

# BENCH BRIEFS

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## TECHNICAL MANUALS — ORGANIZATION AND USE

by Rod Dinkins

With the advent of increasingly sophisticated instruments and circuits, technical manuals are becoming larger and more complex. Finding desired information can be time consuming when you are confronted with a 200 page manual with 30 foldout drawings. A knowledge of manual organization and content helps considerably in effectively using a manual. To help you do a better job of using your HP manual, this article will examine a typical HP technical manual for an instrument such as a VTVM, electronic counter, oscilloscope, etc.



### MANUAL FORMAT

Manuals are really written to serve the needs of several types of readers, such as general readers, operators, repair and calibration personnel, parts stocking personnel, tech writers and instructors. Let's look at each section of a manual and see how it applies to the various types of readers.

Although there are many variations, here is an outline of a typical Hewlett-Packard instrument manual.

- Front Matter
- General Information
- Installation
- Operation
- Theory
- Maintenance
- Parts List
- Schematic Diagrams

### FRONT MATTER

Front matter includes the title page, table of contents, and lists of figures and tables. The title page lists the instrument serial prefix to which the manual applies, the type of manual (operating, service or both), who published it and when, plus an address for directing inquiries or requests. The front matter usually contains statements of certification, warranty, and assistance policies.

The table of contents and lists of figures and tables are extremely helpful because they comprise a directory to the remaining information in the manual. Nearly every information-type of publication has an index or table of contents, and it seems to be the least used portion. See if this story sounds familiar. Ever flip through a large merchandise or radio catalog looking for an item, all the time being sure you knew where to locate it, then after much frustration stumble across the elusive item? So have we all. And yet we all know that a 10 second look at the table of contents or index would have led us directly to the desired page.

If a manual is well written, organized, page numbered and paragraph numbered, any desired item can be found in a matter of seconds. Try it—it works.

Another often overlooked item is the list of figures and tables. In addition to the use explained above, they are especially useful for finding tables or illustrations that you have previously used but whose exact location you cannot recall.

Model 5340A  
Table of Contents

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The Table of Contents is the first place to look.

The front matter is the key to where items are located. It can save lots of time when searching for information.

### IN THIS ISSUE

*dB AND dBm  
WITHOUT LOGS*

*log AND In  
WITH HP80*

**TECHNICAL MANUAL  
ORGANIZATION**

YOUR PRIVATE LINE TO HP CUSTOMER SERVICE

## THE GENERAL INFORMATION SECTION

This section gives an overall summary of what the instrument does, what it looks like, dimensions and weight, what it consists of, accessories available, options, instrument identification, specifications, and applications. The section usually contains just what its title implies — “General” information. As such, it is intended for virtually all readers. By reading this first section, one can quickly determine the instrument’s capabilities, limitations, and performance characteristics. It seldom contains specifics such as how to operate, service, or install the unit. The information is intentionally kept brief and concise to allow all readers to quickly gain an overall view of the equipment. Readers wanting more detail on any specific area can then refer to one of the remaining sections in the manual.

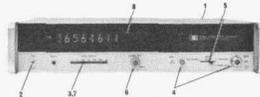
## THE INSTALLATION SECTION

After reading the General section, the reader may logically be interested in installation information to place the equipment in service. This section covers unpacking and inspection and what to do if the instrument was damaged in shipment. Also covered are storage and shipment, rack installation if applicable, power requirements and power connection. The information on power connection is very important for equipment designed to operate from different line voltages. Typically, the correct fuse must be installed and a line selector switch must be properly set. A moment of reading can save time and prevent problems caused by improper power connections.

In some manuals, remote programming is included in the installation section under the premise that this information will be needed during installation if the instrument is used in a remotely controlled configuration.

## THE OPERATION SECTION

As the title indicates, this section is primarily for the operator. Subjects covered include descriptions of controls and indicators, and step-by-step procedures on how to set up and operate the equipment in each of its modes. The descriptions are written from the operator’s viewpoint. For example, you may find “The SAMPLE RATE control varies the interval between measurements from 5 milliseconds to 5 seconds,” instead of, “The SAMPLE RATE control R5 varies the bias on Q6 to fire Schmitt trigger Q8, etc.” Emphasis is placed on how the instrument works from an operating standpoint, not how the instrument functions from within.



1. On Rear Panel set INT-EXT switch to INT position.
2. Set LINE switch to on (up) position.
3. Set RESOLUTION Hz to desired resolution. Recommended starting setting is 1 kHz.

**CAUTION**

DO NOT EXCEED +30 dBm (1 WATT) INPUT AT THE 50 Ω IN CONNECTOR. DAMAGE TO THE INTERNAL SAMPLERS MAY OCCUR. PLEASE READ PARAGRAPH 5-31 FOR DETAILS OF ACCEPTABLE INPUT LEVELS.

4. Connect input signal to appropriate input connector according to input frequency and impedance requirements.
5. Set RANGE switch to correspond with input connector being used.
6. Adjust SAMPLE RATE control for desired interval between measurements.
7. Adjust RESOLUTION Hz switch for desired number of significant digits.
8. Display is as units shown with correct decimal point and significant digits.

*The Operating Section gives detailed procedures for using the instrument.*

Although this section is primarily for the operator, service personnel use it to become familiar with proper control settings. Often, an instrument “malfunction” is the result of improper control settings or cable connections. Here again, careful reading of the operating instructions can save valuable time.

## THE THEORY SECTION

This section describes the internal functions of the equipment. Included are block diagram theory and circuit theory. Also covered are descriptions of components, such as transistors and integrated circuits. The theory is primarily for service personnel, instructors, and others who need to know the

details of how the circuits function. In general, the theory is written at a technician level to provide information for servicing equipment. Usually, no attempt is made to discuss the design methods or alternate designs. Emphasis is placed on how the instrument works, rather than why it was designed as it was. Since the theory is usually organized in a separate section, it can be used when needed and ignored when time does not permit detailed reading.

In addition to helping service personnel understand the equipment’s operation, the theory is especially useful for training or for designers who wish to interface with the equipment’s inputs, outputs, and programming functions.

Schematics in HP manuals are usually printed on a foldout at the end of the manual. This allows reading any section while referring to the schematics.

4-50. When a carry occurs after successful subtraction, DISPLAY and COUNT D pulses are generated. The most significant digit (MSD) is now transferred from the Z-Register to the buffer storage and Display, and the D-Register advanced to D = 1. Each new DISPLAY pulse will produce a COUNT D pulse to advance the D-Register, until all 7 digits have been calculated and displayed. The last digit will be transferred at D = 6.

*Detailed circuit explanation is in the theory section.*

## THE MAINTENANCE SECTION

The maintenance section is the “heart” of HP’s instrument manuals. Major emphasis is placed on troubleshooting, repair, alignment, calibration, and performance checks. The maintenance section

### 5-32. TROUBLESHOOTING PROCEDURE

5-33. The following paragraphs, steps, and charts aid in locating problems. Use this section to isolate trouble to an assembly; then go to that assembly schematic and operation in Section VIII to locate the defective components. The Flow Diagram and Block Diagram should be referred to during the following discussion; these may be folded out from Section VIII.

*The maintenance section contains adjustment and troubleshooting procedures.*

provides information to isolate trouble to a particular pc board or functional area and then to troubleshoot to the stage level or component level. This is accomplished in several ways, including charts, diagrams, trees, or with step-by-step procedures. Usually the trou-

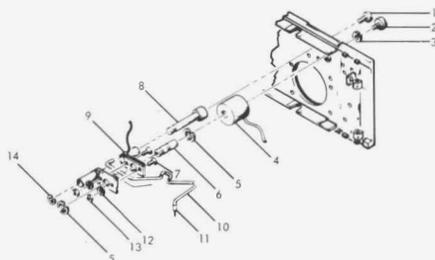
bleshooting method is derived without regard to the format of presentation. Once the best troubleshooting method is determined, then a suitable format is selected or generated to best present this information. Some manuals simply give waveforms, voltages, and service data next to the schematics or overall block diagram.

The in-cabinet performance check allows incoming inspection personnel to verify proper performance.

### THE PARTS LIST

Hewlett-Packard parts lists contain a list of abbreviations, a list of replaceable parts, ordering information, and a list of manufacturers. The list of replaceable parts is in alpha-numeric order by reference designations. Included are HP part numbers, descriptions, federal stock codes of typical manufacturer, and the manufacturers' part numbers.

Although the part values are given on the schematics, the tolerances and ratings are listed on the parts list descriptions. Parts not located on pc boards or assemblies are grouped in a listing entitled "chassis parts" or "miscellaneous parts." For instruments with complex mechanical assemblies, an exploded view with MP (mechanical parts) numbers is usually given.

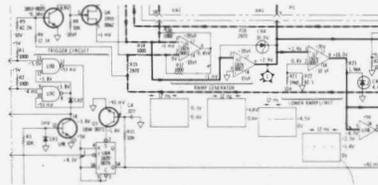


Typical exploded view.

The "quantity" listing gives the total quantity of a particular part used in the instrument. Options are usually listed in a separate title so that these quantities may be added to the quantities in the standard instrument table. This information is usually needed when recommending a selection of spare parts for preventive maintenance and repair.

### SCHEMATIC DIAGRAMS

The schematic diagram sections may be arranged in assembly number order or in signal flow sequence. Component locators are given to aid in locating parts. Frequently, waveforms, troubleshooting methods, signal levels, and voltages are given to aid in isolating trouble to the stage or component level.

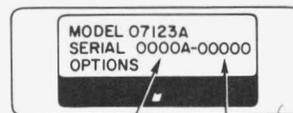


Schematic with waveform and test points identified.

### CHANGE SHEETS

To improve reliability or performance, design changes may be made that require a change in parts or layout. This necessitates manual change sheets to update the manual to reflect the latest instrument configuration.

The way to tell if a particular manual is applicable to your instrument is to compare the serial prefix on the instrument to the serial prefix listed on the title page of the manual. The serial prefix is the four



SERIAL NUMBER PREFIX SERIAL NUMBER

Serial prefix identification.

digit and one letter portion of the serial number. For example, in the serial number 1234A56789, 1234A is the serial prefix and this is used to denote design changes.

When design changes are made, the serial prefix is incremented; thus all instruments with identical configurations will have the same serial prefix. The serial number (56789 in our example) is unique to a specific instrument and is the means of identifying the product.

If the serial prefix of your instrument differs from that listed on the title page of the manual, there are differences between the manual and the instrument. Determining the differences may help reduce repair or calibration time because the procedures in the manual may not now apply exactly as listed.

If the instrument serial prefix is greater than that in the manual, design changes were made after the manual was printed and a Manual Change Sheet that lists the differences should be included with the manual. To obtain missing Change Sheets, contact your local HP office. If the instrument serial

### NETWORK ANALYZER 8410A

SERIALS PREFIXED: 955-

For instruments with prefixes higher than 955, see "Manual Changes" sheet included with this manual. For prefixes below 955, see backdating in Appendix I. This manual does not apply to prefixes below 801.

It is important to verify that the correct manual is being used.

prefix is lower than that of the manual, the manual was printed after the instrument was built and the manual must be altered to make it agree with the instrument. This information is included in the "Backdating" or "Manual Changes" section of the manual. The Manual Change Sheet also includes "errata," errors or information that applies to ALL serial prefixes. Errata means, in effect, "the manual should have read ...".

Typographical errors and improvements or changes in the manual that apply to all serial prefixes are examples of errata.

Manuals and Change Sheets are powerful tools that can be used to advantage by the experienced technician. A little time invested in learning the organization and using the table of contents pays big dividends. We hope you agree.

Rod Dinkins is currently a writing supervisor at the Santa Clara Division of HP. His most recent project was the manual for the 5340A microwave frequency counter. In addition to being an avid photography buff, Rod also enjoys building model cars and airplanes.

## dB AND dBm WITHOUT LOGS

by Dick Gasperini

The last issue contained a discussion of dB and dBm that showed helpful manipulations, but this procedure required the use of logarithms. A great number of situations can be handled without logs by using a simple technique that requires remembering two key numbers.

For 3 dB the key number is 2.

For 10 dB the key number is 10.

A 3 dB change means a power change of 2 to 1. A 3 dB **increase** corresponds to 2 times the original power; a 3 dB **decrease** means 1/2 the original power.

A 10 dB change corresponds to a power change of 10 to 1. A 10 dB **increase** means 10 times the original power; a 10 dB **decrease** corresponds to 1/10 times the reference power.

It is helpful to recall that additions in logs is equivalent to multiplying the power ratios. That is, a 6 dB gain corresponds to a power ratio of 4 to 1, since 6 dB can be broken down into two 3 dB gains, each with a power ratio of 2. Multiplying 2 times 2 yields 4. A 20 dB loss is a power ratio of 1/10 times 1/10 = 1/100 since 20 dB is the equivalent of two individual 10 dB steps. A 30 dB gain corresponds to a power ratio of  $10 \times 10 \times 10 = 1000$ .

### 6 dB = 3 dB + 3 dB

*This method makes logs easy to calculate.*

The 3 dB and 10 dB key numbers can be combined to provide additional capability. For example, 13 dB is the **sum** of 3 dB and 10 dB and can be expressed as a power ratio by **multiplying** the individual power ratios. This is  $2 \times 10$ , or 20. To calculate 16 dB (the sum of 3 dB + 3 dB + 10 dB), multiply the individual power ratios of  $2 \times 2 \times 10$  to obtain 40.

A gain and a loss can be combined easily also. For example, 7 dB is the sum of +10 dB and -3 dB. This corresponds to a power ratio of  $10 \times 1/2 = 5$ , since the power ratio of -3 dB is 1/2. We can also determine 4 dB, which is the sum of +10 dB - 3 dB and -3 dB. The equivalent power ratio is  $10 \times 1/2 \times 1/2 = 2.5$ .

What power ratio is represented by 43 dB? This can be expressed as 10 dB + 10 dB + 10 dB + 10 dB + 3 dB. The equivalent power ratio is:

$$10 \times 10 \times 10 \times 10 \times 2 = 20,000$$

How about 44 dB? This can be expressed as 10 dB + 10 dB + 10 dB + 10 dB + 10 dB - 3 dB - 3 dB. This is a power ratio of:

$$10 \times 10 \times 10 \times 10 \times 10 \times 1/2 \times 1/2 = 25,000$$

Thus excellent range and resolution can be obtained with this method without calculating logarithms. If the exact dB number cannot be reached, we can at least get an approximate power ratio.

For example, 8 dB cannot be reached directly with combinations of 3 dB and 10 dB. But we know 7 dB is a power ratio of 5 and 9 dB is a power ratio of 8. Therefore, 9 dB must be a power ratio between 5 and 8.



This technique can be reversed to convert a power ratio to dB as long as the power ratio can be broken down into a product of 10 and 2. For example, a power ratio of 25 can be broken down to  $10 \times 10 \times 1/2 \times 1/2$ . This **product** corresponds to a **sum** of 10 dB + 10 dB - 3 dB - 3 dB = 14 dB.

Voltage ratios can also be expressed with this method, but it is necessary to double the dB figure for the two key numbers. That is, 6 dB is a voltage ratio of 2 to 1 and 20 dB is a voltage ratio of 10 to 1.

Here is a short quiz to prove how easy this method is:

- Determine the power ratio corresponding to the following dB:
  - 4 dB = \_\_\_\_\_ = \_\_\_\_\_ power ratio.
  - 9 dB = \_\_\_\_\_ = \_\_\_\_\_ power ratio.
  - 31 dB = \_\_\_\_\_ = \_\_\_\_\_ power ratio.
- Determine the dB equivalent of the following power ratios:
  - 20 to 1 power ratio = \_\_\_\_\_ = \_\_\_\_\_ dB.
  - 5 to 1 power ratio = \_\_\_\_\_ = \_\_\_\_\_ dB.
  - 1/4 to 1 power ratio = \_\_\_\_\_ = \_\_\_\_\_ dB.
- What voltage ratio corresponds to the following dB?
  - 4 dB = \_\_\_\_\_ = \_\_\_\_\_ voltage ratio.
  - 12 dB = \_\_\_\_\_ = \_\_\_\_\_ voltage ratio.
  - 28 dB = \_\_\_\_\_ = \_\_\_\_\_ voltage ratio.
- Calculate the dB corresponding to these voltage ratios:
  - .5 to 1 voltage ratio = \_\_\_\_\_ = \_\_\_\_\_ dB.
  - 5 to 1 voltage ratio = \_\_\_\_\_ = \_\_\_\_\_ dB.
- How many watts are equivalent to a signal level of +30 dBm? \_\_\_\_\_.



For example, what voltage ratio corresponds to a gain of 52 dB? This can be expressed as 20 dB + 20 dB + 6 dB + 6 dB, which corresponds to a voltage ratio of  $10 \times 10 \times 2 \times 2 = 400$ .

How many dB correspond to a voltage ratio of 8 to 1? This breaks down to  $2 \times 2 \times 2$ , which is 6 dB + 6 dB + 6 dB = 18 dB.

All of the above apply to dB, which is a relative measurement. This technique also works for measurements stated in dBm, which is an absolute power level, by remembering that the reference for dBm is 1 mw. Multiply the power ratio by 1 mw to obtain the absolute power level. For example, +7 dBm is a power ratio of 5 (obtained by

$10 \times 1/2$ ) multiplied by 1 mw, for an absolute power level of 5 mw. The number of dBm can be determined by reversing the procedure. For example, to determine the dBm equivalent of an absolute power of 2 microwatts, first divide by 1 milliwatt. This yields a power ratio of  $2 \times 10^{-3}$ , which can also be expressed as  $2 \times 1/10 \times 1/10 \times 1/10$ .

The equivalent is +3 dB - 10 dB - 10 dB - 10 dB = -27 dB. This is actually -27 dBm since the initial measurement was in absolute power.

Using this technique, a very wide range of dB and dBm can be covered by remembering only a few key figures.

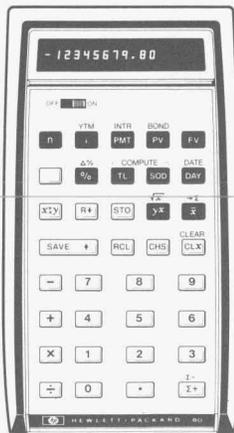


Answers to dB quiz:

1. 4 dB = 10 dB - 3 dB - 3 dB = 10 x 1/2 x 1/2 = 2.5 power ratio.  
9 dB = 3 dB + 3 dB + 3 dB = 2 x 2 x 2 = 8 power ratio.  
31 dB = 10 dB + 10 dB + 10 dB - 3 dB - 3 dB - 3 dB = 10 x 10 x 10 x 1/2 x 1/2 x 1/2 = 1250 power ratio.  
20 to 1 power ratio = 10 x 2 power ratio = 10 dB + 3 dB = 13 dB.  
5 to 1 power ratio = 10 x 1/2 power ratio = 10 dB - 3 dB = 7 dB.  
1/4 to 1 power ratio = 1/2 x 1/2 power ratio = -3 dB - 3 dB = -6 dB.  
4 dB = 20 dB + 20 dB - 6 dB = 10 x 10
3. 4 dB = 20 dB + 20 dB - 6 dB = 10 x 10 x 1/2 x 1/2 x 1/2 x 1/2 x 1/2 x 1/2 = 1/16 voltage ratio.
4. 5 to 1 voltage ratio = 1/2 voltage ratio = -6 dB.  
5 to 1 voltage ratio = 10 x 1/2 = 20 dB - 6 dB = 14 dB.  
30 dBm = 10 dBm + 10 dBm + 10 dBm = 10 x 10 x 10 power ratio.
5. Power = power ratio x 1 mw = 1000 x 1 mw = 1000 mw = 1 watt.

log and ln with HP80

An easy procedure to obtain logarithms with the HP 80 minicalculator.



In the last issue we had a procedure for obtaining logarithms with the HP80 minicalculator. A simpler procedure exists that produces the natural log in addition to the log to the base 10 (usually written log<sub>10</sub>).

Here's the procedure:

9 0 0 i 1 PV

Enter the number FV n

The log<sub>10</sub> now appears on the display. The y register contains the natural logarithm (the log to the base e usually denoted by ln). Push R↓ or xzy to view this number.

For the mathematically minded, here's the reason this procedure works.

The HP80 performs interest and bond calculations using this equation:

$$FV = PV \left(1 + \frac{i}{100}\right)^n$$

Where FV = future value (in \$)  
 PV = present value (in \$)  
 i = interest rate (in %)  
 n = number of payment periods

Substituting 900 for i and 1 for PV, the formula reduces to  $FV = 10^n$ .

When a value for FV is entered and the equation is solved for n, we obtain the log<sub>10</sub> of FV since an equation of this form is the definition of log<sub>10</sub>.

The HP80 uses natural logs (ln) to determine the value of n, however.

$$\ln FV = n \ln 10$$

$$n = \frac{\ln FV}{\ln 10}$$

The value for n appears on the display, but the value for ln FV remains in the y register after the division. Thus the log<sub>10</sub> and ln of FV are both available.

HP 80 procedures have been developed to obtain other common numbers, such as π and e. Space limitations prevent publishing them here, but we would be happy to send you a copy. Please send your request to Bench Briefs Editor at the address on the last page.

## "..call your local HP office..."

That's a phrase frequently seen in HP publications. It appears with shipping instructions, parts ordering information and service literature. That phrase reminds you to call your local HP office if you need help. But to do that you must know where to find your local HP office. As HP continues to grow, many offices find themselves outgrowing their facilities and moving to larger quarters. Occasionally an additional office is added to serve an area. These changes may mean that an HP office is now more conveniently located for you.

Although many HP manuals and other publications contain a complete list of HP offices, the list may not be completely current since it is revised only when the publication is reprinted.

To make sure that you can easily locate your local HP office to obtain the service you have come to expect of Hewlett-Packard, here's an up-to-date listing of field offices for all areas of the world.

An arrowhead ( ▶ ) by the office serving your area indicates that there has been a change in address or telephone number, etc. during the past year. It may be helpful to note the new information and to pass it along to others in your facility also.



### UNITED STATES

#### ALABAMA

P.O. Box 4207  
2003 Byrd Spring Road S.W.  
Huntsville 35802  
Tel: (205) 881-4591  
TWX: 810-726-2204

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▶ 2336 E. Magnolia St.  
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TWX: 910-951-1330

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TWX: 910-373-1280

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TWX: 910-367-2092

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Ft. Lauderdale 33307  
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TWX: 510-955-4099

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TWX: 810-850-0113

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Cherry Hill 08034  
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TWX: 710-892-4945

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Albuquerque 87108  
Tel: (505) 265-3713  
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Las Cruces 88001  
Tel: (505) 526-2485  
TWX: 910-983-0550

#### NEW YORK

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Computer Park  
Albany 12205  
Tel: (518) 458-1550  
TWX: 710-441-8270

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Poughkeepsie 12601  
Tel: (914) 454-7330  
TWX: 510-248-0012

39 Saginaw Drive  
Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

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Tel: (315) 454-2486  
TWX: 710-541-0482

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Woodbury 11797  
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TWX: 510-221-2168

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TWX: 510-926-1516

#### OHIO

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Cleveland 44145  
Tel: (216) 835-0300  
TWX: 810-427-9129

3460 South Dixie Drive  
Dayton 45439  
Tel: (513) 298-0351  
TWX: 810-459-1925

1120 Morse Road  
Columbus 43229  
Tel: (614) 846-1300

#### OKLAHOMA

P.O. Box 32008  
Oklahoma City 73132  
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TWX: 910-830-6862

#### OREGON

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Tualatin 97062  
Tel: (503) 620-3350  
TWX: 910-467-8714

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Tel: (412) 271-0724  
TWX: 710-787-3650

1021 8th Avenue  
King of Prussia Industrial Park  
King of Prussia 19406  
Tel: (215) 265-7000  
TWX: 510-660-2670

#### RHODE ISLAND

873 Waterman Ave.  
East Providence 02914  
Tel: (401) 434-5535  
TWX: 710-381-7573

#### \*TENNESSEE

▶ Memphis  
Tel: (901) 274-7472

#### TEXAS

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201 E. Arapaho Rd.  
Richardson 75080  
Tel: (214) 231-6101  
TWX: 910-867-4723

P.O. Box 27409  
6300 Westpark Drive  
Suite 100  
Houston 77027  
Tel: (713) 781-6000  
TWX: 910-881-2645

231 Billy Mitchell Road  
San Antonio 78226  
Tel: (512) 434-4171  
TWX: 910-871-1170

#### UTAH

2890 South Main Street  
Salt Lake City 84115  
Tel: (801) 487-0715  
TWX: 910-925-5681

#### VIRGINIA

P.O. Box 6514  
2111 Spencer Road  
Richmond 23230  
Tel: (703) 285-3431  
TWX: 710-956-0157

#### WASHINGTON

▶ Bellefield Office Pk.  
1203 - 114th SE  
Bellevue 98004  
Tel: (206) 454-3971  
TWX: 910-443-2303

#### \*WEST VIRGINIA

Charleston  
Tel: (304) 768-1232

#### WISCONSIN

9431 W. Beloit Road  
Suite 117  
Milwaukee 53227  
Tel: (414) 541-0550

#### FOR U.S. AREAS NOT LISTED:

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### CANADA

#### ALBERTA

Hewlett-Packard (Canada) Ltd.  
11748 Kingsway Ave.  
Edmonton  
Tel: (403) 452-3670  
TWX: 610-831-2431

#### BRITISH COLUMBIA

▶ Hewlett-Packard (Canada) Ltd.  
4608 Canada Way  
North Burnaby 2  
Tel: (604) 433-8213  
TWX: 610-922-5059

#### MANITOBA

Hewlett-Packard (Canada) Ltd.  
513 Century St.  
Winnipeg  
Tel: (204) 786-7581  
TWX: 610-671-3531

#### NOVA SCOTIA

▶ Hewlett-Packard (Canada) Ltd.  
2745 Dutch Village Rd.  
Suite 210  
Halifax  
Tel: (902) 455-0511  
TWX: 610-271-4482

#### ONTARIO

Hewlett-Packard (Canada) Ltd.  
1785 Woodward Dr.  
Ottawa 3  
Tel: (613) 255-6180, 255-6530  
TWX: 610-562-8968  
Hewlett-Packard (Canada) Ltd.  
50 Galaxy Blvd.  
Rexdale  
Tel: (416) 677-9611  
TWX: 610-492-4246

#### QUEBEC

Hewlett-Packard (Canada) Ltd.  
275 Hymus Boulevard  
Pointe Claire  
Tel: (514) 697-4232  
TWX: 610-422-3022  
Telex: 01-20607

#### FOR CANADIAN AREAS NOT LISTED:

Contact Hewlett-Packard (Canada) Ltd. in Pointe Claire, at the complete address listed above.

**EUROPE**

**AUSTRIA**  
Hewlett-Packard Ges.m.b.H  
Handelska 52/3  
P.O. Box 7  
A-1205 Vienna  
Tel: (0222) 33 66 06 to 09  
Cable: HEWPAK Vienna  
Telex: 75923 hewpak a

**BELGIUM**  
Hewlett-Packard Benelux  
S.A./N.V.  
Avenue de Col-Vert, 1,  
(Groenkraglaan)  
B-1170 Brussels  
Tel: (02) 72 22 40  
Cable: PALOBN Brussels  
Telex: 23 494 paloben bru

**DENMARK**  
Hewlett-Packard A/S  
Datavej 38  
DK-3460 Birkerød  
Tel: (01) 81 66 40  
Cable: HEWPAK AS  
Telex: 166 40 hp as

Hewlett-Packard A/S  
Torvet 9  
DK-8600 Silkeborg  
Tel: (06) 82-71-66  
Telex: 166 40 hp as  
Cable: HEWPAK AS

**FINLAND**  
Hewlett-Packard Oy  
Bulevardi 26  
P.O. Box 12185  
SF-00120 Helsinki 12  
Tel: (90) 13730  
Cable: HEWPAKCOY Helsinki  
Telex: 12-15363 hel

**FRANCE**  
Hewlett-Packard France  
Quartier de Courtaubouef  
Boite Postale No. 6  
F-91401 Orsay  
Tel: (1) 907 78 25  
Cable: HEWPAK Orsay  
Telex: 60048

Hewlett-Packard France  
4 Quai des Croix  
F-69321 Lyon Cedex 1  
Tel: (78) 42 63 45  
Cable: HEWPAK Lyon  
Telex: 31617

Hewlett-Packard France  
29 rue de la Gare  
F-31700 Blagnac  
Tel: (61) 85 82 29  
Telex: 51957

**GERMAN FEDERAL  
REPUBLIC**  
Hewlett-Packard GmbH  
Vertriebszentrale Frankfurt  
Bernerstrasse 117  
Postfach 560 140  
D-6000 Frankfurt 56  
Tel: (0611) 50 04-1  
Cable: HEWPAKSA Frankfurt  
Telex: 41 32 49 fra

Hewlett-Packard GmbH  
Vertriebsbüro Böblingen  
Herrenbergerstrasse 110  
D-7030 Böblingen, Württemberg  
Tel: (07031) 66 72 87  
Cable: HEPAK Böblingen  
Telex: 72 65 739 bbn

Hewlett-Packard GmbH  
Vertriebsbüro Düsseldorf  
Vogelsanger Weg 38  
D-4000 Düsseldorf  
Tel: (0211) 63 80 31/35  
Telex: 85/86 533 hppd d

Hewlett-Packard GmbH  
Vertriebsbüro Hamburg  
Wendenstr. 23  
D-2000 Hamburg 1  
Tel: (0411) 24 05 51/52  
Cable: HEWPAKSA Hamburg  
Telex: 21 63 032 hpph d

Hewlett-Packard GmbH  
Vertriebsbüro München  
Unterhachinger Strasse 28  
ISAR Center  
D-8012 Ottobrunn  
Tel: (0811) 601 30 61/7  
Telex: 52 49 85  
Cable: HEWPAKSA München

(West Berlin)  
Hewlett-Packard GmbH  
Vertriebsbüro Berlin  
Wilmsdorfer Strasse 113/114  
D-1000 Berlin W. 12  
Tel: (0311) 3137046  
Telex: 18 34 05 hpbm d

**GREECE**  
Kostas Karayannis  
18, Ermou Street  
GR-Athens 126  
Tel: 3230-303, 3230-305  
Cable: RAKAR Athens  
Telex: 21 59 62 rkar gr

**IRELAND**  
Hewlett-Packard Ltd.  
224 Bath Road  
GB-Slough, SL1 4 DS, Bucks  
Tel: (0753) 33341  
Cable: HEWPIE Slough  
Telex: 84413

Hewlett-Packard Ltd.  
The Graftons  
Stamford New Road  
Aldrincham, Cheshire, England  
Tel: (061) 928-8626  
Telex: 668068

**ITALY**  
Hewlett-Packard Italiana S.p.A.  
Via Amerigo Vespucci 2  
I-20124 Milan  
Tel: (2) 6251 (10 lines)  
Cable: HEWPAKIT Milan  
Telex: 32046

Hewlett-Packard Italiana S.p.A.  
Piazza Marconi  
I-00144 Rome - Eur  
Tel: (6) 5912544/5, 5915947  
Cable: HEWPAKIT Rome  
Telex: 61514

Hewlett-Packard Italiana S.p.A.  
Vicolo Pastori, 3  
I-35100 Padova  
Tel: (49) 66 40 62  
Telex: 32046 via Milan

Hewlett-Packard Italiana S.p.A.  
Via Colli, 24  
I-10129 Turin  
Tel: (11) 53 82 64  
Telex: 32046 via Milan

**LUXEMBURG**  
Hewlett-Packard Benelux  
S.A./N.V.  
Avenue de Col-Vert, 1,  
(Groenkraglaan)  
B-1170 Brussels  
Tel: (03/02) 72 22 40  
Cable: PALOBN Brussels  
Telex: 23 494

**NETHERLANDS**  
Hewlett-Packard Benelux/N.V.  
Weerdstein 117  
P.O. Box 7825  
NL-Amsterdam, Z 11  
Tel: 020-42 77 77, 44 29 66  
Cable: PALOBN Amsterdam  
Telex: 13 216 hpa nl

**NORWAY**  
Hewlett-Packard Norge A/S  
Nesveien 13  
Box 149  
N-1344 Haslum  
Tel: (02) 53 83 60  
Telex: 16621 hpnas n

**PORTUGAL**  
Telectra-Empresa Técnica de  
Eléctricos S.a.r.l.  
Rua Rodrigo da Fonseca 103  
P.O. Box 2531  
P-Lisbon 1  
Tel: (19) 68 60 72  
Cable: TELETRA Lisbon  
Telex: 1598

**Yokohama 222**  
Tel: 045-432-1504  
Telex: 382-3204 YHP YOK  
Yokogawa-Hewlett-Packard Ltd.  
Chuo Bldg.  
Rm. 603 3,  
2-Chome  
IZUMI-CHO,  
Mito, 310  
Tel: 0292-25-7470

**KENYA**  
Kenya Kinetics  
P.O. Box 18311  
Nairobi, Kenya  
Tel: 57726  
Cable: PROTON

**KOREA**  
American Trading Company  
I.P.O. Box 1103  
Dae Kyung Bldg., 8th Floor,  
107 Sejong-Ro,  
Chongro-Ku, Seoul  
Tel: (4 lines) 73-8924  
Cable: AMTRACO Seoul

**LEBANON**  
Constantin E. Macridis  
P.O. Box 7213  
RL-Beirut  
Tel: 220846  
Cable: ELECTRONUCLEAR Beirut

**MALAYSIA**  
MECOMB Malaysia Ltd.  
2 Lorong 13/6A  
Section 13  
Petaling Jaya, Selangor  
Cable: MECOMB Kuala Lumpur

**MOZAMBIQUE**  
A.N. Goncalves, Lta.  
162, Av. D. Luis  
P.O. Box 107  
Lourenco Marques  
Tel: 27091, 27114  
Telex: 6-203 Negon Mo  
Cable: ZEGAN

**NEW ZEALAND**  
Hewlett-Packard (N.Z.) Ltd.  
94-96 Dixon Street  
P.O. Box 943  
Courtenay Place,  
Wellington  
Tel: 59-559  
Telex: 3898  
Cable: HEWPAK Wellington

**CAPE TOWN**  
Tel: 2-6941/2/3  
Cable: HEWPAK Cape Town  
Telex: 0006 CT

Hewlett-Packard South Africa  
(Pty.), Ltd.  
P.O. Box 31716  
Braamfontein Transvaal  
Milnerfontein  
30 De Beer Street  
Johannesburg  
Tel: 725-2080, 725-2030  
Telex: 0226 JH  
Cable: HEWPAK Johannesburg

Hewlett-Packard South Africa  
(Pty.), Ltd.  
Breecastle House  
Bree Street  
Cape Town  
Tel: 2-6941/2/3  
Cable: HEWPAK Cape Town  
Telex: 0006 CT

Hewlett-Packard South Africa  
(Pty.), Ltd.  
641 Ridge Road, Durban  
P.O. Box 99  
Overport, Natal  
Tel: 88-6102  
Telex: 567954  
Cable: HEWPAK

**NIGERIA**  
TEIL (Mascan Division)  
25 Moronu Street, Suru-Lere,  
P.O. Box 5707  
Lagos  
Tel: 34545  
Cable: THEITEIL Lagos

**SPAIN**  
Hewlett-Packard Española, S.A.  
Jerez No 8  
E-Madrid 16  
Tel: 458 25 00  
Telex: 23515 hpe

Hewlett-Packard Española, S.A.  
Milanesado 21-23  
E-Barcelona 17  
Tel: (3) 203 62 00  
Telex: 52603 hpbe e

**SWEDEN**  
Hewlett-Packard Sverige AB  
Enighetsvägen 1-3  
Fack  
S-161 20 Bromma 20  
Tel: (08) 98 12 50  
Cable: MEASUREMENTS  
Stockholm  
Telex: 10721

Hewlett-Packard Sverige AB  
Hagakersgatan 9C  
S-431 41 Mölndal  
Tel: (031) 27 68 00/01  
Telex: 21 312 hpmid s

**SWITZERLAND**  
Hewlett-Packard (Schweiz) AG  
Zürcherstrasse 20  
P.O. Box 64  
CH-8952 Schlieren Zurich  
Tel: (01) 98 18 21/24  
Cable: HPAG CH  
Telex: 53933 hpag ch

Hewlett-Packard (Schweiz) AG  
9, Chemin Louis-Pictet  
CH-1214 Vernier - Geneva  
Tel: (022) 41 4950  
Cable: HEWPAKSA Geneva  
Telex: 27 333 hpsa ch

**TURKEY**  
Telekom Engineering Bureau  
Saglik Sok No. 15/1  
Ayaspassa-Beyoglu  
P.O. Box 437 Beyoglu  
TR-Istanbul  
Tel: 49 40 40  
Cable: TELEMATION Istanbul

**UNITED KINGDOM**  
Hewlett-Packard Ltd.  
224 Bath Road  
GB-Slough, SL1 4 DS, Bucks  
Tel: Slough (0753) 33341  
Cable: HEWPIE Slough  
Telex: 84413

Hewlett-Packard Ltd.  
"The Graftons"  
Stamford New Road  
GB-Aldrincham, Cheshire  
Tel: (061) 928-8626  
Telex: 668068

Hewlett-Packard Ltd's registered  
address for V.A.T. purposes  
only:  
70, Finsbury Pavement  
London, EC2A15X  
Registered No: 69057

**SOCIALIST COUNTRIES  
PLEASE CONTACT:**  
Hewlett-Packard Ges.m.b.H.  
Handelskai 52/3  
P.O. Box 7  
A-1205 Vienna  
Ph: (0222) 33 66 06 to 09  
Cable: HEWPAK Vienna  
Telex: 75923 hewpak a

**ALL OTHER EUROPEAN  
COUNTRIES CONTACT:**  
Hewlett-Packard S.A.  
Rue du Bois-du-Lan 7  
P.O. Box 85  
CH-1217 Meyrin 2 Geneva  
Switzerland  
Tel: (022) 41 54 00  
Cable: HEWPAKSA Geneva  
Telex: 2 24 86

**AFRICA, ASIA, AUSTRALIA**

**ANGOLA**  
Telectra-Empresa Tecnica  
de Equipamentos Electricos  
SARL  
Rua de Barbosa, Rodrigues,  
42-1 D1  
P.O. Box 6487  
Luanda  
Cable: TELETRA Luanda

**AUSTRALIA**  
Hewlett-Packard Australia  
Pty. Ltd.  
22-26 Weir Street  
Glen Iris, 3146  
Victoria  
Tel: 20-1371 (6 lines)  
Cable: HEWPAK Melbourne  
Telex: 31 024

Hewlett-Packard Australia  
Pty. Ltd.  
31 Bridge Street  
Pymble,  
New South Wales, 2073  
Tel: 449 6566  
Telex: 21561  
Cable: HEWPAK Sydney

Hewlett-Packard Australia  
Pty. Ltd.  
97 Churchill Road  
Prospect 5082  
South Australia  
Tel: 65-2366  
Cable: HEWPAK Adelaide

Hewlett-Packard Australia  
Pty. Ltd.  
1st Floor, Suite 12/13  
Casablanca Buildings  
196 Adelaide Terrace  
Perth, W.A. 6000  
Tel: 25-6800  
Cable: HEWPAK Perth

Hewlett-Packard Australia  
Pty. Ltd.  
10 Woolley Street  
P.O. Box 191  
Dickson A.C.T. 2602  
Tel: 49-8134  
Cable: HEWPAK Canberra ACT

Hewlett-Packard Australia  
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2nd Floor, 49 Gregory Terrace  
Brisbane, Queensland, 4000  
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P.O. Box 681  
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Colombo 2  
Tel: 26696  
Cable: HOTPOINT Colombo

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P.O. Box 1152  
CY-Nicosia  
Tel: 4528/29  
Cable: KYPRONICS PANDEHIS

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P. O. Box 718  
58/59 Cunningham St.  
Addis Ababa  
Tel: 12285  
Cable: ASACO Addisababa

**HONG KONG**  
Schmidt & Co. (Hong Kong) Ltd.  
P.O. Box 297  
1511, Prince's Building  
15th Floor  
10, Chater Road  
Hong Kong  
Tel: 240168, 232735  
Telex: HKX765 SCHMCO  
Cable: SCHMIDTCO Hong Kong

**INDIA**  
Blue Star Ltd.  
Kasturi Buildings  
Jamshejji Tata Rd.  
Bombay 400 020  
Tel: 29 50 21  
Telex: 3751  
Cable: BLUEFROST

Blue Star Ltd.  
Sahas  
414/2 Vir Savarkar Marg  
Prabhadevi  
Bombay 400 025  
Tel: 45 73 01  
Telex: 3751  
Cable: BLUESTAR

Blue Star Ltd.  
14/40 Civil Lines  
Kampur 208 001  
Tel: 6 88 82  
Cable: BLUESTAR

Blue Star, Ltd.  
7 Hare Street  
P.O. Box 506  
Calcutta 700 001  
Tel: 23-0131  
Telex: 655  
Cable: BLUESTAR

Blue Star Ltd.  
Blue Star House,  
34 Ring Road  
Lajpat Nagar  
New Delhi 110 024  
Tel: 62 32 76  
Telex: 463  
Cable: BLUESTAR

Blue Star, Ltd.  
Blue Star House  
11/11A Magarath Road  
Bangalore 560 025  
Tel: 51473  
Telex: 430  
Cable: BLUESTAR

Blue Star, Ltd.  
1-1-117-1  
Sarojini Devi Road  
Secunderabad 500 003  
Tel: 7 63 91, 7 73 93  
Cable: BLUEFROST  
Telex: 459

Blue Star, Ltd.  
23/24 Second Line Beach  
Madras 600 001  
Tel: 2 39 55  
Telex: 379  
Cable: BLUESTAR

Blue Star, Ltd.  
1B Kaiser Bungalow  
Dindri Road  
Jammedpur 831 001  
Tel: 38 04  
Cable: BLUESTAR  
Telex: 240

**INDONESIA**  
Bah Bolton Trading Coy. N.V.  
Djajah Merdeka 29  
Bandung  
Tel: 4915; 51560  
Cable: ILMU  
Telex: 08-809

**IRAN**  
Multicorp International Ltd.  
Avenue Soraya 130  
P.O. Box 1212  
IR-Teheran  
Tel: 83 10 35-39  
Cable: MULTICORP Tehran  
Telex: 2893 MCI TN

**ISRAEL**  
Electronics & Engineering  
Div. of Motorola Israel Ltd.  
17 Aminadav Street  
Tel-Aviv  
Tel: 36941 (3 lines)  
Cable: BASTEL Tel-Aviv  
Telex: 33569

**JAPAN**  
Yokogawa-Hewlett-Packard Ltd.  
Ohashi Building  
1-59-1 Yoyoji  
Shibuya-ku, Tokyo  
Tel: 03-370-2281/92  
Telex: 232-2024YHP  
Cable: YHPMARKET TOK 23-724

Yokogawa-Hewlett-Packard Ltd.  
Nisei Ibaragi Bldg.  
2-2-8 Kasuga  
Ibaragi-Shi  
Osaka  
Tel: (0726) 23-1641  
Telex: 5332-385 YHP OSAKA

Yokogawa-Hewlett-Packard Ltd.  
Nakamo Building  
No. 24 Kamisazajima-cho  
Nakamura-ku, Nagoya City  
Tel: (052) 571-5171

Yokogawa-Hewlett-Packard Ltd.  
Nitto Bldg.  
2-4-2 Shinohara-Kita  
Kohoku-ku

**Yokohama 222**  
Tel: 045-432-1504  
Telex: 382-3204 YHP YOK  
Yokogawa-Hewlett-Packard Ltd.  
Chuo Bldg.  
Rm. 603 3,  
2-Chome  
IZUMI-CHO,  
Mito, 310  
Tel: 0292-25-7470

**KENYA**  
Kenya Kinetics  
P.O. Box 18311  
Nairobi, Kenya  
Tel: 57726  
Cable: PROTON

**KOREA**  
American Trading Company  
I.P.O. Box 1103  
Dae Kyung Bldg., 8th Floor,  
107 Sejong-Ro,  
Chongro-Ku, Seoul  
Tel: (4 lines) 73-8924  
Cable: AMTRACO Seoul

**LEBANON**  
Constantin E. Macridis  
P.O. Box 7213  
RL-Beirut  
Tel: 220846  
Cable: ELECTRONUCLEAR Beirut

**MALAYSIA**  
MECOMB Malaysia Ltd.  
2 Lorong 13/6A  
Section 13  
Petaling Jaya, Selangor  
Cable: MECOMB Kuala Lumpur

**MOZAMBIQUE**  
A.N. Goncalves, Lta.  
162, Av. D. Luis  
P.O. Box 107  
Lourenco Marques  
Tel: 27091, 27114  
Telex: 6-203 Negon Mo  
Cable: ZEGAN

**NEW ZEALAND**  
Hewlett-Packard (N.Z.) Ltd.  
94-96 Dixon Street  
P.O. Box 943  
Courtenay Place,  
Wellington  
Tel: 59-559  
Telex: 3898  
Cable: HEWPAK Wellington

**CAPE TOWN**  
Tel: 2-6941/2/3  
Cable: HEWPAK Cape Town  
Telex: 0006 CT

Hewlett-Packard South Africa  
(Pty.), Ltd.  
P.O. Box 31716  
Braamfontein Transvaal  
Milnerfontein  
30 De Beer Street  
Johannesburg  
Tel: 725-2080, 725-2030  
Telex: 0226 JH  
Cable: HEWPAK Johannesburg

Hewlett-Packard South Africa  
(Pty.), Ltd.  
641 Ridge Road, Durban  
P.O. Box 99  
Overport, Natal  
Tel: 88-6102  
Telex: 567954  
Cable: HEWPAK

**PAKISTAN**  
Mushko & Company, Ltd.  
Osman Chambers  
Abdullah Haroon Road  
Karachi 3  
Tel: 511027, 512927  
Cable: COOPERATOR Karachi

Mushko & Company, Ltd.  
385, Satellite Town  
Rawalpindi  
Tel: 41924  
Cable: FEMUS Rawalpindi

**PHILIPPINES**  
Electromex, Inc.  
6th Floor, Amalgamated  
Development Corp. Bldg.  
Ayala Avenue, Makati, Rizal  
C.C.P.O. Box 1028  
Makati, Rizal  
Tel: 86-18-87, 87-76-77,  
87-86-88, 87-18-45, 88-91-71,  
83-81-12, 83-82-12  
Cable: ELEMEX Manila

**SINGAPORE**  
Mechanical and Combustion  
Engineering Company Ltd.  
9, Jalan Kilang  
Red Hill Industrial Estate  
Singapore, 3  
Tel: 647151 (7 lines)  
Cable: MECOMB Singapore

Hewlett-Packard Far East  
Area Office  
P.O. Box 87  
Alexandra Post Office  
Singapore 3  
Tel: 633022  
Cable: HEWPAK SINGAPORE

**SOUTH AFRICA**  
Hewlett-Packard South Africa  
(Pty.), Ltd.  
P.O. Box 31716  
Braamfontein Transvaal  
Milnerfontein  
30 De Beer Street  
Johannesburg  
Tel: 725-2080, 725-2030  
Telex: 0226 JH  
Cable: HEWPAK Johannesburg

Hewlett-Packard South Africa  
(Pty.), Ltd.  
Breecastle House  
Bree Street  
Cape Town  
Tel: 2-6941/2/3  
Cable: HEWPAK Cape Town  
Telex: 0006 CT

Hewlett-Packard South Africa  
(Pty.), Ltd.  
641 Ridge Road, Durban  
P.O. Box 99  
Overport, Natal  
Tel: 88-6102  
Telex: 567954  
Cable: HEWPAK

**TAIWAN**  
Hewlett-Packard Taiwan  
39 Chung Shiau West Road  
Sec. 1  
Overseas Insurance  
Corp. Bldg. 7th Floor  
Taipei  
Tel: 389160, 1,2, 375121,  
Ext. 240-249  
Telex: TP824 HEWPAK  
Cable: HEWPAK Taipei

**THAILAND**  
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Cable: UNIMESA Bangkok

**THAILAND**  
UNIMESA Co., Ltd.  
Chongkoinsee Building  
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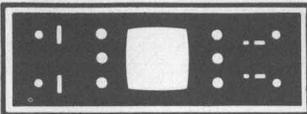
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Export Trade Company  
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Bogotá, 1 D.E.
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Managua
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PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 230833
Telex: 3481003, Curundu,
Canal Zone
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Tel: 4-5069, 4-6272
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Ave. Enrique Canaval 312
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PUERTO RICO
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P.O. Box 5167
Ponce de Leon 154
Pda. 3-PTA de Tierra
San Juan 00906
Tel: (809) 725-3342, 722-3342
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URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
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Hewlett-Packard de Venezuela
C.A.
Apartado 50933
Edificio Segre
Tercera Transversal
Los Ruices Norte
Caracas 107
Tel: 35-00-11
Telex: 21146 HEWPACK
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED,
CONTACT:
Hewlett-Packard
Inter-Americas
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 493-1501
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
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STAFF FOR THIS ISSUE: EDITOR: Dick Gasperini, HP Palo Alto, California
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