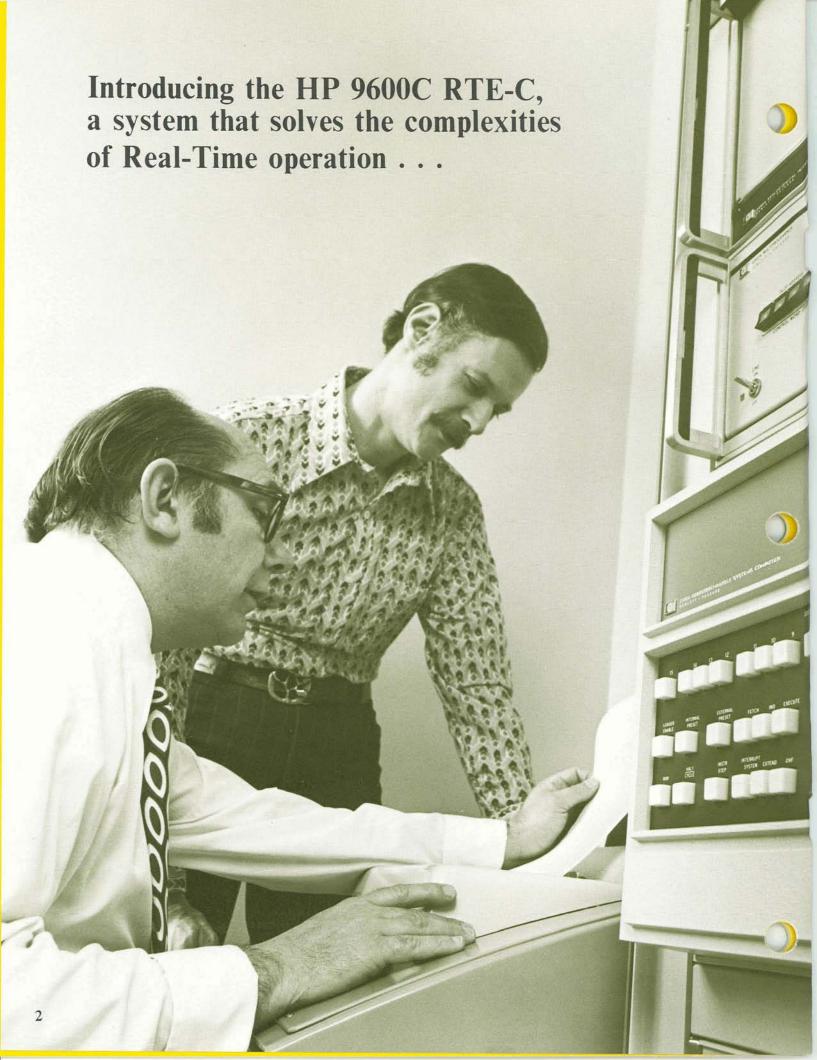


A Core-Based Real-Time Multiprogramming System for Your Applications



complexities like . . .

timing of system operations . . . scheduling multiple programs . . . administering of program priorities . . . providing for orderly interaction of programs . . . control of input and output.

Because the HP 9600C RTE-C system handles these real-time operations under your direction, you are free to concentrate on planning your system's operations, programming your applications, evaluating the results.

The HP 9600C is a low-priced, modular, Real-Time Executive System capable of handling multiple user tasks in a multiprogramming and hardware-protected environment. It provides time- and interrupt-driven, scheduled concurrent operation of multiple programs with online control by the operator. Fast response and low overhead in the executive have been assured by making all programs core resident.

Operates in 8K words of memory, which lets us price the system within your reach.

Configurable on the operational hardware. You won't need another system to configure your HP 9600C RTE-C system.

Flexible. Memory capacity can be increased to 12, 16, 24, even 32K words at any time, at your facility, to provide more space for programs and data. In the same way, the number of input/output channels available for instrumentation and peripherals can be increased from 11 to 42.

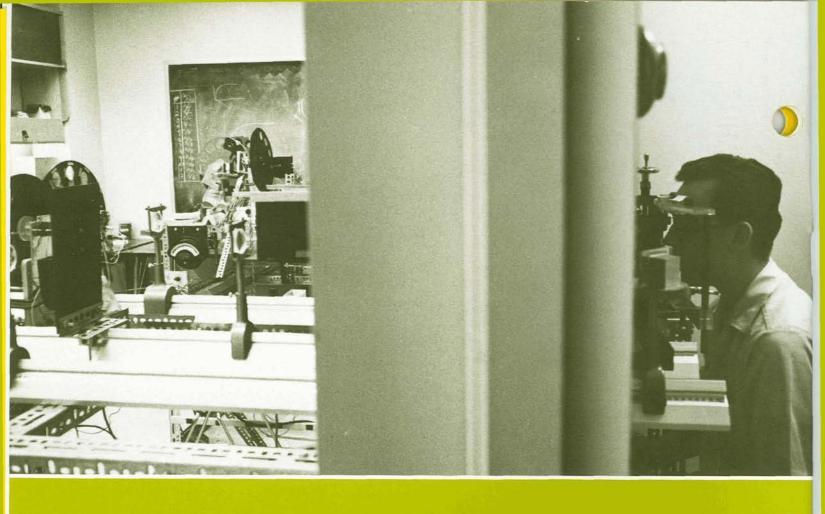
Upward compatible. You can add disc memory and change to a disc-based HP 9600E/F Real-Time Executive system providing on-line program development and great expansion of total storage capacity by simply generating the disc-based Real-Time Executive on the new system configuration. This change does not affect the usability of existing programs.

Includes Floating Point "Hardware". This standard capability gives a minimum five-fold increase in computing speed compared to software floating point routines, speeding calculations.

Microprogrammable. Optional Writeable Control Store and ROM programming capabilities let you enhance your system's instruction set to satisfy special requirements with maximum efficiency.

Programmable in FORTRAN. Your programming time and effort can be minimized by writing your programs in HP FORTRAN, which includes Real Time extensions. Where necessary to make most efficient use of memory, you can also program in HP Assembly language. Programs in either language may be configured and executed together, so most advantageous use can be made of both languages.

Priced Under \$20,000, the HP 9600C brings real-time programming capability to many new application areas. In the remaining pages of this brochure, we invite you to examine the applicability of the HP 9600C to research and development, sensor-based industrial testing, and use in the university lab.



The HP 9600C in Research and Development

More and more research and development laboratories are discovering the power of automatic computer control of experiments and on-line processing of experimental data. User experience has proven that this speeds experimental work and multiplies the productivity of high-paid scientists and technicians. To research and development applications, the HP 9600C RTE-C system brings:

- Concurrent Operation. The system establishes a multiprogramming environment in which the experiment control and data processing programs of several researchers can be running concurrently.
- Multi-terminal Communication. Experimenters can communicate with the system from various experiment locations via remote teleprinters or keyboarddisplay terminals.
- Non-disruptive Experiment Changeover. When one
 phase of an investigation has been completed, the program used for that can be replaced with one pertaining
 to the next phase without stopping the system; all
 other programs will continue to execute on-schedule
 without interruption.
- Wide Choice of Instrumentation. Standard HP subsystems are available for analog-to-digital and digital-to-analog conversions and for digital input and output. In addition, a complete line of general-purpose interface cards simplifies interfacing of special instrumentation equipment to the system.
- Quick Response to Lab Priorities, Differing real-time program priorities are administered in an orderly, predictable manner. Fast response is assured because all programs are in the computer's memory.
- Fast Calculations. Hardware multiply-divide and hardware floating point instructions are standard, speeding the processing of experimental data.

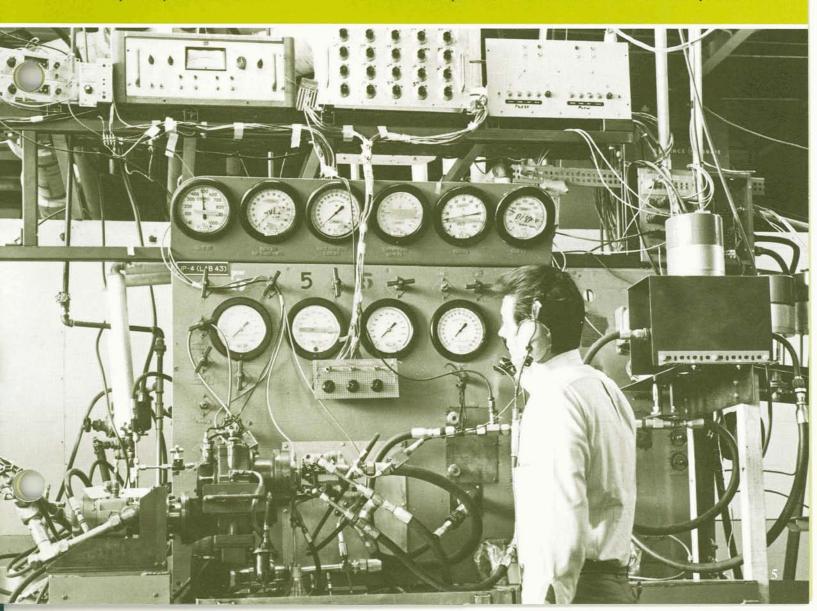
The HP 9600C Real-Time Executive system provides a close match to the scientific needs and budgetary constraints of research and development laboratories. Behind it lie more than 30 years of contribution to the fields of measurement and instrumentation and more than 1000 computer-controlled instrumentation systems. You can start small and add capability as required by your applications.

The HP 9600C in Sensor-Based Industrial Testing

Increasingly, industry is recognizing that real-time computer systems for product testing, instrument calibration, and quality control are cost-effective capital equipment. By relieving people of the manual drudgery of data recording and laborious calculations, shortening the time required to achieve useful results, computer systems rapidly pay for themselves in increased productivity, and lower labor and overhead costs. HP 9600C RTE-C systems are particularly well matched to this type of application, offering the following important benefits.

- Protection of Equipment. Tasks monitoring critical parameters can always be assured on-schedule execution by assigning them highest priority. Out-of-limits operation can be detected and reversed, or testing stopped, before damage results.
- Urgent Needs for Service are Satisfied Quickly because tasks are core-resident.
- Easily Interfaced to Your Application. The system is easily interfaced to your transducers, limit switches, control panels, and control actuators by standard HP analog-to-digital, digital-to-analog, and digital input/ output subsystems and interfaces.
- Easily Incorporated into Distributed System. The system is designed for both stand-alone and distributed system use. It is thus compatible with longterm trends toward totally automated production.

For sensor-based industrial testing applications, the HP 9600C is a no-risk investment. Not only is it well-matched to the needs of the on-line test station, it can be extended in many different ways to meet tomorrow's needs, all without discarding any significant portion of the initial investment in the system.





The HP 9600C in the University Lab

The HP 9600C RTE-C system is a valuable research tool in the university lab. It is delivered ready to connect to your projects and ready to receive and execute your application programs. On the other hand, it's flexible enough to serve the unique requirements of research in physics, chemistry, psychology, the other sciences, and engineering. While the system is aiding research in your science and engineering departments, your graduate and undergraduate students will be gaining authentic, practical experience working with a real-time system typical of those encountered outside of the university environment. To the university lab, the HP 9600C RTE-C system brings qualifications unequalled by any other comparably-priced system, including:

- Concurrent execution of multiple programs, scheduled in real-time.
- · Fast response to lab priorities.
- Plug-in Interfacing and Modular Software which simplify integration of special instrumentation into system operations. No special knowledge or understanding of the inner workings of the computer is required to make use of HP computer interfaces.
- Extensive Library of Scientific Subroutines ready to apply to your data processing calculations.
- Floating Point "Hardware" and Hardware Multiply-Divide, which speed calculations.

- Memory Expandable to 12, 16, 24, or 32 K words, on site.
- User Implemented Microprogrammability (optional) lets you enhance the system's instruction set to satisfy special requirements with optimum efficiency, It also affords an excellent opportunity for computer science students to experiment with firmwaresoftware tradeoffs, gaining experience obtainable in no other way.
- Available I/O Capacity Expandable from 11 to 42 Channels, on site.
- Upgradable to Disc-Based RTE on-site, to provide the additional advantages of on-line program development and great extension of program and data storage capacity without affecting the usability of existing programs.

We at HP have designed the HP 9600C RTE-C system to be fully responsive to your needs, today and tomorrow. Today its low price places the system within reach of the small college, where its use can be shared among several departments. It is affordable by individual departments in the larger colleges and unitersities. Tomorrow, the system is adaptable to your growing needs, both within the original framework of the corebased RTE system and beyond it, into the larger, more spacious framework of a disc-based RTE system. The HP 9600C RTE-C system is a powerful new research tool that no university lab can afford to ignore.





Total Control by the User

System Generation

User's real-time programs and real-time system modules are incorporated into a configured RTE-C System by the Real Time System Generator (RTSGN). Because the HP 9600C RTE-C system software is modular, the user configures his particular programs and I/O device drivers into a Real-Time System, in absolute binary format, that is tailored to his specific needs. The RTE-C operating system can always be generated on the same hardware system in which it will be used, even on a system with as little as 8K of memory.

On-Line Program Loading

Real-time programs can also be added or changed after system generation, without halting the system. It is not necessary to re-generate or stop the system even momentarily to change programs. The system thus continues in productive use, maximizing its value and maintaining real-time reference to external events.

Program Development

In the HP 9600C system, editing, compilation, and assembly of programs are off-line operations. These can be run on the system when it is not engaged in real-time operations, on an HP 9600C backup system, or on a separate HP 9600E/F disc-based Real-Time Executive system or HP 2120 Disc Operating System. Program development on a separate disc-based HP system extends the choice of programming languages available to the HP 9600C user. FORTRAN IV and ALGOL programs compiled on an HP 9600E/F or HP 2120 system can be loaded and run on the HP 9600C system.

System Communications

The user's control extends to dynamic control exercised by system requests from his programs during real time operations. System requests are made in the form of a standard FORTRAN statement or an assembly language subroutine call, to perform any of the following executive functions:

- 1. Read from any input device.
- 2. Write to any output device.
- Control functions on devices such as magnetic tape unit.
- 4. Check status of an I/O device.
- Schedule programs to be run, with or without wait for execution of the called program.
- 6. Turn off running program when it is completed.
- 7. Request current time of day and day of the year.
- 8. Request change in time scheduling of programs.

Operator Communications

The system provides for monitoring and control of Real Time operations via the system teleprinter or optional keyboard-display unit. The operator may:

- 1. Turn programs on or off.
- 2. Suspend any user program which is executing or scheduled.
- 3. Return any user program to active status.
- 4. Examine status of programs.
- 5. Schedule programs to execute at specific times.
- 6. Change priorities of dormant programs.
- Examine status of any I/O device; dynamically alter device buffering assignments.
- 8. Control I/O device availability.
- 9. Dynamically alter I/O logical unit assignments.
- 10. Dynamically alter device time-out parameters.
- 11. Set the real-time clock.
- 12. Print current time.





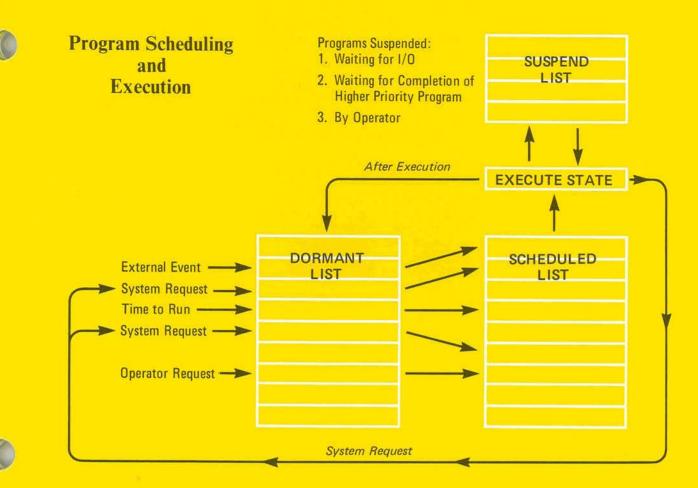
Uses a Rugged, Reliable Systems Computer . . .

The HP 2100S Microprogrammable Systems Computer (shown above, undergoing shake test) is tailored specifically for systems use. It comes equipped, standard, with all of the features required by a Real-Time System — features like:

- Floating Point Hardware for Ultra-Fast Floating Point Calculations
- Memory Protect
- · Hardware Multiply-Divide
- Power Fail Interrupt with Automatic Restart
- 8,192 words of Core Memory with 980 nanosecond Cycle Time
- 11 Input/Output Channels Available in HP 9600C System for Interfacing Instrumentation and Peripherals
- Plug-in Compatibility with Optional User-Implemented Microprogramming of Additional Machine Instructions
- Built-In Programmer's Console
- · Parity Checking With Interrupt
- Crystal-controlled Programmable Time Base
- Communications Control Channel

This computer is built to work where you need it — on the factory floor, aboard ship, in aircraft, at oven temperatures in the desert, or down to a chilly 32 degrees Fahrenheit. In fact, the 2100S works under conditions more severe than those tolerated by most peripherals, an extra margin of ruggedness that keeps your system up and operating reliably, hour-after-hour, day-after-day, year-after-year.





. whose memory becomes intelligence . . .

... the intelligence of the sophisticated, core-based HP 9600C Real Time Executive operating system that manages program scheduling and execution, processes interrupts and input/output requests, and protects itself from user's programming errors.

. . . intelligence applied to program scheduling and execution

Scheduled List. A scheduled list contains 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, when requested by another program or by an operator, or as the system's programmed response to an interrupting external event.

Time Scheduling. Current time is updated every ten milliseconds. Whenever this occurs, a time list of dormant programs is checked and any programs scheduled to execute at that time are placed in the scheduled list. Thus, programs can be initiated on resolutions of hours, minutes, seconds, or even tens of milliseconds.

Priority Levels and Execution. The RTE-C Scheduler recognizes program priority levels from 1 through 99, providing fine discrimination among the relative urgencies of programs in the multiprogramming environment. Execution is initiated immediately for the highest priority program, which is at the top of the scheduled list. If a higher priority program moves to the scheduled list, that program is started executing and the current program is suspended. Because all programs are in core, the switch-over from the current program to one of higher priority is very fast. More than one program may use any given priority level. The only limitation on the number of programs in the system is core memory capacity and requirements for system throughput.



... intelligence applied to interrupt and input/output processing

Interrupt Processing. The HP 9600C uses the multi-priority level hardware interrupt system of the system's computer for power fail detection, memory protect violation, and time base generator inputs, as well as for peripheral I/O and user-interfaced equipment. When one or more interrupts occur simultaneously, the interrupt with the highest hardware priority is recognized first, but the interrupt system also remembers the other interrupts. None can be lost.

Since all response to external interrupts requires some housekeeping, such as saving registers, program control is transferred to a Central Interrupt Control (CIC) routine. After completing its housekeeping chores, the CIC routine decides action to be taken. It will initiate routines to handle memory protect violations, time keeping, I/O operations, and requests for program execution.

Privileged Interrupt. The system offers a special privileged interrupt feature, based on the use of an option P23 control card and the hardware priority structure of the computer. Privileged interrupts bypass the normal interrupt processing of the system to achieve faster response. This meets the needs of interrupts having the greatest urgency.

Input/Output Processing. An I/O Scheduling and Control Monitor (IOC) coordinates the I/O transfers of all standard devices in the system. I/O devices are referenced by a logical unit number rather than the actual physical I/O channel. This saves time and money when the hardware configuration of the system is changed because it minimizes change to existing programs.

Output Buffering. IOC "stacks" output requests by priority of the calling program and provides for automatic memory buffering of output directed to low or medium speed peripherals. This speeds the processing and output of finished results.

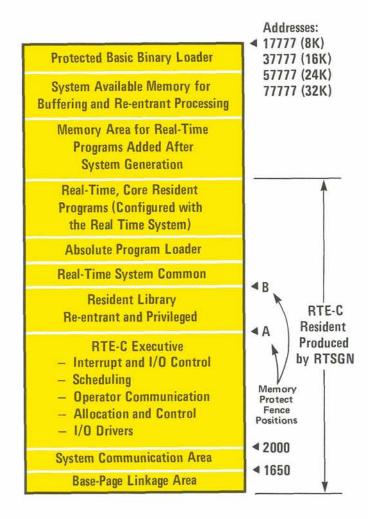
Concurrent I/O Operations. All I/O operations are performed concurrently with program computation in the overall system. One I/O driver is used for each group of like devices. Each device has a table associated with it to store variable information.

Waiting List. When a request is made for action by a busy device, the request is placed in a waiting list according to the priority of the requesting program. This keeps each device optimally utilized.

Device I/O Timeout. At the user's option, operation of any of all I/O devices may be timed out. A device that has not completed a directed action within the timeout period is put on "down" status by the system and a "timed out" message on the teleprinter or keyboard-display terminal notifies the operator. Thus appropriate action can be taken almost immediately to correct an I/O condition that could stall the system.

and system protection

The system is self-protected from errors in user's programs through the use of a hardware "fence" register in the system computer. The fence position in memory is set by the system. All but legal access to the memory area occupied by the system and the resident library (addresses lower than that in the fence register) is prevented.



Core Allocations in a Configured HP 9600C Real-Time System

Capabilities and

High-Speed Analog-to-Digital Subsystems

Digital Input/Output and Analog Output





12 Bits/47 kHz4

Up to 1056 S.E. Inputs

or 528 Diff. Inputs

Also available with single-channel input, true rms AC and Resistance measurement capabilities.

±10.24V fs

COMPUTER 1/0



 Direct Memory Access Writeable Control Store
4K, 8K, 16K, or 24K words Additional Memory

Low-Level MPX Up to 1024 Diff. Inputs ±10mV to ±10.24V fs 15 kHz▲



8/16 Bit Duplex Registers Transistor and Microcircuit Logic Levels

THE R

Multiprogrammer Subsystem up to 240 12-bit channels for Status and Event Sense inputs, Relay and Transistor digital outputs, and D-A outputs.

Relay Register



31 Additional I/O Channels

Medium Speed Analog-to-Digital Subsystems



4 Digits, 900 Chan/Sec ±0.1V to ±10V fs Up to 50 S.E. Inputs

▲ With Direct Memory Access.

High Resolution Analog-to-Digital **Subsystems**



Integrating DVM 1µV Resolution 14 dc Chan/Sec ±0.1V to ±500V fs Up to 1000 Chan Also Available with AC, Res., and Freq.



Integrating DVM 1μV Resolution 40 dc Chan/Sec ±0.1V to ±100V fs Up to 1000 Chan Also Available with

AC and Freq.

← Data – Program →

Communication TO/FROM HOST PROCESSOR

Additional 56-Inch Cabinet Bays Available

HP 9600C RTE-C **Real Time Executive System**

Growth Potential



Interface to Digital Incremental Plotter (Calcomp 563, 565, or equivalent, 11 or 29.5 inches wide, 0.01 inch resolution.)



Plotting

75 Char/Sec.





Tape Punches

120 Char/Sec.

*Tape punch is recommended for system generation and program preparation on the system.

HP 2100S COMPUTER

- 8K Memory
- 11 I/O Channels Available
- Floating Point hardware
- Time Base Generator
- HP 2752A TELEPRINTER I/O (10 Char/Sec)
- HP 2748A TAPE READER UNIT (500 Char/Sec)
- 56-INCH ONE-BAY CABINET



Card Reader



System Software

A strong software package centered around a powerful operating system is required to make even the most state-of-the-art hardware effective. In recognition of the key role played by software, Hewlett-Packard provides comprehensive supporting software with HP 9600 RTE-C systems. The Real-Time Operating System and the System Generation and Expansion software are derived from the highly-successful, fully-debugged software for the disc-based HP 9600E/F Real-Time Executive systems, which has been proven in use in many installations throughout the world. The software provided with HP 9600C systems represents hundreds of man-years and thousands of dollars of software development work which is ready for your use when you receive your system.

The software supplied with HP 9600C Systems embraces every requirement except application programming, and includes:

The Real-Time Operating System

The operational software coordinates system operations, schedules programs in real time, and processes interrupts and controls input/output operations.

- Configured RTE-C system, a tape configured at the factory to work with your HP 9600C System, so you'll be ready to add your application programs and start actually using your system as soon as your programs are ready.
- Real-Time Executive module coordinates all functions of the RTE-C system.
- Real-Time Scheduler schedules programs for execution according to program priorities set by the user.
- Real-Time Input/Output Control module processes system interrupts and controls I/O operations.
- Multiple-Device System Control Driver routine (DVR00) controls teleprinter or optional keyboard-display terminal, tape reader, and optional tape punch input/output.
- Additional Drivers are supplied with other peripherals and subsystems you order for your system, providing a complete I/O control capability when configured in the Real-Time operating system.
- Relocatable Program Library provides re-entrant, privileged, and utility routines which are callable from FORTRAN or HP Assembly language programs.

System Generation and Expansion

The system generation and expansion software generates the system in a conversational, interactive mode and provides for on-line addition of user's programs. It includes:

- Real-Time System Generator gives you the ability to modify or expand your system at your facility, without special assistance, and with little or no change of program coding.
- Absolute Program Loader provides for on-line addition or interchange of user's real-time programs that have been put in absolute form by the Relocating Loader.

Program Preparation

Program preparation software is used in off-line mode to translate your programs to absolute binary (machine language) form for execution in the system. This software includes:

- HP FORTRAN compiler with Real-Time extensions translates FORTRAN programs to relocatable binary form.
- HP Assembler translates HP Assembly language programs to relocatable binary form.
- Cross-Reference Symbol Table Generator prints a crossreference list of all symbols appearing in an HP Assembly language program. This helps isolate program errors and inconsistencies.
- Symbolic Editor used to modify FORTRAN and HP Assembly language programs.
- Relocating Loader converts relocatable binary programs to absolute form for loading into the system.

Software Input/Output (SIO) System

The SIO system is used in off-line mode to set up communication between program preparation software and input/output devices (teleprinter and tape reader, in minimum system). This includes:

- Configured SIO System, a tape configured at the factory to work with your system, so you'll be ready to start processing your programs as soon as your system is received.
- 2. SIO System Dump routine.
- 3. SIO Buffered Teleprinter Driver program.
- 4. SIO Tape Reader Driver program.
- Additional SIO Drivers are supplied with optional peripherals, such as tape punch, magnetic tape unit, or line printer.

Hardware Checkout and Diagnosis

The hardware checkout and diagnostic software is provided to minimize system down-time by speeding and simplifying isolation of any system malfunction. This software includes:

- 1. Low Memory Pattern Test
- 2. High Memory Pattern Test
- 3. Memory Parity Check Test
- 4. Power Fail Diagnostic
- 5. Alter-Skip Instruction Test
- 6. Memory Reference Instruction Test
- 7. Shift-Rotate Instruction Test
- 8. Low Memory Address Test
- 9. High Memory Address Test
- 10. Extended Arithmetic Unit Test
- 11. Interrupt Test
- 12. Memory Protect Test
- 13. Buffered Teleprinter Test
- 14. Tape Reader Test
- 15. Tape Reader Interface Card Diagnostic
- 16. Time Base Generator Test
- Additional test and interface diagnostic routines are supplied with optional peripherals and with the analog-to-digital, digital-to-analog, and digital input/output subsystems in your system.

Supported by . . .

Training. A two-week user training course in FORTRAN and HP Assembler language programming and five days training in the special aspects of Real Time Executive systems is included with the purchase of 9600C Systems. All instruction includes hands-on experience. HP computer maintenance training courses are also available.

Data Centers. Your local HP Sales Office probably has a small data center with system analysts and engineers. Backing this up are four regional data centers in the U.S., four in Europe, and one each in Japan, Canada, and Australia which have been established to meet unique needs of HP computer system users. At these centers, you can obtain the assistance of experienced system engineers and system analysts in the development of specialized solutions to your data acquisition and control applications.

Plus . . . extensive documentation . . . system warranty . . . world-wide service . . . a variety of service agreements . . . experience gained from more than 4,000 computer installations.

The Next Step ...

... with your HP 9600C system is totally up to you. Your choices include:

- Continued stand-alone operation as a core-based system, with memory and I/O expansion as needed to handle growth
 in the scope and complexity of system operations.
- Upgrade to disc-based RTE configuration, offering millions of words of storage for programs and data plus on-line program development simultaneous with real-time operations.
- Operation as host supported terminal system in a distributed system when you decide to coordinate all of your systems
 in a distributed system configuration.

None of these choices involves obsolescence of either your application programs or system hardware. Your choice today of an HP 9600C not only involves no risk, but it offers the solid opportunity of greatly increasing the efficiency of your data gathering, data processing, and control operations, at very low cost. Contact your local Hewlett-Packard Systems Field Engineer for a personal consultation on the application of the HP 9600C RTE-C system, or other HP 9600 series systems (HP 9600A, 9600E, 9600F, or 9600G) to your needs.



For more information, call your local HP Sales Office or East (201) 265-5000 Midwest (312) 677-0400 South (404) 436-6181 West (213) 877-1281. Or write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, CA 94304. In Canada: 275 Hymus Blvd., Point Claire, Quebec. In Europe: Hewlett-Packard, P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland. In Japan: Yokogawa-Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-ku, Tokyo, 151.