM,E,M,P

## SWITZERLAND (Cont'd) TOGO

Hewlett-Packard (Schweiz) AG  
Alimend 2  
CH-8967 WIDEN  
Tel: 41-57-31-2111  
Telex: 53933 hpag ch  
Cable: HPAG CH  
A,C,CM,E,M,P

Hewlett-Packard (Schweiz) AG  
Schwamendingenstrasse 10  
CH-8050 ZURICH  
Tel: 41-1-315-8181  
Telex: 823 537 HPAG CH  
C,P

## SYRIA

General Electronic Inc  
Nuri Basha Ahnaf Ebn Kays Street  
P O Box 5781

**DAMASCUS**  
Tel: 33-24-87  
Telex: 44-19-88  
Cable: ELECTROBOR DAMASCUS  
E

Middle East Electronics  
P O Box 2308

Abu Rumaneh  
**DAMASCUS**  
Tel: 33 45 92  
Telex: 411 771 Meesy  
M

## TAIWAN

Hewlett-Packard Taiwan Ltd  
THM Office

2 Huan Nan Road  
CHUNG LI, Taoyuan  
Tel: (034) 929-666  
C

Hewlett-Packard Taiwan Ltd

Kachsiung Office  
11/F, 456 Chung Hsiao 1st Road  
KAOSIUNG  
Tel: (07) 2412318  
C,E

Hewlett-Packard Taiwan Ltd  
8th Floor, Hewlett-Packard Building  
337 Fu Hsing North Road  
TAIPEI

Tel: (02) 712-0404  
Telex: 24439 HEWPACK  
Cable: HEWPACK Taipei  
A,C,CM,E,M,P

Ing Lih Trading Co  
3rd Floor, No. 7, Sect 2  
Jen Ai Road  
TAIPEI 100  
Tel: (02) 394-8191  
Telex: 22894 SANKWANG  
A

## THAILAND

Unimesa Co Ltd  
30 Patpong Ave., Suriwong  
BANGKOK 5,  
Tel: 235-5727, 234-0991/3  
Telex: 84439 Simonco TH  
Cable: UNIMESA Bangkok  
A,C,E,M

Bangkok Business Equipment Ltd  
5/5-6 Dejo Road  
BANGKOK  
Tel: 234-8670, 234-8671  
Telex: 87699-BEQUIPT TH  
Cable: BUSIQUIPT Bangkok  
P

Societe Africaine De Promotion  
Immeuble Sageb  
Rue d'Atakpame  
P O Box 4150  
**LOME**  
Tel: 21-62-88  
Telex: 5357  
P

## TRINIDAD & TOBAGO

Caribbean Telecoms Ltd  
Corner McAllister Street &  
Eastern Main Road, Laventille  
P O Box 732

**PORT-OF-SPAIN**  
Tel: 624-4213  
Telex: 22561 CARTEL WG  
Cable: CARTEL, PORT OF SPAIN  
CM,E,M,P

Computer and Controls Ltd  
P O Box 51  
1 Taylor Street

**PORT-OF-SPAIN**  
Tel: (809) 622-7719/622-7985  
Telex: 38722798 COMCON WG  
LOGGO AGENCY 1264  
A,P

Feral Assoc  
8 Fitzgerald Lane

**PORT-OF-SPAIN**  
Tel: 62-36864, 62-39255  
Telex: 22432 FERALCO  
Cable: FERALCO  
M

## TUNISIA

Tunisie Electronique S A R L  
31 Avenue de la Liberte

**TUNIS**  
Tel: 280-144  
C,E,P

Tunisie Electronique S A R L  
94 Av Jugurtha, Mutuelleville  
1002 **TUNIS-BELVEDERE**  
Tel: 280144  
Telex: 13238

C,E,P  
Corema S A  
1 ter Av de Carthage  
**TUNIS**  
Tel: 253-821  
Telex: 12319 CABAM TN  
M

## TURKEY

E M A  
Mediha Eldem Sokak No 41/6  
Yenisehir

**ANKARA**  
Tel: 319175  
Telex: 42321 KTX TR  
Cable: EMATRADE ANKARA  
M

Teknim Company Ltd  
Iran Caddesi No 7  
Karaklidere  
**ANKARA**  
Tel: 275800  
Telex: 42155 TKNM TR  
C,E

Kurt & Kurt A S  
Mithatpasa Caddesi No 75  
Kat 4 Kizilay  
**ANKARA**  
Tel: 318875/67/8  
Telex: 42490 MESR TR  
A

Sanwa Bilgisayar Sistemleri A S  
Buyukdere Caddesi 103/6

Gayrettepe  
**ISTANBUL**  
Tel: 1673180  
Telex: 26345 SANI TR  
C,P

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Esentepe, Gazeteciler Sitesi  
Keskın Kalem  
Sokak 6/3, Gayrettepe  
**ISTANBUL**  
Tel: 172 1328, 173 3344  
Telex: 42490  
A

## UNITED ARAB EMIRATES

Emitac Ltd  
P O Box 1641

**SHARJAH**  
Tel: 591181  
Telex: 68136 EMITAC EM  
Cable: EMITAC SHARJAH  
E,C,M,P,A

Emitac Ltd  
P O Box 2711

**ABU DHABI**  
Tel: 820419-20  
Cable: EMITACH ABUDHABI

Emitac Ltd  
P O Box 8391

**DUBAI,**

Tel: 377591  
Emitac Ltd

P O Box 473  
**RAS AL KHAIMAH**  
Tel: 28133, 21270

## UNITED KINGDOM ENGLAND

Hewlett-Packard Ltd  
Miller House

The Ring **BRACKNELL**  
Berks RG12 1XN  
Tel: 44/344/424-898  
Telex: 848733  
E

Hewlett-Packard Ltd  
Elstree House Elstree Way  
**BOREHAMWOOD,** Herts WD6 1SG  
Tel: 01 207 5000  
Telex: 8952716  
C,E

Hewlett-Packard Ltd  
Oakfield House, Oakfield Grove  
Clifton **BRISTOL,** Avon BS8 2BN  
Tel: 44-272-736 806  
Telex: 444302  
C,E,P

Hewlett-Packard Ltd  
9 Bridewell Place  
**LONDON EC4V 6BS**  
Tel: 44-01-583-6565  
Telex: 298163  
C,P

Hewlett-Packard Ltd  
Pontefract Road  
**NORMANTON,** West Yorkshire WF6 1RN  
Tel: 44/924/895 566  
Telex: 557355  
C,P

Hewlett-Packard Ltd  
The Quadrangle  
106-118 Station Road  
**REDHILL,** Surrey RH1 1PS  
Tel: 44-737-686-55  
Telex: 947234  
C,E,P

Hewlett-Packard Ltd  
Avon House  
435 Stratford Road  
Shirley **SOLIHULL,** West Midlands  
B90 4BL  
Tel: 44-21-745-8800  
Telex: 339105  
C,E,P

Hewlett-Packard Ltd  
Heathside Park Road  
Cheadle Heath, Stockport  
SK3 ORB, United Kingdom  
Tel: 44-061-428-0828  
Telex: 668068  
A,C,E,M,P

Hewlett-Packard Ltd  
Harmon House  
No 1 George Street  
**UXBRIDGE,** Middlesex UX8 1YH  
Tel: 895 720 20  
Telex: 893134/5  
C,CM,E,M,P

Hewlett-Packard Ltd  
King Street Lane  
Winnersh **WOKINGHAM**  
Berkshire RG11 5AR  
Tel: 44/734/784774  
Telex: 8471789  
A,C,E,M,P

## NORTHERN IRELAND

Hewlett-Packard (Ireland) Ltd  
Carrickfergus Industrial Centre  
75 Belfast Road, Carrickfergus  
**CO. ANTRIM BT38 8PM**  
Tel: 09603 67333  
C E

Cardiac Services Company  
95A Finaghy Road South  
**BELFAST,** BT10 OBY  
Tel: 0232-625566  
Telex: 747626  
M

## SCOTLAND

Hewlett-Packard Ltd  
1/3 Springburn Place  
College Milton North  
**EAST KILBRIDE,** G74 5NU  
Tel: 041-332-6232  
Telex: 779615  
C,E

Hewlett-Packard Ltd  
**SOUTH QUEENSFERRY**  
West Lothian, EH30 9TG  
Tel: 031 331 1188  
Telex: 72682 HPSQFYG  
C,CM,E,M,P

## UNITED STATES

Hewlett-Packard Co  
Customer Information Center  
Tel: (800) 752-0900  
Hours: 6:00 AM to 5:00 PM  
Pacific Time

## Alabama

Hewlett-Packard Co  
2100 Riverchase Center  
Building 100 - Suite 118  
**BIRMINGHAM, AL 35244**  
Tel: (205) 988-0547  
A,C,M,P\*

Hewlett-Packard Co  
420 Wynn Drive  
**HUNTSVILLE, AL 35805**  
Tel: (205) 830-2000  
C,CM,E,M\*

## Alaska

Hewlett-Packard Co  
4000 Old Seward Highway  
Suite 101  
**ANCHORAGE, AK 99503**  
Tel: (907) 563-8855  
C E

## Arizona

Hewlett-Packard Co  
8080 Pointe Parkway West  
**PHOENIX, AZ 85044**  
Tel: (602) 273-8000  
A,C,CM,E,M,P

Hewlett-Packard Co  
3400 East Britannia Dr  
Bldg C, Suite 124  
**TUCSON, AZ 85706**  
Tel: (602) 573-7400  
C,E,M\*\*

## California

Hewlett-Packard Co  
99 South Hill Dr  
**BRISBANE, CA 94005**  
Tel: (415) 330-2500  
C

Hewlett-Packard Co  
1907 North Gateway Blvd  
**FRESNO, CA 93727**  
Tel: (209) 252-9652  
C,M

Hewlett-Packard Co  
1421 S Manhattan Av  
**FULLERTON, CA 92631**  
Tel: (714) 999-6700  
C,CM,E,M

Hewlett-Packard Co  
7408 Hollister Ave #A  
**GOLETA, CA 93117**  
Tel: (805) 685-6100  
C,E

Hewlett-Packard Co  
2525 Grand Avenue  
**LONG BEACH, CA 90815**  
Tel: (213) 498-1111  
C

Hewlett-Packard Co  
5651 West Manchester Ave  
**LOS ANGELES, CA 90045**  
Tel: (213) 337-8000  
Hewlett-Packard Co  
3155 Porter Drive  
**PALO ALTO, CA 94304**  
Tel: (415) 857-8000  
C,E

Hewlett-Packard Co.  
5725 W Las Positas Blvd.  
**PLEASANTON, CA 94566**  
Tel: (415) 460-0282  
C

Hewlett-Packard Co.  
4244 So. Market Court, Suite A  
**SACRAMENTO, CA 95834**  
Tel: (916) 929-7222  
A\*,C,E,M

Hewlett-Packard Co.  
9606 Aero Drive  
**SAN DIEGO, CA 92123**  
Tel: (619) 279-3200  
C,CM,E,M

Hewlett-Packard Co.  
3003 Scott Boulevard  
**SANTA CLARA, CA 95054**  
Tel: (408) 988-7000  
Telex: 910-338-0586  
A,C,CM,E

Hewlett-Packard Co.  
2150 W Hillcrest Dr  
**THOUSAND OAKS, CA 91320**  
(805) 373-7000  
C,CM,E

**Colorado**  
Hewlett-Packard Co.  
2945 Center Green Court South  
Suite A  
**BOULDER, CO 80301**  
Tel: (303) 499-6655  
A,C,E

Hewlett-Packard Co.  
24 Inverness Place, East  
**ENGLEWOOD, CO 80112**  
Tel: (303) 649-5000  
A,C,CM,E,M

**Connecticut**  
Hewlett-Packard Co.  
500 Sylvan Av  
**BRIDGEPORT, CT 06606**  
Tel: (203) 371-6454  
C,E

Hewlett-Packard Co.  
47 Barnes Industrial Road South  
**WALLINGFORD, CT 06492**  
Tel: (203) 265-7801  
A,C,CM,E,M

**Florida**  
Hewlett-Packard Co.  
2901 N W 62nd Street  
**FORT LAUDERDALE, FL 33309**  
Tel: (305) 973-2600  
C,E,M,P\*

Hewlett-Packard Co.  
6800 South Point Parkway  
Suite 301  
**JACKSONVILLE, FL 32216**  
Tel: (904) 636-9955  
C\*,M\*\*

Hewlett-Packard Co.  
255 East Drive, Suite B  
**MELBOURNE, FL 32901**  
Tel: (305) 729-0704  
CM,E

Hewlett-Packard Co.  
6177 Lake Ellenor Drive  
**ORLANDO, FL 32809**  
Tel: (305) 859-2900  
A,C,CM,E,P\*

Hewlett-Packard Co.  
4700 Bayou Blvd  
Building 5  
**PENSACOLA, FL 32503**  
Tel: (904) 476-8422  
A,C,M

Hewlett-Packard Co.  
5550 W. Idlewild, #150  
**TAMPA, FL 33614**  
Tel: (813) 884-3282  
C,E,M,P

**Georgia**  
Hewlett-Packard Co.  
2015 South Park Place  
**ATLANTA, GA 30339**  
Tel: (404) 955-1500  
Telex: 810-766-4890  
A,C,CM,E,M,P\*

Hewlett-Packard Co.  
3607 Parkway Lane  
Suite 300  
**NORCROSS, GA 30092**  
Tel: (404) 448-1894  
C,E,P

**Hawaii**  
Hewlett-Packard Co.  
Pacific Tower  
1001 Bishop St  
Suite 2400  
**HONOLULU, HI 96813**  
Tel: (808) 526-1555  
A,C,E,M

**Idaho**  
Hewlett-Packard Co.  
11309 Chinden Blvd  
**BOISE, ID 83714**  
Tel: (208) 323-2700  
C

**Illinois**  
Hewlett-Packard Co.  
2205 E Empire St  
P O Box 1607  
**BLOOMINGTON, IL 61702-1607**  
Tel: (309) 662-9411  
A,C,E,M\*\*

Hewlett-Packard Co.  
525 W Monroe, #1308  
**CHICAGO, IL 60606**  
Tel: (312) 930-0010  
C

Hewlett-Packard Co.  
1200 East Diehl Road  
**NAPERVILLE, IL 60566**  
Tel: (312) 357-8800  
C

Hewlett-Packard Co.  
5201 Tollview Drive  
**ROLLING MEADOWS, IL 60008**  
Tel: (312) 255-9800  
Telex: 910-687-1066  
A,C,CM,E,M

**Indiana**  
Hewlett-Packard Co.  
11911 N. Meridian St  
**CARMEL, IN 46032**  
Tel: (317) 844-4100  
A,C,CM,E,M

Hewlett-Packard Co.  
111 E Ludwig Road  
Suite 108  
**FT. WAYNE, IN 46825**  
Tel: (219) 482-4283  
C,E

**Iowa**  
Hewlett-Packard Co.  
4070 22nd Av SW  
**CEDAR RAPIDS, IA 52404**  
Tel: (319) 390-4250  
C,E,M

Hewlett-Packard Co.  
4201 Corporate Dr  
**WEST DES MOINES, IA 50265**  
Tel: (515) 224-1435  
A\*\*,C,M\*\*

**Kansas**  
Hewlett-Packard Co.  
North Rock Business Park  
3450 N Rock Rd  
Suite 300  
**WICHITA, KS 67226**  
Tel: (316) 684-8491  
C,E

**Kentucky**  
Hewlett-Packard Co.  
305 N. Hurstbourne Lane,  
Suite 100  
**LOUISVILLE, KY 40223**  
Tel: (502) 426-0100  
A,C,M

**Louisiana**  
Hewlett-Packard Co.  
160 James Drive East  
**ST. ROSE, LA 70087**  
P O Box 1449  
**KENNER, LA 70063**  
Tel: (504) 467-4100  
A,C,E,M,P

**Maryland**  
Hewlett-Packard Co.  
3701 Koppers Street  
**BALTIMORE, MD 21227**  
Tel: (301) 644-5800  
Telex: 710-862-1943  
A,C,CM,E,M

Hewlett-Packard Co.  
2 Choke Cherry Road  
**ROCKVILLE, MD 20850**  
Tel: (301) 948-6370  
A,C,CM,E,M

**Massachusetts**  
Hewlett-Packard Co.  
1775 Minuteman Road  
**ANDOVER, MA 01810**  
Tel: (617) 682-1500  
A,C,CM,E,M,P\*

Hewlett-Packard Co.  
29 Burlington Mall Rd  
**BURLINGTON, MA 01803-4514**  
Tel: (617) 270-7000  
C,E

**Michigan**  
Hewlett-Packard Co.  
4326 Cascade Road S E  
**GRAND RAPIDS, MI 49506**  
Tel: (616) 957-1970  
C,M

Hewlett-Packard Co.  
39550 Orchard Hill Place Drive  
**NOVI, MI 48050**  
Tel: (313) 349-9200  
A,C,E,M

Hewlett-Packard Co.  
560 Kirts Rd  
Suite 101  
**TROY, MI 48064**  
Tel: (313) 362-5180  
C

**Minnesota**  
Hewlett-Packard Co.  
2025 W. Larpenteur Ave  
**ST. PAUL, MN 55113**  
Tel: (612) 644-1100  
A,C,CM,E,M

**Missouri**  
Hewlett-Packard Co.  
1001 E 101st Terrace Suite 120  
**KANSAS CITY, MO 64131-3368**  
Tel: (816) 941-0411  
A,C,CM,E,M

Hewlett-Packard Co.  
13001 Hollenberg Drive  
**BRIDGETON, MO 63044**  
Tel: (314) 344-5100  
A,C,E,M

**Nebraska**  
Hewlett-Packard  
11626 Nicholas St  
**OMAHA, NE 68154**  
Tel: (402) 493-0300  
C,E,M

**New Jersey**  
Hewlett-Packard Co.  
120 W Century Road  
**PARAMUS, NJ 07652**  
Tel: (201) 265-5000  
A,C,CM,E,M

Hewlett-Packard Co.  
20 New England Av. West  
**PISCATAWAY, NJ 08854**  
Tel: (201) 562-6100  
A,C,CM,E

**New Mexico**  
Hewlett-Packard Co.  
7801 Jefferson N E  
**ALBUQUERQUE, NM 87109**  
Tel: (505) 823-6100  
C,E,M

Hewlett-Packard Co.  
1362-C Trinity Dr  
**LOS ALAMOS, NM 87544**  
Tel: (505) 662-6700  
C,E

**New York**  
Hewlett-Packard Co.  
5 Computer Drive South  
**ALBANY, NY 12205**  
Tel: (518) 458-1550  
A,C,E,M

Hewlett-Packard Co.  
9600 Main Street  
**CLARENCE, NY 14031**  
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C,E,M

Hewlett-Packard Co.  
200 Cross Keys Office Park  
**FAIRPORT, NY 14450**  
Tel: (716) 223-9950  
A,C,CM,E,M

Hewlett-Packard Co.  
7641 Henry Clay Blvd  
**LIVERPOOL, NY 13088**  
Tel: (315) 451-1820  
A,C,CM,E,M

Hewlett-Packard Co.  
No 1 Pennsylvania Plaza  
55th Floor  
34th Street & 7th Avenue  
**MANHATTAN NY 10119**  
Tel: (212) 971-0800  
C,M\*

Hewlett-Packard Co.  
15 Myers Corner Rd.  
Hollowbrook Park, Suite 2D  
**WAPPINGERS FALLS, NY 12590**  
Tel: (914) 298-9125  
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Hewlett-Packard Co.  
2975 Westchester Ave  
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**WOODBURY, NY 11797**  
Tel: (516) 682-7800  
A,C,CM,E,M

**North Carolina**  
Hewlett-Packard Co.  
305 Gregson Dr  
**CARY, NC 27511**  
Tel: (919) 467-6600  
C,CM,E,M,P\*

Hewlett-Packard Co.  
9401 Arrow Point Blvd  
Suite 100  
**CHARLOTTE, NC 28217**  
Tel: (704) 527-8780  
C\*

Hewlett-Packard Co.  
5605 Roanne Way  
**GREENSBORO, NC 27420**  
Tel: (919) 852-1800  
A,C,CM,E,M,P\*

**Ohio**  
Hewlett-Packard Co.  
2717 S Arlington Road  
**AKRON, OH 44312**  
Tel: (216) 644-2270  
C,E

Hewlett-Packard Co.  
4501 Erskine Road  
**CINCINNATI, OH 45242**  
Tel: (513) 891-9870  
C,M

Hewlett-Packard Co.  
9080 Springboro Pike  
**MIAMISBURG, OH 45342**  
Tel: (513) 433-2223  
A,C,CM,E\*,M

Hewlett-Packard Co.  
One Maritime Plaza, 5th Floor  
720 Water Street  
**TOLEDO, OH 43604**  
Tel: (419) 242-2200  
C

Hewlett-Packard Co.  
675 Brooksedge Blvd  
**WESTERVILLE, OH 43081**  
Tel: (614) 891-3344  
C,CM,E\*

**Oklahoma**  
Hewlett-Packard Co.  
3525 N W 55th St  
Suite C-100  
**OKLAHOMA CITY, OK 73112**  
Tel: (405) 946-9499  
C,E\*,M

## UNITED STATES (Cont'd)

Hewlett-Packard Co  
6655 South Lewis,  
Suite 105  
TULSA, OK 74136  
Tel: (918) 481-6700  
A\*, C, E, M\*, P\*

### Oregon

Hewlett-Packard Co  
9255 S. W. Pioneer Court  
WILSONVILLE, OR 97070  
Tel: (503) 682-8000  
A, C, E\*, M

### Pennsylvania

Hewlett-Packard Co  
Heatherwood Industrial Park  
50 Dorchester Rd  
Route 22  
HARRISBURG, PA 17112-2799  
Tel: (717) 657-5900  
C

Hewlett-Packard Co  
111 Zeta Drive  
PITTSBURGH, PA 15238  
Tel: (412) 782-0400  
A, C, E, M

Hewlett-Packard Co  
2750 Monroe Boulevard  
VALLEY FORGE, PA 19482  
Tel: (215) 666-9000  
A, C, CM, E, M

### South Carolina

Hewlett-Packard Co  
Brookside Park, Suite 122  
1 Harbison Way  
COLUMBIA, SC 29212  
Tel: (803) 732-0400  
C, M

Hewlett-Packard Co  
545 N. Pleasantburg Dr.  
Suite 100  
GREENVILLE, SC 29607  
Tel: (803) 232-8002  
C

### Tennessee

Hewlett-Packard Co  
One Energy Centr. Suite 200  
Pellissippi Pkwy  
KNOXVILLE, TN 37932  
Tel: (615) 966-4747  
A, C, E, M, P

Hewlett-Packard Co  
3070 Directors Row  
Directors Square  
MEMPHIS, TN 38131  
Tel: (901) 346-8370  
A, C, E, M

Hewlett-Packard Co  
44 Vantage Way,  
Suite 160  
NASHVILLE, TN 37228  
Tel: (615) 255-1271  
A, C, E, M, P

### Texas

Hewlett-Packard Co  
1826-P Kramer Lane  
AUSTIN, TX 78758  
Tel: (512) 835-6771  
C, E, P\*

Hewlett-Packard Co  
5700 Cromo Dr  
EL PASO, TX 79912  
Tel: (915) 833-4400  
C, E\*, M\*\*

Hewlett-Packard Co  
3952 Sandshell Drive  
FORT WORTH, TX 76137  
Tel: (817) 232-9500  
C

Hewlett-Packard Co  
10535 Harwin Drive  
HOUSTON, TX 77036  
Tel: (713) 776-6400  
A, C, E, M, P\*

Hewlett-Packard Co  
3301 West Royal Lane  
IRVING, TX 75063  
Tel: (214) 869-3377  
C, E

Hewlett-Packard Co.  
109 E. Toronto, Suite 100  
McALLEN, TX 78501  
Tel: (512) 630-3030  
C

Hewlett-Packard Co.  
930 E. Campbell Rd  
RICHARDSON, TX 75081  
Tel: (214) 231-6101  
A, C, CM, E, M, P\*

Hewlett-Packard Co  
1020 Central Parkway South  
SAN ANTONIO, TX 78232  
Tel: (512) 494-9336  
A, C, E, M, P\*

### Utah

Hewlett-Packard Co  
3530 W. 2100 South St  
SALT LAKE CITY, UT 84119  
Tel: (801) 974-1700  
A, C, E, M

### Virginia

Hewlett-Packard Co  
840 Greenbrier Circle  
Suite 101  
CHESAPEAKE, VA 23320  
Tel: (804) 424-7105  
C, E, M  
Hewlett-Packard Co  
4305 Cox Road  
GLEN ALLEN, VA 23060  
Tel: (804) 747-7750  
A, C, E, M, P\*

Hewlett-Packard Co  
Tanglewood West Bldg  
Suite 240  
3959 Electric Road  
ROANOKE, VA 24018  
Tel: (703) 774-3444  
C, E, P

### Washington

Hewlett-Packard Co  
15815 S.E. 37th Street  
BELLEVUE, WA 98006  
Tel: (206) 643-4004  
A, C, CM, E, M

Hewlett-Packard Co  
1225 Argonne Rd  
SPOKANE, WA 99212  
Tel: (509) 922-7000  
C

### West Virginia

Hewlett-Packard Co  
501 56th Street  
CHARLESTON, WV 25304  
Tel: (304) 925-0492  
A, C, M

### Wisconsin

Hewlett-Packard Co  
275 N. Corporate Dr  
BROOKFIELD, WI 53005  
Tel: (414) 784-8800  
A, C, E\*, M

### URUGUAY

Pablo Ferrando S A C e l  
Avenida Italia 2877  
Casilla de Correo 370  
MONTEVIDEO  
Tel: 59-82-802-586  
Telex: 398802586

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Olympia de Uruguay S.A.  
Maquinas de Oficina  
Avda del Libertador 1997  
Casilla de Correo 6644  
MONTEVIDEO  
Tel: 91-1809, 98-3807  
Telex: 6342 OROU UY  
P

### VENEZUELA

Hewlett-Packard de Venezuela C A  
3A Transversal Los Ruices Norte  
Edificio Segre 2 & 3  
Apartado 50933  
CARACAS 1050  
Tel: (582) 239-4133  
Telex: 251046 HEWPACK  
A, C, CM, E, M, P

Hewlett-Packard de Venezuela, C A  
Centro Ciudad Comercial Tamanaco  
Nivel C-2 (Nueva Etapa)  
Local 53H05  
Chua. CARACAS  
Tel: 928291  
P

Albis Venezolana S R L  
Av. Las Marias, Ota. Alix,  
El Pedregal  
Apartado 81025  
CARACAS 1080A  
Tel: 747984, 742146  
Telex: 24009 ALBIS VC  
A

Tecnologica Medica del Caribe, C A  
Multicentro Empresarial del Este  
Ave. Libertador  
Edif. Libertador  
Nucleo "C" - Oficina 51-52  
CARACAS  
Tel: 339867/333780  
M

Hewlett-Packard de Venezuela C.A  
Residencias Tia Betty Local 1  
Avenida 3 y con Calle 75  
MARACAIBO, Estado Zulia  
Apartado 2646  
Tel: 58-2-617-5669  
Telex: 62464 HPMAR  
C, E\*

Hewlett-Packard de Venezuela C A  
Urb. Lomas de Este  
Torre Trebol — Piso 11  
VALENCIA, Estado Carabobo  
Apartado 3347  
Tel: (5841) 222992  
C, P

### YUGOSLAVIA

Do Hermes  
General Zdanova 4  
YU-11000 BEOGRAD  
Tel: (011) 342 641  
Telex: 11433  
A, C, E, M, P

Do Hermes  
Celovska 73  
YU-61000 LJUBLJANA  
Tel: (061) 553 170  
Telex: 31583  
A, C, E, M, P  
Elektrotehna  
Titova 51  
YU-61000 LJUBLJANA  
CM  
Do Hermes  
Kralja Tomislava 1  
YU-71000 SARAJEVO  
Tel: (071) 35 859  
Telex: 41634  
C\*\*, P

### ZAIRE

Computer & Industrial Engineering  
25, Avenue de la Justice  
B. P. 12797  
KINSHASA, Gombe  
Tel: 32063  
Telex: 21552  
C, P

### ZAMBIA

R. J. Tilbury (Zambia) Ltd  
P. O. Box 32792  
LUSAKA  
Tel: 215590  
Telex: 40128  
E

### ZIMBABWE

Field Technical Sales (Private) Limited  
45, Kelvin Road North  
P. O. Box 3458  
SALISBURY  
Tel: 705 231  
Telex: 4-122 RH  
E, P

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