A+

The #1 Apple II Magazine

FIRST LOOK!

The Next Generation

APPLE IIc PLUS
LASER 128 EX/2

DB MASTER V.5
Database Dynamo

WINNERS!
How I Use the II
to Teach Contest

Apple IIc Plus
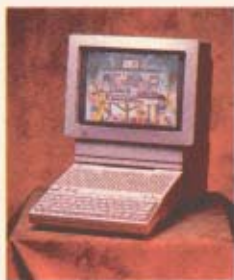
The Next Generation

Faster, smaller, and more "luggable," the next generation of the Apple IIc gives users more flexibility and work ability for

APPLE IIc PLUS

their dollar. Yet the IIc Plus doesn't follow the trail that was blazed by the Apple IIGS. Instead, it's a turbocharged version of the IIc with a high-capacity 3.5-inch disk drive. If you were hoping for a "carry-out" version of IIGS graphics and sound, you may be disappointed.

But Apple isn't the only game in micro-town. Laser Computer's "Next Generation"—the Laser 128 EX/2—offers Apple II compatibility, the speed and 3.5-inch disks of the IIc Plus, and other features that Apple left out, such as a built-in MIDI port, parallel printer port, and numeric keypad. And the 128 EX/2 offers all this at a lower cost than the IIc Plus.

LASER 128 EX/2

In this month's cover stories, Technical Editor Owen Linzmayer compares the two machines' features and runs the benchmarks to help you make the choice.

*Three times faster than
any other 8-bit Apple II,
with the lowest price tag yet*

Apple IIc Plus

The Apple IIc Plus is the most recent addition to the Apple II family of computers, and its introduction proves that the "Apple II Forever" maxim is not an empty promise. Although much of Apple's attention has been focused on the lucrative Macintosh as of late, Apple hasn't ignored the Apple II, the venerable computer that propelled the company into the Fortune 500 in record time and continues to contribute more than $1 billion in revenue annually. Two years ago, Apple introduced the Apple IIGS, a faster Apple II that acted more like a color Mac. And now, with the IIc Plus, the company has given us a computer that runs three times faster than any previous 8-bit Apple II model, with the lowest price tag of any Apple to date.

More than a year in development under code names including Adam Ant, Pizza, and Raisin, the IIc Plus was introduced to the world on September 16 at the AppleFest show in San Francisco. Contrary to rumors that were circulating prior to its release, the IIc Plus is not a IIGS without slots. Instead, as its name implies, it's an Apple IIc with some meaningful improvements: an accelerator that allows the IIc Plus to run up to three times faster than previous models do and a built-in 3.5-inch disk drive with a storage capacity

five times that of a 5¼-inch floppy-disk drive.

Since it has the same 8-bit 65C02 central processing unit (CPU) as the IIe and original IIc, the IIc Plus runs thousands of existing software packages, from sophisticated spreadsheets to colorful double-hi-res games. If a program works on the IIc, it'll probably perform flawlessly on the IIc Plus, often more than three times as fast! In fact, thanks to advances in processor

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*The introduction
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speed and memory caching, the IIc Plus can actually execute many applications faster than its big brother, the IIGS.

Apple is aiming the IIc Plus at first-time users who want to run home productivity and education applications. Even technophobes should feel comfortable with the IIc Plus, since the most popular Apple II expansion features are built in: the equivalent of two Super Serial cards, an AppleMouse

interface, an 80-column card, and a disk controller (see figure 1).

The IIc Plus comes with three books: *IIc Plus Owner's Guide*, which examines the computer and its peripherals; *Apple II System Disk User's Guide*, which explains the features of the included utilities disk; and *A Touch of Applesoft BA-SIC*, an introduction to programming. Also included is a disk called Your Tour of the IIc Plus, which guides new users through the many features of the computer.

Bundled with an AppleColor Composite Monitor and Apple II Monitor Stand, the IIc Plus carries a suggested retail price of $1,099, and standard educational discounts apply. If you want to configure your own system, the IIc Plus lists for $675 as a stand-alone item, but as always, expect street prices to be considerably lower.

Accelerator

Perhaps the most exciting feature of the IIc Plus is its ability to run existing software more than three times faster than an unmodified Apple II. This speed improvement results from a technique called memory caching. In simplified terms, memory caching makes frequently needed data immediately available to the central processing unit, which uses a fast RAM "cache" instead of laboriously fetching the data from memory whenever it needs it. (For a de-
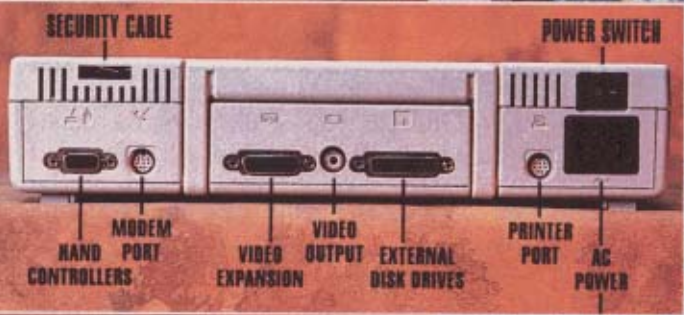
Figure 1: The back panel has connectors for a variety of peripheral devices.

HAND CONTROLLERS

MODEM PORT

VIDEO EXPANSION

VIDEO OUTPUT

EXTERNAL DISK DRIVES

PRINTER PORT

AC POWER

Figure 3: In addition to other slight modifications, the 80/40-column switch of the original IIc has been replaced by a sliding volume control.

Figure 2: The internal 3.5-inch drive can store 800K of data.

tailed explanation of memory caching, see "The Zip Chip: Life in the Fast Lane" in *A+* August 1988.)

When you turn on the IIc Plus, it is in the accelerated (4 MHz) mode. Most software will blaze along without modification in this mode, but for some packages—notably games—the increased speed may be unwanted. To switch the computer into its slow mode, you press Escape-Open Apple-Control-Reset. When the word Normal appears at the top of the screen, the computer is in the standard Apple II 1.024-MHz mode. Alternatively, you can access this mode by holding down the Escape key as you boot the computer. The IIc Plus offers no way to set an intermediate speed, however, nor is there a convenient PEEK for recreational programmers to find out at what speed the computer is operating.

Our test results support Apple's claims of "operation up to 3.3 times faster than on previous models" (see the comparison graphs on page 58). Curiously enough, on four out of five benchmarks, the IIc Plus and a IIc equipped with a Zip Chip from Zip Technology produced nearly identical results. The

IIc Plus doesn't contain a Zip Chip, but the question remains: Has Apple licensed the memory-caching technology from the makers of the Zip Chip? Apple refuses to say, simply maintaining that the IIc Plus uses "Apple's own implementation of a custom gate array."

With accelerated operation, Apple's new entry-level machine outperforms the more costly IIGS (which runs at 2.8 MHz), but the IIc Plus can't run GS-specific software. Perhaps Apple will address this anomaly by offering an enhanced IIGS in the future. Also, the memory-caching techniques of the IIc Plus could also work on the IIe. A revitalization of the entire Apple II line may be in the works.

Disk Drives

The other major improvement in the IIc Plus is the built-in 3.5-inch disk drive (see figure 2). The original IIc had an internal 5¼-inch drive capable of storing 140K of data on a floppy disk. The new 3.5-inch drive is faster and quieter and can save up to 800K on a single disk, virtually eliminating the tiresome "floppy swap" of loading data and program segments with the old drives.

If you need more storage capacity, a DB-19 SmartPort connector allows daisy-chaining of as many as three additional drives to the computer. You can combine 3.5- and 5¼-inch drives on the chain, though you're limited to a maximum of two 5¼-inch drives, and they must be at the end of the chain (see table, next page). The IIc Plus can accommodate UniDisk 3.5 Drives—the only kind that work on the original IIc—but Apple discourages using them, because they are slower than Apple 3.5 Drives. At present, no hard-disk drives are available for the IIc or IIc Plus, but, according to company president Christopher Adams, Chinook Technology is developing one.

The internal 3.5-inch drive may initially prove to be a problem for IIc Plus owners since the majority of 8-bit Apple II software is distributed on 5¼-inch floppy disks. Apple has strongly encouraged third-party developers to embrace the smaller format and convert old titles to 3.5-inch disks. You can easily transfer most unprotected ProDOS programs from floppies to 3.5-inch disks if you have both types of drives. If you own a large library of copy-protected floppies, you may want to purchase at least one external 5¼-inch drive. Despite its concerted efforts, Apple has yet to divest itself of the antiquated 5¼-inch format.

Memory

The IIc Plus comes with 128K of random access memory (RAM), enough for a 56K Desktop in AppleWorks. If this amount of memory doesn't satisfy your needs, you theoretically can add a megabyte of RAM with an internal board, although neither Apple nor any third-party developer has committed to such a product.

Unfortunately for IIc owners thinking of upgrading to the new model, memory-expansion boards for the IIc are incompatible with the IIc Plus. Since most third-party memory boards, such as Applied Engineering's Z-Ram Ultra, plug into the original IIc's CPU and MMU chip sockets and rely on precise timing signals, they don't work properly with the redesigned

POWER SUPPLY

INTERNAL MODEM CONNECTOR

MEMORY EXPANSION CONNECTORS
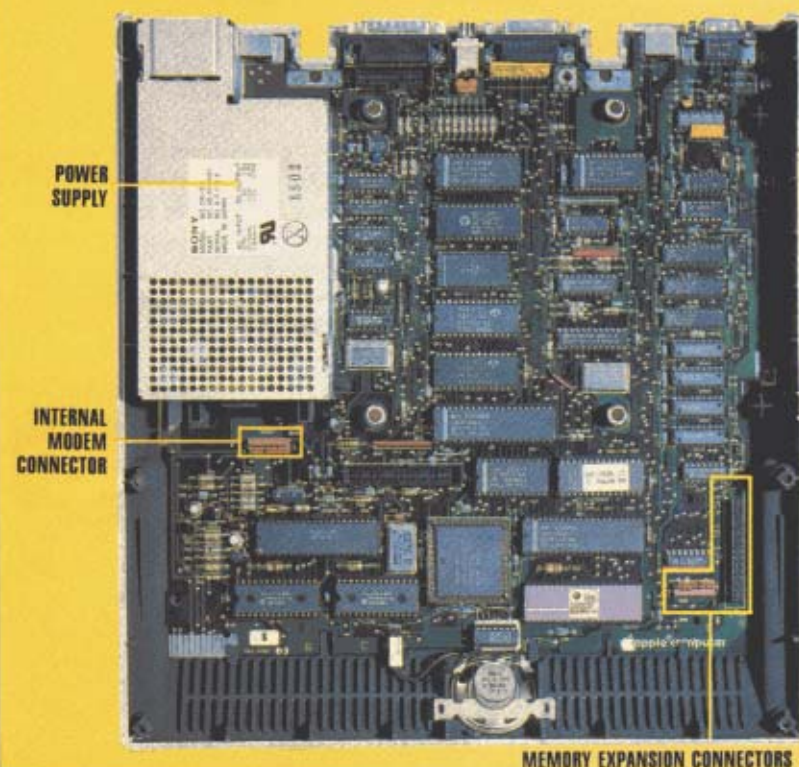
Apple IIc Plus Slots

SLOT	DEVICE
1	Serial printer port
2*	Serial modem port and 3.5" disk drives
3	80-column firmware
4	Memory expansion board
5	3.5" disk drives
6	5¼" disk drives
7	Mouse interface

*No conflict between devices

motherboard of the IIc Plus, but Apple's own card attaches to the internal 34-pin memory-expansion connector, which is supposedly unchanged (see photo, page 38). Sources at Apple claim it might be possible to modify Apple's boards to work in the IIc Plus, but Apple dealers won't offer such a service.

Serial Ports

The IIc Plus has two built-in serial ports that are analogous to Super Serial cards in an Apple IIe. These ports provide a path for future expansion without requiring the purchase of additional interface cards. The two Mini-8 circular connectors on the back of the unit are keyed and labeled with icons to eliminate the possibility of incorrect insertion of cables.

Serial port 1 is primarily for output to printers. The ImageWriter II is the only printer you should seriously consider buying, unless you want to buy a serial-to-parallel convertor and are willing to live with less than 100% compatibility. The second serial port is for communications, using an optional, external modem.

If you're anxious to get on-line, you should know about an internal seven-pin jumper block marked "modem" underneath the IIc Plus keyboard. Expect to see third-party developers announce modem cards that install inside the case. The prospect of an internal modem may sound appealing, but if you ever upgrade to another computer, you probably won't be able to use the modem on the new system. It

may be more prudent to opt for an inexpensive external modem.

Hackers will appreciate the ability to manually configure the RS-232 serial ports on the Apple IIc Plus by using the Apple II System Disk. Parameters such as word length, bit rate (baud), parity, echo output, linefeed, carriage return, and line length are user-definable. You can save your custom configurations to and recall them from disk, thus eliminating repetitious setting of parameters. Casual users need never fuss with these settings, however, as most commercial software runs on the Apple IIc Plus without modification.

According to Apple, all the signals on the original IIc's 5-pin DIN connectors are available on the Mini-8 connectors of the IIc Plus. Therefore, you should be able to build an adapter cable if you want to use peripherals designed for the original IIc. Unfortunately, the three extra pins contain no new signals for third-party developers to exploit. Nevertheless, it's fortunate that the IIc Plus uses the same Mini-8 connectors as the IIGS and Macintosh do.

Controllers

When you look at the rear of the IIc Plus, you see the controller port at the far left. This 9-pin D-type connector is where hand controllers plug in. Joysticks designed to use the 9-pin controller port of the IIe and IIc are 100% compatible with the IIc Plus, but you can't use controllers that connect to the 16-pin I/O socket on the IIe motherboard unless you have a special device such as the 9-16 Adapter from Southern California Research Group. Other peripherals that use the controller port include paddles, light pens, and port extenders.

The IIc Plus also has the equivalent of an AppleMouse card in firmware and MouseText characters in ROM. To take advantage of mouse-compatible software such as MouseWrite from Roger Wagner Publishing, just attach a mouse to the controller port. It's disappointing that Apple has no intention of bundling a mouse with the IIc Plus. The company's missing an opportunity to spark new Apple II soft-

ware development by not standardizing on the desktop interface so popular on the Mac and IIGS.

Keyboard

Owners of the IIc will notice that the IIc Plus has a slightly redesigned keyboard (see figure 3). The Open Apple and Return keys have been enlarged, and the Solid Apple key has been replaced by one marked Option. With these alterations, Apple has standardized on a 63-key layout that's identical across its entire line of computers, from IIc Plus to Mac. The full-stroke keyboard mechanism gives crisp tactile feedback and is sturdier than that of the original IIc.

The keyboard is arranged in the standard QWERTY layout, but by pressing the keyboard switch above the number-2 key, you can select the simplified Dvorak lay-

The IIc Plus is aimed at first-time users who want to run home-productivity and education software.

out. This layout is supposed to let you type at blinding speeds, thanks to its more efficient arrangement of commonly used keys.

Audio

The IIc Plus has an internally mounted 1-inch speaker on the bottom front of the unit and a sliding volume control above the number 3 on the keyboard. On the original IIc, the volume-control knob was on the left side of the computer, next to a two-channel, 3.5-mm audio-output jack that accommodated lightweight headphones. As a cost-cutting measure, this headphone jack has been eliminated on the IIc Plus. This omission is unfortunate for educators who want to use the computer in a classroom setting, where sounds from several computers are most distracting. You can set the volume control to zero, but then you'd miss out on the sound effects altogether.

Video

The IIc Plus can generate 40- and 80-column text, as well as color graphics, from lo-res to double hi-res. The video-expansion connector on the back of the computer lets you hook up alternative display devices and remains unchanged from that of the IIc. You can use a television set as a monitor if you can live without 80-column text. Keep in mind, however, that doing so requires an RF (radio frequency) modulator, which Apple used to supply with the IIc but no longer offers—even as an option.

The video-expansion connector is also good for plugging in flat-panel displays and RGB (red, green, blue) convertors. Apple used to sell its own liquid-crystal display (LCD) for use with the original IIc but has long since discontinued the unit. Roger Coats, a mail-order firm, is reselling the discontinued C-VUE Flat Monitor, a similar device, for $349.

Prior to introducing the IIc Plus, Apple was trying to convince someone to produce a flat-panel display that would fold down over the keyboard for easy carrying, as with many MS-DOS laptop computers. No word yet on whether Apple has found any takers.

As for getting crisp, clear RGB output from the IIc Plus, forget about it for now. Video Seven, the only company that ever sold an RGB convertor for the IIc, is concentrating its efforts on the IBM PC market. The lack of an RGB convertor is not significant, since the AppleColor Composite Monitor bundled with the computer can display both color graphics and 80-column text with the push of a button.

Considering moves toward standardization and in view of the lack of commercial products that plug into the video-expansion port, it's baffling that Apple didn't replace the video port with a GS-style analog RGB interface. RGB may be a luxury for the IIc Plus, but it's mandatory for the IIGS's super-hires graphics. If Apple wants IIc Plus owners to step up to the GS in the future, the upgrade path is smoother if both computers could use the same RGB monitor.

Power

When it introduced the IIc in April 1984, Apple touted it as a portable computer and offered a flat liquid-crystal panel as an optional display device. Carrying the stylish IIc *seemed* like a great idea, but you also had to drag around a bulky external power supply, commonly called a "brick on a leash" or "volt on a rope."

Through an OEM arrangement with Sony, the IIc Plus comes with a lightweight internal power supply that Apple Computer claims uses less electricity than a 100-watt lightbulb. One end of a conventional power cord plugs into an electrical wall socket, and the other plugs directly into the back of the

IIc Plus. No more middleman. Although it would still require a self-contained battery pack to qualify as a true portable computer, the 7-pound IIc Plus is much easier to transport with the power supply built in.

Now that it has an internal power supply, however, you must be sure that the IIc Plus is properly ventilated. To this end, the carrying handle on the back of the unit locks into an upright position that places the keyboard at a comfortable typing angle and allows for convection cooling.

Encouraging Sign

The introduction of the IIc Plus is an encouraging sign that the company has not completely abandoned the II in favor of the Macintosh. The internal 3.5-inch drive, Mini-8 serial ports, and redesigned keyboard of the IIc Plus make clear Apple's long-term philosophy: Peripherals should be compatible across the entire product line. The cost of upgrading is the price of the system unit; you retain your investment in the peripherals.

If you already own a IIc and covet the extra features of the IIc Plus, it might be cost effective to buy a new IIc Plus rather than enhance your IIc. Adding a Zip Chip and a UniDisk 3.5 Drive to a IIc costs roughly $100 less than a brand new IIc Plus. It makes sense to enhance your IIc only if you have a substantial investment in a memory-expansion board or any other internal device.

My first reaction to the IIc Plus was neutral. I was hoping Apple would announce a IIGS without slots in a IIc case. Maybe next time. I'm willing to wait until all the GS tools are nailed down in ROM and memory-chip prices drop.

My initial skepticism began to wear off once I put a IIc Plus through its paces. This baby flies at speeds previously unheard of on an 8-bit Apple II. And I appreciate the convenience of having an 800K 3.5-inch disk drive as standard equipment.

The IIc Plus doesn't break any new ground in the world of computers. It does, however, strengthen the low end of Apple's product line by incorporating several existing technologies in an attractive package suitable for first-time buyers. Considering that the original IIc cost twice as much yet had only one-third the power and one-fifth the storage capacity, the IIc Plus is quite an achievement and demonstrates Apple's continued commitment to the Apple II market. ✦

Owen Linzmayer is the technical editor of A+ and the proud owner of an original Apple IIc.

Packed with features, this inexpensive clone takes on the Apple IIc Plus.

Laser 128 EX/2

The Laser 128 EX/2 is an inexpensive Apple II-compatible computer loaded with standard features and available with a 3.5- or 5¼-inch disk drive built in. Like the Apple IIc Plus, the EX/2 comes with an accelerator that gives it three times the processing power of previous Apple IIs. But, unlike the IIc Plus, the EX/2 has a host of additional features at a *lower* price.

The Laser 128EX sold quite well, since it had all the features of the IIc (128K of memory, disk drive, serial ports, and mouse interface, all in a compact case), yet cost hundreds of dollars less. Moreover, the 128EX had an accelerator, a numeric keypad, memory board, RGB video interface, parallel-printer port, and external expansion slot—all features missing on the IIc. (For a review of the Laser 128EX, see the December 1987 issue.) In fact, some industry observers believe that Apple, fearing the erosion of its low-end market share, specifically designed the IIc Plus as a "Laser killer." If so, engineers at Laser Computer have answered the challenge by giving the EX/2 all the features of the 128EX plus a MIDI music port, internal clock, control panel, and the ability to daisy-chain disk drives (see figure 1).

Accelerator

As with the 128EX, the accelerator is the most useful of the EX/2's features. When you turn on the EX/2, it's in the normal Apple II mode, running at a speed of 1.024 MHz. You can increase the clock speed to 2.3 or 3.6 MHz by holding down the 2 or 3 key respectively during bootup or a Control-Reset warm start. You can set the default system speed from the control panel. There are two ways to tell that the computer is in an accelerated mode: The pitch of the system beep is higher, and a light-emitting diode (LED) marked Turbo is on.

Since it uses the same accelerator as the 128EX, the EX/2 is no faster than its predecessor, but, as the

The EX/2 comes with an accelerator that gives it three times the processing power of previous Apple IIs.

graphs on page 58 demonstrate, the EX/2 is consistently faster than the Apple IIGS.

Control Panel

The EX/2 has a battery-backed control-panel program in ROM that allows you to customize the computer (see photo, page 51). If you hold down the P key when you flip the EX/2 power switch on, or press Control-Reset-P from within an application, a menu appears that lets you change system speed, boot slot, interface configurations, mouse scaling, and clock speed. The ability to specify the boot slot through the control panel is especially helpful when you daisy-chain multiple drives to the EX/2.

Unlike the 128EX, the EX/2 comes with an internal system clock. Most ProDOS applications, including AppleWorks, recognize this clock automatically and use it for time- and date-stamping files. Knowing exactly when a file has been created or modified facilitates proper file maintenance.

Disk Drives

The EX/2 comes in two basic disk-drive configurations. The EX/2 with a built-in 3.5-inch disk drive costs $545; with a 5¼-inch drive, it's $495. The 3.5-inch version is recommended for first-time buyers, since the smaller disks hold 800K and are less prone to damage (see figure 2). Those with a substantial investment in floppy-based software may find the EX/2 with a 140K 5¼-inch drive more attractive, because it costs less and doesn't require transferring programs and data to new media.

The EX/2 can accommodate both 5¼- and 3.5-inch disk drives, with the exception of UniDisk 3.5 Drives. Laser Computer has recently announced its own line of daisy-chainable disk drives to compete with those sold by Apple. The 3.5-inch EX/2 accepts a maximum of one 3.5-inch and two 5¼-inch drives connected through the DB-19 drive port (see table, page 51).

Expansion Connector

The open architecture of the Apple II series is one of its strongest selling points. Slots let you expand a system as new, more sophisticat-

Figure 1: Most peripheral devices
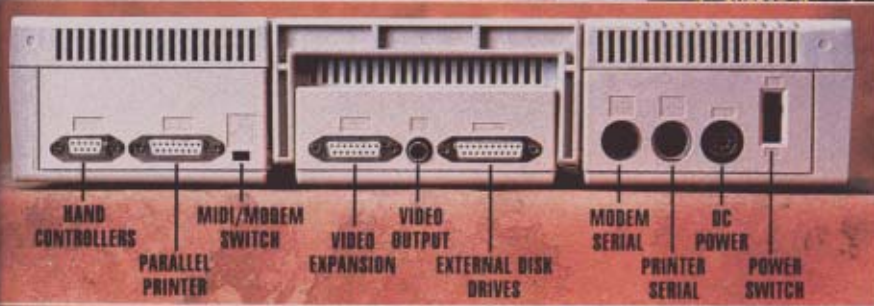plug into the back panel connectors.

LASER 128 CONFIGURATION
Select item to configure:
1. Port 1 Parallel Printer
2. Port 2 Serial Communications
3. Port 4 Mouse Scaling
4. Boot Slot

3:58 PM
/22/88

ESET to exit.

HAND CONTROLLERS
PARALLEL PRINTER
MIDI/MODEM SWITCH
VIDEO EXPANSION
VIDEO OUTPUT
EXTERNAL DISK DRIVES
MODEM SERIAL
PRINTER SERIAL
DC POWER
POWER SWITCH

Figure 2: The EX/2 comes with either
a 3.5 or 5¼-inch disk drive built in.
A headphone jack diverts sound
effects from the speaker.

Figure 3: Keyboard with numeric
keypad, ten function keys, option
switches, and indicator LEDs.

ed technology becomes available. Slots allow the use of peripherals, such as hard-disk drives and video digitizers, that didn't exist when the original Apple II computer was invented.

Not only does the EX/2 have the most popular expansion features built in, but it also has a 50-pin connector that is the functional equivalent of a nonauxiliary IIe slot. You can plug virtually any card that works in slots 1 through 7 on an enhanced IIe into the expansion connector on the left side of the EX/2. Cards attached to this connector are accessed as slot 5 devices. Since a card plugged into this connector is exposed and vulnerable, Laser Computer plans to offer an optional protective enclosure.

Memory

The EX/2 comes with 128K of RAM, 64K of video memory, and an empty internal expansion board capable of holding an additional megabyte of RAM. The system firmware uses the video memory for shadowing, a technique that allows the computer to update screens quickly when the accelerator is in use. This memory is not available for data storage.

When populated with chips, the internal memory-expansion board

Laser 128 EX/2 Slots

SLOT	DEVICE
1*	Serial printer port or Parallel printer port
2*	Serial modem port or MIDI port
3	80-column firmware
4	Mouse interface
5*	Memory expansion board or Expansion slot peripheral
6	5¼" disk drives
7	3.5" disk drives

*Active device is switch-selectable

functions as a card in slot 5. Since this slot is also assigned to the expansion connector, you must specify which you want to use by setting a switch on the underside of the Laser. Unfortunately, you can't use both simultaneously.

The internal memory board is a "slinky" device (like the Apple IIe Memory Expansion Card and the Applied Engineering RamFactor), so ProDOS automatically formats this card as a RAM disk with the volume name /RAM5. The memory is not directly addressable for

BATTERY-BACKED CLOCK AND CONTROL PANEL
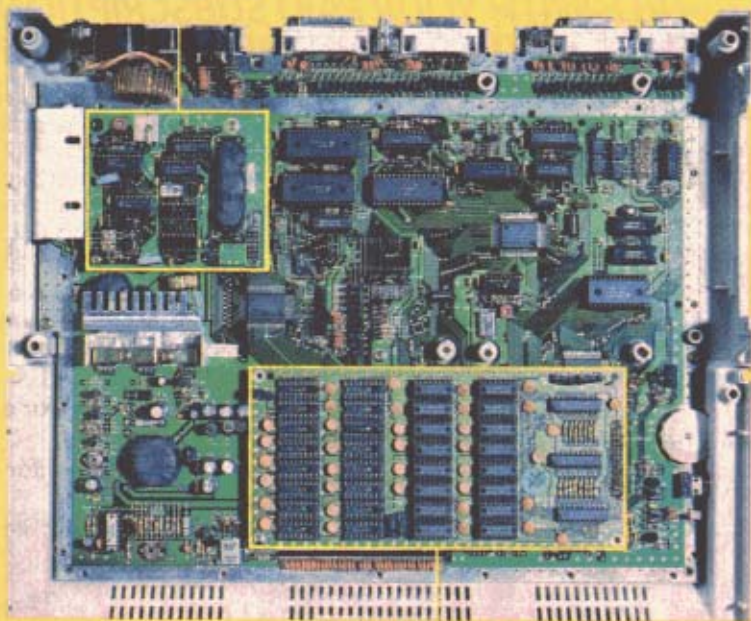
MEMORY EXPANSION BOARD
(SHOWN WITH 512K)

running large programs. The 64K bank of memory in the EX/2's extended 80-column "card" can also serve as a RAM disk in slot 3 if you format it properly.

With memory prices inflated lately, it's nice to know that you can upgrade eight chips at a time, in increments of 256K. Installing these chips is straightforward. You open the EX/2 case, remove a small piece of metal shielding from underneath the keyboard, and insert the chips into the exposed sockets.

Interface Ports

The EX/2 has two built-in RS-232 serial ports that use the same 5-pin DIN connectors as the IIc does, so devices designed for the original IIc should work fine. The first serial port is primarily for output to printers; the second is for telecommunications. These ports are mapped as slots 1 and 2 respectively.

In addition to its serial ports, the 128 EX/2 has a Centronics parallel interface that is compatible with Apple's old parallel card and the Epson APL card. A switch above the numeric keypad selects either the parallel or serial interface as the slot 1 device. An optional $20 parallel cable provides access to a wider selection of printers than does Apple's serial printer port.

MIDI

A back-panel switch turns the Laser's modem port into a MIDI (Musical Instrument Digital Interface) port. A special cable that comes with the computer provides standard MIDI-in and MIDI-out ports that you can connect to keyboards, synthesizers, and other MIDI-compatible music hardware. Two-channel MIDI recording software included with the Laser offers a dabbler's introduction to the MIDI revolution.

The MIDI port works well with the provided program but, based on our software tests, does not appear to be compatible with software for the two Apple II MIDI standards: the Passport Designs MIDI card or Apple's own MIDI interface. Until the Laser MIDI port is made compatible with more capable MIDI software, it is an asset for hobbyists but of limited interest for serious MIDI musicians.

Function-Key Equivalents

FUNCTION KEY	CONTROL EQUIVALENT
F1	Control - @
F2	Control - A
F3	Control - B
F4	Control - C
F5	Control - D
F6	Control - E
F7	Control - F
F8	Control - G
F9	Control - L
F10	Control - X

Controllers

Like the IIc, the EX/2 has a 9-pin D-type connector on its back panel for joysticks, paddles, trackballs, and other hand controllers. You can use a mouse without any modification, since the appropriate firmware and a MouseText-like character set are built in. Using devices designed for the IIe's internal 16-pin I/O socket requires an adapter.

Keyboard

The EX/2 keyboard has the same layout as that of the original 128EX and IIc but with several additions. Above the alphanumeric keyboard are ten function keys labeled F1–10 that generate a variety of Control-key combinations (see figure 3, and "Function Key Equivalents" table above). These combination keypresses are useless in most applications and cannot be reprogrammed through software. It is conceivable, however, that new versions of the EX/2 ROM could allow users to define these function keys via the control panel.

There is a Caps Lock key with an LED indicator, but you can't prevent the computer from booting up into the Caps Lock mode—more room for improvement in the control panel.

The four-function arithmetic

keypad on the right side of the EX/2 contains the numbers 0–9 laid out in a calculator configuration that differs slightly from that of the IIGS and platinum IIe. Numeric keypads are great for spreadsheet jockeys, but the altered key arrangement will confuse users who are accustomed to other systems. Inexplicably, the keypad is also home to

keys marked Pause and Break (which generate Control-S and Control-C respectively), two useful keys to have when you're trying to debug a BASIC program.

Audio

On the right side of the EX/2 are the volume-control dial and earphone jack. Like all Apple IIs, the EX/2 uses a small internal speaker

for sound effects. If you prefer to use lightweight headphones, you plug them into the mini-phone jack, which diverts the audio from the speaker to the headset.

Video

Since the EX/2 is compatible with the Apple IIe, it can generate 40- and 80-column text, as well as color graphics, from lo-res to double hi-res. A 40/80-column switch above the keypad is of limited use, since most software overrides its setting. The color/mono switch, on the other hand, allows you to select the best display mode for the screen device in use. For example, if you are using StyleWare's graphics-based word-processing program MultiScribe with a color monitor, the display is sharpest in the monochrome mode.

The EX/2 has an RCA-type phono jack on the back panel for standard NTSC composite monitors, and you can use your television as a display device with an optional RF modulator. Best of all, the EX/2 has an RGB interface built in. All you need is an optional $20 cable to connect a digital RGB monitor—the low-cost kind that's used with IBM clones. The EX/2 also works with liquid-crystal-display (LCD) panels interfaced through the video-expansion port.
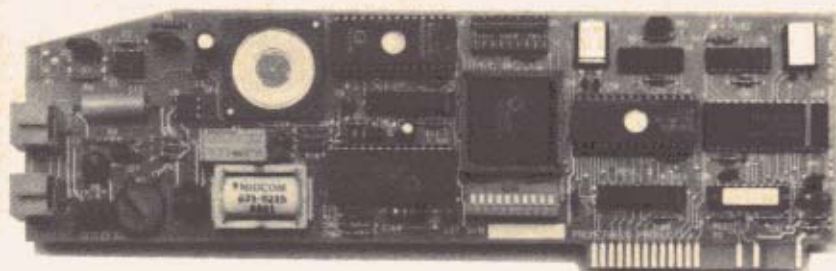
Power

Like its predecessor, the EX/2 uses a bulky external AC adapter for its power supply, in contrast to the IIc Plus' elegant internal supply. One end of this unit plugs into the 7-pin power connector on the back of the EX/2, and the other goes into an electrical wall socket.

Quite a Deal

Considering the features stuffed into the Laser 128 EX/2, it's hard not to recommend the machine outright. But when it comes to buying a clone, you must be willing to live with inevitable hardware and software incompatibilities. Don't buy a clone *expecting* it to run every new piece of software; instead, buy it only after making sure it runs the *existing* software you know you will use. Full compatibility isn't possible without copyright infringement. At *A+*, however, we have noticed an increasing number

of new software titles that mention Laser compatibility prominently on the package.

The EX/2 is compatible with thousands of Apple II software packages, and Laser Computer maintains a list of tested programs that it will send to you upon request. The company periodically updates the system ROM to add features and make its computers compatible with even more products. These $25 upgrades are user-installable.

In addition to compatibility, another important factor to consider is service. The Laser 128 EX/2 is available at most Sears retail stores and from more than 300 authorized Laser dealers. If your computer malfunctions within the 90-day warranty period, expect your salesperson to exchange it for a new EX/2 off the shelf rather than attempt to repair the system. If your Laser breaks down after the warranty has expired, you can take it to the nearest dealer for repair or send it to Laser Computer. Before purchasing anything from a mail-order merchant, find out what form of guarantee, warranty, and service is available. Of particular importance is how quickly the firm promises to turn around repair work, since you don't want to be without your computer for extended periods.

The Laser 128 EX/2 doesn't contain many meaningful improvements over the Laser 128EX. Then again, the 128EX was already a much better buy than a comparably equipped Apple IIe. The EX/2, with its two serial cards, parallel interface, extended 80-column card, RGB interface, memory-expansion board, internal clock, MIDI music port, disk drive, mouse interface, expansion slot, and accelerator, offers prospective buyers almost every option they could want at a price far below what Apple charges for a similar machine. ✦

Apple Bytes or Laser Blasts:
Which One Is for You?

If you compare the Apple IIc Plus and the Laser 128 EX/2 solely on the basis of their features (see table, facing page), choosing between the two is easy: The EX/2 is the clear winner. It's not that simple, though. The EX/2 is undoubtedly better equipped than the IIc Plus and costs less, but there are other important factors to consider before you rush out to buy either machine.

Compatibility

Software and hardware compatibility is the most important asset of any new Apple II or clone. The Laser 128 EX/2 scores extremely well in this department, running more than 1,000 packages. Its maker, Laser Computer, also periodically offers updated ROMs that add features and address known compatibility problems. As with all clones, however, the goal of 100% compatibility remains elusive because it's impossible to perfectly imitate an Apple computer without infringing on Apple's copyrights.

The Apple IIc Plus, because it is an Apple, is more compatible with Apple II-series products than is the Laser, and will receive more support from developers. So if you need the peace of mind that comes with the rainbow-striped Apple logo, the IIc Plus is for you.

However, the IIc Plus still has some incompatibilities with the rest of the Apple II line.

Programs that expect to find an internal 5¼-inch disk drive pose the biggest software compatibility problem for the IIc Plus, but Apple has been getting the word out to third-party developers and expects most to update their products to recognize the internal 3.5-inch drive. Since the IIc Plus is based on the time-tested IIc design, existing software should work flawlessly.

Hardware poses a more significant compatibility problem for the IIc Plus. Since it uses Mini-8 serial ports, it can't accommodate peripherals designed for the original IIc's 5-pin DIN connectors, unless you use adapter cables. Also, memory cards and other boards that go inside the original IIc don't work at all in the IIc Plus.

Service

If you rely on your computer for business or schoolwork, a breakdown can be disastrous. The nice thing about computers—and most solid-state devices for that matter—is that they rarely break down. When a computer malfunctions, the problem usually lies with a mechanical component, such as a disk drive. Even so, having a computer service center nearby is both useful and comforting.

If your Laser breaks down within the 90-day warranty period, you can return it to the place of purchase, where it will be exchanged for a new unit. After the warranty period, you can bring the computer to one of the more than 300 Laser service centers or ship it to Laser Computer for repair.

My experience with Laser computers has been good, but some of our readers have reported problems, particularly with the disk drive. The Apple IIc Plus 3.5-inch disk drive is a solid unit manufactured by Sony. The Laser 128 EX/2, on the other hand, has a Chinon drive that sounds asthmatic in contrast to the robust IIc Plus drive. Don't get me wrong—the drive works. It's just that you can hear the disk spinning, and the whole mechanism rattles.
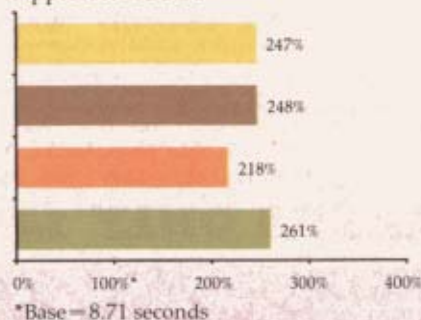
The IIc Plus comes with a 90-day warranty, and you can get service at any of the Apple dealers across the country. If your computer dies mysteriously while under warranty, don't expect your dealer to simply swap machines. Most Apple dealers don't exchange computers or offer loaners while they attempt to diagnose the problem and repair the machine. To its credit, Apple usually has parts delivered overnight or instructs dealers to swap motherboards if they can't solve problems quickly.

Speed Trials

Our benchmark tests compare the Apple IIc Plus and Laser 128 EX/2 with two other souped-up systems (an Apple IIGS and a Zip Chip-equipped IIc), and a standard base: the Apple IIc, running at a clock speed of 1 MHz.

Applesoft GOSUB

APPLE IIGS	247%
LASER 128 EX/2	248%
APPLE IIc PLUS	218%
APPLE IIc (ZIP)	261%

0%   100%*   200%   300%   400%
*Base = 8.71 seconds

AppleWorks database sort

APPLE IIGS	225%
LASER 128 EX/2	296%
APPLE IIc PLUS	341%
APPLE IIc (ZIP)	341%

0%   100%*   200%   300%   400%
*Base = 12.74 seconds
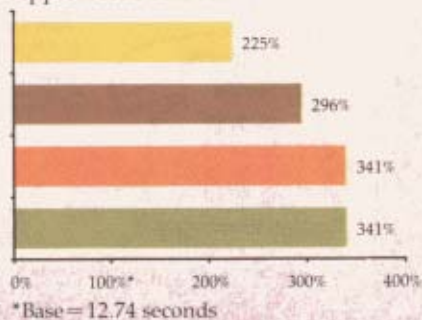
The Bottom Line

If you're waiting for me to tell you which computer—the Apple IIc Plus or the Laser 128 EX/2—to buy, you're going to be disappointed. Both systems offer significant improvements over their predecessors, and each has features the other doesn't offer. Choosing between the two depends on your individual needs.

The Laser 128 EX/2 is an excellent second computer. It's loaded with features and is less expensive than the Apple IIc Plus. Since some programs and peripherals are bound not to work with it, I hesitate to recommend the EX/2 to everyone, but it is hard to ignore the machine's price/performance. However, if the products you want to use can run on the EX/2, then the Laser might be the better buy.

The Apple IIc Plus, with its accelerator and 3.5-inch drive, is a much better buy than the Apple IIc, which it replaces. When you compare it to the EX/2, however, its features don't stack up. True, its accelerator is faster than that of the EX/2, but only marginally (see graphs below). The greatest asset of the IIc Plus is that it comes from Apple, which should translate into better third-party support. However, the developers with whom I've spoken have adopted a wait-and-see attitude. If the market accepts this machine, they will design new products for it. So the fate of the IIc Plus rests on how aggressively Apple markets the machine. ✦

Apple vs. Laser

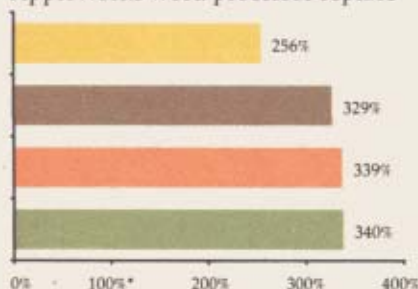| Feature	APPLE IIc PLUS	LASER 128 EX/2
Processor speeds (MHz)	1.024, 4	1.024, 2.3, 3.6
Built-in disk drive	800K 3.5"	800K 3.5"or 140K 5¼"
External drives (max.)	3	3
Memory (RAM)	128K	128K
Memory expansion board	Optional*, 1 Mb maximum	Built-in, 1 Mb maximum
Serial Ports	2	2
Parallel port	NO	**YES**
Expansion slot	NO	**YES**
Internal modem	Optional*	NO
MIDI port	NO	**YES**
Headphone jack	NO	**YES**
Internal clock	NO	**YES**
Mouse interface	**YES**	**YES**
Dvorak keyboard layout	**YES**	NO
Numeric keypad	NO	**YES**
Function keys	NO	**YES**
Control panel	NO	**YES**
RGB video	NO	**YES**
Built-in power supply	**YES**	NO
Price	$675	$545, 3.5" disk; $495, 5¼" disk

*Expansion connectors are built-in, but no products have been announced that use them.
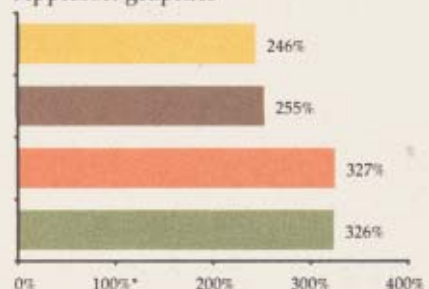
AppleWorks spreadsheet recalculation

235%
318%
315%
318%
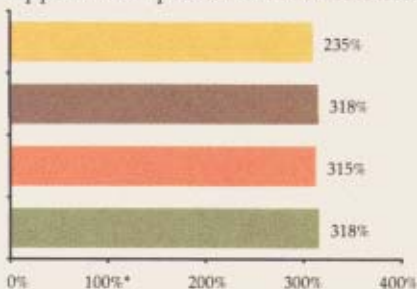
0%   100%*   200%   300%   400%
*Base = 29.63 seconds

AppleWorks word processor replace

256%
329%
339%
340%

0%   100%*   200%   300%   400%
*Base = 60.00 seconds

Applesoft graphics

246%
255%
327%
326%

0%   100%*   200%   300%   400%
*Base = 7.59 seconds