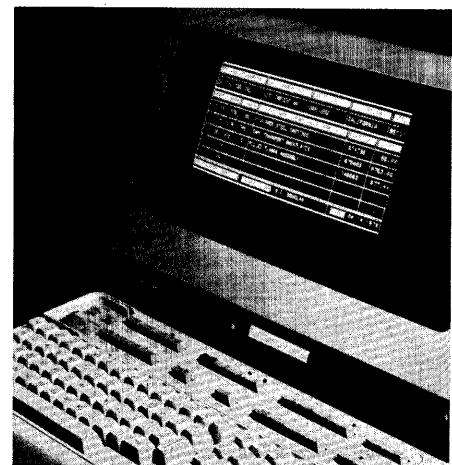
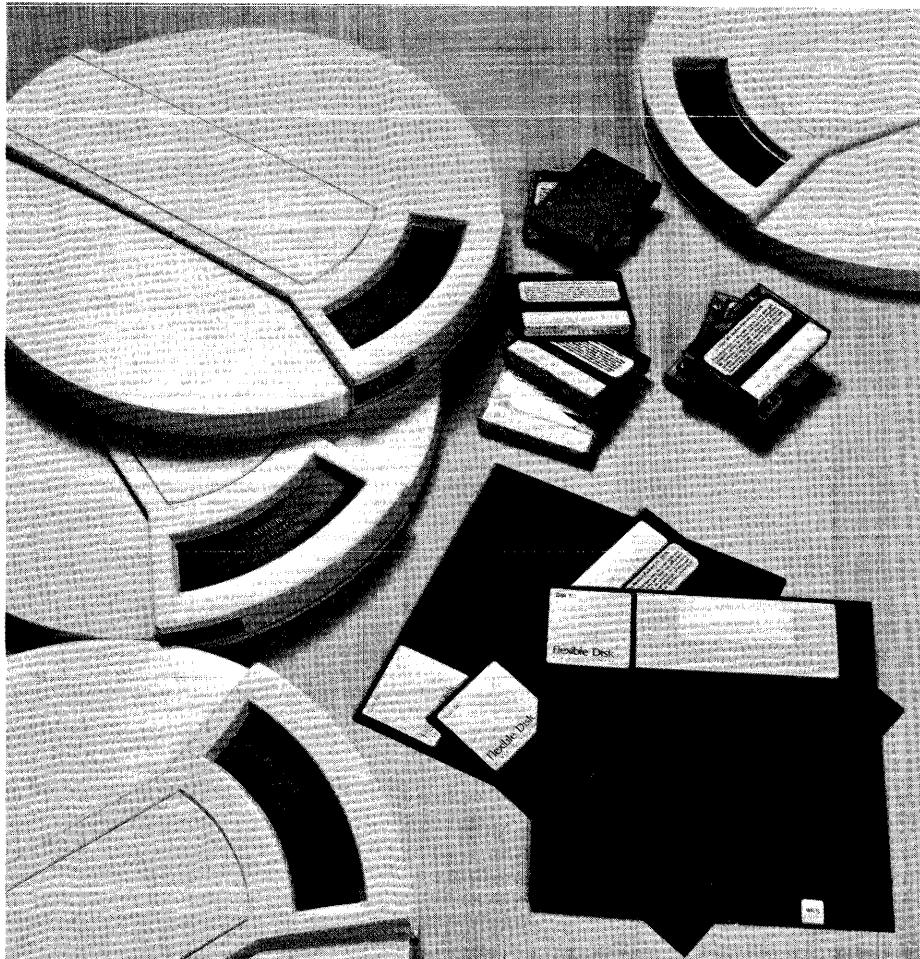
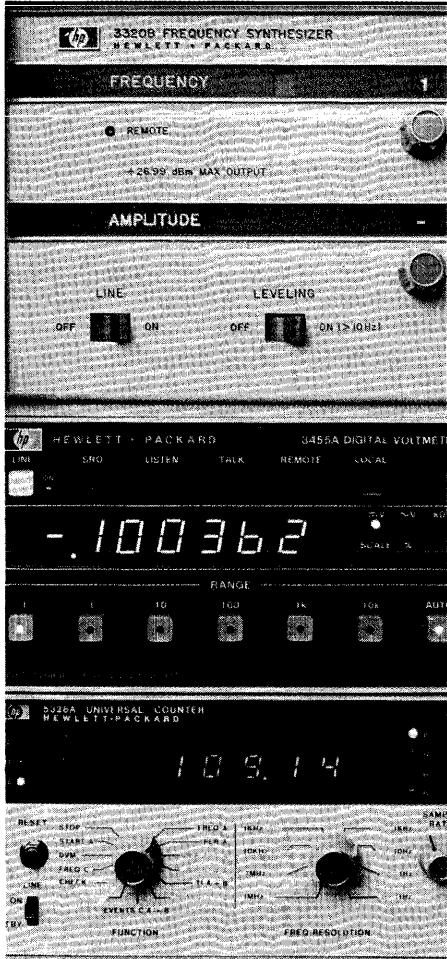


# 21MX Computers

HEWLETT  PACKARD

A modular family of computers for OEM and end-user system applications.

## Software Data



# Introduction

This 21MX Software Technical Data book covers all Hewlett-Packard software currently available for HP 21MX Computers, except for the operating system and related software modules used in the disc-based HP 2000 series Computer system. As shown in the Contents below, separate sections cover operating systems and related subsystems, program development software and supporting libraries, networking software, diagnostics, product support, and training courses offered on the 21MX Computer and related software and hardware products. Where the number of products in a section is relatively large, an overview section precedes the data sheets to place each software product in the proper perspective with the others.

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# 21MX 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, file management, and data base management services as well.

## The 21MX operating systems

Six different operating systems are available for use in 21MX Computers, as follows:

**RTE-M**, Hewlett-Packard's newest operating system, 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-II/III system (requires flexible disc subsystem for program development).
- Management of up to 64 individually-mapped partitions for memory-resident programs in up to 304k words\* of memory, like the RTE-III system

In most 21MX Computer applications, the RTE-M system can replace any of the other memory-based operating systems listed below while providing more capability and a better program-compatible upgrade match to the disc-based RTE-II/III system than either RTE-B or RTE-C.

**RTE-II** is a disc-based, time and event-scheduled, real-time multiprogramming system with memory management support of 2 multi-user disc swapping partitions in up to 32k words of memory.

**RTE-III** 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, in up to 304k words\* of memory.

**RTE-B** is a memory-based, real-time BASIC programmable system for the novice computer user that provides time and event scheduling of up to 16 different user tasks. RTE-B is supported in HP computer networks.

**RTE-C** is a memory-based, real-time multiprogramming system for lower-cost computer systems. RTE-C is supported in HP computer networks.

\*RTE-M and RTE-III provide addressability up to a maximum of 1 million words; current physical memory limit is 304k words.

**BCS** is a memory-based, operator-scheduled, single-program execution system. BCS is supported in HP computer networks.

## Related software subsystems

**BASIC/1000M** and **BASIC/1000D** are real-time BASIC program development and task scheduling subsystems available for RTE-M and RTE-II/III systems.

**iIMAGE/1000** is a data base management subsystem offered for RTE-II/III systems.

## Systems comparison

To facilitate selection of the appropriate operating system, a table is provided on page 1-2 which 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.

**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 systems with disc memory fast enough to use it. 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.

**Memory management** provides individual mapping of partitions in memory above the lowest 32k words, up to a maximum of 304k words. It can thus provide up to 64 individually-protected multi-user partitions for programs, which is essential for multi-user operation in the RTE-M system which does not support program swapping.

**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.

## 21MX operating systems capabilities and definitions

	RTE-M (92064A)	RTE-II (92001B)	RTE-III (92060B)	RTE-B (2300B)	RTE-C (2300C)	BCS (20885A)
<b>MUTIPROGRAMMING</b>	Optional	Yes	Yes	Note A	Yes	No
Multi-user operation	Optional	Optional	Optional	No	No	No
Program Swapping	No	Yes	Yes	No	No	No
Memory management	Optional	No	Yes	No	No	No
No. of partitions	1 - 64	2	1 - 64	1	Note B	1
Priority levels	1 - 32767	1 - 32767	1 - 32767	1 - 99	1 - 99	None
<b>CAPACITY</b>						
Main memory	8 - 304k	24 - 32k	32 - 304k	12 - 32k	8 - 32k	8 - 32k
Disc memory	Opt. flexible 0.5-2M bytes		System disc with 4.9 - 19.6M bytes or 14.7 - 364.7M bytes	No	No	No
<b>PROGRAM SCHEDULING</b>						
By operator	Yes	Yes	Yes	Yes	Yes	Yes
By event interrupt	Optional	Yes	Yes	Yes	Yes	Yes
By other program	Optional	Yes	Yes	Note A	Yes	No
By time of day	Optional	Yes	Yes	Note A	Yes	No
<b>INPUT OUTPUT</b>						
Output buffering	Optional	Yes	Yes	Yes	Yes	Optional
I/O suspend	Yes	Yes	Yes	No	Yes	No
I/O timeout	Optional	Yes	Yes	Yes	Yes	No
Re-entrant I/O	Yes	Yes	Yes	No	No	No
Resource management	Optional	Yes	Yes	No	No	No
Mailbox I/O	Optional	Yes	Yes	No	No	No
<b>PROGRAMMING LANGUAGES</b>						
Fortran IV	Note C	Yes	Yes	No	Note C	Note C
Fortran II	Yes	Yes	Yes	Note D	Yes	Yes
Real-time BASIC	Yes, w/92065A		Yes, with 92101A	Yes	No	No
Algol	Note E	Yes	Yes	No	No	Yes
Assembly language	Yes	Yes	Yes	Note D	Yes	Yes
Micro-assembly	No		Yes, with 92061A	No	No	Option 008
<b>PROGRAM DEVELOPMENT</b>	On-line	On-line	On-line	Off-line	Off-line	Off-line
Supported by	RTE-M	RTE-II	RTE-III	RTE-B	Separate SIO system or host RTE-II/III system	
Program editor	Optional	Interactive editor		None	Symbolic editor	
Microdebug editor	No	Yes, with 92061A		No	No	Option 008
Relocating loader	Optional	Yes	Yes	No	Yes	Yes
On-line absolute loader	Yes	Note E	Note E	No	Yes	No
File manager	Optional	Yes	Yes	No	No	No
Batch monitor	No	Yes	Yes	No	No	No
I/O spooler	No	Yes	Yes	No	No	No
<b>SYSTEM GENERATION</b>	On-line or off-line	On-line or off-line	On-line or off-line	Off-line or in host	Off-line or in host	Off-line or in host
<b>DATA MANAGEMENT</b>						
File creation and access	Local	Local	Local	Remote (requires 91704A/5A/3A)		
Data base management	No	Yes, w/91063A	Yes, w/91063A	No	No	No
<b>DECIMAL ARITHMETIC</b>	No	Yes	Yes	No	No	No
<b>NETWORKING</b>						
Central - central	No	Yes, with 91700A		No	No	No
Central - satellite	No	Yes, with 91700A		Yes, w/91704A	Yes, w/91705A	Yes, w/91703A
RJE - IBM 360/370	No	Yes, with 91780A		No	Yes, w/91780A	No

*Note A: Multiprogramming in the RTE-B system is actually multi-tasking in which up to 16 different task subroutines of a single real-time BASIC program can be scheduled by each other, by time, or by event; the operator schedules the whole real-time BASIC program, not the individual tasks.*

*Note B: In RTE-C, a single user program area is set up which may be occupied by as many user programs as will fit into the available space.*

*Note C: Fortran IV or Algol programs developed on an RTE-II/III host system may be loaded and executed in an RTE-M, RTE-C, or BCS system.*

*Note D: The RTE-B system includes Fortran II and Assembly language program development support in the Software Input/Output (SIO) system environment for user preparation of special subroutines to be incorporated into the system.*

*Note E: The on-line program loading function is built into the RTE-II/III operating system.*

## 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.

## 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, assembler, editor, or relocating loader programs in the system that are used for program development. In the RTE-B system, BASIC/1000M or BASIC/1000D subsystem, and the BCS system, operator scheduling is used to turn on the program in the system.

**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.

**Program development support** is an index to the ease of program development. When development is done on-line concurrently with other operations, only the simple issuance of commands and entry of source language programs is involved. Use of a separate system is less convenient because that system must be substituted for the operating system and later the operating system must be reloaded before the programs can be run. However, it is also possible to develop programs on disc-based host systems for execution in memory based systems that do not provide for program development.

**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.

## 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 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.

## Decimal Arithmetic

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

## 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.

**Central-to-central.** Programs in one 21MX network central system can exchange information with programs in another network central computer system, when both are equipped with the network central communications package (91700A).

**Central-to-satellite.** The RTE-II/RTE-III based network central system supports RTE-B, RTE-C, and/or BCS satellite 21MX computer systems with disc-based program development and program down-loading, program and data file storage, data processing assistance, and remote access to peripherals at the central, when the systems in the network are equipped with the appropriate network communications packages (91700A for the central, 91703A, 91704A, or 91705A for the satellite(s)).

**RJE to IBM 360/370.** An RTE-II, RTE-III, or RTE-C based 21MX computer system can emulate an IBM 2780 Data Transmission Terminal to submit jobs to an appropriately-equipped IBM 360/370 system, when the HP system is equipped with the RJE/1000 package (91780A).

## 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 six 21MX operating systems.

## Hardware and software products support checklist

RTE-M	RTE-II	RTE-III	RTE-B	RTE-C	BCS		Supported Products
Q	A	A	A	A	A		<b>21MX M-Series Processors and Accessories</b> 2105A Computer (2 memory slots, 4 I/O channels) 2108A Computer (4 memory slots, 9 I/O channels) 2112A Computer (8 memory slots, 14 I/O channels)
A	A	A	A	A	A		12892A Memory Protect 12897A Dual Channel Port Controller 12976A Dynamic Mapping System 12539C Time Base Generator
A	A	A	A	A	A		12977A (or 12976A-003) Fast FORTRAN Processor 12620A Breadboard Interface for Privileged Interrupt Control
X	R	X	X	X	X		13197A Writable Control Store (when RTE-II/III system is equipped with 92061A Microprogramming Package)
X	R	X	X	X	X		<b>21MX E-Series Processors and Accessories</b> 2109A Computer (5 memory slots, 9 I/O channels) 2113A Computer (10 memory slots, 14 I/O channels)
X	R	R	R	R	R		12892B Memory Protect 12897B Dual Channel Port Controller 13304A Firmware Accessory Board 13305A Dynamic Mapping System 12539C Time Base Generator
X	X	R	X	X	X		13306A Fast FORTRAN Processor 12620A Breadboard Interface for Privileged Interrupt Control
X	X	R	X	X	X		13197A Writable Control Store (when RTE-II/III system is equipped with 92061A Microprogramming Package)
L	X	X					<b>2100A Computer and Accessories</b> 2100A/S Computer (Up to 32k memory, 14 I/O slots) 12895A Direct Memory Access 12901A Floating Point Firmware 12539C Time Base Generator 12907A Fast FORTRAN Processor 12908B Writable Control Store and 12909B PROM Writer (when BCS system is equipped with option 008) 12620A Breadboard Interface for Privileged Interrupt Control
							<b>CRT Terminals and Accessories</b> 2640A/B CRT Terminal with 12880A-001 (local) or 12531D-002 (modem) interface (240 char/sec, 80 char/line, 25 lines/display) 2644A-020 CRT Terminal with 12966A-001 local block mode interface (240 char/sec, 80 char/line, 25 lines/display, with dual Mini cartridge I/O) 2645A-007, 030 CRT Terminal with 13260B Extended Asynchronous Communication and 12966A-001 local block mode interface (system-to-display rates to 960 char/sec, 80 char/line, 25 lines/display, with dual Mini cartridge I/O) 13246A/B auxiliary thermal Printer Subsystem for use with 2644A-020 or 2645A-007, 030 CRT Terminal (240 LPM, 80 char/line) 13349A auxiliary impact Printer Subsystem for use with 2644A-020 or 2645A-007, 030 CRT Terminal (30 char/sec, 132 char/line)
X	X	X	X	X	X		
X	X	X					
X	X	X					
X	X	X					
X	X	X					

*A = Alternate computer choices supported by the operating system*

*R = Item required by the operating system; only R item associated with the selected alternate computer is required.*

*X = Item supported by the operating system.*

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

*Q = Only RTE-MI is compatible with the 2105A*

RTE-M	RTE-II	RTE-III	RTE-B	RTE-C	BCS	Supported Products
X	X	X	X	X	X	Keyboard-Printer Terminals 2762A/B Terminal Printer with 12531D-001 (local) or 12531D-002 (modem) interface (30/120 char/sec, 75/120 char/line)
X	X	X	X	X	X	2752A Teleprinter with 12531C interface (local only, 10 char/sec, 72 char/line, built-in tape punch and reader)
D	D					Disc Memory Subsystems 12960A Cartridge Disc Subsystem (4.9M bytes; up to 19.6M bytes with three add-on 12960A-010 Drives)
D	D					12962A/B/C/D Cartridge Disc Subsystem (14.7M bytes; up to 117.9M bytes with seven add-on 13180A/B Drives; up to 364.7M bytes with seven add-on 7920S Drives)
X	X	X				12732A Flexible Disc Subsystem (514K bytes; up to 2.056M bytes with three add-on 12733A Drives)
X	X	X	X	X	X	Punched Tape Input/Output Subsystems 12925A Punched Tape Reader Subsystem (500 char/sec) 12926A Tape Punch Subsystem (75 char/sec)
X	X	X	X	X	X	Card Reader Subsystems 12985A Card Reader Subsystem (600 punched cards/min) 12986A Optical Mark Reader Subsystem (300 mark-sense or punched cards/min)
X	X	X	X	X	X	Line Printer Subsystems 12975A Line Printer Subsystem (300 LPM, 136 col) 12983A Line Printer Subsystem (1250 LPM, 132 col) 12987A Line Printer Subsystem (200 LPM, 132 col) 12996A (thermal) Printer Subsystem (240 LPM, 80 col) 13053A Line Printer Subsystem (600 LPM, 136 col)
X	X	X	X	X	X	Plotting and Display Capabilities 12935A Graphic Plotter Subsystem (requires 92409A real-time plotter library in RTE systems) 91200B TV Interface Kit (connects system to B&W or color TV monitors; color requires three cards)
X	X	X	X	X	X	Magnetic Tape Subsystems 12970A Magnetic Tape Subsystem (9-track, 800 bpi, 45 ips, up to four drives per subsystem) 12972A Magnetic Tape Subsystem (9-track, 1600 bpi, 45 ips, up to four drives per subsystem)
X	X	X				Data Entry Terminals 92900A Data Entry Terminal Subsystem (one to 56 hardware-connected HP 3070A Data Entry Terminals per subsystem, up to 2km (6,562 ft), computer to nearest terminal) 3071A Data Entry Terminal (modem connected)
X	X	X	X	X	X	Measurement and Control Subsystems and Interfaces 2313B Analog I/O Subsystem (hardware sample rates to 45,000 chan/sec, 12 bit resolution, up to 500 input chan or 44 analog output chan) 91000A Analog-Digital Interface (hardware sample rates to 20,000 chan/sec, 12 bit resolution, 16 single-ended or 8 differential $\pm 10.24V$ fs inputs) 91063A Digital I/O (multiplexer) Subsystem (up to 2880 digital I/O channels or 240 analog outputs) 59310B Hewlett-Packard Interface Bus (HP-IB) interface (connects up to 14 HP-IB instruments to the system) NOTE: HP-IB identifies Hewlett-Packard instruments, interfaces, and controllers conforming with IEEE Standard 488-1975 "Digital Interface for programmable instrumentation". 91226A/B Remote Station Communications Kit (connects computer system to 9603R or 9611R Remote Measurement and Control Station) 12604B Data Source Interface (32 bit input from a wide variety of instruments or other digital signal sources)

D = Alternate system disc choices supported by the system

X = Supported item

RTE-M	RTE-II	RTE-III	RTE-B	RTE-C	BCS	Supported Products
			X			General-Purpose Interfaces 12551B 16-Bit Relay Register 12554A 16-Bit Duplex Register (transistor levels) 12555B Dual 12-Bit Digital-to-Analog Converter 12556B 40 Bit (output) Register (not usable in 2109A or 2113A) 12566B Microcircuit (16-bit duplex) Interface 12930A Universal (16-bit duplex) Interface
X	X	X	X	X	X	Networking and Data Communications Capabilities 91700A Network Central Communications Package (network communication with another 91700A Package in a remote central system or with 91703A/04A/05A Package in a remote satellite computer system) 91703A BCS Network Satellite Communications Package (network communication with 91700A Package in remote network central system) 91704A RTE-B Network Satellite Communications Package (network communication with 91700A Package in remote network central system) 91705A RTE-C Network Satellite Communications Package (network communication with 91700A Package in remote network central system) 91780A RJE/1000 communication package (for RJE communication with IBM 360/370; includes send and receive interfaces) 12920B Asynchronous Multiplexer (interfaces up to 16 terminals or data sets to the systems; provides three I/O cards; requires 12620A) 12531C Teletype Interface
E	I	I	E	E		Software Products Fortran IV Fortran II 92065A BASIC/1000M 92101A BASIC/1000D Real-time BASIC HP Algol HP 21MX Assembler HP Assembler 92061A RTE Microprogramming Package 20855A-008 Microprogram development support in BCS 92063A IMAGE/1000 Data Base Management System 92400A Sensor-Based DAS Library 92409A Real-Time Plotter Software 92413A ISA Fortran Extensions Package (included in 92066A RTE Measurement and Control Software) 92066A RTE Measurement and Control Software Package, exclusive of the 92413A ISA Fortran Extensions Package
I	I	I	S	I		
X	X	X	I			
			S	I	I	
			X			
L	X	X			X	

E = Execution of Fortran IV or Algol programs prepared on RTE-II/III host system

I = Software module included in the respective operating system

S = Software item included with the operating system for preparation of special subroutines by the user

X = Supported item

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

H = Generation of ISA Fortran table must be done on RTE-II/III system for target RTE-M system



# 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 systems based on Hewlett-Packard 2105A▲, 2108A, 2109A, 2112A, or 2113A 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 304k words\* of memory (RTE-MIII).
- Support for program development in FORTRAN II, 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/44A 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 II, 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 for high-speed analog I/O subsystem and digital I/O multiplexer subsystem.
- Conversational system generation from 2645A/44A 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 1 million words; current physical memory limit is 304k.

UP TO 64 PARTITIONS FOR MEMORY-RESIDENT REAL-TIME PROGRAMS AND/OR PROGRAMS USED FOR MULTI-USER PROGRAM DEVELOPMENT, 2K MINIMUM, 15K TO 21K MAXIMUM*, PER PARTITION (RTE-MII only).	Up to 278,528 (272k) Words of additional memory beyond 32k system (with RTE-MIII only)
BOOTSTRAP LOADER	64 Words
SYSTEM AVAILABLE MEMORY	15,541 to 24,756 Words 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)	1,700 Words (Mini cartridge) 2,530 Words (Flexible disc)
FILE DIRECTORY ACCESS (Optional)	385 Words (Mini cartridge, MII/MIII) 1,060 Words (Flexible disc, MI) 1,005 Words (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	2,048 Words (typical) ▲ 582 Words ▲ (Mini cartridge, MI) 162 Words ▲ (Mini cartridge, MII/MIII) 20 Words ▲ (Flexible disc, MII/MIV/MIII)
ADDITION TO RESIDENT LIBRARY FOR MINI CARTRIDGE FILE DIRECTORY ACCESS	260 Words ▲
AUTO RESTART AFTER POWER FAILURE (Optional)	
MAILBOX DATA EXCHANGE (Optional in RTE-MII/MIII-Requires Resource Management Module)	400 Words ▲
RESOURCE MANAGEMENT (Optional in RTE-MII/MIII)	100 Words ▲
ADDITIONAL ON-LINE OPERATOR COMMANDS (Optional)	610 Words ▲
TIME SCHEDULING OF PROGRAMS (Optional) (Requires real-time clock module)	490 Words ▲
REAL-TIME CLOCK & I/O TIMEOUT (Optional)	110 Words ▲
OUTPUT BUFFERING (Optional in RTE-MI)	170 Words ▲
PROG-PROG SCHED. (Optional in RTE-MI)	320 Words ▲
INSTRUMENT AND/OR PERIPHERAL DRIVERS	Variable *
FLEXIBLE DISC DRIVER DVR33 (Optional)	575 Words ▲
SYSTEM CONSOLE DRIVER DVR05	
RTE-M EXECUTIVE (RTE-MI and RTE-MII include Output Buffering and Program-Program Scheduling)	5,900 Words (RTE-MI) 6,700 Words (RTE-MII) 7,400 Words (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 32k words of memory and also reduce the maximum size of partitions in memory above the first 32k 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.

32k RTE-M SYSTEM WITH POTENTIAL FOR EXPANSION BEYOND 32k IN RTE-MIII CONFIGURATION

## 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.

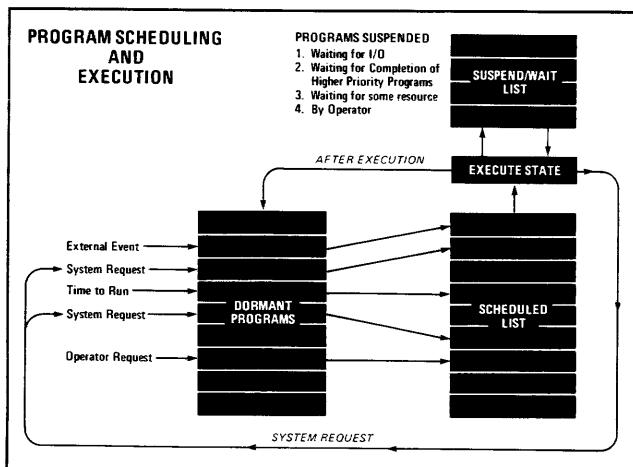
**RTE-MI** is the smallest system and is intended primarily for dedicated, operator-scheduled single-program execute only use, or single-user program development. It is also capable of multiprogramming, but does not support the very important system protection afforded by memory protect. The minimum configuration of RTE-MI will run in 8k of memory. As shown in the composite system map above, this leaves over 24k words for the user's program and program buffers in a computer system with 32k. 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 multi-terminal monitor for multi-user access to the system, but memory capacity limits program development to a single user.

**RTE-MIII** combines all of 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 32k limitation of RTE-MI and MII systems to a maximum of 304k. 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 304k words 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.

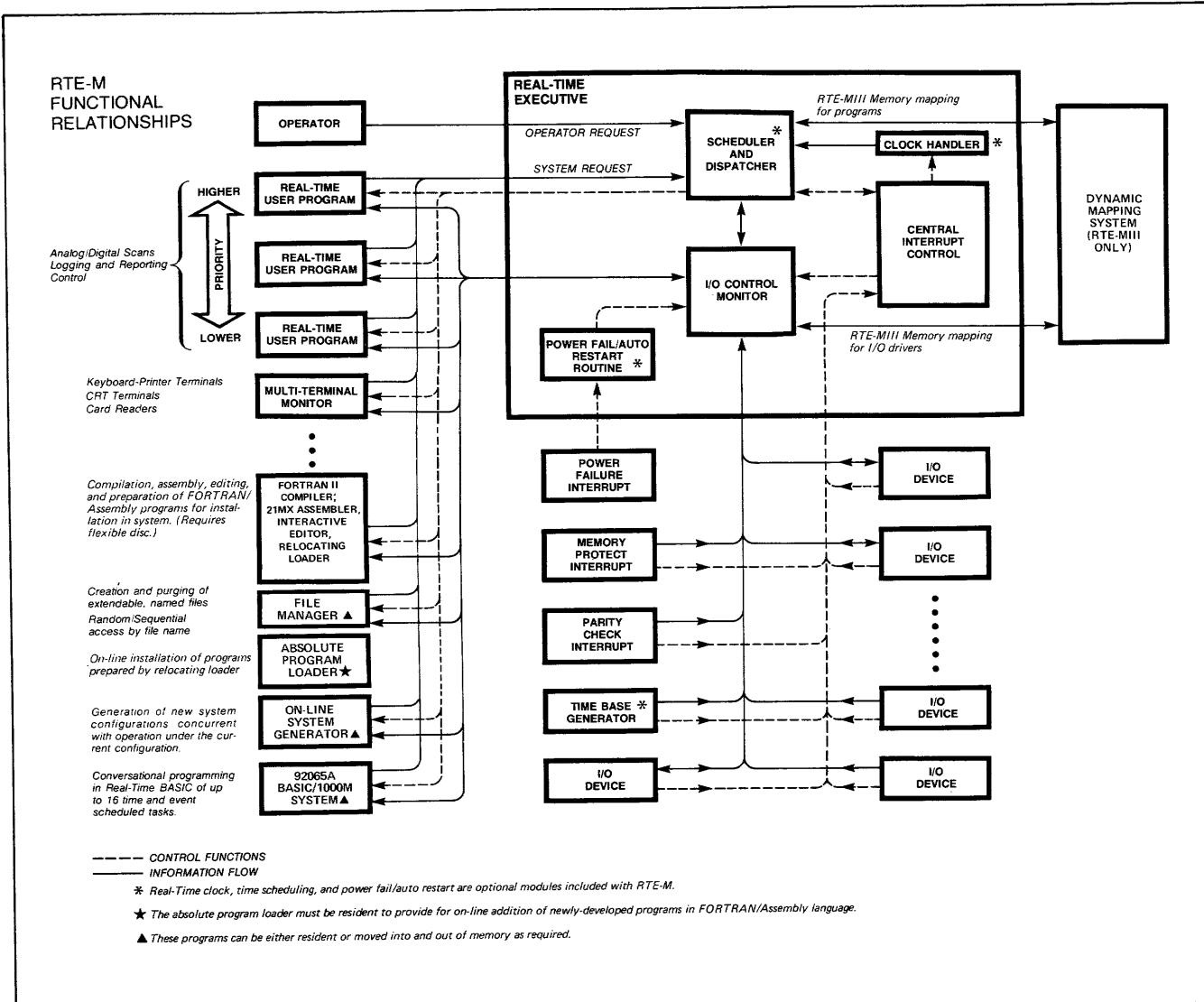
**On-line program installation.** Several programs can be in the user program area of the RTE-MI/MII system at the same time, and many more can be in the partitions in memory above 32k in the RTE-MIII system. To facilitate multiprogramming operation and make maximum use of the system, RTE-M includes 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, vectored 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.



## 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-MII only).
- Optional exclusive assignment protection of system resources being used by a program.

## 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 for keeping each I/O device optimally utilized on backlogged I/O work.
- I/O timeout capability for detecting I/O conditions that could stall the system (optional).

- I/O suspension with automatic rescheduling to make processing time available to programs that can do useful work while other programs are waiting for I/O service.
- 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 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.

## **On-line program development**

The real-time multiprogramming design of the system makes possible on-line program processing 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 II Compiler.
- 21MX Assembler
- Optional 92065A BASIC/1000M system for conversational development of programs in HP Real-Time BASIC (flexible disc not required).
- 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.

## **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 Batch-Spool Monitor. The RTE-M system also includes a file manager based on 2645A/44A 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.

## **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:** 32,768 words (32 pages).

**RTE-MIII configuration:** 311,296 words (304 pages).

### **Operational requirements**

The operational requirements for 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, Algol, or HP Assembly language programs developed on another system requires:

1. HP 2105▲, 2108A, 2109A, 2112A, or 2113A  
Computer with at least 16k 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, Algol, or HP Assembly language programs developed on another system, add 12892A/B Memory Protect to the minimum system.

▲2105A 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 24k.
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 24k.
2. 12897A/B Dual-Channel Port Controller.
3. 12732A Flexible Disc Subsystem and 12992E Flexible Disc Loader ROM.

### **System generation**

System generation requires the following additions to the minimum system:

1. Enough memory to provide 24k.
2. Either a system console with Mini cartridge I/O (2645A-007,030 with 13260B or 2644A-020) or 12732A Flexible Disc Subsystem and 12992E Flexible Disc Loader ROM (also requires 12897A/B 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 48k.
2. 12976A Dynamic Mapping System for 2108A or 2112A Computer or 13304A Firmware Accessory Board and 13305A Dynamic Mapping System for 2109A or 2113A Computer.
3. 12987A/B Dual-Channel Port Controller.
4. 12732A Flexible Disc Subsystem and 12992E Flexible Disc Loader ROM.

### **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-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 (obsolete terminal with Mini cartridge I/O that can be substituted for 2645A-007,030 with 13260B).

- 2640A/B 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 or 2644A.
- 12732A Flexible Disc Subsystem.
- 12925A Tape Reader Subsystem for punched tape input.
- 12926A Tape Punch for punched tape output.

### **Memory requirements (words)**

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 1024 words for base page, which is part of each mapped partition in RTE-MIII.

Software Items	Resident Memory	User Program Area
RTE-MI base system	5,900*	
RTE-MII base system	6,700*	
RTE-MIII base system	7,400*	
Flexible disc driver DVR33	575*	
Program-to-program scheduler module ▲	320*	
I/O buffering module ▲	170*	
Real-time clock and I/O timeout module	110*	
Time scheduling of programs module	490*	
Additional on-line operator commands module	610*	
Resource management module	100*	
Mailbox data exchange module	400*	
Auto restart after power failure module	260*	
File directory access modules (Mini cartridge, RTE-MI)	582*	
(Mini cartridge, RTE-MII/MIII)	550*	
(Flexible disc, RTE-MI)	1,080*	
(Flexible disc, RTE-MII/MIII)	1,025*	
Absolute program loader (Mini cartridge)	1,700*	
Absolute program loader (Flexible disc)	2,530*	
Multi-terminal monitor	400*	
FORTRAN II compiler and symbol table		12-16k <sup>1</sup>
21MX Assembler and symbol table		12-16k <sup>1</sup>
Cross-Ref Table Generator		7-10k <sup>1</sup>
BASIC/1000M		12k
File Manager (Mini cartridge)		8k
File Manager (Flexible disc)		10k
Interactive Editor		10-12k <sup>1</sup>
Relocating Loader		10-12k <sup>1</sup>
System generator		15k

\* 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 FORTRAN II programs or assemble programs.
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-MII/MIII).

## Ordering information

### 92064A RTE-M operating system

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. RTE/DOS Program Libraries Manual (24998-90001).
8. 21MX Assembler Manual (92060-90005).
9. Multi-device driver DVR00 manual (29029-95001).
10. 264x CRT Terminal driver DVR05 manual (92001-90015).
11. 7210A Graphic Plotter driver DVR10 manual (17210-90004).
12. CalComp Plotter driver DVR10 manual (12560-90023).
13. 3070A data entry Terminal driver DVA47 manual (92900-90005).
14. 2892A Card Reader driver DVR11 manual (09600-93010).
15. 2607A Line Printer driver DVA12 manual (92200-93001).
16. 9866A Printer driver DVR12 manual (92001-90010).
17. 91200B TV interface driver DVA13 manual (91200-90005).
18. 7261A Optical Mark Reader driver DVR15 manual (07261-90010).
19. 7970 9-track Mag Tape driver DVR23 manual (92202-93003).
20. 59310B HP-IB Interface driver DVR37 manual (59310-90063).
21. 12732A Flexible Disc driver DVR33 manual (12732-90001).
22. 92062A Software Numbering Catalog (92062-90001).
23. RTE Operating System Drivers and Device Subroutines Programming and Operating manual (92200-93005).

### 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, and power fail/auto restart modules (92064-13304).
5. Mini cartridge 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 92062A 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 absolute program loader, file management program, file manager, and file directory access modules.
2. Program preparation disc (92064-13402), including the FORTRAN II compiler, 21MX Assembler, Cross-Reference Symbol Table Generator, Flexible Disc File Manager modules, Relocating Loader and supporting subroutines, Editor, RTE and RTE-M system libraries, and Multi-terminal monitor modules.

## RTE-II and RTE-III real-time executive operating systems

models 92001B and 92060B

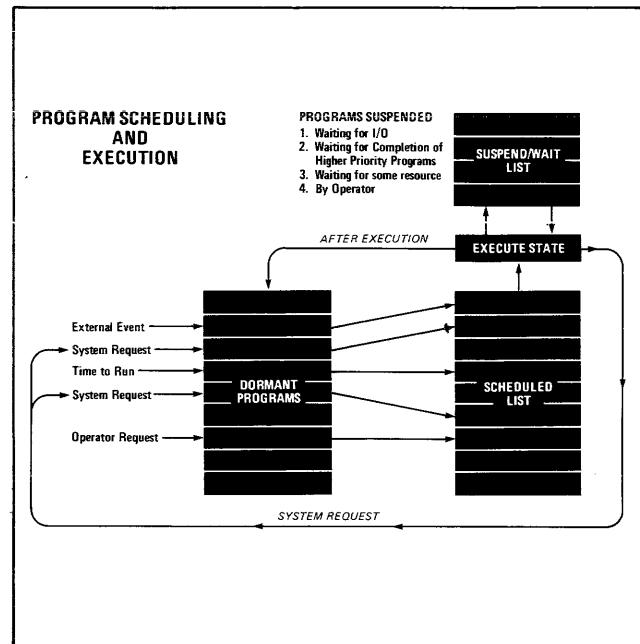
The 92001B RTE-II and 92060B RTE-III are disc-based Real-Time Executive operating systems used for management of the operations and resources of systems based on Hewlett-Packard 2100A/S (RTE-II only), 2108A, 2109A, 2112A, or 2113A Computers.

### Features

- Real-Time and background multi-user swapping partitions in RTE-II, 64 partitions in RTE-III.
- Typically 18k words for user's programs in 32k word RTE-II system, up to 272k words more▲ (up to 18k per partition) in RTE-III system
- Support for choice of 4.9M byte or 14.7M byte cartridge disc subsystem, the latter expandable to 364.7M byte capacity with the use of 7920S add-on drives.
- Batch-Spool Monitor for concurrent disc file management and batch processing.
- Concurrent processing and program development in FORTRAN II/IV, conversational multi-user real-time BASIC/1000D (optional), HP ALGOL, and HP Assembly language.
- Interactive text editor to aid program development.
- Optional RTE Microprogramming package for on-line development of new user-microprogrammed instructions for the computer.
- Multi-terminal access to all system resources, serving multiple users concurrently.
- Input/output spooling to disc to speed throughput with minimal use of main memory for buffering.
- Choice of on-line or off-line system generation.
- Includes RTE drivers and device subroutines for supported peripherals.
- Support of 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 network communications with other RTE-II/III systems, memory-based satellite systems, and RJE to IBM 360/370 systems.
- Distribution on disc cartridge, HP Mini cartridges, or punched tape.

\*The Hewlett-Packard Interface Bus is Hewlett-Packard's implementation of IEEE Standard 488-1975. "Digital Interface for programmable instrumentation."

▲RTE-III provides addressability up to a maximum of one million words; current physical memory limit is 304k words.



### Functional description

RTE-II and RTE-III differ with respect to capacity, responsiveness, and throughput. RTE-II provides two (real-time and background) disc swapping partitions, functioning in a maximum of 32k words of main memory. Its multi-user capability is greatly extended by program swapping to and from the disc memory. To the base capability of RTE-II, RTE-III adds memory management. It can manage up to 64 disc-resident program partitions in up to 304k words▲ of memory. By making it possible for many more programs to be in memory at the same time when sufficient memory is provided, RTE-III minimizes disc swapping and the delay it necessarily involves. This greatly improves responsiveness and throughput as compared to RTE-II.

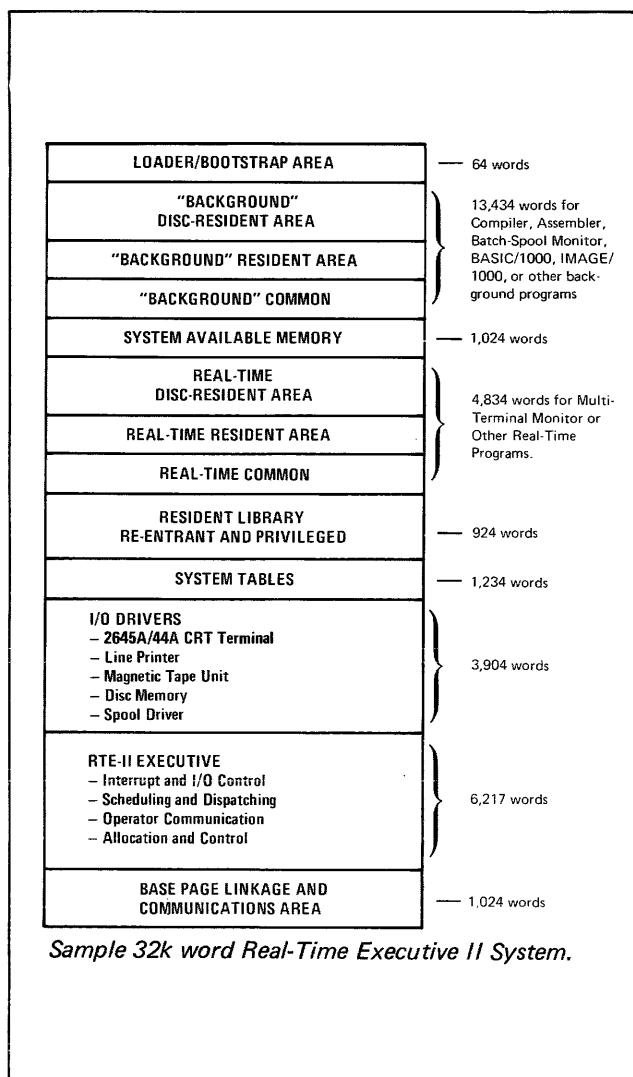
### Real-time multiprogramming

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 several different 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.** The multiple programs in the RTE-II/III system are executed on a scheduled basis, as shown 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 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.

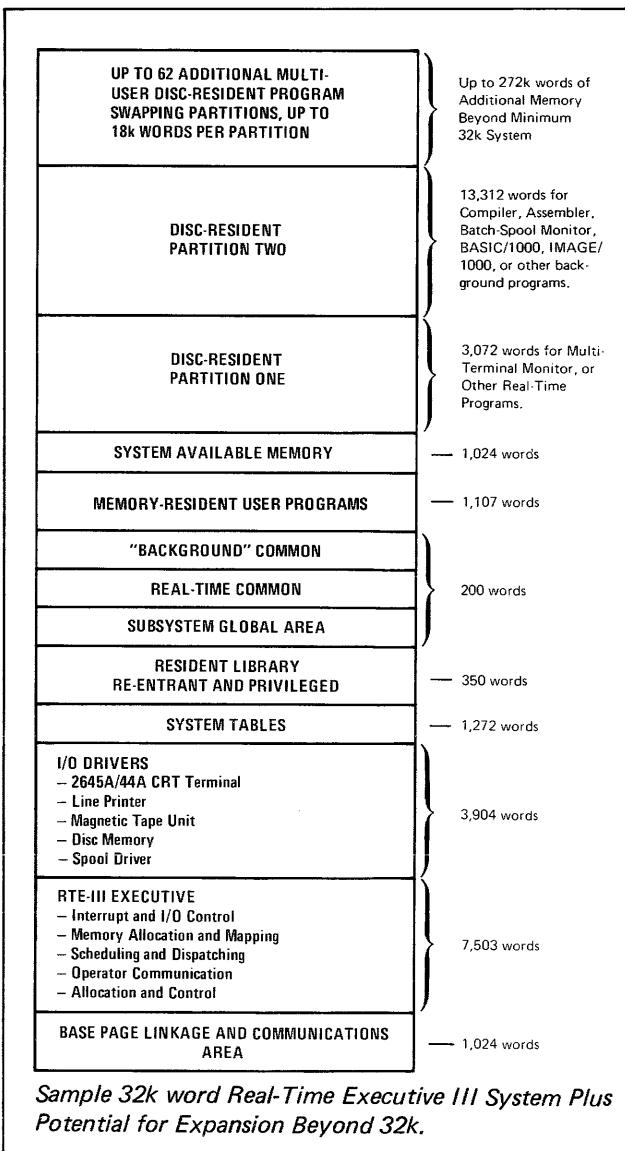
**Dynamic memory mapping (RTE-III only).** The RTE-III system provides fast multiprogram access to as much as 304k words of physical memory by a logical-to-physical address translation using memory maps and dynamic mapping in the system computer. When it's time for a program to run, RTE-III enters an appropriate memory map for that program into the dynamic mapping system. Thereafter, all addressing during program execution is automatic, and completely independent of RTE-III.



**Disc-resident program swapping.** In addition to memory-resident program space, the system provides disc-resident partitions in memory (RTE-II provides two, RTE-III provides up to 64), in accordance with user-specified memory allocation instructions. When a disc-resident program moves to the top of the scheduled list, the system dispatches it in the appropriate partition (after either swapping out or overlaying the current program that may be in that partition as needed to provide execution space for the newly-scheduled program). 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. In RTE-III, when the new program has been dispatched, the system enters its memory map into the dynamic mapping system, as noted above.

### Interrupt processing

RTE-II and RTE-III use the multi-priority level, vectored hardware interrupt system of the system 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 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.

## System integrity

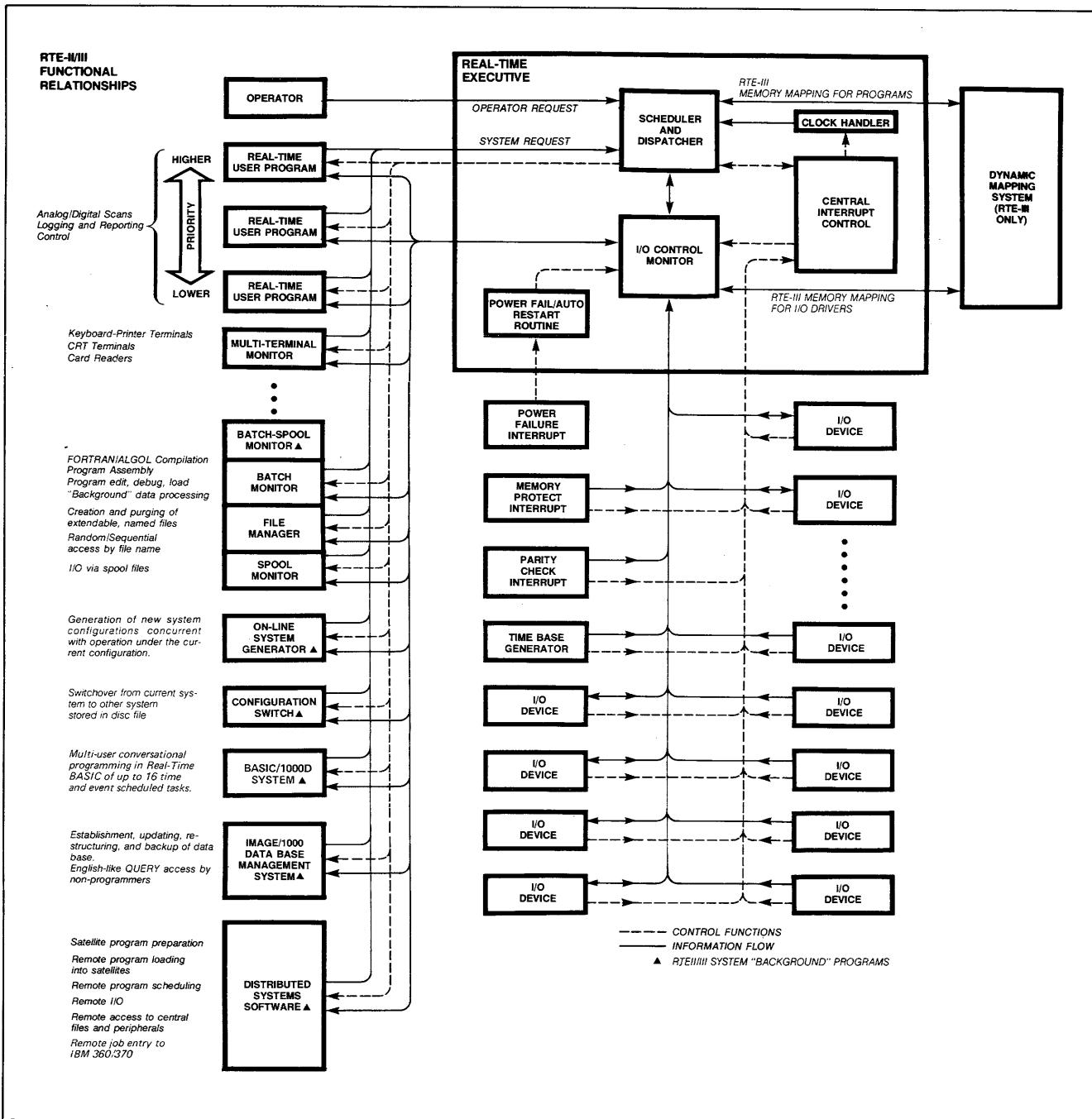
The integrity of the RTE-II/RTE-III system is protected by the following provisions:

- Auto restart after power failure.
- "Fence" register protection of the resident system, library, and common, and real-time programs in RTE-II.
- Optional exclusive assignment protection of disc tracks or other system resources being used by a program.
- Optional security code protection of disc files from unauthorized access.
- Hardware protection of system tracks on the disc.

## 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 for keeping each I/O device optimally utilized on backlogged I/O work.
- I/O timeout capability for detecting I/O conditions that could stall the system.
- I/O suspension with automatic rescheduling to make processing time available to programs that can do useful work while other programs are waiting for I/O service.
- I/O buffering that lets a program initiate an I/O operation then terminate or suspend until that operation has been completed.
- Mailbox data exchange (class I/O) that lets the user set up specific "mailbox" buffers for terminal-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, which may also use the same I/O routine, speeding system response.
- Exclusive assignment of I/O devices 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.
- 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 operation**

A multi-terminal monitor coordinates multi-terminal access to program and data files on the disc. Multiple users can thus edit or run other program processing jobs from several terminals at the same time, concurrently with other real-time operations.

### **On-line program development**

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

- Real-Time FORTRAN IV Compiler (compiles both FORTRAN II and FORTRAN IV programs).
- Real-time ALGOL Compiler.
- Real-time 21MX Assembler.
- Optional 92101A multi-user real-time BASIC/1000 system for conversational development of programs in HP Real-Time BASIC.
- Relocating Loader.
- Batch-Spool Monitor, (BSM).
- Interactive Text Editor.
- Real-Time I/O drivers for peripheral subsystems.

### **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 background processing, 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 editing**

Entry and correction of program, data, and 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 of a file. Of course, this extra capa-

bility is in addition to the usual line or character display, insertion, replacement, and deletion capabilities normally expected in a program or text editor.

### **Data base management (optional)**

RTE-II and RTE-III support IMAGE/1000, an optional Data Base Management System that provides:

- Consolidation of individual data files into a single, inter-related 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 92001B RTE-II or 92060B RTE-III system can be equipped with the 92061A RTE Microprogramming Package. This package provides a microprogram assembler, interactive microdebug editor, writable control store loader and driver routines, and PROM mask tape generator tools for on-line development and testing of user-written micro-coded instructions for 21MX M-series and E-series Computers. This enables the user to improve performance by converting frequently-used software routines to faster-executing microcode instructions. This can be accomplished concurrently with other program development operations.

### **On-line or off-line system generation**

The RTE-II/III operating system can be generated in an on-line mode, concurrently with other system activities, such as program development or interactive access to the system data base. If desired, several different system configurations can be generated and stored in disc files for future use. This capability is provided in addition to an off-line generator.\* Regardless of which system generator is used, modular software makes it easy to configure a real-time system tailored to particular application requirements for input/output peripherals, instrumentation, and optional software. With either the on-line or off-line generator, this may be accomplished interactively through a systematic dialog between user and generator in which the essential parameters of the configuration are specified and appropriate software modules are assembled from the system disc or loaded into the system. With the on-line generator, the configuration is generated from a previously-entered file on the disc, so generation proceeds with minimal operator intervention.

### **Easy switchover from one configuration to the next**

A special utility program is provided for switchover from operation under the current system configuration to operation under a previously generated system configuration stored in a disc file. The facilitates precise matching of the operational environment in which a program being developed for another system will run, so that program can be tested under near-actual run time conditions.

\*The off-line generator works only with 2640A/B, 2762A/B, or 2752A Terminal connected via 12880A or 12531C/D interface, not with 2645A/2644A Terminal.

## **Supporting drivers on the disc**

Drivers for supported data processing peripherals are included in the 92001B RTE-II or 92060B RTE-III operating system. When the system software is on disc cartridge (option 030/031), this saves the operator the trouble of loading the drivers in from Mini cartridges or punched tape, assures that the routines are available when needed and simplifies storage.

## **Master software update utilities**

Utility programs are specifically provided to facilitate updating of the master software system and related modules on the system disc, so that enhancements distributed on Mini cartridges or punched tape as part of the HP Software Subscription Service can be incorporated easily.

## **Disc backup utilities**

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

## **Network capabilities (optional)**

RTE-II and RTE-III support the following network capabilities:

- Distributed systems communication supporting HP memory-based BCS, RTE-B, and RTE-C satellite computer systems with program development and downloading, program and data file storage and access, and data processing assistance, via the 91700A Network Central communications package and counterpart packages in the satellite systems.
- Program-to-program data communication between RTE-II/III based computer systems equipped with the Network Central communications package.
- Remote job entry communication with IBM 360/370 system.

## **Decimal arithmetic library**

RTE-II and RTE-III include a decimal arithmetic library. The routines in this library provide for addition, subtraction, multiplication, and division of decimal character string numbers that exceed the standard integer, floating point, or double-precision arithmetic capacity of the computer and standard libraries.

## **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 swapping partitions**

**RTE-II:** 2, Real-Time and Background.

**RTE-III:** Up to 64, depending upon memory capacity provided.

## **Main memory capacity**

**RTE-II:** 24,576 (24k) to 32,768 (32k) words.

**RTE-III:** 32,768 (32k) to 311,296 (304k) words.

## **Memory requirements (Words<sub>10</sub>)**

The following memory requirements are additive for resident memory. With respect to real-time or background disc-resident memory in RTE-II, the respective partition must be large enough to accommodate the largest single program that will be run in it, then all others will also fit. In RTE-III, the respective partition must be large enough to accommodate the largest single program to run in it, plus 1024 words for base page, which is part of each disc-resident partition in RTE-III.

Software Item	Resident Memory	R-T Disc Resident	B-G Disc Resident
RTE-II System	13,403 <sup>1</sup>		
RTE-III System	16,384 <sup>1</sup>		6-8k <sup>2</sup>
FORTRAN IV Compiler			10-12k <sup>2</sup>
Fast FORTRAN IV Compiler			5-7k <sup>2</sup>
FORTRAN II Compiler			8-12k <sup>2</sup>
HP ALGOL Compiler			6-12k <sup>2</sup>
21MX Assembler			5-9k <sup>2</sup>
Cross-Ref. Table Generator			5-6k <sup>2</sup>
Interactive Editor			7-9k <sup>2</sup>
Relocating Loader			
RTE Microprogramming Package	1,080		8k
On-Line System Generator			10k
Batch-Spool Monitor		1.2k	5k
BASIC/1000D	500	2k	12k
IMAGE/1000	40		12k
SAVE Utility			7-11k <sup>2</sup>
RESTORE Utility			8-11k <sup>2</sup>
COPY Utility			7-11k <sup>2</sup>
VERIFY Utility			7-15k <sup>2</sup>

<sup>1</sup> System memory requirement as listed includes resident system, base page, typical group of drivers, including spool driver, system tables, and resident library, as summarized in the memory map table on page 1-14.

<sup>2</sup> The size of background partition required depends partly on program or buffer size used; short programs or buffers will be processable in the smallest partition size given, larger programs or buffers may take more space, up to the maximum partition size given.

## **Hardware requirements**

### **RTE-II hardware requirements**

1. 2100A/S, 2108A, 2109A, 2112A, or 2113A Computer with at least 24k memory, Direct Memory Access or Dual-Channel Port Controller, Floating Point firmware, Power Fail Recovery, Memory Protect, and 12539C Time Base Generator.
2. 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem.
3. 2645A-007, 030 and 13260B or 2644A-020 CRT Terminal with 12966A-001 interface as system console and standard input unit or 2640A/B CRT Terminal with 12880A-001 interface, 2762A/B Terminal Printer with 12531D-001 interface, or 2752A Teleprinter with 12531C interface as system console and 12925A Punched Tape Reader Subsystem as standard input unit. With punched tape reader, the 12926A Tape Punch is also recommended.

### RTE-III hardware requirements

1. 2108A, 2109A, 2112A, or 2113A Computer with at least 32k memory, Dual-Channel Port Controller, Floating Point firmware, Power Fail Recovery, Dynamic Mapping System, and 12539C Time Base Generator.
- 2-3. Same as items 2 and 3 for RTE-II, above.

### RTE-III memory recommendation

The threshold at which the memory management capability of RTE-III starts to show a response-throughput advantage over RTE-II is a minimum of 48k words of memory, enough for 30-34k user area divided among four or more disc-resident partitions.

### Disc memory capacity

With 12960A Subsystem: 4.9 to 19.6M bytes.

With 12962A/B/C/D: 14.7 to 364.7M bytes with the use of seven 7920A add-on Disc 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 (RTE-III only).
7. Change priority and timing of programs.
8. Examine I/O device or I/O controller status; dynamically alter device buffering assignments.
9. Dynamically alter device logical unit assignments.
10. Control I/O device availability.
11. Dynamically alter device I/O timeout parameters.
12. Set the real-time clock.
13. Print time (time-of-day, day, and year).
14. Compile FORTRAN IV/II or ALGOL programs, or assemble programs.
15. Enter, test, debug, edit, and run Real-Time BASIC programs.
16. Edit program or data files.
17. Load relocatable programs and subroutines into real-time or "background" disc-resident areas of memory.
18. Request load-and-go execution of programs, with option (in RTE-III) to specify partition in which program is to run.
19. Allocate/release program tracks.
20. Back up the disc on mag tape.
21. Update the master software disc cartridge.
22. Generate a new system configuration.
23. Switch from the current system configuration to another system configuration taken from a disc file.
24. Enter batch job commands.
25. Link spool files to peripherals.
26. Create files.
27. Dump contents of a file to another file, or a peripheral device.
28. Copy files from one disc to another.
29. List contents of file directory.
30. Purge files.

31. Repack the disc.

32. Display status of spool jobs.

33. Change spool job priorities.

### 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 disc file area via file management subroutines.
4. Get status of queued read requests, or the resulting input data.
5. Check I/O device or I/O controller 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.
10. Change time scheduling of self or other program.
11. Allocate/release own disc tracks, or global disc tracks available to all programs.
12. Allocate/release I/O devices or other system resources for own exclusive use.
13. Enable/disable swapping of self.
14. Request resource lock/unlock.
15. Request device lock/unlock.
16. Request partition status (RTE-III only).
17. Create files.
18. Rename files.
19. Purge files.
20. Open files.
21. Write on a random or sequential file.
22. Read from a random or sequential file.
23. Locate a file.
24. Close a file.

## Ordering information

### 92001B RTE-II operating system

RTE-II consists of:

1. One of software media choice options 010, 020, 030, or 031, which must be specified on the order.
2. RTE-II Programming and Operating Manual (92001-93001).
3. 92001B Software Numbering Catalog (92001-93003).
4. Real-Time Executive, Batch-Spool Monitor and Operating System Pocket Guide (92060-90010).
5. RTE: A Guide for New Users (92060-90012).
6. RTE Utilities Manual (92060-90010).
7. FORTRAN Manual (02116-9015).
8. FORTRAN IV Manual (5951-1321).
9. HP ALGOL Manual (02116-9072).
10. 21MX Assembler Manual (92060-90005).
11. Decimal String Arithmetic Manual (02100-90140).
12. RTE/DOS Program Libraries Manual (24998-90001).
13. Software Input/Output System Manuals Kit (09600-14005).

14. 7261A Optical Mark Reader Driver DVR15 Manual (07261-90010).
  15. 7970 (7-track) Mag Tape Driver DVR24 Manual (25117-93003).
  16. Multi-Device Driver DVR00 Manual (29029-95001).
  17. 59310B HP-IB Interface Driver DVR37 Manual (59310-90063).
  18. 2892A Card Reader Driver DVR11 Manual (09600-93010).
  19. 7210A Graphic Plotter Driver DVR10 Manual (17210-90004).
  20. 91200B TV Interface Driver DVA13 Manual (91200-90005).
  21. 12560A CalComp Plotter Interface Driver Manual (12560-90023).
  22. 2607A Line Printer Driver Manual (92200-93001).
  23. 264x CRT Terminal Driver DVR05 Manual (92001-90015).
  24. 7970 (9-track) Mag Tape Driver DVR23 Manual (92202-93001).
  25. 3070A Terminal Driver DVA47 Manual (92900-90005).
  26. 12732A Flexible Disc Driver DVR33 Manual (12732-90001).
  27. 9866A Printer driver DVR12 manual (92001-90010).
  28. Batch-Spool Monitor Reference Manual (92060-90013).
  29. Interactive Editor Reference Manual (92060-90014).
  30. RTE-II/RTE-III On-Line Generator Reference Manual (92060-90020).
  31. RTE Operating System Drivers and Device Subroutines Programming and Operating Manual (92200-93005).
  32. 92062A Software Numbering Catalog (92062-90001).
2. RTE-II Utilities: Auto Restart, Program Status Reporter, and Master Software Update Programs (92001-16014, 18014, and 16030, and 92060-16045, 18046, and 18047).
  3. RTE-II Off-Line Generators: for 4.9 and 14.7M byte discs (92001-16013 and 16026).
  4. RTE-II On-Line Generator: Generator and Configuration Switch Programs (92001-16031 and 92060-16038).
  5. RTE-II Batch-Spool Monitor: Batch Monitor and Editor, Batch Library, and Spool Programs (92002-12001, 16010, 16006, and 12002).
  6. Fixed-Head Disc Off-Line Generator (92001-16018).
  7. 24k Software Input/Output System Drivers: for 2607 Line Printer, Mag Tape (DMA), Line Printers, System Dump, Punched Tape Reader, Tape Punch, 2767 Line Printer, Mag Tape, Mag Tape Relocatable, and Terminal Printer (02607-16004, 12970-16004, 29100-60017 through 60023, 60049, and 60050).
  8. RTE Relocatable Library (24998-16001).
  9. RTE FORTRAN Formatters: for FORTRAN II/ALGOL and FORTRAN IV (24153-60001 and 24998-16002), and Decimal String Arithmetic Package (24306-60001).
  10. RTE Assembler and Cross-Reference Symbol Table Generator (92060-12004 and 16028).
  11. RTE ALGOL (24129-60001 and 60002).
  12. RTE FORTRAN IV (24170-60001 through 60003).
  13. RTE Fast FORTRAN IV (24177-60001 and 60002).
  14. RTE FORTRAN II (20875-60001 through 60005).
  15. RTE Disc Backup Utilities (92060-16039 through 16044).
  16. 92062A RTE Drivers Package, as specified in the 92062A data sheet.

#### **92001B option 020**

92001B option 020 provides all the software modules listed under 92001B option 010, above on the following 9162-0061 Mini Cartridges for read-in by 2645A-007 or 2644A CRT Terminal:

1. RTE-II Software (92001-13301).
2. RTE-II Utilities (92001-13302).
3. RTE-II Off-Line Generators (92001-13303).
4. RTE-II On-Line Generator (92001-13304).
5. 92002A-020 Batch-Spool Monitor: Batch Monitor and Editor, Batch Library, and Spool Program (92002-13301 through 13303).
6. Fixed-Head Disc Off-Line Generator (92001-13306).
7. 24k Software Input/Output System Drivers (92001-13305).
8. RTE Relocatable Library (92060-13302).
9. RTE FORTRAN Formatters and Decimal String Arithmetic Package (92060-13303).
10. RTE Assembler and Cross-Reference Symbol Table Generator (92060-13304).
11. RTE ALGOL (92060-13305).
12. RTE FORTRAN IV (92060-13306).
13. RTE Fast FORTRAN IV (92060-13307).
14. RTE FORTRAN II (92060-13308).
15. RTE Disc Backup Utilities (92060-13309).
16. RTE Drivers 92062-13302 through 13305).

#### **92060B RTE-III operating system**

RTE-III consists of:

1. One of software media choice options 010, 020, 030, or 031, which must be specified on the order.
  2. RTE-III Programming and Operating Manual (92060-90004).
  3. 92060B Software Numbering Catalog (92060-90019).
- 4-32 Same as items 4 through 32 for RTE-II, above.

#### **92001B options**

##### **92001B option 001**

92001B option 001 provides a discount to customers upgrading from 92001A and 92002A Batch-Spool Monitor to 92001B.

##### **92001B option 010**

92001B option 010 provides the following software modules on punched tape.

1. RTE-II Software: Relocating Loader, Multi-Terminal Monitor, Power Fail Program, RTE System Library, Memory-Resident RTE-II System, and RTE-II Commands Program (92001-16002 through 16005, 16012, and 16029).

### **92001B option 030**

92001B option 030 provides all the software modules listed under 92001B option 010, above, on 92001-13001, a 12869A disc cartridge for 12960A (4.9M byte) Cartridge Disc Subsystem.

### **92001B option 031**

92001B option 031 provides all the software modules listed under 92001B option 010, above, on 92001-13101, a 12940A disc cartridge for 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem.

## **92060B options**

### **92060B option 001**

92060B option 001 provides a discount to customers upgrading from 92060A to 92060B.

### **92060B option 002**

92060B option 002 provides a discount to customers upgrading from 92001A/B to 92060B.

### **92060B option 010**

92060B option 010 provides the following software modules on punched tape:

1. RTE-III Software: Multi-Terminal Monitor, RTE System Library, Memory-Resident RTE-III System, Power Fail Program, Relocating loader, Privileged Driver Map loader, and RTE-III Commands Program (92001-16003 and 16005, 92060-12003, 16001, 16004, 16035, and 16036).
  2. RTE-III Utilities: Auto Restart, Program and Partition Status Reporter, and Master Software Update Programs (92001-16014, 18014, and 16030, and 92060-16045, 18046, and 18047).
  3. RTE-III Off-Line Generators: for 4.9 and 14.7M byte discs (92001-16013 and 16026).
  4. RTE-III On-Line Generator: Generator and Configuration Switch Program (92001-16031 and 16038).
  5. RTE-III Batch-Spool Monitor: Batch Monitor and Editor, Batch Library, and Spool Programs (92002-12001, 16010, and 16006 and 92060-12001).
- 6-15. Same as items 7 through 16 of 92001B option 010, above.

### **92060B option 020**

92060B option 020 provides all the software modules listed under 92060B option 010, above, on the following 9162-0061 Mini cartridges for read-in by 2645A-007 or 2644A CRT Terminal.

1. RTE-III Software (92060-13301).
2. RTE-III Utilities (92060-13310).

### **3. RTE-III Off-Line Generators (92060-13311).**

### **4. RTE-III On-Line Generator (92060-13312).**

### **5. RTE-III Batch-Spool Monitor: Batch Monitor and Editor, Batch Library, and Spool Program (92002-13301 and 13302 and 92060-13313).**

6-15. Same as items 7 through 16 furnished with 92001B option 020, above.

### **92060B option 030**

92060B option 030 provides all the software modules listed under 92060B option 010, above, on 92060-13001, a 12869A disc cartridge for 12960A (4.9M byte) Cartridge Disc Subsystem.

### **92060B option 031**

92060B option 031 provides all the software modules listed under 92060B option 010, above, on 92060-13101, a 12940A disc cartridge for 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem.

## **Additional manuals available**

RTE-III General Information Manual, 92060-90009.

## **Additional software available**

1. 92101A multi-user real-time BASIC/1000D System for conversational programming of tasks in HP Real-Time BASIC, with time and event-scheduled execution of up to 16 tasks.
2. 92063A IMAGE/1000 Data Base Management System for establishment updating, and simplified QUERY access to data base maintained on system disc.
3. 92061A RTE Microprogramming Package for on-line development of new microcoded computer instructions by the user.
4. 92400A Sensor-Based DAS Utility Library (provides thermocouple linearization and conversion, humidity calculations, statistical analysis, code conversion, curve fitting, interpolation, and integration functions and routines).
5. 92409A Real-Time Plotter Software (characters, symbols, numbers, axes, lines, and points plotting with scaling capability).
6. 92066A Measurement and Control Software Package, including 92413A ISA FORTRAN Extension Package.



# 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 RTE-M or RTE-II/III real-time executive operating systems.

## Features

- Concurrent multi-user development and execution of Real-Time BASIC programs in RTE-MIII, or RTE-II/ III.
- Conversational programming.
- Time and event scheduled operation of up to 16 tasks for a single user.
- High-level subroutine calls for instrumentation, 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 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, ALGOL, 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-M, RTE-II, and RTE-III host systems all support single-user operation. In RTE-MIII, RTE-II, and RTE-III 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-MIII or RTE-II/III 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-MIII or RTE-II/III 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.

#### 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-MIII or RTE-II/III 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, event interrupt (such as contact closure), or request from another task. (This requires the provision of time scheduling, which is optional in RTE-M.) BASIC/1000M and D recognize priority levels from 1 through 99.

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

## Additional capabilities of BASIC/1000D

### Program testing

BASIC/1000D provides user requests for tracing program execution, inserting up to four breakpoints, 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 RTE-II/III 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 subroutines 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 24k words of memory.

**BASIC/1000D:** Disc based RTE-II system with at least 24k words of memory or RTE-III system with at least 32k words of memory (48k preferred).

### Basis of BASIC task scheduling for execution

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

## BASIC task priority levels

1 through 99, the lowest number designating highest priority.

## 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	X	Create a data file on disc or other device.
X	X	Delete program or data file from disc.
X	X	Rename program or data file on disc.
X	X	Request or release exclusive use of peripheral device.
X	X	Trace program execution for correcting program faults.
X	X	Set up program breakpoints for correcting program faults.
X	X	Display and/or set subroutine call variables for simulation of subsystems not in the host computer system.
X	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	X	Open or close files on disc or flexible disc.
X	X	Read from or write on disc.
X	X	Access data base via IMAGE/1000 interface.
X	X	Link from current program to another named program or program segment on disc.

## 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.

## 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.

## Software not supported

BASIC/1000M and D do not support the 92400A Sensor-Based DAS Utility Library or the 92413A ISA Fortran Extension Package.

## 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-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.

### 92101A BASIC/1000D system (for use in RTE-II/III 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-007 or 2644A CRT Terminal.

# IMAGE/1000 data base management system

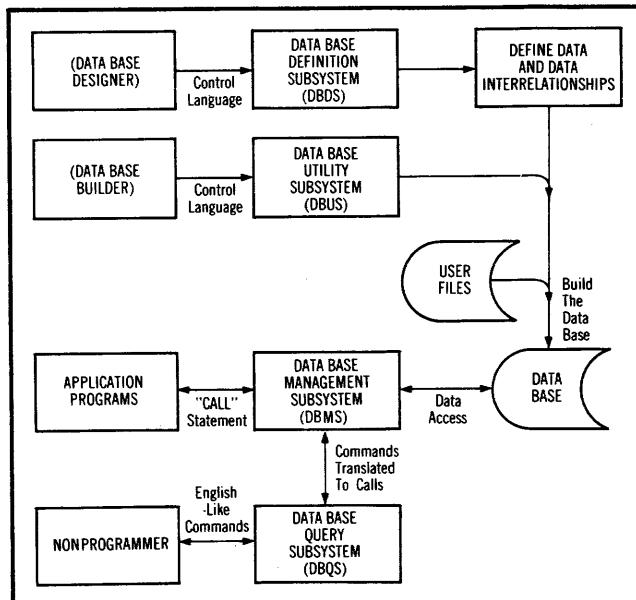
Model 92063A

IMAGE/1000 is a data base management software system designed for use with Hewlett-Packard 2100 and 21MX Series minicomputers and RTE-II or RTE-III operating systems. 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)

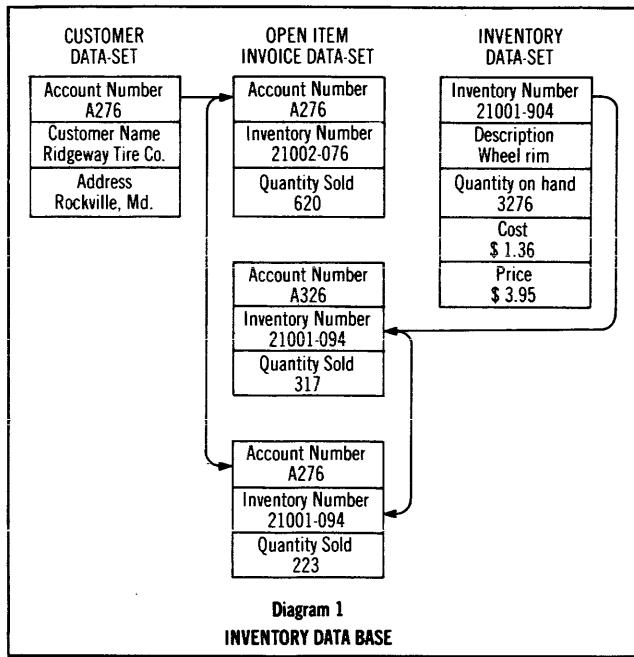
The Data Base Definition Subsystem processes a description of the user data base and produces an internal system description of the data base (called a 'root' file).

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.

### Data base utility subsystem (DBUS)

The Data Base Utility Subsystem (DBUS) consists of five 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 five 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 DBOPEN.
- 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.
- Report Formatting  
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 quantity sold is less than 600" will retrieve records 2 and 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 subroutines. In this sense, it may be thought of as a generalized application program. The commands available are:

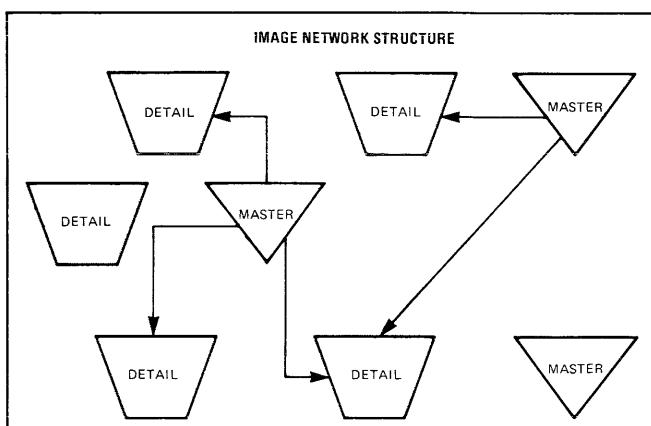
- FIND – multicriteria data selection
- REPORT – report formatting and generation with sorting of data entries.
- UPDATE – data modification, addition, and deletion
- CREATE – procedure creation
- DISPLAY – display procedures
- EXECUTE – schedules a program
- FORM – displays data base structure
- HELP – 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 512 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 Entry: 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.*

### Minimum requirements

1. 92001A/B RTE-II or 92060A/B RTE-III operating system.
2. 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem.
3. 2100A/S (RTE-II only) or 2108A, 2109A, 2112A, or 2113A computer (RTE-II or RTE-III).
4. Batch spool monitor (included with 92001B and 92060A/B).
5. Memory ranging upward from 32k words depending on user requirements. QUERY requires 12k words of background memory.

### Memory usage (words)

IMAGE/1000 uses 40 words 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-III 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 (150 to 3,400 words depending on size and complexity of the user's data base) and may also be needed for file control blocks (144 to 1,732 words; maximum size gives best performance).

IMAGE PROGRAM	RTE-II SIZE	RTE-III SIZE*	USES CTRL. BLOCKS?
DBDS	7.5k	8.5k	no
DBBLD	8.3k	9.3k	yes
DBSTR	3.0k	4.0k	no
DBRST	4.1k	5.1k	no
DBULD	5.4k	6.4k	yes
DBLOD	8.2k	9.2k	yes
QUERY	10.3k	11.3k	yes

\*Including 1,024 words 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 18010).
5. IMAGE/1000 Reference Manual (92063-90001).

### 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-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.



# Basic control system (BCS)

model 20855A

The 20885A Basic Control System (BCS) is an operator-scheduled, minimum cost, single-task memory-based operating system for computer systems based on Hewlett-Packard 2100A/S, 2105A, 2108A, or 2112A Computers.

## Features

- Device-independent, off-line programming in FORTRAN II, ALGOL, and HP Assembly language.
- Loading and linking of relocatable programs and library routines.
- Output buffering and interrupt processing.
- Optional operation as satellite system in distributed multiprocessor networks.

## Functional description

### Interrupt processing

BCS uses the multi-priority level, vectored hardware interrupt system of the system computer for peripheral I/O and user-interfaced equipment. When one or more interrupts occur simultaneously, the interrupt with the highest priority is serviced first, but the system also remembers the other interrupts so none are forgotten or lost.

### Input/output

An I/O control system interprets program calls and directs them as I/O requests to the proper I/O driver. The driver initiates the I/O operation and returns control to the calling program. Whenever the I/O device has data ready, it interrupts the system and the driver temporarily resumes control to transfer the next element of data. When a particular I/O operation is completed, the I/O control system makes the status of the operation available for checking by the program.

### Program development

Editing, compilation, and assembly of programs in the BCS system are off-line operations. This is supported by FORTRAN II and ALGOL Compilers, an HP Assembler, Symbolic Editor, Relocating Loader, Relocatable Libraries, a Debugging System, BCS drivers for virtually all of the instrument and peripheral subsystems used in HP computer systems, and an optional 92400A Sensor-Based DAS library.

### Relocating loader

The Relocating Loader loads object code programs produced by the FORTRAN and ALGOL Compilers and the Assembler. The linking capability of the Loader gives the user the ability to assemble and test several subprograms separately and finally to load, link, and execute all of them as one program. Object subprograms written in any of the three source languages can be linked to and run with each other. The subprograms are linked through symbolic entry points and external references.

BASIC BINARY LOADER	64 words
BUFFERED INPUT/OUTPUT CONTROL	558 words
DRIVERS AND RELATED EQUIPMENT TABLE LOCATIONS	591 words
LIBRARY ROUTINES REQUIRED IN MINIMUM SYSTEM	155 words
PROGRAM AVAILABLE MEMORY (Used for application programs, additional I/O drivers and program library routines, and storage of buffered input/output control output requests)	5,800 words
BASE PAGE AVAILABLE MEMORY (for program linkage and other uses)	820 words
BASE PAGE SYSTEM LINKAGES	140 words
INTERRUPT LOCATIONS	64 words

Typical Minimum 8K BCS System

The Loader also provides indirect addressing whenever an operand of an instruction does not fall within the same page as that into which the instruction is being loaded. This frees the programmer of concern for page boundaries.

Optionally, the user can obtain an absolute dump of a relocatable program plus the Basic Control System and library subroutines referenced by the Loader.

The process of generating the absolute program is such that instructions (not just common storage) may be allocated to the area normally occupied by the Loader. This makes maximum use of available memory, and also provides for faster loading by the Basic Binary Loader.

### Network capability

BCS supports operation as a distributed systems satellite communicating with an RTE-II or RTE-III based network central system via the 91703A BCS Network Satellite Communications Package.

### System generation

BCS includes a Prepare Control System which produces an absolute version of the Basic Control System from relocatable BCS subprograms. During the construction of the absolute BCS, the user also establishes the relationships among I/O channel numbers, drivers, interrupt entry points in the drivers, and unit-reference numbers.

## **Debugging system**

The debugging system provides aids in program testing. Options provided will print selected areas of memory, trace parts of the program during execution, modify the contents of selected areas in memory, modify simulated computer registers, halt execution of the program at specified breakpoints, and initiate execution at any point in the program.

## **Functional specifications**

### **Minimum system requirements**

1. 2100A/S, 2105A, 2108A, or 2112A Computer with at least 8k memory.
2. 2752A Teleprinter as system console and standard input/output unit, or other keyboard-printer or keyboard-CRT terminal with 12925A Punched Tape Reader Subsystem and 12926A Tape Punch Subsystem.

### **Memory requirement**

BCS using buffered I/O control requires 2392 words of memory including system console driver, but exclusive of other drivers and library routines needed to support programs in the BCS environment.

## **Ordering information**

### **20855A basic control system (BCS)**

BCS consists of the following items (all software on punched tape):

1. Prepare Control System (20021-60001).
2. Input/Output Control, buffered (24172-60001) and non-buffered (24173-60001).
3. BCS Debug Routine (20002-60001).
4. BCS Relocating Loader (20018-60001).
5. BCS Relocatable Library (EAU) (24145-60001).
6. BCS FORTRAN IV Library (24149-60001).
7. Symbolic Editor (20100-60001).
8. Extended Assembler (EAU) (24032-60001).
9. FORTRAN II Compiler (20548-60001 and 60002).
10. ALGOL Compiler (24044-60001).
11. Cross-Reference Symbol Table Generator (24109-60001).
12. 2100A/S Fast FORTRAN Package (FFP) BCS Subroutine Library (12907-16004).
13. 21MX FFP BCS Subroutine Library (12977-16003).
14. HP single-terminal BASIC system (20392-60001).

15. I/O Drivers for data processing peripherals: Teleprinter (20017-60001), Punched Tape Reader (20005-60001), Tape Punch (20006-60001), 2610/2614 Line Printer (24273-60001), 2767A Line Printer (24167-60001), 9-Track Mag Tape (13023-60001), 2762 Console (24330-60001), 12908B Writable Control Store (24277-60001).
16. Software Input/Output Drivers for 8k memory: Teleprinter (24125-60001), Punched Tape Reader (20306-60001), Tape Punch (20307-60001), and SIO Dump (20313-60001).
17. Software Input/Output Drivers for 16k memory: Teleprinter (24127-60001), Punched Tape Reader (20319-60001), Tape Punch (20320-60001), and SIO Dump (20355-60001).
18. Manuals for: Basic Control System (02116-9017), Relocatable Subroutines (02116-91780), HP Assembler (02116-9014), HP FORTRAN (02116-9015), Symbolic Editor (02116-9016), HP ALGOL (02116-9072), BASIC (02116-9077), installation of 2100A/S FFP (12907-90001) and 21MX FFP (12977-90001), BCS Small Programs (5951-1391), Small Programs Introduction (5951-1369), SIO System Configuration (5951-1374), and SIO Operator's Guide (5951-1390).
19. Driver manuals for: 2610/2614 Line Printer (12845-90004), 2607A Line Printer (12987-90008), 2767A Line Printer (12653-90005), 9-Track Mag Tape (13023-90010), 2762 Console (02762-90003), and 12908B Writable Control Store (12908-90003).

### **20855A options**

- 006** Replaces items 5 and 8 of standard 20855A with the following items:
1. BCS Relocatable Library, Floating Point (24250-60001).
  2. Extended Assembler, Floating Point (24246-60001).
- 008** Adds the following Microprogramming Support Items:
1. BCS Microassembler (24279-60001).
  2. BCS Microdebug Editor (24281-60001).
  3. WCS I/O Utility Diagnostic (24283-60001).
  4. Microprogramming Guide (5951-3028).
  5. Microprogramming Reference Manual (5951-4431).
  6. Microprogramming Software Manual (02100-90133).

### **BCS as supplied in 9640A option A00**

BCS as supplied in 9640A option A00 does not include buffered I/O Control (24172-60001).

model 2300B

RTE-B is a memory-based Real-Time BASIC operating system for the novice user of computer systems based on Hewlett-Packard 2100A/S, 2105A, 2108A, or 2112A Computers.

## Features

- Device-independent, off-line conversational Real-Time BASIC programming.
- Time and event scheduled operation of up to 16 user's tasks.
- Operation in as little as 12k of memory, or up to 32k.
- High-level subroutine calls for instrumentation.
- Program-compatible upgrading to RTE-M or disc-based RTE-II or RTE-III system.
- Optional operation as satellite system in distributed multiprocessor networks.

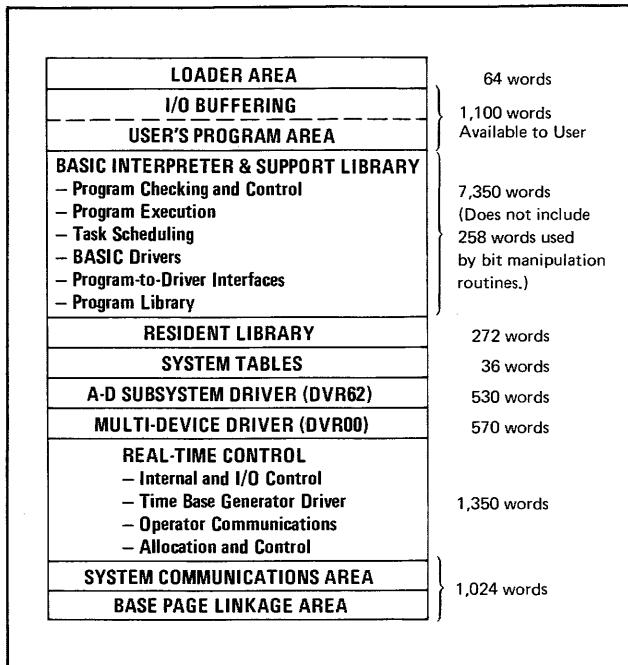
## Functional description

### Real-time multitasking

The RTE-B system supervises the execution of up to 16 user's tasks, including programs for measurement, control, data processing, and data reporting. Multitasking gives the user the ability to match the frequency and timing of programmed task actions to the diverse needs of real-time applications in research and manufacturing.

**Scheduling.** The multiple tasks in the RTE-B system are programmed as subroutines of a single Real-Time BASIC program, as shown in Figure 1. Real-Time BASIC includes statements that assign execution priority to tasks and provides statements to schedule tasks as a function of time, and to connect task subroutines to event interrupts, such as contact closures. A statement is also provided for rescheduling tasks to be repeated during the course of system operations. RTE-B recognizes priority levels from 1-99.

**Execution.** Execution is started immediately for the highest priority task that is currently scheduled to run. After the execution of each program statement, the RTE-B scheduler checks for time and event interrupts. It examines task timing and priorities and either continues running the current task or starts running a newly-scheduled task having higher priority.



Typical minimum 12k RTE-B system

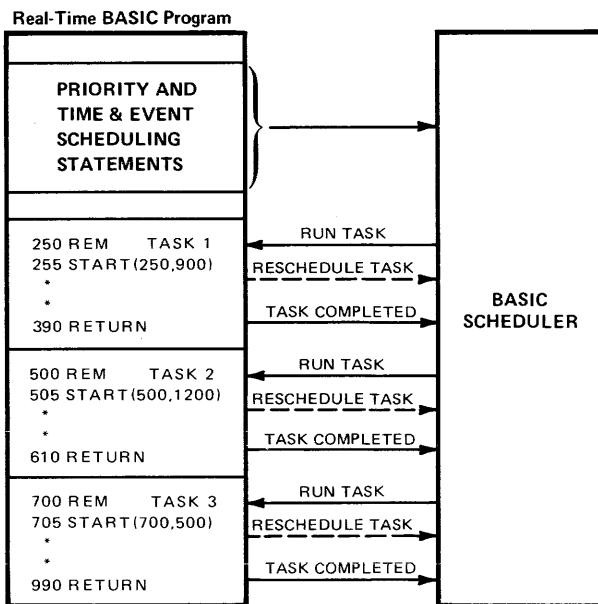


Figure 1. Program-Scheduler relationships

## **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:

- Multi-terminal input/output.
- Device I/O timeout capability for detecting I/O conditions that could stall the system.
- Output buffering that "stacks" output requests and provides for automatic memory buffering of output directed to low or medium speed peripherals.

## **Conversational program development**

Real-Time BASIC programs are entered directly into the system via a keyboard input unit. The RTE-B 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 when programs are run are flagged and corrected with similar ease.

Conversational operation lets the user test and prove programs step-by-step as they are being prepared. It keeps the user in close touch with the computer system, its functioning, and its results.

Program development is supported by a Real-Time BASIC interpreter, program library, real-time I/O drivers for all instrument and peripheral subsystems used in HP computer systems, and optional 92400A Sensor-Based DAS Library.

## **Network capability**

RTE-B supports operation as a distributed systems satellite communicating with an RTE-II or RTE-III based network central system via the 91704A RTE-B Network Satellite Communications Package.

## **System generation**

Modular software makes it easy to configure an RTE-B system tailored to particular requirements for instrumentation, input/output peripherals, and optional software. This is accomplished systematically through a dialog between user and system in which the operating parameters of the system are specified and appropriate software modules are loaded.

## **Functional specifications**

### **Minimum system requirements**

1. 2100A/S, 2108A, or 2112A Computer with at least 12k memory, and 12539C Time Base Generator.
2. 2752A Teleprinter or other system console and a 12926A Tape Punch Subsystem.
3. 12925A Punched Tape Reader Subsystem.

### **Memory requirement**

RTE-B requires 10,658 words of memory, including the driver required for the system console and standard input and output units, but exclusive of drivers and library routines needed to support other peripherals. 16k of memory is the recommended minimum for all but the smallest applications.

## **Ordering information**

### **2300B RTE-B real-time BASIC system**

RTE-B consists of the following items (all software on punched tape):

1. RTE-B Programming and Operating Manual (29102-93001).
2. RTE-B Software Kit (29102-64001), as follows:
  - a. System generator (29101-60011).
  - b. RTE-B table generator (29102-60030).
  - c. RTE-B operating system (92000-60001).
  - d. BASIC Interpreter (25117-60069).
  - e. RTE-B Library and auxiliary routines (29102-60001, 60012, 60013, 29100-16003, 92000-16001, 92001-16004, and 92413-16007).
  - f. RTE-B standard branch and mnemonic table (29102-60009).
3. Auxiliary Software Kit (29101-64003), as follows:
  - a. Multi-Device Driver DVR00 (29029-60001).
  - b. Small programs manual (5951-1369).
  - c. Relocatable Library (for FORTRAN/Assembly subroutines) (24151-60001) and Manual (02116-91780).
  - d. Formatter, Floating Point Library, and FORTRAN IV Library routines (24153-60001, 24248-60001, 24152-60001).
  - e. FORTRAN Compiler (25117-60289 and 25121-60014) and Manual (02116-9015).
  - f. HP Assembler (25117-60574) and Manual (02116-9014).
  - g. Symbolic Editor (20100-60001) and Manual (02116-9016).
  - h. Software Input/Output Driver for 8k memory: System Console (24125-60001), Tape Reader (20306-60001), Tape Punch (20307-60001), and SIO Dump (20313-60001).
  - i. Software Input/Output Drivers for 12k memory: System Console (24299-60001), Tape Reader (20327-60001), Tape Punch (20328-60001), and SIO Dump (24298-60001).
  - j. Software Input/Output Drivers for 16k memory: System Console (24127-60001), Tape Reader (20319-60001), Tape Punch (20320-60001), and SIO Dump (20335-60001).
  - k. Software Input/Output System manuals for System Console (02116-91760) and SIO Subsystem (5951-1390).

model 2300C

RTE-C is a memory-based, time and event scheduled real-time multiprogramming system for computer systems based on Hewlett-Packard 2100A/S, 2108A, or 2112A Computers.

## Features

- Time and event scheduled multiprogramming.
- Operation in as little as 8k of memory, or up to 32k.
- Device-independent, off-line FORTRAN II and HP Assembly language programming.
- On-line task installation and removal.
- Program-compatible upgrading to RTE-M or disc-based RTE-II or RTE-III system.
- Optional operation as satellite system in distributed multiprocessor networks.
- Optional data communication with IBM 360/370.

## Functional description

### Real-time multiprogramming

The RTE-C system supervises the execution of multiple programs, including user's programs for measurement, control, data processing, and data reporting. Multiprogramming gives the user the ability to match the frequency and timing of programmed task actions to the diverse needs of real-time applications in research and manufacturing.

**Scheduling.** The multiple programs in the RTE-C system are executed on a scheduled basis, as shown at right. RTE-C lists all programs in order of priority that are ready for execution. Programs are placed in this list when it is time for them to run, in response to external event interrupt, and when execution is requested by another program or by the operator. RTE-C recognizes priority levels from 1 through 99, and program execution may be scheduled on time resolutions as small as tens of milliseconds.

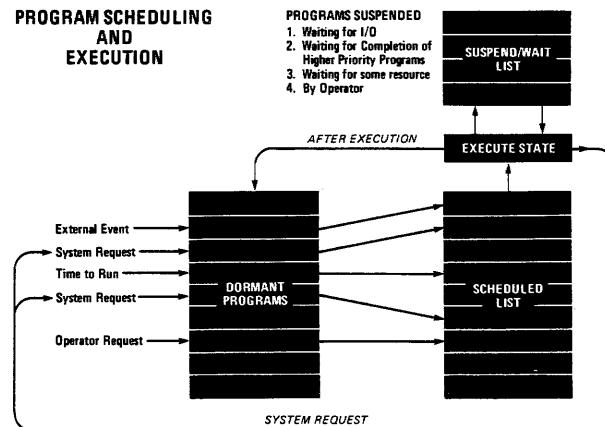
**Execution.** Execution is started immediately for the highest priority program, at the top of the scheduled list. If a higher-priority program moves to the scheduled list, that program starts execution and the current program is suspended.

### Interrupt processing

RTE-C uses the multi-priority level, vectored hardware interrupt system of the system 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 priority is recognized first, but the system also remembers the other interrupts so no interrupt is forgotten or overlooked.

LOADER AREA	64 words
SYSTEM AVAILABLE MEMORY FOR BUFFERING AND RE-ENTRANT PROCESSING	256 words
MEMORY AREA FOR REAL-TIME PROGRAMS ADDED AFTER SYSTEM GENERATION	500 words
REAL-TIME RESIDENT PROGRAMS CONFIGURED WITH THE SYSTEM	1,024 words
ABSOLUTE PROGRAM LOADER	860 words
REAL-TIME COMMON	44 words
RESIDENT LIBRARY	100 words
RTE-C EXECUTIVE — Interrupt and I/O Control — Scheduling — Operator Communication — Allocation and Control	4,222 words
I/O DRIVERS — Teletype, Tape Reader, and Tape Punch	570 words
BASE PAGE LINKAGE AREA	1,024 words

Typical minimum 8k RTE-C system



### Privileged interrupt

RTE-C 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.

### System integrity

The RTE-C system saves its operating status in event of power failure. A "Fence" register protects the resident system, library, and common from user's programming errors.

## **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 for keeping each I/O device optimally utilized on backlogged I/O work.
- Device I/O timeout capability for detecting I/O conditions that could stall the system.
- I/O suspension with automatic rescheduling to make processing time available to programs that can do useful work while other programs are waiting for I/O service.
- Output buffering that "stacks" output requests and provides for automatic memory buffering of output directed to low or medium speed peripherals.

## **Program development**

Editing, compilation, and assembly of programs in the RTE-C system are off-line operations run when the system is not running real-time operations. This is supported by a FORTRAN II Compiler, HP Assembler, Symbolic Editor, Relocating Loader, Relocatable Libraries, real-time I/O drivers for all instrument and peripheral subsystems used in HP computer systems, and optional 92413A I.S.A. FORTRAN and 92400A Sensor-Based DAS libraries.

## **On-line task installation and removal**

RTE-C includes an Absolute Program Loader for installing previously-prepared programs in the system during real-time operations. It is thus possible to change from one set of operations to others without regenerating the system.

## **Network capabilities**

RTE-C supports operation as a distributed systems satellite communicating with an RTE-II or RTE-III based network central system via the 91705A RTE-C Network Satellite Communications Package. It also supports communication with IBM 360/370 systems via the 91780A RJE/1000 Communications Package.

## **System generation**

Modular software makes it easy to configure an RTE-C system tailored to particular requirements for instrumentation, input/output peripherals, and optional software. This is accomplished systematically through a dialog between user and system in which the operating parameters of the system are specified and appropriate software modules are loaded.

## **Functional specifications**

### **Minimum system requirements**

1. 2100A/S, 2108A, or 2112A Computer with at least 8k memory, memory protect, and 12539C Time Base Generator.
2. 2752A Teleprinter or other system console and 12926A Tape Punch Subsystem.
3. 12925A Punched Tape Reader Sybsystem.

## **Memory requirement**

RTE-C requires 5,980 words of memory, including the driver required for the system console and standard input and output units, but exclusive of drivers and library routines needed to support other peripherals. 16k of memory is the recommended minimum for most applications.

## **Ordering information**

### **2300C RTE-C system**

RTE-C consists of the following items (all software on punched tape):

1. RTE-C Programming and Operating Manual (29101-93001).
2. RTE-C Software Kit (29101-64001), as follows:
  - a. System Generator (29101-60011).
  - b. Operating System Kit (29101-64002), consisting of RTE-C Executive, Scheduler, I/O Control, and Absolute Program Loader.
  - c. Relocating Loader (29101-60010).
3. Auxiliary Software Kit (29101-64003), as follows:
  - a. Multi-Device Driver DVR00 (29029-60001).
  - b. Small programs manual (5951-1369).
  - c. Relocatable Library (for FORTRAN/Assembly subroutines) (24151-60001) and Manual (02116-91780).
  - d. Formatter, Floating Point Library, and FORTRAN IV Library routines (24153-60001, 24248-60001, 24152-60001).
  - e. FORTRAN Compiler (25117-60289 and 25121-60014) and Manual (02116-9015).
  - f. HP Assembler (25117-60574) and Manual (02116-9014).
  - g. Symbolic Editor (20100-60001) and Manual (02116-9016).
  - h. Software Input/Output Drivers for 8k memory: System Console (24125-60001), Tape Reader (20306-60001), Tape Punch (20307-60001), and SIO Dump (20313-60001).
  - i. Software Input/Output Drivers for 12k memory: System Console (24299-60001), Tape Reader (20327-60001), Tape Punch (20328-60001), and SIO Dump (24298-60001).
  - j. Software Input/Output Drivers for 16k memory: System Console (24127-60001), Tape Reader (20319-60001), Tape Punch (20320-60001), and SIO Dump (20335-60001).
  - k. Software Input/Output System manuals for System Console (02116-91760) and SIO Subsystem (5951-1390).

# 21MX program development, microprogram development, and supporting libraries overview

Program development software and supporting libraries provide source program translation and data processing support for user's application programs. The micro-program development software provides for translation of users source programs to microcoded instructions for 21MX and 21MX E-Series Computers. The completeness and ease of use of these categories of software is critically important to effective computer system implementation.

## 21MX program development software

Program development software for 21MX Computers consists of:

1. Standard compilers and assemblers, included in the operating systems, which translate source programs to relocatable object code. These are covered, along with item 2, in a standard program languages data sheet in this section.
2. BASIC interpreters, which translate source programs to executable form incrementally, statement by statement, during execution. They are included in the BASIC/1000M and D subsystems for RTE-M and RTE-II/III and in the RTE-B system.
3. Multi-user interactive editors included in the RTE-M and RTE-II/III operating systems and a single-user symbolic editor included in the RTE-C and BCS systems are provided for listing and changing the text of source language programs.
4. Relocating loaders included in the RTE-M, RTE-II/III, RTE-C, and BCS operating systems convert the relocatable object code produced by the standard compilers and assemblers to absolute executable form for loading into the computer.
5. Absolute loaders included in the RTE-M and RTE-C operating systems load the absolute executable programs prepared by the relocating loader into the appropriate computer memory locations for execution, a process that can be run on-line, while other programs are running. In RTE-II/III, this same on-line process is performed by the operating system itself. In BCS, absolute programs are loaded during system generation by the prepare control system.

## Microprogram development software

Microprogram development software for the development of new microprogrammed computer instructions by the user is supported in the RTE-II/III and BCS systems. The RTE microprogramming software is covered in a data sheet in this section; the BCS microprogramming software is generally similar, but without the on-line, disc-based program preparation convenience afforded by the RTE-II/III systems.

## Supporting libraries

The supporting libraries for 21MX Computers include:

1. The standard relocatable library, which is included in the operating systems. This provides standard functions and operators, including square root, exponentiation, trigonometric, and utility functions, as well as the base capabilities of addition, subtraction, multiplication, and division. These are covered by a data sheet in this section.
2. The decimal string arithmetic routines, which are included in the RTE-II/III operating system, for addition, subtraction, multiplication, and division of integer decimal strings that are beyond the capacity of the standard library routines.
3. The 92400A Sensor-Based DAS Utility library, which is a separately available collection of routines and functions providing ready-to-use calculation capabilities that have proven helpful to Hewlett-Packard measurement and control system users. It is covered by a data sheet in this section.
4. The 92409A Real-Time Plotter Software library, a separately-available library of plotter utility routines for use in RTE systems. This library is covered by a data sheet in this section.
5. The 92062A RTE Drivers package, which is a library of data processing peripheral drivers included in the RTE-M, RTE-II, and RTE-III operating systems. It is covered by a data sheet in this section.
6. The 92066A RTE Measurement and Control Software Package, a library of drivers and device subroutines that support the measurement and control systems that are compatible with 21MX Computers. It also includes the 92413A ISA Fortran Extension Package which provides industry standard calls to measurement and control instruments. The 92066A package is available separately; it is covered by a data sheet in this section.



## Program languages

The standard program languages for 21MX Computer systems include Fortran and HP Algol, real-time BASIC and HP Assembly language. These are described individually in the following paragraphs.

### Fortran IV compiler

HP 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:

1. Program, subprogram, and external names are limited to five characters.
2. Named COMMON blocks are not allowed.
3. BLOCK DATA subprograms are not allowed.
4. 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.

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

### Functional specifications

See the program language specifications table, page 2-2.

### Ordering information

Two Fortran IV compilers, one which minimizes use of memory and another which runs faster because of less segmentation are included in the 92001B RTE-II and 92060B RTE-III operating systems.

### Fortran II

HP Fortran II programs are translated by a two-pass Compiler producing relocatable object code. It is based on ASA Basic FORTRAN.

### ASA basic Fortran extensions

The following extensions expand the capabilities and increase the power of HP Fortran II, as compared with ASA basic Fortran:

- Special characters included with ASCII input data direct its formatting; a FORMAT statement need not be specified in the source program.
- Heading and editing information can be specified in the FORMAT statement through the use of "... notation, so alphanumeric data can be read or written without giving the character count.
- Array declarations may be contained within a COMMON statement.
- An END statement is interpreted automatically as a RETURN statement.
- External functions are provided for masking (Boolean) operations.
- Two-branch IF is provided.
- Octal constants.

### Functional specifications

See the program language specifications table, page 2-2.

### Ordering information

The Fortran II compiler is provided in the memory-based 92064A-040 RTE-M operating system, in the disc-based 92001B RTE-II or 92060B RTE-III operating system, and in the memory-based 2300B RTE-B, 2300C RTE-C, and BCS operating systems.

### HP Algol

HP ALGOL programs are translated by a one-pass compiler producing relocatable object code. It translates a source language similar to that defined by the ALGOL 60 Revised Report, *Communications of the ACM*, January 1963.

### Extensions of Algol 60

The following extensions expand the capabilities of HP Algol, as compared to Algol 60:

- Intermixing of REAL and INTEGER variables on the left-side of assignment statements.
- Unrestricted nesting of conditional statements within conditional statements.
- All variables treated as OWN variables.

- Initialization of variables or arrays within type declarations.
  - Values assignable to variables with EQUATE declaration.
  - Logical unit designation in I/O statements.
  - HP FORTRAN FORMAT specification for I/O operations.
  - Free-field data input optional.
  - Ability to reference external ALGOL, FORTRAN, or Assembly language procedures.

## How HP Algol Differs from Algol 60

In addition to the extensions listed above, HP Algol differs from Algol 60 in the following respects:

- Only upper-case characters are allowed.
  - The character set differs.
  - Dynamic storage allocation is not included.
  - IF is usable only for conditional operations.
  - The Algol 60  $\supset$  (implies) and  $\equiv$  (equivalent) logical operators have been eliminated.

## Functional specifications

See the program language specifications table on this page.

## **Ordering information**

The HP Algol compiler is provided in the disc-based 92001B RTE-II and 92060B RTE-III operating systems and in the memory-based 20855A BCS system.

## Program language specifications

										Specifications		
FORTRAN IV		FORTRAN II		HP ALGOL		BASIC/1000M		BASIC/1000D		RTE-B BASIC	21MX Assembler	HP Assembler
X	X	X	X			X	X			<b>Data Types</b>		
X	X	X	X	X	X	X	X			Integer data (a 16-bit quantity including sign, ranging from +32767 to -32768)		
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		X			X	X	X			Logical data (a 16-bit variable in which only the integer sign bit is used to determine the Boolean value, true or false)		
										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	X	X	X	X	X		The 26 letters A through Z (capitals only)		
X	X	X	X	X	X	X	X	X		The 10 digits 0 through 9		
X	X	X	X	X	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	X	X	X	X	X	X		Special characters: quotation mark		
X	X	X	X	X	X	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				X	X				Special characters: back arrow, percent and @ signs, and back-slash.		

## **Real-time BASIC**

Real-time BASIC is an easily-learned language that provides interactive, conversational programming. Unlike the other 21MX 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 three different BASIC languages available for 21MX Computer systems are shown in the program language specifications table (facing).

### **Ordering information**

The real-time BASIC interpreters are included in the 92065A BASIC/1000M subsystem for RTE-M, the 92101A BASIC/1000D subsystem for RTE-II/III, and the 2300B RTE-B system.

## **HP assembly language**

HP Assembly language symbolic source language instructions are translated by either of two HP Assemblers 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 two different HP Assemblers available for 21MX Computer systems are shown in the program language specifications table (facing).

### **Ordering information**

The 21MX Assembler is included in the 92064A-040 RTE-M, 92001B RTE-II, and 92060B RTE-III operating systems. The more limited HP Assembler is included in the 2300B RTE-B, 2300C RTE-C, and 20855A BCS operating systems.



## RTE microprogramming package

Model 92061A

The 92061A is a support package for on-line development by the user of special microprogrammed instructions for Hewlett-Packard 21MX and 21MX E-Series Computers coordinated by the RTE-II or RTE-III operating 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, ALGOL, 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 subroutining 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-III 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 both 21MX M-Series and E-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 21MX M-Series or 21MX E-Series 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 Micro-debug 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 micro-debug editor can also be called programmatically from any user program.

**Linking programs to new computer instructions.** The HP 21MX 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, BASIC, or ALGOL 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/III 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 92060A/B RTE-III system.

#### Memory usage

The WCS driver requires 1080 words of resident memory. Other programs in the RTE Microprogramming Package require an 8k word background partition in RTE-II or a 9k word partition in RTE-III, including the 1k words required for base page in each RTE-III 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.

## **Minimum requirements**

1. 92001A/B RTE-II or 92060A/B RTE-III operating system.
2. 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte Cartridge Disc Subsystem).
3. HP 2108A, 2109A, 2112A, or 2113A Computer.
4. Batch-Spool Monitor (included in 92001B and 92060A/B).
5. At least 24k words of memory in RTE-II system, 32k words of memory in RTE-III system.

## **PROM burn tape requirement**

To output PROM burn tapes, a tape punch is required. If PROM burn tapes are generated infrequently, the 10 byte/sec tape punch of the 2752A Teleprinter may be sufficient. For faster production, the 75 byte/sec 12926A Tape Punch Subsystem is strongly recommended.

## **Ordering information**

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

The microprogramming package consists of:

1. RTE Microassembler (92061-16001), translates symbolic 21MX 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-007 or 2644A CRT Terminal interfaced to the computer via the 12966A-001 interface and to the operating system via RTE driver DVR05.

### **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.



## 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 21MX Assembly and HP 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 Table 1. Table 1 also includes the comparable mathematical and utility routines callable from real-time BASIC.

Table 1. RTE Relocatable Library

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

- Provided in microcode of Fast FORTRAN Processor.
- ▲ Appropriate calls to FADSB, .FDV, and .FMP subroutines are automatically generated by the FORTRAN II/IV or ALGOL Compiler or the Real-Time BASIC Interpreter whenever a plus, minus, division, or multiplication sign is encountered when translating source programs.

Table 1, Continued

USABILITY					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I	A L G O	A S M B	
*	*	*	*	*	
*	*	*	*	*	
*	*	*	*	*	
*	*	*	*		
<b>Mathematical Subroutines and Functions, continued</b>					
*	*	*	*	*	DABS Calculates absolute value of double real X.
*	*	*	*	*	DATA1 Calculates double real arctangent of double real X.
*	*	*	*	*	DATA12 Calculates double real arctangent of quotient of two double real numbers (Y/X).
*	*	*	*	*	DBLE Converts real X to double real Y. ■
*	*	*	*	*	DCOS Calculates double real cosine of double real X.
*	*	*	*	*	.DCPX Converts double real X to a complex Y.
*	*	*	*	*	DDINT Truncates double real X to double real Y. ■
*	*	*	*	*	DEXP Calculates double real exponent of double real X.
*	*	*	*	*	DIM Calculates positive difference between real X and Y.
*	*	*	*	*	.DINT Converts a double real X to an integer I.
*	*	*	*	*	DLOG Calculates double real natural log of double real X.
*	*	*	*	*	DLOGT Calculates base 10 log of double real X.
*	*	*	*	*	DMOD Calculates double real remainder of two double real values.
*	*	*	*	*	DSIGN Transfers sign of double real X to a double real Y.
*	*	*	*	*	DSIN Calculates double real sine of double real X.
*	*	*	*	*	DSQRT Calculates double real square root of double real X.
*	*	*	*	*	.DTOD Raises a double real X to a double real power Y.
*	*	*	*	*	.DTOI Raises a double real X to an integer power I.
*	*	*	*	*	ENTIE Calculates greatest integer not exceeding a real X.
*	*	*	*	*	ENTIX Calculates greatest integer not exceeding a double real X.
*	*	*	*	*	EXP Calculates e of real X.
▲	▲	▲	▲	▲	FADSB Adds or subtracts real X to real Y.★
▲	▲	▲	▲	▲	.FDV Divides real X by real Y.★
*	*	*	*	*	FLOAT Converts integer I to real X.★
▲	▲	▲	▲	▲	.FMP Multiplies real X by real Y.★
*	*	*	*	*	IABS Calculates absolute value of integer I.
*	*	*	*	*	IAND Takes logical product of integers I and J.
		*			AND Takes logical product of real X and Y.

- ★ Provided in standard 21MX and 21MX E-Series Computer Floating Point Firmware Instructions.

Table 1, Continued

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 L										
<b>Mathematical Subroutines and Functions, continued</b>														
*	*	*	*	*	IDIM	Calculates positive difference between integers I and J.								
*	*	*	*	*	IDINT	Truncates double real X to integer J.								
*	*	*	*	*	IFIX	Converts real X to integer I.								
*	*	*	*	*	INT	Truncates real X to integer J.								
*	*	*	*	*	IOR	Takes logical inclusive OR of integers I and J.								
*	*	*	*	*	.ITOI	Raises integer I to integer power J.								
*	*	*	*	*	OR	Takes logical inclusive OR of real X and Y.								
*	*	*	*	*	ISIGN	Calculates sign of integer of real X times absolute value of integer I.								
*	*	*	*	*	LOG	Calculates base 10 log of real X.								
*	*	*	*	*	.MANT	Extracts mantissa of real X.								
*	*	*	*	*	MOD	Calculates integer remainder of I/J for integer I and J.								
*	*	*	*	*	MXMND	Calculates maximum or minimum of series of double real values.								
*	*	*	*	*	MXMNI	Calculates maximum or minimum of series of integer values.								
*	*	*	*	*	MXMNRI	Calculates maximum or minimum of series of real values.								
*	*	*	*	*	NOT	Takes logical NOT of real X.								
*	*	*	*	*	.PWR2	Calculates X times $2^n$ for real X and integer n.■								
*	*	*	*	*	.RTOD	Raises real X to double real power Y with double real result Z.								
*	*	*	*	*	.RTOI	Raises real X to integer power I.								
*	*	*	*	*	.RTOR	Raises real X to real power Y.								
*	*	*	*	*	SGN	Calculates sign of real X.								
*	*	*	*	*	SIGN	Calculates sign of real or integer Z times the absolute value of real X.								
*	*	*	*	*	SIN	Calculates sine of a real X (radians).								
*	*	*	*	*	SNGL	Converts double real X to real Y.■								
*	*	*	*	*	SNGM	Converts double real X to a real Y without rounding.								
*	*	*	*	*	SQR	Calculates square root of real X.								
*	*	*	*	*	SQRT	Calculates square root of real X.								
*	*	*	*	*	TAN	Calculates tangent of real X (radians).								
*	*	*	*	*	TANH	Calculates hyperbolic tangent of real X.								
*	*	*	*	*	XADSB	Double real addition and subtraction.■								
*	*	*	*	*	XDIV	Divides double real X by double real Y.■								
*	*	*	*	*	XMPY	Multiples double real X by double real Y.■								
*	*	*	*	*	XPOLY	Evaluates double real polynomial.								

- Provided in microcode of Fast FORTRAN Processor.
- ▲ Appropriate calls to FADSB, .FDV, and .FMP subroutines are automatically generated by the FORTRAN II/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 21MX and 21MX E-Series Computer Floating Point Firmware Instructions.
- † Available in BASIC/1000 only.
- ◆ Available in 92101A BASIC/1000 only.

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

## Ordering information

Relocatable libraries appropriate to the program languages supported are included in the 92064A RTE-M, 92001B RTE-II, 92060B RTE-III, 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.



## Sensor-based DAS utility library

model 92400A

The 92400A Sensor-Based DAS Utility Library is a collection of routines and functions (Table 1) 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.

Table 1. 92400A Sensor-Based DAS Utility Library

USABILITY					SUBROUTINES AND FUNCTIONS									
F T N 2	F T N 4	B A S I O C	A L G O B L	A S M B										
<b>Thermocouple Linearization</b>														
* * B * *														
* * B * *	FECON Converts Iron-Constantan thermocouple output voltage to °C/°F with correction of non-linearity.													
* * B * *	CRALM Converts Chrome-Alumel thermocouple output voltage to °C/°F with correction of non-linearity.													
* * B * *	CUCON Converts Copper-Constantan thermocouple output voltage to °C/°F with correction of non-linearity.													
<b>Humidity Calculations</b>														
* * B * *	PPDWR Calculates vapor pressure from dew point temperature.													
* * B * *	PPRH Calculates vapor pressure from relative humidity.													
* * B * *	PPBLB Calculates vapor pressure from wet and dry bulb temperatures.													
* * B * *	RHDWP Calculates relative humidity from dew point temperature.													
* * B * *	RHBLB Calculates relative humidity from wet and dry bulb temperatures.													
<b>Data Interpolation</b>														
* * B * *	FRSTU Performs first-order interpolation of uniformly-spaced data.													
* * B * *	SCNDU Performs second-order interpolation of uniformly-spaced data.													
* * B * *	FRSTR Performs first-order interpolation of randomly-spaced data.													
* * B * *	SCNDR Performs second-order interpolation of randomly-spaced data.													

USABILITY					SUBROUTINES AND FUNCTIONS									
F T N 2	F T N 4	B A S I O C	A L G O B L	A S M B										
<b>Statistical Analysis</b>														
* * B * *														
* * B	STATF Calculates mean and standard deviation of fixed array of real data.													
* * B	STATI Calculates mean and standard deviation of fixed array of integer data.													
* * B	HISTF Generates histogram of fixed array of real data.													
* * B	HISTB Generates histogram of fixed array of real data.													
* * B	HISTI Generates histogram of fixed array of integer data.													
* * B	INTLF Initializes for recording of running real data.													
* * B	INTLB Initializes for recording of running real data.													
* * B	INTLI Initializes for recording of running integer data.													
* * B	RCRDF Records running real data.													
* * B	RCRDB Records running real data.													
* * B	RCRDI Records running integer data.													
* * B	REPRT Reports mean and standard deviation and number of data points after recording of running data.													
<b>Code Conversion</b>														
* * B	ASCEB Converts ASCII to EBCDIC.													
* * B	EBCAS Converts EBCDIC to ASCII.													
* * B	ASCBC Converts ASCII to BCD.													
* * B	BCDAS Converts RCD to ASCII.													
<b>Curve Fitting</b>														
* * B	CRVFT Fits user's data to any of six different standard functions.													
<b>Data Integration</b>														
* * B	FAREA Performs numerical integration of a fixed array of data.													
* * B	STRTA Initializes for integration of running data.													
* * B	AREA Computes latest value of running integral.													

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, and 93001).
3. Humidity Package, relocatable and source programs and manual (92402-60001, 80001, and 93001).
4. Statistical Analysis Package, relocatable and source programs and manual (92403-60001, 80001, and 93001).

5. Code Conversion Package, relocatable and source programs and manual (92404-60001, 80001, and 93001).
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, and 93001).

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

Replaces software on punched tape with software on 9162-0061 Mini cartridges (92400-13301) for read-in by 2645A-007 or 2644A CRT Terminal.



## Real-time plotter software library

model 92409A

The 92409A Real-Time Plotter Software is an optional library of routines required with the 12935A Graphic Plotter Subsystem operated in the RTE-M, RTE-II/III, RTE-B, or RTE-C operating system. The routines are summarized in Table 1.

Table 1. 92409A Real-Time Plotter Software Library

USABILITY					SUBROUTINES AND FUNCTIONS
F T N 2	F T N 4	B A S I	A L G O	A S M B	
*	*	*	*	*	AXIS Plots one axis, X or Y, per call.
*	*	*	*	*	PLOT Moves pen, up or down, to the next point.
*	*	*	*	*	LINES Plots line and/or symbols through series of points from X and Y data arrays.
*	*	*	*	*	SYMB Plots characters and/or other symbols.
*	*	*	*	*	NUMB Plots a number, with or without decimal point.
*	*	*	*	*	URITE Moves pen to upper right for paper change.
*	*	*	*	*	LLEFT Sets origin of plot to 0, 0.
*	*	*	*	*	SCALE Scales array of X or Y values to fit graph size.
*	*	*	*	*	SFACT Enters size of paper to be used.
*	*	*	*	*	WHERE Determines current X, Y coordinates of pen.
*	*	*	*	*	PLTLU Enters logical unit number of plotter into system.

## Ordering information

### 92409A Mini cartridge option 020

The 92409A library package consists of:

1. Relocatable Plotter Library on punched tape (92409-60001).
2. 7210 Plotter Library Reference Manual (92409-93001).

### 92409A option 020

Replaces the punched tape library with the same software modules on 9162-0061 HP Minicartridge (92409-13301) for read-in by 2645A-007 or 2644A CRT Terminal interfaced to the computer via the 12966A-001 interface and to the operating system via RTE driver DVR05. This option is not compatible with RTE-B or RTE-C systems, which do not support Mini cartridge I/O.



## RTE drivers package

model 92062A

The 92062A is a set of driver routines that link user's FORTRAN, Real-Time BASIC and 21MX Assembly and HP Assembly language program calls to HP 2108A, 2109A, 2112A, and 2113A Computer system peripheral devices in the RTE-M, RTE-II, or RTE-III 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 specification starting on this page.

### 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 feed options of the 2762B.

**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.

Driver name	Peripherals supported	Approx. Memory Required	Punched Tape Part Nos.	Mini Cartridge Part Nos.	Manual Part Nos.
Character mode multi-device driver DVR00	2762A/B, 2752A/54B, 2640A/B and 3071A Terminals with 12531C/D or 12880A interface and 2748B Tape Reader and 2895B Tape Punch with 12597A interfaces	560 words	29029-60001	92062-13302	29029-95001
Page mode terminal driver DVR05	2640A/B-020, 2644A-020, and 2645A-030 plus 13260B Terminals with 12966A-001 interface and 13246A/B or 13349A auxiliary printer subsystems for the 2645A-007, 030 with 13260B, 2645A-030 with 13260B and 13261A, or 2644A-020 Terminal	900 words 1450 words (Note A)	92001-16028 92001-16027		92001-90015
Graphic plotter driver DVR10	7210A Graphic Plotter with 17210A interface	200 words 1000 words	72009-60001 72008-60001		17210-90004
CalComp plotter driver DVR10 and graphics library	563/565 CalComp Plotter connected to system via HP 12560A interface	1850 words including library	20808-60001 20810-60001		12560-90023
Data entry terminal driver DVA47	Up to 56 HP 3070A data entry Terminals and 40280A interface	1300 words 1500 words (Note B)	92900-16002 92900-16003		92900-90005
CR driver DVR11	2892B Card Reader with 12924A interface	550 words	29030-60001	92062-13303	09600-93010
Line printer driver DVA12	2607A, 2610A, 2613A, 2617A, and 2618A Line Printers with 12845B interface	350 words	92001-16020		92200-93001
LP driver DVR12	9866A Printer with 1266B-004 interface or 12984A Line Printer S/S	480 words	29028-60002		92001-90010
TV interface driver DVA13, library, and verification	91200B TV Monitor Interface card	250 words 1100 words	91200-16001 91200-16002 91200-16004		91200-90005
OMR driver DVR15	7261A Optical Mark Reader with 17200-60001 interface	600 words	09601-16021	92062-13304	07261-90010
9-track MTU driver DVR23	Up to four 7970B/E 9-Track Mag Tape Units with 13181A/13183A interface	450 words	92202-16001		92202-93003
HP-IB interface driver DVR37 and utility library	59310B Hewlett-Packard Interface Bus (HP-IB) interface	1000 words 1200 words (Note C)	59310-16002 59310-16003 59310-16004		59310-90063
Flexible disc driver DVR33	12732A Flexible Disc Subsystem, with up to three additional 12733A Disc Drives	575 words	12732-16001		12732-90001
7-track MTU driver DVR24 (Note D)	Up to four 7970B 7-Track Mag Tape Units with 13182A interface	700 words	25117-60499	92062-13305 (Note D)	25117-93003
F-H disc driver DVR30 (Note D)	2770 series Fixed-Head Disc/Drum Memories	275 words	20747-60001		
M-H disc driver DVR31 (Note D)	Up to four 7900A Disc Drives with 13210A interface	665 words	29013-60001		
M-H disc driver DVR32 (Note D)	Up to eight 7905A and/or 7920A Disc Drives with 13037B Disc Controller and 13175A interface	900 words	92060-16031		

Note A: Smaller DVR05 supports keyboard-display; larger DVR05 also supports the Mini cartridge transport in the 2645A-007 or 2644A Terminal and 13246A/B or 13349A auxiliary printer subsystem.

Note B: Smaller DVA47 supports operation in RTE system without dynamic mapping; larger DVA47 is required in RTE-M/II or RTE-III system.

Note C: Smaller DVR37 does not provide SRQ (Service Request) interrupt capability; larger driver provides SRQ.

Note D: These drivers are not provided with the RTE-M real-time executive system.

## **Page mode terminal driver DVR05**

### **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-007 or 2644A).
5. Write to/read from Mini cartridge tape unit 1 or 2 (2645A-007 or 2644A).
6. Print output on 13246A or 13349A Subsystem (requires 2645A-007, 2645A with 13261A, or 2644A-020).
7. Bidirectional control of printwheel carrier on 9871A-122 Printer.

**Capabilities not supported.** Modem operation and plotting or reverse linefeed on 9871A-122 Printer.

**Character set.** DVR05 passes the extended character sets and display enhancements of the 2640 series CRT Terminals, but these are not recognized by the operating system or program processing software. Only upper case ASCII characters are usable in operating system, file manager, or editor commands, or in program statement names and labels.

## **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 and 7-track mag tape unit drivers DVR23 and DVR24**

### **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 3070A data entry Terminals.
2. Display output to any of 15 prompt signal lights on any of up to 56 HP 3070A data entry Terminals.

## **Ordering information**

The 92062A RTE Drivers Package as listed in the table on the previous page is furnished with the 92001B RTE-II or 92060B RTE-III operating system with software on punched tape if 92001B or 92060B option 010 is ordered, on Mini cartridges 92062-13302 through 13305 if 92001B or 92060B option 020 is ordered, or on 12869A (7900A) or 12940A (7905A) disc cartridge if 92001B or 92060B option 030 or 031 is ordered.

Mini cartridges 92062-13302 through 13304 and corresponding manuals are furnished with the 92064A RTE-M operating system.



## RTE measurement and control software package

model 92066A

The 92066A Package contains drivers, device subroutines, and on-line verifications that support the measurement and control subsystems which are compatible with HP 2108A,

2109A, 2112A, 2113A Computers. It also includes the ISA FORTRAN Extension Package. The software and manuals provided are summarized in the table below.

Software Items	Approximate Memory Req'd	Software Part No.	Manual Part No.	Instruments and Functions Supported
Driver DVR62 for RTE-II	2,100 bytes	29009-60001	Software information is in manual furnished with subsystem	2313B Analog I/O Subsystem and 12764A and 12765A Extenders (including operation in 9603R or 9611R-100 Remote Measurement and Control Station) and 91000A Plug-in Analog-to-Digital Interface card.
Driver DVR62 for RTE-III	2,500 bytes	02313-16001		DVR62 and R2313 support single-channel, sequential, or random-scan measurement of specified analog input channels in 2313B or 91000A, pacer control optional in 2313B. These routines also support setting and reading the gain of 2313B low-level multiplexer channels.
Device subroutine R2313	1,680 bytes	29011-60001		
On-line verification	15,200 bytes	02313-16002		
Device subroutine P2313	330 bytes	29011-60002		2313B Analog I/O Subsystem and 12764A and 12765A Extenders only (including operation in 9603R or 9611R-100 Remote Measurement and Control Station).
Device subroutine D2313	830 bytes	29011-60004		P2313 supports setting of pace rate and starting and stopping of programmable pacer.
				D2313 supports output of one or more digital values in analog form from one or more DAC output channels, pacer control optional.
Driver DVA72	3,250 bytes	09611-16005	29100-93003	91063A Digital I/O Subsystem and 91140A Extenders (including operation in 9603R-T19 or 9611R Remote Measurement and Control Station).
On-line verification	8,000 bytes	09611-16006	09611-90010	DVR72 supports exec calls to read a specified number of digital input words from one or more specified digital input card channels and exec calls to write a specified number of digital output words to one or more specified digital or DAC card output channels.
92413A ISA FORTRAN Extension Package:			09610-93003	2313B and 91000A Analog I/O Subsystems and 91063A Digital I/O Subsystem, including use of the 2313B and 91063A in 9603R and 9611R Remote Measurement and Control Stations and including 12764A, 12765A, and 91140A Extenders.
On-line Table Generator	10,200 bytes	92413-12001		Generates linkage table connecting user's ISA FORTRAN format program calls to appropriate driver and/or executive subroutines.
Off-Line Table Generator	13,400 bytes	92413-16011		
TRPNT Routine	110 bytes	92413-16006		Dummy routine required if BASIC is not in system.
Event Sense Interrupt Program	1,050 bytes	92413-16007		Determines which event sense/interrupt card in the 91063A Digital I/O Subsystem has issued an interrupt.
Event Sense Routine	1,100 bytes	92413-16008		Sets up or disconnects a linkage between a given event and a program.
Stall Program	250 bytes	92413-16009		Repeatedly resets timer card in 91063A Digital I/O Subsystem before it times out; failure of the system, but not the digital I/O subsystem triggers a stall alarm connected to the timer card when it times out because it has not been reset.
ISA FORTRAN Library	6,000 bytes	92413-16010		Provides the additional routines and program calls to driver that are summarized in Table 1 on next page.

Table 1. ISA FORTRAN Extension Package

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 L										
<b>Executive Interface Routines</b>														
* * * B * * * * * * START Starts a program immediately, or after a specified time delay.														
* * * B * * * * * * TRNON Starts a program at a specified time.														
* * * B * * * * * * WAIT Suspends execution of a program for a specified interval.														
<b>Analog Input using 2313B Analog I/O Subsystem</b>														
* * * * * AISQ Requests analog input from a series of sequential channels; AISQW adds wait for completion.														
* * * * * AIRD Requests analog input from a series of channels in arbitrary order; AIRDW adds wait for completion.														
* * * B * * * * * * AISQF Requests analog input from a series of sequential channels with wait for completion and output in real instead of integer form.														
* * * B * * * * * * AIRDF Requests analog input from series of channels in arbitrary order with wait for completion and output in real instead of integer form.														
<b>Analog Output using 2313B Analog I/O Subsystem or 91063A Digital I/O Subsystem</b>														
* * * * * AO Requests analog output of integer data to specified analog output channels; AOW adds wait for completion.														
* * * B * * * * * * AOF Requests analog output of real data with wait for completion.														
<b>Digital Input/Output using 91063A Digital I/O Subsystem</b>														
* * * B * * * * * * DI Requests input of specified number of digital words written into specified array via designated array of digital I/O channels; DIW adds wait for completion.														
* * * * * DOM Requests output of a specified number of digital words, read out of a specified array via a designated array of digital I/O channels, with output set for a specified time; DOMW adds wait for completion.														
* * * B * * * * * * DOL Requests output of a specified number of digital words, read out of a specified array via a designated array of digital I/O channels, with output set until it is changed; DOLW adds wait for completion.														
<b>Bit Manipulation</b>														
* * * B * * * * * * IEOR Requests Exclusive OR of two integers.														
* * * B * * * * * * ISHFT Shifts a digital word a specified number of bit positions left or right.														

Table 1, Continued

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 L										
<b>Event Sense</b>														
* * * * * EVSNS Establishes or removes a linkage between a given event and a program.														
<b>Auxiliary Analog I/O Subsystem Routines</b>														
* * * * * NORM Initializes the 2313B Analog I/O Subsystem.														
* * * * * SGAIN Sets gain of low-level multiplexer channels.														
* * * * * RGAIN Reads gain of low-level multiplexer channels.														
* * * * * PACER Sets subsystem pace rate.														
<b>Special Digital I/O Subsystem Functions</b>														
* * * * * FREQ Measures frequency using digital I/O timer and pulse counter plug-in cards.														
* * * * * PSET Presets pulse counter to specified count and sets up interrupt when counter has counted down the preset number of pulses; the interrupt can event-schedule a program through the EVSNS routine.														
* * * * * STEP Advances a stepper motor "N" steps clockwise or counterclockwise, using the stepping motor control card; STEPW adds wait for completion.														
<b>Stall Alarm Program</b>														
* * * * * STALL Prevents issuance of an alarm contact closure while the system continues to reschedule it, resetting a programmable timer card in the digital I/O subsystem. The digital I/O subsystem must also continue to function.														

B Identifies routine in Real-Time BASIC library similar to the routine listed here as part of 92413A ISA FORTRAN Extension Package.

## Ordering information

### 92066A RTE measurement and control software package (Software on punched tape)

The 92066A package consists of the software modules (on punched tape) and manuals that are listed in the table on the previous page.

### 92066A Mini cartridge option 020

Option 020 replaces software modules on punched tape with the following 9162-0061 Mini cartridges for read-in by 2645A-007 or 2644A CRT Terminal:

- Driver and device subroutine Mini cartridge (92066-13301), including software modules 29009-60001, 02313-16001 and 16002, 29011-60001, 60002 and 60004, and 09611-16005, 16006, 16007, and 16015.
- ISA Fortran Extension Package Mini cartridge (92413-13301), including all ISA Fortran Extension Package modules listed in the table on the previous page.

# Networking software overview

It is rapidly becoming apparent that the usefulness of most computer systems will, in large part, be judged by their ability to function, in a coordinated fashion, in computer networks, with operations at each system benefitting from the particular strengths of the other systems in the network. Today, Hewlett-Packard distributed systems packages offer a complete capability for integrating instrumentation and operations management functions in a resource-sharing network. HP distributed systems network packages are now proving themselves in over 150 installations throughout the world.

## HP distributed systems

As shown in the diagram on page 3-2, HP distributed systems packages for HP 1000 Computer Systems and 21MX Computers include the following capabilities:

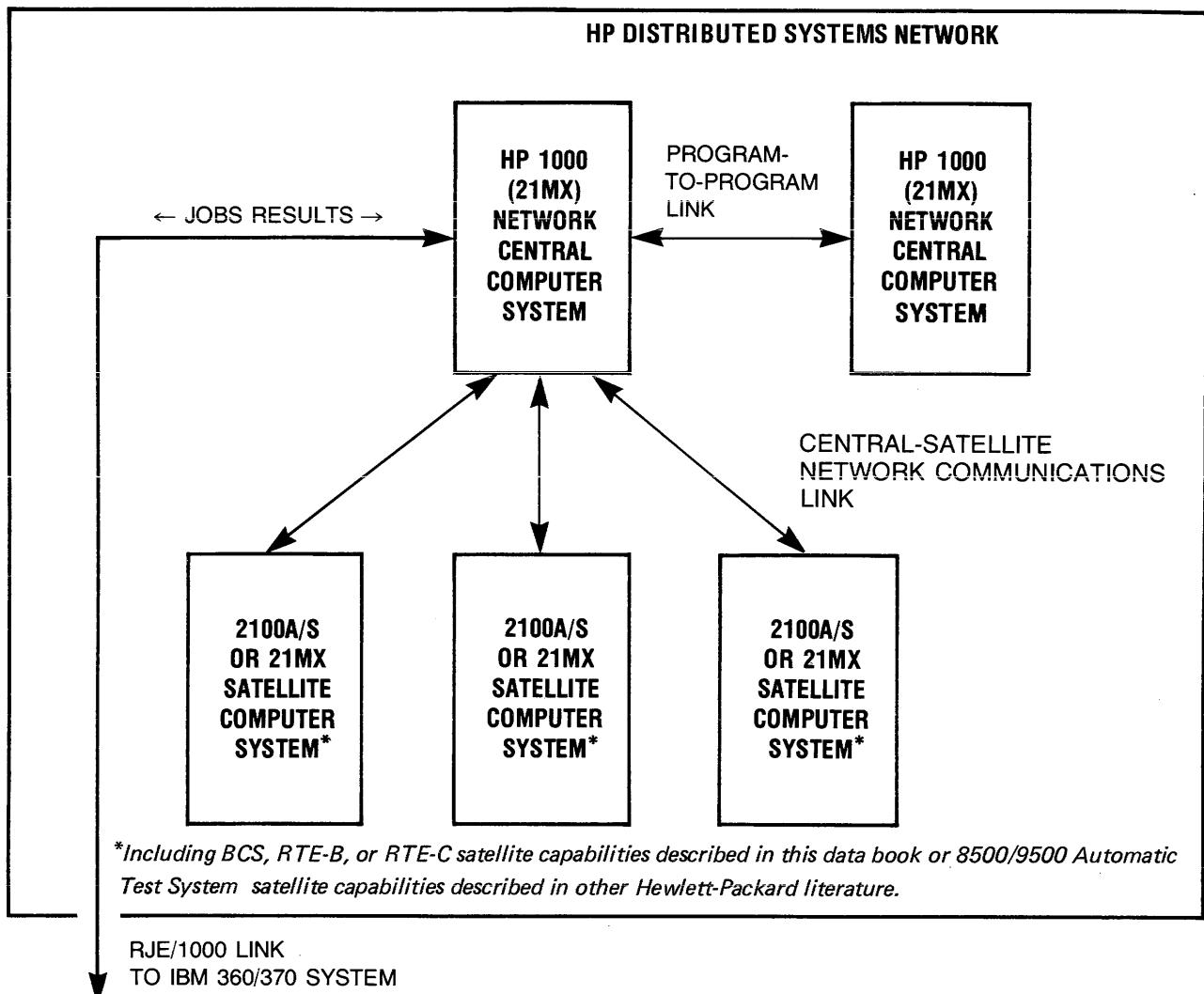
1. HP 1000 or 21MX Network Central Computer Systems managed by the RTE-III (or RTE-II) operating system can exchange data via hardwire or modem links. Program-to-program communication between these systems is accomplished as easily and transparently as if all programs were in the same system, using Network Central Communications Packages in both systems, which include the appropriate data communications interfaces.
2. More extensive network communications support for memory-based network satellite computer systems. Via hardwired or modem links, a Network Central System can communicate with 21MX (or 2100A/S) Network Satellite Computer Systems managed by BCS, RTE-B, and/or RTE-C operating systems, providing the following capabilities:

- Program-to-program communication between network central systems and satellite systems.
- Centralized data collection, storage, and retrieval, using Remote File Access calls from the satellite computer systems.
- Satellite-to-central and central-to-satellite remote task scheduling.
- Remote I/O resource sharing allows satellites to print reports on a central line printer, read in data from a central card reader, and execute many other central I/O functions, or vice versa.
- Centralized, disc-based generation of new satellite system configurations and remote down-loading to the satellite.
- Centralized, disc-based program development and program down-loading to the satellite.
- Remote operator requests.

The central-to-satellite links use the Network Central Communications Package in the central and Satellite Communications Packages in the BCS, RTE-B, or RTE-C based 21MX (or 2100A/S) Computer Systems. The network central also supports 8500/9500 Automatic Test System satellite capabilities described in other HP literature.

## RJE/1000

Remote job entry to IBM 360/370 systems from HP 1000 or 21MX Computer Systems managed by the RTE-III, RTE-II, or RTE-C operating system or 2100A/S Computer Systems managed by RTE-II or RTE-C is provided by the RJE/1000 communications package. Via synchronous modem and a data communications link, the programs in the HP computer system emulate the IBM 2780 Data Transmission Terminal, passing jobs and processing requests to the IBM system and receiving the completed results.



HP distributed systems network relationships

# Distributed systems communications packages

The 91700 series identifies a group of communications packages that work together to create a distributed systems network of memory-based HP 21MX satellite Computer Systems coordinated and supported by a disc-based HP 1000 or 21MX Computer System functioning as the Network Central System. In addition to the central-satellite relationship, the 91700A package also supports program-to-program communication between HP 1000 or 21MX Network Central Systems.

## Features

- Choice of hardwire or modem communications.
- Satellite system generation at central.
- Satellite program development at central.
- Operating system and/or program down-load to satellites.
- Program-to-program data exchange.
- Remote file access data transfers.
- Network resource sharing by remote I/O.
- Remote task assignment.

## Functional specifications

### Network capabilities

The network capabilities are provided by the communications executive software that is included in the respective communications packages, as summarized below.

#### 91700A network central communications executive

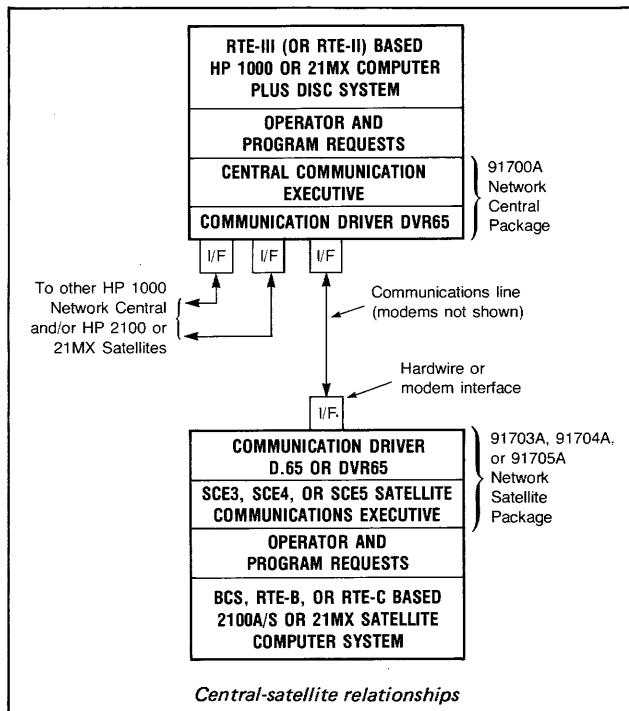
The Network Central Communications Executive supports:

- Program-to-program communication between RTE-III (or RTE-II) based HP 1000 or 21MX Computer Systems when both are equipped with the 91700A Network Central Communications Package. (See program-to-program communication requests in Table 1 on the next page.)
- All capabilities listed for BCS, RTE-B, and RTE-C based network satellite computer systems in Tables 1 and 2 on the next page.

#### Network satellite communications executives

Three Network Satellite Communications Executives are available for BCS, RTE-B, and RTE-C based satellite computer systems. Each of the satellite communications packages includes two loaders, called SCE/1 and SCE/2.

models 91700A, 91703A, 91704A, and 91705A



SCE/1 is a 64 word basic binary loader, which is supplied on punched tape for 2100 A/S Computers and on ROM IC for 21MX Computers. SCE/2 is a loader enhancement which gives the satellite system operator the ability to request program down-loading and execution from the satellite system console.

#### 91703A BCS network satellite communications executive

SCE/3 supports the high-level program and operator requests listed for BCS satellite in Tables 1 and 2.

#### 91704A RTE-B network satellite communications executive

SCE/4 supports the high-level program and operator requests listed for RTE-B satellite in Tables 1 and 2.

#### 91705A RTE-C network satellite communications executive

SCE/5 and operator communications interface REMAC support the high-level program and operator requests listed for RTE-C satellite in Tables 1 and 2.

### Data transfer conditions

Data can be transferred from satellites to central, or vice versa, in two different ways. Transfers can be routed indirectly, via files on the central disc, or directly between programs. Program-to-program data transfers can also be made between network central systems. Data transfers are

*Table 1. Program request capabilities*

Central to/from				
Other Central	BCS Satellite	RTE-B Satellite	RTE-C Satellite	Program Request Capabilities
<b>Program-to-program communication requests</b>				
X	X	X		Open communication between calling master program and slave program in remote central or satellite system.
X	X	X	X	Write data from master program to slave program in remote central or satellite system.
X	X	X	X	In master program, read data from slave program in remote central or satellite system.
X	X	X	X	Send program control information from calling master program to slave program in remote central or satellite system.
X	X	X	X	In slave program, initiate response to request (open, read, write, or close, etc.) from master program in remote central or satellite system.
X	X	X	X	From slave program, return acceptance or rejection of most recent master request to master program in remote central or satellite system.
X	X	X	X	Close program-to-program data transfer operations.
	X			Inhibit BCS satellite's response to operator requests during program-to-program data transfer operations.
X				Check for BCS satellite operator requests received during program-to-program data transfer operations.
X				Restore normal response to BCS satellite operator requests for attention (after completion of program-to-program data transfers).
X				Obtain BCS satellite's logical unit number at central from the central system.
<b>Utility and remote system requests</b>				
X	X			Load program from central into satellite (central can force-load only into RTE-C satellites).
X	X			Schedule or execute program in remote central or satellite system with or without wait.
	X			Issue event interrupt from central to RTE-B satellite system to initiate execution of task subroutine.
X	X	X		Read from input device of remote central or satellite system.
X	X	X		Write on output device of remote central or satellite system.
X	X	X		Request time from real-time clock in remote central or satellite system.
X	X	X		Set execution interval and absolute start time of program in remote central or satellite system.
X	X	X		Requests status and type of I/O device, identified by logical unit number, at remote central or satellite system.
<b>Remote file access requests</b>				
X	X	X		Create named file on the central disc.
X	X	X		Delete file and directory entry from central disc.
X	X	X		Open named file on the central disc prior to access.
X	X	X		Close named file on the central disc after access.
X	X	X		Read one record from named central disc file to user's program buffer in satellite system.
X	X	X		Write one record from user's program buffer in satellite system into named file on central disc.
X	X	X		Direct next read/write to new record earlier or later than the most recently accessed record, in named file on central disc.
X	X	X		Random access to specific record in named file on central disc.
X	X	X		Reset file address to first record in named file on central disc.
X	X	X		Issue control request to central peripheral accessed as type zero file.
X	X	X		Return 125 words of directory from central disc.
X	X	X		Return record pointer location and status of named file on central disc.
X	X	X		Rename specified file on central disc.

*Table 2. Remote operator request capabilities*

Central to/from				
Other Central	BCS Satellite	RTE-B Satellite	RTE-C Satellite	Remote Operator Request Capabilities
X	X	X		Schedule program to run in remote central or satellite system.
2	2	2		Load executable program from central disc file into remote satellite system.
2	2	2		Run program in satellite system.
2	2	2		Load named program from central disc file into satellite system and run it.
2				Run program at specified memory address in BCS satellite system.
	X			Save program currently in RTE-B satellite in a named file on the central disc.
X	X			Terminate execution of program in satellite system.
X	X	X		Send message from local operator at central or satellite system to operator at remote satellite or central system.
X	X	X		Displays time of real-time clock at remote central or satellite system.
	X			Issue event interrupt from central to RTE-B satellite system to initiate execution of task subroutine.
	X			List information from ID segments of programs in RTE-C satellite system at central system.
	X			Removes program from remote RTE-C satellite system without intervention of remote operator.
X	X	X		Create a new named file on the central disc.
X	X	X		Close a named file on the central disc.
X	X	X		Transfer input control to command file on central disc or local input device at central or satellite.
X	X	X		Delete named file from central disc.
X	X	X		List central file directory at satellite system.
X	X	X		Rename file on central disc.
	X			Store from satellite or central input device to file on central disc.
	X			Dump file from central disc to satellite or central output device.
	X			Switch from local control to remote commanding of RTE-C satellite from central or remote commanding of central from RTE-C satellite or return to local control.

*2 = request that is available from SCE2 as well as SCE3, 4, or 5*

### **Computer I/O channels used**

**In central system:** one for each computer interconnection.

**In satellite system:** one channel.

## Hardwire transmission distances and rates

Data transmission rate is determined by cable length, as summarized below.

CABLE LENGTH		LINE SPEEDS	
Metres	Feet		Bits/Second
0 to 180	0 to 600		1 000 000
180 to 360	600 to 1200		500 000
360 to 600	1200 to 2000		250 000
600 to 900	2000 to 3000		125 000
900 to 1200	3000 to 4000		250 000*
1200 to 1600	4000 to 5400		125 000
1600 to 2200	5400 to 7300		62 500
2200 to 3000	7300 to 10000		31 250

*\*For distances to 900 metres (3000 feet), current limiting resistors are in series with the receivers in both data interface cards; these resistors are shorted for lengths greater than 900 metres (3000 feet), giving the increase in line speed shown for the 900 to 1200 metres (3000 to 4000 foot) cable length.*

program language independent, provided that the destination program works with the type of data transmitted. For example, Real-Time BASIC can process real data, but not double real or complex data, as Fortran IV can.

## Modem transmission distances and rates

Transmission distances are limited only by the telephone network. Line speeds, up to 20,000 bits per second, are determined by the choice of line and modem.

## System requirements

**91700A network central package in RTE-III system (preferred configuration).** HP 2108A, 2109A, 2112A, or 2113A Computer with dynamic mapping system and at least 48k words of main memory, 92060A/B RTE-III operating system, dual-channel port controller, 12539C Time Base Generator, 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem, system console, and standard input unit (for program input).

**91700A network central package in RTE-II/BSM system.** HP 2100A/S, 2108A, 2109A, 2112A, or 2113A Computer with 32k words of main memory, memory protect, 92001A/B RTE-II operating system, 92002A batch-spool monitor (included in 92001B), 12539C Time Base Generator, direct memory access, 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem, system console, and standard input unit (for program input).

**91703A BCS network satellite package.** HP 2100A/S, 2105A, 2108A, or 2112A Computer with at least 8k words of main memory, 9640A option A00 or 2085A BCS operating system, and system console and 12925A Punched Tape Reader Subsystem, if desired for local control and program input at the BCS satellite.

**91704A RTE-B network satellite package.** HP 2100A/S, 2105A, 2108A, or 2112A Computer with at least 16k words of main memory, 9640A option A01 or 2300B RTE-B operating system, 12539C Time Base Generator, and system console and 12925A Punched Tape Reader Subsystem, if desired for local control and program input at the RTE-B satellite.

**91705A RTE-C network satellite package.** HP 2100A/S, 2108A, 2109A, or 2112A Computer with at least 16k words of main memory, 9640A option A02 or 2300C RTE-C operating system, 12539C Time Base Generator, memory protect, system console and 12925A Punched Tape Reader Subsystem.

## Computer memory usage (words<sub>10</sub>)

	Resident	R-T Area	B-G Area
CCE in RTE-III	2350* $\Delta$	5120†	8192†
CCE in RTE-II	2350* $\Delta$	3600	6900
SCE/1 basic binary loader	64		
SCE/2 BCS loader	670		
91703B in BCS satellite	3750 $\Delta$		
91704B in RTE-B satellite	3900 $\Delta$		
91705B in RTE-C satellite	4270 $\Delta$		
REMAC in RTE-C satellite	1900		

\* Plus user-defined system buffer area of 700 words or more.

† Even-page partition requirement, rounded up to the next-highest page requirement, including 1024 words required for base page in each RTE-III partition.

$\Delta$  Including data communications driver, and also including IOC in BCS system.

## Ordering information

### 91700A network central communications package

The 91700A network central package, consists of the following items (**all software on punched tape**):

1. Diagnostics for hardwire and modem data communication interfaces (29005-60001 and 29024-60001) and SCE 1, exchange boot loader, and SCE 2 (91700-16160, 16161, and 16162).
2. Satellite system generator (91700-12100), operator communication interface (91700-16102), and upline and listen routines (91700-16107 and 16109).
3. Command and request libraries (91700-12101 and 12102), driver DVR65 (91700-16100) and the other modules that make up CCE (91700-16101, 16103 through 16106, 16124 through 16130, 16149, 16153, 16154, 16157, and 16159).
4. CCE programming and operating manual (91700-93001).
5. 91700A software numbering catalog (91700-93005).
6. Hardwire interface card (12665-60001).
7. Hardwire interface cable with male connector (12665-60002).
8. Diagnostic hood (12665-60002).
9. Interface manual (12665-90001).

### 91700A options

- 001: Replaces items 6 through 9 of standard 91700A package, listed above, with the following:
  1. Modem interface (12773-60001).
  2. Modem interface cable (12773-60002).
  3. Diagnostic hood (12773-60003).
  4. Interface manual (12773-90001).
- 002: Replaces item 7 of standard 91700A package, listed above, with Hardwire interface cable with female connector (12665-60003) for central-to-central connection.
- 020: **Software on Mini cartridges;** replaces software modules listed in items 1 through 3 of the standard 91700A, above, with the same modules on corresponding 9162-0061 Mini cartridges 91700-13301, 13302, and 13303, for read-in via 2645A-007 or 2644A CRT Terminal.
- 100: Deletes items 1 through 5 of standard 91700A, above, to provide interface card only, for additional satellite communication channels.

### 91703A BCS satellite communications package

The 91703A satellite package consists of the following items (**all software on punched tape**):

1. SCE/1 – SCE/2 kit (91700-14002), including SCE/1 and SCE/2 on punched tape, SCE/1 ROM loader, and SCE/1 manual.
2. Diagnostics for the hardwire and modem data communications interfaces (29005-60001 and 29024-60001).

3. Driver D.65 (91703-16101) and the other modules that make up SCE/3 (91703-16102 through 16107).
4. SCE/3 programming and operating manual (91703-93001).
5. 91703A software numbering catalog (91703-93003).
6. Two hardwire interface cards (12665-60001).
7. Two interface cables, one male, and other female (12665-60002 and 60003).
8. Two diagnostic hoods (12665-60004).
9. Two interface manuals (12665-90001).

#### **91704A RTE-B satellite communications package**

The 91704A satellite package consists of the following items (**all software on punched tape**):

- 1-2. Same as items 1 and 2 for 91703A package, above.
3. Driver DVR65 (91700-16100) and the various other modules that make up SCE/4 (91704-12100, 12101, 16103, and 16110).
4. SCE/4 programming and operating manual (91704-93001).
5. 91704A software numbering catalog (91704-93003).
- 6-9. Same as items 6 through 9 for 91703A package, above.

#### **91705A RTE-C satellite communications package**

The 91705A satellite package consists of the following items (**all software on punched tape**):

- 1-2. Same as items 1 and 2 for 91703A package, above.
3. Driver DVR65 (91700-16100), operator communications interface (91705-16109), and the various other modules that make up SCE/5 (91705-12100, 12101, 16101, 16102, 16105 through 16108, and 16113).
4. SCE/5 programming and operating manual (91705-93001).
5. 91705A software numbering catalog (91705-93003).
- 6-9. Same as items 6 through 9 for 91703A package, above.

#### **91703A, 91704A, and 91705A options**

**001:** Replaces items 6 through 9 of the standard satellite communications package with:

1. Two modem interface cards (12733-60001).
2. Two modem interface cables (12773-60002).

3. Two diagnostic hoods (12773-60003).
4. Two interface manuals (12773-90001).

*NOTE: Option 020 for the 91703A, 91704A, or 91705A is exclusively for generation and loading of the satellite operating system from the network central system. BCS, RTE-B, and RTE-C do not support Mini cartridge I/O.*

**020:** Software on Mini cartridges for read-in by 2645A-007 or 2644A CRT Terminal; replaces items 1 through 3 of the standard satellite communications package with:

1. Hardwire and modem diagnostics, SCE/1, SCE/2, and exchange boot loader on 9162-0061 Mini cartridge (91700-13301).
2. SCE/3 Mini cartridge (91703-13301) with 91703A option 020, or SCE/4 Mini cartridge (91704-13301) with 91704A option 020 or SCE/5 Mini cartridge (91705-13301) with 91705A option 020, including all of the software modules listed in item 3 for the respective standard communications package.
3. SCE/1 programming and operating manual (91700-93003).
4. SCE/1 ROM loader.

**100:** One hardwire interface, replaces items 6 through 9 of the standard communications package with:

1. One hardwire interface (12665-60001).
2. One hardwire interface cable with female connector (12665-60003).
3. One diagnostic hood (12665-60004).
4. One interface manual (12665-90001).

**101:** One modem interface; replaces items 6 through 9 of the standard satellite communications package with:

1. One modem interface card (12773-60001).
2. One modem interface cable (12773-60002).
3. One diagnostic hood (12773-60003).
4. One interface manual (12773-90001).

**200:** Deletes items 6 through 9 from the standard satellite communications package to provide software and related manuals only.



# RJE/1000

model 91780A

RJE/1000 is a data communications interface package that equips RTE-III (or RTE-II or RTE-C) based Hewlett-Packard 2100A/S\*, 2108A/12A, or 2109A/13A\* Computer systems for Remote Job Entry (RJE) communication with IBM 360/370 Systems via telephone lines and user-furnished modems.

## Features

- Emulation of IBM 2780.
- Remote Job Entry (RJE) for batched-job communication with IBM 360/370 using IBM Bisync protocol.
- Autoanswer and autoturnaround.
- Line speeds to 9600 bits/sec.
- Operation in disc-based RTE-II/III system using 7900 or 7905 disc.
- Communication with HASP or user application programs using BTAM and TCAM software in the IBM system.
- Choice of ASCII or EBCDIC code.
- Dial-up or private line communication, either half-duplex or full-duplex.
- Choice of transparent or non-transparent mode.
- Choice of timeout or indefinite wait (if using dedicated leased lines).
- Configurable for variable or fixed-length records.
- A wide choice of input, list, and punch-stream devices.

## Functional specifications

### Emulation

RJE/1000 emulates the IBM 2780 Data Transmission Terminal.

### System compatibility

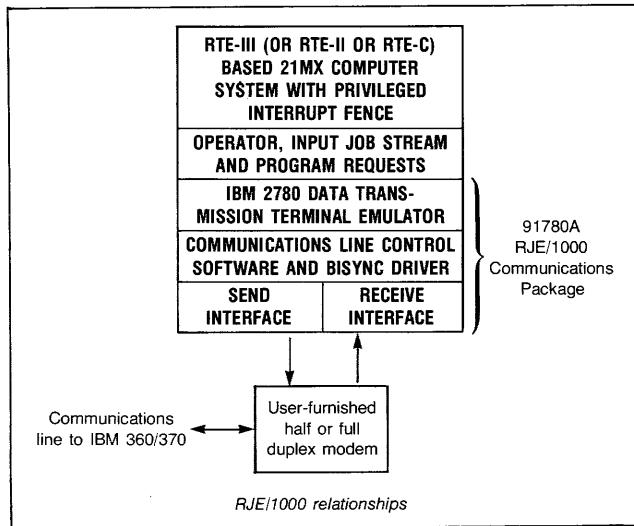
#### Local Hewlett-Packard system

RJE/1000 is compatible with 2100A/S\*, 2108A/12A, or 2109A/13A\* Computers with RTE-III\*, RTE-II/BSM, or RTE-C\* operating system. No other operating system (BCS, RTE-B, etc.) is provided or supported.

\* RTE-III is not compatible with 2100A/S and Hewlett-Packard does not support use of RTE-C on 2109A or 2113A Computers.

#### Remote system

RJE/1000 is compatible with HASP and user application programs using BTAM and TCAM software in the remote IBM 360/370 system. It is also compatible with another RJE/1000 in a remote Hewlett-Packard system. In addition RJE/1000 may be compatible with other host systems or other 2780 emulators, but it is specifically NOT WARRANTED TO FUNCTION WITH ANY HOST OTHER THAN IBM 360/370, WITH HASP, BTAM, OR TCAM OR ANY 2780 EMULATOR OTHER THAN RJE/1000.



### Unsupported 2780 features

RJE/1000 does not support the following IBM 2780 features:

- Terminal identification.
- Multipoint operation.
- Bell operation.

### Connections and modems

RJE/1000 is compatible with the telephone connections and modems listed in Table 1, next page. Regardless of which modem is used, it must meet the following requirements:

1. Synchronous operation.
2. Timing internal to the modem.
3. EIA RS232C or CCITT V.24 compatibility.
4. New Sync is not used.
5. Reverse channel is not used.
6. Unattended answering is optional.
7. Alternate voice should be available for voice coordination.
8. Full-duplex modems may be used to reduce line turnaround time and improve throughput, but half-duplex is the minimum requirement.

### Transmission

#### Data format

The user submits data to RJE/1000 in card and/or printer images for transmission in the same manner as standard tab card and line printer data.

#### Transmission codes

RJE/1000 is configurable for transmission in either ASCII or EBCDIC code.

Table 1. Connections Modems, and Data Rates

Connection Via	Modem Type	Maximum Synchronous Data Rate, half or full-duplex
Switched telephone (Direct Distance Dialing) Network	Bell 201A	2000 bits/sec
	Bell 201C	2400 bits/sec
	Bell 208B	4800 bits/sec, half duplex only
	Non-Bell	4800-9600 bits/sec
Private lines	Bell 201B	2400 bits/sec
	Bell 201C	2400 bits/sec
	Bell 208A	4800 bits/sec
	Bell 209A	9600 bits/sec, half, full, or multiplexed <sup>t</sup>
	Non-Bell	4800-9600 bits/sec

*tMultiplexed modems allow line sharing by terminals as follows: 1 terminal at 7200 bps and 1 terminal at 2400 bps  
2 terminals at 4800 bps or 4 terminals at 2400 bps  
1 terminal at 4800 bps and 2 terminals at 2400 bps*

#### RJE input sources at local HP system

Disc files (in RTE-II/BSM or RTE-III system), Mini cartridge tapes, card readers, punched tape reader, 9-track mag tape units, and keyboard-CRT/printer terminals.

#### RJE output destinations at local HP system

Disc files (in RTE-II/BSM or RTE-III system), Mini cartridge tapes, line printers, 9-track mag tape units, keyboard-printer terminals, and keyboard-CRT terminals.

#### Pre-transmission and post-reception formatting

RJE/1000 does not format binary data files for transparent transmission, nor does it reformat them when they are received. Formatting must be accomplished by user's programs.

#### Distances and data rates

Transmission distance is limited only by the telephone network. Line speeds, up to 9600 bits/sec, are determined by the user's choice of connection and modem, as summarized in Table 1, above.

#### Multi-record transmission

RJE/1000 blocks and transmits multiple records, which improves throughput by avoiding line turnaround at the end of each record.

#### Horizontal format control

An electronic tab function identical to the tab on a typewriter allows deletion of spaces in formatted lines, increasing transmission throughput of meaningful data.

#### Auto turnaround

RJE/1000 automatically switches to receive, without operator intervention, after sending a message, minimizing line time.

#### End of media (optional, configurable)

RJE/1000 indicates the end of a record when variable-length records are sent. This reduces line time because trailing blanks in a record are not sent.

#### Auto answer

RJE/1000 automatically answers an incoming call on a dial-up communication line.

#### RTE priorities and throughput

RJE/1000 uses privileged interrupt, which gives it the highest priority in the system, assuring fast response and

maximizing throughput. However, it is possible to set up another privileged interrupt activity in the system. If set up, that other activity must be assigned a lower priority than RJE/1000 to assure proper functioning of RJE/1000.

#### RJE/1000 control

##### Operator requests

**ON,RJE** schedules RJE/1000 to send or receive data, designating the local source and/or destination(s) by logical unit number of the peripheral device(s) involved, or by file name(s) in a previously-prepared configuration file.

**#M** in RTEII/BSM or RTE-III environment provides for on-line configuration or reconfiguration of RJE/1000 prior to start of communications activity.

**\*BR,RJE** (or **ON,#INRP** for non-BSM version) interrupts data stream being received from remote IBM 360/370 system, permitting insertion of HASP commands or other data into the input stream, using the system console.

**ctrl-D** terminates the insertion of data, permitting continuation of the original processing.

**OF,RJE** terminates line activity to get line out of data mode in **#D** or **#T** input stream request.

##### Program request

**EXEC9,10,23, or 24,RJE** sets up a data transfer to/from remote IBM 360/370 system, with choice of local dialing or answering. Provides for specifying the input device or file and the print and punch output device or file, using logical unit numbers or a configuration file containing the names of source and destination files.

##### Input stream requests

**#E** gives automatic line turnaround with approximate 20-second listen time (configurable).

**#R** gives automatic line turnaround with approximate 60-second listen time (configurable).

**#W** provides automatic line turnaround with continual listening to the line. This feature is for leased-line operations where dial-up line charges are not a factor. The continual wait interval can be interrupted with the **\*BR,RJE** or **\*ON,#INRP** operator interrupt command.

**#D** causes transmission of disconnect sequence.

**#I** causes temporary substitution of system console as source of input data stream.

**#C,xx** changes source and/or destination of input, print, and punch streams. Automatically creates specified files for list and punch streams if they do not already exist.

**#T,xx** switches RJE/1000 to transparency mode for input from the current input stream device with automatic transfer to logical unit number xx or file with name xx following detection of end-of-file for the current data stream. It also provides for reconfiguration of the list and punch streams as in the **#C,xx** request.

#### System requirements

##### In RTE-C environment

HP 2100A/S, 2108A, or 2112A Computer\* with at least 16k words of main memory, 2300C RTE-C operating system, system console, standard input unit (for program input), and 12620A interface for privileged interrupt control.

### In RTE-II/BSM environment

HP 2100A/S, 2108A, 2109A, 2112A, or 2113A Computer\* with at least 32k words of main memory, 92001A/B RTE-II operating system, 92002A Batch-Spool Monitor (BSM – included in 92001B), direct memory access, 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem, system console, standard input unit (for program input), and 12620A interface for privileged interrupt control.

### In RTE-III environment

HP 2108A, 2109A, 2112A, or 2113A Computer\* with at least 48k words of main memory and dynamic mapping system, 92060A/B RTE-III operating system, dual channel port controller, 12960A (4.9M byte) or 12962A/B/C/D (14.7M byte) Cartridge Disc Subsystem, system console, standard input unit (for program input), and 12620A interface for privileged interrupt control.

\*The computer also requires time base generator and memory protect.

### Computer I/O channels used

Three, one each for send, receive, and privileged interrupt control.

### Computer memory usage (words<sub>10</sub>)

	Resident	B-G Area	S/S Global Area
RTE-II/BSM config. #1	410	6583*	---
RTE-II/BSM config. #2	2330	4662*	---
RTE-III config. #3	410	7607*†	---
RTE-III config. #4	410	4963*†	2644
RTE-C	4922		

\*Including FMP and library subroutines.

†Including 1024 words for partitions's base page in RTE-III.

Config. #1 minimizes the amount of resident memory used.

Config. #2 provides maximum flexibility in use of memory, since partition required for RJE/1000 can also be used for other programs.

Config. #3 minimizes the amount of system memory that must be mapped into all partitions, but does not allow swapping in the partition when RJE/1000 is running.

Config. #4 provides faster execution for RJE/1000, allows swapping, and minimizes the amount of system memory that must be mapped into other partitions.

## Power requirements

### Computer interface current required

2.8A (+5V), 0.095A (+12V), 0.07A (-12V), 0.23A (-2V).

## Customer's responsibilities

The customer is responsible for integrating RJE/1000 with the IBM 360/370. To confirm beforehand that such integration is practical, the customer, prior to purchase, must provide the responsible Hewlett-Packard system engineer with accurate information on the following:

1. IBM Computer type to be interfaced.
2. Operating system and telecommunication language used (HASP, BTAM, TCAM, etc.).
3. Whether end of media is required.
4. What pad characters are required.
5. Modem and network type (customer must have modems installed prior to installation of RJE/1000).
6. Transmission code used (ASCII or EBCDIC).

7. Baud rate of the IBM modem and telephone line connection.
8. Any other pertinent data that will help HP complete a successful RJE/1000 installation for the customer.

## Ordering information

### 91780A RJE/1000 communications package

RJE/1000 consists of:

1. Synchronous communications interface cards, receive (12621-60001) and send (12622-60001).
2. Test connector assemblies, receive (12621-60005) and send (12622-60006).
3. Branched cable assembly (12618-60001).
4. Diagnostics manuals (12621-90008 and 12622-90008).
5. 12618A interface operation and service manual (12618-90001).
6. 12621A and 12622A interface manuals (12621-90001 and 12622A-90001).
7. RJE/1000 programmer's guide (91780-93001).
8. RJE/1000 software numbering catalog (91780-93004).
9. Interface diagnostic routines (12621-16001 and 12622-16001) on punched tape.
10. The following software modules on punched tape.
  - a. #RDT5 device emulators: 91780-16001 for use with File Manager Program (FMP) in RTE-II/III systems and 91780-16002 for use in RTE-C system or without FMP in RTE-II/III system.
  - b. #COMN bisync timeout values and data buffers module (91780-16003).
  - c. #DIAL manual dialing program (91780-16004).
  - d. DVR50 system-resident bisync driver front-end (91780-16005).
  - e. #BSC bisync driver (91780-16006).
  - f. #INXT operator interrupt library program for RTE-C or non-FMP use (91780-16007).
  - g. #INRP operator interrupt program for RTE-C or non-FMP use (91780-16008).

## Options

- 020 Replaces the paper tape software modules listed under item 10, above, with software on one 9162-0061 HP Mini cartridge (91780-13301) for reading by 2645A-007 or 2644A CRT Terminal interfaced to the computer via the 12966A-001 interface and to the operating system via RTE driver DVR05.  
**This option is not compatible with RTE-C, which does support DVR05.**
- 100 Deletes items 1 through 6 and 9, above to provide only communications software and manuals for the customer who already has the 12618A (12621A and 16222A) interface kit.

## Additional equipment required for operation

1. 12620A breadboard interface, used for privileged interrupt control.
2. IBM 360/370 with HASP, BTAM, or TCAM and suitable telephone and modem communications link.



## 21MX computer series diagnostics

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

HP 24396 diagnostic library products enable 21MX computer users to load a diagnostic or control program into memory from any one of seven different input devices. These include paper tape, cartridge discs for HP 7900 or 7905, magnetic tapes for HP 7970B or 7970E, and cartridge tapes for 2644A or 2645A.

### Features

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

The following diagnostics are available:

**24396A CPU and memory diagnostics on paper tape**—Consists of four boxes of paper tape and one binder of manuals. The first paper tape is the diagnostic configurator, and the remaining three contain 16 HP 2100 Series CPU and memory diagnostics. The configurator manual and manuals for the 16 diagnostics are supplied in one binder.

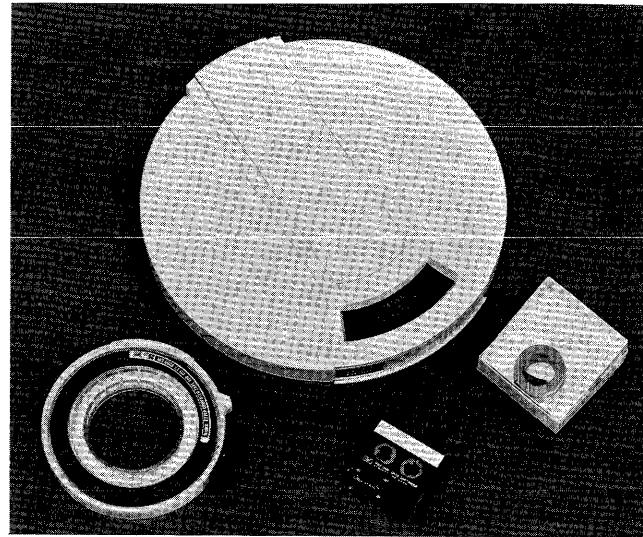
**\*24396B diagnostic library on HP 7900A or 7901A cartridge disc drive**—Consists of an HP 7900 cartridge disc.

**\*24396C diagnostic library on HP 7905A cartridge disc drive**—Consists of an HP 7905 cartridge disc.

**\*24396D diagnostic library on HP 7970B magnetic tape unit**—Consists of an 800 CPI, NRZ nine-track magnetic tape, with NRZI recording mode compatible with HP 7970B magnetic tape drives.

**\*24396E diagnostic library on HP 7970E magnetic tape unit**—Consists of a 1600 CPI, NRZ nine-track magnetic tape, phase encoded, with recording mode compatible with HP 7970E magnetic tape drives.

**\*24396F diagnostic library on HP 2644A/2645A minicartridges**—Consists of ten HP 2644A/2645A cartridge tapes. Each has the diagnostic configurator as the first file, followed by the diagnostics specified in the attached chart.



### Functional specifications

**24396A**—The 24396A Diagnostic Paper Tapes meet all environmental, format, and physical media specifications for HP 2748A/B, 2758A, and HP 2737A/B paper tape readers.

**Shipping weight:** 4.1 Kg (9 lbs)

**24396B**—The 24396B Diagnostic Disc Cartridge meets all environmental, electrical, physical, and format specifications for HP 7900A and HP 7901A cartridge disc drives.

**Shipping weight:** 13.1 Kg (29 lbs)

**24396C**—The 24396C Diagnostic Disc Cartridge meets all environmental, electrical, physical, and format specifications for HP 7905A cartridge disc drives.

**Shipping weight:** 13.1 Kg (29 lbs)

**24396D**—The 24396D Diagnostic Magnetic Tape meets all environmental, electrical, physical and format specifications for HP 7970B 800 CPI magnetic tape units.

**Shipping weight:** 10.4 Kg (23 lbs)

**24396E**—The 24396E Diagnostic Magnetic Tape meets all environmental, electrical, physical, and format specifications for HP 7970E 1600 CPI phase encoded magnetic tape units.

**Shipping weight:** 10.4 Kg (23 lbs)

**24396F**—The 24396F Diagnostic Cartridge Tapes meet all environmental, electrical, physical, and format specifications for HP 2644A/2645A mini data station cartridge units.

\* Each has 2100 Series Diagnostic Control programs plus a complete set of the associated manuals in four binders.

## Configuration information

**CPU required:** HP 21MX or 2100A/S

**CPU options required:** As specified by the diagnostic to be executed

**Memory required:** 4k minimum, except as noted in "Software and Documentation Supplied" chart

### Prerequisites:

- 24396A: 2748A/B, 2758A, or 2737A/B paper tape readers; 2752A or 2754A teletype, and 21MX or 2100A/S computers.
- 24396B: 7900A or 7901A cartridge disc drive, 12992A disc loader ROM, DCPC, and 21MX computer
- 24396C: 7905A cartridge disc drive, 12992B disc loader ROM, DCPC, and 21MX computer
- 24396D: 7970B magnetic tape unit, 12992D tape loader ROM, DCPC, and 21MX computer
- 24396E: 7970E magnetic tape unit, 12992D tape loader ROM, DCPC, and 21MX computer
- 24396F: 2644A/2645A mini data station, 21MX 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 require 21MX loader ROM's for proper operation.

## Product support

### Installation

The 24396A, B, C, D, E, and F are customer installed products. Hewlett-Packard will provide installation services on a time and materials cost basis. Customers desiring this installation service should contact their local Hewlett-Packard sales office.

### Warranty

HP products are warranted against defects in materials and workmanship for 90 days following date of delivery. HP will repair or replace products which prove to be defective during the warranty period. Necessary travel within countries where HP has specified availability of Computer Systems Products will be provided at no charge during the warranty period, to locations regularly served by public transportation.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED.  
HP IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

## Ordering information

### Software and documentation supplied

—see attached chart—

### Multiple file diagnostics:

24396A	Diagnostics on paper tape
24396B	Diagnostics on 7900A disc cartridge
24396C	Diagnostics on 7905A disc cartridge
24396D	Diagnostics on 7970B magnetic tape (800 CPI)
24396E	Diagnostics on 7970E magnetic tape (1600 CPI;PE)
24396F	Diagnostics on 2644A/2645A cartridge tape

### Individual cartridges:

Any of the individual 2644A or 2645A cartridges may be ordered using the part numbers shown in the software supplied section of this data sheet. Manuals for these may be ordered using the manual part numbers shown in the same chart. 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 software supplied section of this data sheet. Manuals for these may be ordered using the manual part numbers shown in the same chart. 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.

DESCRIPTION	REQ MEM SIZE	SINGLE FILE BINARY TAPE	MANUAL	24396A PAPER TAPE	24396B 7900A DISC	24396C 7905A DISC	24396D 800 CPI TAPE	24396E 1600 CPI TAPE	24396F 2644/45 CARTRIDGE TAPE	MANUAL VOLUME
DIAGNOSTIC CONFIGURATOR	4K	24296-60001	02100-90157	24296-60001	24396-13001	24396-13101	24396-13501	24396-13601	24396-13301	14396-14001
MEMORY REFERENCE INSTRUCTION GROUP	4K	24315-16001	02100-90218	24396-12001						
ALTER SKIP INSTRUCTION GROUP	4K	24316-16001	02100-90211							
SHIFT ROTATE INSTRUCTION GROUP	4K	24317-16001	02100-90212							
CORE MEMORY (2100/16/15/14)	4K	24323-16001	02100-90219							
SEMICONDUCTOR MEMORY (21MX)	4K	24395-16001	24395-90001	24396-12001						
EAU INSTRUCTION GROUP	4K	24319-16001	02100-90214	24396-12002						
FLOATING POINT INSTRUCTION GROUP	4K	24320-16001	24320-90001							
MEMORY PROTECT (2114/15/16)	4K	24324-16001	02100-90220							
MEMORY PARITY CHECK (2114/15/16)	4K	24325-16001	02100-90221							
MEMORY PROTECT/PARITY ERROR (2100/21MX)	4K	12892-16001	12892-90005	24396-12002						
POWER FAIL AUTO RESTART	4K	24321-16001	02100-90216	24396-12003						
INPUT OUTPUT INSTRUCITON GROUP	4K	24318-16001	02100-90213							
GENERAL PURPOSE REGISTER	4K	24391-16001	24391-90001							
DIRECT MEMORY ACCESS (2114/15/16)	4K	24322-16001	02100-90217							
DIRECT MEMORY ACCESS (2100/21MX)	4K	24322-16002	24322-90002	24396-12003						
EXT. INSTR. GROUP (INDEX)	4K	12943-16002	12943-90001							
EXT. INSTR. GROUP (WORD,BYTE,BIT)	4K	12943-16001	12943-90001						24396-13302	24396-14002
2100 FAST FORTRAN PACKAGE	4K	12907-16003	12907-90003							
21MX FAST FORTRAN PACKAGE 1	4K	12977-16004	12977-90002							
21MX FAST FORTRAN PACKAGE 2	4K	12977-16005	12977-90002							
2900 ACCESS COM PROCESSOR F. 2100	8K	13206-15001	13207-90003							
2000 ACCESS COM PROCESSOR F. 21MX	8K	13207-16001	13207-90003							
MICROCODED SEMICONDUCTOR MEMORY	4K	24395-16002	24395-90002							
MEMORY EXPANSION UNIT	16K	12929-16001	12929-90003							
TIME BASE GENERATOR	4K	12539-16001	12539-90011							
12979 I/O CHANNEL OR EXTENDER	4K	12979-16001	12979-90010						24396-13303	
12936 PRIVILEGED INTERRUPT	4K	12936-16001	12936-90003							
12908/12978 WCS 256W.	4K	12908-16001	12908-90013							
13197 WCS 1K WORD	4K	13197-16002	13197-90002							
12889 HARDWIRED SERIAL INTERFACE	4K	24335-16001	02100-90169							
59310 INTERF. BUS INTERFACE	4K	59310-16001	59310-90061						24396-13303	24396-14002
12587 ASYN. DATA SET INTERFACE	8K	12587-16001	12587-90013							
12920 ASYN. MULTIPLEXER (DATA)	4K	12920-16001	12920-90009						24396-13304	24396-14003
12920 ASYN. MULTIPLEXER (CNTL)	4K	12920-16002	12920-90009							
12621 SYNC. DATA SET (RECEIVE)	4K	12621-16001	12621-90008							
12622 SYNC. DATA SET (SEND)	4K	12622-16001	12622-90008							
12967 SYNC. INTERFACE	4K	12967-16001	12967-90001							
12966 ASYN. DATA SET	8K	12966-16001	12966-90004							
12968 ASYN. COM. INTERFACE	4K	12968-16001	12968-90003							
2600 KEYBOARD DISPLAY TERMINAL	4K	24200-16002	24200-90002							
TELEPRINTER	4K	12531-16001	12531-90042						24396-13305	
2762A/B TERMINAL (TERMINET)	8K	02762-16001	02762-90035							
2615 VIDEO TERMINAL	4K	24351-16001	02615-90002						24396-13305	
2640 INTERACTIVE TERMINAL	8K	02640-16001	02640-90020						24396-13306	
2644 MINI DATA STATION (NON CTU)	8K	02644-16001	02644-90012							
2644 MINI DATA STATION (CTU ONLY)	8K	02644-16002	02644-90012							
92900A TERMINAL SUBSYSTEM (3070, 40280)	4K	92900-16001	92900-90003							
2610/14 LINE PRINTER	4K	24366-16001	24366-90001						24396-13307	24396-14004
2767 LINE PRINTER	4K	12984-16001	12984-90005							
2607 LINE PRINTER	4K	24340-16001	12987-90004							
2613/17/18 LINE PRINTER	4K	02618-16001	02618-90006							
9866 LINE PRINTER	4K	12996-16001	12996-90001							
9-TRACK MAG TAPE (7970, 13181/3)	8K	13181-16001	13181-90095							
7/9 TRACK MAG TAPE (13184 INTF)	8K	13184-16001	13184-90008							
DISC FILE (2883)	8K	12965-16001	12965-90009						24396-13308	
7900/01 CARTRIDGE DISC	8K	12960-16001	12960-90003							
7905 CARTRIDGE DISC	16K	12962-16001	12962-90001						24396-13308	
PAPER TAPE READER-PUNCH	4K	12597-16001	12597-90031						24396-13309	
DIG. PLOTTER INTERFACE (CALCOMP)	4K	12560-16001	12560-90029							
2892 CARD READER	4K	12924-16001	12924-90006							
2894 CARD READER PUNCH	8K	12989-16001	12989-90001							
7261 CARD READER	4K	07261-16005	07261-90005							
DIAGNOSTIC CROSS LINK	4K	24296-16003	02100-90157						24396-13310	
7900/7905 DISC INITIALIZATION	4K	24296-16002	02100-90157						24396-13310	

# Product support overview

Support provided and/or offered for HP 21MX Computer software products includes:

1. Training (see support applicability summary).
2. Installation (see support applicability summary).
3. Warranty (applies to all products).
4. Software subscription service (SSS – see support applicability summary).

## Training

The user training courses summarized in the User training services section (next section of this data book) are offered to familiarize customers with the use of 21MX Computer software systems and subsystems to maximize the benefits realized from their use.

## Installation

On-site installation assistance from Hewlett-Packard is included in certain of the software products listed in this data book. This on-site assistance includes travel (in the U.S., up to 100 miles from the nearest HP service facility; an additional charge may be made for travel outside of the 100 mile service radius. Products that include on-site installation assistance are identified in the applicability summary with an **HP** entry in the **Inst. By** column. All other products are customer-installed, as indicated by the entry **cus** in the **Inst. By** column. However, installation assistance is provided on request for customer installed products at prevailing service rates.

## Warranty

Except where otherwise defined in volume purchase agreements or other contracts, HP products are warranted against defects in materials and workmanship for 90 days following the date of delivery. HP will repair or replace products which prove to be defective during the warranty period. Necessary travel up to 100 miles within countries where HP has specified the availability of Computer Systems products service facilities will be provided at no charge during the warranty period, to locations regularly served by public transportation; an additional charge may be made for travel outside of the 100 mile radius. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

## Software subscription service (SSS)

The software subscription service provides distribution of update information and material necessary to maintain HP software products and associated documentation to the latest level. This service is offered for a standard monthly charge that will be quoted on request by your local Hewlett-Packard customer engineer. It is important to understand that the software subscription service does not include Hewlett-Packard assistance with installation, regeneration, or debugging of software.

## Software support applicability summary

Software Product	Training Course No.	Inst. By	SSS Av?
92064A RTE-M operating system	22985A	HP	Yes
92001B RTE-II operating system	22965B	HP	Yes
92060B RTE-III operating system	22965B	HP	Yes
92065A BASIC/1000M system	22979A	cus	Yes
92101A BASIC/1000D system	22979A	cus	Yes
92063A IMAGE/1000 data base mgt. system	22977A	cus	Yes
20885A BCS operating system	22960A▲	HP	Yes
2300B RTE-B operating system	Note A	HP	Yes
2300C RTE-C operating system	Note A	HP	Yes
Program languages	22950A▲	HP	*
92061A RTE microprogramming package	22960A & 22983A	cus	Yes
92400A sensor-based DAS library	none	cus	No
92409A real-time plotter software	none	cus	Yes
92062A RTE drivers package	22980A 22981A†	cus	*
92066A RTE meas. & control software	22968A	cus	No
91700 series network software	22969A	HP	Yes
91780A RJE/1000	none	HP	Yes
24396A-F diagnostics library	none	cus	No

▲22950A covers only the HP Assembler, software input/output (SIO) system, and BCS; it does not cover any other program languages, such as Fortran or HP Algol.

\*SSS support of the program languages and the 92062A RTE drivers is included in the support of the operating system in which they are supplied.

Note A: Training on the RTE-B and RTE-C operating systems is available on request at Hewlett-Packard technical centers.

†22980A and 22981A cover only HP-IB programming using the HP-IB software from the 92062A RTE Drivers package; no other drivers are covered in formal training courses.

# User training services

## 22985A RTE-M real-time executive system course

This course covers the use of the RTE-M operating system, program preparation using standard flexible disc based compiler, assembler, editor, and relocating and absolute program loaders; system software generation; and use of the file manager.

**Length:** 5 days.

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

**Prerequisites:** Fortran programming experience, preferably on HP computers; experience with HP Assembly language programming also desirable.

## 22965B RTE-II/III real-time executive system course

This course covers the use of the RTE-II and RTE-III operating systems; program preparation using standard compilers, assembler, and loader; disc usage; system software generation; and use of the Batch-Spool Monitor, including the file manager.

**Length:** 10 days.

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

**Prerequisites:** Fortran programming experience, preferably on HP computers; experience with HP Assembly language programming also desirable.

## 22979A Multi-user real-time BASIC course

This course covers operator's commands for BASIC program development, accessing BASIC disc files, debugging a BASIC language program, designing and implementing user subroutines, and loading the 92065A or 92101A BASIC/1000 software system into the host RTE-M or RTE-II/III system.

**Length:** 3 days.

**Lab:** Provides hands-on experience with BASIC/1000.

**Prerequisite:** Some acquaintance with one or more high-level program languages.

## 22977A IMAGE/1000 data base management system course

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.

**Prerequisites:** Completion of the 22965A/B real-time executive system course or equivalent experience.

## 22969A Distributed systems course

This course covers operation, programming, and generation of the RTE-II/III network central communications executive and the BCS, RTE-B\*, and RTE-C\* satellite communications executives.

**Length:** 5 days.

**Lab:** Provides hands-on experience in generating and operating network central and satellite systems.

**Prerequisites:** Completion of the 22965A/B real-time executive system course.

## 22968A Measurement and control subsystems course\*

This course covers the programming of the HP 2313B analog I/O Subsystem and HP 91063A (HP 6940B Multi-programmer) Digital I/O Subsystem.

**Length:** 2 days.

**Lab:** Provides hands-on experience in programming the 2313B and 91063A.

**Prerequisites:** Completion of the 22965A/B or 22985A real-time executive system course, or equivalent knowledge.

## 22950A 2100 series Assembler programming course

This course covers operation of the 2100 series Computer and associated peripherals; coding, editing, assembly, loading, and execution of programs; the Software Input/Output (SIO) off-line programming system; the BCS system; and interpretation of assembler listings and diagnostic messages.

**Length:** 5 days.

**Lab:** Provides hands-on experience with SIO system configuration and HP Assembly language program development.

**Prerequisites:** None.

## 22960A 21MX M-Series microprogramming course

This course covers the theory and use of Hewlett-Packard microprogramming hardware and software to prepare, alter, and install microprograms for HP 21MX M-Series Computers.

**Length:** 5 days.

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

**Prerequisites:** Fortran or Assembly language programming experience.

## 22983A 21MX E-Series microprogramming course

This course covers the theory and use of Hewlett-Packard microprogramming hardware and software to prepare, alter, and install microprograms for HP 21MX E-Series Computers.

\*Certain training is available on request only at the various technical centers. Check the Computer Systems Group Course Schedule for course availability.

**Length:** 5 days.

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

**Prerequisites:** Fortran or Assembly language programming experience.

### **22980A HP-IB\* minicomputer bus basics**

This course provides an introduction to HP-IB\* concepts and theory as they apply to use in computer-controlled measurement systems.

**Length:** 3 days.

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

**Prerequisite:** Familiarity with BASIC and/or Fortran programming languages.

### **22981A HP-IB\* programming under RTE**

This course provides training in the programming of HP-IB\* on a real-time minicomputer system.

**Length:** 2 days.

**Lab:** Provides hands-on experience with real-time programming of a computer controlled HP-IB instrumentation system.

**Prerequisites:** 22985A or 22965A/B real-time executive system course and 22980A HP-IB minicomputer bus basics course.

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

### **22982A 21MX E-Series computer maintenance course**

This course provides theory and lab training in troubleshooting, repair, and maintenance of the 21MX E-Series Computer.

**Length:** 5 days.

**Lab:** Provides hands-on troubleshooting and sub-assembly replacement experience.

**Prerequisite:** A strong background in digital electronics, including binary, octal, and decimal number system conversions; knowledge of machine or Assembly language programming is also helpful.

### **22942A 7900A disc drive maintenance course**

This course provides the student with the fundamental knowledge needed to troubleshoot, repair, adjust, align, and maintain the 7900A Disc Drive and its power supply (part of 12960A Cartridge Disc Subsystem).

**Length:** 5 days.

**Lab:** Provides hands-on experience with alignment and preventive maintenance.

**Prerequisites:** Digital electronics background.

### **22945A 7905A disc drive maintenance course**

This course provides the student with the fundamental knowledge needed to troubleshoot, repair, adjust, align, and maintain the 7905A Disc Drive and the 13037 Disc Controller (part of 12962 Cartridge Disc Subsystem).

**Length:** 5 days.

**Lab:** Provides hands-on experience with alignment and preventive maintenance.

**Prerequisites:** Digital electronics background.



Sales and service from 172 offices in 65 countries  
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