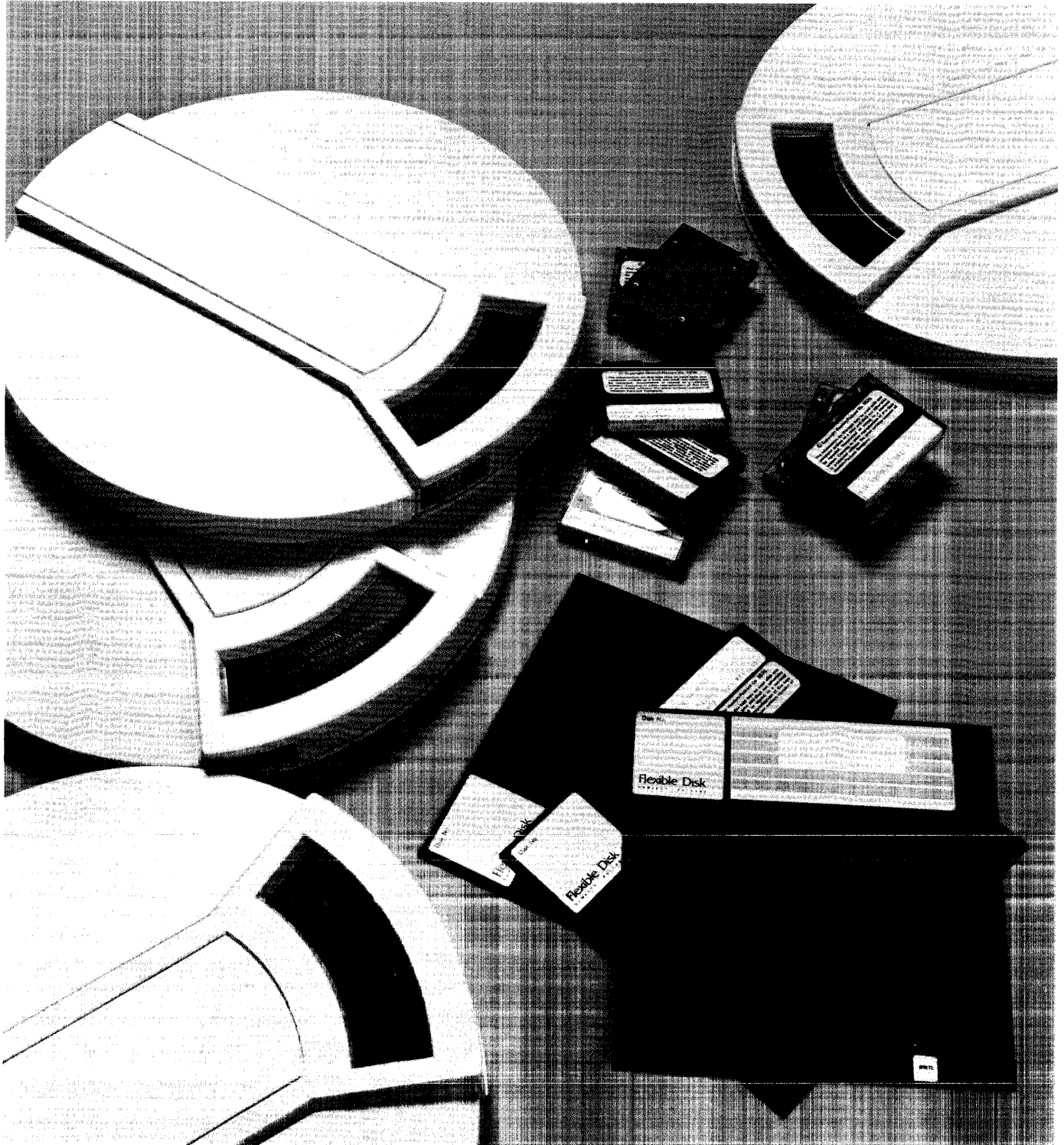


# HP 1000 Computers and Systems

HEWLETT  PACKARD

Powerful processing capabilities for  
computation, instrumentation, and  
data management

Active Software Data



# Introduction

## Content and organization of this data book

This data book provides information on software rights and privileges and data sheets on software support, active software operating systems, program languages, libraries and support packages, and data management software.

For fast, easy location of a particular category of information in this book, use the Quick reference index (facing).

## Other related publications

The following additional publications provide supplementary technical data, pricing, and configuration information.

**HP 1000 Computers and Systems Mature Software Data book.** Provides data sheets on:

- Software support
- User training services for mature software and subsystems supported by mature software operating systems
- RTE-II, BCS, RTE-B, and RTE-C operating systems
- Program languages
- Supporting libraries, including the 92066A RTE Measurement and Control Software package
- Distributed systems software supported by the mature software operating systems

**HP 1000 Computers and Systems Peripherals and Interfaces Data book.** Provides data sheets on:

- CRT, printing and data capture terminals
- Disc memories
- Magnetic tape units
- Line printers
- Card readers
- Punched tape I/O subsystems
- Graphics display and plotting devices and interfaces
- Instrumentation interfaces and subsystems
- Cabinets
- Environmental and physical characteristics and power requirements

**HP 1000 Computers and Systems Distributed Systems and Communications Data book.** Provides data sheets on:

- DS/1000 software-firmware and interfaces
- RJE/1000 communications package
- CRT and printing terminals and related terminal per I/O channel software
- Multipoint software and interface
- Other data communications interfaces

**HP 1000 Computers Hardware Data book.** Provides data sheets on:

- HP 1000 F-, E-, and M-Series Computers and M- and E-Series Board Computers
- Memory systems
- Mainframe plug-ins
- Firmware products
- User microprogramming accessories
- Power fail recovery systems
- Input/output and memory extenders
- General purpose I/O interfaces
- Environmental specifications and product support information
- Power specifications and applicability summary

**HP 1000 Computer Systems Technical Data book.** Provides data on:

- HP 1000 concept and HP 1000 Computer Systems
- HP 1000 Computers, memory systems, and accessories used in HP 1000 Computer Systems
- System consoles
- System disc memories
- Cabinets
- Product support
- Site planning information

**HP 1000 Computers Selection and Configuration Guide.** Provides selection, configuration, price, and prerequisite information for HP 1000 Computers, options, accessories, and compatible interfaces, peripherals, software, and support services.

**HP Computer Systems Configuration and Site Preparation Guide.** Provides configuration, price, prerequisite, and site preparation information for HP 1000 Computer Systems, options, accessories, and support services.

# Quick Reference Index

## Support

---

- Software Support ..... 1-1
- User Training Services ..... 1-5

## Operating Systems

---

- Overview ..... 2-1
- 92064A RTE-M memory-based real-time executive system ..... 2-6
- 92067A RTE-IV disc-based real-time executive system ..... 2-13

## Program and Microprogram Development Software

---

- Program languages ..... 3-1
- 92065A and 92101A BASIC BASIC/1000M and BASIC/1000D Subsystems ..... 3-3
- 92061A RTE Microprogramming Package ..... 3-8

## Libraries and Support Packages

---

- Standard Libraries ..... 4-1
- 92400A Sensor-based DAS Utility Library ..... 4-3
- 92062B RTE Drivers Package ..... 4-5
- 24396F Diagnostics Library ..... 4-7
- 92840A GRAPHICS/1000 Graphics Plotting Software ..... 4-9

## Data Management and Data Capture Software

---

- 92063A IMAGE/1000 Data Base Management System ..... 5-1

# Hewlett-Packard Company

## HP 1000 Software Rights and Privileges Statement

May 1, 1978

Hewlett-Packard software, the logical pattern implemented in firmware, and printed documentation are all copyrighted materials, protected under law. Unless HP specifically grants a customer the right to reproduce copyrighted materials, these may not be copied except for archive purposes, to replace a defective copy, or for program error verification purposes.

Specific grants of the right under copyright law to reproduce certain HP software products and the qualifications and prerequisites for those grants are described herein. While HP copyrighted firmware may be included with software or the "right to reproduce" certain software, it is specifically excluded from any grant of rights to reproduce copyrighted material. *The logical pattern contained in Hewlett-Packard firmware may not be reproduced under any circumstances.*

### Definition of software types

Hewlett-Packard defines two types of HP 1000 software, software-firmware, and subsystems products through the vehicle of the HP Purchase Agreement. These are Type I and Type II.

**Type I** products in general include those that are the largest and most powerful. For first time use on an HP computer, an HP Purchase Agreement customer purchases the original software (and firmware if any) product once; this original product is typically designated by an "A" product number suffix. For use on an additional HP computer, an HP Purchase Agreement customer who meets prerequisites described herein may purchase a separate Type I product, typically designated by an "R" product suffix, which contains HP copyrighted firmware (if any), manuals, and the "Right to Reproduce" the software contained in the associated original product (typically designated by an "A" suffix). HP's acknowledgement of a valid order for a Type I product containing the Right to Reproduce specific software actually grants the customer the right to make **one** copy of the associated original copyrighted software.

**Type II.** Other HP 1000 software and subsystem products are categorized as Type II on the HP Purchase Agreement. After an HP Purchase Agreement customer who meets the prerequisites described herein purchases a Type II product once at full list price (less appropriate discounts), HP grants that customer the right to make **one** copy of the original copyrighted software in the Type II product for use on an HP computer being purchased or previously purchased.

Action for qualifying HP Purchase Agreement customers is summarized below.

	For first time use on an HP 1000 Computer	For use on each additional HP 1000 Computer
<b>Type I</b>	Purchase the original copyrighted software-firmware or software product typically designated by an "A" suffix	Purchase the firmware and/or "Right to Reproduce" the original software once. Such a product is typically designated by an "R" suffix
<b>Type II</b>	Purchase the software or subsystem product typically designated by an "A" suffix	Reproduce the software contained in the original software or subsystem product once

### Prerequisites to Right to Reproduce

A customer must meet four important prerequisites before Hewlett-Packard grants the right to reproduce the copyrighted software contained in any Type I or II product. These are:

1. The customer must have a valid, signed HP Purchase Agreement working and in force at the time of their order for a Type I firmware and/or "Right to Reproduce" software product or at the time any Type II software is reproduced.
2. The customer must have already purchased or be concurrently purchasing at least one separate original of the Type I or Type II software-firmware, software, or subsystem product (typically designated by an "A" suffix) at full HP list price less appropriate discounts, but excluding software upgrade products or options and software bundled with HP 1000 Computer Systems.

3. The customer must install the customer-reproduced software on a Hewlett-Packard computer equipped with Hewlett-Packard memory of at least the minimum configuration specified in the data sheet for the product.
4. The customer must agree to label each copy of the original software with the following copyright notice "© Copyright Hewlett-Packard Company, 197X. Copy made by permission of Hewlett-Packard". The year contained in the label is the year date of the product's first publication.

### Ordering/Acknowledgement procedures

When a valid order for one or more Hewlett-Packard Type I firmware and/or "Right to Reproduce" software products is received at an HP factory, the following order acknowledgment will be sent:

#### "SPECIFIC RIGHTS TO REPRODUCE S/W GRANTED"

At that point, Hewlett-Packard specifically grants the customer the right to reproduce the software contained in the associated Type I product(s) once for each "Right to Reproduce" product ordered in accordance with the four prerequisites described above. The right to reproduce HP copyrighted software contained in Type II products is granted only after a customer meets all of the four prerequisites contained in this Statement.

### Further information

For additional information, contact your local Hewlett-Packard Sales Representative.

### Type I and II Software-Firmware, Software, and Subsystem Products

<b>Type I</b>	
91740A	DS/1000 Software and Firmware for HP 1000 M-Series Computers
91740P	DS/1000 Firmware for HP 1000 M-Series Computers and "Right to Reproduce" 91740A/B Software once
91740B	DS/1000 Software and Firmware for HP 1000 E and F-Series Computers
91740R	DS/1000 Firmware for HP 1000 E and F-Series Computers and "Right to Reproduce" 91740A/B Software once
91741A	DS/1000 Software Enhancement for HP 1000 ↔ HP 3000 Comm.
91741R	"Right to Reproduce" 91741A Software once
92067A	RTE-IV Operating System Software and Firmware
92067R	RTE-IV Firmware and "Right to Reproduce" 92067A Software once
92903A	DATACAP/1000 Software
92903R	"Right to Reproduce" 92903A Software once
<b>Type II</b>	
2300B	RTE-B Real-Time BASIC Operating System Software
2300C	RTE-C Operating System Software
20855A	Basic Control System (BCS)
24396A-F	Diagnostics
91700A	Network Communications Package
91703A	Network Communications Package
91704A	Network Communications Package
91705A	Network Communications Package
91730A	Multipoint Terminal Subsystem Software
91780A	RJE/1000 Communications Package
92001B	RTE-II Operating System Software
92060B	RTE-III Operating System Software
92061A	RTE Microprogramming Package
92062A	RTE Drivers Package
92063A	IMAGE/1000 Software
92064A	RTE-M Operating System Software
92065A	BASIC/1000M Software
92066A	RTE Measurement and Control Drivers
92101A	BASIC/1000D Software
92400A	Sensor-Based Utility Library
92409A	Real-Time Plotter Software Library
92840A	GRAPHICS/1000 Graphics Plotting Software



# Software support for HP 1000 Computers and Systems

## Introduction

Software is the essential intelligence that makes it possible for computer systems to perform a wide variety of useful tasks. Because software is an indispensable part of your computer system, it is important for you to know in advance the types and categories of Hewlett-Packard software and support that are available for your HP 1000 Computers and Systems. These are summarized briefly in the table below and further explained in this data sheet.

## HP software — tools designed for your success

Software for HP computers and computer systems is designed to function as powerful and effective tools that provide a solid foundation on which to build your application programs. Collectively, these tools, including category A (active) and to a less extent category B (mature) software, form a family of easily used standard software products, which includes:

- Software operating systems for computer system management that range from single-program, execute-only memory-based systems up to disc-based, time and event scheduled real-time multiprogramming systems complete with file management, on-line program development, multi-terminal input/output, and concurrent batch processing capabilities.

- Subsystems for data base management, distributed systems network communications, microprogram development, and real-time BASIC program development and execution.
- Extensive program libraries, including floating point, transcendental and complex functions, and decimal string arithmetic as well as software drivers for a wide variety of data processing and graphics peripherals and measurement and control interfaces and subsystems.

## Special and contributed software

**Special software.** Certain software items are available from the factory Special Software Development Group to accomplish special jobs or achieve higher performance under specialized conditions than is available with Active or Mature software. Support for special software is negotiated at time of purchase. For more information about software in this category (Category D), check with your HP Sales Representative.

**Contributed software.** Programs which have been written for HP 1000 Computers by users have been contributed to the Library of Contributed User Software (LOCUS). This Category F software can provide you with many useful routines to help you further apply your system. You can order the LOCUS catalog and contributed software through your HP Sales Representative. Assistance with LOCUS software is available only on a Software Consulting basis.

HP 1000 software support summary

SOFTWARE CATEGORIES AND DEFINITIONS	CATEGORY A: ACTIVE SOFTWARE Active software includes operating systems, subsystems, peripheral device drivers, and supporting libraries that may receive periodic enhancements.	CATEGORY B: MATURE SOFTWARE Mature software includes operating systems, subsystems, peripheral device drivers, and supporting libraries for which enhancements are no longer being considered.	CATEGORY C: COPIED SOFTWARE Copied software includes active or mature HP software that has been duplicated by permission, which may involve the purchase of a right to copy product.
CUSTOMER TRAINING AVAILABILITY	Regularly-scheduled courses are available on most active software products	Most training for mature products is scheduled on request	Depends upon training available for software copied
PRODUCT CONTENT	Software and manuals (and firmware if part of the product) plus 90-day replacement warranty for defective media and parts		Manuals, firmware (if part of a right to copy product) and hardware warranty on firmware
SOFTWARE SUPPORT SERVICES	Available through purchase of specific support service products	Limited availability of support services	Depends upon category of software copied
Software Notification Service	Provides information on software applications, problem resolutions and updates, as well as new contributed library programs	Provides information on changed software parts and manuals not covered by other support services	Permission to duplicate extends to information provided by Software Notification Service
Software Subscription Service	Provides software and manual updates. Software Notification Service is included in Software Subscription Service for operating systems	Limited to certain mature products which continue to receive a significant incidence of revisions	Permission to duplicate extends to updates provided by Software Subscription Service
Comprehensive Software Support	Provides Software Subscription Service and Phone-In Consulting Service	Available only for mature products that are covered by Software Subscription Service	Comprehensive Software Support availability is same as for software that is copied
SOFTWARE CONSULTING	On-site assistance with software associated with all categories can be ordered		

## Software obsolescence

HP is continually introducing new software products to provide state-of-the-art technology for optimum hardware usage, replacing older products that are withdrawn from the market. Although support services are no longer available and assistance is available only on a Software Consulting basis, users of this type of software can continue to purchase software parts and manuals for at least five years after the start of the obsolescence period.

## How to obtain software

HP Active and Mature software can be purchased as an integral part of an HP 1000 Computer System, or as individual components which the user integrates into his own system.

## Implementation — putting HP software to work for you

### Selecting the right software

You will find it helpful to discuss your intended application with your Hewlett-Packard Sales Representative, who will help you choose the correct software for your job and help you determine if your application needs can best be met by the purchase of an integrated HP 1000 Computer System, or if you should obtain the various hardware and software items as components. If necessary, your Sales Representative will call in an HP Systems Engineer to help you better understand how the operating system and other system software will handle your application.

### You'll want a competent system manager

Hewlett-Packard computer systems and software products are powerful and sophisticated computer tools that require a professional level of user knowledge for proper utilization. To realize the full potential benefits of your HP computer system and HP software, we recommend that you establish a position of System Manager in your organization and fill that position with a computer-knowledgeable person who has a degree in Computer Science, Electrical Engineering, or an equally-strong background. You should do this for the following reasons:

**Reason one:** Your System Manager has the responsibility of putting your HP 1000 Computer System to work. This requires specific application and software knowledge to do the job.

**Reason two:** HP can support your system and software most effectively when the person calling for assistance is familiar enough with your system to effectively communicate with our Customer Engineers and System Engineers. This same, knowledgeable person is also best-equipped to receive, understand, and successfully apply the suggestions of our technical field people. As with reason one, most effective HP support ultimately adds up to the most cost-effective implementation.

When your HP 1000 Computer Systems are linked together in a network, one System Manager should be appointed the Network Manager. By having this one person make all contacts with our Customer Engineers and Systems Engineers, a valuable base of network experience is built up that helps assure successful implementation of your network while minimizing your support costs.

### HP's user training will prepare you in advance

After you've purchased your software, your System Manager should attend the appropriate HP customer training courses to learn the use of the operating systems and software subsystems. Most of these courses include extensive hands-on experience and all of them will help your System Manager to implement your system. You may also want to send other members of your programming staff to the training courses to equip them to be most productive. At a minimum, your System Manager should attend these courses:

- 22991A HP 1000 Disc-Based RTE System Course or
- 22992A HP 1000 Memory-Based RTE System Course

For more information on these and other courses, see the User Training Services data sheet on page 1-5.

### Site prep consultation service

To assist you in planning your HP 1000 Computer System installation, Hewlett-Packard offers Site Prep Consultation as part of the system product. After you've ordered your system, an HP Customer Engineer will come to your facility to consult on site preparation with your System Manager or Site Coordinator. The Customer Engineer will bring the HP Site Preparation manual and, using it as a guide, will assist your people in determining what electrical and environmental preparation should be accomplished at the system's operating site prior to installation.

### Primary software systems to make your implementation easier

The primary system provided with HP 1000 Computer Systems, is an operating system that is configured with the essential software required in most systems. This primary system provides your people with a ready-to-use system that provides programming access to the major system features (languages, utilities, common I/O devices). This primary system can also be used as the basis for generation of your own custom-configured system. In addition to providing a common starting point, the primary system can be used at any time to verify that your system will function as it did when installed.

### How HP 1000 Systems installation gets you started

After your System Manager has seen to it that the operating site is prepared and confirmed that the necessary hardware and software have been delivered and moved to the operating site, your HP Customer Engineer will:

1. Supervise unpacking, assembly, and installation of the system components and peripheral hardware.
2. Test the primary system.
3. Test primary system peripherals and subsystems.
4. Run off-line diagnostic tests on non-configured peripherals.
5. Demonstrate the software back-up procedure.
6. Provide your System Manager with the phone number for the Phone-in-Consulting Service.

### Getting started with components

When you purchase your software and hardware as components, you should be able to assume responsibility for installation of the hardware and generation of the software. Should you need assistance with the installation of system hardware

or add-on components, your local HP Customer Engineer will perform the hardware installation at prevailing service rates. System Engineering assistance can be purchased if you need help with the generation of HP software or the configuration of additional software into an existing system.

## HP support — a choice of services for keeping you current and helping you apply your system

### Software Notification Service

On an annual basis, you can receive the following publications to keep you current with respect to your system software:

- Six periodically-published issues of the Communicator containing useful application data, abstracts and ordering information for new contributed software, current revision codes of various software products, and the latest schedules of pertinent training courses.
- Twenty-four issues of Software Status Bulletins that discuss reported discrepancies in software and manuals and give any available temporary corrections or ways to avoid the symptoms of discrepancies. Every three months, a cumulative printing of these consolidates all current information.
- Four issues of Software Update Notices, which cover changes in software. The notices tell what the factory has changed, the effect of the changes, and data concerning decreases or increases in memory requirements. In addition, it gives instruction on how customers on the Software Subscription Service can update their archival copy and incorporate the new software into their operating systems.

### Software Subscription Service

The purchaser of an HP 1000 RTE operating system, subsystem, or related software package can order the Software Subscription Service for that product to provide updates of software and manuals whenever design changes are released by the factory. This automatically provides the latest enhancements and changes to the software. The updates are available on various types of media, as defined in the individual software data sheets.

Software Subscription Service purchased for an operating system also automatically includes the Software Notification Service.

### Comprehensive Software Support

Support for keeping your software up-to-date and for dealing with software questions is available by purchasing HP's Comprehensive Software Support service, which includes:

- Software Subscription Service, as defined above
- Phone-In Consulting Service. With Comprehensive Software Support, your System Manager is provided a specific telephone "hot line", which can be used to contact a trained HP System Engineer in regard to questions concerning the use of HP software. If considered necessary by the local HP field office, a System Engineer may come to your site for first-hand observation and assistance.

Comprehensive Software Support provides resolution of questions directly related to use of HP supplied software. Assistance with applications software or HP software which has been modified by the user is expressly covered by prevailing service/consultation rates and is not covered by Comprehensive Software Support.

When you purchase an HP 1000 system you will also receive the Comprehensive Software Support service for the three months immediately following installation.

## Warranty

All Hewlett-Packard software products, computers, components, and systems are covered by warranty for a minimum of 30 days or a maximum of 90 days, depending upon the type of product and the conditions of purchase. For specific information, contact your Hewlett-Packard Sales Representative.

## Ordering information

### Product and option numbers and prices for user training courses and software support services

Product numbers and descriptions for user training courses and product and option numbers for Software Subscription Service and Comprehensive Software Support are given in individual data sheets in this book. Prices for training courses and all software support services are given in the HP 1000 Computers Selection and Configuration Guide and the HP 1000 Computer Systems Configuration and Site Preparation Guide.

### Software Notification Service

The Software Notification Service is included with the Software Subscription Service or Comprehensive Software Support for any HP 1000 operating system. It may also be purchased separately on an annually-renewable basis as the 92830A Software Notification Service.

### Software Subscription Service

Software Subscription Service coverage is modularly available for the principal HP 1000 software operating systems and subsystems. Each Software Subscription Service product is ordered in monthly units for a minimum of six months, billable quarterly, or it can be prepaid for an entire year. Options to each Software Subscription Service product provide a means of specifying the media on which updates are to be provided. This service has the requirement that your software be of the current software revision level when the service is started. If you need to bring your software up to date, this can be done by ordering the latest version of your operating system with option 001 and by ordering the different parts of software subsystem products.

### Comprehensive Software Support

Comprehensive Software Support is ordered on the same basis as the Software Subscription Service and has the same requirement that your software be current when the service is initiated. Additional requirements for Comprehensive Software Support are that all associated hardware must be maintained at the latest required revision code level and all HP software products making up your system must be covered by Comprehensive Software Support.

Comprehensive Software Support can be substituted for Software Subscription Service at the start of a quarterly billing period by simply purchasing Comprehensive Support.

**Software subscription service and comprehensive software support product numbering**

Product numbering for Software Subscription Service and Comprehensive Software Support products has been designed to facilitate ordering. These support products carry the basic product number of the software product that they support, plus a suffix letter S for the subscription service and a suffix letter T for Comprehensive Software Support. For example, the Software Subscription Service product for the 92067A RTE-IV operating system is 92067S; the Comprehensive Software Support product is 92067T.

**Support of duplicated software (software copies) at multi-system sites**

Support for your multiple stand-alone or network-connected systems software used in computers located in the same building is most conveniently provided by Hewlett-Packard when we can work through a single person, your Systems Manager. When you establish the Systems Manager as our single point of contact for all HP 1000 Computers in a building, we will provide Comprehensive Software Support for those systems on the following basis:

1. The first copy of each unique software product will be covered at the full Comprehensive Software Support rate for that product.

2. Each additional copy for each software product to be covered will be supported at a reduced rate; an option is provided for that discount.
3. All of the software in all of the computers connected in a network must be covered if the software in any of the computers is to be covered.
4. Stand-alone systems or networks need not be covered, but no Comprehensive Software Support assistance will be provided for software in systems or networks that are not covered.

**Software Consulting**

Assistance by a Hewlett-Packard System Engineer can be ordered as product number 22976B. This assistance is intended to provide a one-day on-site visit by a qualified HP System Engineer to help you better understand how to apply your HP software. Although this service does not include coding of software for your particular application, the insight gained through this service can help you better understand how to use the full potential of your HP 1000 Computer System and software. Multiple days of this service are ordered as a quantity multiplier of the 22976B product number.





## User training services

HP 1000 user training services supporting active software products include the courses listed in this section. The course listings are subdivided into regularly-scheduled courses whose times of presentation are listed on the Hewlett-Packard Computer Systems Group Course Schedule and request-scheduled courses, which are scheduled by the respective Hewlett-Packard Technical Center when there are sufficient requests to justify presentation of the course material. Any of the courses listed here may be presented at suitably-equipped customer's facilities by arrangement with the nearest Hewlett-Packard Technical Center. Technical Center addresses and telephone numbers are listed on the Hewlett-Packard Computer Systems Group Course Schedule.

### Regularly-scheduled training courses

#### 22951B Introduction to HP Minicomputers

**Description:** This course provides an entry point into HP computer training for those customers who have had no previous experience with minicomputer systems. Upon completion of the course, the student will be familiar with the concepts of:

1. HP minicomputer architecture.
2. Operating systems.
3. High level languages.

**Length:** 3 days.

**Lab:** Provides a hands-on introduction to the hardware and software operation of HP 1000 minicomputers. This includes operation of the computer front panel, system boot-up procedures and on-line loading and execution of programs.

**Prerequisites:** None. Students may be either hardware or software oriented.

#### 22991A HP 1000 Disc-Based RTE System Course

**Description:** This course covers the operation of the RTE-IV operating system in an HP 1000 system environment. This includes program preparation using standard compiler, assembler, editor, and loader; disc usage; system software generation; and use of the Batch-Spool Monitor (BSM), including the file manager.

**Length:** 10 days.

**Lab:** Provides hands-on experience in operating, programming, and generating the RTE-IV system, including BSM.

**Prerequisites:** Demonstrated proficiency in FORTRAN programming (such as completion of a FORTRAN programming course) and completion of the Introduction to HP Minicomputers course (22951B) or equivalent minicomputer experience.

#### 22992A HP 1000 Memory-Based RTE System Course

**Description:** This course covers the use of the RTE-M operating system in an HP 1000 system environment. This includes program preparation using the standard flexible disc-based FORTRAN IV compiler, assembler, editor, re-locating and absolute loaders; system software generation; and use of the file manager.

**Length:** 10 days.

**Lab:** Provides hands-on experience in operating, programming, and generating the RTE-M system, and in on-line program loading and removal.

**Prerequisites:** Demonstrated proficiency in FORTRAN programming (such as completion of a FORTRAN programming course) and completion of the Introduction to HP Minicomputers course (22951B) or equivalent minicomputer experience.

#### 22987A DS/1000 User's Course

**Description:** This course covers the fundamentals of the HP DS/1000 Distributed Systems Network, including: network philosophy, operator commands, remote I/O, remote file access, remote EXEC calls, program-to-program calls, and store-and-forward communications. Information is provided on both memory-based and disc-based RTE systems operation in addition to information on an HP 3000 MPE link.

**Length:** 5 days.

**Lab:** Provides hands-on experience in programming of a multi-node DS/1000 distributed systems network.

**Prerequisites:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A), or equivalent RTE experience. The HP 3000 Comprehensive Introduction Course (22801A) is also recommended for those customers whose networks include an HP 3000 node.

#### 22961B Theory of Operation of DS/1000

**Description:** This course provides a thorough exposure to the internal functioning of the DS/1000 software as it relates to an HP 1000-to-HP 1000 link. Topics covered include communications management, microcoded driver, remote file manager, network configuration, link protocol, generation, and performance evaluation. Information is provided on the level of program listings, flowcharts, and tables.

*NOTE: Customers whose networks include an HP 3000 node should also take the one-day DS/1000 to HP 3000 Theory of Operation Course (22962B).*

**Length:** 4 days.

**Lab:** Provides hands-on programming of a DS/1000 network, use of system utilities, diagnostics, and troubleshooting tools. System generation and network configuration are covered in detail.

**Prerequisite:** Completion of the DS/1000 User's Course (22987A).

### **22962B Theory of Operation for DS/1000-to-HP 3000**

**Description:** This course provides a thorough exposure to the internal functioning of the DS/1000 software as it relates to an HP 1000-to-HP 3000 link. Topics covered include communications management, network configuration, link protocol, HP 1000 as a master to MPE, and HP 1000 as a slave to MPE. Information is provided on the level of program listings, flowcharts, and tables.

**Length:** 1 day.

**Lab:** None.

**Prerequisite:** Completion of the Theory of Operation of DS/1000 Course (22961B), which is normally taken earlier in the same week.

### **22977A IMAGE/1000 Data Base Management System Course**

**Description:** This course covers the creation, building, back-up, and modification of data bases using the IMAGE/1000 Data Base Management System. It also includes the writing of programs to access a data base and the use of QUERY to access a data base.

**Length:** 5 days.

**Lab:** Provides hands-on experience with IMAGE/1000 software on an HP 1000 system.

**Prerequisite:** Completion of the HP 1000 Disc-Based RTE System Course (22991A) or equivalent disc-based RTE experience.

### **22952B HP 1000 Assembler Programming Course**

**Description:** This course covers the operation of the RTE assembler in an HP 1000 computer system environment. Major emphasis is placed on the development of assembly language programs for use in an RTE operating system.

**Length:** 5 days.

**Lab:** Provides extensive hands-on experience in the coding, editing, assembly, and debugging of RTE assembler programs using an HP 1000 system.

**Prerequisites:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A), or equivalent RTE experience.

### **22990A HP 1000 Driver Writing Course**

**Description:** This course covers the techniques and requirements for developing RTE device drivers for use in an HP 1000 system. Topics covered include: HP 1000 Computer family hardware and software I/O structure, interrupt-driven drivers, RTE driver structure and operation, use of DCPC by drivers, and privileged RTE drivers.

**Length:** 3 days.

**Lab:** Provides extensive hands-on programming experience in the development of RTE drivers.

**Prerequisites:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A) and the HP 1000 Assembler Programming Course (22952B), or equivalent RTE and assembly language experience.

### **22980B HP-IB in a Computer Environment**

**Description:** This course provides an introduction to HP-IB concepts and theory as they apply to use in HP 1000 Computer System controlled measurement systems as well as training in the programming of HP-IB on an RTE system.

**Length:** 4 days.

**Lab:** Provides hands-on experience with a typical HP 1000 computer controlled HP-IB instrument system.

**Prerequisite:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A) or equivalent RTE experience.

### **22983A HP 1000 E-Series Computers Microprogramming Course**

**Description:** This course covers the theory and use of HP microprogramming hardware and software to prepare, alter, and install microprograms for HP 1000 E-Series computers.

**Length:** 5 days.

**Lab:** Provides hands-on experience with preparation and installation of microprograms.

**Prerequisite:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A) and the HP 1000 Assembler Programming Course (22952B), or equivalent RTE and assembly language experience.

### **HP ATS Test Programming Course**

**Description:** This course is intended for customer's test engineers who write test programs for an HP-ATS Automatic Test System. Topics covered include Automatic Test System architecture, test monitor, instrument programming in BASIC, UUT interfacing, and switching control.

**Length:** 5 days.

**Lab:** The student uses a multi-terminal system in laboratory sessions to develop programming skills.

**Prerequisite:** A strong background in electronic test equipment and test procedures as well as training or experience in BASIC or FORTRAN programming. The student must also complete at least the first week of the HP 1000 Disc-Based RTE System Course (22991A).

## **Request-scheduled training courses**

### **22960A HP 1000 M-Series Computers Microprogramming Course**

**Description:** This course covers the theory and use of HP microprogramming hardware and software to prepare, alter, and install microprograms for HP 1000 M-Series computers.

**Length:** 5 days.

**Lab:** Provides hands-on experience with preparation and installation of microprograms.

**Prerequisite:** Completion of either the HP 1000 Disc-Based RTE System Course (22991A) or the HP 1000 Memory-Based RTE System Course (22992A) and the HP 1000 Assembler Programming Course (22952B) or equivalent RTE and assembly language experience.

## **Maintenance training courses**

Maintenance training is also available. See the current HP Computer Systems Group Course Schedule for the list of available courses.

## **Ordering, registration, and scheduling information**

Information on tuition for scheduled courses is provided in the HP 1000 Computers Selection and Configuration Guide and in the HP 1000 Computer Systems Configuration and Site Preparation Guide. Registration and course scheduling information is provided in the current HP Computer Systems Group Course Schedule. All of these documents are available from your Hewlett-Packard Representative.



## Active software operating systems overview

An operating system is a modular software system that gives computer systems a base of intelligent, systematic functions on which to build application programs and operations. The operating system sets up the conditions for program development, loading, and scheduling for execution. It also controls input and output, and may provide or support memory management, extended memory area management, file management, and data base management services as well.

## The active software operating systems

Two different active software operating systems are available for use in HP 1000 Computers and Systems, as follows:

**RTE-M**, is a memory-based real-time executive. Because it is highly modular, RTE-M can be configured for:

- Simple, single-program, execute only operation.
- Memory-based, real-time multiprogramming operation with on-line program load capability.
- Memory-based, conversational BASIC programmable, real-time multi-tasking operation (requires addition of BASIC/1000M).
- Real-time multiprogramming with on-line development of FORTRAN or Assembly language programs like the disc-based RTE-IV system (requires flexible disc subsystem for program development).
- Management of up to 64 individually-mapped partitions for memory-resident programs in up to 2.048M bytes\* of memory, like the RTE-IV system.

**RTE-IV, Hewlett-Packard's newest operating system**, is a disc-based, time and event-scheduled, real-time multiprogramming system with memory management support of up to 64 individually-mapped, multi-user disc swapping partitions, up to 56k bytes per partition, extended addressing of up to nearly 2 megabytes of mapped data in available memory, in up to 2.048M bytes\* of memory.

## Systems comparison

To facilitate selection of the appropriate operating system, a table on the next page summarizes the principal capabilities provided in the respective operating systems. Where the entry *optional* appears in this table, it denotes a capability whose software support is included in the operating system, but which the user does not have to include in his particular configuration of the operating system. The various capabilities are explained in the following paragraphs.

### Multiprogramming

Multiprogramming is the system's ability to supervise the running of multiple programs for different functions. It may thus effectively provide several systems in one to multiple users or make it easier to satisfy diverse needs of a single application.

*\*RTE-M and RTE-IV provide addressability up to a maximum of 2.048 million bytes; current physical memory limit with fault control memory, recommended for large-memory systems, is 1.792M bytes.*

**Multi-user operation** is provided by a multi-terminal monitor in the operating system that coordinates system communications with users at several different terminals.

**Program swapping** gives expansion of memory capacity to the RTE-IV system. However, such expansion is achieved at the expense of response time; it takes 50 to 100 times as long to swap one disc resident program for another as it does to switch between programs in memory.

**Priority levels** provide a means for the user to discriminate between his most urgent programs and those of lesser urgency. If two programs are scheduled to run at the same time the program with the lowest priority number will run first.

### Capacity

Capacity provides an indication of the system resources that can be put to work on user's applications.

**Main memory** capacity provides an indication of how many different system programs and user programs can be in memory at the same time. As the proportion of programs in memory is increased, program swapping is reduced, the time required to switch between them decreases, response improves and the system's throughput increases.

**Disc memory** capacity provides an indication of the volume of program and data files, and/or the size of the data base that can be maintained on the system.

### Memory management

Memory management provides individual mapping of partitions in memory above the lowest 64k bytes, up to a maximum of 2.048M bytes.

**Number of partitions** indicates how many different user's programs and/or program development subsystems can be in memory at the same time. With respect to the disc-based RTE-IV system, having many programs in memory at the same time minimizes the response and throughput-slowness effect of program swapping to and from disc. With respect to the memory-based RTE-M system, having multiple partitions is essential to provide multi-user operation, because RTE-M does not support program swapping.

**Maximum user space in partition** tells how large a program or program segment can be accommodated. The range of sizes shown for RTE-M reflects the fact that partition space available to the user is 64k bytes less the size of the operating system, which is highly variable in RTE-M because of its modularity and because I/O drivers and resident library routines are effectively part of the system. In the RTE-IV system, a relatively small 8k byte system communication and support area leaves up to 56k bytes of address space for the user in partitions.

**Extended Memory Area (EMA) for data** is a memory management feature of the new RTE-IV system. This feature provides mapped accessing of an extended area, which can be all of the physical memory remaining after allocation of memory to the system, related libraries, I/O drivers, subsystems, program development modules, and user partitions outside of the EMA. In practical systems, nearly 2 megabytes of memory can be used as Extended Memory Area for data in a computer system with 2.048M bytes of memory.

### Program scheduling

**Operator scheduling** gives the operator control of the execution of programs in disc-based RTE systems. Operator scheduling is generally most used to turn on the compiler,

Active operating systems capabilities and definitions

	92064A RTE-M	92067A RTE-IV
<b>MULTIPROGRAMMING</b>	Optional	Yes
Multi-user operation	Optional	Optional
Program swapping	No	Yes
Priority levels	1-32,767	1-32,767
<b>CAPACITY</b>		
Main memory	16k to 2.048M bytes	128k to 2.048M bytes
Disc memory	Optional flexible disc with 0.5-2M bytes	System disc with 4.9-19.6M bytes, 14.7-365.2M bytes, 20-320M bytes, or 50-400M bytes
<b>MEMORY MANAGEMENT</b>	Optional	Yes
Number of partitions	1 - 64	1 - 64
Maximum user space in partition	30 to 42k bytes	56k bytes
Extended Memory Area (EMA) for data	No	Available memory up to nearly 2M bytes
<b>PROGRAM SCHEDULING</b>		
By operator	Yes	Yes
By event interrupt	Optional	Yes
By other program	Optional	Yes
By time of day	Optional	Yes
<b>INPUT/OUTPUT</b>		
Output buffering	Optional	Yes
I/O suspend	Yes	Yes
I/O timeout	Optional	Yes
Re-entrant I/O	Yes	Yes
Resource management	Optional	Yes
Mailbox data exchange	Optional	Yes
<b>PROGRAMMING LANGUAGES</b>		
FORTRAN IV	Requires flexible disc	Yes
Real-time BASIC	Requires 92065A BASIC/1000M	Requires 92101A BASIC/1000D
RTE Assembly language	Requires flexible disc	Yes
Micro-assembly language	No	Requires 92061A Microprogramming Package
<b>PROGRAM DEVELOPMENT</b>		
Interactive editor	Requires flexible disc	Yes
Microdebug editor	No	Requires 92061A Microprogramming Package
Relocating loader	Yes	Yes
On-line absolute loader	Yes	Built into operating system
File manager	Optional	Yes
Batch monitor	No	Yes
I/O spooler	No	Yes
<b>DECIMAL ARITHMETIC</b>	No	Yes
<b>SYSTEM GENERATION</b>	On-line or off-line	On-line or off-line
<b>DATA MANAGEMENT</b>		
File creation and access	Optional	Yes
Data base management	No	Requires 92063A IMAGE/1000
<b>DISTRIBUTED SYSTEMS NETWORKING</b>		
With other HP 1000 Systems	Requires 91740A/B DS/1000 Network software-firmware	
With directly connected HP 3000	Requires 91740A/B and 91741A DS/1000 software enhancement	

assembler, editor, or relocating loader programs in the system that are used for program development.

**Event interrupt scheduling** makes program execution subject to the occurrence of an external event, connected to the computer's interrupt system.

**Program-to-program scheduling** provides for the execution of one program at the request of another program, which simplifies the set-up of conditional performance of system functions.

**Time scheduling** gives the user the ability to have programs running at a given time and/or at given intervals so system actions can be correlated with external processes occurring in real time.

## Input/output

**Output buffering** lets a program turn over its output operations to the system, then continue on to completion, or suspend in favor of another program that can do useful work while waiting for the output operation to finish. The system is not kept waiting for output and its productivity is maximized.

**I/O suspend** provides for suspending execution of a program that is waiting for I/O so processing time can be made available to other programs that can do useful work during the wait.

**Re-entrant I/O** permits the suspension of a program which has an active I/O request in process in favor of a higher-priority program, which may also use the same I/O routine, speeding system response.

**Resource management** provides for the exclusive assignment of any system resource that can be accessed by a user program. With I/O devices for example, resource management can be used to assure that a low-priority program completes its use of a printer without having that use pre-empted by a higher-priority program.

**Mailbox Data Exchange** (class I/O) can be used to set up specific "mailbox" buffers in memory for terminal-to-program or program-to-program communication without the use of common. It also provides for read without wait.

## Program development

On-line program development provides for the preparation of new programs on the system at the same time other programs are running. With off-line program development, execution of existing programs on the system must be interrupted for program development, or new programs must be developed on another system.

**Interactive editor** provides for the editing of programs or text in data files. It is thus an essential tool for updating and correcting programs.

**Relocating loader** converts relocatable programs to absolute, executable form and provides linkage where program code crosses a page boundary.

**Microdebug editor** and related microprogram development software provides for development by the user of his own microprogrammed instructions for the computer, to increase the efficiency and power of his machine.

**On-line absolute loader** provides for on-line installation and removal of programs without interrupting other programs running in the system.

**File manager** simplifies editing and other program development operations through the ease of creation, reading, writing, duplicating, and purging of named files.

**Batch monitor** converts the file manager to a batch processor that reads in and batch-processes user-submitted program development jobs with minimal operator supervision.

**I/O spooler** increases the number of jobs that can be backlogged for batch processing by recording them on disc files and moves large capacity output buffering from main memory to the disc.

## Decimal Arithmetic

Addition, subtraction, multiplication, and division of decimal integer character strings is provided by a decimal arithmetic library included in the RTE-IV system. This makes possible arithmetic computations on decimal numbers that exceed the arithmetic capacity of the standard libraries.

## System generation

On-line system generation provides for preparation of several different system configurations, while other programs are running. These can be stored on disc for future use or different applications. With off-line system generation, normal operations of the system must either be interrupted to generate a new system configuration or the new system must be generated on a host system.

## Data management

**File creation and access** is provided by the same file manager that helps with program preparation. User's programs can create and write data into named files on the disc (or Mini cartridge or flexible disc in RTE-M) which other programs can open and read.

**Data base management** provides for simplified access to data files by keyword. Because individual data files can be accessed in several different ways through the data base schema structure, redundant data can be eliminated and files consolidated.

## Distributed systems networking

Networking is a powerful tool for coordination and sharing of the information gathering and data processing power and peripheral resources of multiple computer systems.

**Communication with other HP 1000 Computers or Systems.** DS/1000 in the RTE-M and RTE-IV systems supports nodal addressing with automatic store-and-forward communication throughout a network of HP 1000 Computer Systems. Network capabilities include remote command processing, program-to-program data exchange, remote file access, remote exec calls, and remote I/O. RTE-IV based DS/1000 nodes (systems) can support neighboring RTE-M based or RTE-IV based nodes with remote system generation and remote program development.

Communication with directly connected HP 3000. With addition of the DS/1000 software enhancement, an RTE-M or RTE-IV based system can function as a virtual terminal to HP 3000 systems, gaining access to facilities not available on the HP 1000, such as the COBOL compiler and QUERY/3000. Other capabilities include program-to-program data exchange and remote file access under program control. The HP 3000 system can also issue remote exec commands to the HP 1000 system for remotely controlled operation.

## Supported hardware and software products

The following table provides a summary guide to the support of computers and accessories, peripherals, measurement and control subsystems, interfaces, and optional software packages with respect to the operating systems.

## Hardware and software products support checklist

RTE-M	RTE-IV	Supported Products
		<b>HP 1000 M-Series Computers and Accessories</b>
A		2105A Computer (2 memory slots, 4 I/O channels)
A		2108 Computer (5 memory slots, 9 I/O channels)
A		2108MK (325 ns) Board Computer with 12728E base instruction set and 12728A card cage (capacity equivalent to 2105A Computer).
A	A	2108MK (325 ns) Board Computer with 12728E base instruction set and 12728J card cage (capacity equivalent to 2108 Computer).
A	A	2112 Computer (10 memory slots, 14 I/O channels)
X		12892A/B Memory protect
X	R	12897B Dual-Channel Port Controller
X	R	12976B Dynamic Mapping System
X	R	12539C Time Base Generator
X	X	12977B (or 12976B opt. 003) Fast Fortran Processor
X	X	12620A Breadboard interface for Privileged Interrupt Control
	X	13197A Writable Control Store (when RTE-IV System is equipped with 92061A Microprogramming Package)
		<b>HP 1000 E-Series and F-Series Computers and Accessories</b>
A	A	2109 Computer (5 memory slots, 9 I/O channels)
A	A	2109E K (175/280 ns) Board Computer with 12728J card cage (capacity equivalent to 2109 Computer).
A	A	2113 Computer (10 memory slots, 14 I/O channels)
A	A	2111 Computer (5 memory slots, 9 I/O channels, and floating point hardware)
A	A	2117 Computer (10 memory slots, 14 I/O channels, and floating point hardware)
X	R	12892B Memory Protect
X	R	12897B Dual-Channel Port Controller
X	R	13304A Firmware Accessory Board
X	R	12731A Memory Expansion Module
X	R	13307A Dynamic Mapping Instructions
X	R	12539C Time Base Generator
X	X	13306A Fast Fortran Processor
X	X	12620A Breadboard interface for Privileged Interrupt Control
X	X	13197A Writable Control Store (when RTE-IV System is equipped with 92061A Microprogramming Package)

RTE-M	RTE-IV	Supported Products
		<b>CRT Terminals and accessories</b>
X	X	2640A/B CRT Terminal with 12880A+001 (local) or 12531D+002 (modem) interface (up to 240 char/sec, 80 char/line, 25 lines/display)
X	X	2644A+020 CRT Terminal* with 12966A+001 local interface (up to 240 char/sec, 80 char/line, 25 lines/display, with dual Mini cartridge I/O)
X	X	2645A+030 Display station with 13260B and 12966A+001/002 local/modem interface (up to 960 char/sec, 80 char/line, 25 lines/display)
X	X	2648A+030 Graphics Terminal with 13260B and 12966A+001/002 local/modem interface (up to 960 char/sec, 80 char/line, 25 lines/display; graphics display up to 190 vectors/sec)
X	X	2645A/2648A option 007: Adds Mini cartridge I/O to 2645A/2648A, up to 350 char/sec
X	X	13246A/B auxiliary (thermal) Printer Subsystem for use with 2644A+020 or 2645A/2648A+007, 030 and 13260B (240 LPM, 80 char/line)
X	X	13349A auxiliary (impact) Printer Subsystem for use with 2644A+020 or 2645A/2648A+007, 030 and 13260B (30 char/sec, 132 char/line)
X	X	2631A+240 auxiliary (dot-matrix impact) Printer Subsystem for use with 2645A/2648A+007, 030 and 13260B (180 char/sec, 136 char/line)
		<b>Keyboard-printer terminals</b>
X	X	2635A+051 Printing Terminal with 12966A+001 local interface or 2635A Printing Terminal with 12966A+002 modem interface (up to 180 char/sec, 136 char/line).
X	X	2752A Teleprinter* with 12531C local only interface (10 char/sec, 72 char/line)
X	X	2762A/B Terminal Printer* with 12531D+001/002 local/modem interface (30/120 char/sec, 75/120 char/line)
		<b>Disc memories</b>
	D	12960A (4.9M byte) Cartridge disc subsystem (up to 19.6M bytes with three add-on 12960A+010 Disc Drives)
	D	12962A/B/C/D (14.7M byte) Cartridge disc subsystem* (up to 117.9M bytes with seven add-on 13180A/B Disc Drives; up to 365.2M bytes with seven add-on 7920S Disc Drives)
	D	7906M/MR (19.6M) byte Master cartridge disc drive with 13175A interface (up to 156.8M bytes with seven add-on 7906S/SR Disc Drives; up to 370M bytes, with seven add-on 7920S Disc Drives)
	D	7920M (50M byte) Master top-loading disc pack drive with 13175A interface (up to 400M bytes with seven add-on 7920S Disc Drives)
X	X	12732A (500k byte) Flexible disc subsystem (up to 2M bytes with three add-on 12733A Drives)
		<b>Punched tape input/output subsystems</b>
X	X	12925A Punched tape reader subsystem (500 char/sec)
X	X	12926A Tape punch subsystem (75 char/sec)
		<b>Card reader subsystems</b>
X	X	12985A Card reader subsystem (600 punched card/min)
X	X	12986A Optical mark reader subsystem (300 mark-sense or punched cards/min)
		<b>Printer subsystems</b>
X	X	2613A+100 Line Printer Subsystem (300 LPM x 136 col.)
X	X	2617A+100 Line Printer Subsystem (600 LPM x 136 col.)
X	X	2618A+100 Line Printer Subsystem (1250 LPM x 132 col.)
X	X	2631A+210 Printer Subsystem (180 char/sec x 136 col.)
X	X	12987A Line Printer Subsystem* (200 LPM x 132 col.)
X	X	12996A (thermal) Printer Subsystem (240 LPM x 80 col.)
		<b>Plotting and Display Products</b>
X	X	12935A Graphic Plotter Subsystem (requires 92409A real-time plotter library in RTE systems)
X	X	9872A (four color) Plotter (connects to computer via 59310B HP-IB interface)
X	X	91200B TV Interface (connects system to B&W or color TV monitors; color requires three 91200B TV interfaces)
		<b>Magnetic tape subsystems</b>
X	X	12970A Magnetic tape subsystem (9-track, 800 bpi, 45 ips, up to four drives per subsystem)
X	X	12971A Magnetic tape subsystem (7-track, 200/556/800 bpi, 45 ips, up to four drives per subsystem)
X	X	12972A Magnetic tape subsystem (9-track, 1600 bpi, 45 ips, up to four drives per subsystem)



RTE-M	RTE-IV	Supported Products
X	X	<b>Real-time data entry applications terminals</b> 92900B Data capture terminal subsystem (one to 56 hardwire-connected HP 3070B Data capture terminals per subsystem, up to 2km (6,562 ft) from computer to farthest terminal)
X	X	3071A Real-time applications terminal, modem-connected
X	X	<b>Measurement and control products</b> 2240A Measurement and control processor (supports function cards for up to 128 analog and/or digital I/O points, expandable with 2241A extender to 256 analog and/or digital I/O points; hardware rates to 20,000 points/sec; connects to computer via 59310B HP-IB interface)
X	X	2313B Analog I/O Subsystem (supports function cards for up to 144 analog inputs; up to 528 with two extenders; hardware rates to 45,000 channels per second)
X	X	59310B HP-IB interface (connects up to 14 HP-IB instruments to the computer system)
X	X	91000A A-to-D interface card (16 single-ended/8 differential inputs, hardware rates to 20,000 channels per second)
X	X	<b>Data communications and network interfaces</b> 12531C Teletype interface
X	X	12531D Terminal interface (local/remote)
X	X	12771A Computer serial (hardwired) interface (two interface cards used with 91740A/B DS/1000 Network Software-Firmware).
X	X	12773A Computer modem interface (single interface card used with 91740A/B DS/1000 Network Software-Firmware).
X	X	12880A local-only CRT terminal interface
X	X	12889A Hardwired serial interface (single interface card used with 91741A DS/1000 Software enhancement for HP 1000-to-HP 3000 communication).
X	X	12790A Multipoint interface for multiple 2645A or 2648A CRT terminals, up to 8 interfaces per computer, supported by 91730A Multipoint software.
X	X	12966A Buffered asynchronous communications interface for local/modem connection to 2635A Printing Terminal or 264x/B CRT terminal, operating in block or character mode

RTE-M	RTE-IV	Supported Products
X	X	<b>Distributed systems network software-firmware</b> 91740A/B DS/1000 Network software-firmware (requires separately-ordered 12771A Computer Serial interface and/or 12773A Computer Modem interfaces in each system).
X	X	91741A DS/1000 Software enhancement for HP 1000-to-HP 3000 communications (requires separately-ordered 12889A Hardwired serial interface in local HP 1000 system and 30360A Serial interface and 32190A DS/3000 Software in the remote HP 3000 System); connection is via 30220A Cable kit.
F	I	<b>Program language support</b> RTE FORTRAN IV
X	X	92065A BASIC/1000M
F	I	92101A BASIC/1000D
L	X	RTE Assembler
X	X	92061A RTE Microprogramming Package
X	X	<b>Software products</b> 92063A IMAGE/1000 Data Base Management System
X	X	92400A Sensor-Based DAS Utility Library
X	X	91730A Multipoint terminal subsystem software
X	X	92840A Graphics Plotting Software

A = Alternate computer choices supported by the operating system. Older computers and accessories may require updating to latest serial prefix status to achieve compatibility with RTE-IV.

R = Item required by the operating system; only R items associated with the selected computer are required.

X = Item supported by the operating system.

L = RTE-M supports only the WCS Load utility and WCS driver DVR36.

D = Alternate system disc choices supported by the operating system.

F = included in 92064A RTE-M system with flexible disc media option 040.

I = Program language support included with the respective operating system.

\*Identifies product no longer available that is listed here for reference.



# RTE-M real-time executive system

model 92064A

The 92064A RTE-M is a memory-based operating system for management of the operations and resources of HP 1000 Model 20 Computer Systems, and user assembled systems based on Hewlett-Packard 2105†, 2108, 2109, 2111, 2112, 2113 or 2117 Computers.

## Features

- Flexible configurability to support:
  - A minimum single-terminal, single program, execution-only environment with program development optional (RTE-MI).
  - A multiprogramming, multi-user environment with multi-terminal support, concurrent single-user program processing, and buffered output (RTE-MII).
  - A multiprogramming environment with all capabilities of RTE-MII plus management of up to 64 individually mapped and protected partitions in up to 2.048M bytes\* of memory (RTE-MIII).
- Support for program development in FORTRAN IV, conversational real-time BASIC/1000M (optional), and HP Assembly language.
- File manager for creating, opening, writing, reading, listing, closing, and purging of named files on 2645A/48A Mini cartridges or Flexible discs.
- Interactive editor, relocating loader, and on-line program installation and removal.
- Support for sensor-based DAS library.
- Multi-terminal operation:
  - Multi-user BASIC/1000M in RTE-MIII.
  - Multi-user program development using FORTRAN IV, BASIC/1000M and HP Assembler in flexible disc environment.
- Includes software drivers for more than 18 different instrument and peripheral subsystems, including HP-IB interfaced instruments and 3070A Data Entry Terminals.
- Support of DS/1000 software-firmware for communication with other HP 1000 Computer Systems and/or with an HP 3000 System.
- Conversational system generation from 2645A/48A Mini cartridges or flexible discs.

†The 2105A can be used only for the RTE-MI configuration, not for RTE-MII or MIII.

\*RTE-MIII provides addressability up to a maximum of 2.048 million bytes; current fault control memory limit is 1.792M bytes.

## Functional description

### Configuration choices

The RTE-M system is a complete package that has been designed to be configured modularly to offer the user exceptional configuration flexibility. It provides the following three levels of configuration, with optional modules adding still further configuration flexibility.

UP TO 64 PARTITIONS FOR MEMORY-RESIDENT REAL-TIME PROGRAMS AND/OR PROGRAMS USED FOR MULTI-USER PROGRAM DEVELOPMENT, 4k BYTES, MINIMUM 30k to 42k BYTES MAXIMUM*, PER PARTITION (RTE-MIII only).	Up to 2,031,616 (1.984M) bytes of additional memory beyond 64k byte system (with RTE-MIII only)
BOOTSTRAP LOADER	128 Bytes
SYSTEM AVAILABLE MEMORY	31,082 to 49,512 Bytes available for program development and/or user's programs and program buffers, depending upon choice of operating system configuration (RTE-MI/MII/MIII) and optional modules included in the system†
USER PROGRAM AREA	
ABSOLUTE LOADER FOR ON-LINE INSTALLATION OF PROGRAMS (Optional in RTE-MI/MII, required in RTE-MIII)	3,400 Bytes (Mini cartridge) 5,160 Bytes (Flexible disc)
FILE DIRECTORY ACCESS (Optional)	770 Bytes (Mini cartridge, MII/MIII) 2,120 Bytes (Flexible disc, MI) 2,010 Bytes (Flexible disc, MII/MIII)
SYSTEM COMMON	Part of user's memory
SUBSYSTEM GLOBAL AREA	Usage depends upon HP software subsystems used in RTE-M system
RESIDENT LIBRARY	4,096 Bytes (Typical)
ADDITION TO RESIDENT LIBRARY FOR MINI CARTRIDGE FILE DIRECTORY ACCESS	1,064 Bytes (Mini cartridge, MI) 324 Bytes (Mini cartridge, MII/MIII) 40 Bytes (Flexible disc, MI/MII/MIII)
AUTO RESTART AFTER POWER FAILURE (Optional)	520 Bytes
MAILBOX DATA EXCHANGE (Optional in RTE-MI/MIII- (Requires Resource Management Module)	800 Bytes ▲
RESOURCE MANAGEMENT (Optional in RTE-MII/MIII)	200 Bytes ▲
ADDITIONAL ON-LINE OPERATOR COMMANDS (Optional)	1,220 Bytes ▲
TIME SCHEDULING OF PROGRAMS (Optional) (Requires real-time clock module)	980 Bytes ▲
REAL-TIME CLOCK & I/O TIMEOUT (Optional)	220 Bytes ▲
OUTPUT BUFFERING (Optional in RTE-MI)	340 Bytes ▲
PRDG-PRDG SCHED. (Optional in RTE-MI)	640 Bytes ▲
INSTRUMENT AND/OR PERIPHERAL DRIVERS	Variable*
FLEXIBLE DISC DRIVER DRVR33 (Optional)	1,550 Bytes ▲
SYSTEM CONSOLE DRIVER DVR05	
RTE-M EXECUTIVE (RTE-MII and RTE-MIII include Output Buffering and Program-Program Scheduling)	11,800 Bytes (RTE-MI) 13,400 Bytes (RTE-MIII) 14,800 Bytes (RTE-MIII)
BASE PAGE LINKAGE AREA	

\* Additional I/O drivers for instrument and/or peripheral subsystems will reduce the memory area available for user's programs and buffers in the first 64k bytes of memory and also reduce the maximum size of partitions in memory above the first 64k bytes in the RTE-MIII system.

▲ These module sizes are approximate, and are subject to growth of no more than 10% if current page linking is used.

64k byte RTE-M system with potential for expansion beyond 64k bytes.

RTE-MI is the smallest system and is intended primarily for dedicated, operator-scheduled single-program execute only use, or single-user program development. It is also capable of multiprogramming, but does not support the very important system protection afforded by memory protect. The minimum configuration of RTE-MI will run in 64k bytes of memory. As shown in the composite system map above, this leaves over 48k bytes for the user's program and program buffers in a computer system with 64k bytes. To the extent that memory space is available, optional modules can be

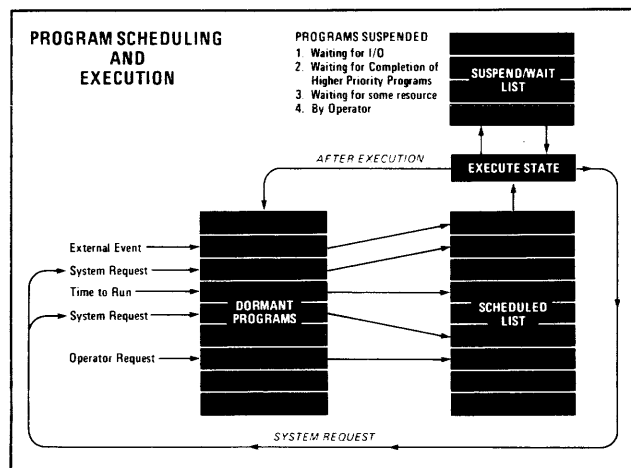
added to RTE-MI to provide I/O buffering, program-to-program scheduling, real-time clock and I/O timeout, time scheduling of programs, additional on-line commands, auto restart after power failure, file directory access, and on-line installation of programs.

**RTE-MII** is a multiprogramming system that supports memory protect and includes I/O buffering and program-to-program scheduling, which are optional in RTE-MI. In addition to all of the configuration options available with RTE-MI, RTE-MII supports resource management and mailbox data exchange (class I/O) for more effective control of multiprogramming operations. It also supports a multiterminal monitor for multi-user access to the system, but memory capacity limits program development to a single user.

**RTE-MIII** combines all the capabilities of RTE-MII with management of up to 64 mapped partitions in memory, which also makes possible extension of total system memory available for multi-user program development and execution beyond the 64k byte limitation of RTE-MI and MII systems to a maximum of 2.048M bytes of memory. The absolute loader for on-line program installation is required with the RTE-MIII system.

## Multiprogramming

The RTE-M system can supervise the execution of multiple programs, so the computer system can be performing several different functions concurrently — receiving and responding to data inputs, running computations, printing out reports, or controlling instruments or industrial equipment.



**Scheduling.** Multiple programs in the RTE-M system are executed on a scheduled basis, as shown in the diagram above. The system lists all programs in order of priority that are ready for execution. In the minimum system, programs are placed in this list when requested by the operator or when an external event interrupt calls for program execution. With program-to-program scheduling (standard in RTE-MII/MIII, optional in RTE-MI), one program can place another in the scheduled list. When the optional real-time clock and time scheduling modules are configured into the RTE-M system, programs will also be placed in the scheduled list when it is time for them to run on a regularly-scheduled basis.

**Priorities and Execution.** Priority scheduling gives fine control over which tasks are done first, using priority levels from 1 through 32,767. Execution is started immediately for the highest priority (lowest priority number) program, at the top of the scheduled list, and may be scheduled on time resolutions as small as tens of milliseconds. If a higher-priority (lower priority number) program moves to the scheduled list, that program starts execution and the current program is suspended.

**Dynamic Memory Mapping (RTE-MIII only).** The RTE-MIII system provides fast multiprogram access to as much as 2.048M bytes of physical memory by a logical-to-physical address translation using memory maps and dynamic mapping in the system computer. When it's time for a program to run, RTE-MIII enters an appropriate memory map for that program into the dynamic mapping system. Thereafter, all addressing during program execution is automatic, and completely independent of RTE-MIII.

**On-line program installation.** Several programs can be in the user program area of the RTE-MI/MII system at the same time, and many more can be in the partitions in memory above 64k bytes in the RTE-MIII system. To facilitate multiprogramming operation and make maximum use of the system, RTE-M includes an absolute program loader that can be used to install new programs in the user area or RTE-MIII managed partitions without interfering with the system or with execution of other programs. The absolute loader works with programs that have been converted from relocatable to absolute form by the RTE-M relocating loader. The absolute loader is optional on RTE-MI/MII systems, and required on RTE-MIII systems.

## Interrupt processing

RTE-M uses the multi-priority level, stored hardware interrupt system of the system computer for power fail detection (optional), memory protect violation (RTE-MII/MIII only), parity error, and time base inputs, as well as for peripheral I/O and user-interfaced equipment. When one or more interrupts occur simultaneously, the interrupt with the highest priority is recognized first, but the system also remembers the other interrupts, so no interrupt is forgotten or overlooked.

## Privileged interrupt

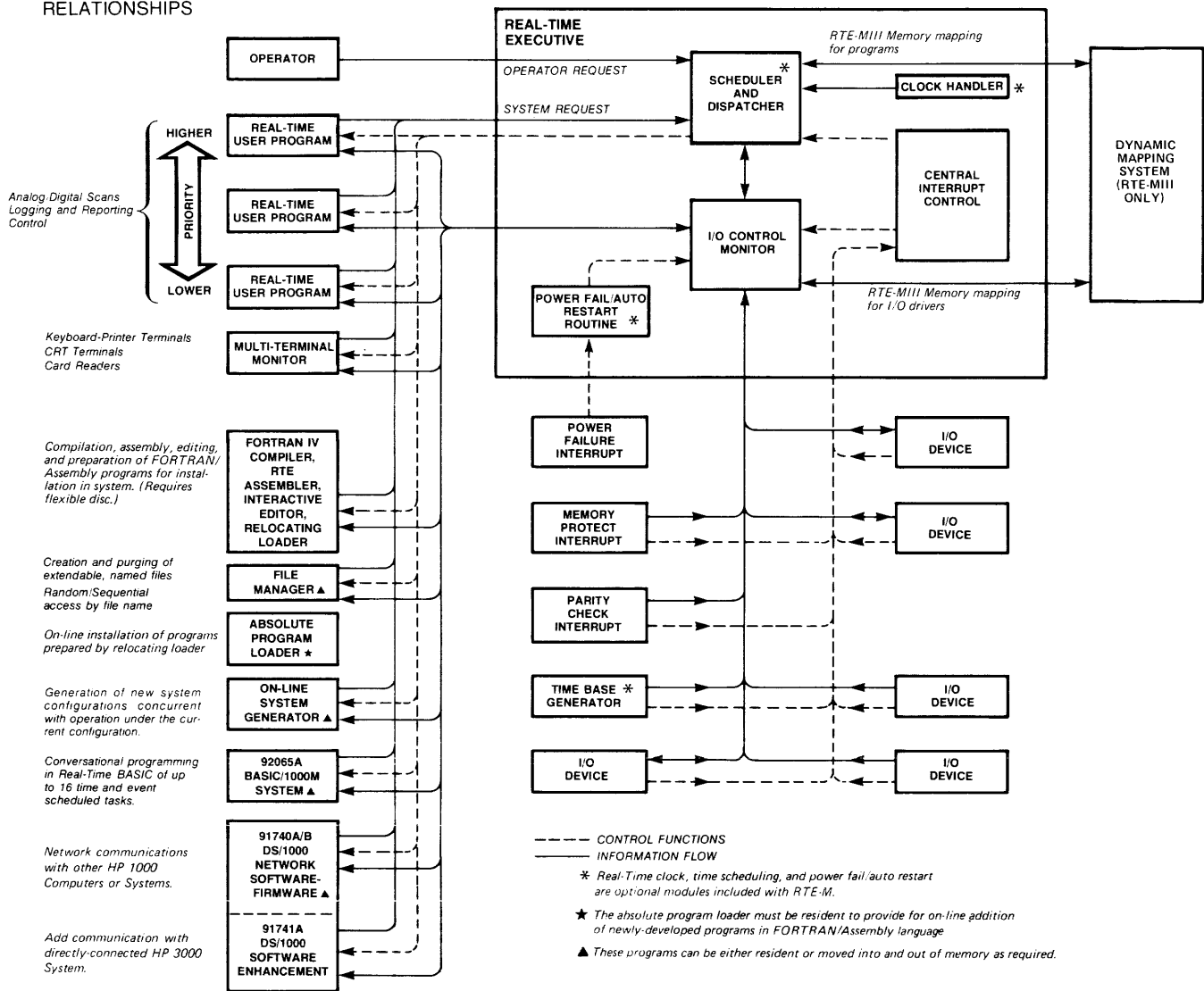
The system also offers a privileged interrupt capability that can be used to bypass normal interrupt processing for fastest response to interrupts having the greatest urgency or high frequency, such as modem communications in DS/1000 networks.

## System integrity

The integrity of the RTE-M system can be protected by the following provisions:

- Auto restart after power failure (optional).
- "Fence" register protection of the resident system, library, and common, and real-time programs in RTE-MII/MIII.
- Protection of mapped programs from each other (RTE-MIII only).
- Optional exclusive assignment protection of system resources being used by a program.

# RTE-M FUNCTIONAL RELATIONSHIPS



## Input/output

An I/O scheduling and control monitor provides I/O operation concurrent with program execution, using only one I/O driver for each group of like devices. It also provides:

- A waiting list of backlogged I/O work for keeping each I/O device optimally utilized.
- I/O timeout capability for detecting I/O conditions that could stall the system (optional).
- I/O suspension with automatic rescheduling of programs waiting for I/O service to make processing time available to other programs that can do useful work.
- Output buffering that lets a program initiate an I/O operation then continue on to completion or suspend until that operation has been completed (optional in RTE-MI, standard in RTE-MII/MIII).
- Mailbox data exchange (class I/O) that lets the user set up specific buffers for terminal-to-program or program-to-program communication instead of using common (optional in RTE-MII/MIII).
- Resource management for the exclusive assignment of any system resource that can be accessed by a user program, which optionally can be used to assure that a

low priority program completes its use of a printer, for example, without having that use pre-empted by a higher-priority program (optional in RTE-MII/MIII).

- Automatic downing of I/O devices on a controller when they encounter an equipment error that could stall the system, without affecting other devices on the same controller.

## Multi-Terminal Monitor

A Multi-Terminal Monitor (optional in RTE-MII/MIII) coordinates multi-terminal access to the system. Multiple users can edit or run other program processing jobs from several terminals at the same time, concurrently with other real-time operations.

## Multipoint terminal subsystem software (optional)

Optionally, RTE-MIII systems can be equipped with 91730A Multipoint terminal subsystem software for 2645A/2648A CRT terminals interfaced to the computer via HP's new 12790A multipoint interface. For more information, see the 91730A and 12790A data sheets in the HP 1000 Computers and Systems Distributed Systems and Communications Data book.

## On-line program development

The real-time multiprogramming design of the system makes possible on-line program preparation concurrent with real-time operations when the system is equipped with a flexible disc. This is supported by the following standard and optional software:

- FORTRAN IV Compiler.
- RTE Assembler
- Optional 92065A BASIC/1000M system for conversational development of programs in HP Real-Time BASIC\*
- Relocating Loader that provides either base page or current page linking of programs that cross page boundaries\*
- File Manager
- Interactive Text Editor
- Real-Time I/O drivers for peripheral subsystems
- Absolute Program Loader\*

*\*Flexible disc is not required for this software item*

## File management

The RTE-M system includes a flexible disc based file manager for creating, opening, writing, reading, listing, copying, closing, and purging of automatically-extendable, named program and data files on the flexible disc only. The RTE-M file manager is generally upward compatible with the RTE-II/III/IV Batch-Spool Monitor. The RTE-M system also includes a file manager based on 2645A/48A mini cartridge tapes only, for creating, opening, reading, writing, copying, or closing named data files.

## Interactive editing

Entry and correction of ASCII data or program files on the flexible disc are greatly facilitated by a powerful interactive editor which is provided in the 92064A+040 version of RTE-M. This editor provides character string search and correction capabilities that let the user locate and change all occurrences of a particular string of characters throughout a file or only in specific lines of a file. Of course, this extra capability is in addition to the usual line or character display, insertion, replacement, and deletion capabilities normally expected in a program or text editor.

## On-line program installation

By using the optional absolute program loader, the system can dynamically incorporate new programs as needed, without regeneration or interruption of existing operations.

## Supporting drivers

Drivers for supported data processing peripherals are included in the RTE-M system. This assures that the routines are available when needed, and simplifies storage.

## System generation and configuration changeover

The modular nature of the RTE-M software makes it easy to configure a system tailored to your particular requirements, including application requirements for input/output peripherals, instrumentation, and optional software modules. This is accomplished interactively through a systematic dialog between the user and the system generator in which the essential parameters of the configuration are specified

and appropriate software modules are loaded into the system. In RTE-MIII, additional systems can be generated on-line concurrently with other operations and stored in disc files. Start up from any system on the currently-mounted flexible disc is easily accomplished by addressing provided in the flexible disc ROM loader.

## Soft key utilities

Soft key utilities included with RTE-M facilitate the establishment of single-keystroke commands using the programmable "soft" keys on the 2645A/48A CRT Terminal that serves as system console, or an auxiliary 2645A/48A terminal that also uses driver DVR05 or DVA05. The KEYS utility provides for creation, change, or listing of soft key command sets (up to eight single keystroke commands per set) and the transfer of the current soft key command set to the CRT Terminal that is to use it, or to a disc or Mini cartridge file or CRT cartridge tape LU to save it. Each keystroke command can be used to issue an RTE-M system or software subsystem command up to 80 characters long. A KYDMP utility is provided for use in RTE-M systems whose limited memory precludes the file manager being in memory at all times. KYDMP provides for transfer of a soft key command set from an LU or file to the terminal that is to use it.

## DS/1000 network operations

**HP 1000-to-HP 1000.** RTE-MII/MIII based HP 1000 Computer Systems with 91740A/B DS/1000 Network software-firmware support DS/1000 distributed systems network communications with other RTE-M or RTE-IV based HP 1000 systems. Supported capabilities include network-wide nodal addressing with automatic store-and forward, remote command processing, program-to-program data exchange, remote file access, remote exec calls, and remote I/O. RTE-M nodes can be supported with remote system generation and remote program development with down-loading of either or both from a neighboring RTE-IV based HP 1000 Computer System.

**HP 1000-to-HP 3000.** With the addition of the 91741A DS/1000 software enhancement to 91740A/B, RTE-M based HP 1000 Computer Systems can also communicate with suitably-equipped HP 3000 Systems. (RTE-MIII configuration is required for simultaneous support of both HP 1000-to-HP 1000 and HP 1000-to-HP 3000 communication.) Thus equipped, the RTE-M based HP 1000 system can function as a virtual terminal to the HP 3000, gaining access to facilities not available on the HP 1000, such as the COBOL compiler and QUERY/3000. Other capabilities supported include program-to-program data exchange and remote file access. The HP 3000 system can also issue remote exec commands to the RTE-M based HP 1000 system for remote I/O, program scheduling, and time and device status requests.

## Functional specifications

### Type of operating system

Memory-based real-time multiprogramming.

### Basis of program scheduling for execution

By operator or optionally by time, event, or another program, in order of program priority.

### Program priority levels

1 through 32,767, the lowest number designating highest priority.

## Main memory capacity

RTE-MI/MII configuration: 65,536 bytes (32 pages).

RTE-MIII configuration: 2,097,152 bytes (1024 pages).

## Operational requirements for HP 1000 Computer Systems

The HP 1000 Model 20 and 25 Computer Systems satisfy operational requirements for real-time BASIC program development and execution; time, event, and program-to-program scheduled multiprogram execution of FORTRAN IV, and/or HP Assembly language programs prepared on another system; and system generation†.

### FORTRAN and Assembly programming

Development of FORTRAN and HP Assembly language programs requires addition of 2174/2175 Flexible Disc option 032 to the base HP 1000 Model 20 or 25 System.

†The base HP 1000 Model 20 or 25 system supports both on-line and off-line system generation; however memory limitations may prevent successful on-line generation of some configurations; the multi-user program development configuration (below) is also recommended for on-line system generation.

### Multi-user program development

Multi-user development of BASIC, FORTRAN, or HP Assembly language programs requires the following additions to the base HP 1000 Model 20 or 25 System (also provides recommended configuration for on-line system generation):

1. 2174/2175 Flexible Disc option 032.
2. Memory expansion to 128k bytes or more.

## Operational requirements for user-assembled systems

The operational requirements for user-assembled RTE-M systems differ according to the functions that the system is expected to perform, as follows:

### Minimum, single-program execute only system

An RTE-M system to run single FORTRAN or HP Assembly language programs developed on another system requires:

1. HP 2105\*, 2108, 2109, 2111, 2112, 2113 or 2117 Computer with at least 32k byte memory.
2. Any supported system console and any supported standard input unit.

### Multiprogram execute only system

For an RTE-M system to run multiple FORTRAN or HP Assembly language programs developed on another system, add 12892 Memory Protect to the minimum system.

\*2105 is compatible only with RTE-MI, not with RTE-MII or MIII.

### Real-time BASIC program development and execution

Addition of single-user BASIC program development and execution to the system requires the following additions to the minimum system:

1. Enough memory to provide at least 48k bytes.
2. 92065A BASIC/1000M system.

### FORTRAN and Assembly programming

Development of FORTRAN and HP Assembly language programs requires the following additions to the minimum system:

1. Enough memory to provide 48k bytes.
2. 12897A/B Dual-Channel Port Controller.
3. 12732A Flexible Disc Subsystem.

## System generation

System generation requires the following additions to the minimum system:

1. Enough memory to provide 48k bytes.
2. Either a system console with Mini cartridge I/O (2645A/2648A+007,030 with 13260B) or 12732A Flexible Disc Subsystem and 12897 Dual-Channel Port Controller).

### Multi-user program development and on-line system generation

Multi-user development of FORTRAN or HP Assembly language programs (also BASIC programs with 92065A) requires the following additions to the minimum system (also supports on-line system generation):

1. Enough memory to provide at least 96k bytes.
2. 12976 Dynamic Mapping System for 2108 or 2112 Computer or 13304A Firmware Accessory Board and 13305A Dynamic Mapping System for 2109, 2111, 2113 or 2117 Computer.
3. 12987 Dual-Channel Port Controller.
4. 12732A Flexible Disc Subsystem (also requires 12897 Dual-Channel Port Controller).

### Real-time clock, I/O timeout, and time scheduling of programs

Real-time clock, I/O timeout, and time scheduling of programs requires the addition of the 12539C Time Base Generator to the system (can be execute-only system).

## Supported system consoles

- 2645A/2648A+007, 030 CRT Terminal with 13260B Extended Asynchronous Communication and 12966A+001 interface (preferred because it combines the functions of system console and Mini cartridge standard I/O unit)
- 2644A+020\* CRT Terminal with 12966A+001 interface
- 2631A+051 Printing Terminal with 12966A+001 interface
- 2640A\*/2640B CRT Terminal with 12880A+001 interface
- 2762A/B\* Terminal Printer with 12531D+001 interface
- 2752A\* Teleprinter with 12531C interface

## Supported standard I/O units

- Mini cartridge I/O on 2645A/2648A+007 or 2644A\*
- 12732A Flexible Disc Subsystem.
- 12925A Tape Reader Subsystem for punched tape input and 12926A Tape Punch for punched tape output.

\*Identifies product no longer available that is listed here for reference only.

## Memory requirements (bytes)

The following requirements are additive for resident memory. With respect to programs added after system generation, the user memory area must be large enough to accommodate the largest single program that will be run in it. Mapped RTE-MIII partitions must be large enough to accommodate the largest program that will be run in them, plus 2048 bytes for base page, which is part of each mapped partition in RTE-MIII.

Software Items	Resident Memory	User Program Area
RTE-MI base system	11,800*	
RTE-MII base system	13,400*	
RTE-MIII base system	14,800*	
Flexible disc driver DVR33	1,150*	
Program-to-program scheduler module†	640*	
I/O buffering module†	340*	
Real-time clock and I/O timeout module	220*	
Time scheduling of programs module	980*	
Additional on-line operator commands module	1,220*	
Resource management module	200*	
Mailbox data exchange module	800*	
Auto restart after power failure module	520*	
File directory access modules		
(Mini cartridge, RTE-MI)	1,164*	
(Mini cartridge, RTE-MII/MIII)	1,100*	
(Flexible disc, RTE-MI)	2,160*	
(Flexible disc, RTE-MII/MIII)	2,050*	
Absolute program loader (Mini cartridge)	3,400*	
Absolute program loader (Flexible disc)	5,060*	
Multi-terminal monitor	800*	
KEYS Utility		11k
KYDMP Utility		4k
FORTTRAN IV compiler and symbol table		28-32k <sup>1</sup>
FORTTRAN II compiler and symbol table		24-32k <sup>1</sup>
RTE Assembler and symbol table		24-32k <sup>1</sup>
Cross-Ref Table Generator		14-20k <sup>1</sup>
BASIC/1000M		24k
File Manager (Mini cartridge)		16k
File Manager (Flexible disc)		20k
Interactive Editor		20-24k <sup>1</sup>
Relocating Loader		20-24k <sup>1</sup>
System generator		30k
Optional 91730A Multipoint software	2,400*	

\*These module sizes are approximate and are subject to growth of no more than 10% if current page linking is used.

†These modules are optional only in RTE-MI; they are included in RTE-MII and RTE-MIII.

<sup>1</sup>The size of User Program Area (plus system available memory) required depends partly on program or buffer size used; short programs or small buffers will be processable in the smallest size given; larger programs or buffers may take more space, up to the maximum size given.

### On-line operator requests

1. Turn programs on or off.
2. Suspend user program, either executing or scheduled.
3. Activate user program.
4. List programs currently executing in the system.
5. List status of any program.
6. List status of any partition (RTE-MIII only).
7. Change priority and timing of programs <sup>1</sup>.
8. Examine I/O device status; dynamically alter device buffering assignments<sup>2</sup>.
9. Dynamically alter device logical unit assignments.<sup>2</sup>
10. Control I/O device availability.
11. Dynamically alter device I/O timeout parameters<sup>3</sup>.
12. Set the real-time clock<sup>3</sup>.
13. Print time (time-of-day, day, and year)<sup>3</sup>.
14. Display or establish limits on use of system available memory for output buffering<sup>2</sup>.
15. Indicate change of left or right Mini cartridge in CRT system console.
16. Compile FORTTRAN IV programs or assemble programs with flexible disc.

17. Enter, test, change, and run Real-Time BASIC programs with BASIC/1000M system.
18. Edit program or data files.
19. Convert relocatable programs and subroutines to absolute form for loading into memory.
20. On-line program installation and removal.
21. Generate a new system configuration.
22. Create files on Mini cartridge or flexible disc.
23. Copy files from Mini cartridge to flexible disc, or vice versa.
24. List contents of file directory.
25. Purge files from Mini cartridge or flexible disc.

### System requests from programs

1. Read from any non-disc input device with or without wait.
2. Write to any non-disc output device with or without wait.
3. Access flexible disc file via file management subroutines.
4. Get status of queued read requests, or the resulting input data.
5. Check I/O device status.
6. Control functions on magnetic tape unit or other peripheral device.
7. Schedule programs to be run, with or without wait for completion of the called program.
8. Make dormant or suspend self or other program.
9. Obtain current year, day, and time of day<sup>3</sup>.
10. Change time scheduling of self or other program<sup>1</sup>.
11. Allocate/release I/O devices or other system resources for own exclusive use<sup>4</sup>.
12. Request resource lock/unlock<sup>4</sup>.
13. Request device lock/unlock<sup>4</sup>.
14. Request partition status (RTE-MIII only).
15. Create files (Flexible disc only).
16. Rename files (Flexible disc only).
17. Purge files (Flexible disc only).
18. Open files.
19. Write on a random or sequential file.
20. Read from a random or sequential file.
21. Locate file (Mini cartridge or Flexible disc).
22. Close a file (Mini cartridge or Flexible disc).
23. Write EOF on Mini cartridge file.

<sup>1</sup>Timing control of programs requires time-of-day clock and time scheduling modules.

<sup>2</sup>These commands are provided in the additional on-line commands module.

<sup>3</sup>Time-of-day and timeout control requires the real-time clock and I/O timeout module.

<sup>4</sup>These commands require the resource management module (optional in RTE-MIII/MIII).

## Ordering information

### 92064A RTE-M operating system (for user-assembled systems)

RTE-M consists of:

1. One of software media choice options 020 or 040, which must be specified on the order.
2. RTE-M Programming and Operating Manual (92064-90002).
3. RTE-M System Generation Manual (92064-90003).
4. RTE-M Editor Manual (92064-90004).
5. 92064A Software Numbering Catalog (92064-90001).

6. FORTRAN Manual (02116-9015).
7. FORTRAN IV manual (92060-90023).
8. RTE/DOS Program Libraries Manual (24998-90001).
9. 21MX Assembler Manual (92060-90005).
10. Multi-device driver DVR00 manual (29029-95001).
11. 264x CRT Terminal driver DVR05/DVA05 manual (92001-90015).
12. 7210A Graphic Plotter driver DVR10 manual (17210-90004).
13. CalComp Plotter driver DVR10 manual (12560-90023).
14. 3070A data entry Terminal driver DVA47 manual (92900-90005).
15. 2892A Card Reader driver DVR11 manual (09600-93010).
16. 2607A Line Printer driver DVA12 manual (92200-93001).
17. 2767A Printer driver DVR12 manual (92001-90010).
18. 91200B TV interface driver DVA13 manual (91200-90005).
19. 7261A Optical Mark Reader driver DVR15 manual (07261-90010).
20. 7970 9-track Mag Tape driver DVR23 manual (92202-93003).
21. 59310B HP-IB Interface driver DVR37 manual (59310-90063).
22. 12732A Flexible Disc driver DVR33 manual (12732-90001).
23. 92062A Software Numbering Catalog (92062-90001).
24. RTE Operating System Drivers and Device Subroutines Programming and Operating manual (92200-93005).
25. RTE Utilities manual (92060-90017).
26. RTE-M Pocket Guide (92064-90007).
27. 2631A/5A Printer Utility Subroutine manual (92062-90003).

### 92064A RTE-M options

- 001 Upgrades customers from mini cartridge RTE-M to flexible disc RTE-M or from 2300B RTE-B or 2300C RTE-C system to 92064A RTE-M system. RTE-B upgrade must also include purchase of 92065A BASIC/1000M.
- 020 Provides software on the following 9162-0061 Mini cartridges for read-in by 2645A+007, 030 or 2644A+020 CRT Terminal:
  1. RTE-MI operating system (92064-13301), including optional modules for output buffering, program-to-program scheduling, real-time clock, time scheduling, additional on-line commands, and dummy library.
  2. RTE-MII operating system (92064-13302), including optional modules for real-time clock, time scheduling, additional on-line commands, resource management, mailbox data exchange, and dummy library.
  3. RTE-MIII operating system (92064-13303), including optional modules for real-time clock, time scheduling, additional on-line commands, resource management, class I/O, and dummy library.
  4. Mini cartridge file management program, file directory access, soft key utilities, and power fail/ auto restart modules (92064-13304).

5. Relocating loader, absolute program loader, system generator, file manager, and multi-terminal monitor modules (92064-13305).
6. System libraries (92064-13306).
7. Off-line generator (92064-13307).
8. RTE/DOS relocatable library (92060-13302).
9. RTE/DOS FORTRAN formatters (92060-13303).
10. RTE Driver Mini cartridges 92062-13302 through 13304 (see list of drivers in the 92062B data sheet).

**040** Provides software on the following flexible discs for read-in by the 12732A Flexible Disc Subsystem:

1. Generation disc (92064-13401), including all software items provided in option 020 plus flexible disc versions of the file management program, file manager, and file directory access modules.
2. Program preparation disc (92064-13402), including the FORTRAN IV compiler, Assembler, Cross-Reference Symbol Table Generator, Flexible Disc File Manager modules, Relocating Loader and supporting subroutines, Editor, RTE and RTE-M system libraries, soft key utilities, and Multi-terminal monitor modules.

### RTE-M operating system in HP 1000 Computer Systems

The 92064A RTE-M operating system with Mini cartridge option 020 is included in HP 1000 Model 20 (2174A/B) or 25 (2175A/B) Computer Systems. Flexible disc option 032 to 2174A/B or 2175A/B substitutes 92064A flexible disc option 040 for Mini cartridge option 020.

### 92064S Software Subscription Service

The 92064S Software Subscription Service provides software and manual updates as required to keep your RTE-M system current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92830A Software Notification Service is also included. The 92064S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92064T, must be specified when ordering 92064S.

### 92064T Comprehensive Software Support

The 92064T Comprehensive Software Support includes the Software Subscription Service, as described under 92064S, above, and a Phone-In Consulting Service for discussion of questions on your RTE-M software with a qualified HP Systems Engineer. The 92064T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92064S and 92064T media options

- 020:** Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.
- 040:** Software updates on flexible disc for read-in via 2174A/B or 2175A/B option 032 or 12732A Flexible disc subsystem.

### 92064T option 200

92064T option 200 provides a discount for Comprehensive Software Support of an additional copy of RTE-M.





# RTE-IV real-time executive operating system

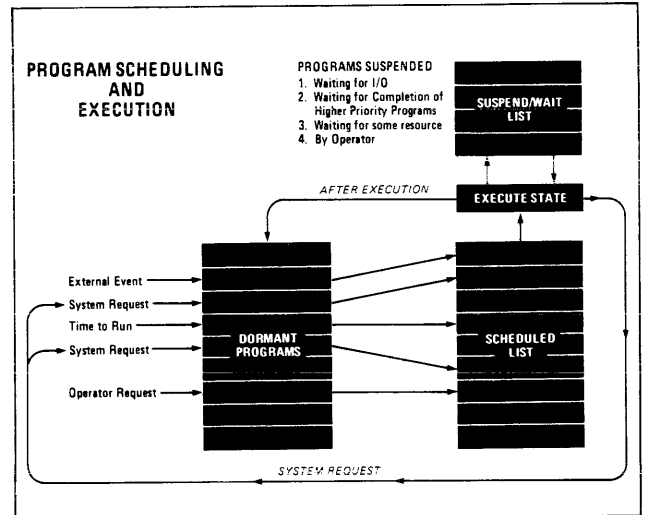
model 92067A

The 92067A RTE-IV is a disc-based Real-Time Executive operating system used for management of the operations and resources of HP 1000 Model 40 and 45 Computer Systems and user-assembled systems based on Hewlett-Packard 2108, 2109, 2111, 2112, 2113, or 2117 Computers.

## Features

- Management of up to 64 disc-resident program partitions in up to 2.048 Megabytes of memory
- Non-swappable memory resident programs
- Up to 56k bytes for user's program code, data, and base page linkages independent of physical memory used by the operating system and drivers, plus addressing of extended memory area for data limited only by available memory (nearly 2 Megabytes in a 2.048 Megabyte system).
- Support for choice of 4.9, 14.7, 19.6, or 50M byte system disc, the latter expandable to 400M byte capacity with additional 50M byte disc drives
- Batch-Spool Monitor for concurrent disc file management and batch processing.
- Concurrent execution and development of BASIC (optional), FORTRAN IV, and Assembly language programs
- FORTRAN IV compiler support of user-transparent program access to large data arrays
- Interactive debug package and interactive editor to aid program development
- Optional RTE microprogramming package for on-line development of user-microprogrammed subroutines for faster data processing by the computer
- True multi-terminal program development in all program languages using input and output files
- Memory, partition, and I/O reconfigurability at boot-up
- Input/output spooling to disc to speed throughput with minimal use of main memory for buffering
- RTE drivers and device subroutines for supported peripherals included with the system
- Support of optional IMAGE/1000 Data Base Management System for more efficient use of data files, easier access to data
- Time, event, and program-to-program scheduling for real-time measurement, control, and/or automatic test applications
- Support of multiple instrument clusters connected via the Hewlett-Packard Interface Bus (HP-IB)
- Support of optional DS/1000 software-firmware for communication with other HP 1000 Computer Systems and/or with HP 3000 Systems.
- Distribution on disc cartridge or 800/1600 bpi magnetic tape

*\*The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's implementation of IEEE Standard 488-1975, "Digital Interface for programmable instrumentation" and identical ANSI Standard MC1.1.*



## RTE-IV — Unprecedented power and flexibility for computational applications

RTE-IV is Hewlett-Packard's next generation, mapped-memory, disc-based real-time executive operating system. Though based upon previous disc-based RTE systems which have been put to work with outstanding success in thousands of installations throughout the world since 1968, RTE-IV provides a significant jump in computational support capability over previous models, as discussed in the following paragraphs.

### More partition space for the user

In RTE-IV, maximum user partition space is 56k bytes, (including the user's 2k byte base page), a capacity that is not diminished by the physical memory allocated to the operating system, I/O drivers, or resident library.

### Even more memory space for large data arrays

Through the use of a new Extended Memory Area (EMA) capability, data arrays over 33 times larger than the maximum user partition space can be processed by user's programs in systems with 2.048 megabytes of memory. The area available for data is equal to total physical memory less the memory allocated to the system, I/O drivers, resident programs, COMMON areas, and user's disc-resident programs. This EMA capability makes it possible for HP 1000 computers and systems to tackle problems that formerly could be handled only by far more expensive machines. Moreover, because all data is in main memory, processing is faster than many systems that use a disc-virtual memory addressing scheme.

## Exceptional flexibility

One or more disc-resident programs using their own Extended Memory Areas for data being processed can be executed concurrently. A disc-resident program using a large EMA area may occupy all of the space of a large partition, called a "mother" partition. When that use is completed, other multiple EMA or non-EMA programs with smaller memory space requirements can run in sub-partitions of the "mother" partition. Thus, large-scale computational needs and extensive multi-user operations can be handled easily in the same system without regeneration or reconfiguration.

## Functional description

RTE-IV is a member of Hewlett-Packard's compatible family of real-time executive operating systems, which also includes the memory-based RTE-M system. It thus shares and expands upon the capabilities of the entire RTE family, as described below.

### Real-time multiprogramming

The RTE system supervises the execution of multiple programs, effectively converting a single disc-based system to several systems, each serving one of several different users. The system can be receiving and responding to data inputs, retrieving data, running computations, printing out reports, processing programs, or performing other jobs for various users at the same time. In addition to providing several systems in one, multiprogramming makes it easy to match the diverse needs of real-time measurement and control or automatic testing applications in manufacturing and research.

**Scheduling.** Multiple programs running under control of the RTE-IV system are executed on a scheduled basis, as shown in the diagram on the previous page. The system lists all programs in order of priority that are ready for execution. Programs are placed in this list when requested by the operator, when it is time for them to run on a regularly-scheduled basis, when an external event interrupt calls for program execution, or when requested by another program.

**Priorities and execution.** Priority scheduling gives exceptionally fine control over which tasks are executed first, using priority levels from 1 through 32767. Execution is started immediately for the highest priority (lowest priority number) scheduled program. Programs may be scheduled to run at time intervals, with resolutions as small as tens of milliseconds. If a higher-priority (lower priority number) becomes scheduled, that program starts execution and the current program is temporarily suspended.

**Dynamic memory mapping.** The RTE-IV system provides fast multiprogram access to as much as 2.048 megabytes of physical memory by a logical-to-physical address translation using memory maps and the Dynamic Mapping System in the system computer. When it's time for a program to run, RTE-IV sets up the appropriate map for that program in the Dynamic Mapping System. Thereafter memory addressing through the map is automatic and completely independent of RTE-IV, although RTE-IV may modify the map during program execution as discussed in the section on memory management.

**Disc-resident program swapping.** In addition to memory-resident program space, the RTE-IV system manages up to 64 disc-resident partitions in memory. When a disc-resident program moves to the top of the scheduled list, the system dispatches it in an appropriate partition (after swapping out any program that may be in that partition). Swapping greatly extends system program capacity while providing fast response for higher priority programs. Higher priority programs do not have to wait for completion of lower priority programs before being granted execution space and time. As the new program begins execution, the system enters its memory map into the Dynamic Mapping System, as noted above.

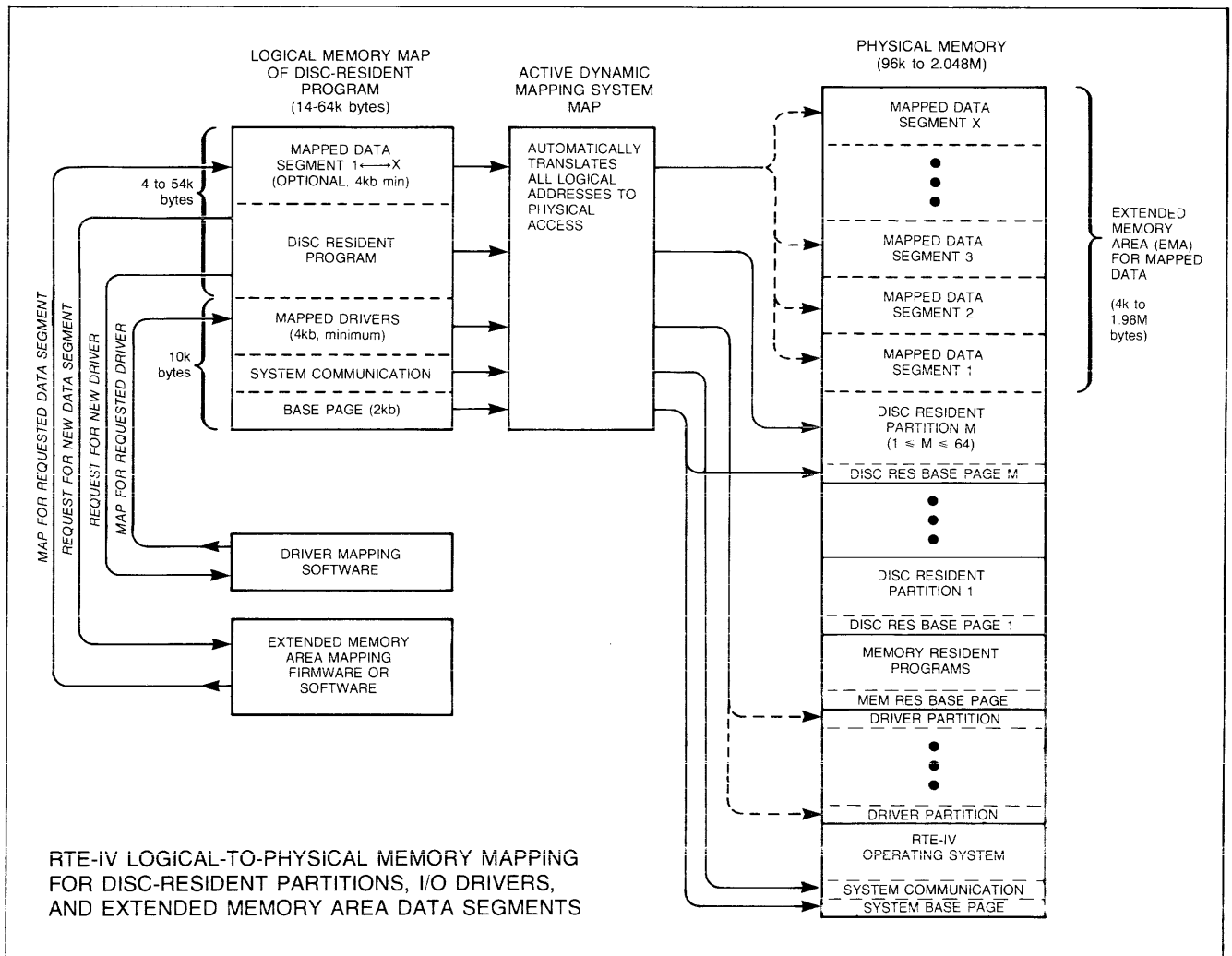
### Memory management

**Program partitions.** Memory partitions are defined during system generation and can be redefined at system boot-up. Program partitions in RTE-IV can be as large as the available amount of physical memory. They can be all of the same type or they can be divided into real-time and background categories. Disc-resident programs, when scheduled for execution, will be loaded into the smallest available partition or, if none is available, will force the swapping of the lowest priority program in a partition of suitable size. To further increase throughput, programs can be assigned to a particular disc-resident partition and will thus only be loaded into that partition. The maximum executable user code in a partition is 54k bytes, as shown in the diagram (facing).

**Mother partition.** A partition in RTE-IV that can be larger than the maximum code address space is called a "mother partition". This partition allows for sub-partitions. RTE-IV uses mother partitions to dispatch programs that use an Extended Memory Area (EMA). Subpartitions of a mother partition have the same characteristics (real-time or background) as the mother partition, and they give the user the capability of using the large amount of memory assigned to the mother partition to run many smaller programs when the mother partition is not in use.

**Extended Memory Area (EMA) for data.** The Extended Memory Area (EMA) is an area for arrays or other data that extends the logical address space up to the available physical memory. One or more small or very large arrays may reside in the EMA. An EMA can extend well beyond the maximum program-addressable space by occupying the available memory in the program's partition that extends beyond the program's logical address space. At least two pages are reserved in the program's logical address space for the mapping of a window segment (MSEG) of the EMA. When an EMA element needs to be accessed, the appropriate segment of the EMA containing the required element is mapped into the program's logical address space. This mapping requires no disc swaps; therefore it is very fast. EMA mapping is quickest in HP 1000 E and F-Series computers, which use fast-executing firmware subroutines; in HP 1000 M-Series computers, software subroutines are used for EMA mapping.

A segmented program may use EMA, thus allowing many separate operations to be performed on the same EMA (one segment can read in the data, a second can process it, and a third can save the results).



Extended Memory Areas are used for large amounts of data storage, acquisition, and processing. Because EMA data accessing does not involve disc access, it is useful for data acquisition from fast devices at real-time rates. EMAs are also useful for data processing that requires a lot of data accessing from random locations, such as sorting. Scientific applications using large matrices, including matrix inversion, can be performed with ease and speed.

### EMA programming

Standard FORTRAN I/O and array accesses to arrays residing in EMA, using subscripts, are handled without any special action by the user. User's FORTRAN IV programs access the EMA as a named COMMON. This COMMON may have any of the usual entries in it, except that the total address space of any array may exceed 64k bytes and may be as large as nearly 2 Megabytes. The user designates that a particular COMMON is an EMA COMMON with the following statement.

**\$EMA (COMMON name, MSEG window size in pages of memory)**

The use of EMA is illustrated in the following program example:

```

$EMA(COMMM,3)
PROGRAM EX
COMMON/COMMM/A(100,2000),C(3000,80)
.
EQUIVALENCE(A(99,1000),B)
.
B=SIN(A(J,K))
S=UFUNC(A(J,K))
.

```

From the EMA statement and the contents of the program, the RTE FORTRAN IV compiler generates all needed EMA map requests. The ability to declare EMA access is also provided in the RTE Assembler, so the assembly language programmer may generate the required mapping subroutine calls.

### Interrupt processing

RTE-IV uses the multi-priority level, vectored hardware interrupt system of the HP 1000 computer for power fail detection, memory protect violation, parity error, and time base inputs, as well as for peripheral I/O and user-interfaced equipment. When one or more interrupts occur simultaneously, the interrupt with the highest hardware priority is recognized first, but the system also remembers the other interrupts, so no interrupt is forgotten or overlooked.

# RTE-IV FUNCTIONAL RELATIONSHIPS



Analog/digital scans,  
Quick-look data logging,  
and Control

Computation, array scans and sorts, logging,  
plotting, and reporting

Interactive user debugging of programs  
under development

Interactive editing of program or text files with powerful  
character string search and replacement capabilities

On-line or batch development of user's  
application programs

Coordinates access to system resources by CRT  
terminals, keyboard-printer terminals, and  
card readers

Entry of program development and other batch  
processing jobs

Creation, reading, writing, and/or purging of  
extendable, named files

Input/output via spool files

Generation of new system concurrently with  
operation under the present system

Switchover from the current system to other  
system in disc file

Multi-user conversational programming in real-time  
BASIC of up to 16 time-and-event-scheduled tasks

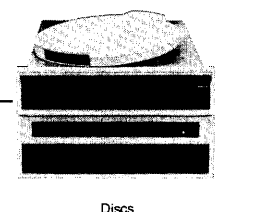
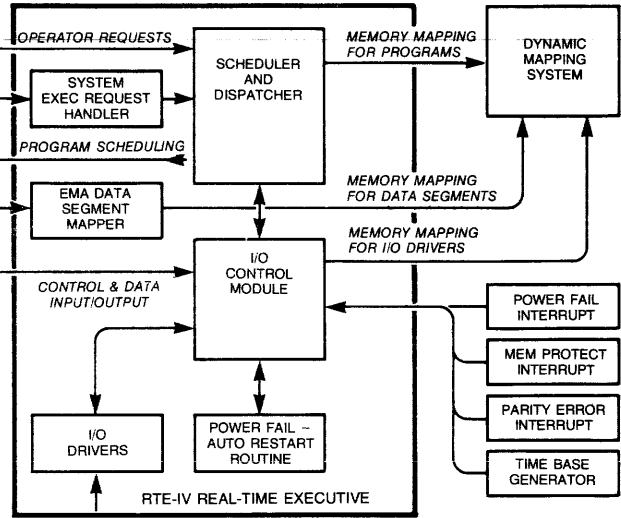
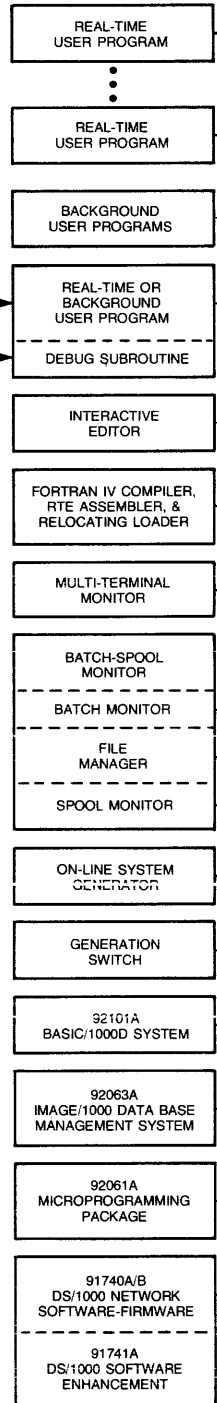
Establishment, updating, restructuring, and back-up of  
on-line data base. English-like QUERY access by non-  
programmers

Preparation, installation, testing, and application  
of user-developed microprogrammed subroutines

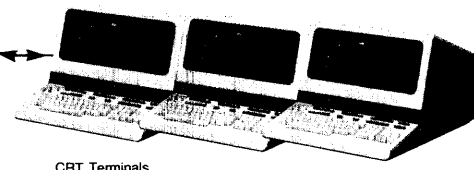
Network communications with other HP 1000  
Computers or Systems with nodal addressing  
and store-and-forward message handling

Adds communication with directly-connected  
HP 3000 System

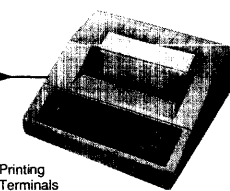
HIGHER  
↑  
PRIORITY  
↓  
LOWER



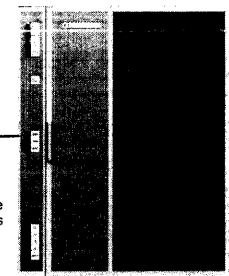
Discs



CRT Terminals



Printing Terminals



Mag Tape Units

Line printers,  
plotters,  
measurement and control peripherals  
and other I/O devices

## Privileged interrupt

The system also offers a privileged interrupt capability that can be used to bypass normal RTE-IV interrupt processing for fastest response to interrupts having the greatest urgency or highest frequency.

## System integrity

The integrity of the RTE-IV system is protected by the following provisions:

- Auto restart after power failure.
- "Fence" register protection of the system table areas, driver partitions, COMMON, and base page from program alteration
- Dynamic Mapping System protection between the system, memory-resident programs, and disc-resident programs.
- Write protection of the drivers, system, table areas, and base page
- Continued execution on parity error encountered in a user program (hard parity error aborts only program encountering it; system notifies operator and automatically downs affected partition until next boot-up). (Parity error in system will halt the system.)
- Automatic "downing" (with a message to the operator) of I/O device that failed to respond within a predetermined time (I/O device timeout)
- Optional exclusive assignment protection of disc tracks
- Optional security code protection of disc files from unauthorized access
- Hardware protection of system memory image tracks on the disc

## Input/output

An I/O control module manages I/O operations, which proceed concurrently with program execution, using only one I/O driver for each group of similar devices. It performs memory mapping for I/O drivers and also provides:

- A waiting list of backlogged I/O work for keeping each I/O device optimally utilized.
- I/O timeout capability for detecting I/O conditions that could stall the system
- I/O suspension with automatic rescheduling of programs waiting for I/O service to make processing time available to other programs that can perform useful work.
- I/O buffering that lets a program initiate an I/O operation, then continue execution while the I/O is in progress, rather than suspending for I/O completion
- Mailbox data exchange (class I/O) that lets the user set up specific "mailbox" buffers for device-to-program or program-to-program communication instead of using COMMON
- Re-entrant I/O that provides for swap-out of a disc-resident program which has an active I/O request in progress in favor of a higher-priority program, speeding system response
- Exclusive assignment of I/O devices which, for example, can be used to assure that a low-priority program completes its use of a printer, without having that use preempted by another program.
- Automatic downing of I/O devices on a controller when they encounter an equipment error that could stall the system, without affecting other devices on the same controller.

## Multi-Terminal Monitor

An improved Multi-Terminal Monitor (MTM) coordinates multi-user access to all system facilities from up to 16 different terminals. The MTM gives each terminal user access to

1. Automatically schedules a previously-created copy of the File Manager, sets it up to communicate with that terminal, and executes a user-written transfer file for performing log-on functions.
2. When the operator requests the running of a program, the MTM automatically sets up an individually-identified copy for use by that terminal, so multiple users can run the same program without interfering with each other.
3. The MTM provides for terminal-specific BReak and ABort commands that the operator can use to interrupt or terminate the program currently executing in response to previous request from that terminal without interfering with other terminal users, even those running the same original program.

## Multipoint software (optional)

Optionally, the RTE-IV system can be equipped with 91730A Multipoint software for 2645A/2648A CRT terminals interfaced to the computer via HP's new 12790A multipoint interface. For more information, see the 91730A and 12790A data sheets in the HP 1000 Computers and Systems Distributed Systems and Communications Data Book.

## On-line multi-user program development

The disc-based real-time multiprogramming design of RTE-IV makes possible on-line program processing concurrent with real-time operations. All program development and loading is done from disc files, so there is no restriction on multiple use of any program development facility. Program development in RTE-IV is supported by the following standard and optional disc-based software:

- RTE FORTRAN IV Compiler, which provides automatic generation of map requests for EMA programs
- RTE Assembler, which includes ability to facilitate preparation of mapping subroutine calls by the programmer for EMA programs
- Cross-reference generator
- Optional 92101A multi-user Real-Time BASIC/1000D system for conversational development of programs in HP Real-Time BASIC
- Relocating loader
- Batch-Spool Monitor
- Interactive debug package
- Interactive text editor
- Real-time I/O drivers for peripheral subsystems
- Optional 92061A user microprogramming package

## File management, batch, and spooling

The Batch-Spool Monitor (BSM) provides:

- File management that includes creating, opening, writing, reading, listing, closing, and purging of automatically-extendable, named program and data files, as well as repacking, moving, and duplicating files

- Job-controlled program development and other data processing jobs, with device independent job I/O and job priority and time limit controls exercised by a simple, easily-used job command language, making possible unattended batch processing. All system-level operator commands may be incorporated in batch job stream files
- Input/output spooling that increases the number of jobs that can be backlogged for batch processing and moves large-capacity output buffering from main memory to the disc

### Interactive symbolic debugging

DBUGR, a program-callable or loader-appendable utility subroutine, provides user requests for examination and modification of the contents of memory locations and registers, insertion of a breakpoint, and the tracing of program execution. To facilitate interpretation, DBUGR translates machine language code back to assembly language mnemonics and octal numbers, which are more easily checked against assembly language listings generated by the Assembler or the FORTRAN IV compiler.

### Interactive editing

Editing to correct program bugs or to enter and correct program, data, or text files on the disc are greatly facilitated by a powerful interactive editor. This editor provides character string search and correction capabilities that let the user locate and change all occurrences of a particular string of characters throughout a file, or only in specific lines or columns of a file. Of course, this extra capability is in addition to the usual line or character display, insertion, replacement, and deletion capabilities normally expected in a program editor.

### Decimal arithmetic library

RTE-IV includes a decimal arithmetic library containing routines for addition, subtraction, multiplication, and division of decimal character string numbers that exceed the integer, floating point, and extended precision capabilities of the standard libraries.

### Data base management (optional)

RTE-IV supports IMAGE/1000, an optional Data Base Management System that provides:

- Consolidation of individual data files into a single, interrelated data base
- English-like QUERY language for keyword access to information for retrieval or updating by non-programmers
- Report generation with sorting and editing capabilities that simplify arrangement of data from the data base into easily-understood report formats
- Automatic linkage between related items of information
- Protection against unauthorized access down to the data item level

### On-line development of computer microprograms (optional)

Optionally, the RTE-IV system can be equipped with the 92061A RTE Microprogramming Package. This package provides a microprogram assembler, interactive debug editor, writable control store loader and driver routines, and PROM mask tape generator software for on-line development and testing of user-written microcoded subroutines for HP 1000 M, E, and F-Series Computers. This enables the user to improve performance by converting frequently-used

software routines to faster-executing microcoded routines. Microprogram development and testing can be accomplished concurrently with other program development operations.

### On-line system generation

The RTE-IV system is generated in an on-line mode, concurrent with other system activities, such as program development or interactive access to a data base. As needed, several different system configurations can be generated and stored in disc files for future use. Modular software makes it easy to configure an RTE-IV system tailored to particular application requirements for input/output peripherals, instrumentation, and optional software. This may be accomplished interactively through a systematic dialog between user and generator in which the parameters of the configuration are specified and appropriate software modules are retrieved from the disc and loaded into the system file. With the On-line Generator, the configuration can also be generated from a previously-entered response file on the disc, so that generation can proceed with minimal operator intervention.

### Easy system switchover

A special utility program is provided for switchover from operation under one system configuration to operation under another previously-generated configuration stored in a disc file.

### Reconfiguration at boot-up

At every boot-up, the user can elect to enter a reconfiguration dialog during which any or all of the following can be accomplished:

- Change of I/O select code assignments
- Identification of pages of memory that contain parity errors
- Change the total number of memory pages
- Change the size of system available memory
- Change the number and size of disc-resident partitions
- Change program assignments to specific partitions
- Change the size requirements of individual programs

The changes in I/O and memory configuration can be made temporarily, for only the current boot-up, or can be permanently incorporated into the system during the reconfiguration dialog. The ability to substantially reconfigure the system without regenerating it provides exceptional flexibility and saves considerable time and effort when the system configuration must be modified.

### Soft key utilities

Soft key utilities included with RTE-IV facilitate the establishment of single-keystroke commands using the programmable "soft" keys on the 2645A/48A CRT Terminal that serves as system console, or an auxiliary 2645A/48A terminal that also uses driver DVR05 or DVA05. The KEYS utility provides for creation, change, or listing of soft key command sets (up to eight single keystroke commands per set) and the transfer of the current soft key command set to the CRT Terminal that is to use it, or to a disc or Mini cartridge file or CRT cartridge tape LU to save it. Each keystroke command can be used to issue an RTE-IV system or software subsystem command up to 80 characters long. A KYDMP utility is provided for transfer of previously-developed soft key command sets from an LU or file to the terminal where such transfer is the only capability that is required.

## Master software update utility

A utility program is provided to facilitate updating of the grandfather disc, so that enhancements distributed on Mini cartridges as part of the 92067S Software Subscription Service or 92067T Comprehensive Software Support service can be incorporated easily.

## Disc backup utilities

Other utility programs provide for saving and restoring information from the disc to magnetic tape and vice versa. These same utilities also facilitate disc-to-disc copying.

## DS/1000 network operations (optional)

**HP 1000-to-HP 1000.** RTE-IV based HP 1000 Computer Systems with DS/1000 Network software-firmware support network communications with similarly-equipped RTE-IV, RTE-III, or RTE-M based HP 1000 Computer Systems. Supported capabilities include network-wide nodal addressing with automatic store-and-forward, remote command processing, program-to-program data exchange, remote file access, remote EXEC calls, and remote I/O. The RTE-IV based DS/1000 node can support other DS/1000 nodes with remote system generation and remote program development services. An RTE-IV terminal operator can generate absolute programs for RTE-M nodes and download them by operator command or program call. Relocatable programs for remote RTE-IV or RTE-III nodes can be generated by an RTE-IV terminal operator, transferred via the file copy routine, and loaded using remote command processing facilities. An RTE-IV terminal operator can also generate operating systems for remote RTE-IV, RTE-III, and RTE-M nodes and these must be loaded by an operator at the target node.

**HP 1000-to-HP 3000.** With the addition of the DS/1000 software enhancement to DS/1000 network software-firmware, RTE-IV based HP 1000 systems can also communicate with suitably-equipped HP 3000 systems. Thus equipped, the local RTE-IV based system can function as a virtual terminal to the HP 3000, gaining access to facilities not available on the HP 1000, such as the COBOL compiler and QUERY/3000. Other capabilities supported include program-to-program data exchange and remote file access. The HP 3000 system can also issue remote EXEC commands to the RTE-IV based HP 1000 system for remote I/O, program scheduling, and time and device status requests.

## Functional specifications

### Type of operating system

Disc-based real-time multiprogramming

### Basis of program scheduling for execution

By operator, time, event, or another program, in order of program priority.

### Program priority levels

1 through 32767, the lowest number designating highest priority.

### Number of disc-resident swapping partitions

Up to 64, including mother partitions and subpartitions, depending upon physical memory provided and partition sizes desired.

### Maximum program space per partition

Up to 54k bytes for large background disc resident partitions.

## Main memory capacity

RTE-IV can address up to 2.048M bytes (1024 pages) of memory; however, the current physical limit on fault control memory in HP 1000 Computers with memory extender is 1.792M bytes (896 pages). Fault control memory is recommended for large-memory systems.

## Extended memory area for data

The Extended Memory Area for data can be equal to the total physical memory less the physical memory used by the system, System Available Memory, driver partitions, resident library, system COMMON area, and memory-resident and disc-resident program partitions.

## Approximate memory requirements (bytes)

The following memory requirements are additive for resident memory. The requirements for disc-resident partitions include 2k bytes for base page, which is part of each disc-resident partition.

Software Item	Resident Memory	R-T Disc Resident	B-G Disc Resident
RTE-IV system	48k*		
RTE FORTRAN IV Compiler			22-28k†
RTE Assembler			18-24k†
Cross-reference symbol table generator			16-28k†
On-line System Generator			26-40k†
Relocating Loader			24-28k†
Batch-Spool Monitor		5k	14k
Interactive DBUGR routine			5k
Interactive Editor			12-14k†
SAVE Utility			14-22k†
RESTORE Utility			16-24k†
COPY Utility			14-22k†
VERIFY Utility			14-30k†
KEYS Utility			11k
KYDMP Utility			4k
Optional 91730A Multipoint software	2400		
Opt. 92061A Microprog Package	2200		18k
Opt. 92063A IMAGE/1000 DBMS	100		26k
Opt. 92101A BASIC/1000D	1000	6k	28k

\*System memory requirement as listed includes resident system, table areas, common, subsystem global area, and base page; disc, system console, and spool drivers; and 6k bytes of System Available Memory.

†The size of background partition required depends partly on size or complexity of program being compiled or assembled, or buffer size used; short or simple programs or short buffers will be processable in the smallest partition size given, larger programs or buffers may take up to the maximum partition size given.

## Operational requirements for HP 1000 Computer Systems

HP 1000 Computer Systems, Models 40 and 45, satisfy operational requirements for the RTE-IV operating system.

## Operational requirements for user-assembled systems

- 2108, 2109, 2111, 2112, 2113, or 2117 Computer with at least 96k bytes of memory, although 128k bytes is a strongly recommended minimum for most applications, 12897B Dual-Channel Port Controller, 13304A Firmware Accessory Board (with 2109 or 2113 Computers), 12976B or 13305A Dynamic Mapping System, 12944B or 12991B Power Fail Recovery System, and 12539C Time Base Generator.

2. 12960A (4.9M byte), 12962A/B/C/D (14.7M byte), 7906M/MR with 13175A interface (19.6M byte), or 7920M\* with 13175A interface (50M byte) Disc Subsystem.

3. Any supported system console.
4. Any supported standard input/output unit.

\*Systems containing a single 7920 disc also require a 9-track HP Mag tape unit for back-up.

### Supported system consoles

- 2645A/2648A CRT Terminal with 12996A+001 interface (provides the fastest data rate) or 12880A+001 interface
- 2645A+007, 030/2648A+007, 030 CRT Terminal with 13260B Extended Asynchronous Communication and 12966A+001 interface (preferred because it combines the functions of system console and Mini cartridge standard input/output unit).
- 2644A+020\* CRT Terminal with 12966A+001 interface.
- 2631A+051 Printing Terminal with 12966A+001 interface.
- 2640A\*/2640B CRT Terminal with 12880A+001 interface.
- 2762A\*/B\* Terminal Printer with 12531D+001 interface.
- 2752A\* Teleprinter with 12531C interface.

### Supported standard I/O units

- Mini cartridge I/O on 2645A+007, 2648A+007, or 2644A\*.
- 12925A Tape Reader Subsystem for punched tape input and 12926A Tape Punch Subsystem for punched tape output.

\*Identifies product no longer available that is listed here for reference only.

### Computer and accessories serial prefix compatibility

RTE-IV is compatible with HP 2108 and 2112 Computers, serial prefix 1810A and later, 2109 and 2113 Computers, serial prefix 1812A and later, which has Dynamic Mapping Instruction ROM part numbers 13307-18021 through 18026, and all 2111 and 2117 Computers. Accessories shipped with computers that meet this serial prefix requirement are also compatible.

Compatibility of earlier computers and the possibility of bringing such computers and their accessories up to compatible status should be checked with your Hewlett-Packard Sales Representative.

### Compatibility with software subsystems

Software subsystems, such as BASIC/1000D, IMAGE/1000, etc., used with previous disc-based RTE operating systems may require updating to be compatible with RTE-IV. Disc-based RTE subsystems that have been kept up to date with the aid of HP's Software Subscription Service will be compatible as the result of such updating. If you have disc-based RTE subsystems that have not been kept up to date, check with your Hewlett-Packard Sales Representative to determine what action if any will be required to bring them up to date to achieve compatibility with RTE-IV.

### Compatibility with programs for other RTE systems

Most programs written for other Hewlett-Packard memory-based or disc-based RTE systems will run in RTE-IV, with little or no change, except for those that make use of I/O devices or software routines which are not supported in RTE-IV.

### Disc memory capacity

With 12960A Subsystem: 4.9 to 19.6M bytes.

With 12962A/B/C/D Subsystem: 14.7 to 365.2M bytes with seven 7920S add-on 50M byte drives.

With 7906M + 13175A Subsystem (or equivalent rack-mounting Subsystem): 20 to 370M bytes with seven 7920S add-on 50M byte drives.

With 7920M + 13175A Subsystem: 50 to 400M bytes with seven 7920S add-on 50M byte drives.

### On-line operator requests

1. Turn programs on or off.
2. Suspend user program, either executing or scheduled.
3. Activate user program.
4. List programs currently executing in the system.
5. List status of all programs.
6. List status of all partitions.
7. Change priority and timing of programs.
8. Examine I/O device or I/O controller status; dynamically alter device buffering assignments.
9. Set buffer limits.
10. Examine or change page requirements for compilers or other disc-resident programs with job-dependent space requirements.
11. Dynamically alter I/O device timeout parameters.
12. Dynamically alter device logical unit assignments.
13. Control I/O device availability.
14. Set the real-time clock.
15. Display time (time-of-day, day, and year).
16. Request execution of programs.
17. Assign program to a specific partition.
18. Unreserve a partition for assigned programs only.
19. Allocate/release program tracks.
20. Increase or decrease memory available for EMA programs.

### Program development requests

1. Compile FORTRAN IV programs or assemble programs.
2. Enter, test, debug, edit, and run real-time BASIC programs (with optional BASIC/1000 subsystem).
3. Trace program execution and examine and modify memory and register contents with the DBUGR utility.
4. Edit program and data files.
5. Load relocatable programs and subroutines into disc-resident partitions.

### Batch-Spool Monitor and utility requests

1. Enter batch job commands.
2. Link spool files to peripherals.
3. Create files.
4. Dump contents of a file to another file, or a peripheral device.
5. Copy files from one disc to another.
6. List contents of file directory.
7. Purge files.
8. Repack the disc.
9. Display status of spool jobs.
10. Change spool job priorities.
11. Back up the disc on magnetic tape.



12. Update the master software (grandfather) disc cartridge.
13. Generate new operating system.
14. Switch from the current system to another system taken from a disc file.

### System requests from programs

1. Read from/write to any non-disc input/output device with or without wait.
2. Read from/write to disc with wait.
3. Get status of queued read requests, or the resulting input data.
4. Check I/O device or I/O controller status.
5. Control functions on magnetic tape unit or other peripheral device.
6. Schedule programs to be run, with or without wait on completion of the called program.
7. Make dormant or suspend self or other program.
8. Obtain current year, day, and time of day.
9. Change time scheduling of self or other program.
10. Allocate/release own disc tracks or global disc tracks available to all programs.
11. Allocate/release I/O devices or other system resources for own exclusive use.
12. Enable/disable swapping of self.
13. Request resource lock/unlock.
14. Request device lock/unlock.
15. Request partition status.
16. Determine size of own address space.

### Batch-Spool Monitor File Manager program requests

1. Create files.
2. Rename files.
3. Purge files.
4. Open files.
5. Write on a random or sequential file.
6. Read from a random or sequential file.
7. Locate a file.
8. Close a file.

## Ordering information

### 92067A RTE-IV operating system for user-assembled systems

RTE-IV consists of:

1. The following software on one of media options 030, 031, 032, 050, 051, 052, or 053, which must be ordered:
  - RTE-IV operating system
  - On-line system generator, system switch, and boot-up reconfigurator
  - Multi-Terminal Monitor
  - RTE FORTRAN IV compiler, RTE-IV Assembler, Cross-Reference Table Generator, Interactive DBUGR utility, Interactive RTE Editor, Relocating Loader, Relocatable Library, and Decimal Arithmetic Library
  - EMA software routines
  - Batch-Spool Monitor
  - 92062B RTE Drivers Package software
  - Update and backup utilities

2. EMA Firmware ROMs (92067-80001 through 80003).
3. RTE-IV Programmer's Reference Manual (92067-90001).
4. RTE-IV Generator Manual (92067-90002).
5. RTE-IV Assembler Manual (92067-90003).
6. RTE-IV Software Numbering Catalog (92067-90004).
7. RTE-IV Debug Manual (92067-90005).
8. RTE-IV EMA Firmware Installation Manual (92067-90006).
9. RTE-IV EMA Firmware Diagnostic Manual (92067-90007).
10. Decimal String Arithmetic Manual (02100-90140).
11. ROM Loader Manual (12992-90001).
12. 7261 Card Reader Driver Manual (07261-90010).
13. DVR11 Card Reader Driver Manual (09600-93010).
14. CalComp Plotter Driver Manual (12560-90023).
15. DVR33 Flexible Disc Driver Manual (12732-90001).
16. 7210A Plotter Driver Manual (17210-90004).
17. RTE/DOS Relocatable Library Manual (24998-90001).
18. DVR00 Multi-device Driver Manual (29029-95001).
19. DVR37 HP-IB Driver Manual (59310-90063).
20. DVA13 TV Monitor Driver Manual (91200-90005).
21. DVA12 Line Printer Driver Manual (92001-90010).
22. DVR05/DVA05 264x Console Driver Manual (92001-90015).
23. Batch-Spool Monitor Manual (92060-90013).
24. RTE Interactive Editor Manual (92060-90014).
25. RTE Utilities Manual (92060-90017).
26. RTE FORTRAN IV Manual (92060-90023).
27. DVR12 Line Printer Driver Manual (92200-93001).
28. Driver Writing Manual (92200-93005).
29. DVR23 Mag Tape Driver Manual (92202-93001).
30. 3070 Driver Manual (92900-90005).

### 92067A RTE-IV options

- 030:** Provides all RTE-IV system software on 92067-13001, 12869A (2.5M byte) disc cartridge for 12960A (4.9M byte) Cartridge Disc Subsystem.
- 031:** Provides all RTE-IV system software on 92067-13101, a 12940A (10M byte) disc cartridge for 12962A/B/C/D (14.7M byte) or 7906M + 13175A (20M byte) Cartridge Disc Subsystem.
- 032:** Provides all RTE-IV system software on 92067-13201, a 13394A (50M byte) disc pack for 7920M + 13175A (50M byte) Disc Subsystem.
- 050:** Provides all RTE-IV system software on 92067-13501, an 800 bpi, 9-track mag tape in image format for 2.5M byte disc cartridge, plus 92067-13301 (Mini cartridge) and 92060-16044 (paper tape) off-line disc backup utilities for copying the mag tape to 12869A disc cartridge in a 12960A Cartridge Disc Subsystem from an 800 bpi, 9-track HP Mag Tape Subsystem.
- 051:** Same as 050, above, but with RTE-IV system software on 92067-13601, a 1600 bpi, 9-track mag tape for copying to 12960A Cartridge Disc Subsystem from a 1600 bpi, 9-track HP Mag Tape Subsystem.

- 052:** Provides all RTE-IV system software on 92067-13502, an 800 bpi, 9-track mag tape in image format for 10M byte disc cartridge and 50M byte disc pack, plus 92067-13301 (Mini cartridge) and 92060-16044 (paper tape) off-line disc backup utilities for copying the mag tape to 12940A disc cartridge in a 12962A/B/C/D or 7906M + 13175A Cartridge Disc Subsystem or to a 13394A disc pack in a 7920M + 13175A Disc Subsystem from an 800 bpi, 9-track HP Mag Tape Subsystem.
- 053:** Same as 052, above, but with RTE-IV system software on 92067-13602, a 1600 bpi, 9-track mag tape for copying to 12962A/B/C/D or 7906M + 13175A Cartridge Disc Subsystem or to 7920M + 13175A Disc Subsystem from a 1600 bpi, 9-track HP Mag Tape Subsystem.
- 001:** Provides a discount to customers upgrading from 92001B RTE-II or 92060B RTE-III system.

### RTE-IV operating system in HP 1000 Computer Systems

The 92067A RTE-IV system with media option appropriate to the disc ordered is included in HP 1000 Model 40 and 45 (2176A/B and 2177A/B) Computer Systems.

### 92067R Right to duplicate RTE-IV for use on an additional computer system

92067R consists of:

1. The right to make one copy of software purchased with the 92067A RTE-IV system.
2. The right to make one copy of software updates supplied by Hewlett-Packard under the 92067S or 92067T support services for the purpose of updating item 1, above.
3. All manuals furnished with 92067A and EMA firmware for use on 2109, 2111, 2113, or 2117 Computer, items 2 through 31 of 92067A, above.

### 92067S Software Subscription Service

The 92067S Software Subscription Service provides software and manual updates as required to keep your RTE-IV system current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92830A Software Notification Service is also included. The 92067S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92067T, must be specified when ordering 92067S.

### 92067T Comprehensive Software Support

The 92067T Comprehensive Software Support includes the Software Subscription Service, as described under 92067S, above, and a Phone-In Consulting Service for discussion of questions on your RTE-IV software with a qualified HP Systems Engineer. The 92067T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92067S and 92067T Media options

- 020:** Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.
- 050:** Software updates on 800 bpi, 9-track mag tape in image format for 2.5M byte disc cartridge (used with 12960A Cartridge Disc Subsystem and 800 bpi, 9-track HP Mag Tape Subsystem).
- 051:** Same as 050, above, but with updates on 1600 bpi, 9-track tape (used with 12960A Cartridge Disc Subsystem and 1600 bpi, 9-track HP Mag Tape Subsystem).
- 052:** Software updates on 800 bpi, 9-track mag tape in image format for 10M byte disc cartridge or 50M byte disc pack (used with 12962A/B/C/D, 7906M + 13175A, or 7920M + 13175A disc subsystem and 800 bpi, 9-track HP Mag Tape Subsystem).
- 053:** Same as 052, above, but with updates on 1600 bpi, 9-track tape (used with 12962A/B/C/D, 7906M + 13175A, or 7920M + 13175A disc subsystem and 1600 bpi, 9-track HP Mag Tape Subsystem).

### 92067T option 200

92067T option 200 provides a discount for comprehensive software support of an additional copy of RTE-IV (purchased as right-to-duplicate product 92067R) that is used in the same building as the original (purchased with 92067A). This discount is available on the basis specified in the Software Support data sheet under the *Support of duplicated software (software copies) at multi-system sites* heading.



## HP 1000 Program languages

The program languages available for HP 1000 Computers and Systems using active software operating systems include RTE FORTRAN IV, real-time BASIC (optional), and RTE Assembly language. These are described individually in the following paragraphs.

### RTE FORTRAN IV compiler

RTE FORTRAN IV programs are translated by a two-pass compiler producing relocatable object code. It is based on ANSI Standard FORTRAN IV (X3.9-1966), except that intrinsic functions are treated as external functions.

#### Extensions of standard FORTRAN IV

The following extensions expand the capabilities and increase the power of HP FORTRAN IV, as compared with ANSI Standard FORTRAN IV:

- A subscript expression may be any expression allowed in HP FORTRAN IV.\*
- Initial, terminal, and step-size parameters of a DO statement may be any arithmetic expressions.\*
- The step-size parameter of a DO statement may be either positive or negative, which provides for incrementing or decrementing to the terminal value.
- The integer variable reference in a computed GO TO can be replaced by any arithmetic expression.\*
- Any two arithmetic types may be mixed in any relational or arithmetic operation except exponentiation.
- An unsubscripted array name is an admissible list element in a DATA statement.
- Automatic EMA map request generation for FORTRAN IV programs to be used in RTE-IV operating systems.

*\*Expressions other than integer are converted to integer after evaluation.*

#### Functional specifications

See the program language specifications table, next page.

#### Ordering information

The RTE FORTRAN IV compiler is included in the 92064A+040 RTE-M, 92001B RTE-II, and 92067A RTE-IV operating systems.

### Real-time BASIC

Real-time BASIC is an easily-learned language that provides interactive, conversational programming. Unlike the other HP 1000 program languages, programming in real-time BASIC does not involve a separate compilation or assembly operation. Statements are checked for correct syntax immediately. The partly completed program can be run at any stage to confirm that it executes as intended.

#### Functional specifications

The specifications of the BASIC/1000M and BASIC/1000D BASIC languages are shown in the program language specifications table, next page, and given more extensively in a separate data sheet in this section.

#### Ordering information

The real-time BASIC interpreters are included in the 92065A BASIC/1000M subsystem for RTE-M, and the 92101A BASIC/1000D subsystem for RTE-II/IV.

### RTE assembly language

HP Assembly language symbolic source language instructions are translated by the RTE Assembler into absolute or relocatable object code in a two-pass operation. The source language provides mnemonic machine operation codes, assembler-directing pseudo instructions, and symbolic addressing.

#### Functional specifications

The specifications of the RTE Assembler are shown in the program language specifications table, next page.

#### Ordering information

The RTE Assembler is included in the 92064A-040 RTE-M, 92001B RTE-II, and 92067A RTE-IV operating systems.

FORTRAN IV	BASIC/1000M	BASIC/1000D	Assembler	Specifications
<b>Data Types</b>				
X			X	Integer data (a 16-bit quantity including sign, ranging from +32767 to -32768)
X	X	X	X	Real data (a 32-bit quantity with sign, exponent, and mantissa, ranging from $\pm 2^{-127}$ to $\pm 2^{+127}$ , providing 6 to 7 decimal digit accuracy)
X				Double precision data (a 48-bit quantity with sign, exponent, and mantissa having range identical to real data, but providing 11 to 12 decimal digit accuracy)
X				Complex data (a 64-bit quantity consisting of two real data quantities, one for the real, the other for the imaginary part of a complex quantity)
X				Logical data (a 16th-bit variable in which only the integer sign bit is used to determine the Boolean value, true or false)
	X	X		Octal data (a 16-bit quantity including sign that can be entered into programs, manipulated, and output, using the bit manipulation statements provided in HP real-time BASIC)
<b>Character Set</b>				
X	X	X	X	The 26 letters A through Z (capitals only)
X	X	X	X	The 10 digits 0 through 9
X	X	X	X	Special characters: blank; equals, plus, and minus signs; asterisk; slash; left and right parentheses; comma; decimal point; and currency symbol
	X	X	X	Special characters: quotation mark
	X	X	X	Special characters: greater than; less than; up arrow and # signs; left and right brackets; apostrophe and question marks; colon and semi-colon; exclamation point; and ampersand.
			X	Special characters: back arrow, percent and @ signs, and back-slash.
<b>Environment</b>				
X		X	X	Provides on-line program development in disc-based RTE-II/IV system in interactive mode
X			X	Provides on-line program development in disc-based RTE-II/IV system in batch mode, using the Batch-Spool Monitor
	X			Provides off-line conversational program development in memory-based RTE-M system

FORTRAN IV	BASIC/1000M	BASIC/1000D	Assembler	Specifications
<b>Supported Capabilities</b>				
X			X	Real-time operation, by providing for the passing of program priority, type, and time-scheduling information from the source language program I.D. statement to the relocatable object program
	X	X		Real-time operation by providing program statements for specifying task priority and time scheduling and for linking event interrupts to task subroutines
X			X	System-to-system program statements addressed to the 91740A/B and/or 91741A DS/1000 Network software-firmware for communication with other HP 1000/21MX Computer systems and/or HP 3000 Systems (except in RTE-II)
X		X	X	Disc file access program statements addressed to the Batch-Spool Monitor in RTE-II/IV systems
X	X	X		High-level calls to instrumentation and control and peripheral subsystems
	X	X		Bit manipulation program statements for examination, logical addition and multiplication, shifting and selective setting and clearing of digital word patterns
			X	Word, byte, and bit processing
			X	Index register instructions
	X	X		Character string definition and manipulation: character strings up to 255 characters long may be represented and manipulated using string variables
			X	Automatic chaining or linking together of program segments so they run as one long program
X	X	X		Data base access and manipulation program statements addressed to IMAGE/1000 in RTE-II/IV systems
X			X	Decimal string arithmetic program calls for adding, subtracting, multiplying, or dividing decimal strings (in integer form) whose length exceeds the capacity of the standard integer, floating point, or standard program libraries.
X			X	Extended Memory Area mapping in RTE-IV system.



## BASIC/1000M and BASIC/1000D

models 92065A and 92101A

Hewlett-Packard's BASIC/1000M and BASIC/1000D are subsystems for conversational development, testing, and execution of Real-Time BASIC programs in computer systems managed by HP's memory-based RTE-M or disc-based RTE-II/IV real-time executive operating systems.

### Features

- Concurrent multi-user development and execution of Real-Time BASIC programs in RTE systems.
- Conversational programming.
- Time and event scheduled operation of up to 16 tasks for a single user.
- High-level subroutine calls for instruction, including multi-instrument clusters bus-connected via HP-IB\*.
- Easy access to disc file storage for programs and data or to IMAGE/1000 data base in RTE-II/III/IV only.
- Character string manipulation with string variables.
- Upward compatibility from BASIC/1000M to BASIC/1000D.
- Support of bit manipulation.
- Usability of subroutines or functions in FORTRAN or Assembly language.

### Functional description

BASIC/1000M is a program-compatible subset of the disc-based BASIC/1000D. These BASIC language subsystems differ mainly with respect to the capabilities they support, as described in the following paragraphs.

#### Capabilities common to both BASIC/1000M and BASIC/1000D

**Single-user and multi-user operation.** The RTE host systems all support single-user operation. In RTE systems with sufficient memory and the multiterminal monitor, multi-user operation can be provided by individually-identified copies of BASIC/1000M or D, each serving a different user. All active copies run concurrently with each other and with other programs in the RTE system, but only one copy can execute time and event scheduling at one time.

**On-line program development.** BASIC/1000M and D operate in either conversational (program development) or run (program execution) mode. In the RTE system, several copies of BASIC/1000M or D can be used for conversational program development while another is running a program, so BASIC-programmed operations can be extended without disrupting the BASIC interpreter.

\*HP-IB (Hewlett-Packard Interface Bus) is Hewlett-Packard's implementation of IEEE Standard 488-1975, "Digital Interface for programmable instrumentation."

**Conversational program development.** Real-Time BASIC programs are entered directly into the system via the system console or another keyboard terminal. The BASIC system checks each statement as it is entered. If a statement contains an error, the system immediately returns a message that helps the user re-enter that statement correctly, in a conversational process. Errors encountered during program execution are flagged and corrected with similar ease.

**Character string manipulation.** Strings up to 255 characters long can be represented by variables. This provides a shorthand representation of frequently-used strings that can save programming time and effort. It also makes possible the extraction of string segments using subscripts and character-by-character comparison of two strings.

**Real-time multi-tasking.** The host RTE system provides a multi-program, multi-partition environment in which BASIC/1000M or D operates. This environment provides for multi-user operation via multiple copies of the BASIC system. User's BASIC program code in each of these copies or in single-user BASIC/1000M or D is not just a single task, but can be subdivided into as many as 16 tasks that are BASIC subroutines. This subdivision gives the user the ability to match the frequency, timing, and basis for execution of programmed task actions to the diverse needs of real-time applications in research and manufacturing. For one of the copies of BASIC in the system, task executions may be scheduled as a function of time or event interrupt (such as contact closure). (This requires the provision of time scheduling, which is optional in RTE-M) BASIC/1000M and D recognize priority levels from 1 through 99.

#### Additional capabilities of BASIC/1000D

**Program testing.** BASIC/1000D provides user requests for tracing program execution, inserting up to four break-points, and for simulating execution of subroutine calls. These capabilities are very convenient for testing programs on a system different from the target system in which they will be used.

**Program editing.** Using the interactive editor of the disc-based RTE system, the user can edit characters within a statement line, leaving some characters unchanged, inserting characters, and replacing or deleting characters as desired. This is in addition to the complete line replacement and insertion capabilities characteristic of BASIC/1000M and most other BASIC systems.

**Program statement renumbering.** In BASIC/1000D, the user can systematically change program statement numbering with a simple command, without retyping statements, a capability that greatly facilitates insertion of additional program statements where needed.

Disc storage of programs and data. BASIC/1000D programs are easily saved in named disc files, in either source or semi-compiled (faster-executing) form. The user can also create files on the disc for data storage and retrieval access with simple PRINT and READ program statements. Files are easily renamed or purged to accommodate changing needs.

**Data base access.** BASIC/1000D includes an interface to the IMAGE/1000 Data Base Management System. This interface connects BASIC/1000D program calls to sub-routines of IMAGE/1000, including the routines that open or close the data base, locate, read, update, add, or delete data, and lock or unlock the data base.

**Program linking.** BASIC/1000D includes a CHAIN statement for automatically linking programs together so they run as one long program. This statement in the current program retrieves a named program from the disc and starts it running from the first statement, or any later statement specified in the CHAIN statement.

## Functional specifications

### Environment

**BASIC/1000M:** Mini cartridge or flexible disc based RTE-M system with at least 48k bytes of memory.

**BASIC/1000D:** Disc based RTE-II system with at least 48k bytes of memory, or RTE-IV system with at least 128k bytes of memory, or RTE-III system with at least 96k bytes of memory.

### Operator requests

BASIC/1000M	BASIC/1000D	Operator requests
X	X	Load program into memory.
X	X	Merge additional tasks or statements into program already in memory.
X	X	Run program that is in memory or stored on an off-line media.
X	X	List program that is in memory.
X	X	Save program that is in memory on Mini cartridge, magnetic tape or punched tape.
	X	Save program that is in memory on flexible disc, cartridge disc, or disc pack in either source or semi-compiled (faster-executing) form.
X	X	Delete current program from memory.
X	X	Enter individual program statements, operator requests, or data inputs into system.
X	X	Delete a line(s) of program.
X	X	Interrupt or abort a running program.
	X	Create a data file on disc or other device.
	X	Delete program or data file from disc.
	X	Rename program or data file on disc.
	X	Request or release exclusive use of peripheral device.
	X	Trace program execution for correcting program faults.
	X	Set up program breakpoints for correcting program faults.
	X	Display and/or set subroutine call variables for simulation of subsystems not in the host computer system.
	X	Renumber program statements.

### System requests from programs

BASIC/1000M	BASIC/1000D	System requests
X	X	Read from any non-disc input device.
X	X	Print on any non-disc output device.
X	X	Access disc via file manager in Batch-Spool Monitor.
X	X	Schedule task to be run at specified time, at specified intervals, and/or in response to specific event, including terminal keystroke.
X	X	Enable or disable self or other task.
	X	Open or close files on disc or flexible disc.
	X	Read from or write on disc.
	X	Access data base via IMAGE/1000 interface.
	X	Link from current program to another named program or program segment on disc.

### Supported capabilities

BASIC/1000M	BASIC/1000D	Supported capabilities
X	X	Real-time operation program statements are provided for specifying task priority and time scheduling, and for linking event interrupts to tasks. (Time and event scheduling are usable by only one copy of BASIC/1000M or D during any particular execution period.)
	X	Disc file access.
	X	Access to IMAGE/1000 data base.
X	X	High-level calls to instrumentation and peripheral subsystems, including analog I/O, digital I/O, instruments on the Hewlett-Packard Interface Bus (HP-IB), mag tape I/O, and punched or mark-sense tab card input, in addition to CRT and hard copy terminals, line printers, and punched tape I/O subsystems.
X	X	Bit manipulation program statements are provided for examination, logical addition and multiplication, shifting and selective setting and clearing of digital word bit patterns.
X	X	Character string definition and manipulation: ASCII strings up to 255 characters long may be represented and manipulated through the use of string variables.
	X	Chaining or linking together of program segments so they run as one long program.
X	X	Computation: real-time BASIC can call on 23 different standard functions and operators, including square root, exponentiation, logarithmic, logical, and trigonometric functions, as well as the base capabilities of addition, subtraction, multiplication, and division.
	X	Decimal string arithmetic.

### Basis of BASIC task scheduling for execution

By operator, another task, time, or event (only one copy of BASIC can use time and/or event scheduling) in order of task priority.

### BASIC task priority levels

1 through 99, the lowest number designating highest priority.

## Program data types

- REAL data — a 32-bit quantity with sign, exponent, and mantissa, ranging from  $\pm 2^{-127}$  to  $\pm 2^{+127}$ , with 6 to 7 decimal digit accuracy.
- OCTAL data — a 16-bit quantity including sign that can be entered into programs, manipulated, and output using the bit manipulation statements provided in HP Real-Time BASIC.
- STRING data — ASCII strings up to 255 characters long represented and manipulated by variables.

## Program character set

- The 26 upper case letters A through Z.
- The ten digits 0 through 9.
- Special characters: blank; equals, greater than, less than, plus, minus, up arrow, and # signs; asterisk; slash; left and right parentheses and left and right brackets; quotation, apostrophe, and question marks; comma; colon; semi-colon; decimal and exclamation points; ampersand; and currency symbol.

## Software not supported

BASIC/1000M and D do not support the 92400A Sensor-Based DAS Utility Library or the 92413A ISA Fortran Extension Package. The 92840A GRAPHICS/1000 Graphics Plotting Package is not supported in BASIC/1000M.

## Program vocabulary

PROGRAM VOCABULARY ITEMS		USES
For BASIC/1000M	For BASIC/1000D	
General Program Statements		
X	X	COM P(8),T(18) Allocates common program storage.
X	X	DIM A(3),B(3),K(5) Allocates program storage.
X	X	REM TASK 1 Inserts remarks in program listing.
X	X	LET R=R*100+R2 Assigns value ("LET" is optional).
X	X	DEF FN(A)=A↑3 Sets up user-defined function.
X	X	FOR I=1 TO 50 STEP 7 Sets up repetitive operations loop.
X	X	NEXT I Returns to start of loop for next repetition, or terminates loop if NEXT I would exceed limit.
X	X	INPUT X,Y,Z Receives data from system console.
X	X	READ#N:A(1),A(2),A(3) Reads input from unit number N.
X	X	READ#N,M:A(1), A(2), A(3) Reads record M of disc file N or from unit N.
X	X	READ D(1),I(1),J(2),J(1) Reads values from DATA statement.
X	X	DATA 1,27.5,10,35.79 Provides values to READ statement.
X	X	RESTORE Resets READ pointer for next reading of DATA.
X	X	RESTORE 120 Resets READ pointer for specific DATA statement for next reading of data.
X	X	IF M1=24 THEN 590 Sets up conditional action.
X	X	GOTO 2480 Unconditional transfer to specified statement.
X	X	GOTO X+3 OF 200,300,400 Multibranch transfer.
X	X	PRINT "UNIT GOOD" Prints on system console.
X	X	PRINT #X:T;TAB(13);R1 Prints on, or outputs to, unit number X.
X	X	PRINT #Z,Y:A,"STRING",A(1) Writes record Y on disc file Z or unit Z.
X	X	WAIT (1000) Inserts specified delay in program.
X	X	GOSUB 980 Transfers to specified subprogram statement.
X	X	GOSUB A+8 OF 120,340,710 Multi-branch transfer to subprogram statement.
X	X	RETURN Returns from subprogram to statement following GOSUB that caused most recent transfer.
X	X	PAUSE Interrupts program execution.
X	X	PAUSE (10) Pause for a specified interval.
X	X	STOP or END Terminates program execution, returning system to conversational mode.
X	X	CHAIN "PROG2".S Retrieves named program from local or remote disc and starts it running, from statement number S.

PROGRAM VOCABULARY ITEMS		USES
For BASIC/1000M	For BASIC/1000D	
Event, Time, and Priority Scheduling and Control Program Statements		
X	X	TRAP 1 GOSUB 250 Links event interrupt to execution of task.
X	X	TIME(T) Gets time of day for program.
X	X	SETP (250,1) Sets task priority level (1-99).
X	X	TRNON (250,1200) Turns on task execution at specified time.
X	X	START (250,95) Starts timing to next execution of task.
X	X	DSABL (250) Disables task (prevents scheduling).
X	X	ENABL (250) Enables task (permits scheduling).
X	X	TTYS (U,N) Schedules trap N task from keyboard unit U.
2313B Analog I/O Subsystem Program Statements (Except in RTE-IV)		
X	X	AISQV (5,1,V(1),S) Requests analog input in sequential mode.
X	X	AIRDV (5,C(1),V(1),S) Requests analog input in random mode.
X	X	PACER (1,5,2) Sets pacer interval.
X	X	SGAIN (1,1000) Sets gain of analog channel(s).
X	X	RGAIN (1,G) Reads gain of analog channel(s).
X	X	AOV (12,C(1),V(1),S) Requests analog output of digital value(s).
X	X	NORM(N) Normalizes the analog I/O subsystem.
59310B HP-IB Interface Kit Program Statements		
X	X	READ#I:D(1),D(2) . . . D(N) Reads data values D(1) through D(N) from HP-IB device I.
X	X	PRINT#I:D(1),D(2) . . . D(N) Outputs data values D(1) through D(N) to HP-IB device I.
X	X	HPIB (I,R,P) Issues control request.
X	X	SRQ (I,R,PNAME) Sets up scheduling of program PNAME in response to Service Request from HP-IB device I.
X	X	CMDW (I,C,D) Issues bus I/O request to write command C and/or output data D via HP-IB interface I.
X	X	CMRD (I,C,D) Issues bus I/O request to write command C and/or read input data D via HP-IB interface I.
X	X	E = IBERR(I) Retrieves device or interface I error code E.
X	X	S = IBSTS(I) Retrieves device or interface I status byte S.
12935A Graphic Plotter Subsystem Program Statements		
X	X	AXIS (X,Y,L1,L2,A,V1,V2) Plots one axis, X or Y, per call.
X	X	PLOT (X,Y,Z) Moves pen, up or down, to next point.
X	X	LINES (X(1),Y(1),N,S,C) Plots line and/or symbols through series of points from X(1) and Y(1).
X	X	SYMB (X,Y,H,"VOLTS",90,1) Plots characters and/or other symbols.
X	X	NUMB (X,Y,H,N,A,N1) Plots a number, with or without decimal point.
X	X	URITE Moves pen to upper right for paper change.
X	X	LLEFT Sets origin of plot to 0,0.
X	X	SCALE (D(1),L,N,S) Scales array of X or Y values to fit graph size.
X	X	SFACT (15,10) Enters size of paper to be used.
X	X	FACT (X,Y) Sets ratio between horizontal and vertical axes.
X	X	WHERE (X,Y) Determines current X,Y coordinates of pen.
X	X	PLTLU (15) Enters logical unit number of plotter.
91200A TV Interface Kit Program Statements		
X	X	VIDLU (U,M) Enters unit number and mode (white on black, or vice versa).
X	X	ERASE Erases entire screen.
X	X	VECTR (X,Y,D,L) Writes line of length L in any of eight directions D, starting from point X,Y.
X	X	CHARS (X,Y,AS,S,D,N,M) Writes/erases N characters of size S, represented by AS, in direction D, starting from point X, Y, as specified by M.
X	X	AREA (X,Y,H,W,D,M) Selectively writes/erases per mode M, an area starting from point X,Y, of height H and width W.
X	X	POINTS (P(1),N,M) Writes/erases per mode M, N points contained in coordinates array P(1).
X	X	VEND (X,Y) Determines end point coordinates of last-drawn vector on the display.
12604B Data Source Interface Program Statement (Except in HP 1000 and RTE-IV)		
X	X	DSI (U,N,V,F) Reads data source input via unit U, converting N BCD digits to floating point form, returning six most significant digits in V, and function digit in F.

PROGRAM VOCABULARY ITEMS		USES
For BASIC/1000M		
For BASIC/1000D		
<b>12551B (output only), 12554A, 12597A, 12566B, and 12930A Program Statements (Except in HP 1000 and RTE-IV)</b>		
X	X	GPRSB (U,F,P,S) For register U, reads/writes state S of bit in position P as specified by function F.
X	X	GPRMB (U,F,B) For register U, reads/writes bit pattern B as specified by function F.
X	X	GPRI0 (U,F,A,B) For register U, writes value A out and reads B in on interrupt, as specified by F (not applicable to 12551B).
<b>12555B Digital-to-Analog Converter Program Statement (Except in HP 1000 and RTE-IV)</b>		
X	X	DAC (N,X(I),Y(I)) Requests output of N points from X-Y buffer, consisting of arrays X(I) and Y(I).
<b>12556B 40-Bit (output) Register Program Statement (Except in HP 1000 and RTE-IV)</b>		
X	X	FBTWR (U,A,B,C,X,M) From register U, outputs four most significant digits A, second most significant four digits B, and two least significant digits C (or equivalent octal number capacity), and 41st bit X as specified by mode M.
<b>12970A — 12972A Magnetic Tape Subsystem Program Statements</b>		
X	X	MTTRD (U,V(1),64,F,N2) Reads data from magnetic tape.
X	X	MTTRT (U,V(1),64,F,N2) Writes data to magnetic tape.
X	X	MTTPT (U,5,-3) Positions magnetic tape.
X	X	MTTFS (U,0) Controls magnetic tape subsystem functions.
<b>Formatted I/O Data Conversion Program Statements</b>		
X	X	DCODE (A\$,V,FS) Converts character string A\$ to value V as specified by format string FS.
X	X	DCODE (V,AS,FS) Encodes value V into character string AS as specified by format string FS.
X	X	CHRS (V,AS(2,2)) Assigns decimal value V to character 2 in character string AS.
X	X	V=NUM (AS(2,2)) Equates variable V to decimal value of character 2 in character string AS.
<b>Bit Manipulation Program Statements (can also be used as functions)</b>		
X	X	I0R (M,N,R) Adds M and N, bit-by-bit, giving result R.
X	X	IN0T (M,N) Returns complement N of M.
X	X	IE0R (M,N,R) Adds M and N exclusively, giving result R.
X	X	IAND (M,N,R) Logically multiplies M by N, giving result R.
X	X	iSHFT (M,N,R) Shifts M by ±N bit positions, giving result R.
X	X	IBTST (V,B,S) Returns state S of bit B in value V.
X	X	IBSET (V,B,R) Sets bit B in value V, giving result R.
X	X	IBCLR (V,B,R) Clears bit B in value V, giving result R.
X	X	IS0TC ("177077",K) Sets variable K equal to an octal constant.
<b>Disc File Program Statements</b>		
X		FILES DATA, RESULTS Designates and opens up to 16 files simultaneously to a program.
X		READ #1,M;A\$,A,B,C,D Reads character string A\$ and variables A through D from record M of first file listed in FILES statement.
X		PRINT #3,X;R,W(1),RS,END Prints variables R through RS in record X of third file listed in FILES statement; END (End-of-File) is optional.
X		ASSIGN "NEWFL",4,S Opens new file and associates it with specified file number.
X		IF END #2 THEN 800 Defines exit procedure at End of File on specified file.
<b>Character String Program Statements</b>		
X	X	COM A\$(10),US(3,8),A(16) Allocates common storage for string variables as well as other variables.
X	X	DIM GS(12),XS(6,3),W(24) Allocates program storage for string variables as well as other variables.
X	X	LET A\$= "CHAR. STRING" Assigns character string to variable, or adds or subtracts character string variables.
X	X	IF A\$<=B\$ THEN 230 Conditional action based on character string comparison.
X	X	INPUT A\$,BS,CS Character string entry from system console.
X	X	READ US,PS Reads character strings from DATA statement.
X	X	DATA "UNIT", "PASSES" Provides character strings to READ statement.
X	X	PRINT US,PS Prints characters represented by string variables.

PROGRAM VOCABULARY ITEMS		USES
For BASIC/1000M		
For BASIC/1000D		
<b>Functions (shown in program statements)</b>		
X	X	LET X=ABS (W+V-Z) Calculates absolute value of variable or expression.
X	X	LET Z=EXP (X) Calculates base e exponential value of variable or expression.
X	X	IF Y<INT(X) THEN 240 Gives integer part of variable or expression.
X	X	LET R=R+LOG (S+T+Y*Z) Gives base 10 logarithm of variable or expression.
X	X	LET B=C*LN (D-G) Gives base e logarithm of variable or expression.
X	X	LET Y=RND(X) Generates random numbers (0 through 1).
X	X	LET S=SGN (X+Y-Z*Q) Returns sign (+/-) of variable or expression.
X	X	LET H=SQR (Y*Z) Calculates square root of variable or expression.
X	X	IF SWR(6) THEN 300 Returns state of specified computer switch register bit.
X	X	PRINT A,TAB(20),B,TAB(36),C Controls column spacing in PRINT statements.
X	X	LET T=SIN(A)*3.25 Calculates sine of variable or expression.
X	X	LET U=COS(T)+21.575 Calculates cosine of variable or expression.
X	X	IF TAN(X)>5.347 THEN 420 Calculates tangent of variable or expression.
X	X	LET V=ATAN(Y+Z) Calculates arctangent of variable or expression.
X	X	PRINT OCT(K),J,M Provides for printing of octal values.
X	X	IF LEN(B\$)>=21 THEN 1000 Determines length (no. of characters) in string (B\$).
X	X	IF TYP(N)=2 THEN 1500 Determines type (number, character string, or end-of-file) of the next item in file N.
<b>Operators (shown in program statements)</b>		
X	X	LET X=Y+Z Addition.
X	X	LET X=Y-Z Subtraction.
X	X	LET X=Y*Z Multiplication.
X	X	LET X=Y/Z Division.
X	X	LET X=Y↑Z Exponentiation.
X	X	IF X AND Y>Z THEN 500 Logical AND.
X	X	IF X OR Y<Z THEN 670 Logical OR.
X	X	IF NOT X THEN 330 Logical NOT.
<b>Relators (shown in program statements)</b>		
X	X	IF X # THEN 130 Not equal to.
X	X	IF X < Y THEN 490 Less than.
X	X	IF X > Y THEN 520 Greater than.
X	X	IF X <= Y THEN 420 Less than or equal to.
X	X	IF X >= Y THEN 310 Greater than or equal to.
X	X	LET C = A+B-Q Equal to.

## Ordering information

### 92065A BASIC/1000M system (for use in RTE-M system)

The 92065A BASIC/1000M System consists of the following items:

1. One of software media choice options 020 (mini cartridge) or 040 (flexible disc), which must be ordered.
2. BASIC/1000M Programming and Operating Manual, (92065-90001).
3. 92065A Software Numbering Catalog (92065-90002).

### 92065A BASIC/1000M options

020 Provides BASIC/1000M software on the following 9162-0061 Mini cartridges for read-in by 2645A/2648A+007 or 2644A CRT Terminal:

1. Table generator, BASIC interpreter, error message and error codes modules, and dummy trap module (92065-13301).



2. Libraries, task scheduler, 6940 BASIC subroutines, BASIC device subroutines, Alarm module, and BASIC table generator (92101-13301).

040 Provides the BASIC/1000M software listed under option 020, above, on a flexible disc (92065-13401) for read-in by the 12732A Flexible Disc Subsystem.

### 92065S Software Subscription Service

The 92065S Software Subscription Service provides software and manual updates as required to keep your BASIC/1000M subsystem current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92065S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92065T, must be specified when ordering 92065S.

### 92065T Comprehensive Software Support

The 92065T Comprehensive Software Support includes the Software Subscription Service, as described under 92065S, above, and a Phone-In Consulting Service for discussion of questions on your BASIC/1000M software with a qualified HP Systems Engineer. The 92065T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92065S and 92065T Media options

- 020 Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.
- 040 Software updates flexible disc for read-in via 12732A Flexible Disc Subsystem.

### 92101A BASIC/1000D system (for use in RTE-II/III/IV system—Software on punched tape)

The 92101A BASIC/1000D System consists of the following items:

1. Multi-user real-time BASIC resident library, subroutine library including mag tape subroutines, table generator, task scheduler, IMAGE/1000 and decimal string arithmetic interfaces, 6940 and 2313 device subroutines, and relocatable alarm program (92101-12002, 12003, 16008, 16103, 16019, and 16020, 29102-16003, and 16016, and 92413-16007).

2. BASIC Interpreter (92101-12001).
3. Multi-User Real-Time BASIC Programming and Operating Manual (92060-90016).

### 92101A BASIC/1000D Mini cartridge option 020

92101A option 020 replaces software items 1 and 2 in the standard 92101A listing above, with the same software modules on two 9162-0061 Mini cartridges, 92101-13301 and 13302, for read-in by 2645A/2648A+007 or 2644A CRT Terminal.

### 92101S Software Subscription Service

The 92101S Software Subscription Service provides software and manual updates as required to keep your BASIC/1000D subsystem current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92101S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92101T, must be specified when ordering 92101S.

### 92101T Comprehensive Software Support

The 92101T Comprehensive Software Support includes the Software Subscription Service, as described under 92101T, above, and a Phone-In Consulting Service for discussion of questions on your BASIC/1000D software with a qualified HP Systems Engineer. The 92101T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92101S and 92101T Media options

- 010 Software updates on paper tape in image format for 2.5M byte disc cartridge (used with 12960A Cartridge Disc Subsystem and 800 bpi, 9-track HP Mag Tape Subsystem).
- 020 Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.

### 92065T/92101T option 200

92065T/92101T option 200 provides a discount for Comprehensive Software Support of an additional copy of BASIC/1000M or BASIC/1000D.



## RTE microprogramming package

model 92061A

The 92061A is a support package for on-line development by the user of special microprogrammed instructions for HP 1000 Computers and Systems operating under the RTE-II or RTE-IV system. Although the computer instruction set is very powerful, users with special needs can often increase program execution speeds 2 to 20 times by converting frequently-used program subroutines to microcoded instructions called from FORTRAN, BASIC, or HP Assembly language programs. Converting appropriate program subroutines to microcode in the computer's control store increases execution speed by:

1. Eliminating unnecessary microinstructions.
2. Shortening individual instruction execution times.
3. Taking advantage of the extra power and flexibility of 16 general-purpose registers, combined instruction formats, and multi-level stacked subroutines in the control processor.

Microprogramming is particularly useful for high-speed data communications with special character checks, sorting and merging of data, table searching and updating, trigonometric and transcendental library routines like sine and square root, fast Fourier transforms, interrupt processing, directory examination, and I/O device drivers.

### Features

- On-line operation in RTE-II/RTE-IV system.
- Simple assembly language for microprogramming.
- Cross-reference generator for simplified program development.
- Microdebug editor for interactive program editing and checkout.
- Operator-entered microprogram breakpoints.
- Full WCS support, including driver, load utilities, and load verification routines.
- Dynamic WCS overlay utilities.
- Up to 3072 instructions in WCS.
- PROM tape generator for outputting production microcode on (punched) PROM "burn" tapes in user-specified format.
- Supports HP 1000 M-Series, E-Series and F-Series microprogram development.

### Microprogramming in the RTE environment

**Writing microprograms.** The user writes microprograms in symbolic form. The microassembler in the microprogramming package translates this symbolic code into HP 1000 Computer micro object code. The micro object code can then be loaded into Writable Control Store (WCS) using the Microdebug Editor or the WCS Load Utility.

**Testing, debugging, and editing.** After it has been loaded into WCS, the microcode can be used by programs that call the newly-implemented instructions. Testing and debugging of microprogrammed functions is facilitated by the Microdebug Editor. Interactively, via a terminal, the user can load or store micro object code to or from a WCS board and a disc file, set break points in the microprogram, in symbolic form, and perform many other functions. The microdebug editor can also be called programmatically from any user program.

**Linking programs to new computer instructions.** The HP RTE Assembler provides a pseudo instruction specifically for defining new user instructions for HP Assembly language programs. This pseudo instruction associates a unique, user-specified mnemonic name with its octal instruction code location in the computer's read-only or writable control store. It also links any parameters to be passed to the new instruction. FORTRAN or BASIC programs can use new user-implemented computer instructions via calls to simple, user-written assembly language subroutines that pass parameters to/from the higher level program and access the new instructions from the assembly language coding level.

**WCS operating modes.** WCS cards can be fully used in the multiprogrammed environment of the RTE-II/IV operating system. The following modes of operation are possible:

- Several programs executing in memory can use different microprogrammed functions in WCS.
- Several executing programs can share the same WCS microprograms.
- Several executing programs can share the same WCS control store space and the required microprograms can be overlaid into that space as needed by each program.

**Generating PROM "burn" tapes.** When the user wants to permanently implement microprograms, the PROM Tape Generator can be used to generate punched mask tapes in the formats most commonly used by vendors that fuse PROM chips.

### Functional specifications

#### Environment

92001A RTE/II system with 92002A Batch-Spool Monitor or 92001B RTE-II system or 92067A RTE-IV system.

#### Memory usage

The WCS driver requires 2160 bytes of resident memory. Other programs in the RTE Microprogramming Package require an 16k byte background partition in RTE-II or an 18k byte partition in RTE-IV, including the 2k bytes required for base page in each RTE-IV disc-resident partition.

#### Microprogram capacity

The WCS Load Utility and Driver programs work with up to three 13197A WCS boards (3072 user instructions) in the Computer.

## System requirements

Same as 92001B RTE-II system or 92067A RTE-IV system.

## PROM burn tape requirement

To output PROM burn tapes, a 12926A Tape Punch Subsystem will be required.

## Ordering information

### 92061A RTE microprogramming package, with software on punched tape

The microprogramming package consists of:

1. RTE Microassembler (92061-16001), translates symbolic HP 1000 Computer microprograms into micro object code, in standard format recognized by the Microdebug Editor, PROM mask tape generator, and the WCS Loader Utility. The source can be input from disc or a peripheral device; the micro object code can be output to a disc file or a tape punch.
2. RTE Micro Cross Reference Generator (92061-16002), generates a cross-reference symbol table listing to aid debugging of microprograms.
3. RTE PROM Mask Tape Generator (92061-16003), generates mask tapes to be used for burning PROMs from the object code produced by the Microassembler. The generator output can be specified to support a variety of mask tape formats.
4. RTE Microdebug Editor implemented as a main program (92061-16004), provides for interactive loading, editing, testing, and debugging of microprograms in WCS.
5. RTE Microdebug Editor implemented as a user-callable subroutine (92061-16005), provides for calling microprograms from user's programs.
6. RTE WCS Driver (13197-16001), provides for read, write, write/verify, and setup of base addresses of WCS cards, enabling and disabling of WCS cards, and reading the logical state of WCS cards.
7. RTE WCS Loader Utility (13197-16002), loads microprograms from a file or input peripheral into one or more WCS cards.
8. 21MX M-Series Microprogramming Manual (02108-90032).
9. 21MX E-Series Microprogramming Manual (02109-90004).
10. WCS Driver DVR36 and Loader Manual (13197-90001).

### 92061A Mini cartridge option 020

Replaces the punched tape software modules listed under items 1 through 7, above, with software on one 9162-0061 HP Mini cartridge (92061-13301) for read-in by 2645A/2648A+007, 030 or 2644A CRT Terminal.

### Additional equipment required for operation

To be usable, microprogram instructions must be loaded into one or more (three max.) 13197A WCS boards installed in the computer.

### 92061S Software Subscription Service

The 92061S Software Subscription Service provides software and manual updates as required to keep your RTE Microprogramming package current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92061S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92061T, must be specified when ordering 92061S.

### 92061T Comprehensive Software Support

The 92061T Comprehensive Software Support includes the Software Subscription Service, as described under 92061S, above, and a Phone-In Consulting Service for discussion of questions on your RTE Microprogramming package with a qualified HP Systems Engineer. The 92061T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92061S and 92061T Media options

010: Software updates on paper tape.

020: Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.

### 92061T option 200

92061T option 200 provides a discount for Comprehensive Software Support of an additional copy of the RTE Microprogramming Package.





# Standard libraries

The standard libraries provide subroutines and functions for the common arithmetic and transcendental functions, including complex and double precision functions usable in FORTRAN and Assembly language programs. The library also includes a Formatter, debug package, and other utility subroutines and functions. The most important of the mathematical and utility subroutines and functions and their program language usability are summarized in the table, below. The table also includes the comparable mathematical and utility routines callable from real-time BASIC.

## Ordering information

Relocatable libraries appropriate to the program languages supported are included in the 92064A RTE-M, 92001B RTE-II, 92067A RTE-IV, 2300C RTE-C, and 20855A BCS systems. Comparable libraries appropriate to the BASIC interpreter and the operating environment are included in the 92065A and 92101A BASIC/1000 subsystems and the 2300B RTE-B system.

### Relocatable Library

Usability					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I C	A L G O L	A S M B	
<b>Mathematical Subroutines and Functions</b>					
X	X	X	X	X	ABS Calculates absolute value of a real X.
X	X		X	X	AIMAG Extracts imaginary part of a complex X.
	X		X		AINT Truncates a real X.
X	S	X		S	ALOG Calculates natural log of a real X.
	S			S	ALOGT Calculates base 10 log of a real X.
X	X	X	X	X	AMOD Calculates real remainder of X/Y for real X and Y.
X	S	X	X	S	ATAN Calculates arctangent of real X.
X	X		X	X	ATAN2 Calculates arctangent of Y/X for real X and Y.
X	X		X	X	CABS Calculates real absolute value of complex X.
X			X		CADD Adds complex X to complex Y.
X			X		CDIV Divides complex X by complex Y.
	X		X		CEXP Calculates complex exponential of a complex X.
			X		.CHEB Evaluates chebyshev series at a real X for a particular table of coefficients C.
	X		X		CLOG Calculates complex natural log of a complex X.
X	X	X	X	X	CMPLX Combines real X and imaginary Y into complex Z.
X			X		CMPY Multiplies complex X by complex Y.
X	X		X	X	CONJG Forms conjugate Y of a complex X.
X	S	X	X	S	COS Calculates cosine of a real X (radians).
	X		X		CSNCS Calculates complex sine or cosine of complex X.
X	X		X	X	CSQRT Calculates complex square root of complex X.
X			X		CSUB Subtracts complex Y from complex X.
			X		.CTOI Raises a complex X to an integer power I.

Usability					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I C	A L G O L	A S M B	
<b>Mathematical Subroutines and Functions, continued</b>					
X	X		X	X	DABS Calculates absolute value of double real X.
X	X		X	X	DATAN Calculates double real arctangent of double real X.
X	X		X	X	DATN2 Calculates double real arctangent of quotient of quotient of two double real numbers (Y/X).
A	A		A	A	DBLE Converts real X to double real Y.
X	X		X	X	DCOS Calculates double real cosine of double real X.
				X	.DCPX Converts double real X to a complex Y.
A	A		A	A	DDINT Truncates double real X to double real Y.
	X		X		DEXP Calculates double real exponent of double real X.
X	X		X	X	DIM Calculates positive difference between real X and Y.
				X	.DINT Converts a double real X to an integer I.
	X		X		DLOG Calculates double real natural log of double real X.
	X		X		DLOGT Calculates base 10 log of double real X.
X	X		X	X	DMOD Calculates double real remainder of two double real values.
X	X		X	X	DSIGN Transfers sign of double real X to a double real Y.
X	X		X	X	DSIN Calculates double real sine of double real X.
	X		X		DSQRT Calculates double real square root of double real X.
				X	.DTOD Raises a double real X to a double real power Y.
				X	.DTON Raises a double real X to an integer power I.
			X	X	ENTIE Calculates greatest integer not exceeding a real X.
X	X		X	X	ENTIX Calculates greatest integer not exceeding a double real X.
X	S	X	X	S	EXP Calculates e of real X.
B	B	B	B	X	FADSB Adds or subtracts real X to real Y.‡
B	B	B	B	X	.FDV Divides real X by real Y.‡
X	X		X		FLOAT Converts integer I to real X.‡
B	B	B	B	X	.FMP Multiplies real X by real Y.‡
X	X		X		IABS Calculates absolute value of integer I.
X	X		X		IAND Takes logical product of integers I and J.
			X		AND Takes logical product of real X and Y.
X	X		X	X	IDIM Calculates positive difference between integers I and J.
X	X		X	X	IDINT Truncates double real X to integer J.
X	X		X		IFIX Converts real X to integer I.
	X	X		X	INT Truncates real X to integer J.
X	X		X		IOR Takes logical inclusive OR of integers I and J.
				X	.ITOI Raises integer I to integer power J.
			X		OR Takes logical inclusive OR of real X and Y.
X	X		X		ISIGN Calculates sign of integer of real X times absolute value of integer I.
			X		LOG Calculates base 10 log of real X.
				X	.MANT Extracts mantissa of real X.
X	X		X	X	MOD Calculates integer remainder of I/J for integer I and J.
X	X		X	X	MXMND Calculates maximum or minimum of series of double real values.
X	X		X	X	MXMNI Calculates maximum or minimum of series of integer values.
X	X		X	X	MXMNR Calculates maximum or minimum of series of real values.

Usability					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I C	A L G O L	A S M B	
					<b>Mathematical Subroutines and Functions, continued</b>
		X			NOT Takes logical NOT of real X.
				A	.PWR2 Calculates X times 2 <sup>n</sup> for real X and integer n.
X	X		X	X	REAL Extracts real part of a complex X.
				X	.RTOD Raises real X to double real power Y with double real result Z.
				X	.RTOI Raises real X to integer power I.
				X	.RTOR Raises real X to real power Y.
		X			SGN Calculates sign of real X.
X	X			X	SIGN Calculates sign of real or integer Z times the absolute value of real X.
X	S	X	X	S	SIN Calculates sine of a real X (radians).
A	A		A	A	SNGL Converts double real X to real Y.
X	X		X	X	SNGM Converts double real X to a real Y without rounding.
		X			SQR Calculates square root of real X.
X	S		X	S	SQRT Calculates square root of real X.
X	S	X	X	S	TAN Calculates tangent of real X (radians).
X	S		X	S	TANH Calculates hyperbolic tangent of real X.
				A	XADSB Double real addition and subtraction.
A				A	XDIV Divides double real X by double real Y.
A				A	XMPY Multiplies double real X by double real Y.
				X	XPOLY Evaluates double real polynomial.

Usability					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I C	A L G O L	A S M B	
					<b>Utility Subroutines and Functions</b>
X	X			X X	ABREG Gets contents of computer A and B registers.
X	X			X X	BINRY Reads/writes data at specified location on disc.
X	X			X X	CLRIO Clears system to make all I/O devices available for new operation.
X	X			X X	FORMATTER Structures input/output and converts between ASCII and binary.
X	X			X X	ISSR Sets S-register to value N.
X	X			X	ISSW Sets sign bit of A-register equal to bit N of the computer switch register.
			D		LEN Determines length (no. of chars.) of character string.
X	X			X	NAMR Reads input buffer of any length and produces a parameter buffer of 10 words.
X	X			X X	MAGTP Performs rewind, read/write of data blocks, writes a gap, issues clear request, and checks status.
			X		OCT Provides for printing of octal values.
X	X			X X	PTAPE Positions magnetic tape on tape unit by spacing forward or backward "N" files and/or records.
			X		RND Generates random numbers (0 through 1).
			X		SWR Returns state of specified computer switch register bit.
			X		TAB Controls column spacing in PRINT statements.
			E		TYP Determines type (number, character string, or end-of-file) of next item in disc file.

A Provided in microcode of Fast FORTRAN Processor.

B Appropriate calls to FADSB, .FDV, and .FMP subroutines are automatically generated by the FORTRAN III/IV or ALGOL Compiler or the Real-Time BASIC Interpreter whenever a plus, minus, division, or multiplication sign is encountered when translating source programs.

‡ Provided in standard HP 1000 Computer Floating Point Firmware Instructions.

D Available in BASIC/1000 only.

E Available in 92101A BASIC/1000 only.

S Provided in microcode of Scientific Instruction Set, which also requires Floating Point Processor.



# Sensor-based DAS utility library

model 92400A

The 92400A Sensor-Based DAS Utility Library is a collection of routines and functions (table below) providing ready-to-use calculation capabilities that have proven helpful to Hewlett-Packard computer system users. The standard libraries satisfy all of the externals required by the DAS Library.

92400A Sensor-Based DAS Utility Library

Usability				SUBROUTINES AND FUNCTIONS
F T N	B A S I C	A L G O L	A S M B	
				<b>Thermocouple Linearization</b>
X	B	X	X	FECON Converts iron-Constantan thermocouple output voltage to °C/°F with correction of non-linearity.
X	B	X	X	CRALM Converts Chrome-Alumel thermocouple output voltage to °C/°F with correction of non-linearity.
X	B	X	X	CUCON Converts Copper-Constantan thermocouple output voltage to °C/°F with correction of non-linearity.
				<b>Humidity Calculations</b>
X	B	X	X	PPDWR Calculates vapor pressure from dew point temperature.
X	B	X	X	PPRH Calculates vapor pressure from relative humidity.
X	B	X	X	PPBLB Calculates vapor pressure from wet and dry bulb temperatures.
X	B	X	X	RHDWP Calculates relative humidity from dew point temperature.
X	B	X	X	RHBLB Calculates relative humidity from wet and dry bulb temperatures.
				<b>Data Interpolation</b>
X	B	X	X	FRSTU Performs first-order interpolation of uniformly-spaced data.
X	B	X	wx	SCNDU Performs second-order interpolation of uniformly-spaced data.
X	B	X	X	FRSTR Performs first-order interpolation of randomly-spaced data.
X	B	X	X	SCNDR Performs second-order interpolation of randomly-spaced data.
				<b>Statistical Analysis</b>
X	B	X	X	STATF Calculates mean and standard deviation of fixed array of real data.
X		X	X	STATI Calculates mean and standard deviation of fixed array of integer data.
X		X	X	HISTF Generates histogram of fixed array of real data.
X	B		X	HISTB Generates histogram of fixed array of real data.
X		X	X	HISTI Generates histogram of fixed array of integer data.
X		X	X	INTLF Initializes for recording of running real data.
X	B		X	INTLB Initializes for recording of running real data.
X		X	X	INTLI Initializes for recording of running integer data.
X		X	X	RCRDF Records running real data.
X	B		X	RCRDB Records running real data.
X		X	X	RCRDI Records running integer data.
X	B	X	X	REPRT Reports mean and standard deviation and number of data points after recording of running data.

Usability				SUBROUTINES AND FUNCTIONS
F T N	B A S I C	A L G O L	A S M B	
				<b>Code Conversion</b>
X		X	X	ASCEB Converts ASCII to EBCDIC.
X		X	X	EBCAS Converts EBCDIC to ASCII.
X		X	X	ASCBC Converts ASCII to BCD.
X		X	X	BCDAS Converts BCD to ASCII.
				<b>Curve Fitting</b>
X	B	X	X	CRVFT Fits user's data to any of six different standard functions.
				<b>Data Integration</b>
X	B	X	X	FAREA Performs numerical integration of a fixed array of data.
X	B	X	X	STRTA Initializes for integration of running data.
X	B	X	X	AREA Computes latest value of running integral.
				<b>HP 2240A High Speed Read Package</b>
X		X	X	R2240 Reads ASCII record from 2240A.
X		X	X	C2240 Converts ASCII characters from 2240A to integer data.
				<b>Executive Interface Routines</b>
X		X	X	START Starts a program immediately, or after a specified time delay.
X		X	X	TRNON Starts a program at a specific time.
X		X	X	WAIT Suspends execution of a program for a specified interval.
				<b>Bit Manipulation</b>
X		X	X	IEOR Requests Exclusive OR of two integers.
X		X	X	ISHFT Shifts a digital word a specified number of bit positions left or right.

B = supported only by 2300B RTE-B BASIC.

## Ordering information

### 92400A Sensor-Based DAS Utility Library

The 92400A consists of the following items (software is on punched tape).

1. DAS Utility Library Manual (92400-93001).
2. Thermocouple Linearization Package, relocatable and source programs and manual (92401-60001, 80001).
3. Humidity Package, relocatable and source programs and manual (92402-60001, 80001).
4. Statistical Analysis Package, relocatable and source programs and manual (92403-60001, 80001).
5. Code Conversion Package, relocatable and source programs and manual (92404-60001, 80001).
6. Curve Fit Package, relocatable and source programs and manual (92405-60001, 80001, and 93001).
7. Interpolation Package, relocatable and source programs and manual (92406-60001, 80001, and 93001).

8. Integration Package, relocatable and source programs and manual (92407-60001, 80001).
9. HP 2240 High Speed Read package, relocatable and source programs (92400-16001 and 80001).
10. Bit Manipulation and Executive Interface Package, relocatable and source (09610-60025 and 80025).
11. 92400A Software Numbering Catalog (92400-93003).

#### **92400A Mini cartridge option 020**

Replaces software on punched tape with software on the following 9162-0061 Mini cartridges for read-in by 2645A/2648A+007 or 2644A CRT Terminal:

1. Relocatable software (92400-13301).
2. Source software (92400-13302 and 13303).

#### **92400S Software Subscription Service**

The 92400S Software Subscription Service provides software and manual updates as required to keep your Sensor-based DAS Utility Library current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92400S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92400T, must be specified when ordering 92400S.

#### **92400T Comprehensive Software Support**

The 92400T Comprehensive Software Support includes the Software Subscription Service, as described under 92400S, above, and a Phone-In Consulting Service for discussion of questions on your Sensor-based DAS Utility Library with a qualified HP Systems Engineer. The 92400T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

#### **92400S and 92400T Media options**

- 010: Software updates on paper tape
- 020: Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal





## RTE drivers package

model 92062B

The 92062B is a set of driver routines that link user's FORTRAN, Real-Time BASIC and Assembly language program calls to computer system peripheral devices in the RTE-M or RTE-IV operating system environment. The drivers and manuals provided in this package are summarized in the table below. The capabilities supported and not supported, and the character set handled by the respective drivers are given in the specifications.

### Functional specifications

#### Multi-device driver DVR00

##### Supported capabilities

1. Character mode keyboard input (ASCII).
2. Punched tape input (ASCII or binary), using 2748B or 2752A/2754B.
3. Printer/CRT display output (ASCII).
4. Punched tape output (ASCII or binary), using 2895B or 2752A/2754B (can be independent of 2752A/2754B printout).
5. Enabling/disabling of program scheduling by keystroke on terminal.
6. Keyboard terminal operation with Bell 103 or equivalent modem.

**Capabilities not supported.** Auto answer, horizontal tabs, vertical tabs, and form options of the 2762B or other keyboard printer terminal.

**Character set.** DVR00 passes the entire ASCII character set, but only upper-case characters can be used in system, file manager, or editor commands or program statement names and labels. Other characters, such as lower case, result in an error message. However, this does not exclude the entry/retrieval of other characters in data files, their use in program documentation comments, or the editing of strings containing lower case characters by the editor.

#### Page mode terminal drivers DVR05 and DVA05

##### Supported capabilities

1. Keyboard input in character or block mode.
2. Write to/read from display.
3. Enabling/disabling of program scheduling by keystroke on terminal.
4. Write EOF, forward/backspace one record or file, or locate specific file, on Mini cartridge transport 1 or 2 (2645A/2648A+007 or 2644A).
5. Write to/read from Mini cartridge tape unit 1 or 2 (2645A/2648A+007 or 2644A).
6. Print output on 2631A+240, 13246A/B, or 13349A Subsystem (requires 2645A/2648A+007, 2645A/2648A with 13261A, or 2644A+020).
7. Bidirectional control of printwheel carrier on 13349A Printer.
8. Modem communication via Bell Type 103A2 or 103A3, VADIC VA3400, or equivalent modems to 2635A, 2640B, 2645A, and 2648A terminals (DVA05 only).

9. Hardwired communication to any supported peripheral (DVR05 or DVA05).

**Capabilities not supported.** Plotting or reverse linefeed on 13349A Printer or remote system console operation over modem links.

**Character set.** DVR05 and DVA05 pass the extended character sets and display enhancements of the 264xA/B series CRT Terminals, but these are not recognized by the operating system or program processing software. Only upper case ASCII characters and numerals are usable in operating system, file manager, or editor commands, or in program statement names and labels. Other characters, such as lower case result in an error message. However, this does not exclude the entry/retrieval of other characters in data files, their use in program documentation comments, or the editing of strings containing lower case characters using the interactive editor.

#### Graphic plotter driver DVR10

**Supported capabilities.** Plotting of points, lines, axes, numbers, and alphanumeric characters.

**Additional requirement.** 92409A Real-Time Plotter Software Library.

#### CalComp plotter driver DVR10

**Supported capabilities.** Plotting of points, lines, axes, numbers, and alphanumeric characters.

#### Card reader driver DVR11

**Supported capabilities.** Reading of punched cards in Hollerith, packed binary, or column image binary format.

#### Line printer driver DVA12

**Supported capabilities.** Printing, 64 or 96 character set and automatic page eject with controllable line skipping.

**Character set.** DVA12 passes up to 96 ASCII characters.

#### Line printer driver DVR12

**Supported capabilities.** Printing, 64-character set.

#### TV interface driver DVA13 and library

**Supported capabilities.** Display of points, vectors, or characters with selective writing or erasure of any area of the screen.

#### OMR driver DVR15

##### Supported capabilities

1. Reading of mark-sense or punched cards in Hollerith, packed binary, or column-image binary format.
2. Sorting of previously-read cards into select and output hoppers.
3. Ringing of operator-signalling bell.

## 9-track mag tape unit driver DVR23

### Supported capabilities (up to four units)

1. Read/write records on magnetic tape.
2. Write End-of-File (EOF).
3. Forward/backspace one record or file.
4. Rewind.
5. Erase four inches of tape.

## Moving-head disc driver DVR31

Supported capabilities (up to four drives). Write/read access to specific tracks and sectors in specific disc drives.

## Moving-head disc driver DVR32

Supported capabilities (up to eight drives). Write/read access to specific tracks and sectors in specific disc drives.

## Flexible disc driver DVR33

Supported capabilities (up to four drives). Write/read access to specific tracks and sectors in specific disc drives.

## HP-IB\* interface driver DVR37

### Supported capabilities

1. Reads from/writes to automatically-addressed instruments/devices on the Hewlett-Packard Interface bus (HP-IB).

2. Commanding of instruments/devices on the HP-IB.
3. Alarm scheduling of programs in response to service requests from devices on the HP-IB.
4. Read/write control of the HP-IB protocol itself.

## Data entry terminal driver DVA47

### Supported capabilities.

1. Numeric or special function keyboard input from any of up to 56 HP 3070 Data Capture Terminals.
2. Display output to any of 15 prompt signal lights on any of up to 56 HP 3070 Data Capture Terminals.

## Ordering information

The 92062B RTE Drivers Package as listed in the table below is furnished with the 92067A RTE-IV operating system with software on the distribution media specified for that system.

Mini cartridges 92062-13303, 13304, and 13306 and corresponding manuals are furnished with the 92064A+020 RTE-M operating system; the same drivers are provided on flexible disc with the 92064A+040 RTE-M system.

92062B RTE Drivers Package summary

Driver name	Peripherals supported	Approx. Memory Required	Paper Tape Part Nos.	Mini Cartridge Part Nos.	Manual Part Nos.
Character mode multi-device driver DVR00	2635A, 2752A*, 2762A/B*, 2640A*, 2640B, with 12531C/D or 12880A interface and 2748B Tape Reader and 2895B Tape Punch with 12597A interfaces	1,120 bytes	29029-60001	92062-13306	29029-95001
Local page mode terminal driver DVR05	2635A, 2640A*, 2640B, 2644A+020*, 2645A or 2648A with or without options 007 and 030 plus 13260B, all using 12966A+001/002 interface; also supports 13246A/B, 13349A, and 2631A+240 auxiliary printers for 2644A and 2645A/2648A+007, 030 and 13260B	1,800 bytes† 2,900 bytes‡	92001-16028 92001-16027		92001-90015
Local or modem page mode terminal driver DVA05		3,200 bytes	92062-16035		
Graphic plotter driver DVR10	7210A Graphic Plotter with 17210A interface	400 bytes 2,000 bytes	72009-60001 72008-60001		17210-90004
CalComp Plotter driver DVR10 and graphics library	563/565 CalComp Plotter connected to system via HP 12560A interface	3,700 bytes, including library	20808-60001 20810-60001		12560-90023
Data entry terminal driver DVA47	Up to 56 HP 3070 Data capture terminals and 40280A interface	2,800 bytes	92900-16003	92900-90005	
CR driver DVR11	2892B Card Reader with 12924A interface	1,100 bytes	29030-60001	92062-13303	09600-93010
Line printer driver DVA12 2631A device subroutine LP31	2607A*, 2610A*, 2613A, 2617A, 2618A, and 2631A Printers with 12845B interface	700 bytes 1,600 bytes	92001-16020 92062-16003		92200-93001 92062-90003
Line printer driver DVR12	2767A* Line Printer with 12653A interface and 9866A Printer with 12566B interface	960 bytes	29028-60002		92001-90010
TV interface driver DVA13, library, and verification	91200B TV Monitor interface card (one card for B&W, three cards for color)	500 bytes 2,700 bytes	91200-16001 91200-16002 91200-16004		91200-90005
OMR driver DVR15	7261A Optical Mark Reader with 17200-60001 interface	1,200 bytes	09601-16021		07261-90010
9-track MTU driver DVR23	Up to four 7970B/E 9-Track Mag Tape Units with 13181A/13183A interface	900 bytes	92202-16001	92062-13304	92202-93003
HP-IB interface driver DVR37 and library	59310B Hewlett-Packard Interface Bus (HP-IB) interface	2,100 bytes‡ 2,600 bytes‡ 500 bytes‡ 200 bytes	59310-16002 59310-16003 59310-16004 59310-16005		59310-90063
Flexible disc driver DVR33	12732A Flexible Disc Subsystem with up to three 12733A additional disc drives	1,150 bytes	12732-16001		12732-90001
M-H disc driver DVR31	Up to four 7900A Disc Drives with 13210A interface	1,330 bytes	29013-60001	92062-13307	
M-H disc driver DVR-32	Up to eight 7905A, 7906A, and/or 7920A Disc Drives with 13037A/B Disc Controller and 13175A interface	1,800 bytes	92060-16031		

\*Identifies peripheral device no longer available that is listed here for reference only.

† Smaller DVR05 supports keyboard-display only; larger DVR05 also supports Mini cartridge I/O in the 2645A/2648A+007 or 2644A Terminal and 13246A/B, 13349A, and 2631A+240 auxiliary printer subsystems.

‡ Smaller DVR37 (59310-16002) does not provide SRQ; larger DVR37 (59310-16003) provides SRQ.



## Diagnostics library

models 24396A, B, C, D, E, F

HP 24396 diagnostic library products enable HP 1000 computer users to load a diagnostic or control program into memory from any one of nine different input devices. These include the 2748A Punched Tape Reader; HP 7900, 7905, or 7906 disc drive; HP 7970B or 7970E Magnetic Tape Unit; or 2644A, 2645A+007, or 2648A+007 CRT Terminal.

### Features

- A broad range of diagnostic software support media
- Increased service efficiency by reducing test time
- CPU and peripheral diagnostics in a compact form
- Disc cartridges, magnetic tapes, and cartridge tape versions provide a wide range of peripheral subsystem diagnostics

### Configuration information

#### CPU required

HP 1000 or 2100A/S

#### CPU options required

As specified by the diagnostic to be executed

#### Memory required

8k bytes minimum; certain diagnostics may require more, see the "Diagnostics library summary".

#### Prerequisites

**24396A:** 2748A/B, 2758A, or 2737A/B paper tape readers; 2752A or 2754A teletype, and HP 1000 or 2100A/S computers.

**24396B:** 7900A or 7901A cartridge disc drive, 12992A disc loader ROM, DCPC, and HP 1000 computer.

**24396C:** 7905A/7906A cartridge disc drive, 12992B disc loader ROM, DCPC, and HP 1000 computer.

**24396D:** 7970B magnetic tape unit, 12992D tape loader ROM, DCPC, and HP 1000 computer.

**24396E:** 7970E magnetic tape unit, 12992D tape loader ROM, DCPC, and HP 1000 computer.

**24396F:** 2644A/2645A+007/2648A+007 CRT terminal, HP 1000 computer, and 12992C cartridge loader ROM.

*NOTE: 2100A/S computers are supported only by single file or 24396A diagnostic products. 24396B/C/D/E/F diagnostic libraries require HP 1000 loader ROMs for proper operation.*

### Ordering information

**24396A** Diagnostics on paper tape

**24396B** Diagnostics on 2.5M byte disc cartridge

**24396C** Diagnostics on 10M byte disc cartridge

**24396D** Diagnostics on 7970B magnetic tape (800 BPI; NRZI)

**24396E** Diagnostics on 7970E magnetic tape (1600 BPI;PE)

**24396F** Diagnostics on 2644A/45A/48A cartridge tape

#### Individual cartridges

Any of the individual 2644A, 2645A, or 2648A cartridges may be ordered using the part numbers shown in the diagnostics library summary of this data sheet. Manuals for these may be ordered using the manual part numbers listed in the same summary. When ordering, specify both part numbers; one for the cartridge tape and one for its appropriate manual. Each cartridge includes the diagnostic configurator.

#### Single file diagnostics

These may be ordered using the binary tape part numbers shown in the diagnostics library summary of this data sheet. Manuals for these may be ordered using the manual part numbers shown in the same summary. When ordering, specify both part numbers; one for the diagnostic on paper tape and one for the appropriate manual. Single file diagnostics require the 24296-60001 diagnostic configurator for proper operation.

#### Diagnostics supplied in HP 1000 Computer Systems

HP 1000 Computer Systems include their own Diagnostic Library, HP part no. 24998-14002. This provides diagnostics on Mini cartridges for all computer and peripheral capabilities that are supported in HP 1000 Computer Systems as well as manuals on those diagnostics.

#### 24396S HP 1000 Diagnostic Subscription Service

The 24396S HP 1000 Diagnostic Subscription Service provides quarterly distribution of revised diagnostic routines and the associated updating information. These items are necessary to keep the diagnostics and manuals supplied with your 24396A/F/D/E Diagnostics Library or the Diagnostics Library supplied with your HP 1000 Computer System up to date with respect to changes by the factory. The 24396S service provides updates for a year, renewable annually. Updates are available on paper tape, Mini cartridge, or 800 or 1600 bpi magnetic tape, selectable by specifying one of the following media options, which must be ordered along with 24396S to receive the Diagnostic Subscription Service:

#### 24396S Media options

**010:** Updates on paper tape for 24396A Diagnostics library.

**020:** Updates on Mini cartridge for 24396F Diagnostics Library.

# Diagnostics library summary

TESTED CAPABILITY/PRODUCT	REQ. MEM. SIZE (bytes)	SINGLE FILE		24396A PAPER TAPE	DISCS & MAG TAPES	24396F 2644/45/48 CARTRIDGE TAPE	MANUAL VOLUME
		BINARY TAPE	MANUAL				
Diagnostic configurator	8k	24296-60001	02100-90157	24296-60001	↑	24396-13301	24396-14001
Memory ref. instr. group	8k	24315-16001	02100-90218	24396-12001			
Alter-skip instr. group	8k	24316-16001	02100-90211				
Shift-rotate instr. group	8k	24317-16001	02100-90212				
Core memory (2100/16/15/14)	8k	24323-16001	02100-90219	24396-12001			
Semiconductor memory (HP 1000)	8k	24395-16001	24395-90001				
EAU instr. group	8k	24319-16001	02100-90214	24396-12002			
Floating point instr. group	8k	24320-16001	24320-90001				
Memory protect (2114/15/16)	8k	24324-16001	02100-90220				
Memory parity check (2114/15/16)	8k	24325-16001	02100-90221	24396-12002			
Memory prot/parity error (2100/HP 1000)	8k	12892-16001	12892-90005				
Power fail/auto restart	8k	24321-16001	02100-90216	24396-12003			
I/O instruction group	8k	24318-16001	02100-90213				
General-purpose register	8k	24391-16001	24391-90001				
Direct memory access (2114/15/16)	8k	24322-16001	02100-90217	24396-12003			
Direct memory access (2100/HP 1000)	8k	24322-16002	24322-90002				
Ext. instr. group (index instr.)	8k	12943-16002	12943-90004	24396B 2.5Mb DISC 24396-13001		24396-13301	24396-14001
Ext. instr. group (word, bit, byte)	8k	12943-16001	12943-90004			24396-13302	24396-14002
2100 Fast Fortran package	8k	12907-16003	12907-90003	24396C 10Mb DISC 24396-13101		24396-13302	
HP 1000 Fast Fortran package 1	8k	12977-16004	12977-90002				
HP 1000 Fast Fortran package 2	8k	12977-16005	12977-90002	24396D 800 BPI Mag Tape 24396-13501	24396-13303		
2000 ACCESS Com. processor F.2100	16k	13206-16001	13207-90003				
2000 ACCESS Com. processor F.21MX	16k	13207-16001	13207-90003	24396E 1600 BPI Mag Tape 24396-13601	24396-13304	24396-14003	
Microcoded semicond. memory	8k	24395-16002	24395-90003				
Memory expansion unit	32k	12929-16001	12929-90003	24396-13304	24396-13305	24396-14004	
Time base generator	8k	12539-16001	12539-90011				
12979 I/O extender	8k	12979-16001	12979-90010	24396-13305	24396-13306	24396-14003	
12936 Priv. interrupt fence	8k	12936-16001	12936-90003				
12908/12978 256 word WCS	8k	12908-16001	12908-90013	24396-13306	24396-13307	24396-14004	
13197 1k WCS	8k	13197-16002	13197-90002				
12889 Hardwired serial interface	8k	24335-16001	02100-90169	24396-13307	24396-13308	24396-14004	
59310 HP-IB interface	8k	59310-16001	59310-90061				
12587 Async data set interface	16k	12587-16001	12587-90013	24396-13308	24396-13309	24396-14004	
12920 Async multiplexer (data)	8k	12920-16001	12920-90009				
12920 Async multiplexer (control)	8k	12920-16002	12920-90009	24396-13309	24396-13310	24396-14004	
12621 Sync data set interface (rec)	8k	12621-16001	12621-90008				
12622 Sync data set interface (send)	8k	12622-16001	12622-90008	24396-13310	24396-13311	24396-14004	
12967 Sync data set interface	8k	12967-16001	12967-90001				
12966 Async data set interface	16k	12966-16001	12966-90004	24396-13311	24396-13312	24396-14004	
12968 Async comm interface	8k	12968-16001	12968-90003				
2600 Keyboard-display terminal	8k	24200-16002	24200-90002	24396-13312	24396-13313	24396-14004	
Teleprinter	8k	12531-16001	12531-90042				
2762A/B Terminal (Terminet) printer	16k	02762-16001	02762-90035	24396-13313	24396-13314	24396-14004	
2615 Video terminal	8k	24351-16001	02615-90002				
2640 Interactive terminal	16k	02640-16001	02640-90020	24396-13314	24396-13315	24396-14004	
2644 Mini data station (non CTU)	16k	02644-16001	02644-90012				
2644 Mini data station (CTU only)	16k	02644-16002	02644-90012	24396-13315	24396-13316	24396-14004	
92900A Terminal s/s (3070, 40280)	8k	92900-16001	92900-90003				
2610/14 Line printer	8k	24366-16001	24366-90001	24396-13316	24396-13317	24396-14004	
2767 Line printer	8k	12984-16001	12984-90005				
2607 Line printer	8k	24340-16001	12987-90004	24396-13317	24396-13318	24396-14004	
2612/17/18 Line printer	8k	02612-16001	02612-90006				
2631 Printer	16k	02631-16001	02631-90906	24396-13318	24396-13319	24396-14004	
2635 Printing terminal	16k	02635-16001	02635-90906				
9866 Line printer	8k	12996-16001	12996-90001	24396-13319	24396-13320	24396-14004	
9-track Mag tape (7970, 13181/3)	16k	13181-16001	13181-90095				
7/9-track Mag tape (13184 I/F)	16k	13184-16001	13184-90008	24396-13320	24396-13321	24396-14004	
Disc file (2883)	16k	12965-16001	12965-90009				
12732A Flexible disc subsystem	16k	12732-16003	12732-90003	24396-13321	24396-13322	24396-14004	
7900/01 Cartridge disc	16k	12960-16001	12960-90003				
7905/06/20 Cartridge disc	32k	12962-16001	12962-90001	24396-13322	24396-13323	24396-14004	
Paper tape reader-punch	8k	12597-16001	12597-90031				
Dig. plotter I/F (CalComp)	8k	12560-16001	12560-90029	24396-13323	24396-13324	24396-14004	
2892 Card reader	8k	12924-16001	12924-90006				
2894 Card reader-punch	16k	12989-16001	12989-90001	24396-13324	24396-13325	24396-14004	
7261 Card reader	8k	07261-16005	07261-90005				
Diagnostic cross-link	8k	24296-16003	02100-90157	24396-13325	24396-13326	24396-14004	
7900/7905/7906/7920 Disc initialization	8k	24296-16002	02100-90157				

- 025: Updates on Mini cartridges for HP 1000 Computer System Diagnostics Library.
- 050: Updates on 800 bpi magnetic tape for 24396D Diagnostics Library.
- 051: Updates on 1600 bpi magnetic tape for 24396E Diagnostics Library.



# GRAPHICS/1000 Graphics plotting software

model 92840A

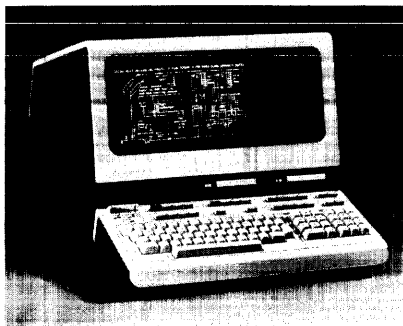
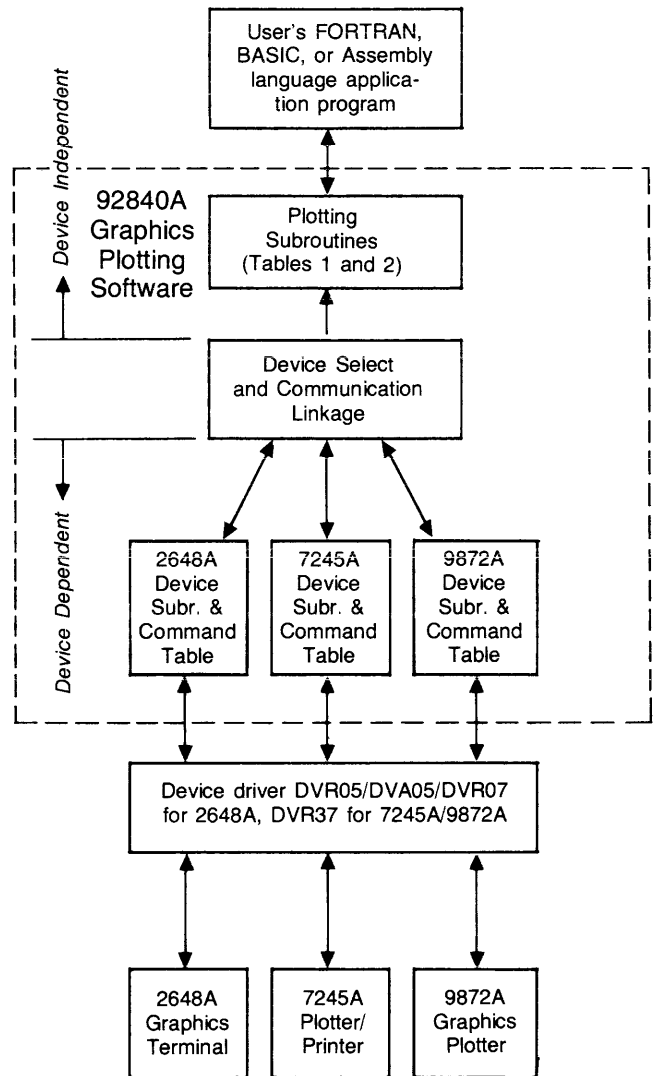
The 92840A Graphics Plotting Software is the first in a new family of GRAPHICS/1000 software products for use in HP 1000 Computers and Systems operating under the RTE-M or RTE-IV real time executive system. This new package offers a powerful set of modularly-usable plotting support routines for the FORTRAN, BASIC, or Assembly language programmer. Its modularity also makes possible the support of a wide variety of Hewlett-Packard graphics output devices, currently including the HP 2648A raster-scan Graphics Terminal, the 9872A Graphics Plotter, and the 7245A Plotter/Printer.

## Features

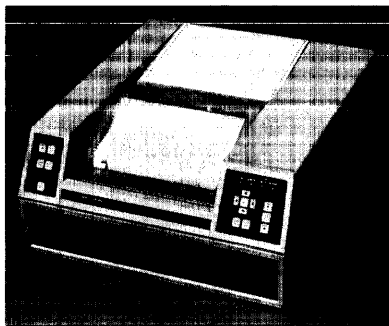
- 55 device-independent plotting subroutines
- User-defined world coordinate system for data plotting
- Automatic axis and grid drawing and labeling
- Easy development of application programs for interactive graphics, picture handling, and creation of graphical data structures
- Usability with FORTRAN IV, real-time BASIC, and HP's RTE Assembly language
- Compatibility with RTE-M and RTE-IV operating systems and 2648A Graphics terminal, 9872A Graphics Plotter, and 7245A Plotter/Printer
- Modular design for efficient use of memory

## Functional description

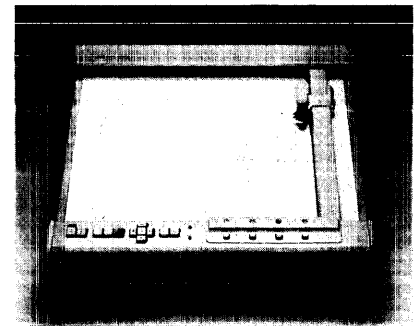
The modular organization of the 92840A Graphics Plotting Software provides device-independent operation, as shown in the diagram at right. Any or all of the devices noted in the diagram can be in the system. Programmer's plotting requests simply identify the destination device by logical unit and device subroutine I.D. number. In that way, the flexibility and power of the plotting subroutines can be applied to any or all of a variety of plotting devices.



2648A Graphics Terminal



7245A Plotter/Printer



9872A Graphics Plotter

## Applications

The 92840A Graphics Plotting Software provides two levels of programming support for plotting. For the novice user, the 92480A software includes easily-used plotting subroutines which facilitate the creation of engineering or business graphs. These fundamental subroutines are listed in Table 1. Additional subroutines, listed in Table 2, help to simplify the programming of more sophisticated graphics applications by the experienced user. Overall, the 92840A provides powerful plotting support capabilities important to a wide range of users in the following computer-aided application areas:

- Research and engineering data plotting
- Electrical and mechanical design
- Graphic presentation of management data
- Display monitoring of plant status and utilization in process control
- Drafting
- Education
- Display of Quality Control data
- Design of printed circuit and integrated circuit layouts

The ease of use of the 92840A software is illustrated by the program and plotting example at right and below.

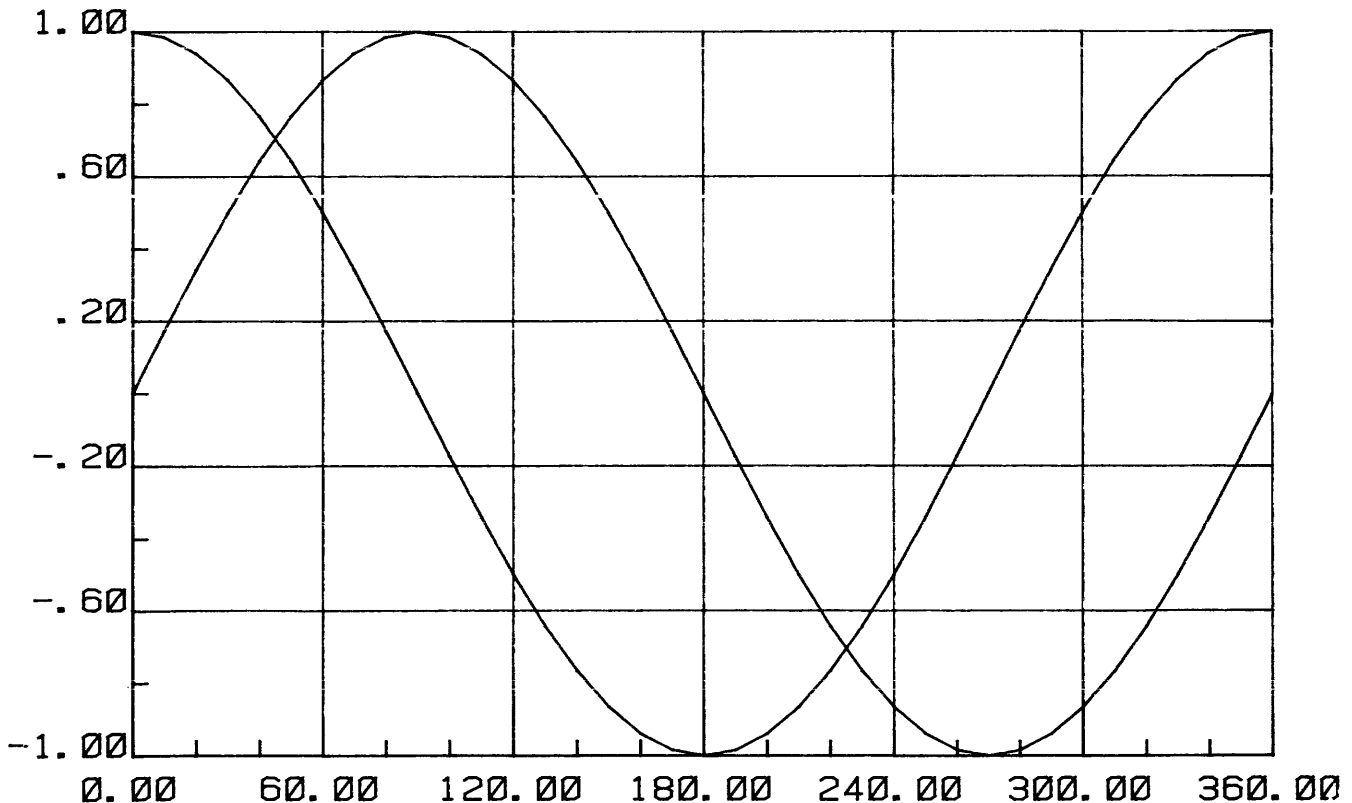
### Sample plotting program

```

FTN,L
PROGRAM DRMGD
DIMENSION IGCB(128),IPRAM(5)
EQUIVALENCE (IPRAM,LU),(IPRAM(2),ID)
C
C THIS PROGRAM IS AN ILLUSTRATION OF THE SEQUENCE OF
C PLOT COMMANDS TYPICALLY USED TO GET A SIMPLE PLOT.
C NOTE THE ORDER OF EVENTS. FIRST THE PLOT PACKAGE IS
C INITIALIZED (PLOT), THEN THE VIEWPORT (CLIPPING
C BOUNDARY) IS ESTABLISHED, AND FINALLY THE WINDOW
C IS SETUP FOR CREATING THE MATHEMATICAL TRANSFORMATION
C CONSTANTS WHICH WILL TRANSFORM USER UNITS INTO MACHINE
C UNITS MAPPED ONTO THE PRE-ESTABLISHED VIEWPORT
C
C GET THE LU NUMBER AND ID FOR THE DEVICE
C
C CALL RMPAR(IPRAM)
C
C INITIALIZE PLOT PACKAGE
C
C CALL PLOT(IGCB,ID,1,LU)
C
C ESTABLISH VIEWPORT AND DEFAULT SOFT CLIPPING BOUNDARY
C
C CALL VIEWP(IGCB,10.,90.,10.,60.)
C
C SETUP WINDOW - MATHEMATICAL TRANSFORMATION CONSTANTS.
C SINE AND COSINE FROM 0 TO 360 DEGREES RANGE FROM -1 TO +1.
C
C CALL WINDW(IGCB,0.,360.,-1.,1.)
C CALL FXD(IGCB,2)
C
C DRAW GRID WITH LABELS F7.2 FORMAT
C
C CALL LGRID(IGCB,20.,.2,0.,0.,3.,.2.,1.)
C
C NOW LOOP TO DRAW SINE AND COSINE WAVEFORMS
C
DO 550 I=1,2
X = 0.
Y = 0.
CALL MOVE(IGCB,X,Y)
ANGL = 0.
DO 100 K=1,37
X = ANGL
Y = COS(ANGL/57.3)
IF(I.EQ.2)Y = SIN(ANGL/57.3)
CALL DRAW(IGCB,X,Y)
ANGL = ANGL + 10.
100 CONTINUE
200 CONTINUE
END

```

Sample plot, resulting from sample program (above, right)



# Functional specifications

Plotting subroutines  
See Tables 1 and 2.

## Compatibility

**Operating system:** 92064A RTE-M operating system (RTE-MII or MIII configuration) (BASIC/1000M is not supported) and 92067A RTE-IV system with or without 92101A BASIC/1000D.

**Program languages:** FORTRAN IV, Real-Time BASIC, and HP RTE Assembly language.

**Graphics output devices:** HP 2648A Graphics Terminal (can be 2648A+007 also used as system console), 9872A Graphics Plotter, and 7245A Plotter/Printer.

Table 1. 92840A Fundamental Subroutines

OUTPUT PRIMITIVES	
<b>MOVE</b>	Moves pen to absolute position
<b>MOVEI</b>	Moves pen to incremental position
<b>DRAW</b>	Draws line to absolute position
<b>DRAWI</b>	Draws line to incremental position
<b>CPLOT</b>	Draws line or moves pen in increments of character blocks
<i>Note: No specific text primitive is provided. A write or print statement causes the information to appear on the graphics display when the graphics text mode is turned on. See LABEL below.</i>	
OUTPUT PRIMITIVE ATTRIBUTES	
<b>PEN</b>	Selects a pen
<b>LINE</b>	Selects one of a predefined set of line styles (solid, dashed, etc.)
<b>LABEL</b>	Used to turn on and off the graphics text mode
<b>CSIZE</b>	Specifies character height, width/height, and slant for graphics text
<b>LDIR</b>	Establishes direction of a group of graphics text characters
<b>LORG</b>	Designates origin of a group of graphics text characters relative to the current pen position
VIEWING TRANSFORMATIONS	
<b>SETAR</b>	Defines width/height ratio of the logical view surface boundary. This is used to guarantee transportability of plots from one device to another.
<b>VIEWP</b>	Defines mapping area (viewport) on logical view surface in normalized device coordinates.
<b>WINDW</b>	Defines the area in world coordinate space to be mapped onto the viewport. The boundaries of this region are the soft clip limits. Only the portion of the picture within the soft clip limits will appear on the graphics display.
INPUT PRIMITIVES	
<b>CURSR</b>	Reads cursor (locator) position
<b>POINT</b>	Moves cursor to absolute position
<b>DIGTZ</b>	Reads cursor position with a prompt and wait
CONTROL	
<b>PLOTR</b>	Select and initialize graphics device
<b>GPON</b>	"Power on" reset of a graphics device
<b>GCLR</b>	Clears the display area or advances plot paper
<b>LIMIT</b>	Allows user to set device plotting limits within default physical device limits
<b>CLPOF</b>	Turns off soft clipping
<b>CLPON</b>	Turns on soft clipping

Table 2. 92840A Additional subroutines

DATA DISPLAY FUNCTIONS	
<b>AXES</b>	Draws a pair of axes with optional tic marks
<b>LAXES</b>	Performs <b>AXES</b> with labelling of tick marks
<b>GRID</b>	Draws a full grid within the limits of the data display area
<b>LGRID</b>	Performs <b>GRID</b> with labelling
<b>FXD</b>	Selects <b>LAXES</b> and <b>LGRID</b> labelling format
<b>FRAME</b>	Draws a rectangle around the limits of the data display area
OUTPUT PRIMITIVES	
<b>PENUP</b>	Logically raises the pen
<b>PENDN</b>	Logically lowers the pen
<b>LABON</b>	Turns on graphics text mode
<b>LABOF</b>	Turns off graphics text mode
<b>PLOT</b>	Absolute position plotting with pen control
<b>IPLOT</b>	Incremental plotting with pen control
<b>MOVER</b>	Moves pen to relative position
<b>DRAWR</b>	Draws line to relative position
<b>RPLOT</b>	Relative plotting with pen control
OUTPUT PRIMITIVE ATTRIBUTES	
<b>PORG</b>	Defines origin for relative plotting
<b>PDIR</b>	Sets plotting direction (angle of rotation) for relative and incremental plotting
VIEWING TRANSFORMATIONS	
<b>MSCAL</b>	Input units are in millimeters. Forces mapping so that picture is in true 1:1 scale
<b>SETGU</b>	Selects normalized device coordinate units as the input units for plotting and control
<b>SETUU</b>	Selects world coordinate system units as the input units for plotting and control
<b>SHOW</b>	Defines a window surrounding a region of interest in world coordinate space that gives isotropic scaling
<b>CLIP</b>	Redefines soft clip limits set by <b>WINDW</b> . The mapping remains unchanged
<b>MARGN</b>	Specifies the placement of the viewport within the physical limits of the plotting or display area
CONTROL	
<b>XMIT</b>	Transmits data in I/O buffer to graphic device
<b>LGERR</b>	Sets the logical unit number of the error logging device
<b>IGERR</b>	Returns the most recent "soft" error, which is an error that does not prevent continued operation of the graphics software
<b>HDERR</b>	Causes all errors to be reported and may also stop processing by the graphics software because of an error that would not normally result in termination
<b>WHERE</b>	Returns the logical pen location and state (up or down)
<b>GPMM</b>	Converts millimeters to normalized device coordinates
<b>GSTAT</b>	Returns Graphics Plotting Software package status
<b>DSTAT</b>	Returns graphics device characteristics
<b>DSIZE</b>	Returns display size information

## Minimum system requirements

In **RTE-IV**: Same as 92067A RTE-IV system with 2645A+007 or 2648A+007 CRT terminal; plus one or more compatible graphics output devices, selected from those listed on the previous page.

In **RTE-M**. Same as 92064A RTE-MII or MIII (multi-terminal) configuration of RTE-M system with 2645A+007 or 2648A+007, plus one or more compatible graphics output devices, selected from those listed on the previous page.

## Required RTE drivers

For **2648A**: DVR05 or DVA05, included in 92062B RTE Drivers Package, or DVA07 included in 91730A Multipoint Terminal Subsystem Software Package.

For **7245A and 9872A**: DVR37 included in 92062B RTE Drivers Package.

## Approximate memory requirements

**Plotting subroutines**: 4-16k bytes; 8k bytes typical.

**Device select and communications linkage**: 5k bytes

**Device subroutine and command tables**: 1.6k bytes per device.

**Driver DVR05**: 2.9k bytes

**Driver DVA05**: 3.2 bytes

**Driver DVR07**: 2.5k bytes

**Driver DVR37**: 2.1k bytes

## Ordering information

### 92840A Graphics Plotting Software

The Graphics Plotting Software consists of:

1. Software media choice option 020, which must be ordered.
2. Manual (92840-90001).
3. Software numbering catalog (92840-90005).

### 92840A Option

**020**: Provides Graphics Plotting Software on Mini cartridges 92840-13301 and 13302 for read-in via 2645A+007 or 2648A+007 CRT Terminal.

### 92840S Software Subscription Service

The 92840S Software Subscription Service provides software updates on Mini cartridges and manual updates as required to keep your Graphics Plotting Software current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92840S service is ordered in monthly units for at least six months, billable quarterly. A media option must be specified from that listed below.

### 92840T Comprehensive Software Support

The 92840T Comprehensive Software Support includes the Software Subscription Service, as described under 92840S, above, and a Phone-In Consulting Service for discussion of questions on your Graphics Plotting Software with a qualified HP Systems Engineer. The 92840T service is ordered in monthly units for at least six months, billable quarterly. A media option must be specified from that listed below.

### 92840S and 92840T Media Option

**020**: Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.

### 92840T option 200

92840T option 200 provides a discount for Comprehensive Software Support of an additional copy of the Graphics Plotting Software.





# IMAGE/1000 data base management system

model 92063A

IMAGE/1000 is a data base management software system designed for use in computer systems managed by HP's RTE-II or RTE-IV operating system. It is a complete software package for consolidating individual data files into a single, interrelated data base that can be shared by many different people for a wide variety of purposes.

Once established, IMAGE/1000 users have multi-terminal, multi-program access to the data base for interactive addition, deletion, retrieval, and reporting of information. IMAGE/1000 also includes QUERY, an easy-to-use inquiry language that allows non-programmer users to access the data base with simple, English-like commands. QUERY and three other subsystems provide all the "software tools" necessary to define, build, access, maintain, and restructure a data base tailored to a user's unique needs.

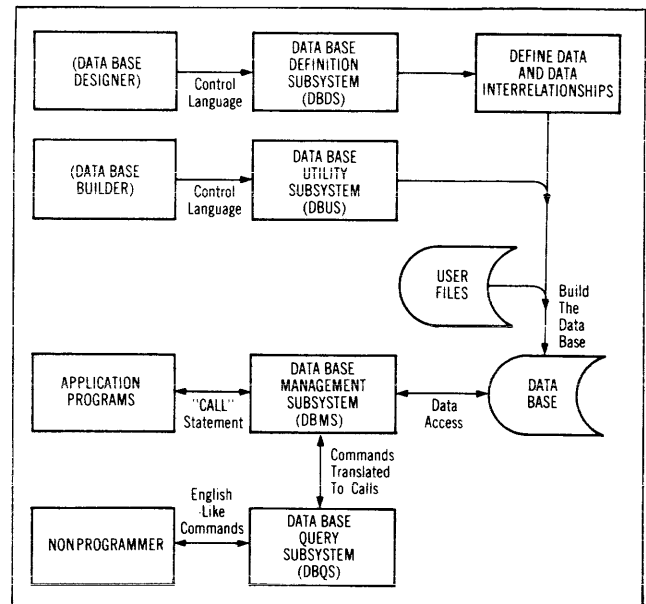
## Features

- Data access by multiple key values (such as a customer's name and part number).
- Minimum information redundancy through file consolidation.
- Automatic linkage between related information items for quick and flexible access.
- Protection of the data base against unauthorized data access at the data item level.
- Easy convertibility of your present file system to an IMAGE/1000 data base.
- Expandability of your IMAGE/1000 data base across disc volumes.
- Sequential, direct (by relative record number), or random (by alphanumeric key value) access to data.
- Multi-terminal retrieval and updating.
- Embedded QUERY language which enables the non-programmer to interactively retrieve, alter, and report information using English-like commands.
- Restructuring of your IMAGE/1000 data base without having to alter your related application programs.
- Automatic linkage management when data is added, modified or deleted from your data base.
- Data base security provided through utilities which allow you to backup and restore your data base.

## IMAGE/1000 subsystems

To provide for all your information handling needs, IMAGE/1000 utilizes four easy-to-use subsystems:

- A data base definition subsystem (DBDS)
- A data base utility subsystem (DBUS)
- A data base management subsystem (DBMS)
- A data base QUERY subsystem (DBQS)



A more detailed description of these four subsystems is provided on the following pages.

### Data base definition subsystem (DBDS)

The Data Base Definition Subsystem processes a description of the user data base and produces an internal system description of the data base (called a 'root' file).

The five main steps in using DBDS are:

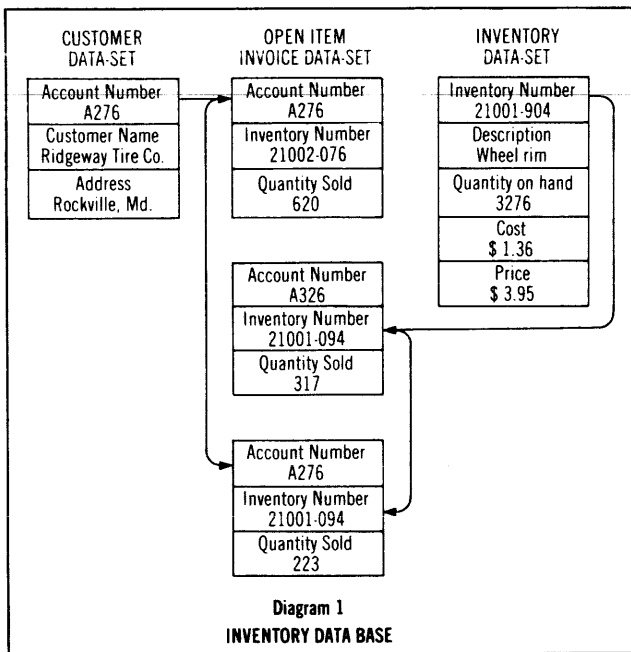
- Defining the nature of the data and the relationships between data
- Identifying degrees of privacy and privacy passwords
- Identifying items of data, their type (ASCII character, integer, or real), and degree of read and write privacy on each item
- Identifying groupings of items of data (data sets) and the relationship between them
- Processing (or compiling) this description by DBDS

Diagram 1 (next page) portrays a simplified data base designed to handle a typical inventory control problem. Specifically, a company needs to know:

- How many goods a particular customer has purchased
- How many of a particular product has been sold

Using DBDS, the designer defined 3 data sets:

- A customer data set consisting of account number, customer name, address
- An inventory data set consisting of inventory number, description, quantity on hand, cost, price, etc.
- An open item invoice data set consisting of account number, inventory number, quantity sold



Defining a linkage between the customer and open item invoice data set via the account number will provide the means to find all items an account has purchased. Likewise, a linkage between data sets inventory and open item invoice via inventory number will find the number of a particular item sold.

The Data Base Utility Subsystem (DBUS) consists of seven programs used primarily for general maintenance of a data base. This includes loading large amounts of data from disc files, magnetic tape, cards, etc., into a newly defined (through DBDS) data base; copying data from a data base onto magnetic tape with the option of restructuring the data base (adding new data items, data sets, etc.); or simply dumping the data base to magnetic tape for the purpose of security. The seven DBUS programs are:

- DBBLD (Data Base Build). Loads data into a data base. DBBLD is useful for initially storing large amounts of data into your data base, or adding data to existing data bases.
- DBULD (Data Base Unload). Copies data from an existing data base onto a magnetic tape file. Unloading the data base using this routine allows the user to reload the data base into a different data base structure.
- DBLOD (Data Base Load). Builds a data base according to a specified root file from a magnetic tape created by the DBULD program. DBLOD users have the option to restore the data to the same data base structure or create a new data base structure using a new data base definition.
- DBSTR (Data Base Store). Copies the data base root file and an existing data base onto magnetic tape. This is a physical unload for the purpose of back-up security. No restructuring of the data base is possible using this program.
- DBRST (Data Base Restore). Restores a root file and a data base from a magnetic tape created by DBSTR. No modification of the data base structure is allowed.

- DBSPA (Data Base Space). Reports data base capacity in use and available.
- RECOV (Data Base Recovery). Closes previously-opened data base accesses not properly closed by the user, for recovery of normal data base access for subsequent users.

### Data base management subsystem (DBMS)

The Data Base Management Subsystem (DBMS) consists of eleven subroutines designed to access and manipulate data stored in an IMAGE/1000 data base. The location of information is known to DBMS through the structure of the data base (known as the root file).

These subroutines, which are callable from your Fortran IV, BASIC, or Assembler application programs, perform such functions as opening the data base for access, closing it after usage, reading, writing, updating, adding and deleting information. These eleven subroutines are:

- DBOPN (Data Base Open). Prepares a data base for subsequent accesses by the other DBMS subroutines. This consists of defining the subset of the data base a particular user can gain access to.
- DBCLS (Data Base Close). Closes or posts the updated root file and prevents further accesses of the data base.
- DBGET (Data Base Read). Accesses data from a data base in a sequential, direct (or random), chain, or keyed read fashion.
- DBUPD (Data Base Update). Modifies existing data in a data base.
- DBPUT (Data Base Put). Adds new data to a data base.
- DBDEL (Data Base Delete). Deletes existing information from a data base.
- DBFND (Data Base Find). Locates the head of a chain using a mathematical transformation (randomizing) on a key value. This is done in order to perform subsequent chained reads via DBGET.
- DBINF (Data Base Information). Returns information about the data-base structure. The information can be the type and length of data items, the relationships between data, etc.
- DBLCK (Data Base Lock). Gives the user temporary exclusive use of the data base to update entries.
- DBUNL (Data Base Unlock). Relinquishes exclusive user control and restores the data base to full use by others.
- DBINT (Data Base Initialize) Constructs data base control blocks and buffers.

An example of the use of DBMS can be shown by referring back to the Inventory Control problem of Diagram 1. To find what goods customer "Ridgeway Tire Co." has purchased it is necessary for the application program to:

- Open data base "Inventory" using DBOPN.
- Call DBINF to locate the position of "Quantity sold" from the information to be retrieved.
- Call DBFND, randomizing on account number A276, to find the head of the chain in data set customer.
- Call DBGET in chain read mode on the open item invoice data set extracting and totaling the quantity sold field.
- When the chain is exhausted, you will have determined what goods were purchased by "Ridgeway Tire Co."

## Data base QUERY subsystem (DBQS)

The Data Base QUERY Subsystem was designed to allow the nonprogrammer to interactively retrieve and report data from a data base through easy-to-use English-like commands. All this can be done from multiple terminals, each with its own copy of QUERY, without having to write any application programs. QUERY provides:

- **Multicriteria data selection.**  
Precise information can be retrieved using logical relationships between data items and their values (is, is not, is less than, etc.) using conjunctions and disjunctions ("and"s and "or"s). This is a powerful and flexible capability. Referencing the Open Item Invoice data set in Diagram 1, the users query statements are as follows:  
"Find account number is not A300" will retrieve records 1, 2 and 3  
"Find account number is A276" will retrieve records 1 and 3  
"Find account number is A276 and inventory number is 21001-094" will retrieve record 2  
"Find account number is A276 and inventory number is 21001-094" will retrieve record 3
- **Report Formatting**  
After information is retrieved from a data base, QUERY can format and generate a variety of reports. Reports can include page headings, column headings, page numbers, etc. Items of data can appear in any order on a report, can be format edited, totaled, and sub-totaled. Information to be reported can be sorted by multiple categories.
- **Data Modification**  
After information is retrieved it can be modified or deleted from the data base. In addition new records can be added with automatic linkage maintenance.
- **Procedure Capability**  
A procedure is a programmer issued command followed by the information needed to execute that command (such as: find account number is A276). Since procedures can be lengthy (especially report procedures) QUERY allows you to save procedures in a disc file and execute them later, saving needless typing when repetitive functions are performed.

QUERY translates user commands into calls to DBMS sub-routines. In this sense, it may be thought of as a generalized application program. The commands available are:

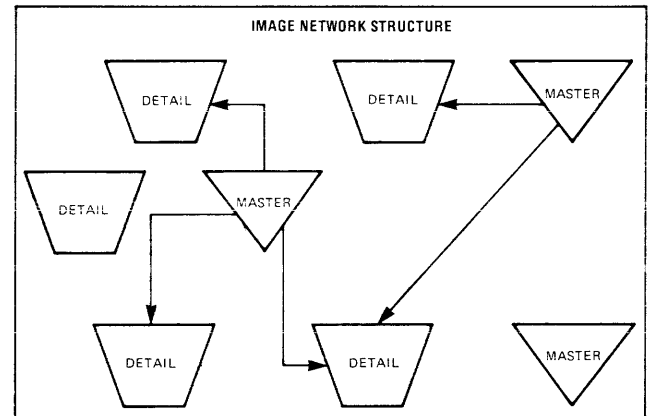
- **FIND** — multicriteria data selection
- **REPORT** — report formatting and generation with sorting of data entries.
- **UPDATE** — data modification, addition, and deletion
- **CREATE** — procedure creation
- **DISPLAY** — display procedures
- **EXECUTE** — schedules a program
- **FORM** — displays data base structure
- **HELP** — displays syntax of all commands
- **EXIT** — exits from QUERY
- **DESTROY** — purges a procedure
- **LIST** — change list device

## Can IMAGE/1000 suit your needs?

As has been seen, IMAGE/1000 can reduce data redundancies, thus optimizing file space. This means that less file space may be needed for your IMAGE/1000 system than for your current file system.

IMAGE/1000 capacities are as follows:

- An item of data can be character (maximum of 126), integer, or real data type.
- A collection of data items which form a data entry (record) can be up to 510 bytes long.
- 255 data items per data base.
- A collection of data entries which form a data set (file) may contain up to 32,767 data entries. Note: If you have files that have more than 32,767 records, they can be broken into smaller files at data base definition time.
- A collection of data sets form a data base. A data base may have up to 50 data sets. If more data sets are needed it is possible to build additional data bases on the system.
- Data sets are linked for fast retrieval of related information. A master data set may be linked to up to 5 detail data sets.



## Functional specifications

### Data base capacity

**Data Item Length:** Up to 126 bytes, ASCII characters, integer, or real data.

**Data Item Names Per Data Base:** 255.

**Data Sets Per Data Base:** 50.\*

**Characters Per Data Set Name:** 5.

**Characters Per Data Item:** 6.

**Data Items Per Data Set:** 127.

**Maximum Entry Size:** 510 bytes.

**Keys Per Detail Data Set:** 5.

**Detail Data Sets Per Master Data Set:** 5.

**Data Entries Per Data Set:** 32,767.

**Maximum Data Base Size:** 117.9M bytes.

**Maximum Data Set Size:** 32.767 disc sectors.

*\*The space occupied by any single data set cannot exceed the capacity of one disc sub-channel; however, the total data base is limited only by the total available storage.*

## System requirements

Same as 92001B RTE-II system with 64k bytes of memory or 92067A RTE-IV system.

## Approximate memory usage (bytes)

IMAGE/1000 uses 80 bytes of memory-resident area plus background partition space that depends in RTE-II upon the largest IMAGE program that will be used; in an RTE-IV system with extensive memory capacity, it may be desirable to have several different IMAGE programs in memory simultaneously. See the listings below. In addition to the memory used by the subsystem, space is required for run time tables (300 to 6,800 bytes depending on size and complexity of the user's data base) and may also be needed for file control blocks (288 to 3,464 bytes; maximum size gives best performance).

IMAGE PROGRAM	RTE-II SIZE	RTE-IV SIZE*	USES CTRL. BLOCKS?
DBDS	15k	18k	no
DBBLD	17k	20k	yes
DBSTR	6k	12k	no
DBRST	9k	10k	no
DBULD	11k	16k	yes
DBLOD	17k	22k	yes
QUERY	21k	24k	yes
DBSPA	20k	22k	yes
RECOV	20k	22k	yes

\*Including 2,048 bytes for base page

## Ordering Information

### 92063A IMAGE/1000 data base management system (software on punched tape)

IMAGE/1000 consists of:

1. IMAGE Management System (92063-12001).
2. QUERY Program (92063-16011 and 16012).
3. DBDS, DBBLD, DBSTR, DBRST, DBULD, DBLOD, RECOV, and DBSPA Utility Programs (92063-16002 through 16007 and 16013 and 16014).
4. QUERY Help File Utility and Data Programs (92063-16009 and 16010).
5. IMAGE/1000 Reference Manual (92063-90001).
6. IMAGE/1000 Pocket Guide (92063-90004).

### 92063A Mini cartridge option 020

92063A option 020 replaces software items 1-4 in the standard 92063A listing, above, with the following items on 9162-0061 Mini cartridges for read-in by 2645A/2648A+007 or 2644A CRT Terminal.

1. IMAGE Management System (92063-13301).
2. QUERY Program (92063-13302 and 13303).
3. DBDS, DBBLD, DBSTR, DBRST, DBULD, DBLOD, RECOV, and DBSPA Utility Programs (92063-13304).
4. QUERY Help File Utility and Data Programs (92063-13305).

### Recommended additional equipment

12970A or 12972A 800 or 1600 bpi, 9-track, 45 ips Magnetic Tape Subsystem or additional disc drive.

### 92063S Software Subscription Service

The 92063S Software Subscription Service provides software and manual updates as required to keep your IMAGE/1000 system current with respect to enhancements and other design changes as they are released by Hewlett-Packard. The 92063S service is ordered in monthly units for at least six months, billable quarterly. A media option, selected from those listed following 92063T, must be specified when ordering 92063S.

### 92063T Comprehensive Software Support

The 92063T Comprehensive Software Support includes the Software Subscription Service, as described under 92063S, above, and a Phone-In Consulting Service for discussion of questions on your IMAGE/1000 software with a qualified HP Systems Engineer. The 92063T service is ordered in monthly units for at least six months, billable quarterly. A media option must be selected from those listed below.

### 92063S and 92063T Media options

**010:** Software updates on paper tape.

**020:** Software updates on Mini cartridges for read-in via 2645A+007 or 2648A+007 CRT Terminal.

### 92063T option 200

92063T option 200 provides a discount for Comprehensive Software Support of an additional copy of IMAGE/1000.



Sales and service from 172 offices in 65 countries.

1501 Page Mill Road, Palo Alto, California 94304