

# Total Solution APL

New APL software and CRT terminal for  
HP 3000 Series II Computers

HEWLETT  PACKARD





# Hewlett-Packard's APL\3000

All the power of APL on a low cost computer

For a broad spectrum of business, education, and engineering applications involving data manipulation, the APL language provides an easy, convenient solution to data processing problems. Because of its ability to express complex calculations in a concise manner—perhaps better than any other language—APL has attracted an enthusiastic and growing following. An outstanding characteristic of the language is the facility with which the programmer can put numerous computer operations into a few lines of code. As a result of this power, difficult programs can be written in much less time than with other high level languages.

Realizing the potential of the language for knowledgeable users as well as the uninitiated, and capitalizing upon the inherent capabilities of the HP 3000 Series II Computers, Hewlett-Packard has developed a combination of software and hardware to provide a total solution for your APL applications.

Hewlett-Packard's new APL\3000 software for the first time puts big APL capability on a small, low-cost, general purpose computer. APL\3000 is a new-technology APL employing firmware assisted virtual workspaces and dynamic incremental compiler techniques.

Complementing the software is the new HP 2641A interactive CRT terminal designed especially for the language. It features both APL and ASCII character sets, and two optional tape cartridges for local mass data storage.

In the past, the full use of APL has required access to a large-scale computer, either in-house or on a timeshare basis. Alternatively, a small desktop system has offered limited APL capabilities. In such an environment many potential APL users have been unable to take advantage of the language's possibilities.

## Revolutionary

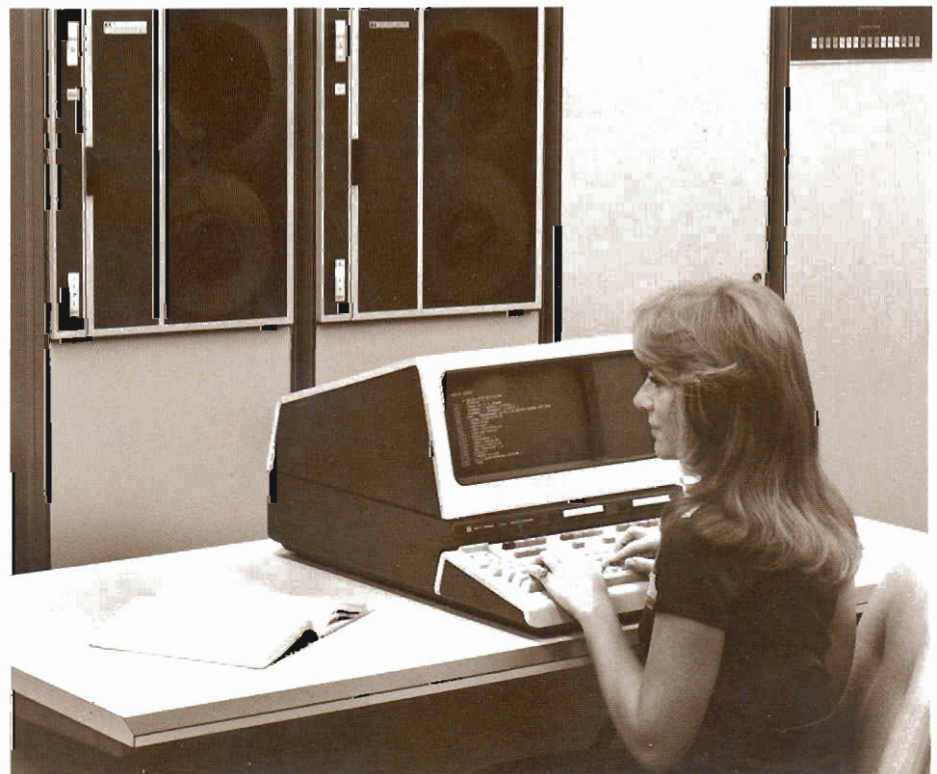
The idea of a powerful APL operating on a small computer will, we believe, revolutionize the availability of the language. Insurance actuaries, computer science educators, finance managers, engineers, research scientists, marketing researchers—in fact anyone who needs to express complex calculations in a concise manner—can now draw upon the power of APL to solve their problems.

## But there's more

But APL\3000 is only a part of the story. Since it is a subsystem of the HP 3000 Series II, the full resources of the computer are available to non-APL users as well. In addition to APL\3000, there's a choice of five other programming languages. And they can be accessed concurrently with APL in batch or interactive mode by multiple users. All this activity is made possible by the efficiency of the HP 3000 Series II's sophisticated Multiprogramming Executive Operating System.

## APL\3000's significance

Not only does APL\3000 make APL available to a wider audience, it also represents a significant price breakthrough for a fully implemented APL system. APL\3000 offers the user important features, flexibility, and power often not afforded by even the very largest systems. And it does so on a small, general purpose computer.



# APL\3000 Features

Expanded capabilities for more performance

APL\3000 is patterned after APLSV, IBM's implementation of the language for 370 computers, and employs the same standard notations. APL\3000 is an efficient interactive language, yet can also be accessed in batch mode when this is appropriate for your application.

In order to create a more complete APL package, Hewlett-Packard has not only included the capabilities available with other versions, but has added several outstanding features which significantly expand its power and make it easy to use.

**Large Workspaces:** APL\3000 is written so as to practically eliminate any limitation on the size of the workspace. The user is restricted only by the amount of available on-line storage. Such large virtual workspaces are feasible because of special firmware assisted (micro-code) support for handling virtual memory. This type of workspace not only exceeds that available on any other APL, but also drastically reduces the requirement for a file system.

**File System:** The very large workspace feature of APL\3000 eliminates the need to use files as extensions of workspaces, however, APL\3000 still provides the full power of the HP 3000 Series II file system through the shared variable facility. This permits the use of files for such activities as data base management and the exchange of information with other users and processors.

**Dynamic Compiler:** On HP 3000 Series II Systems, APL is implemented as a dynamic incremental compiler operating as a standard software subsystem under the computer's MPE Operating System. Rather than interpreting APL expressions, as most systems do, APL\3000 compiles them quickly, statement-by-statement, binding on certain criteria such as the rank of arrays and internal data representation. Subsequent executions will thus run faster. This compiled code is used until the criteria change, at which time a new compilation is performed, often making the new code more flexible and less subject to binding change. Since large, frequently-used programs will thus execute very efficiently, this dynamic compiling method makes APL\3000 exceptionally advantageous for production programs.

```

      BASIC
10 DIM X(100)
20 S=0
30 READ N
40 FOR I=1 TO N
50 READ X(I)
60 S=S+X(I)
70 NEXT I
80 PRINT S/N
90 DATA 8,5,7,11,26,15,27,9,12
100 END

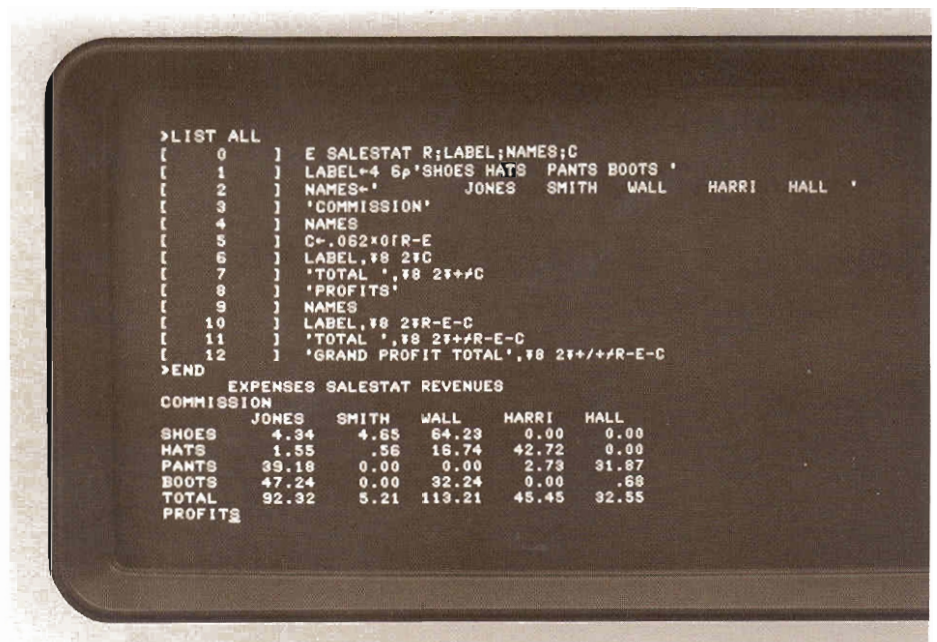
RUN

      14
DONE

      APL

      X←5 7 1 26 15 37 9 12
      (+/X)÷P←X

      14
    
```



These two programs indicate the power of APL. Note that BASIC requires five times as many lines to calculate an average as APL\3000.

The Hewlett-Packard 2641A Terminal features crisp standard and overstrike APL characters, as well as ASCII alpha- numerics.



**APLGOL:** One aspect of APL which in the past may have inhibited general realization of its full power is its reputation for being hard to read and hence maintain. To overcome this, APLGOL, an extension of APL\3000, is included.

APLGOL combines the advantages of structured programming with the power of APL, and makes the code easier to read. The user has the option of defining functions in either APL or APLGOL.

In APLGOL, key words that describe the flow of a given procedure are incorporated with the standard APL expressions, while APL-only programs provide a branch function to control the flow through the algorithm. APLGOL makes the program simple to read and, therefore, to support and modify using such statements as HALT, FOREVER DO, IF DO, IF THEN ELSE, WHILE DO, and REPEAT UNTIL.

**Friendly, Powerful Editor:** To make all the capabilities of the APL\3000 editor easy to take advantage of, it is modeled on the standard HP 3000 Series II editor. For commands, APL\3000 uses ordinary words or abbreviations such as: ADD, CHANGE, COPY, DELETE, END, FIND, HELP, LIST, MATRIX, MODIFY, and REPLACE.

One of the more useful editor commands is UNDO, which is used literally to undo any previous editing. This facility is valuable when mistakes are made during editing which would require considerable work to reconstruct.

In addition to function editing, APL provides the power of a full text editor so that text can be entered, edited, and converted to a matrix or vector of characters for later use. An editing capability is also available in calculator mode to save retyping an entire complicated line when only simple typing errors need correction.

**Standard Program Extensions:** APL\3000 contains the extensions to IBM APL\360 which typically are part of most recent implementations of the language. These include: format (  $\uparrow$  ), execute (  $\downarrow$  ), scan (  $\backslash$  ), and matrix (  $\boxtimes$  ); continue workspace; ten system variables; shared variables; and system functions such as canonical representation (  $\square CR$  ), name list (  $\square NI$  ), and ten debugging functions.

**Extended Control Functions:** A set of extended control system functions is provided in APL\3000 for organizing user-defined functions in a flexible manner. Standard APL implementations limit the user to a linear stack, while APL\3000 with its extended control functions offers capabilities such as co-routineing and backtracking. Such capabilities are particularly useful for debugging and for applications which require returning to previous environments.

#### APL Factorial Program

```
[ 0 ] Z←FACT N
[ 1 ] →('N<1')∨L
[ 2 ] Z←1
[ 3 ] →0
[ 4 ] L:Z←N×FACT N-1
```

```
FACT 6
720
FACT 5
120
FACT 12
479001600
```

#### APLGOL Factorial Program

```
[ 0 ] PROCEDURE Z←FAC N;
[ 1 ] IF N<1 THEN
[ 2 ] Z←1
[ 3 ] ELSE
[ 4 ] Z←N × FAC N-1;
[ 5 ] END PROCEDURE
```

```
FAC 5
120
FAC 6
720
FAC 12
479001600
```

#### APL\3000 Editor

```
* >EDIT
* [ 0 ] R←A HYP B;TEMP
* [ 1 ] TEMP←+(A,B)×A2
* [ 2 ] R←TEMP×.5
[ 3 ]
* >MODIFY 1
[ 1 ]
TEMP←+(A,B)×A2
R←
TEMP←+/(A,B)×A2
* >END
3 HYP 4
THE HYPOTENUSE IS
5
* >ADD 1,1
[ 1,1 ] 'THE HYPOTENUSE IS'
[ 1,2 ]
* >END
3 HYP 4
THE HYPOTENUSE IS
3 4
)EDIT HYP
* OLD FUNCTION
)LIST ALL
[ 0 ] R←A HYP B;TEMP
[ 1 ] TEMP←+(A,B)×A2
[ 2 ] 'THE HYPOTENUSE IS'
[ 3 ] R←TEMP×.5
```

\*line typed by user

```
* >MODIFY 1
[ 1 ]
TEMP←+(A,B)×A2
I←
TEMP←+/(A,B)×A2
```

```
* >END
3 HYP 4
THE HYPOTENUSE IS
5
```

#### Calculator Mode

```
A←3
B←4
((A×A+B×B)×.5
19583
(Enter edit mode)
((A×A+B×A2)×.5
I(
((A×A+B×A2)×.5
I)
((A×A)+B×A2)×.5
```

5

*With the APL\3000 editor, entering and modifying data to calculate the hypotenuse of a right triangle is an efficient process. In calculator mode, the user easily retrieves and edits a line to correct an error.*

# APL\3000 Performance Data

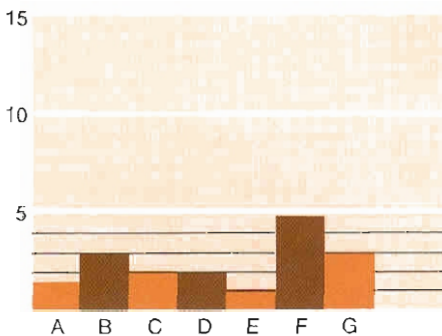
Fast response even with multiple users

In any installation the performance of APL\3000 depends on several factors including:

- Number of simultaneous users
- Size of machine memory
- Amount of work requested by each user
- Number of language subsystems used

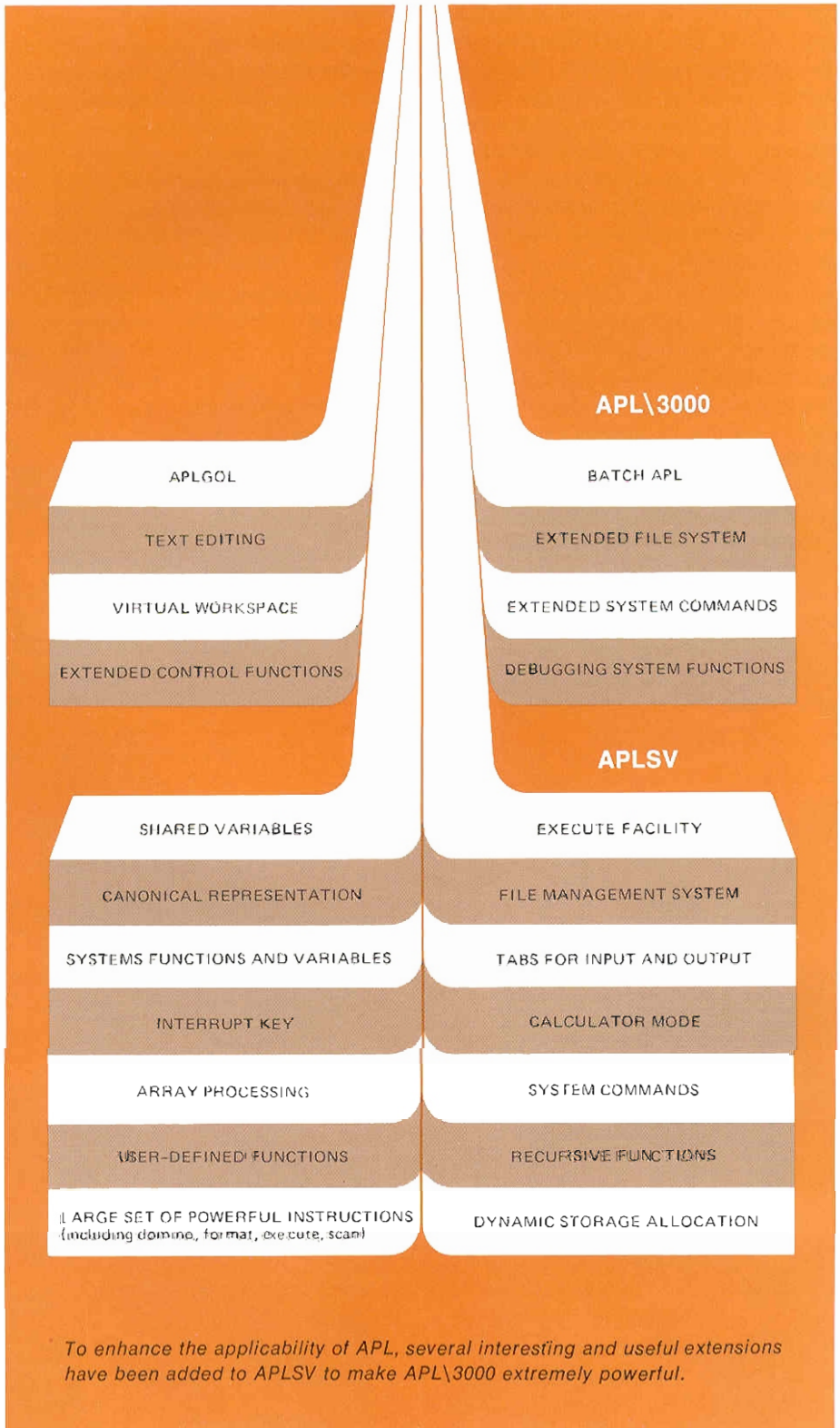
As an indication of the type of performance to be expected with APL\3000, the response-time chart below was compiled for a heavy working environment. With an HP 3000 Series II System containing a 512k byte memory, a mix of twelve users performed various tasks. These included one compute bound function with large arrays which caused swapping, two compute bound functions, three interactive programs, three editor users, and three in calculator mode.

The chart represents only one typical installation. Your particular performance needs should be discussed with a Hewlett-Packard representative



Response times for the various activities of one user are illustrated in this chart. The other eleven users were accessing APL concurrently.

- A = Begin execution of function (1.6 sec).
- B = Accept input (3 sec).
- C = Assignment (2 sec).
- D = Edit mode calculation (2 sec).
- E = Editing (1 sec).
- F = Log-on to system (5 sec).
- G = Obtain editor (3 sec).



To enhance the applicability of APL, several interesting and useful extensions have been added to APLSV to make APL\3000 extremely powerful.



# HP 2641A APL Display Station

Handles both APL and ASCII data

An integral part of the Hewlett-Packard APL\3000 is the new HP 2641A terminal designed especially for APL. The terminal features a full 128-character APL set plus a 64-character overstrike set. Adding to the terminal's versatility is the fact that it is also equipped with a standard 64-character uppercase Roman set (expandable to 128) for ASCII operation.

The microprocessor-controlled terminal contains 4k bytes of RAM semiconductor memory which can be enlarged optionally to 12k bytes. Two fully integrated cartridge tape transports, another option, provide up to 220k bytes of mass storage, which means that the 2641A can save whole APL workspaces, prepare data off line, and batch input information. Off line editing capabilities for correcting data before transmission to the CPU include automatic data logging (with tape option), numeric/alpha field checking, movable margins, character wraparound, and transmit-only fields.

**High Resolution Display:** Since the terminal has a high resolution CRT display, the readability and clarity of the standard as well as the overstrike APL characters are exceptional. The 2641A verifies overstrikes by actually displaying the complete overstruck characters, which are well-defined and easy to read. Thus, there is no need for alternate video scans or manual switching.

The terminal's 5 x 10 inch display has a 24-line by 80-column format. Standard display enhancements include inverse video (black on white), blinking, half bright, and underlining in all 16 combinations.

In the ASCII mode the terminal is fully Teletype compatible. Its bit-pairing type keyboard is clearly marked with both the ASCII and APL characters.

As an option the terminal also supports one additional character set, which may be the line-drawing, the large-character, or the mathematical symbol set.

**Asynchronous Operation:** With the HP 3000 Series II, the HP 2641A is RS232C-compatible and transmits asynchronous ASCII data point-to-point at 110 to 2400 baud. The terminal may be hardwired to the Series II and operate at speeds as high as 2400 baud. Using modems such as the Bell 202, connection to the computer may be made over dial-up or leased telephone networks at speeds to 1800 baud.

**Special Function Keys:** Eight special function keys are also available to be programmed as the user desires. These can be programmed to issue a string of as many as 80 characters, or to trigger any of several control sequences stored in the terminal. For instance, a complete log-on sequence to the computer could be executed with a single keystroke.

**Immediate Verification of Proper Operation:** Like other terminals of the HP 2640 series, the 2641A has a self-test feature which checks the random access memory, verifies the firmware operation, and displays the resident character sets on the screen.



HP 2641A interactive APL terminal.



The terminal keyboard is marked with both APL and ASCII characters.

# HP 3000 Series II Computers

The only low cost, general purpose systems that accommodate large APL applications

The most important contribution of APL\3000 is the fact that it offers complete APL capabilities on a small general purpose computer. Of course this would not be possible except for the unique design of the HP 3000 Series II Systems.

Hewlett-Packard 3000 Series II Systems represent a computer advance in data processing price/performance. With exceptional processing capabilities, large memory capacity, concurrent batch and terminal processing, and convenient operation, Series II Systems present a fresh approach to handling data for many users.

Several aspects of the Series II Systems made it possible to implement APL\3000.

**Stack-oriented Architecture:** Many powerful operating system features are realized through the computer's use of true hardware stacks, or linear data storage areas. The significance of this for APL users is that it makes recursion and re-entry of code automatic.

**Microprogrammed Operation:** A 32-bit bipolar ROM-based microprocessor is the heart of the computer. It contains 209 unique firmware instructions to control the CPU and I/O functions. Numerous system operations, normally accomplished through software, are executed in Series II computers with microinstructions in the microprocessor. This provision is extremely important for APL\3000. Eleven special APL microcode instructions were included for the compiler to improve performance and provide virtual workspaces.

**Multiprogramming Executive:** The HP 3000 Series II has a true Multiprogramming Operating system which makes it possible to execute more than one job or program at a time and thus process more work in a given period. This MPE is one of the major reasons the HP 3000 outperforms competitive computers of comparable size and cost. To the individual user, MPE means that he can access the machine interactively or in batch mode in any of the available languages simultaneously with

other users. Series II Systems operate in six languages—APL plus BASIC, FORTRAN, COBOL, RPG, and SPL, our own high level system programming language which, incidentally, was used in developing APL\3000.

In designing the HP 3000 Series II Systems, a building-block technique was used to make them adaptable to a broad range of applications. Optional equipment may be added to any of the standard model configurations to customize a system to your specific requirements.

A typical system for APL applications would include an HP 3000 Series II with a 320k byte fault control memory (expandable to 512k), two 47 megabyte discs, 1600 bpi magnetic tape unit, system console, and a 16-port asynchronous terminal controller. Such a configuration has the processing power to satisfy the general computer demands, including APL tasks, of many organizations.

Your local Hewlett-Packard representative can assist you in determining the configuration required for your applications.





**To obtain additional information  
on APL\3000 or HP 3000  
Series II Computer Systems,  
contact your local Hewlett-  
Packard representative, or write**

Hewlett-Packard  
General Systems Division  
Marketing Dept.  
5303 Stevens Creek Blvd.  
Santa Clara, CA 95050  
Telephone (408) 249-7020

In Europe: Hewlett-Packard S.A.  
7, rue du Bois-du-Lan,  
P.O. Box CH-1217 Meyrin 2  
Geneva, Switzerland  
Tel: (022) 41 54 00

In Japan: Yokogawa-Hewlett-Packard  
59-1, Yoyogi 1-chome  
Shibuya-ku, Tokyo, 151  
Tel: 03-370-2281

In Canada: Hewlett-Packard Ltd.  
6877 Goreway Drive  
Mississauga, Ontario L4V 1L9  
Tel: (416) 678-9430

Other International Locations:  
Hewlett-Packard  
3200 Hillview Avenue  
Palo Alto, Calif. U.S.A. 94304  
Tel: (415) 493-1501



Sales and service from 172 offices in 65 countries.

1501 Page Mill Road, Palo Alto, California 94304

Printed in U.S.A. 9/76 5952-5596(47) D