

The IBM 5150 Personal Computer

By Bruce Nikkel

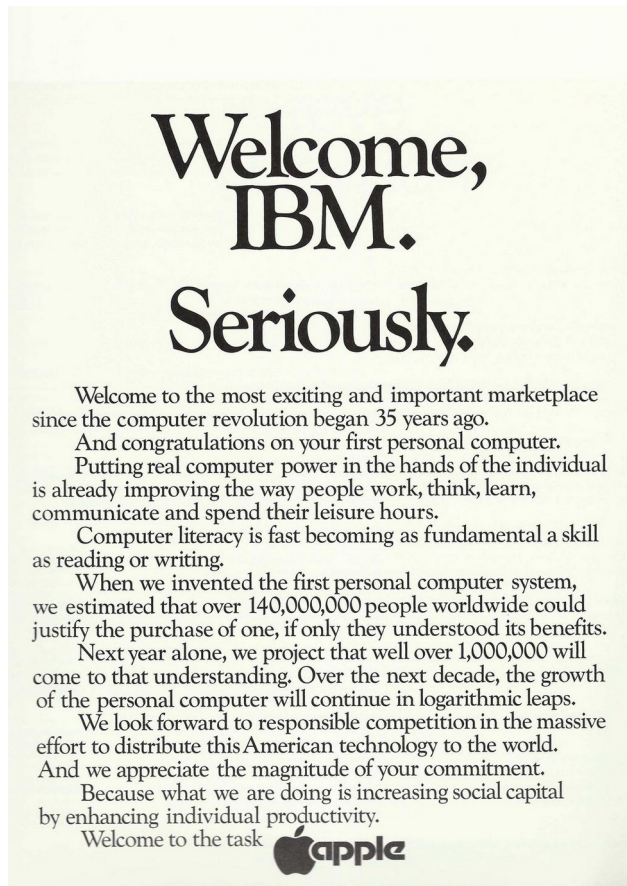
August 1981, four days after Roger Federer was born, IBM announced the 5150 personal computer¹. The market for small business and home computers was already booming, IBM was arriving late. Breaking with traditional IBM management, design, and development processes, a small team of a dozen people created the IBM 5150 in one year. The team used external vendors for hardware components, choosing Intel to provide the CPU. Another third party software vendor, Microsoft, provided the operating system (PC-DOS) and a programming language (BASIC). Even the sales channel was non-standard for IBM, using existing retail stores in the U.S. (Computerland, Sears) to sell the PC. IBM used Charlie Chaplin's "Tramp" character for marketing the computer, including a series of humorous television commercials². In 1983 the IBM was released to the international market.



1 https://www.ibm.com/ibm/history/exhibits/pc25/pc25_press.html

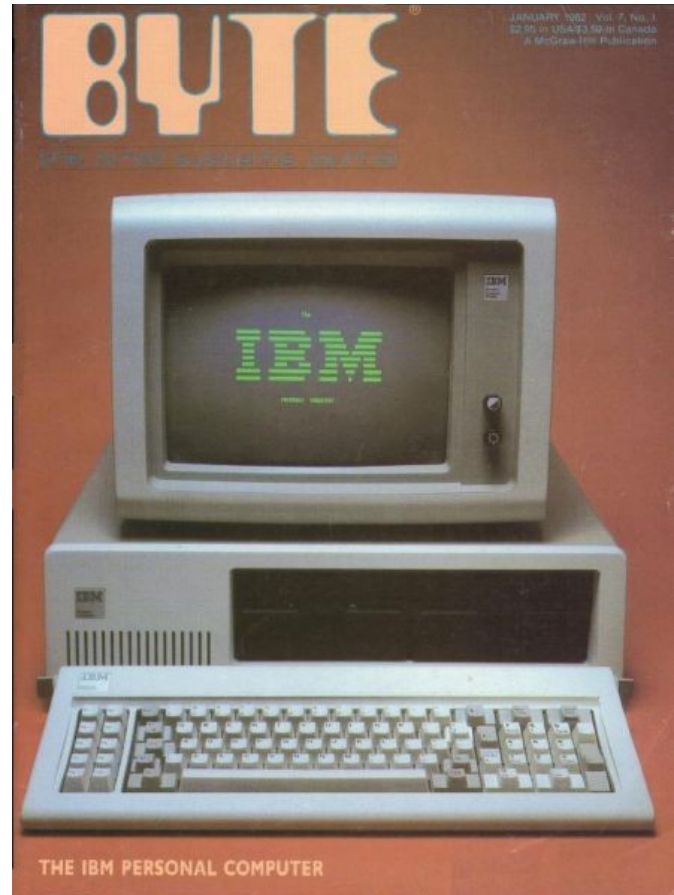
2 https://youtu.be/kQT_YCBb9ao

The personal computer industry grew up in the 1970s without IBM. The market was owned by names like Apple, Atari, Commodore, and Radio Shack. The IBM announcement of August 1981 generated much excitement in the industry. Apple published a teasing welcome response to IBM's announcement with a full page advertisement in the Wall Street Journal.



**Welcome,
IBM.
Seriously.**

Welcome to the most exciting and important marketplace since the computer revolution began 35 years ago.
And congratulations on your first personal computer.
Putting real computer power in the hands of the individual is already improving the way people work, think, learn, communicate and spend their leisure hours.
Computer literacy is fast becoming as fundamental a skill as reading or writing.
When we invented the first personal computer system, we estimated that over 140,000,000 people worldwide could justify the purchase of one, if only they understood its benefits.
Next year alone, we project that well over 1,000,000 will come to that understanding. Over the next decade, the growth of the personal computer will continue in logarithmic leaps.
We look forward to responsible competition in the massive effort to distribute this American technology to the world. And we appreciate the magnitude of your commitment.
Because what we are doing is increasing social capital by enhancing individual productivity.
Welcome to the task



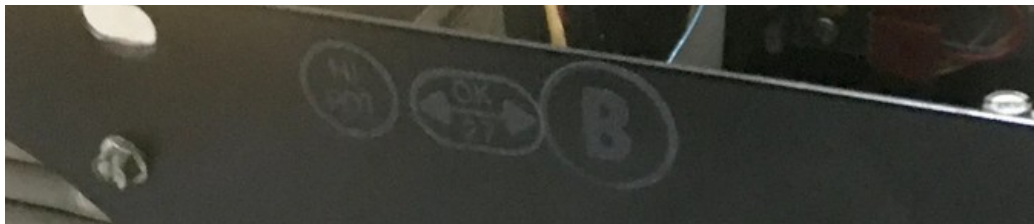
The announcement inspired the creation of a new computer magazine: "PC - The Independent Guide to IBM Personal Computers". Popular computer magazines like BYTE³ and INTERFACE AGE, had the new IBM personal computer prominently displayed on their covers.

The cheapest IBM Personal Computer was available for USD1565.- without floppy drives or monitor, and only 16K memory. This basic system was intended for home users using a TV and cassette player which was common for home computers at the time. An expanded system for business users cost USD4500.- and included 64K memory, two floppy drives, a color graphics monitor, and a dot-matrix printer. The equivalent prices in 2023 (adjusted for inflation and converted to Swiss Francs) would be roughly CHF6000 and CHF14,000 for these two models.

3 <https://archive.org/details/byte-magazine-1982-01>

The technical specifications of the IBM 5150⁴ were similar to other personal computers on the market in the early 1980s. Memory on the original mainboard was available from 16K to 64K, it had two 160K floppy drives, and a 4.77MHz Intel 8088. Nothing revolutionary in terms of specifications.

The 16KB-64KB 5150 PC was initially available in the US and Canada, and in 1983 a newer 64KB-256KB model was announced⁵ and also made available for the international market. IBM Germany produced a marketing brochure describing the newly available machine for German customers⁶. Some vintage computer collectors call this the 5150 “model B” due to the stamped letter B on the back of this model of computer (but this was not used in official IBM documentation).



Documentation

IBM's PC documentation was extensive and detailed. The documentation was useful for the PC owner to operate the hardware and software, for hardware developers and repair technicians, and for software developers. IBM provided hardware schematics, architecture block diagrams, information about interfaces, and programming details like interrupts and BIOS routines. IBM even made the source code of the BIOS available. The documentation (paper pages in ringed binders) was part of the *Personal Computer Hardware Reference Library*. Scanned copies can be found online⁷⁸⁹. Here is a list of some IBM documentation for the 5150 PC:

- Guide to Operations (August 1981, 252 pages)
- Technical Reference (August 1981, 392 pages)
- Hardware Maintenance and Service (August 1981, 356 pages)
- Disk Operating System (August 1981, 242 pages)
- BASIC (May 1982, 544 pages, Second Edition Version 1.10)

Handbooks were also translated into some local languages for international customers, like the German speaking region.

4 https://www.ibm.com/ibm/history/exhibits/pc25/pc25_fact.html

5 https://web.archive.org/web/20220124140840/https://www.ibm.com/common/ssi/rep_ca/8/897/ENUS183-068/index.html

6 <https://www.kultboy.com/index.php?site=pic&id=253>

7 <https://www.minuszerodegrees.net/manuals.htm#IBM>

8 <https://archive.org/details/ibm-pc-dos-1.0-aug.-1981>

9 <https://archive.org/details/IBMBASICAV1.10Manual>

All of this hardware and software transparency helped make the 5150 a commercial success. Hardware vendors could easily build compatible expansion cards and software developers could easily develop compatible programs. However, this openness also resulted in an explosion of cheaper IBM-compatible clones.

Physical Characteristics

The size of the system unit was 50.8 cm wide, 40.6 cm deep, and 14 cm high. The 30 cm high monitor (when placed on top) brought the total PC's height to 44 cm.

An novel feature of the IBM PC that we take for granted today was the detached keyboard. Most personal computers of the day had the keyboard integrated into the machine itself. In the press release, IBM explicitly mentions the flexibility of having a separate keyboard. The keyboard had 83 keys and was large, loud, and heavy, weighing 2.7 kg.

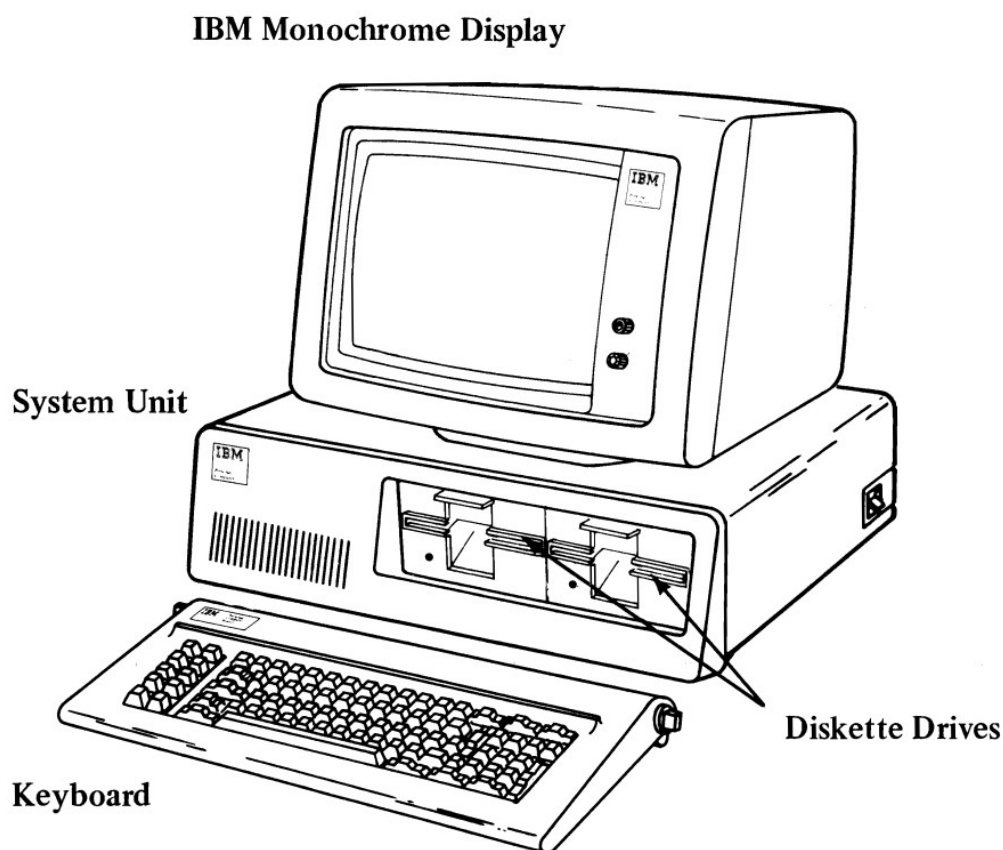


Diagram taken from the Guide to Operations manual

The system unit with two floppy drives weighed 12.7 kg and the monitor 7.7 kg. Together with the keyboard, the entire system weighed 23 kg.

Hard disk drives were not mentioned in the press release. These were not available as an option with the original 5150 PC. There is also no mouse mentioned. The use of a mouse for navigation only became popular several years later.

Inside the Case

The components inside the “System Unit” case included:

- power supply
- mainboard
- storage devices (zero, one, or two floppy drives)
- necessary internal cables
- expansion cards
- audio speaker

The basic components of a modern PC are still mostly the same as they were in the first 1981 IBM PC.



Photo taken from vintagecomputer.com

Mainboard

The 1981 release of the 5150's mainboard supported 16KB-64KB of onboard memory. Additional memory could be added with an expansion board for a

maximum of 256KB RAM (specified with configuration switches on the mainboard). The 1983 revision ("model B") had 64KB-256KB of memory on the mainboard. Expansion boards could increase the maximum RAM to 640KB. An amount that Bill Gates famously stated "ought to be enough for anybody".

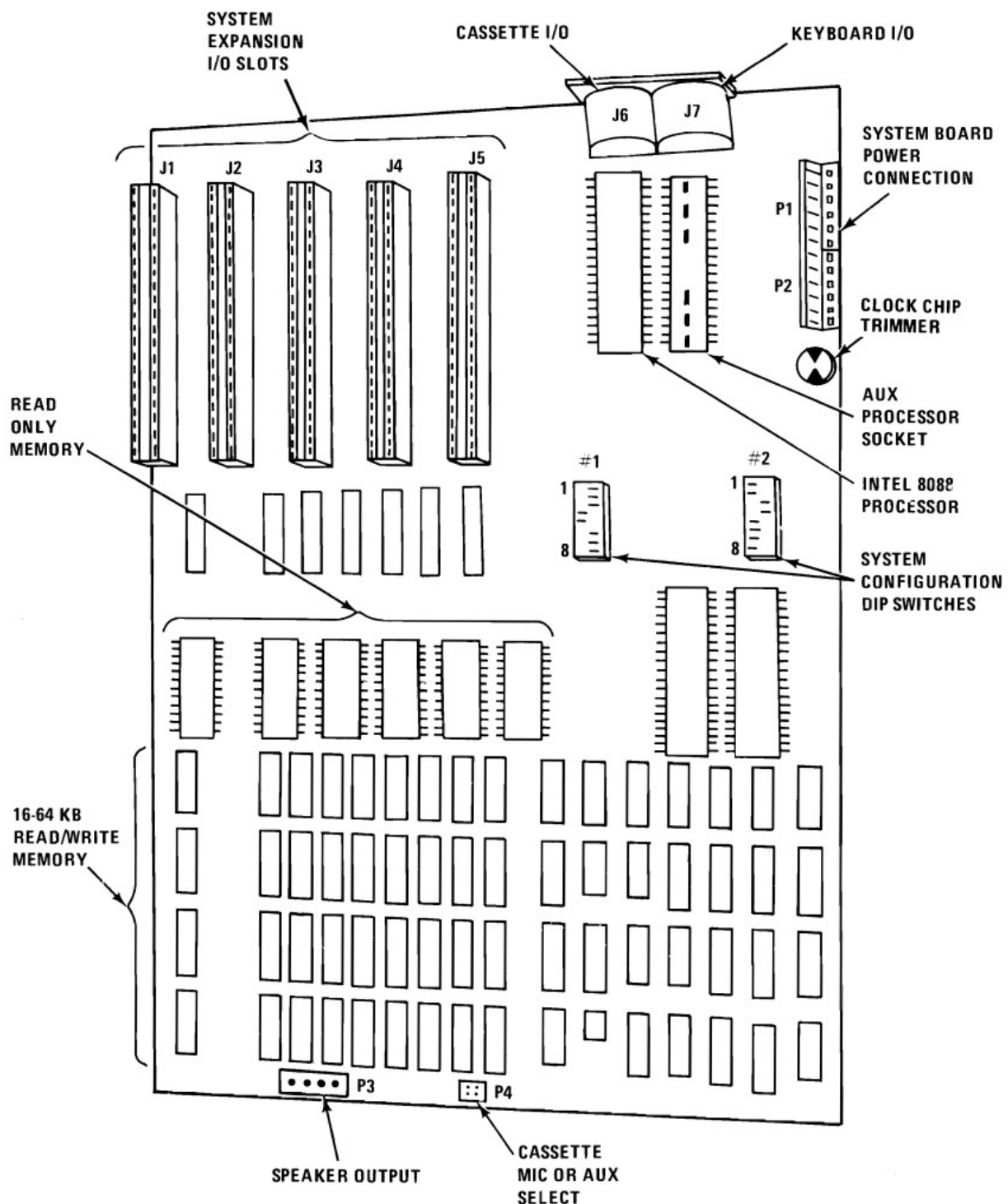
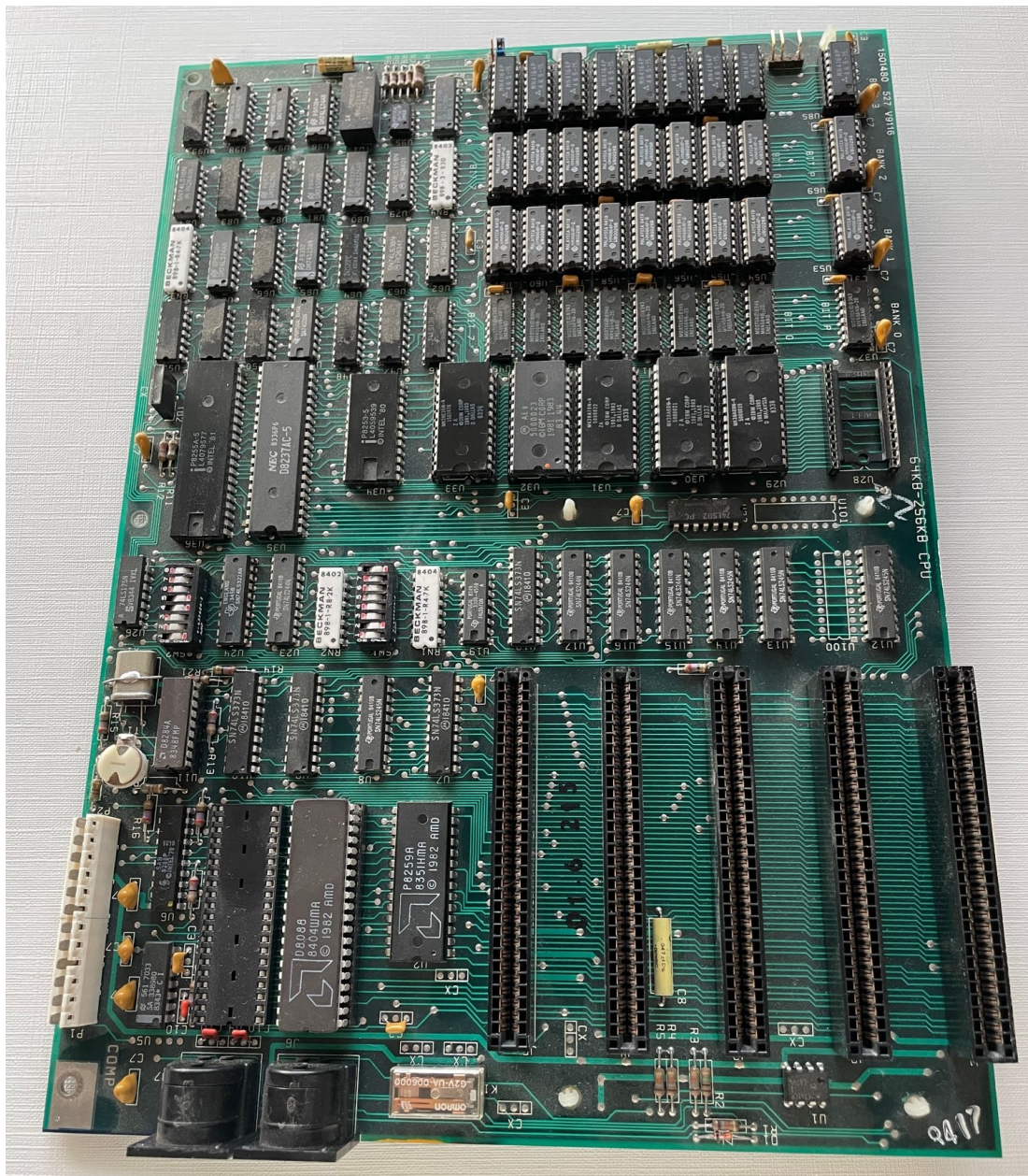


Diagram taken from the Technical Reference manual

The components on the mainboard also have similarities to modern mainboards. There is a CPU, RAM, jumpers and switches for configuration, slots for expansion cards, support chips like BIOS and controllers, and external connectors like the keyboard.



The mainboard BIOS had three revisions during the lifetime of the 5150, two in 1981 and a final revision at the end of 1982. Updating the BIOS meant ordering a new ROM chip, physically pulling out the old chip, and replacing it with the new one – a very different process from the easy firmware updates we have today. In this example the BIOS was the third revision (IBM part number 1501476):



The mainboard model could be determined by the by a label on the edge of the board. In this example the label indicates a “model B” mainboard (the “model A” would have “16KB-64KB”):



CPU

The CPU chosen for the IBM 5150 was the Intel 8088. This was a cheaper variant of the 8086 that operated at 4.77MHz. The CPU had an 8-bit data bus and 20-bit address bus, allowing memory addressing up to 1MB. Contrast that with a modern CPU that can operate at 4-5GHz, one thousand times faster than the 8086!

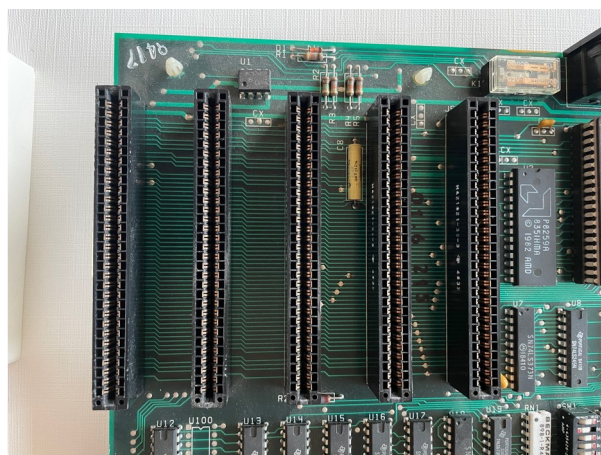
IBM involved multiple suppliers for components, and this included the CPU. AMD also had a compatible 8088 CPU, and this was used in some models and regions. This example shows an AMD 8088 CPU with an empty slot for a co-processor.



Unlike modern CPUs, the 8088 did not require a heat sink or fan to manage heat dissipation.

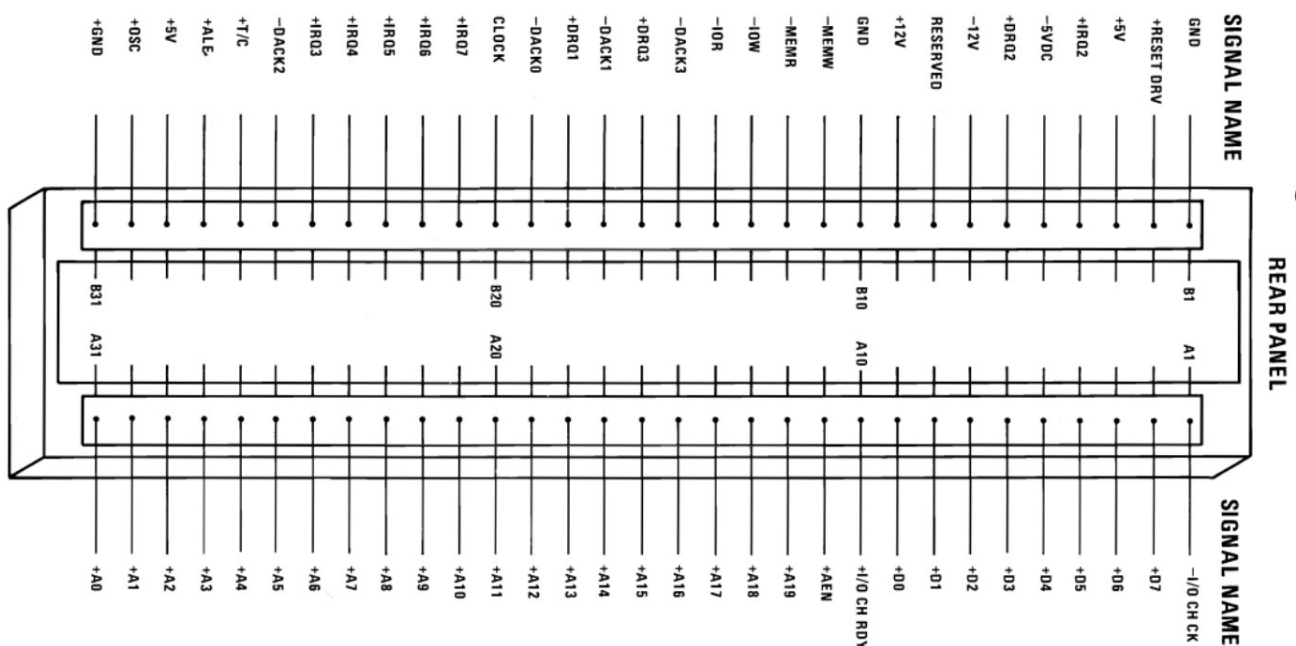
Internal Expansion Slots and Cards

The 5150 had 5 internal expansion slots. Today we call these ISA (Industry Standard Architecture) slots, but when the PC was released, this was not (yet) considered an industry standard, and IBM called it the “I/O Channel”.



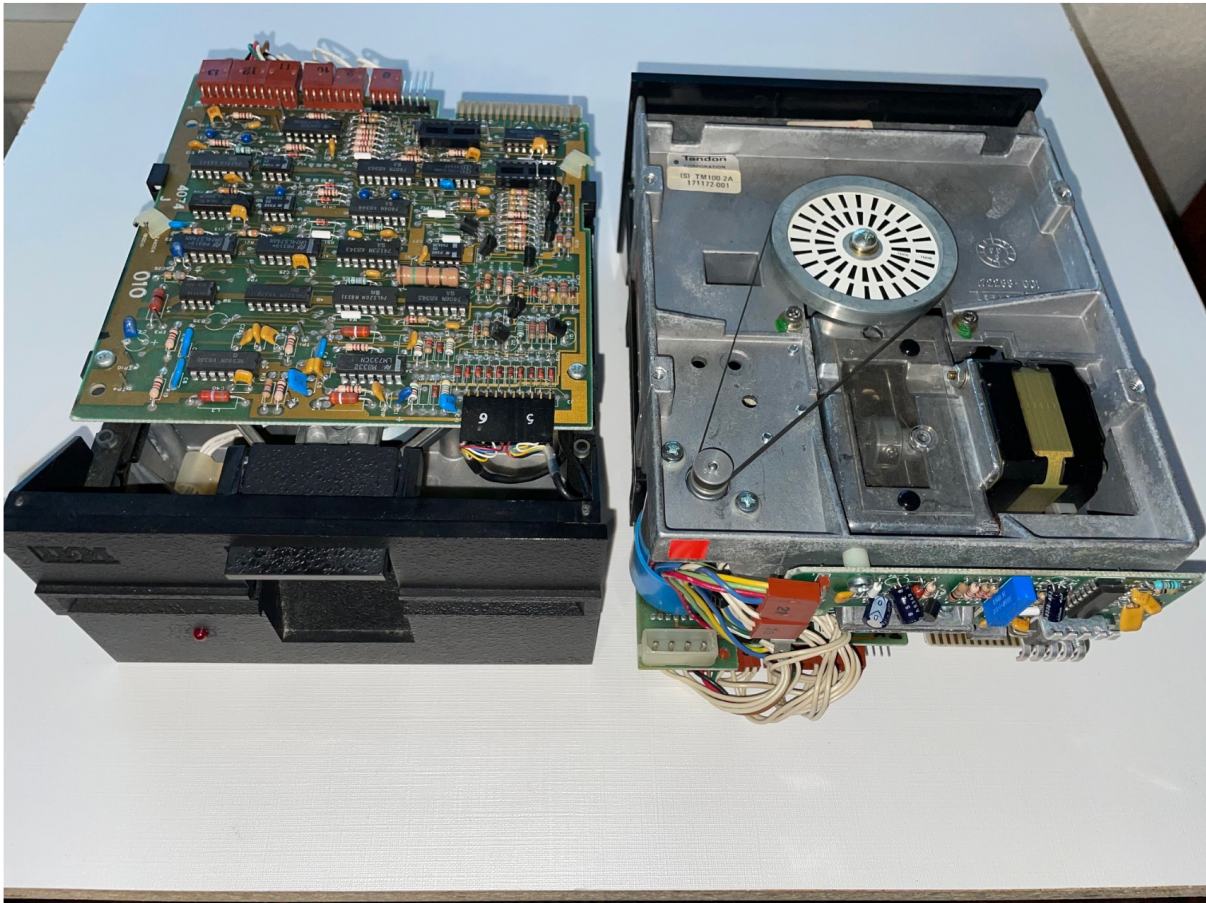
The I/O Channel was connected to the CPU, and as a result had an 8-bit data bus and 20 address lines. The slots also had interrupt signals, control lines for memory (including DMA – Direct Memory Access), timing control, and multiple power levels (+/- 5V and +/- 12V). An expansion slot had 62 pins for add-on cards. The pin-out is shown here (take from the IBM Technical Reference manual):

Depending on the PC ordered, expansion cards may have included a floppy disk controller and one or more adapters for attaching a display, printer, or RS232 device (modem). Modern PCs have moved away from parallel bus systems in favor of serial-based connections like PCI Express or USB because serializing/de-serializing data can be done at much higher speeds than a parallel row of bits.



Storage

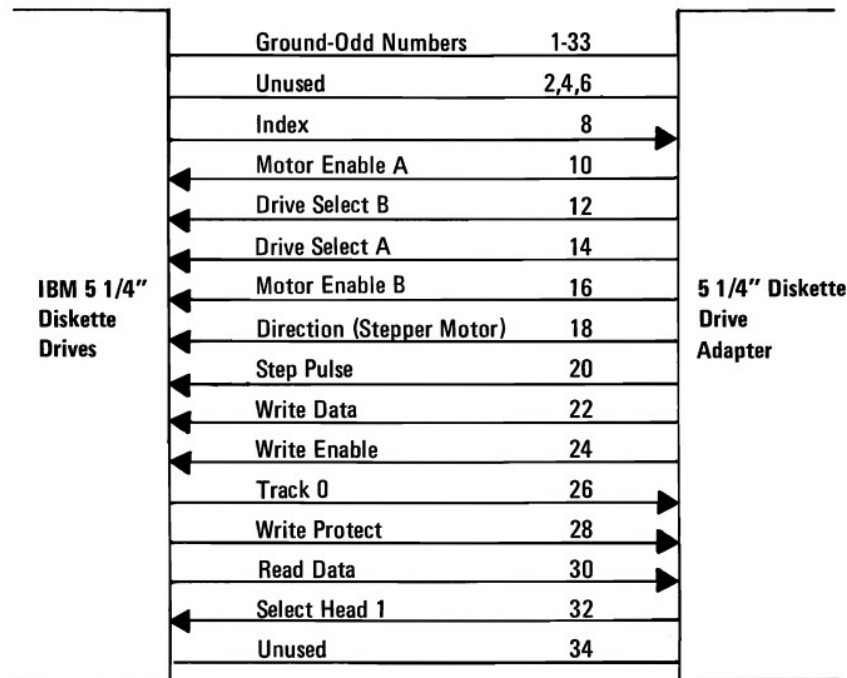
The 5150 shipped with zero, one, or two 5.25 inch floppy drives. A 5-pin DIN plug next to the keyboard allowed a cassette player to be attached and controlled. Data could be read and written to a cassette tape, a data storage method popular among home users.



The 5.25 inch floppy drives initially available were soft sector, single-sided, and double density (MFM). They had 40 tracks per side, 8 sectors per track, and 512-bytes per sector, for a total of 160KB of storage per floppy diskette. The “model B” shipped with double-sided drives and used 9 sectors per track for a total of 360KB per floppy.

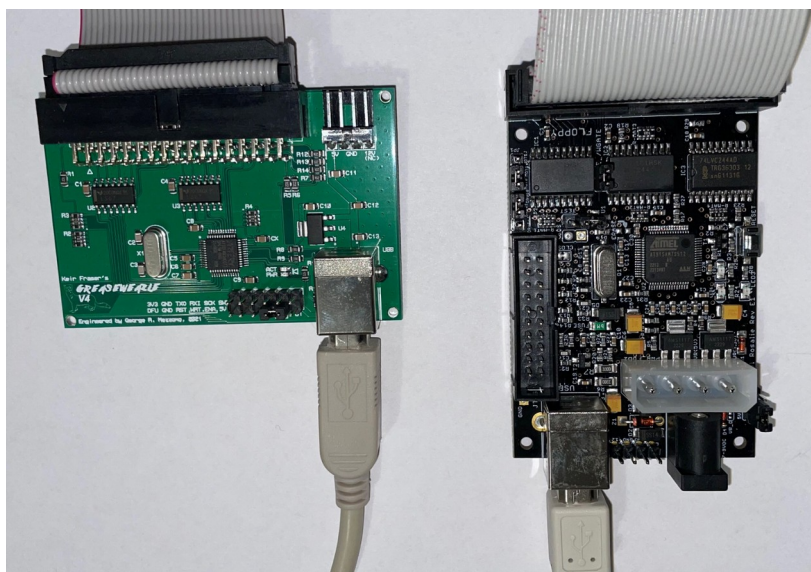
The floppy drives are powered using a standard Molex plug with +5 (red) and +12 (yellow) and two ground wires (black). This is the same power connector still found inside modern PCs today.

The signal interface is a standard 34-wire flat ribbon cable connected between the floppy drives and the controller card. The controller card uses one expansion slot on the mainboard. Data is transferred to and from the drive using registers and commands sent by the controller. The 34-pin edge connector is shown here:



The original IBM 5150 PC did not ship with a hard disk (an additional controller card and stronger power supply would be needed). It was possible to use the expansion unit 5161 (it looked almost identical to the IBM PC) to add additional expansion cards, and two drive bays for floppies or hard drives.

Original floppy diskette images for PC-DOS, applications, and games can be found online¹⁰¹¹. Transferring an image from a modern PC to a 5.25 inch floppy requires a special USB device that can write directly to the floppy's magnetic surface. The Greaseweazle (<https://github.com/keirf/greaseweazle>) and the Kryoflux (<https://www.kryoflux.com/>) can read and write images using 5.25 inch floppy drives for different vintage computer formats.



10 <https://winworldpc.com/product/pc-dos/1x>

11 <https://www.goodolddays.net/diskimages/>

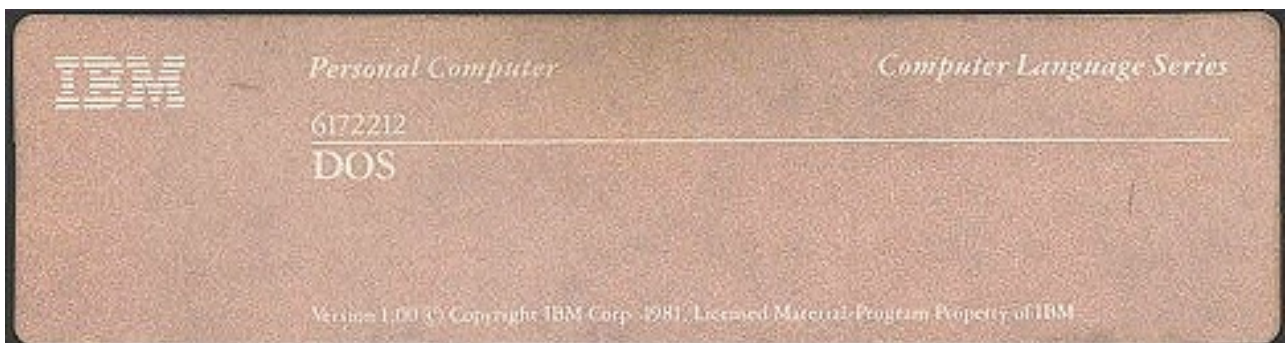
External Peripherals

Examples of external peripherals are described in the Technical Reference manual. These include:

- Cassette player/recorder attachment
- Speaker attachment
- Keyboard attachment
- Joysticks
- RS-232C devices (modems)
- TV or monitor (monochrome or color)
- Parallel port for printer
- Light pen

The open and well documented architecture, especially the expansion slots, led to a large market of third party interface cards.

PC DOS



The initial 5150 was shipped with the IBM-branded PC DOS, or simply “Disk Operating System”, which was supplied by Microsoft. There was a market expectation to provide CP/M, a popular operating system at the time, but the version for the 8088 CPU (CP/M-86) was not ready in time for the initial shipment of PCs. When CP/M-86 was finally available, it was much more expensive, and the market majority purchased PCs with the cheaper PC DOS.

A detailed forensic analysis of the original PC DOS has been performed and documented here: <https://thestarman.pcministry.com/DOS/ibm100/index.html>

PC DOS included a set of commands and utilities for managing disks and files, and had the original FAT (File Allocation Table) file system. The initial version did not support sub-directories so all files were presented in a “flat” file structure. Single sided floppies could hold up to 64 files, double sided floppies held up to 112 files.

The PC DOS core components included the following:

- The boot sector – 512 bytes located on track0, sector0, side0 of every formatted disk
- IBMBIO.COM - provided access to ROM and devices
- IBMDOS.COM - provided file management routines for user programs and other functions
- COMMAND.COM - the command interpreter (basically the "shell")

The boot process was a sequence of events leading up to the command prompt for the user. First the boot sector loads IBMBIO.COM and IBMDOS.COM into memory, reading directly from disk sectors at fixed locations on the first couple of tracks (not using the file system structure). Control is passed to the first byte of IBMBIO.COM which checks the status, and initializes devices and interrupt vectors. It then jumps to IBMDOS.COM which sets up the filesystem (file allocation tables), buffers, more interrupt vectors, and prepares memory for the command prompt. The COMMAND.COM file is then loaded into memory and executed. If an AUTOEXEC.BAT file exists, those commands are then executed.

Security

Computer security in the 1980s? Yes, it is actually mentioned in the DOS handbook, but not in the context of viruses and hacking as we think of today. It suggests physically storing floppy diskettes in a safe place, making backups, and keeping the computer located in a secure facility.

Malicious code and worms already existed in the 1970s, but the first IBM PC compatible virus (“Brain”) did not appear until 1986. The term “Computer Virus” was not widely used until the mid-1980s. See my HISTEC articles on the history of hacking for more information.

Conclusion

The IBM model 5150 Personal Computer was discontinued in 1987, replaced by the IBM model 5160 (the PC/XT). Over its 6 year lifespan the 5150 transformed the world.

Much of our computing infrastructure today, from the smallest IoT devices, to personal notebooks and desktops, to enterprise cloud infrastructure, have roots in the IBM 5150 from 1981.