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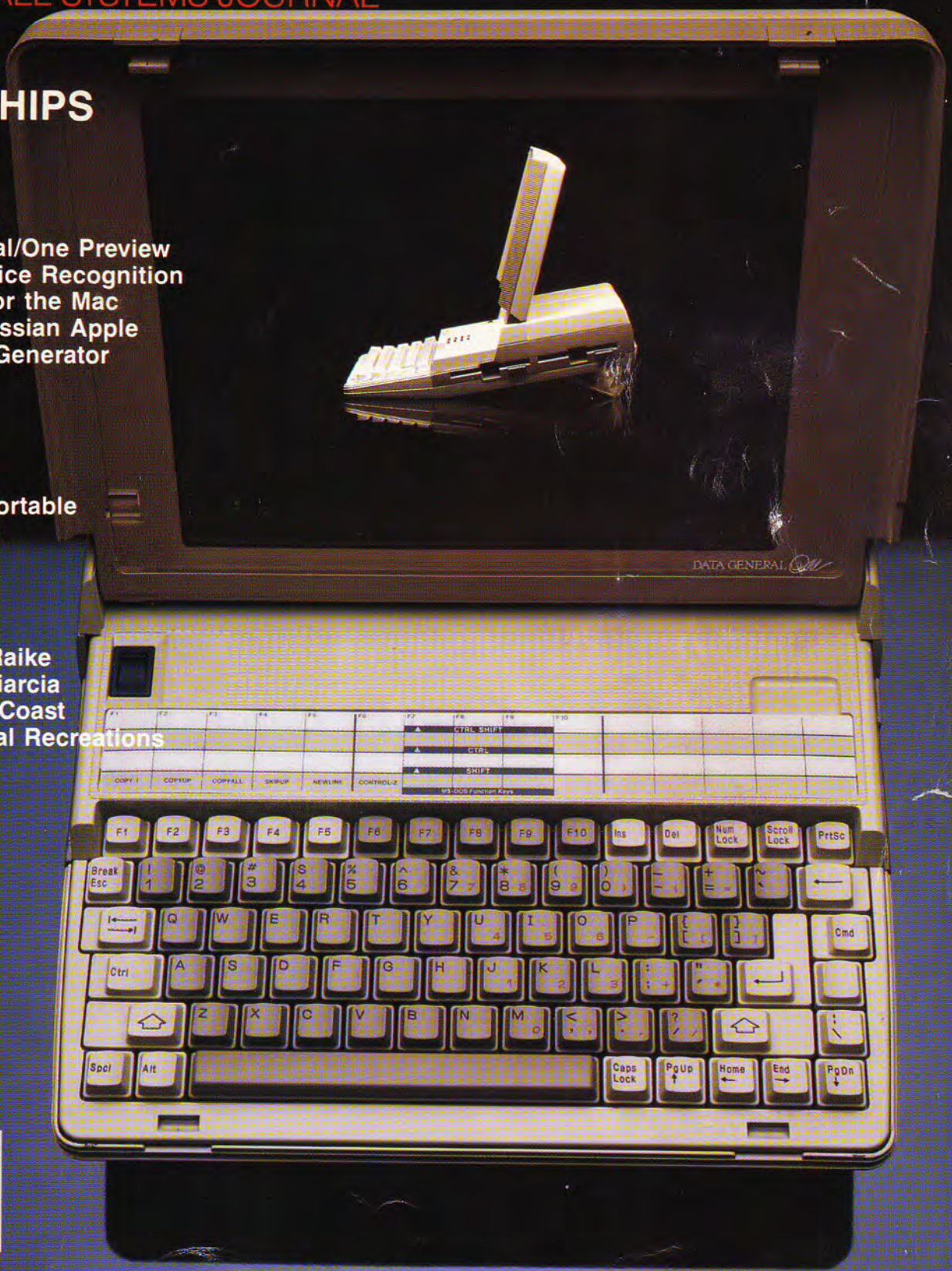

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THE DATA GENERAL ONE

A 10-pound battery-powered portable that's fully compatible with the IBM PC

Editor's Note: The following is a BYTE *product description. It is not a review. We provide an advance look at this new product because we feel it is significant. A complete review will follow in a subsequent issue.*

IMAGINE A PORTABLE COMPUTER that weighs only 10 pounds but has a full-size display screen, a standard keyboard, and two disk drives. Imagine that it can run for up to eight hours on built-in batteries or use an ordinary wall outlet. Now imagine that it is software-compatible with the IBM Personal Computer (PC) and can have up to 512K bytes of internal RAM (random-access read/write memory). Imagine two serial ports, an optional built-in modem, and an expansion bus that will let you connect the system to a monitor in your office or add on third-party hardware.

Earlier this year, David Winer, president of Living Videotext and publisher of ThinkTank, dreamed of just such a portable computer (see "Portables—1984 and Beyond," by David Winer and Peter Winer, in the January BYTE, page 243). Winer predicted that this ideal portable would take two to three years to arrive, that it would weigh up to 25 pounds, and that it would cost up to $5000.

Imagine Winer's surprise when, in June, he received a preproduction unit that included all of the above features and was told that the system would be available this fall for "well under $3000."

The system is the $2895 Data General/One, a portable computer that incorporates a number of state-of-the-art innovations in a sleek 10-pound package.

The Data General/One features a full-size, flip-up LCD (liquid-crystal display) screen that displays 25 lines of 80 characters, or 256 by 640 pixels for software that uses bit-mapped graphics. Although the display is less than an inch thick, its viewing surface is as large as that of a standard IBM monitor and much larger than the displays of other portable computers. (There are, unfortunately, some trade-offs associated with such a large LCD, as we'll explain later.) Although color graphics are not yet available, the video system will display most monochrome and color graphics in shades of gray.

The Data General/One's keyboard (see photo 1c) is a standard, full-size, low-profile QWERTY keyboard with a variety of special and function keys designed to make it compatible with the IBM PC while maintaining compatibility with the Data General line of computers. Thus, IBM's Control, Alternate, and Delete keys are present, as well as Data General's Command and Special keys and even a blank key for future use.

Ten function keys are arrayed across the top of the keyboard, and above them is a ridge for inserting plastic command cards for programs such as word processing. Four cursor-control keys are lined up along the bottom right.

Like other PC clones—and unlike the IBM PC—the Data General/One has large Shift and Return keys in the places where a typist would hope to find them. Finally, a numeric keypad is superimposed over a group of keys on the right-hand side of the keyboard; it's activated by hitting the Num Lock key.

(continued)

Photo 1: ***The Data General/One with case closed (1a) and case open (1b). The keyboard (1c) is a full-size QWERTY unit compatible with IBM's PC and Data General's line of computers. The portable comes with a 3½-inch microfloppy-disk drive on the right-hand side (1d), and there's room for an additional drive.***

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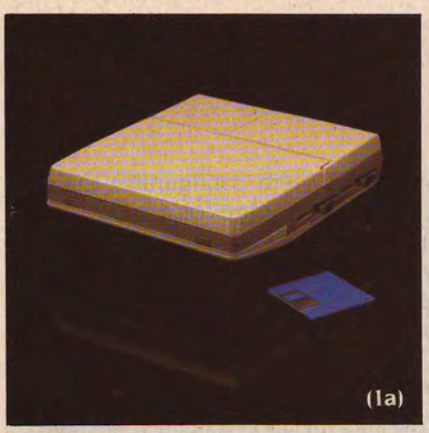
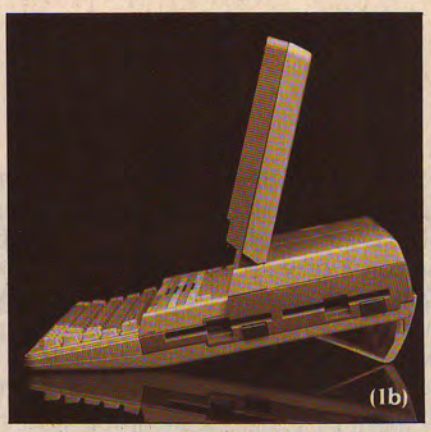
BY GREGG WILLIAMS AND KEN SHELDON



(1a)



(1b)

(1c)

(1d)

PHOTOGRAPHED BY PAUL AVIS

The Data General/One comes with a 3½-inch floppy-disk drive on the right-hand side, and there's room for an additional built-in drive (see photo 1d). These double-sided drives provide 512 bytes per sector, 8 or 9 sectors per track, and 40 or 80 tracks per side—a maximum of 720K bytes of storage per disk. An external 5¼-inch drive, with up to 360K bytes per disk, may also be attached to the unit. With this external drive, the Data General/One can run most of the software available for the IBM PC or transfer software that's not copy-protected to 3½-inch disks. At the time of this writing, 20 major software packages are already available in 3½-inch format, including Lotus 1-2-3, WordStar, dBASE II, VisiCalc, and the PFS series.

An A/C adapter, included in the base price, enables you to use the system with a wall outlet. You can also install an optional battery pack containing 10 nickel-cadmium batteries by removing a cover on top of the machine. The battery pack comes with a recharger that lets you charge the batteries from a wall outlet, even while running the system from another outlet.

On the back of the Data General/One are a bus-expansion connector and two RS-232C serial ports. One of the serial ports also doubles as an RS-422 port, thanks to a program-controllable switch.

Options

Options for the Data General/One include internal memory expansion in 128K-byte chunks (up to 512K bytes maximum), a built-in 300-bps (bits per second) modem, an external 5¼-inch drive, an external 1200-bps modem, the battery pack and charger, a carrying case, and a portable printer. The printer has a 27-pin print head that provides type that's quite readable on thermal paper or smooth sheet paper—this rules out rough-surfaced bond paper. The printer can run from the system's power supply or its own set of nickel-cadmium batteries.

Software

The Data General/One supports MS-DOS, CP/M-86, and various programming languages. According to Data General's software team, a great deal of IBM PC software will run as is, using the external 5¼-inch drive. In addition, several software developers have signed agreements with Data General to release their software in 3½-inch format. Among these developers are Ashton-Tate, Infocom, Lotus Development Corporation, Micro-Pro, Microsoft, Peachtree, and Software Arts.

A few pieces of software have been built into the system's ROM (read-only memory). These programs include Notebook, a kind of scratch pad that lets you print output or send it via modem to another computer (but does not let you save it); Terminal, which enables the computer to act as a dumb terminal to the Data General line of minicomputers; and a system configurator that lets you configure the Data General/One for different monitors, keyboards, printers, and so on. Each of these programs is menu-driven and makes use of the function keys.

Data General has also announced DG Term, an advanced terminal program, and CEO Connection, which enables the Data General/One to tie into the company's CEO office-automation system.

Inside

The Data General/One is built around the 80C88, a CMOS (complementary metal-oxide semiconductor) version of the 8088 microprocessor used in the IBM PC and most of the PC clones. The 80C88 uses less power than the 8088—an obvious advantage in a portable system—but it is a little slower, operating at 4 MHz as compared to the 8088's 4.77 MHz.

The Data General/One comes with 128K bytes of RAM on the main printed-circuit board, 80K bytes of which is available to the user. (The system uses 48K bytes of RAM to manage screen graphics.) Also located on the main board are 32K bytes of ROM that contain the BIOS (basic input/output system), diagnostics, and built-in software.

Mounted on the main board is a small box in which up to three 128K-byte memory expansion cards may be added, providing a maximum of 512K bytes, with 464K bytes available for user programs.

The I/O (input/output) components are located on a separate card, as are the power-supply components, and the disk-controller hardware is located on top of the disk drive(s). An optional 300-bps modem card may also be installed internally.

Technological Innovations

The Data General/One could not have been built without pushing current technology to the limit—in many cases, designing the machine around parts announced but at the time not available. Three innovations stand out: technology to create an LCD panel the size of a standard monitor display, the inclusion of custom gate arrays that decrease the component count, and the use of CMOS parts to reduce heat and power consumption.

The Data General/One's LCD panel is innovative from both manufacturing and design standpoints. A liquid-crystal display consists of two glass sheets separated by a conductive liquid material. Nippon Data General engineers overcame manufacturing difficulties associated with creating an LCD of this size, the main problems being the size of the glass sheets and the evenness of the distance between the two inner surfaces.

LCDs are often criticized for being "slow"—that is, leaving a ghost image that fades slowly enough for the eye

(continued)

Development of the Data General/One

According to Kazuhiro Miyashita, head of the research and development team that designed the Data General/One, a portable computer was the last thing on his mind when he went to the National Computer Conference (NCC) in May of 1982.

"We had just finished designing a laser printer for Nippon Data General, and I went to NCC in search of a new project for our team," Miyashita says. "At the time, we had no intention of doing a portable computer."

At NCC, however, laptop portables such as the Gavilan were stealing the show, and when Miyashita returned to Japan, his list of possible projects included a proposal for a portable computer. The laptop project was approved in September of 1983.

At the time, the proposal was only a concept, with none of the hardware specified. By January of 1984, however, an initial design was presented, one that included a large LCD (liquid-crystal display) screen and emphasis on CMOS (complementary metal-oxide semiconductor) technology. In other respects, the design differed significantly from the final product. The cover of the proposed portable flipped aside to reveal an LCD, a microcassette, and a small keyboard. It looked, literally, like a three-ring notebook—thus the code name for the project, Book-1.

The microcassette was the first major element to change; it was replaced by a floppy-disk drive because, as Bob Miller, senior vice president for Data General, put it, "Nobody's going to buy a portable computer with a microcassette."

Although there were many floppy-disk options to choose from, the design team settled on 3½-inch drives (licensed by Sony and made by Epson) for three main reasons: a small size that would allow for two built-in drives, less power drain than other drives, and use of hard-shell disks that can contain increased amounts of data.

The change in storage media dictated a change in software philosophy, away from a concentration on ROM (read-only memory) software and toward mass-market applications. To the Data General software team located in North Carolina—they had struggled to convince vendors to make software for the company's Desktop Generation microcomputer—this meant only one thing: as much IBM PC compatibility as they could get. Ironically, then, it was the third-party software team that spelled out the requirements for much of the Data General/One's internal hardware, in order to make the system IBM PC compatible.

In June of 1983, Edson DeCastro, president of Data General, visited Nippon Data General to discuss the project. DeCastro wanted the portable to be compatible with his company's line of mini- and microcomputers; he pressed the team to incorporate a full 25-line by 80-column display in the design. Nippon Data General's contacts with other Japanese manufacturers quickly became invaluable.

The largest LCDs available at the time were 480 by 128 pixels, and no vendor was willing to commit to making a larger screen because the technical challenges were too great. Miyashita was able to convince two vendors, however, that to develop a full-size LCD screen would be beneficial for all involved. In September, Hitachi agreed to try and make a 640- by 256-pixel LCD that would provide 25 rows and 80 columns of 7 by 9 characters (8 by 10 with spacing). Epson followed quickly thereafter. (Interestingly, the division of Epson that makes the LCDs is distinct from its sister company that makes portable computers. The LCD maker apparently prefers to sell its parts to outside companies because it makes more money that way. As one member of Data General's third-party software team put it, "Good old capitalism strikes again.")

By October of 1983, the essential elements of the design had been finalized in spite of the fact that major parts, such as the LCD and 80C88 microprocessor, were not available yet. "We had to design to the specifications given to us by the parts designers and synchronize our design with theirs," Miyashita says. In this "design by speculation," Nippon Data General had an advantage over American laptop portable manufacturers such as Hewlett-Packard and Apple, which have had trouble getting Japanese manufacturers to commit to volume production of large LCDs.

During this time, the design of the Data General/One's case was taking place in Data General's Westboro, Massachusetts, division, while development of the ROM software and deals with third-party software vendors were taking place in North Carolina. The ROM software was purposely limited so as not to scare off the vendors of application software; those vendors generally found that making versions of their programs for the Data General/One consisted of simply putting the IBM PC version on a 3½-inch microfloppy disk.

In January, the "final form factor" of the project was completed—a prototype with essentially the same external appearance as the final product would have. Still, neither the 80C88 nor the commercial gate arrays were yet available; they were included in the second prototype, released in April. The third and final prototype was unveiled in June, and preproduction units began shipping to third-party software developers, like David Winer of Living Videotext.

"We were blown away," Winer says. "When we wrote the article for BYTE [see "Portables—1984 and Beyond" on page 243 of the January issue], it seemed as if we were being overambitious in our projections. Actually, we were conservative."

to catch. The challenge for the designers of the Data General/One was to create a full-size panel that would be both readable and "fast." Faster LCDs have to receive electrical pulses more often in order to retain their opacity, a doubly difficult challenge for a proposed panel with more than 2.6 times as many pixels as the largest LCDs being produced then (640 by 256 pixels versus 480 by 128 pixels).

The solution was an ingenious one. Since there was no way to pulse 163,840 pixels often enough to produce a dark image, the designers created a single physical panel divided electrically into a number of smaller panels that are driven simultaneously. Functions such as smooth scrolling from one screen to another are tricky with this kind of system, and the challenge was finding video-display drivers that could handle the task.

The engineers solved this problem by using CMOS gate arrays, which also significantly contributed to the Data General/One's compactness and portability. Two 4000-gate gate arrays control the video display and replace about 500 integrated circuits (ICs), which would use lots of space and power: one gate array controls the LCD panel's contents and contrast, based on the contents of video memory; the other mediates the processor's access to video memory and emulates a superset of the functions of the Motorola 6845 video-controller chip (the one used in the IBM PC). The computer "sees" the same character and graphics memory areas as are in the IBM PC.

Reducing Power Consumption

As previously stated, extensive use of CMOS parts such as the 80C88 processor and the memory chips radically decreases the power needed to run the Data General/One. (Because machines using CMOS parts also develop negligible heat, a designer can create compact designs without having to worry about heat-dissipation problems.) CMOS integrated circuits hold information with virtually no current (usually in the range of microamps) and require only milliamps of extra current when that information is being accessed or changed. Also, the 80C88 has half as many data lines as its parent chip, the 80C86. Although this means about a 20 percent decrease in processing power, it also means that the computer has eight fewer data lines to drive.

The designers also reduced power consumption by careful choice of their 64K-byte static CMOS RAM chips. Most memory designs use 64K- by 1-bit designs, thus requiring eight chips to be activated to retrieve a single byte (1 bit from each chip); by using 8K- by 8-bit chips, the designers made it possible for the processor to read or write 1 byte of data by activating only one CMOS chip.

Finally, the designers created hardware and software that automatically switch power on and off to subsystems (such as the floppy disks and communications subsystem) that normally consume large amounts of power.

Making It Smaller

The Data General/One fits in a space of 355 cubic inches—about the size of two three-ring binders. The wise choice of components (3½-inch disk drives, gate arrays, and the thin LCD panel) helps in terms of size, as does a state-of-the-art printed-circuit-board technique known as surface mounting. Surface mounting lets manufacturers put specially packaged ICs directly onto the copper traces without having to first drill holes through the board. The lack of holes means that the designers can lay more traces per board and use both sides of the board. For example, the 128K-byte memory card (see photo 2b) packs 18 ICs onto both sides of a board about the size of a playing card and only a quarter-inch thick.

Other Innovations

Because the Data General/One is not designed to be opened by the end user, the machine's engineers included the aforementioned configuration program in ROM. The user's choices are stored in RAM, backed up by a lithium battery that should, according to Data General, last for three years.

Another nice touch is that the Data General/One character set is downloaded from ROM to RAM at C5000 hexadecimal (see table 1). This lets software vendors and other programmers redefine the character set, a feature that often makes software more versatile.

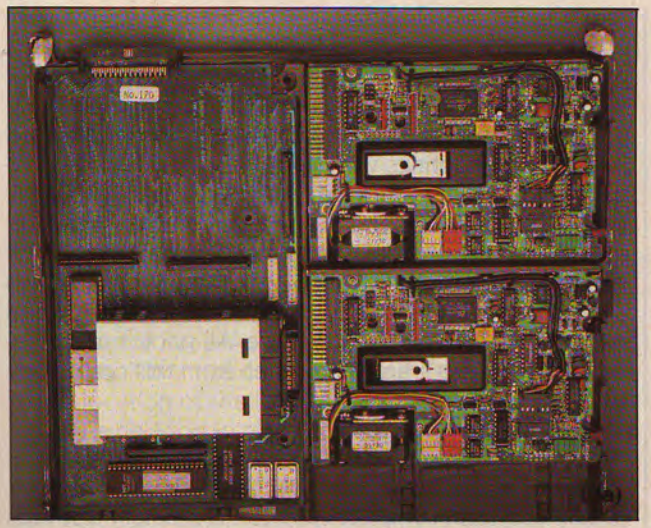
IBM PC Compatibility

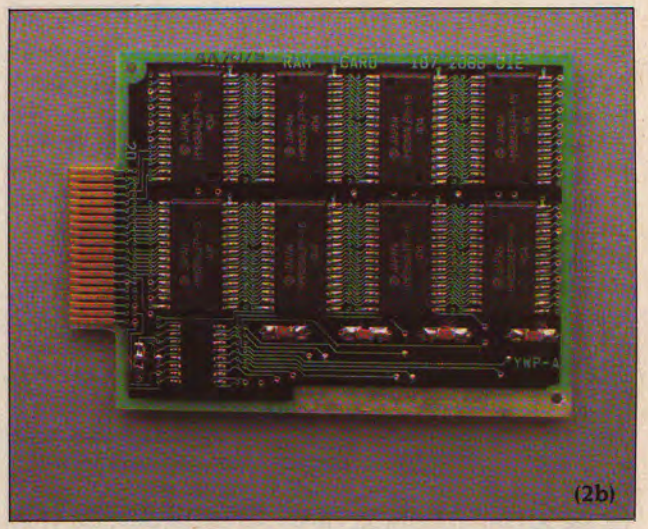
According to Data General, programs that use the documented IBM DOS and BIOS interfaces will run on the external 5¼-inch drive without modification. Although we did not conduct exhaustive tests, a fair amount of the PC software we had on hand booted up without problems, including WordStar, PeachText, PC-Talk, Turbo Pascal, and others. Some programs exhibited problems. Flight Simulator ran fine, but there were scattered pieces of graphics along the top and bottom of the screen. Lotus 1-2-3 ran well except that the printer driver did not work; the 3½-inch-disk version announced concurrently with the Data General/One does not have this problem.

On the hardware end, Data General has announced

(continued)

Photo 2: *A top view (2a) of a preproduction Data General/ One shows the power-supply board at top left, the disk-drive controllers at the right, and the main board at bottom left. The I/O board is not shown. A case mounted on the motherboard holds 128K-byte RAM cards (2b), which are the size of playing cards. The bottom of the main board is in 2c.*





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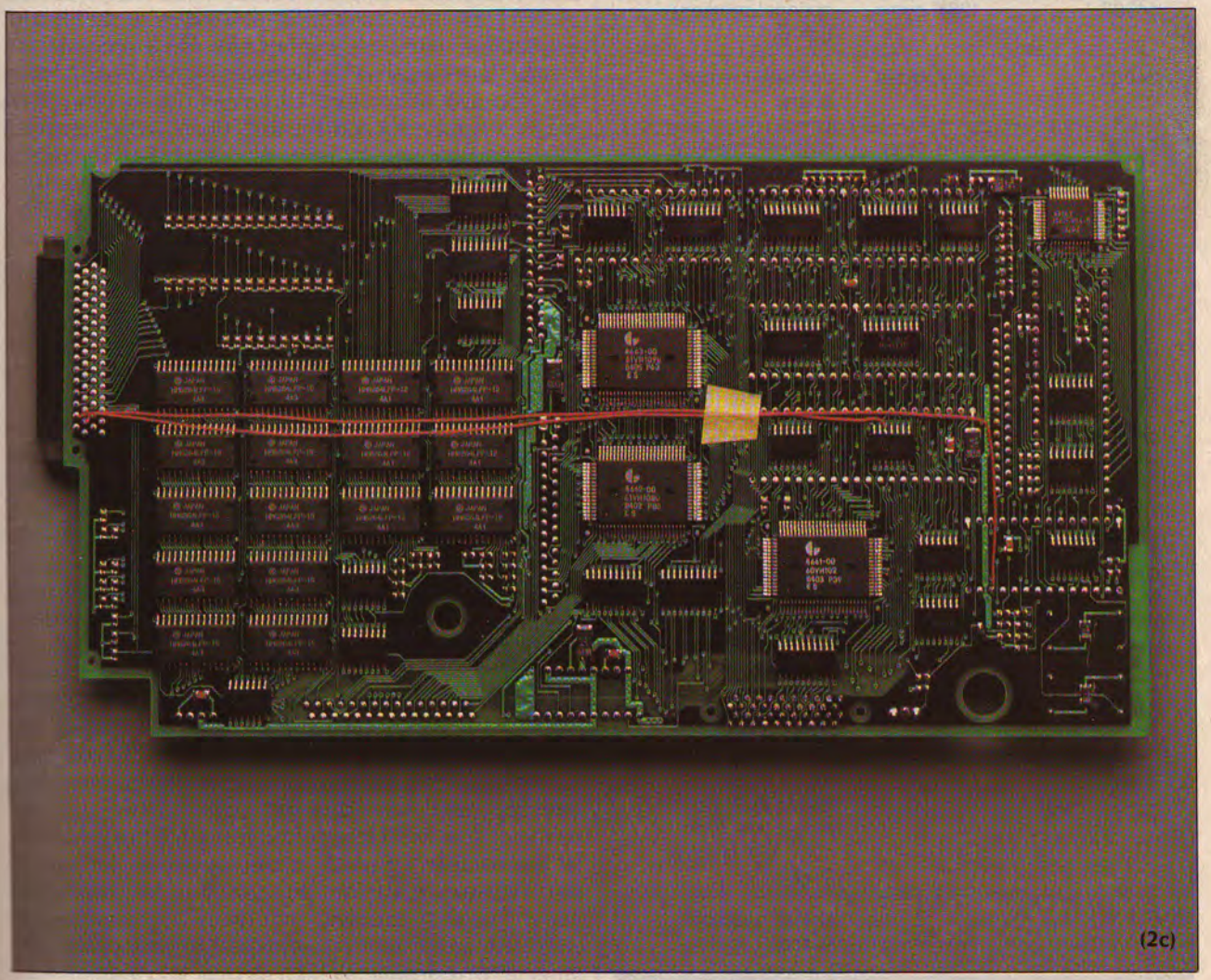
(2c)

Table 1: *The Data General/One memory map. The 128K bytes of memory on the motherboard includes 80K bytes of available memory and 48K bytes of dual-ported RAM (marked with asterisks) used to support the LCD panel. (This video memory actually totals 52K bytes, not 48K bytes. This is because 4K bytes are shared by the monochrome and color-video memory areas and are mapped to the appropriate address depending on the video mode that is active at the moment.)*

BEGINNING LOCATION (HEXADECIMAL)	AMOUNT OF MEMORY	NOTES
00000	80K bytes	motherboard; user memory
14000	128K bytes	optional memory board
34000	128K bytes	optional memory board
54000	128K bytes	optional memory board
74000	240K bytes	memory space for external memory
B0000	4K bytes*	monochrome video memory
B1000	28K bytes	used by gate arrays
B8000	16K bytes*	color video memory
BC000	16K bytes	used by gate arrays
C0000	20K bytes*	image buffer that stores bit map for LCD panel
C5000	12K bytes*	font memory
C8000	32K bytes	reserved for future use by Data General
D0000	128K bytes	memory space for external memory
F0000	32K bytes	system ROM; includes BIOS, bootstrap code, Notebook and Terminal programs
FFFFF		end of address space

its intention to release an expansion chassis that will enable you to add IBM PC-compatible plug-in boards.

Caveat

The information in this product description is based on two days of meetings with Data General people, a telephone conversation with the design team leader in Japan, access to the Data General/One programmer's manual, and more than a week's access to a fully functional, late-preproduction machine with 512K bytes of memory, two 3½-inch disk drives, battery pack, internal modem, and external 5¼-inch floppy-disk drive. All photos and measurements in this article were taken from this preproduction machine.

Initial Tests

We ran a few tests on the Data General/One in our offices. The system completes its internal memory test (with 512K bytes) in 10.3 seconds; an IBM PC at BYTE with the same amount of memory takes 43.8 seconds.

Data General claims the batteries will last 8 to 10 hours with the disk being used 20 percent of the time. With the battery fully charged, the Data General/One we tested lasted 6 hours, 51 minutes running a GW BASIC program that wrote to disk once a minute, a process that took 8 seconds, resulting in a 13.3 percent duty cycle. (The nickel-cadmium batteries are said to recharge in 6 to 8 hours; for this test, we left the recharger connected overnight.)

The infamous Gilbreath Sieve of Eratosthenes benchmark took 202 seconds to complete one iteration using Microsoft's GW BASIC; the IBM PC took 191 seconds using its BASICA.

The prototype Data General/One we had (fully configured) weighed 12 pounds, 10 ounces. The AC power adapter weighed 1 pound, 13 ounces. The battery recharger weighed 4 ounces.

Strengths and Weaknesses

The Data General/One's most important strength is that it is truly portable and fully functional. We've seen machines that are small, light (under 15 pounds), and useful (the Radio Shack Model 100 is the most popular example so far). But this is the first such machine that is as useful as the computer on your office desk, has 512K bytes of memory, an LCD panel the size of a standard display, two large-capacity disk drives, a comfortable keyboard, and a modem.

One of the nicest things about the LCD panel is that its low-persistence pixels make it possible for text to scroll at normal display speed without leaving behind ghost images (a problem with many LCD panels). It is also different in that it uses 2-to-1 aspect pixels (rectangular pixels twice as high as they are wide) instead

of the 1-to-1 aspect pixels used in other LCD panels. Because the 2-to-1 aspect pixel most closely matches that of video displays, the Data General/One display looks like a CRT (cathode-ray tube) display, while others (the announced LCD panel for the Apple IIc, for example) give a distorted image that is compressed vertically.

The Data General/One brings us again to the inevitable adjustments to yet another keyboard layout. All in all, Data General has done a good job of creating a keyboard that is compatible with both IBM PC and Data General keyboards. The keys, though they give some audible feedback, are not as loud as those of the IBM PC or other portables. For those of us who have finally gotten used to the location of the left Shift key on the IBM PC, Data General's decision to place it in its preferred, pre-PC position means we'll have to readjust again.

One change that we like is the placement of the function keys above the number keys. This enables you to insert directly above the keys plastic templates that tell the function of each key and its function when used with Shift, Control, and Control-Shift. Because Data General computers have 15 function keys, the keyboard layout lets Data General software use the F1 through F10 keys and the five keys to their right as function keys.

Data General is to be commended for choosing a standard disk format for its 3½-inch drives. The Data General/One uses unmodified Sony 80-track, double-sided disk drives and formats each track as nine 512-byte sectors; this is the proposed standard used by Microsoft for 3½-inch-disk MS-DOS systems. Hewlett-Packard and Apple, the first major vendors to use 3½-inch drives, have both used incompatible, nonstandard disk formats. According to one engineer, Data General places a high value on industry-wide compatibility and hopes that future vendors will adopt this format. (The Data General/One can read and write disks using one or two sides and 8 or 9 sectors per track. With some limitations, it can also write sectors of 128, 256, and 1024 bytes each.)

On the negative side, we must point out that the LCD panel is difficult to read in conditions less than ideal. It looks great if you have diffuse light coming over one shoulder and you're wearing light-colored clothing; otherwise, the image is not strong enough to overcome the image reflected on the glass face of the LCD (even when you adjust the LCD's contrast). Also, because of the physics of driving rows and columns of LCD pixels, you can see faint streaks above and below and dark vertical bars in the LCD image. The LCD image is functional—good enough for an airport but not for sustained use at the office. (Fortunately, Data General claims it will fix this inadequacy with a "system expansion box"; see "Plans.")

Another disappointment is the quality of the ROM-based Notebook and Terminal programs, which are limited in that they cannot interact with the microfloppy disks. Although you can use the Notebook to write something and print it out (or transmit it to a remote computer using the Terminal program), you cannot recall and save work directly to a disk, which makes us think that we wouldn't use these programs very often. The Data General engineers explained that the two programs "came free" because of ROM space left over after the Configuration program had been written. They also didn't want to anger third-party software developers, who are less enthusiastic about writing software for a given machine if adequate programs are bundled with it (in ROM or on disk).

Finally, we must point out a simple inadequacy of some importance: the machine has no built-in handle. Granted, Data General will offer several carrying cases, but they are too inconvenient for those times when you want to carry the machine to the library downstairs. Maybe someone will invent a harness that has a handle and never needs to be removed from the machine.

Plans

A Data General spokesperson said that a "system expansion box" would be available "60 to 90 days after product announcement" (September 20). Although he could not provide specifications for the unit, he said that it would definitely include the ability to drive a color or a monochrome monitor. With this feature (and perhaps the 5¼-inch disk drive), we can see possibly buying a Data General/One instead of an IBM PC.

On the Data General/One main board, there is an empty socket beside the 80C88 that is the same size as the empty socket beside the 8088 in the IBM PC. Since we now know that that IBM PC socket is meant to house an Intel 8087 arithmetic coprocessor chip, it is plausible to speculate that the empty Data General/One socket will house an 80C87 or some other coprocessor that will enhance the machine's performance. The Data General spokesperson would not comment, but he pointed out that the Data General/One is "not the only product in this line we intend to put out" and that Data General has plans to ensure that its products will provide state-of-the-art performance.

Another interesting possibility springs from the fact that there are four DMA (direct memory access) channels in the Data General/One, two internal and two external. Of the internal DMA channels, one is used for the 3½-inch drives, and the other is reserved "for future use." An obvious enhancement to this machine would be substitution of a 3½-inch Winchester hard disk (which might hold, say, 10 megabytes) for the second disk drive. A machine of such capacity, at less than half the weight of a suitcase-size AC-powered transportable computer, would be impressive indeed. ■