

# Data General Nova 4 Series

## MANAGEMENT SUMMARY

The Data General Nova 4 Series consists of a family of three computers that feature "up to 50 percent faster speed than the Nova 3, improved reliability/maintainability, and greater economy than ever available in the Nova line." The new line is clearly destined to replace some of the earlier Nova 3 models.

Introduced in December 1978, the new models include the compact Nova 4/C, featuring a complete 64K-byte computer on a single circuit board; the standard Nova 4/S, a higher-performance model with up to 64K bytes of memory implemented on two boards; and the extended-memory Nova 4/X, which features a standard memory management and protection capability, allowing a 256K-byte computer to reside on two boards.

All three Nova 4 computers offer significant enhancements over the Nova 3 line in performance, function, and economy. The Nova 4/C packs the speed of a Nova 3 computer on a single board, and the Nova 4/S and 4/X models feature 50 percent higher speed than the Nova 3. Increased performance also results from instruction set enhancements, which add new byte manipulation and integer arithmetic capabilities to the Nova 3 instruction set.

The Nova 4/X can support dual operations under the RDOS operating system. This capability allows it to run a multi-terminal data entry program in the foreground while processing a remote job entry or local batch program in the background.

The new Nova 4 family of computers consists of the Nova 4/C, featuring a complete 64K-byte computer on a single circuit board; the Nova 4/S, a higher-performance model with up to 64K bytes on two boards; and the extended-memory Nova 4/X with a standard memory management and protection capability, allowing a 256K-byte computer to reside on two boards.

## CHARACTERISTICS

**MANUFACTURER:** Data General Corporation, Route 9, Westboro, Massachusetts 01581. Telephone (617) 366-8911.

Data General is a leading manufacturer of minicomputers, peripherals, and associated equipment. The company maintains sales offices in most major North American cities and in South America, Europe, and Australia. Manufacturing operations are located in Southboro, Massachusetts; Westbrook, Maine; Portsmouth, New Hampshire; Clayton, North Carolina; and Sunnyvale, California. Assembly operations are also performed in Hong Kong and in Thailand.

**MODELS:** Nova 4/C, 4/S, and 4/X.

**DATE ANNOUNCED:** December 1978.

**AVAILABILITY:** 90 days for all three models.

**DATA FORMATS**

**BASIC UNIT:** 16-bit word or 8-bit byte.



The Nova 4 computers feature up to 50 percent higher speeds than the Nova 3's. The microprogrammed Nova 4 Series incorporates the architectural features of the Nova 3 computers, including hardware stack and frame pointer, high-speed direct memory access (DMA) channel, and 16-level priority interrupt structure.

## Data General Nova 4 Series

### CHARACTERISTICS OF THE DATA GENERAL NOVA 4 FAMILY

	Nova 4/C	Nova 4/S	Nova 4/X
Maximum number of terminals	4	8	16
Standard disk capacity, megabytes	96	200	400
Main memory capacity, bytes:			
Minimum	32K	32K	128K
Maximum	64K	64K	256K

➤ The Nova 4 CPU board contains an asynchronous terminal interface, real-time clock (optional in the Nova 4/C), memory management and protection unit (Nova 4/X only), automatic program load, power fail/auto restart, virtual console, and optional hardware multiply/divide. In the Nova 4/C, the CPU board also contains up to 64K bytes of MOS memory.

#### BACKGROUND

When the original Nova minicomputer—forerunner of a family that at one time included 11 active models—was introduced in September 1968, it was based upon a 16-bit word length at a time when most manufacturers were busily developing 12-bit machines (e.g., DEC's PDP-8 family). Less than a year later, Data General introduced the Supernova, a machine with more than three times the speed of the original Nova and with unusually strong processing capabilities for a minicomputer of that day. That machine subsequently was followed by the Supernova SC, the first commercial minicomputer to employ semiconductor main memory. The Supernova SC extended the upper limit of the Nova family to nearly seven times its original processor capability.

Also announced in October 1970, with the Supernova SC, were the Nova 1200 and Nova 800, using 1200-nanosecond and 800-nanosecond core memories, respectively. About a year later, the Models 1200 and 800 were, in turn, redefined by the 1210, 1220, 1230, and 820. The primary distinction between these models and the earlier 1200 and 800 systems was in mechanical packaging that permitted more economical production and assembly methods.

With the addition of the larger Model 840 (800-nanosecond memory) in April 1973 and the low-priced Nova 2/4 and 2/10 (1-microsecond or 800-nanosecond memories) in June 1973, Data General focused its marketing attention on the 2/4 and 2/10 for orders of five or more units and on the 840 system for heavy processing requirements. A 1-microsecond version of the 840, designated the 830, was introduced in November 1974.

The Models 3/12 and 3/D, announced in October 1975 and August 1976, respectively, mark the top of the Nova 3 line with the largest main memory capacities among the Nova 3's. Dual-purpose, shared-disc Nova 840 and Nova 2/10 configurations, announced in early 1974, were largely supplanted by comparable systems employing the Nova 3/12 and 3/D.

➤ **FIXED-POINT OPERANDS:** 16-bit words can be interpreted as signed or unsigned binary numbers, logical words, memory addresses, or portions of decimal character strings.

Decimal numbers can be either character decimal or packed decimal. In character decimal format, each digit is an 8-bit ASCII character, and the sign is either carried separately as an extra character at the beginning or end of the decimal string or by modifying either the first or last digit in the string. The packed decimal format places each digit in 4-bit hexadecimal code with a separate sign character at one end of the string.

**FLOATING-POINT OPERANDS:** All Nova processors can implement single- and double-precision floating-point arithmetic through software subroutines. With the optional Floating-Point (FPU) on the 4/S and 4/X, single- and double-precision arithmetic can be handled by the hardware.

**INSTRUCTIONS:** One-word instructions. There are four basic instruction types; each with a different format: Jump and Modify Memory, Move Data, I/O, and Arithmetic and Logic. The instruction repertoire includes the Nova 3 instruction set plus local byte, store byte, and signed multiply and divide.

In the Jump and Modify instructions, bits 3 and 4 identify the specific function (op code), and the rest of the word contains information used to calculate the effective address. This information consists of an 8-bit displacement, a 2-bit index register specification, and a 1-bit indicator to specify direct or indirect addressing. In Move Data instructions, bits 3 and 4 address an accumulator, the op code is in bits 1 and 2, and the rest of the word is identical in structure to the Jump and Modify type above. For I/O instructions, bits 5-9 specify the function (indication of transfer direction, selection of an I/O device register, and/or specification of an operation). Bits 3 and 4 select an accumulator for transfer, and bits 10-15 indicate a specific device. Arithmetic and Logic instructions use bits 1 and 2 to identify an accumulator containing a second operand (if present), bits 5-7 to specify primary function, and the rest of the word to specify secondary functions, if any (such as shift and skip test).

For all memory reference instructions, bits 5-15 are used for addressing, using bits 8-15 as the displacement or direct address. Each instruction can address 256 words directly, or can use either relative or base register addressing.

**INTERNAL CODE:** ASCII and binary.

#### MAIN STORAGE

**TYPE:** 4K-chip MOS RAM for 64K-byte memory increments, 16K-chip MOS RAM for 128K- and 256K-byte memory increments; both chips employ N-channel, silicon-gate technology.

**CYCLE TIME:** 400 nanoseconds, with four-way memory interleaving on the 4/S and 4/X.

**CAPACITY:** 16,384 to 65,536 bytes for the Nova 4/C; 32,768 to 65,536 bytes for the Nova 4/S; and 131,072 to

## Data General Nova 4 Series

### PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	MANUFACTURER
<b>MAGNETIC TAPE EQUIPMENT</b>		
6020	Transport and controller; industry-compatible, 7-track, NRZI, 10.5-inch reels, 75 ips, 556/800 bpi, vacuum columns, 8 drives per controller; 42/60 KBS	Data General
6021	Transport and controller; industry-compatible, 9-track, NRZI, 10.5-inch reels, 75 ips, 800 bpi, vacuum columns, 8 drives per controller; 60 KBS	Data General
6022	Transport; industry-compatible, 7-track, 75 ips, NRZI, 10.5-inch reels, 556/800 bpi, vacuum columns; 42/60 KBS	Data General
6023	Transport; industry-compatible, 9-track, 75 ips, NRZI, 10.5-inch reels, 800 bpi, vacuum columns; 60 KBS	Data General
6026	Transport and controller; industry-compatible, 9-track, NRZI; 10.5-inch reels, 75 ips, 800/1600 bpi; vacuum columns, 8 drives per controller; 60/120 KBS	Data General
6026	Transport; industry-compatible, 9-track, NRZI, 10.5-inch reels, 75 ips, 800/1600 bpi; vacuum columns; 60/120 KBS	Data General
6027	Transport and controller; industry-compatible, 9-track, NRZI, 10.5-inch reels, 75 ips, 800 bpi, vacuum columns, 8 drives per controller; 60 KBS	Data General
<b>LINE PRINTERS</b>		
4215	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 600 lpm	Dataproducts
4216	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 436 lpm	Dataproducts
4218	Drum; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 300 lpm	Dataproducts
4219	Drum; 136 positions, 96 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 240 lpm	Dataproducts
4244	Band; 136 positions, 64 ASCII character set, 10 characters per inch, 6 or 8 lines per inch, 4- to 16.8-inch paper, 12-channel VFU; 900 lpm	Dataproducts
4245	Band; 136 positions, 96 ASCII character set, 10 characters per inch, 4- to 16.8-inch paper, 12-channel VFU; 600 lpm	Dataproducts
6086/8	Serial LP2; 7 x 9 matrix, 132 positions, 96 ASCII character set, 10 characters per inch, 6 or 8 lines per inch; 180 cps	Data General
6087/9	Serial LP2; 7 x 9 matrix, 132 positions, 96 ASCII character set, condensed or expanded/condensed printing, 6 or 8 lines per inch; 180 cps	Data General
<b>CARD EQUIPMENT</b>		
4016D/I	Reader; 80-column, punched card (4016D) or mark sense (4016), 550-card hopper and stacker, 12-bit parallel; 285 cpm	Documation
4016E/J	Reader; 80-column, punched card (4016E) or mark sense (4016J), 100-card hopper and stacker, 12-bit parallel; 400 cpm	Documation
4016F	Reader; 80-column, punched card, 1000-card hopper and stacker, 12-bit parallel; 600 cpm	Documation
4016G	Reader; 80-column, punched card, 1000-card hopper and stacker, 12-bit parallel; 1000 cpm	Documation
<b>PAPER TAPE EQUIPMENT</b>		
6013	Reader; fanfold tape, 8-channel; 400 cps	Data General
4012A/B	Punch; fanfold tape, 8-channel; 63.3 cps	Teletype
<b>TERMINALS</b>		
6012	CRT display/keyboard, 1920 characters, 24 lines by 80 characters, 64 ASCII character set, 5 x 7 dot matrix, variable codes, local editing, EIA or 20-ma current loop interface, full or half-duplex, up to 4800 bps	Data General
6040, 6041, 6042, 6043	Terminal printer, 5 x 7 dot matrix, inclined right 10 degrees, 132 positions, 96 character set (128 opt.), 10 characters per inch, 6 lines per inch, 40-character buffer, 4- to 15-inch forms; receive only (6041 & 6043); standard typewriter keyboard (6040 & 6042); RS-232C, 20-ma current loop interfaces; 60 or 30 cps (6040 & 6041); 10, 15, or 30 cps (6042 & 6043)	Data General
6052	CRT display/keyboard, 1920 characters, 24 lines by 80 characters, 64 ASCII character set, 5 x 7 dot matrix, detachable teletype style keyboard, 8 ftm. keys, 11 key data entry pad, EIA or 20 ma current loop interface, full duplex, Dasher attachment, up to 19.6K bps (sync)	Data General
6053	Same as 6052 except 96 ASCII character set, 5 x 8 dot matrix, detachable typewriter style keyboard, 11 ftm. keys, and other features such as direct cursor positioning and programmable intensity	Data General
<b>PLOTTER</b>		
4017E	Plotter; 11-inch 2-fold paper, drum-type, 120-foot X-axis; 0.005-inch (4017E), 0.010-inch (4017E-A), 0.10-mm (4017E-B), or 0.25-mm (4017E-C) step size; 300 steps per second	Houston Instruments

#### ➤ HARDWARE

Although processor options and configuration rules are not the same among various members of the Nova family, all employ the same basic 16-bit architecture, with four accumulators for computational use (two of which can be used for index registers), an I/O Bus, either a standard or high-speed Direct Memory Access (DMA) data channel, common 15-inch square PC ➤

➤ 262,144 bytes for the Nova 4/X with MMPU (memory management and protection unit).

CHECKING: None.

**STORAGE PROTECTION:** A memory management and protection unit (MMPU) is available on the Nova 4/X for expanding the memory capacity to 256K bytes, protecting memory, and restricting physical-level I/O device access from user programs. The MMPU divides main memory into 2K- ➤

## Data General Nova 4 Series

▷ board packaging design, and strong communications capabilities. The actual number of devices that can be configured with any Nova system depends upon the number of available plug-in circuit board "slots" in the chassis.

The microprogrammed Nova 4 line incorporates most of the architectural features of the Nova 3 computers, including hardware stack and frame pointer, high-speed direct memory access (DMA) channel, and 16-level priority interrupt structure. The Nova 4/S and 4/X models have a number of advanced performance features. A pre-fetch processor boosts performance by storing instructions in a high-speed buffer in the CPU, eliminating the memory fetch cycle in most cases. High-speed 400-nanosecond memories are accelerated with standard four-way interleaving, allowing the pre-fetch processor to load instructions at a 20-megabyte/second rate and reducing memory conflicts on memory modification instructions. These features result in typical instruction execution times of 400 nanoseconds for a store and 200 nanoseconds for an add. Performance can also be increased with the optional Floating-Point Unit (FPU), which operates in parallel with the CPU and is considerably faster than previous Nova FPU's. For example, the FPU executes a double-precision store in 200 nanoseconds and a double-precision add in 1.6 microseconds.

Memory boards are available in 32K- and 64K-byte increments for the Nova 4/S and in 32K-, 64K-, 128K-, and 256K-byte increments for the 4/X. The Nova 4/C is available with 32K or 64K bytes of memory on the CPU board. Memory management and protection hardware in the Nova 4/X performs logical-to-physical address translation, providing user programs with access to 256K bytes of main memory through four address extension tables, or maps: two program maps and two data channel maps. The Memory Management and Protection Unit (MMPU) also supports privileged instructions, I/O device protection, and main memory write and validity protection. This allows multi-user activities to occur in a hardware-protected environment.

All Nova 4 instructions are one 16-bit word in length. The basic instruction set contains instructions that perform fixed-point arithmetic and logical operations between accumulators, transfer of operands between accumulators and main memory, transfer of program control, and I/O operations.

A push-down stack provides a convenient method for saving return information and passing arguments between subroutines. The stack also provides an expandable area for the temporary storage of variables and intermediate results.

The floating-point feature allows the manipulation of both single-precision (32 bits) and double-precision (64 bits) floating-point numbers. Floating-point calculations can take place between two 64-bit accumulators or between one of the accumulators and operands in main memory. ▷

▶ byte pages, and can protect individual pages through software support under the Real-Time Disc Operating System (RDOS).

In addition to the storage protection, the Nova MMPU also provides three other forms of system protection: I/O protection, validity protection, and runaway defer protection. I/O protection prevents the use of any specified I/O device; any instruction attempting to address the protected device causes a system interrupt. Validity protection is used in conjunction with memory mapping and can be extended to any 1024-word page in memory by mapping it to page 127; this indicates that the page is protected and, if addressed by any means, causes a system interrupt. Runaway defer protection prevents infinite indirect loops by counting the number of consecutive times a particular address is referenced through a defer (indirect) cycle; if addressed 17 times consecutively, a system interrupt is generated.

The MMPU holds two program maps and two data channel maps at the same time. Each map consists of 32 1K pages. Although both data channel maps can be enabled at the same time, only one program map may be enabled.

**RESERVED STORAGE:** Certain low-end memory locations are reserved for use during interrupt servicing, MMPU protection processing, stack fault processing, and power failure. Sixteen locations are reserved for increment and decrement registers.

### CENTRAL PROCESSORS

**GENERAL:** The Nova 4 high-density architecture allows a 64K-byte Nova 4/C to be configured on one board, and a 64K-byte Nova 4/S or 256K Nova 4/X to be configured on two boards. The Nova 4's feature Nova 3 stack capabilities, similar to those of the Eclipse series. The operation of the push-down stack is controlled through two hardware registers, the stack pointer and the frame pointer.

The Nova 4/C is housed in a 5-slot chassis, and the Nova 4/S and 4/X are housed in a 16-slot chassis. The Nova 4's use a horizontally microcoded CPU implementation for overlap, and a look-ahead prefetch processor also increases performance.

Processor options for all Nova 4 models include hardware multiply/divide and a real-time clock. The latter attaches and operates like a peripheral device. An optional hardware floating-point arithmetic unit (FPU) is available for the 4/S and 4/X. The Nova 4 FPU is faster than previous Nova FPU's, executing a double-precision store in 200 nanoseconds and a double-precision add in 1.6 microseconds. An optional battery back-up system can support a single board of memory for 30 minutes on the 4/C and for 90 minutes on the 4/S and 4/X. Recharge time from the fully depleted state is 24 hours during normal CPU operation. One to two milliseconds are provided for the execution of a save routine during a power failure.

**CONTROL STORAGE:** None.

**REGISTERS:** All Nova 4 processors have four 16-bit accumulators and a 15-bit program counter. Two accumulators can be used for address indexing. The Nova 4 computers also have a last-in/first-out (LIFO) push-down stack implemented in any 256 consecutive memory locations and two additional hardware registers, the stack pointer and the frame pointer. The stack pointer identifies the first memory location designated as the stack, and the frame pointer marks intra-stack boundaries to permit several "register saves" to be accumulated in the stack.

The MMPU dual program maps are composed of 32 registers, each register controlling a 1K word space. ▶ The same is true for the 64 data channel map registers. ▶

## Data General Nova 4 Series

The optional Memory Allocation and Protection (MAP) feature performs logical to physical address translation using two user maps and two data channel maps. Only one user map can be enabled at any one time, but both data channel maps are enabled at the same time. In addition to translating addresses, the feature also performs various protection functions. A user is allowed to access only those blocks of memory allocated to him. The MAP also detects and inhibits indirect chains that go deeper than 16 levels, and provides I/O protection which allows all I/O devices to be declared accessible or inaccessible to a user.

The Nova 4 I/O bus is made up of a 6-line device selection network, interrupt circuitry, command circuitry, and 16 data lines. Each I/O device is connected to the device selection network in such a way that it will only respond to commands that contain its own device code. There are 54 device codes available. The interrupt circuitry of the I/O bus contains the capability to implement up to 16 levels of priority interrupts through a 16-bit priority mask.

Data General offers a comprehensive array of I/O devices for the Nova 4 computers, ranging from teletypewriters to line printers to video displays for man-machine interaction; and from paper tape to magnetic tape to fixed- and moving-head disks for data storage. Also available are various multiplexers and telecommunications adapters, including an IBM 360/370 interface.

### SOFTWARE AND SUPPORT

The Nova series features three operating systems—DOS, RTOS, and RDOS/Mapped RDOS. DOS, the Disc Operating System, is diskette-based, while RTOS, the Real-Time Operating System, is memory-based. Both DOS and RTOS are compatible subsets of RDOS, the Real-Time Disc Operating System, which is hard disc-based. Four high-level languages are available for the Nova Series: single- and multi-user Extended BASIC, Business BASIC, FORTRAN IV (with ISA real-time extensions), and optimizing FORTRAN 5. An extended assembler, macro assembler, symbolic debugger, communications package, and a library of utilities—sort/merge, plotting routines, commercial subroutines, and text editor—are also available.

In the area of data communications, Data General provides RJE80, the Remote Job Entry Control Program; HASP II, the remote batch terminal emulator; SAM, the Sensor Access Manager; and CAM, the Communications Access Manager. RJE80 and HASP II allow for remote job entry and communications between Nova processors and IBM 360/370 systems (in IBM 2780/3780 mode), or between Nova processors and other Data General computers. CAM supports all types of communications and is designed to work with such hardware units as the DCU/50 Data Control Unit and various asynchronous and synchronous multiplexers. ➤

➤ Beyond these hardware registers, Nova processors also have 16 reserved memory locations which function as auto-increment or auto-decrement registers when addressed indirectly.

**ADDRESSING MODES:** Direct addressing of 1024 words via absolute, relative, and indexed modes; multilevel indirect addressing of 32,768 words; stack addressing on a last-in, first-out basis and on a random-indexed basis.

When the MMPU is implemented, the 15-bit logical address coming from the CPU or data channel is translated to a 17-bit physical address. Memory access cycle time is unchanged.

The mapping information needed to service a CPU or data channel request is given to the address translation hardware by the operating system through I/O instructions that reference the address translation hardware. This information is transmitted before the supervisor enables either the user map or the data channel map.

All addresses can be mapped, including those acquired from DMA controllers.

**INSTRUCTION REPERTOIRE:** All Nova 4's have the same basic complement of 4 Jump and Modify Memory instructions, 2 Move Data instructions, 2 byte manipulation instructions, 7 stack processing instructions, 16 I/O instructions, and 8 arithmetic and logic instructions. (There are 256 variations on each of the arithmetic and logic instructions.) Hardware multiply/divide instructions and a floating-point unit are available as options.

The optional Floating-Point Unit adds 31 I/O-format instructions to the basic set; this option is not available for the Nova 4/C. The 4/X MMPU adds 10 I/O-format instructions.

**INSTRUCTION TIMINGS:** The following times are the averages of the maximum and minimum values, in microseconds, for Nova 4 processors with the standard 400-nanosecond NMOS memory.

Load/Store:	0.8/0.4
Add/Subtract:	0.2/0.2
Multiply/Divide	4.4/5.4
Compare and Branch:	0.2/1.2

**INTERRUPTS:** Each I/O device is wired to one of 16 bus positions, and can be either authorized or denied authorization to interrupt particular service routines by an Interrupt Disable Mask Bit that corresponds to the bus position of the device. I/O devices that operate at similar speeds are normally connected to the same mask bit. User-written routines can recognize and process up to 16 levels of priority interrupts.

**PROCESSOR MODES:** The Nova 4/X recognizes either a supervisor or user mode of program execution for use with the memory allocation and protection options. The executive program runs in the supervisor mode, and can write-protect portions of each user's memory area. With this option and operating in user mode, no user can write in a protected area, use more than 16 levels of indirect addressing, or issue I/O instructions.

The Nova 4/X provides four memory maps: two program maps and two data channel maps, each consisting of 32 2K-byte pages. All addresses can be mapped, including those acquired from DMA controllers.

**PHYSICAL SPECIFICATIONS:** All Nova 4 processors are housed in either 5.25-inch (5-slot) or 10.5-inch (16-slot) high chassis which are 19 inches wide and approximately 28 ➤

## Data General Nova 4 Series

➤ Data General provides its own maintenance and field support service through about 93 field service centers distributed nationwide, which employ more than 500 service personnel. Five depot locations—Framingham, Massachusetts; El Segundo, California; Toronto, Canada; Frankfurt, Germany; and London, England—provide comprehensive repair facilities.

With the growing popularity of small business computer systems, many turnkey systems vendors now offer custom solutions to business problems based on Nova series minicomputers.

Data General feels that in computational environments such as semiconductor testing, the economy and packaging of the Nova 4/C makes it well suited for incorporation into automated test equipment. The Nova 4/S is aimed at higher-performance applications, such as front-end processing in image processing systems. A processing system of this type could be expanded by adding a Multiprocessor Communications Adapter (MCA) for linking with other Data General Nova or Eclipse computers. The Nova 4/X supports dual operations under RDOS in areas such as retail or commercial applications. The 4/X can run a multi-terminal data entry program in the foreground while processing a remote job entry or local batch program in the background with full hardware and software protection.

Data General believes the Nova 4 line will compete successfully against DEC's PDP-11/34 and Hewlett-Packard's 1000 Series computers, stating that the Nova 4's offer substantial price/performance advantages over these competitive machines. □

➤ inches deep. Weights vary from 40 to 130 pounds fully loaded. The expansion chassis weighs 130 pounds fully loaded. Four AC line voltages are available: 100v, 120v, 220v, or 240v, all operable within the range of 47 to 63 Hz at maximum load. Power consumption is 1200 watts for a fully loaded 16-slot chassis. Recommended operating environment for the Nova 4 computer systems is between 68° F (20° C) and 86° F (30° C), but temperatures between 32° F (0° C) and 130° F (55° C) can be tolerated. Non-condensing humidity of up to 99% can be tolerated.

### INPUT/OUTPUT CONTROL

One (4/C) or two (4/S and 4/X) memory buses and a Direct Memory Access (DMA) channel are standard on all Nova 4's. Various high-speed options are available. The DMA data channel provides a multiplexer-like capability and can be seized by any device through a data channel request to handle 16-bit data transfers to and from main memory. In high-speed mode, the maximum word transfer rates per second are: Nova 4/C—625K in, 500K out; Nova 4/S and 4/X—1000K in, 710K out.

### CONFIGURATION RULES

The actual number of devices that can be attached to a particular Nova depends upon the available slots in the basic chassis and any available chassis extensions.

All processors occupy one slot. Any size memory module also occupies one slot. The price list at the end of this report

states the number of slots remaining after the processor and memory requirements for each particular configuration are satisfied. The multiply/divide feature and parity option share the same board as the CPU. The floating-point option requires one slot.

In general, all peripheral I/O interface subassemblies/controllers require one slot. These include applicable units for reel-to-reel magnetic tape drives, cassette drives, printers, punched card equipment, paper tape units, terminals, plotters, and disc units. Also requiring one slot each are the I/O interface subassembly for the bus control card, various communications controllers, and the DCU/50 and DCU/200 Data Control Units. The programmable interface to an IBM 360/370 requires two slots.

### MASS STORAGE

All Data General disc subsystems can be accessed by two controllers to allow dual-processor, shared-disc systems.

**6030 FLOPPY DISC SUBSYSTEM:** Consists of a four-drive controller and either a 6030 single drive or a 6031 dual drive. Each floppy disc stores up to 315K bytes on 77 tracks. Maximum storage capacity is 1.26 million bytes on a four-drive subsystem. Average head positioning time is 260 milliseconds, and average rotational delay is 83 milliseconds. Data transfer rate is 31K bytes/second. The 6030 drives feature IBM 3740 compatibility and are supported by Data General's RDOS operating system. The controller occupies one slot. The 6030 drives are manufactured by Data General.

**6063 AND 6064 FIXED-HEAD DG/DISC SUBSYSTEMS:** Consist of a four-drive controller plus up to four 1-megabyte 6063-A disc drives or up to four 2-megabyte 6064-A drives. Each sector contains 512 bytes. There are 32 sectors per track and either 32 tracks per surface (6063) or 64 tracks per surface (6064). Either subsystem can be expanded with 1- or 2-megabyte drives for a total of from 4 to 8 megabytes.

Average rotational delay is 10.22 milliseconds, and the data transfer rate is 910K bytes per second. The pack requires 10 seconds to come up to speed initially and 6 seconds to stop for removal.

**6060, 6061, AND 6067 DG/DISC STORAGE SUBSYSTEMS:** Consist of a 96-, 190-, or 50-megabyte disc pack drive and a controller for up to four drives. Thus, the same controller can handle from 50 to 760 megabytes of on-line storage. The drives are 3330-type units designed and manufactured by Data General at its Westbrook, Maine, facility. Model 6060 is a 96-megabyte drive, Model 6061 is capable of storing 190 megabytes, and Model 6067 is a 50-megabyte drive. Data density is 4040 bits per inch for all three drives, although their track densities are different. The drives employ a servo track-following technique that allows 192 tracks per inch for a total of 411 tracks per surface on the Model 6060, and 370 tracks per inch for a total of 815 tracks per surface on the Model 6061 and 6067. There is a total of 411 or 815 cylinders, each containing 19 tracks on the 6060 and 6061, or 5 tracks on the 6067.

The Model 6060 employs an IBM 3336-type pack, while the Model 6061 and 6067 utilize an IBM 3336-11-type pack. The 6060 and 6061 disc packs contain 10 platters with 19 usable surfaces, while the 6067 contains 3 platters with 5 usable surfaces. There are 24 sectors per track and 512 bytes per sector, yielding 12,288 bytes per track. Total surface capacity is either 5,050,368 or 10,014,720 bytes per surface, depending on the model. Total formatted drive capacity is 95,956,992 bytes for Model 6060, 190,279,680 bytes for Model 6061, and 50,073,600 bytes for Model 6067.

Disc rotational speed is 3600 rpm, and average rotational delay is 8.3 milliseconds. Track-to-track head positioning

## Data General Nova 4 Series

► time is 6 milliseconds, average head positioning time is 35 milliseconds, and average access time is 43.3 milliseconds.

The controller employed with these drives can handle up to four Model 6060, 6061, or 6067 drives in any combination. Software limitations restrict the number of controllers per system to two. The controller features independent command and read/write channels and reserve-and-trespass capabilities for users to transfer data. In multiple shared-disc environments, privileged file structures are allowed. An error correction feature makes it possible to detect and correct all error bursts of 11 bits or less.

These drives replace the 92-megabyte 4231A and B units that were manufactured by Control Data Corporation and utilized by Data General in the past. Due to formatting differences, the 4231A and B drives may not be intermixed with the 6060 or 6061 drives on the same controller. The new drives can be configured into any Eclipse system supported by the RDOS or AOS operating system. The drives feature a transfer rate of 806K bytes/second.

**6045/46/47/48 CARTRIDGE DISC SUBSYSTEMS:** Each subsystem consists of a controller and up to four 10-megabyte, top-loading cartridge disc drives. The four systems are being manufactured at Data General's Westbrook, Maine, facility. These subsystems, configured with one, two, three, and four cartridge disc drives, are respectively designated the Model 6045, 6046, 6047, and 6048.

Each drive employs two platters, one fixed and the other an IBM 5540-type removable cartridge, both mounted on a common spindle. Each platter is capable of storing 5,013,504 bytes, or 2,506,762 bytes per surface. There are 200 tracks per inch, 408 tracks per surface, 408 cylinders per drive, and 4 surfaces per drive. Recording density is 2200 bits per inch. All tracks are divided into 12 sectors of 512 bytes each, yielding a formatted track capacity of 6144 bytes. Each cylinder consists of four tracks, giving a formatted cylinder capacity of 24,576 bytes. Total drive capacity is 10,027,008 bytes.

Drive rotational speed is 2400 rpm. Track-to-track, average, and full-stroke head positioning times are 8, 38, and 70 milliseconds, respectively. The data transfer rate is 312,500 bytes per second. Drive start-up to full operating speed takes 30 seconds, and the drive requires 25 seconds to come to a full stop. All four subsystems are supported under the RDOS and RTOS operating systems.

An add-on drive, the Model 6050, allows field upgrading of already installed cartridge disc subsystems. Dual porting can be implemented by adding the Model 6051 option. The Model 6050-F is an add-on drive for an existing floppy disc subsystem. Any mix of floppy and cartridge disc drives up to a maximum of four is allowable. Likewise, floppy drives can be added to a previously installed cartridge disc subsystem. Diskette drives offer advantages in diagnostic program loading and compact file backup.

**6070 CARTRIDGE DISC SUBSYSTEM:** Consists of essentially the same components and specifications as the 6045 subsystem, except for a doubled recording density resulting in twice the storage capacity and a doubled transfer rate.

**6099 DG/DISC STORAGE SUBSYSTEM:** Consists of a Winchester-type 12.5-megabyte drive and controller. Two read/write heads access both surfaces of the single disc. Track density is 166 per inch for a total of 348 tracks per surface, and data density is 5760 bpi. The access mechanism is stepper motor driven, controlled by a microprocessor velocity determination algorithm that optimizes head acceleration and deceleration. The 6099 disc controller is located in the Nova 4 CPU. The rotational speed is 2964 rpm, with a data transfer rate of 910K bytes per second. The 6099

allows up to 16 logically contiguous sectors to be transferred with one I/O command. It is fully supported by RDOS.

## INPUT/OUTPUT UNITS

See Peripherals/Terminals table.

Data General is also an OEM peripherals supplier. Its OEM products are covered in Section M13 of *DATAPRO REPORTS ON MINICOMPUTERS*. Data General also provides a broad array of data acquisition, process control, and analog/digital I/O equipment.

## COMMUNICATIONS CONTROL

The DG/CS Communications Subsystem is a hardware and software system that is modular in nature. It is composed of the ALM-16 and ALM-8 Series asynchronous multiplexers, the SLM-2 Series asynchronous multiplexers, the 4251 Communications Chassis, and the DCU/50 or DCU/200 Data Control Unit. The CAM Communications Access Manager provides software support for teletypewriter terminals and Bisync line protocol.

Low-to-medium-performance applications use the appropriate multiplexers in the 4251 chassis, which is connected directly to the host computer I/O bus. For high-performance applications, the DCU/50 is inserted as a "peripheral processor" between the host CPU and the communications subsystem.

The DG/CS supports both full- and half-duplex operation. Line interface support is provided for EIA RS-232C/CCITT V.24, 20-ma current loop, and 23-ma current loop.

The DG/CS is supported by the RDOS, mapped RDOS, and RTOS operating systems. Other software support includes Data General's HASP Work Station Emulator, DCU-resident physical I/O routines, and the aforementioned CAM.

**DCU/50 DATA CONTROL UNIT:** Provides a dedicated communications controller consisting of a Nova processor with a local 1K words of memory on a single card that plugs into the host computer chassis. A DMA interface to the host allows any of the host memory to be "windowed" into the DCU/50 address space above 4K to give the DCU access to the host processor's communications buffers without the need to interrupt the host. Communications with the various asynchronous and synchronous line multiplexers is via the DCU/50's I/O bus (separate from that of the host). Control of these multiplexers is in parallel with the main processor. The DCU/50 can be programmed for composite throughputs of up to 48K characters per second over up to 256 asynchronous or synchronous lines. Programming of the DCU/50 can also handle unique protocols and character processing functions. Multiple DCU/50's can be connected to a single Eclipse processor for increased communications loads.

A single DCU/50 can provide 10,000 to 12,000 characters per second of communications throughput with an average of 10 percent computer overhead. The unit is normally used to perform all character-level interrupt processing, control character processing, code translation, error checking, and buffer maintenance.

**DCU/200 DATA CONTROL UNIT:** This unit has essentially the same capabilities as the DCU/50, except that it has 4K words of local memory compared to the DCU/50's 1K words, and a 400-nanosecond rather than a 300-nanosecond memory cycle. The DCU/200 acts as an intelligent front end to the processor for communications and sensor I/O applications, off-loading interrupt processing, line protocol, and error-control chores for greater system throughput. ►

## Data General Nova 4 Series

► **4263/4264 SLM-2 SYNCHRONOUS LINE MULTIPLEXER:** Provides one or two lines with speeds of up to 9600 bps as a stand-alone unit or up to 56,000 bps in conjunction with the DCU/50 and an optional high-speed interface for Bell 303 Series modems. Line operation may be either full- or half-duplex. Full character buffering is offered.

Programmable line characteristics include parity type (even, odd, or none); 6-, 7-, or 8-bit code level; SYN (synchronous) and DLE (delete) characters; transmitter/receiver on or off; and either CRC-16 or CCITT-16 cyclic redundancy check (CRC) polynomials, if the optional CRC Generator/Checker is installed. The internal clock is jumper-selectable to one of eight frequencies from 300 bps to 56,000 bps. Modem control is offered for Bell 201, 203, 208, 209, and 303 or equivalent data sets. Modem control signals include carrier detect, data set ready, ring indicator, request to send, data terminals ready, and clear to send. The RS-232C/CCITT V.24 interface is standard, while an interface for a Bell 303 is optional.

Up to 32 synchronous lines can be supported with the DCU/50 or DCU/200 using 4263 dual-line SLM-2's. Off-line error detection and diagnostics are a standard feature.

**4255/4256 ALM-8 ASYNCHRONOUS LINE MULTIPLEXER:** Offers a line speed of 5 to 9600 bps on a program-selectable basis. The 4255 offers eight lines, while the 4256 offers four. Full-character buffering is standard. Line operation may be full- or half-duplex. Full modem control, including automatic answer capabilities for Bell 103, 202, or equivalent data sets, is standard. Modem control signals include carrier detect, ring indicator, data set ready, request to send, data terminal ready, and clear to send.

Programmable line characteristics include parity type (odd, even, or none); 5-, 6-, 7-, or 8-bit code level; 1 or 2 stop bits; and the aforementioned line speed. Diagnostics and error detection on an off-line basis are standard. Up to 128 asynchronous lines can be supported with the DCU/50 or DCU/200 and the 4255's. The EIA RS-232C/CCITT V.24 interface is standard.

**4257/4258 ALM-16 ASYNCHRONOUS LINE MULTIPLEXER:** Provides a line speed of 5 to 9600 bps on a program-selectable basis. The 4257 handles 16 lines, while the 4258 handles 8. Full-character buffering is standard. Line operation may be full- or half-duplex. Programmable line characteristics include parity type (odd, even, or none); 5-, 6-, 7-, or 8-bit code level; 1 or 2 stop bits; and the aforementioned line speed. Diagnostics and error detection on an off-line basis are standard. Up to 256 asynchronous lines can be supported with either the DCU/50 or DCU/200 and any combination of the 4257 or 4258. Interfacing is by the 4260 4-line, 20-ma current loop module or the 4261 4-line, EIA RS-232C/CCITT V.24 module. Both modules can be intermixed on the same ALM-16 board. Interfacing is also available to a Bell 103 data set for manual answer-only operations.

**4010 ASYNCHRONOUS LINE CONTROLLER:** Provides a full-duplex current-loop interface for a local 33 ASR, 33 KSR, 35 ASR, or 35 KSR teletypewriter, a local 6012 video display, or a Bell 103 or equivalent data set through the 4023 EIA interface. The 4029 interface provides control for Bell 103, 202, or equivalent data sets with automatic or manual answer. Clock signals required for the 4023 interface are jumper-selectable. Ten standard frequencies between 75 and 9600 bps are available.

**4023 ASYNCHRONOUS SINGLE-LINE CONTROLLER:** Provides a full-duplex interface for a single Teletype Model 37ASR or 37KSR; 6012 CRT display; or Bell System 103, or equivalent, with manual answer. Standard rate is 150 bps for

10- or 11-unit codes. Other rates are optionally available. The 4029 option adds modem control features for Bell System 202 units with Automatic Answer.

**4025 IBM 360/370 PROGRAMMABLE INTERFACE:** Attaches to an IBM selector or multiplexer channel, and can simulate the IBM 2803, 2700 series, etc. Operates in multiplexed or burst mode at up to 150,000 bytes per second. A 4025 IBM Software Driver is provided for I/O programming. The 4025 can operate with RDOS or RTOS in a real-time environment. On-line and off-line diagnostics are provided.

**4061 ASYNCHRONOUS MULTIPLEXER:** Provides interfaces for up to 64 lines (4 lines per subassembly) at speeds from 45 to 9600 bits per second with 5- to 8-level codes. The 4061 is wired with junction panels to provide system expansion capabilities.

**4206 MULTIPROCESSOR COMMUNICATIONS ADAPTER:** Interconnects up to 15 Nova central processors into multiprocessor rings. The 4206 features simultaneous program-controlled data transmission and reception. Two jumper-selectable modes of operation are available: normal and fast. In normal mode, data is transferred at 625,000 bytes per second. In fast mode, up to 1 million bytes of data are transferred per second. Up to 15 computers are supported in normal mode, while a maximum of four can be sustained in fast mode. The 4206 is fully supported by RTOS and RDOS.

### COMMUNICATIONS SOFTWARE

**COMMUNICATIONS ACCESS MANAGER (CAM):** Supports all types of communications, with or without the DCU/50 or DCU/200 Data Control Unit. SLM-2, ALM-8, and ALM-16 line multiplexers are supported under CAM, as well as the DCU units. CAM is modular and can be generated by the Communications System Generation Program (COMGEN) to include only those program segments required for each individual system. It operates under RTOS, RDOS, or mapped RDOS, and since it uses the operating system's runtime-defined interrupt service, it is brought into main memory from disc only as needed. This frees large segments of memory in a real-time communications system for other processing tasks. Portions of CAM can also reside in the memory of the DCU/50 or DCU/200, if either is present, further reducing main memory overhead.

CAM software can support both standard and special user-defined protocols, including Bisync (BSC) and an asynchronous terminal line procedure. Synchronous and asynchronous protocols can be intermixed. Multi-drop lines are supported through polling and selection sequences. Modem control support for auto answer/auto disconnect is a standard feature. CAM provides a queue for I/O completions that permits a single user task to control several asynchronous lines.

CAM also features a FORTRAN IV or FORTRAN 5 interface, permitting communications I/O in FORTRAN programs.

CAM operates on any Nova processor with 32K bytes of main memory, a real-time clock, and a communications chassis which includes at least one SLM-2, ALM-8, or ALM-16.

**REMOTE JOB ENTRY CONTROL PROGRAM (RJE80):** Allows for remote job entry and communications between Nova processors and IBM 360/370 systems, or between Nova processors and other Data General computers. Support is provided for four types of RJE systems:

- Point-to-point communications between a Nova or Eclipse emulating an IBM 2780/3780 and an IBM 360/370 host. ►

## Data General Nova 4 Series

- ▶ ● Point-to-point communications between two Data General systems running RJE80.
- Multi-drop Data General systems emulating IBM 3780 slave terminals, communicating with an IBM 360/370 host.
- Multi-drop Data General Systems emulating IBM 3780 slave terminals, communicating with a Nova or Eclipse master system also running RJE80.

RJE80 running under mapped RDOS also allows a user to run one application in either the foreground or background mode while RJE80 runs independently in either mode.

RJE80 is supported by RTOS, RDOS, and mapped RDOS, as well as CAM. Features include horizontal and vertical printer format control; error detection on transmission and reception; and disc, tape, or card transmission to remote systems. Transmission between host systems may be to unattended RJE80 systems, and because of device-independent I/O capabilities, any combination of I/O devices can be utilized without additional software.

Under RTOS, RJE80 requires a 32K-byte Nova with a card reader, line printer, console terminal, real-time clock, 4251 or 4252 communications chassis, and an SLM-2 Synchronous Line Multiplexer.

Under RDOS, RJE80 requires a 48K-byte Nova with 512K bytes of disc storage, a line printer, a console terminal, a real-time clock, a 4251 or 4252 communications chassis, and an SLM-2 Synchronous Line Multiplexer. RJE80 can handle line speeds up to 9600 bps with the SLM-2 or up to 56K bps with the DCU/50 or DCU/200 Data Control Unit and SLM-2 combination. Any modem of the Bell 201, 203, 208, 209, or 303 type, or equivalent, can be utilized.

A library of communications software is available for operation under RDOS, Mapped RDOS, or RTOS. The library includes a Binary Synchronous Communications package callable from FORTRAN programs, device-independent drivers for intercomputer communications, particular multi-processor Data General configurations, and direct channel interfacing to an IBM 360 or 370 system.

## SOFTWARE

**OPERATING SYSTEMS:** Four levels of system control programming are available for various configurations of the Nova systems. Each of these includes an appropriate level of language processors and utility programs.

*Real-Time Disc Operating System (RDOS)* is a full-scale operating system that supports multi-tasking. It can schedule and allocate program resources to many different sub-program tasks. It is a comprehensive, modular system with a system generation procedure allowing the user to tailor the operating system to his hardware configuration and his application.

RDOS can be used either interactively from a console keyboard or in batch mode from job streams entered via card readers, disc files, cassette files, or magnetic tape files. RDOS can simultaneously support both foreground and background tasks, so that users can run two jobs at the same time. The higher-priority job, which is normally a real-time or response-dependent application program, is run in the foreground, while the lower-priority job is run in the background. Data from a background job is typically processed while waiting for an event or for data from the foreground job. Background mode can also be used to develop new programs without interrupting ongoing jobs. Foreground and background programs can be hardware-protected from each other and from the operating system.

RDOS includes a multi-partitioning system that gives users flexibility in overlaying programs from disc into main memory. Large user programs can be segmented into disc-resident overlays to allow efficient use of main memory and to make the programs more manageable. Tasks stored on the disc occupy main memory only when they are ready for execution. The dual-processor, shared-disc feature allows RDOS users to share peripherals and to access common data and programs on disc.

Also available to RDOS users is the Batch command interpreter and job supervisor. Batch calls in and controls execution of user and system programs. Any program that an on-line user can execute interactively from the console can be called. The Batch processor is not an integral part of RDOS and occupies no main memory when it is not being run.

RDOS supports Business BASIC, Extended BASIC, and Extended FORTRAN IV and 5.

RDOS operates on any Data General minicomputer with 16K words of main memory, a teletypewriter, and a disk. In addition, RDOS can support additional memory (up to 32K words), 8 disk cartridges or disk pack drives, and 8 magnetic tape transports (either 7- or 9-track). Card readers, line printers, communications equipment, and analog and digital conversion equipment are also supported.

*Mapped RDOS* is available on the Nova 4/X to support two-partition multiprogramming with 32K-word user program areas and an operating system area of up to 32K words (typical size is 8K to 12K words). Mapped RDOS provides an extensive file management capability. It features a common I/O interface, checkpointing for a background task, program segmentation, communication between tasks, and compatibility with RTOS and DOS. Mapped RDOS supports systems of up to 128K words, with each partition protected from the remainder of main memory. Mapped RDOS foreground/background designations are merely a reference to the usual priority designations, which are set up by the user and can be altered at any time. The two partitions could even be given equal priority.

*Real-Time Operating System (RTOS)* is an upward-compatible subset of the Real-Time Disc Operating System (RDOS). RTOS provides standard interrupt servicing, device handling, and executive scheduling functions. Supporting a multi-tasking environment, RTOS sets up multiple execution paths to perform functions nonsequentially. Tasks are scheduled based on their need to use the processor or I/O devices and the availability of those devices. When more than one task is ready to execute, a multi-level priority structure determines processing sequence by insuring that the highest-priority function is serviced first.

RTOS is modular and re-entrant, and provides the user with a library of modules for system, task, and device processing. It also provides executive functions that schedule task execution. Tasks are scheduled under program or operator control, either after a given time delay, periodically by a real-time clock, or in response to an external event. Once a task begins execution, the task can modify its own priority, can terminate or delay its execution, or can suspend, awaiting the completion of an I/O operation.

In an RTOS-controlled application, asynchronous tasks communicate with each other through an intertask message mechanism. This communication capability makes it possible to coordinate parallel activities controlling the user environment.

RTOS runs on a minimum configuration of 8K words of memory and a real-time clock. It will also support up to 32K words of memory, multiple teletypewriters or CRT's, fixed- and moving-head discs, magnetic and cassette tape trans-

## Data General Nova 4 Series

► ports, paper tape reader/punches, card readers, line printers, plotters, process I/O equipment, and asynchronous, synchronous, and intercomputer controllers.

Real-time support for the Extended and Macro Assemblers and FORTRAN IV is available under RTOS.

*Disc Operating System (DOS)* is another upward-compatible subset of the Real-Time Disc Operating System (RDOS). DOS is diskette-based and provides medium-scale program development on a small-scale system. Like its larger brothers, DOS is memory- and file-based. Features provided by DOS include a comprehensive disc and tape file system, device-independent file transparency, multitasking facilities, user program segmentation, and interactive program development via the DOS Command Line Interpreter (CLI). Besides CLI, DOS operates with other Data General system software including the text editor, library file editor, and relocatable loader. DOS supports up to 32K words of memory and the full range of peripherals available from Data General.

Languages operational under DOS include the Macro and Extended Assemblers, BASIC Interpreter, and FORTRAN IV Compiler. File management is provided for both random-access and fixed-length sequential files. A multi-task scheduler provides for user-written programs designed to handle multiple terminals, instrumentation and control processes, and complex communications schedulers. Three methods of user program segmentation are employed: chaining, swapping, and overlaying.

DOS requires a Nova with a minimum of 16K words of memory, a real-time clock, a single diskette drive and controller, and a terminal. This configuration can be utilized for user program execution and program development with the Extended Assembler. However, a dual-diskette system is required for DOS generation and for software development using BASIC, FORTRAN IV, or the Macro Assembler.

**LANGUAGES:** Four high-level compiler languages are available for use on Nova computers: Extended FORTRAN 5, Real-Time FORTRAN IV, single- and multi-user Extended BASIC, and Business BASIC.

*FORTRAN 5* is a superset of Data General's FORTRAN IV, ANSI FORTRAN, IBM FORTRAN IV (H Extended), and Univac FORTRAN V. Special compiler features include global code optimization, comprehensive error checking and diagnostics, and re-entrant code. Language extensions beyond ANSI FORTRAN include static and dynamic storage allocation, statement functions expanded as in-line code, data initialization in DIMENSION and data type statements, implied DO loops, flexible declaration order, double-precision and complex arithmetic, IMPLICIT statements, Include statement, full mixed-mode arithmetic, extended array manipulation capabilities, generic library functions, simplified I/O, bit manipulation, and multi-tasking capability.

FORTRAN 5 operates on any Data General minicomputer running under RDOS. It requires a minimum of 32K words of main memory, hardware multiply/divide, the floating-point processor, 512K words of disc storage, and a console terminal. FORTRAN 5 software is supplied on either cassette tape or magnetic tape and requires the appropriate tape drive to interface with the system. Conversational I/O requires a printer terminal or video display console.

*Extended BASIC* has all the features of Time-Sharing BASIC as well as extended facilities that allow access to Data General I/O peripherals for both data and program files. Supported peripherals include: high-speed paper tape reader/punch, line printer, fixed-head discs, and moving-head disc pack and disc cartridge drives.

Five versions of the Extended BASIC system include:

- Single-user with disc,
- Single-user without disc,
- Multi-user (non-swapping) with disc,
- Multi-user (non-swapping) without disc, and
- Multi-user (swapping) with disc.

The swapping version of Extended BASIC will time-slice main memory among multiple users. Extended BASIC operates under RDOS or DOS.

*Business BASIC*, developed as a spin-off of the still-viable RDOS Extended BASIC, can be run under RDOS or Mapped RDOS. Mapped RDOS users can run Business BASIC as a time-sharing system in one partition while concurrently running a batch, time-sharing, or real-time job in the second partition. Extensions to BASIC for business applications in multiple-terminal environments include a multiple-keyed indexed sequential file access method, dynamic record allocation, six-character variable names, common area, direct block I/O, and commercial string functions. Business BASIC uses double-precision integer arithmetic, maintaining accuracy to  $\pm 21,474,836.47$  and eliminating the rounding problem of floating-point arithmetic. Print formatting statements allow output strings to be left or right justified, filled with a character, or truncated. They also handle decimal points, fixed and floating signs, and zero suppression.

Business BASIC provides access to standard RDOS sequential, random, and contiguous files, but also provides its own multiple-keyed indexed sequential file structure for keyed data access. Each ISAM index is a separate, balanced tree-structured file, and multiple indices may have access to the same data file. Data records can be allocated to disc dynamically. Both index and data files have lock and unlock protection. Record lockout provides file integrity when files are accessible by multiple users. An optional interface to the INFOS data management system is available for use with commercial Eclipse systems. Files created with this interface are compatible with INFOS ISAM and DBAM files created by COBOL, FORTRAN IV, FORTRAN 5, and the Idea data entry software.

Program development features include the RENUMBER statement for the entire program, the RUNUM statement for specific line numbers, and the VAR statement for a sorted listing of all variables used in a program. A cross-reference listing can also be produced. An attach and de-attach facility lets a user start a job at a terminal and then de-attach it to run independently of any terminal, so that the user can work on other programs at the same terminal. For file maintenance, Business BASIC statements allow files to be sorted on disc and allow editing of ASCII text files. The file maintenance package also supports simultaneous creation, modification, and accessing of files by multiple users. A set of utility programs is provided to simplify program development and aid documentation. System security is maintained by statements that can prevent users from accidentally accessing Business BASIC at the monitor level.

The minimum equipment configuration required for Business BASIC is any Nova 4 computer licensed to run RDOS, with 64K bytes of memory, any Data General terminal, a real-time clock, and 10 megabytes of disc storage.

The *Extended Assembler* is similar to the basic Nova Absolute Assembler in that it converts symbolic assembly statements into machine-executable code. In addition to the Absolute Assembler features, the Extended Assembler also provides relocation, interprogram communication, conditional assembly, and more powerful number definition facilities. ►

## Data General Nova 4 Series

► The *Macro Assembler* adds extensive macro capabilities to the facilities of the Extended Assembler.

**UTILITIES:** A library of utility programs for Nova 4 systems includes the FORTRAN Commercial Subroutine Package, a superset of IBM's CSP for data and format conversion and extended-precision integer arithmetic. Also included are a batch job control supervisor for executing stacked jobs; a real-time I/O system to support A-D and D-A interfaces and RDOS sort/merge; a text editor for 1 to 20 users; a symbolic debugger; Dataplot, a set of FORTRAN-callable routines for line drawing and axis rotation on digital plotters; and three editing programs—the Macro Editor, the Library File Editor (LFE), and the Octal Editor (OEDIT).

Utilizing simple command string input, the *Macro Editor* edits paper tape input to produce updated paper tape output. The user may define command strings in a special macro register. The command string may then be executed repeatedly by specifying the macro register name in subsequent command strings. A common application for the Macro Editor is the modification of program source tapes in preparation for a new assembly.

*LFE* allows the user to analyze the contents of a given library file, to merge and update libraries, and to create his own library files.

*OEDIT* permits the user to examine and modify, in octal, locations on a disc file. A common use of *OEDIT* is in making simple changes to executable saved files.

**APPLICATIONS:** No separate applications packages have been announced for the Nova systems to date. Other software consists of about 20 mathematical routines, more than 24 CPU and peripheral device diagnostics, and a variety of language processor libraries, format conversion routines, etc.

## PRICING

**POLICY:** Data General offers the Nova series on a purchase-only basis, with two types of separately priced maintenance agreements: the On-Call Service contract and the Depot Service contract, which involves return of faulty equipment to a designated repair location. In either case, all parts and labor are included at no additional cost.

Normal prime-time on-call contract service hours are 9 a.m. to 5 p.m. Charges quoted in the price list are applicable to customers within 100 miles of a service center. Additional but uniform monthly charges are in effect beyond 100 miles of a Data General service center. These charges are \$150 for customers between 100 and 300 miles from the center and \$225 for customers beyond 300 miles.

Under a Depot Service contract, any portion of a system may be covered, the minimum contract being \$75. The customer assumes all transportation and insurance costs. For non-contract on-site service, the hourly maintenance rates are \$40 for prime time and \$48 for all other times. A \$135 regular-time or \$165 premium-time minimum charge applies. Depot service hourly labor charges are \$45 for prime time and \$55 for all other times.

Most of the Data General software is unbundled and offered at license fees which are listed in the "Software Prices" section at the end of this report. One-day on-site consulting service, including RDOS system generation, is billable at \$300 plus transportation costs from the nearest office, except for systems costing over \$30,000 with a high-speed input device, where the service is free.

The Data General Software Subscription Service provides automatic updates and documentation for Data General software at a price ranging from \$50 to \$350 per software product, and for \$75 per product on any order totalling \$1,000 or more.

The Hardware Subscription Service provides automatic updates, additions, and notification of new documentation on all Data General hardware for a fixed yearly fee. It is available to any owner of Data General equipment. This includes owners who have purchased their equipment through another vendor. Initial subscriptions include updates for one year. Prices are as follows: Nova processors, \$980; peripherals, \$920; and communications and I/O, \$920. Additional log books for any of the above topics are \$500 each without updates. Yearly renewal rates are \$480 for Nova processors, \$420 for peripherals, and \$420 for communications and I/O. A 40 percent discount applies for additional updates beyond the first to the same type of log book, ordered at the same time and deliverable to the same address.

Data General provides training courses for customers at its Southboro, Massachusetts, headquarters, at its Western Training Center in El Segundo, California, and at its United Kingdom Training Center in Greenford, Middlesex, England. Two training credits are given for each system purchased (end user) or two training credits per purchase agreement (OEM). One training credit entitles a customer to approximately one man-week of training. Schedules for training courses can be obtained at any Data General field office.

Courses currently being offered include: Introduction to Small Computers, 3 days, \$175; Introduction to Assembly Language Programming, 10 days, \$625; Assembly Language Program Implementation, 5 days, \$325; FORTRAN Program Implementation, 5 days, \$325; RTOS, 5 days, \$325; RDOS Assembly, 5 days, \$325; RDOS FORTRAN, 5 days, \$325; RDOS Systems Programming, 5 days, \$375; Real-Time FORTRAN for Industrial Control, 3 days, \$225; Small Computer Hardware Fundamentals, 5 days, \$300; Nova Multiply/Divide Option, 2 days, \$150; Floating-Point Unit Option, 3 days, \$225; Basic I/O Interfacing, 2 days, \$150; Magnetic Tape, 3 days, \$275; Data General Cassette, 2 days, \$175; Moving-Head Disc, 3 days, \$275; Line Printer, 2 days, \$175; and Card Reader, 2 days, \$175.

On-site training is available when necessary. Costs involve \$600 per day (with a three-day minimum) for instructional charges including the instructor's daily expenses, instructor's travel expenses, \$100 per weekend for subsistence when incurred, and a per-student charge for actual documentation used.

The Data General Users' Group provides a forum for interchange of programs. The programs are available for a fee to cover reproduction and distribution costs.

Prices shown in the Equipment Prices list are for single-unit quantities. Standard OEM three-to-five quantity discounts of 19 percent apply. Discounts of about 40 percent are available for quantities for 200 or more units. Third-party leases are available.

**EQUIPMENT:** The following system purchase prices include all required control units, adapters, and cables.

**MODEL 8390-H:** Consists of a Nova 4/C with 64K bytes of MOS memory, asynchronous interface, automatic program load, power fail/auto restart, and 5-slot chassis. Purchase price is \$3,500.

**MODEL 8393-H:** Consists of a Nova 4/S with 64K bytes of MOS memory, asynchronous interface, real-time clock, automatic program load, power fail/auto restart, and 16-slot chassis. Purchase price is \$7,600.

**MODEL 8395-N:** Consists of a Nova 4/X with 256K bytes of MOS memory, floating-point processor, MPMU, asynchronous interface, real-time clock, automatic program load, power fail/auto restart, 16-slot chassis, battery backup, 20-megabyte disc with six cartridges, 800-bpi, 75-ips magnetic tape subsystem, 180-cps LP2 printer, four 6053 displays, and 2-bay cabinet. Purchase price is \$56,886. ■

## Data General Nova 4 Series

### EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
<b>PROCESSORS</b>			
All Nova 4 systems include four hardware accumulators, I/O system with programmed data transfer, 16-level programmed priority interrupt, DMA channel, virtual console, asynchronous interface, automatic program load, and power fail/auto restart.			
Model 4C systems include an extended stack facility.			
8390-G	Model 4/C with 32K bytes of MOS memory, 4 available slots	\$ 2,800	\$ 45
8391-G	Model 4/C with 32K bytes of MOS memory, 15 available slots	4,400	56
8390-H	Model 4/C with 64K bytes of MOS memory, 4 available slots	3,500	50
8391-H	Model 4/C with 64K bytes of MOS memory, 15 available slots	5,100	61
Model 4/S systems also include a real-time clock, an extended hardware stack facility, and four-way interleaved memory.			
8392-G	Model 4/S with 32K bytes of MOS memory, 4 available slots	5,800	56
8393-G	Model 4/S with 32K bytes of MOS memory, 15 available slots	7,000	67
8392-H	Model 4/S with 64K bytes of MOS memory, 4 available slots	6,400	64
8393-H	Model 4/S with 64K bytes of MOS memory, 15 available slots	7,600	75
Model 4/X systems also include an MMPU.			
8394-K	Model 4/X with 128K bytes of MOS memory, 4 available slots	10,400	78
8395-K	Model 4/X with 128K bytes of MOS memory, 15 available slots	11,600	94
8394-N	Model 4/X with 256K bytes of MOS memory, 4 available slots	13,100	102
8395-N	Model 4/X with 256K bytes of MOS memory, 15 available slots	14,300	118
<b>PROCESSOR OPTIONS</b>			
8380	Battery Backup	500	3
8381	Real-Time Clock (4/C only)	400	4
8382	Signed and Unsigned Multiply/Divide	750	6
8383	Multiply/Divide and Real-Time Clock (4/C only)	1,150	10
8388	Floating-Point Unit (4/S or 4/X with 16 slots only)	3,000	25
<b>MULTIPROCESSOR OPTIONS</b>			
8080	I/O Bus Switch Chassis with 14 I/O slots, power supply, selector switch for two computers	4,500	45
8081	Bus Control Card for connecting computer I/O bus to Bus Switch Chassis; two normally required	1,700	17
<b>EXPANSION MEMORY</b>			
8384	32K-byte MOS module (4/S or 4/X only)	2,200	20
8385	64K-byte MOS module (4/X only)	3,000	28
8386	128K-byte MOS module (4/X only)	5,000	42
<b>MASS STORAGE</b>			
6060	DG Disk Storage Subsystem; includes 96-megabyte disc pack drive and controller for up to four 50-, 96-, and/or 190-megabyte drives; one 3336-type disc pack is included	25,800	220
6060A	Add on 96-megabyte disc pack drive	20,800	160
6061	DG Disc Storage Subsystem; includes 190-megabyte disc pack drive and controller for up to four 96- and/or 190-megabyte drives, one 3336-11 type disc pack is included	31,000	220
6061A	Add on 190-megabyte disc drive	26,000	160
6062	Dual Port for 6060 or 6061; includes controller	6,000	50
6067	DG/Disc Storage Subsystem; includes 50-megabyte disc pack drive and controller for up to four drives, and one 3330-11 disc pack	21,800	190
6067A	Add on 50-megabyte disc drive	14,800	140
6099	DG/Disc Storage Subsystem; includes 12.5-megabyte disc pack drive and controller	5,100	41
6045	DG 10-megabyte Cartridge Disc Subsystem; includes one cartridge disc drive with 5 megabytes each of fixed and removable disc storage, controller for four drives, and one certified disc cartridge	10,100	120
6046	DG 20-megabyte Cartridge Disc Subsystem; consists of a 6045 system with two drives and two certified disc cartridges	18,250	200
6047	DG 30-megabyte Cartridge Disc Subsystem; consists of a 6045 system with three drives and three certified disc cartridges	26,400	280
6048	DG 40-megabyte Cartridge Disc Subsystem; consists of a 6045 system with four drives and four certified disc cartridges	34,550	360

## Data General Nova 4 Series

## EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
<b>MASS STORAGE (Continued)</b>			
6050	Add-on 10-megabyte cartridge disc drive for 6045 or 6047 subsystem; includes power supply and one certified disc cartridge	9,000	80
6050F	Add-on 10-megabyte cartridge disc drive for an existing floppy disc subsystem; includes power supply and one certified disc cartridge	9,600	115
6051	Dual port option for 6045, 6046, or 6047 subsystem; includes controller	4,500	50
6070	DG 20-megabyte Cartridge Disc Subsystem; includes one cartridge disc drive with 10 megabytes each of fixed and removable disc storage, controller for four drives, and six disc cartridges	13,500	140
6070B	Same as 6070 except 2 disc drives	21,500	230
6070C	Same as 6070 except 3 disc drives	29,500	320
6070D	Same as 6070 except 4 disc drives	37,500	410
6070A	Add-on removable 20-megabyte disk cartridge for 6070, 6070B, or 6070C	10,300	90
6070E	Dual port option for 6070, 6070B, 6070C, or 6070D	4,500	50
6063	DG Fixed-Head Disc Storage Subsystem; includes 1-megabyte pack disc drive and controller for up to four 1- and/or 2-megabyte drives	9,900	90
6063A	Add-on 1-megabyte disc pack	7,900	80
6064	Same as 6063 except 2-megabyte drive	13,900	125
6064A	Same as 6063A except 2-megabyte drive	11,900	115
6066	Four-megabyte subsystem; consists of 6064 and 6064A	23,800	240
6030	Dual diskette subsystem including two drives with power supply and control for up to four drives	3,900	45
6030A	Add-on dual diskette drives with chassis and power supply; for single or dual diskette subsystems	3,400	40
6030B	Add-on dual diskette drives with chassis and power supply; for addition to a 10-megabyte cartridge disc subsystem	3,400	40
6031	Single diskette subsystem including drive with power supply and control for up to four drives	2,900	40
6031A	Add-on single diskette drive with chassis and power supply; for single or dual diskette subsystems	2,400	35
6031B	Add-on single diskette drive with chassis and power supply; for addition to a 10-megabyte cartridge disc subsystem	2,400	35
<b>MAGNETIC TAPE EQUIPMENT</b>			
6020	Magnetic tape subsystem; includes 7-track, 75-ips tape transport, switch-selectable at 556 or 800 bpi, and control for up to eight drives	9,900	90
6022	Add-on magnetic tape transport; 7-track, 75-ips, switch-selectable at 556 or 800 bpi	6,700	65
6021	Magnetic tape subsystem; includes 9-track, 75-ips tape transport, switch-selectable at 556 or 800 bpi, and control for up to eight drives	9,900	90
6023	Add-on magnetic tape transport; 9-track, 75-ips, switch-selectable at 556 or 800 bpi	6,700	65
6026	Magnetic tape subsystem; includes 9-track, 75-ips tape transport, switch-selectable at 800 or 1600 bpi, and control for up to eight transports	14,500	115
6026A	Add-on magnetic tape transport for use in a 6026 or 6027 magnetic tape subsystem	10,300	85
6027	Same as 6026 except 800 bpi only	10,900	100
<b>LINE PRINTERS/PLOTTERS</b>			
4215	Line printer subsystem; includes 600-lpm, 136-column, 64-character-set printer and controller	18,000	110
4216	Line printer subsystem; includes 436-lpm, 136-column, 96-character-set printer and controller	19,900	115
4218	Line printer subsystem; includes 300-lpm, 136-column, 64-character-set printer and controller	12,500	85
4219	Line printer subsystem; includes 240-lpm, 136-column 96-character-set printer and controller	14,400	90
4217	Programmable Interval Timer for 4215, 4216, 4218, or 4219 subsystem	900	6
4244	Line printer subsystem; includes 900-lpm, 136-column, 64-character-set, 6/8-line-per-inch printer and controller	25,500	174
4245	Same as 4244 except 660-lpm, 96-character set	27,000	181
4014	I/O interface subassembly; must be ordered with incremental plotter control and/or line printer control	200	4
4017	Incremental plotter control for all 4017 Series plotters	1,500	10
4017E	Incremental plotter with Z-fold paper; 11-inch paper, 300 steps per second; step size 0.005 inch (4017E), 0.01 inch (4017E-A), 0.10 mm (4017E-B), or 0.25 mm (4017E-C)	5,000	100

## Data General Nova 4 Series

### EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
<b>LINE PRINTERS/PLOTTERS (Continued)</b>			
6086	Dasher LP2 Serial 7 x 9 matrix printer; 64-character set, 180 cps; bidirectional, logic-seeking; up to 132 characters per line; 6/8 lines per inch	3,950	45
6087	Same as 6086 except condensed and expanded/condensed printing	4,050	46
6088	Same as 6086 except data channel subsystem with data channel subsystem with data channel controller	4,650	51
6089	Same as 6088 except condensed and expanded/condensed printing	4,800	52
<b>PAPER TAPE EQUIPMENT</b>			
4007	I/O interface subassembly; must be ordered with paper tape reader control (4011) and/or paper tape punch control (4012)	200	4
4011	Paper tape reader control for 6013 reader	850	9
6013	High-speed paper tape reader; 400 cps, fanfold, 8-channel tape	1,150	12
4012	Paper tape punch control for 4012A punch	700	8
4012A	High-speed paper tape punch; 63.3 cps, fanfold, 8-channel paper tape	2,400	12
4012B	Same as 4012A but for use with 4013 remote-operation modification	2,400	12
4013	Remote-operation modification to punch; allows power turn-on/turn-off under program control	300	3
<b>PUNCHED CARD EQUIPMENT</b>			
4036	I/O interface subassembly; must be ordered with card reader control (4016)	200	4
4016D	Medium-speed punched card reader, 285 cpm	2,900	40
4016E	Medium-speed punched card reader, 400 cpm	3,900	55
4016F	High-speed punched card reader, 600 cpm	4,100	80
4016G	High-speed punched card reader, 1000 cpm	5,000	80
4016I	Medium-speed mark sense card reader, 285 cpm	4,100	40
4016J	Medium-speed mark sense card reader, 400 cpm	6,000	55
<b>TERMINALS</b>			
6042	Dasher terminal printer; 30 cps, KSR	2,400	25
6043	Dasher terminal printer; 30 cps, RO	2,200	23
6040	Dasher terminal printer; 60 cps, KSR	2,650	28
6041	Dasher terminal printer; 60 cps, RO	2,450	26
6052	CRT; 24 lines by 80 characters, 5 x 7 dot matrix, 64-character set; to 19.6K bps	1,990	20
6053	CRT; 24 lines by 80 characters, 5 x 7 dot matrix, 96-character set, additional features such as blink and underscore; to 19.6K bps	2,290	20
6054	Printer interface for 6052 or 6053 CRT terminal; to 1200 bps	400	5
6055	Printer subsystem for 6052 or 6053; consists of 6054 interface and 6041 Dasher RO terminal	2,500	30
6083A	Dasher display subsystem; typewriter-style keyboard, 9600 bps	3,090	26
6084A	Same as 6083A except "foreground" console	2,690	23
6085A	Same as 6083A except Teletype-style keyboard	2,790	26
<b>COMMUNICATIONS—ASYNCHRONOUS</b>			
4007	I/O interface subassembly; must be ordered with 4010 asynchronous line controller	200	4
4010	Asynchronous line controller for Models 33 ASR and KSR, 35 ASR and KSR, 6012, etc.	150	3
4023	EIA voltage I/O interface for Model 37 ASR and 37 KSR teletypewriters, 6012 video display, and Bell System 103 data set or equivalent when manual answer only is used; 150 bps	50	2
4029	EIA voltage interface for Bell System 202 data set or equivalent (1200 bps), or 103 data set or equivalent (150 bps)	200	2
4075	I/O interface subassembly; for 4077 TTY I/O interface	150	2
4077	Teletypewriter I/O interface; same as 4010 except uses same interface subassembly as 4076 cassette controller	150	1
4078	EIA-type interface; same as 4023 except for use with 4077 interface	50	—
4061	Four-line subsystem of 64-line maximum asynchronous multiplexer with hardware character assembly, disassembly, and buffering; full-duplex operation with transmission characteristics and line speed selectable by jumpers; programmed I/O interface, provided for use with 4050 or 4083 junction panels	1,500	13
<b>COMMUNICATIONS SUBSYSTEMS</b>			
4250	Data control unit (DCU/50); provides data channel interface to any DG computer	3,000	36
4251	DG/CS 4-slot communications chassis for any Nova; includes power supply, terminator card, and cable	1,800	22
4253	Add-on 4-slot communications chassis for 4251	1,400	14
4254	DCU/200 data control unit; 4K controller and data channel interface	3,900	47

Data General Nova 4 Series

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>
<b>COMMUNICATIONS SUBSYSTEMS (Continued)</b>			
4255	8-line asynchronous multiplexer; programmable, includes full modem controls, for 4251 systems	2,000	16
4256	Same as 4255 except for 4 lines	1,250	16
4257	16-line asynchronous multiplexer; programmable, does not include modem controls, for 4251 systems	2,000	20
4258	Same as 4257 except for 8 lines	1,300	20
4260	4-line current-loop interface for 4257 or 4258 multiplexer; for TTY or 6012 display interface	160	2
4261	4-line EIA interface for 4257 or 4258 multiplexer; RS-232C or CCITT V.24 compatible; for 6012 displays or Bell 103 or equivalent modems (with manual answer only)	160	2
4263	2-line synchronous line multiplexer; programmable, for 4251 systems; includes full modem controls	1,500	12
4264	Same as 4263 except for 1 line only	1,000	12
4265	Current-loop interface for 4263 or 4264; for Bell 303 or equivalent modems	200	2
4266	CRC generator/checker for 4263 or 4264	500	4
4300	Sensor I/O subsystem with 16-card chassis	2,200	16
<b>CABINETS AND HARDWARE</b>			
1012K	Cabinet; 70.5 inches high; provides 56 inches of rack space; includes blower	950	—
1012L	Cabinet; two-bay version of 1012K	1,900	—
1012M	Cabinet; 3-bay version of 1012K	2,850	—
1012N	Cabinet; half-bay version of 1012K; provides 19.25 inches of rack space	725	—
1012P	Cabinet; same as 1012K with power	950	—
4116	Blower for 1012 cabinets	150	—
1079A	Cabinet; 72.25 inches high; includes refrigeration unit; 1750 watts head load	2,900	30
1079B	Cabinet; same as 1079A except with air-to-air heat load	1,950	15

SOFTWARE PRICES

	<u>Purchase Price</u>	<u>Purchase Price</u>
	<u>Initial</u>	<u>Subsequent</u>
<b>OPERATING SYSTEMS</b>		
RTOS	100	NC
Mapped RTOS	750	NC
RDOS	NC	NC
DOS	300	NC
<b>LANGUAGES</b>		
RDOS COBOL	7,000	5,000
DOS BASIC	1,000	NC
RDOS Business BASIC	4,000	1,800
DOS Business BASIC	1,600	550
FORTTRAN 5	NC	NC
<b>COMMUNICATIONS SOFTWARE</b>		
RJE80	1,250	1,000
HASP II	1,500	1,250
CAM	100	NC

NC—No charge.