

**Full-stroke Keyboard;  
Expandable to 512K**



# IBM PCjr

## Thomas V. Hoffmann

There is an old saying that the more things change, the more they remain the same. In 1981 when Will Fastie first looked at the IBM PC for *Creative Computing*, he described his first encounter of the close kind this way:

"I entered the contemporary but unremarkable building . . . Jeannette Maher of the Public Relations Department escorted me . . . through a tastefully decorated lobby and through smoked glass doors set in a wall of smoked glass. Inside . . . and there they were. Three IBM Personal Computers sat on three modular display stations." Then he began to drool.

Two years later, my first trip to Boca Raton was like visiting Déjà Vu City. Jeannette is no longer the sole PR person, but the tasteful lobby, smoked glass (now sporting a splashy neon *object de signage*), modular display stations, and three PCs were all there, just as Will described. Surprise! No PCjrs, not even a peanut shell on the floor.

### Blind Man and Dancing Elephants

The good old days, when reviewers were ushered into the sedate presence of the original PC, have given way to more participatory modern times. The juniors were upstairs in someone's office.

We carted the stuff downstairs, cast aside the old PCs, and began setting up the juniors. The operation was totally trivial: open the box, attach the power

## HARDWARE PROFILE

**Product:** PCjr

**Type:** Personal computer

**CPU:** Intel 8088

**RAM:** 64K, expandable to 512K

**ROM:** 64K

**Keyboard:** 62-key wireless keyboard, wire is optional

**Display:** Can run on IBM color display, none is included.

**Graphics:** 320 x 200 pixels, 640 x 200 pixels, 160 x 200 pixels

**Printer:** Can attach serial or parallel printer; none is included.

**Ports:** ROM cartridge sockets, bus extender, two joysticks, modem connection, audio output, composite video, direct drive monitor.

**Dimensions:** 14" x 11.5" x 3.5"

**Documentation:** Guide to operations, Basic manual, manual for each software package.

**Price:** \$599 with 64K and no disk drive \$999 with 128K and disk drive.

**Summary:** Extremely compatible with the IBM PC, easy to set up, suitable for home, office, and classroom.

**Manufacturer:**

IBM Corp./Entry Systems Division  
P.O. Box 1328  
Boca Raton, FL 33432  
(305) 998-2000

cord to the system unit, attach a monitor to the appropriate connector, put batteries in the keyboard, and turn on the system—less than five minutes from box to operation, and only one third more calories than attaching a video game to a TV set. The PCjr might also be called IBM Lite—it weighs less than nine pounds with disk drive, and you can hold it in one hand and wave it around. (Yes, I did, and no, I don't know why. It seemed reasonable at the time.)

So just what *is* this PCjr? Is it a cheap PC or an expensive game machine? Who is it for? Where will it be used: home, office, classroom? How expandable is it?

How compatible with its older siblings? Is it worth the price? The answers depend, of course, on one's point of view.

It is definitely a PC, extremely compatible with its IBM predecessors, and significantly less expensive (about half the cost of a similarly configured original PC). The enhanced graphics and sound features make it a better machine for games and animation than the bigger PCs, but there are better and less expensive game machines. The real strength of the PCjr is that it is an IBM PC in every respect: same processor (the Intel 8088), same operating system (PC DOS), identical disk formats, and

compatible displays. The basic unit includes several features that are extra cost options on the big PCs: the video display adapter, serial port, and joystick adapter are all built in.

What, no bad news? Only a little: the PCjr is somewhat slower than previous IBM PCs, it can't support the 8087 arithmetic processor, and the current limitations on memory and disk may prevent the use of some large programs and data files. The speed difference is attributable to the design of the video display and RAM memory system, and is permanent. The other limitations, except for the absence of the 8087, are almost certainly temporary. The architecture of the PCjr will support considerable expansion; IBM and other manufacturers, such as Tecmar, Legacy Technologies, and Impulse Computer Products already offer a wide variety of options.

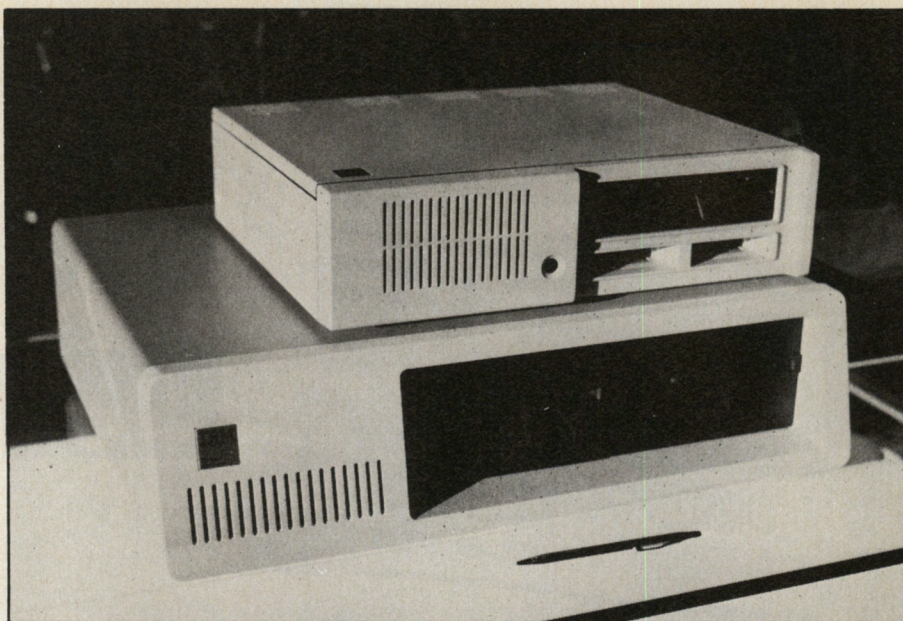
### First Impressions

The PCjr is both more and less than the standard PC. Like the original IBM PC (now called PC1) it consists of two major components, a system unit and a keyboard, to which a display must be added to make a complete computer. The most striking difference between the junior and its predecessors is purely physical: it is *much* smaller.

At 14" wide by 11.5" deep by 3.5" high the system unit occupies only 43 percent of the volume of the PC1. The reduction in weight is even greater due to the plastic case (the others have metal cases) and external power transformer (sort of a giant AC adapter).

The 62-key wireless keyboard is perhaps the most innovative feature of the PCjr. It is powered by four AA batteries and communicates with the system unit over an infrared serial link with a range of up to 20 feet. An optional (i.e., extra cost) cable is available to connect the keyboard directly to the system unit. When connected by the cable, the keyboard is powered directly from the system unit, and the infrared system is disabled. This conserves batteries and eliminates interference among multiple systems in the same vicinity, as might occur in a classroom, for example. The cable may also be necessary to avoid interference with other infrared devices such as TV remote controls, in the home.

Another innovation, for IBM at least, is the provision for ROM program cartridges. Each cartridge contains 32K of ROM, but is quite a bit smaller than traditional video game cartridges. While there will be few programs available in this format initially, cartridges offer several significant advantages. They are much more rugged and reliable than



*The PCjr system unit atop a standard PC system unit. The round opening is the infrared receiver for the cordless keyboard. The two ROM cartridge slots are directly under the half-height disk drive.*

disk and cassette tapes, and are safer and easier for children to use. There is no loading time; the programs are instantly available when the cartridge is plugged in. Furthermore, since the cartridge programs can execute directly from ROM they leave all the RAM available for data storage.

Finally, cartridges offer greater immunity to casual software piracy, so vendors may be more likely to charge

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***It is a good bet that  
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reasonable prices per copy for programs. (It has been estimated that for many popular programs, illegal copies in use vastly outnumber the legitimate ones. This undoubtedly raises software prices as vendors try to compensate for "free" copies.)

### System Unit

The system unit is a marvelous example of low cost construction that never looks cheap, just inexpensive. It consists of a plastic box with a snap-on top cover. Inside, the main printed circuit card is mounted flat against the bottom, resting on snap-on plastic studs. There are four dedicated connectors for the power regu-

lator, memory expansion, internal modem, and disk adapter cards, which mount vertically. The on/off switch and the connector for the power cord (from the external step-down transformer) are mounted directly on the back of the power regulator card, and are accessed through openings in the outer case. The modem card has a standard modular telephone jack and a matching hole in the rear panel. All other peripheral and expansion connectors are mounted directly on the main system card and align with openings in the outer case.

The only two screws (actually bolts) in the box hold the disk drive in place. Everything else snaps in and out with bare hands: inexpensive to assemble, easy to upgrade or repair. It is a good bet that IBM has plenty of room for price reductions, should competitive pressures require them.

The main system board is about 11" by 14" and contains the following major elements:

- An Intel 8088 processor running at 4.77 MHz. The processor is configured in "min mode," which means the 8087 arithmetic processor cannot be used. There is no direct memory access (DMA) controller. An Intel 8259A interrupt controller chip and 8255A programmable peripheral interface are also used.

- 64K of ROM comprising cassette Basic (32K), BIOS or Basic I/O System (8K), and built-in diagnostics

- 64K of RAM for user programs

- An Intel 8253 timer chip, used for keeping time of day, timing I/O operations, cassette I/O, and PC1-compatible sound generation



The new IBM PCjr keyboard features 62 full-stroke typewriter style keys in standard QWERTY layout. The built-in infrared serial link has a range of 20 feet.

- Keyboard interface circuitry for both infrared and direct wire links

- Video display circuitry based on the Motorola 6845 CRT controller chip and a custom video timing and control chip, with connectors for high resolution RGB monitor, composite video monitor, TV receiver (with RF modulator), and light pen

- Audio cassette interface, compatible with that in the PC1

- Three channel sound/music generation circuitry based on the same Texas Instruments SN76496N sound chip used in the ColecoVision video game, with a standard RCA phono jack for audio output. Sound is also available through the TV when the TV adapter cable is used.

- Joystick interface

- Standard RS-232 serial interface, for external modems, printers, plotters, etc.

- Connectors for two ROM program cartridges

- I/O expansion connector for the parallel printer adapter and future add-on devices

There are two models of PCjr available. The entry system lists for \$599 and includes the wireless keyboard and system unit with 64K RAM and all the interfaces listed above. The enhanced system is \$999 and comes with an additional 64K of user RAM for a total of 128K, a disk adapter, and one half-height 5 $\frac{1}{4}$ " double sided, double density disk drive with a capacity of 360K, all mounted inside the system unit.

The connectors for peripheral devices, such as serial printer, high-resolution display, and joysticks, are not the usual 9- and 25-pin D connectors usually found in small computers. The PCjr uses rectangular arrays of pins, similar to those used for flat cable connectors on PC cards, soldered directly to the main systems board. Special adapter cables are available for each device, where appropriate, to convert to industry standard D connectors. This lowers the cost

of the system unit, but adds an occasional \$20 or \$30 for adapter cables for displays (essential) and serial devices.

The disk drive, manufactured by Qume, is mounted horizontally in the upper right corner of the system unit, right above the two cartridge slots. It is half the height of a standard 5 $\frac{1}{4}$ " mini-floppy drive, and very slightly slower due to longer head settling times. The difference is hardly noticeable.

In a standard minifloppy drive you insert the disk and flip down a hinged door to engage the drive spindle and read/write head. On the PCjr you rotate a lever counter-clockwise to engage the mechanism; the same lever blocks the entry slot so the disk can't be removed until the lever is flipped back. I found the lever mechanism easy to use, once I overcame my instinctive groping for the flip-down door. If you have never used a standard floppy, there may be no instincts to overcome.

The 360K capacity of the floppies is identical to the PC1 and PC/XT, and quite a bit greater than most other "home" computers in this price range, where single sided, single density drives of about 100K are the norm.

## Keyboard

The original PCjr keyboard generated a great deal of controversy. IBM called it "a cordless, portable, hand-held device (utilizing) full travel, carbon contact/rubber dome technology for long wear and reliability." Critics called it a cheap "chiclet" keyboard unworthy of a "real" computer, with the infrared link a superfluous gimmick. In the end, IBM admitted that the keyboard needed to be replaced.

The new keyboard uses the infrared link and has 62 fullstroke typewriter style keys. The key legends are printed directly on the keys, not in between the keys as on the old keyboard. Better yet, IBM uses the real standard QWERTY

layout on the PCjr keyboard. It has no backslash key in between the Z and the left SHIFT key; the RETURN key is correctly placed above the right SHIFT key; and labels are on the SHIFT, RETURN, BACKSPACE, and TAB keys.

The keyboard is slant adjustable and includes a ridge along the top to hold pencils or prop manuals between the keyboard and system unit. The keyboard dimensions are 13.45" x 6.61" x 1.12", and it weighs a little less than two pounds.

The standard PC keyboard has 83 keys, the PCjr only 62. What is missing? The ten function keys on the left of the standard keyboard are gone. Instead, a new FUNCTION SHIFT key has been added to the upper right side. To generate a function code, depress the FUNCTION SHIFT key (surrounded by a green box), then the corresponding numeric key in the top row (1 through 0). For SHIFT, CONTROL, and ALTERNATE shift combinations, the same procedure applies; first hold down the FUNCTION SHIFT, then press the desired combination. This sounds much worse than it really is. The technique is entirely consistent, logical, and obvious.

The separate numeric keypad is also gone, replaced with four cursor control keys. The HOME, PAGE UP, PAGE DOWN, and END cursor controls are triggered with the FUNCTION SHIFT key. Other keys, such as SCROLL LOCK, BREAK, and PRINT SCREEN, are also triggered with a FUNCTION and letter key combination.

Perhaps the best news, at least to owners of the old PCjr keyboard, is that you can obtain the new keyboard free-of-charge. Just bring proof of purchase back to the dealer from whom you bought the PCjr, fill out the forms, and let the dealer mail the forms to IBM. IBM then sends the new keyboard to your dealer.

## Audio

In addition to the simple tone generator from the older PCs, the PCjr has a sound generator chip with three independent channels, or voices, each with independent attenuation (volume control), plus a noise generator. Music in three-part harmony, explosions, and other neat effects are possible with the right programming. The extended Basic cartridge includes statements to support these enhanced sound capabilities.

The audio output is available at the rear of the system unit. With an external amplifier and speaker (or home stereo or tape deck) connected to the audio output jack, you can play to the whole neighborhood, record for posterity, or do other creative audiophile kinds of things. Even more interesting is the audio *input* line in the external I/O expansion

sion bus, which can be mixed with the internally generated sound. Can add-on speech synthesizers be far behind? Daisy, Daisy . . .

## Video Displays

The video display system in the PCjr is a direct descendent of the original PC color graphics adapter, with three significant improvements. First, most of the logic on the old card has been put in a single custom integrated circuit; what was previously a whole circuit board is now two big chips and a few little ones, and included in the basic price (instead of being a \$244 "mandatory option"). Second, the entire 128K of user RAM can be used for video storage; previously only 16K on the video card was available. This allows many more "pages" or images to be kept in memory and switched rapidly to the display—good for quick help screens, animation, and the like. Third, the color capability has been improved significantly.

The old PCs could display 320 by 200 dots in four colors (medium resolution), or 640 by 200 dots in two colors (high resolution). Unfortunately, in high resolution one of the colors was always black, and in medium resolution the color choice was limited, confusing, and a little ugly. The PCjr makes two important enhancements: independent choice of graphic resolution (160, 320, or 640 dots wide) and color resolution (16, 4, or 2 colors), and a completely general color palette. The high resolution 16-color mode would consume all 128K of memory, and thus could be reasonably used only by a cartridge program.

The color palette allows an arbitrary choice of any of the 16 possible colors to be assigned in any mode. The result is a much more flexible all-points-addressable color graphics system, much better suited to pictorial displays for games and educational programs. In other words, it looks much better and is more fun.

There is support in Basic for the enhanced color modes as well as the standard (i.e., old PC) graphics and 40- and 80-column alphanumeric display modes. The PCjr has the same 256-character display set as the previous IBM PCs. The designers have gone to considerable trouble to make the new hardware compatible with most of the software tricks that existing PC programs have used in display generation, and they have done an excellent job.

The PCjr does not support the high-resolution IBM monochrome display. There are provisions for connecting high-resolution RGB color monitors (via a \$20 adapter cable), composite video monitors (via a standard RCA phono plug), and television sets (via a \$30 cable

including an RF modulator). The TV connection also sends the audio output to the set, where it can be adjusted with the volume control knob.

## Options

Another bone of contention between IBM and the critics concerned the RAM available. IBM deliberately limited the original memory of the PCjr to 128K, which is not really enough to run many of the popular software packages. Third party manufacturers like Tecmar, Legacy Technologies, and Impulse Computer Products stepped in to make RAM expansion units. IBM, realizing that the 64K upgrade to 128K was not enough, introduced the 128K Memory Expansion Attachment.

The Memory Expansion Attachment adds 128K RAM, boosting the total memory to 256K, which is enough to run just about every software package on the market. Better yet, two more Mem-

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***IBM people taunted us about the mysterious connector marked L on the rear panel. They said it stands for "later."***

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ory Expansion Attachments can hook up to the PCjr, albeit indirectly via a Power Expansion Attachment, bringing the machine up to a respectable 512K RAM.

Other hardware options include an Internal Modem, Parallel Printer Attachment, and Speech Attachment.

The internal modem, made by Novation, is a full-featured smart modem for 110 and 300 baud communications. The modem card contains its own serial interface device, so the standard serial port is still available for attaching a printer or other device. The modem supports automatic dialing (pulse or tone) and answering, with error detection and diagnostics supplied in the system ROM.

The parallel printer attachment attaches to the 60-pin I/O channel expansion connector on the right side of the system unit. The attachment is required to support standard parallel printers such as the IBM Graphics Printer, Epson, Oki, and others. The I/O channel is passed through so that future options may be attached, always moving rightward. The current power supply will support up to five attachments on the I/O channel, plus the internal disk and modem.

The PCjr ROMs have provisions for handling "non-Keyboard scan codes" arriving through the infrared link. Speculation about wireless joysticks received an immediate "we can't comment on that" response from IBM people in the vicinity, who then taunted us about the mysterious connector marked L on the rear panel. They said it stands for "later." Stay tuned.

The speech attachment is a speech synthesizer using Linear Predictive Coding and Continuously Variable Slope Delta modulation to support speech and sound. It contains 196 words in ROM, supports speech encoding in compressed mode, and includes a microphone jack. Speech can be recorded to disk or cassette.

## Software

The built-in 64K ROM contains diagnostics, hardware I/O routines (BIOS) used by Basic, and the disk operating system, and the cassette Basic interpreter. PCjr cassette Basic is essentially the same as the standard PC cassette Basic: the essential features of the language plus program and data files on cassette tapes.

Advanced Basic features are provided in the PCjr Cartridge Basic (\$75), which plugs into either of the two ROM cartridge slots in the front of the system unit. The 32K ROM cartridge augments the standard cassette Basic with advanced graphics, sound and music, communications support (including a terminal emulator), and disk I/O (with DOS 2.1). The result is a superset of the standard PC advanced Basic, which requires disk and DOS and is partially RAM resident, all in ROM. DOS is required only if you want to use disk files.

DOS version 2.1 is the recommended disk operating system for the PCjr. (Earlier versions seemed to work as well, but IBM will support only version 2.1 and beyond.) DOS 2.1 has the same functions and storage requirements as DOS 2.0, and runs on the PC1 and PC/XT as well as the PCjr. The major difference is that Basic and BasicA require Cartridge Basic on the PCjr as a prerequisite. If the cartridge isn't plugged in, disk Basic won't run. Most of the utility programs supplied with DOS are identical in versions 2.0 and 2.1; the few that are different seem to have had some minor bug repairs made, but there are no significant enhancements.

There are now quite a few game cartridges available for the PCjr. Many, if not most, of the disk software packages for the PCjr are identical to those for the PC1 and PCXT. In some cases, only the latest versions will work on all three machines. Dealers will have a complete list of IBM-produced or distributed software

compatible with the PCjr.

### Compatibility

Whether any piece of software is compatible with the PCjr is hard to predict with certainty, but certain considerations should be taken into account. The most obvious is the single disk drive. The single drive will function as two logical drives, A and B, with the system prompting you to change disks when necessary.

For some applications, this is acceptable. For others, it is ridiculous. For example, if a program copies data from one disk to another one record at a time instead of in big blocks, thousands of insertion/removal/insertion cycles might be required. Logically, it works; physically, you should live so long. Try before you buy.

Programs, such as APL, that require the 8087 will never work in the PCjr. Programs that make assumptions about the length of time a sequence of instructions should take may not work, since the PCjr is slower in accessing the user RAM. Programs that directly access some devices (especially the disk and display systems) also may not work. Some software copy protection schemes might fall into these traps.

In general, programs that follow the rules of BIOS or DOS for device access, don't require more memory than is available, and don't need hardware that isn't there (like the monochrome display), will run without change on the PCjr.

### Conclusions

I like this machine very much. For the home, its graphics and sound features provide a good base for high quality, enjoyable games and educational software. Its compatibility with the PC1 and PCXT make it ideal for occasional work-at-home use, sharing programs and data with the machine at the office.

The PCjr makes sense for the office, too, as a PC-compatible spreadsheet workstation, programmable telecommunications terminal, or wherever the higher cost standard PC isn't quite justifiable. It is a great machine for schools as well—at all levels. From Logo for the little ones, through introductory computer architecture for college classes, the PCjr is a credible vehicle for serious education with or about computers.

For myself, I would love to have one right now. Instead of sitting upstairs in my cold den, typing fast to keep my fingers from stiffening from the cold air flowing through the gaps around my storm windows, I could be downstairs, comfortably nestled on the couch, with a roaring fire in the fireplace, warmly, leisurely, cordlessly processing these final words. But then I might never finish. ■

CIRCLE 498 ON READER SERVICE CARD

## Prices and Configurations

Here is a quick summary of the prices for representative PCjr hardware and software components, and some typical configurations.

Description	Price
PCjr System Unit (64K, keyboard)	\$599
64K Memory/Display Option	140
PCjr 128K Memory Expansion Attachment	325
PCjr Disk Option	480
PCjr Power Expansion Attachment	150
<b>PCjr System Unit (128K, keyboard, disk)</b>	<b>\$999</b>
IBM Color Display	680
PCjr Internal Modem (300 baud)	199
PCjr Parallel Printer Attachment	99
Connector for TV (with RF modulator)	30
Connector for RGB Display	20
Connector for Cassette	30
Connector for Serial Devices	30
Cable for Parallel Printer	45
Keyboard Cable	20
IBM Graphics Printer	\$449
IBM PC Compact Printer (thermal)	175
IBM PCjr Attachable Joystick	40
PCjr Speech Attachment	300
PCjr Carrying Case	60
Cartridge Basic	75
DOS 2.1	65
Multiplan 1.10	250
VisiCalc 1.2	200
HomeWord	75
EasyWriter	175
<b>Entry Level Home Configuration</b>	
PCjr System Unit (64K, keyboard)	\$599
Connector for TV (with RF modulator)	30
Connector for Cassette	30
Cartridge Basic	75
	<b>\$734</b>
<b>Home Budget/WP System</b>	
PCjr System Unit (128K, keyboard, disk)	\$999
Connector for TV (with RF modulator)	30
IBM PC Compact Printer (thermal)	175
Cartridge Basic	75
DOS 2.1	65
Visicalc 1.2	200
Homeword	75
	<b>\$1,619</b>
<b>Communicating Office System</b>	
PCjr System Unit (256K, keyboard, disk)	\$1324
IBM Color Display	680
Connector for RGB Display	20
PCjr Internal Modem (300 baud)	199
PCjr Parallel Printer Attachment	99
IBM Graphics Printer	449
Cartridge Basic	75
DOS 2.1	65
Multiplan 1.10	250
	<b>\$3161</b>