PC MEMORY

MEMORY is only one of the REQUIRED hardware components of a PC. It is not more important, nor less important than the other components of your PC. But much of our modern day software will not operate efficiently, if at all, without "gobs" of memory.

MEMORY is a term that is used to represent storage that has "almost" instantaneous access by the CPU or other processor. Every computer will have some type of memory. However, the memory we speak of the most often is Random Access Memory (RAM).

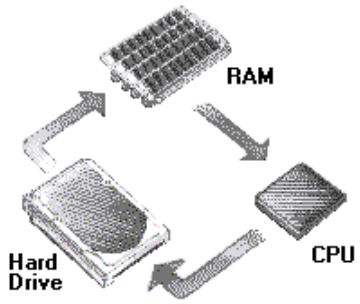
RAM is the primary memory used when we "boot" (start up) a microprocessor and the PC's operating system and device drivers are loaded into RAM.

RAM has many functions, but its primary function is to store programs and drivers for the various system devices. It is probably the most important type of memory in your PC.

We will discuss three types of memory:

- RAM
- ROM
- Cache

When you enter a command from your keyboard, the CPU (microprocessor) processes the command and calls for data (a program or data file) to be copied from a storage device (hard disk, floppy, CD-ROM, etc.) into memory, where it is stored temporarily until the CPU needs it. The memory then provides the data to the CPU more quickly than from the storage device. This data may be a program and actual data. This bulk memory is called "RAM", and is what you are referring to when you say "my system has 8, 16, 32 MB of memory".



The RAM is divided into multiple parts (locations, not types):

- Conventional Memory (location 0 thru 640 KB)
- High (Upper) Memory (641 thru 1 MB)
- Extended Memory (addresses above 1 MB)
- Expanded Memory (sometimes).

RAM, itself, usually consists of Dynamic Random Access Memory (DRAM). DRAM has several variations (such as FPM RAM, EDO RAM, and SDRAM) of chips mounted on Single In-Line Memory Modules (SIMM)boards or chips, or on Dual In-Lin memory modules. A single 30-pin SIMM can hold up to 4MB and a 72-pin SIMM can hold up to 32 MB of memory. I think I am right in saying that a 168-pin DIMM chip can contain up to 256MB of SDRAM.

Numerous "types" of memory exist and your specific PC may contain several types of memory for different purposes. Some of the terms you will hear are: RAM, DRAM, SRAM, EDORAM, SDRAM, ROM, PROM, EPROM, EEPROM, FLASH, internal and external cache, etc. These terms will be discussed below and in the "Terms and Definitions" selection.

Before I confuse you more, let me give you a table which will list these types and the normal uses for them:

ROM-BIOS, CMOS, Special function Chips.

RAM-Main Memory - FPM RAM, EDO & BEDO RAM, Synchronous DRAM (SDRAM)

DRAM-Chips on SIMM boards or Motherboard (Main Memory)-DRAM is actually FPM, EDO RAM, or SDRAM on a chip.

SRAM-Static RAM, used as External (L2)CACHE. L2 SRAM is on chips. L2 On-board cache is in the CPU chip. It comes in 3 basic types - Async SRAM, Sync SRAM, and PB SRAM (Pipelined Burst RAM - the fastest).

FPM-Fast Page Mode RAM used in 486 or before style motherboards. I think it is normally 30 pin SIMMs, but may also be on 72 pin SIMMs in some Intel Pentium based systems. The 70ns access time will work with the older, slower 486 CPUs, but for a system with bus speeds of 66MHz, you will need the 60ns speed SIMMs.

EDO RAM-Extended Data Out RAM Memory used on Pentium or later type motherboards. EDO RAM is not designed for 486 or earlier motherboards. EDO RAM is on 72-pin SIMMs. EDO RAM comes in plain EDO and Burst EDO (BEDO RAM) versions. EDO and BEDO RAM are ok in systems with bus speeds up to 66MHz.

SDRAM-Synchronous DRAM (Pentium w/MMX has SDRAM as main memory). SDRAM memory is on 168-pin DIMM chips. SDRAM comes in several types with speeds from 10, 15, 20, and 25 nanoseconds.

FLASH-Normally, it is memory on a card. The size of a PCMCIA card.

VRAM-Is a special, expensive, type of RAM. It can send at the same time it is receiving new information. It is most often placed on video cards, where the card can process information and not interfere with the main CPU.

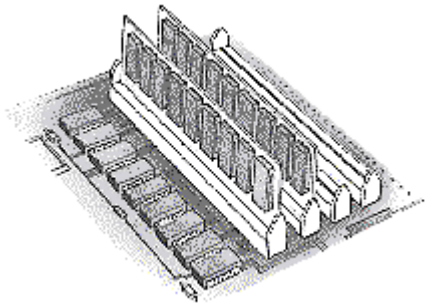
RANDOM ACCESS MEMORY (RAM)

RAM MEMORY provides the work areas where your operating system (DOS, Win95, NT, etc.), and applications are loaded and perform their functions.

RAM holds temporary instructions and data needed to complete a task!

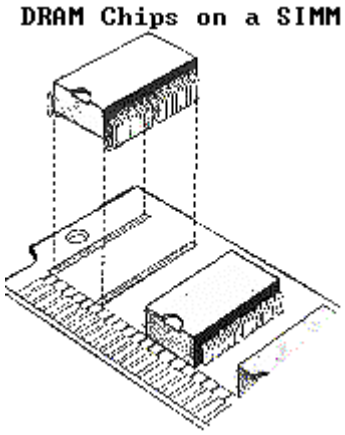
RAM consists of chips of memory, either in short chips (Dual In-line Pin (DIP) chips) or in memory modules called "Single Inline Memory Module" SIMMs, "Single Inline Pin Packets" SIPPs, DIMMs 'Dual In-Line Memory Modules", etc.

A SIMM will have a number (most often 8 or 9) of Dynamic RAM (DRAM) chips mounted on it. The DRAM chips are the actual memory, and the SIMM chips hold the DRAM and interface it to the system bus.



This illustration is Courtesy of Kingston Technology Corp. and shows two SIMM chips (9 DRAM chips per SIMM chip, so it is parity memory) in a memory bank; and just in front of the SIMM chips, there is some external "cache" memory chips (in DIPs) mounted directly to the board.

DRAM chips are mounted on SIMM chips like this:



SIMMs and SIPPs come in various pin configurations, SIMMs originally were 30 pin boards, and later 72 pin chips (boards), etc. DIMMs can come in 168 pin boards, allowing for 64 bit storage. DIMMs must have special motherboard receptacles, but DIMM is high capacity modules. In actuality, SIPPs are old technology, so you may never see a SIPP chip.

Each 30-pin SIMM chip can contain from 256KB to 4 MB memory, and 72 pin SIMMs can have from 1 MB to 32 MB memory (see table below).

SIMM TYPE	SIMM FORMAT	SIMM CAPACITY
30-pin	256K x 8	256KB
	1M x 8	1MB
	4M x 8	4MB
	256K x 9 (Parity)	256KB
	1M x 9 (Parity)	1MB
	4M x 9 (Parity)	4MB
72-pin	256K x 32	1MB
	1M x 32	4MB
	2M x 32	8MB
	4M x 32	16MB
	8M x 32	32MB
	256K x 36 (Parity)	1MB
	1M x 36 (Parity)	4MB
	2M x 36 (Parity)	8MB
	4M x 36 (Parity)	16MB
	8M x 36 (Parity)	32MB

Courtesy of Kingston Technology Corporation.

Memory chips (whether SIMMs or SIPPs) are placed in receptacles which are usually arranged in banks of 4 or 8 receptacles (see the first illustration above).

RAM is normally divided (or used by the PC) into three primary areas:

1. Connventional Memory (the first 640KB of RAM)

2. High (Upper) Memory (the next 384KB of the first Megabit of RAM)

3. Extended Memory (Memory above 1MB)

When you boot your PC, you usually see a display of memory which shows Conventional and Extended memory. The combination of extended, conventional, and upper memory usually will add up to the total number of memory you have installed on your PC.

Note that a 72 pin SIMM has 4 times the memory of a 30 pin SIMM. Also, note that if you have a "n x 8" 30 pin SIMM, it is a non-parity chip. A "n x 9" 30 pin SIMM is a parity chip. If you have a "n x 36" 72 pin SIMM, you have a parity chip. If you have a "n x 32" pin SIMM, it is a non-parity chip.

It is important to you to know this if you need to purchase memory. As a potential purchaser of memory, READ YOUR USER MANUAL to determine the type of memory you want to replace, or add to your PC.

RAM can come in many types, although main memory is most often DRAM on a SIMM chip. Some of these are:

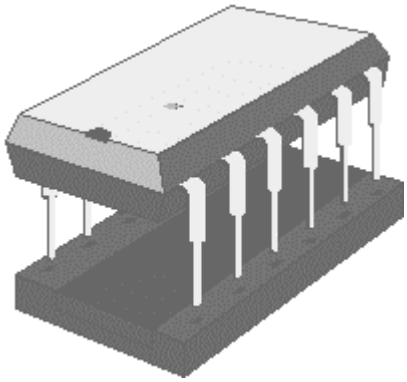
- Dynamic RAM
- Static RAM
- FPM (Fast Page Mode)
- EDO (Extended Data Out)
- SDRAM (Synchronous Dynamic RAM)
- Video RAM (VRAM)

READ ONLY MEMORY (ROM)

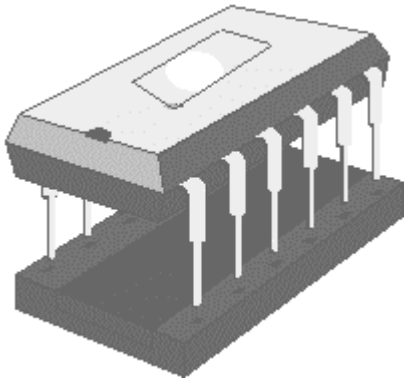
ROM MEMORY is reserved for use by operating systems (DOS, Win95, NT, etc.), and hardware devices, BIOS, CMOS, etc. You cannot use this memory for applications such as MS-WORD, buffers, etc.

"BIOS" controls the computer's startup processes and other basic components such as the keyboard, monitor/display, disk drives, etc. BIOS is always on a ROM or version of ROM such as EPROM, etc.

ROM may be in chips that look something like this:



PROM Chips look like this with a window in the chip.



Erasable Programmable READ ONLY MEMORY (EPROM)

EPROM MEMORY is an evolution of earlier ROM and PROM chips.They are used for chips for BIOS, CMOS, etc. You cannot use this memory for applications such as MS-WORD, buffers, etc.

CACHE MEMORY (RAM)

CACHE MEMORY provides the quick access to information. Main memory access by the CPU may take as long as 180ns; however, it make take 45ns to access external cache memory, even less for internal (L1) or on-board (L2) cache. While the CPU is processing information retrieved from cache, the cache controller is refreshing cache with data and instructions from main memory or a storage device

There are two categories of cache memory: Internal and External.

In older CPUs, and even in some current CPUs, Internal cache is memory located in the CPU, and external is located on the motherboard between the RAM and the CPU. It is often called 'cache RAM'. Internal Cache memory is often called "level 1" or L1 cache. External cache is often called "level 2" or L2 cache. L2 Cache may be on-board (in the CPU chip) or in Static RAM (SRAM) chips on the motherboard.

L2 Cache RAM is a small block of high-speed memory, usually SRAM (Static RAM), located between the CPU and main memory. It is used to store data or instructions that are used often. It also has the quickest access for memory for the CPU. There are several types of SRAM with the fastest having a speed of 4-8 ns.

External cache acts as a quick access buffer between the RAM and L1 cache in the CPU. From experience, external cache is a type of buffer for for data movement between devices such as disks, or

CD-ROM. Our experience with a 486DX with "external" cache versus one with no external cache is this: The two were started reading 31MB of data from a CD-ROM over the network. The one with external cache finished the job in half the time of the one without external cache.

Internal Cache memory usually runs from about 1KB (1024 bytes) to 64KB. External Cache memory usually runs from 64KB to 1 MB. Internal cache normally cannot be upgraded; however, external cache can often be upgraded.

External cache is normally a plug device - it plugs into "cache" sockets located on motherboards, and even on individual boards such as Network Interface Cards, video cards, etc.

NOW: In the newer processors, such as Pentium Pro and Pentium II, you will see new designations for cache. Some will have L1 cache (internal cache) and L2 cache (what used to be external cache). The Pentium II processor claims to have 512KB of integrated L2 cache. These machines have both types of cache integrated into the microprocessor.

This is a serious improvement - it gets the external cache, or L2, off the motherboard, and puts it where the cache can run at the full CPU speed rather than at the slower motherboard speed. A new designation "L3" will be used for cache that is on the motherboard.

When you boot your PC, you usually see a display of memory which shows Conventional and Extended memory, as well as the types and amounts of cache.

I would recommend you purchase a PC with at least 256 KB of cache - if you can afford it. The first 256K of cache saves the computer lots of time, but adding more does not improve performance proportionally.

For a complete discussion of all types of memory, I suggest you go to "www.kingston.com", or "www.centon.com" on the WEB.

HOW MUCH RAM MEMORY DO YOU NEED?

No one can say exactly - you need to know things about your system operating system, the type of applications you will run on your PC (graphics, multi-media, word processing, etc). Let me give you a few hints: Quantity

GENERAL USES

4 MB DOS applications, maybe Windows 3.1, a few old word processing packages, etc.

8-12 MB Windows for Workgroups, small word-processing, E-Mail,only a few (1 to 3) applications open. Maybe an Internet package such as Internet Explorer or Netscape, AOL, etc. Will be somewhat inefficient.

12-16 MB Windows for Workgroups, supposedly Windows 95 (not really!), Word processing, E-Mail, WEB interfaces, FAX, spreadsheets, and low level graphics applications. Few applications open simultaneously.

16-24 MB You can now load Windows NT Server, Windows NT Workstation, and Windows 95. NT Server works inefficiently at this level. Some number crunching, spreadsheets, E-Mail, WEB browsers, some graphics and audio-visual (but weak).

24-32 MB Now you can do heavy applications. Spread sheets, statistical analysis programs, large databases, and multiple applications open. Even a little graphics and games – a an acceptable speed.

32-64 MB Starting into decent graphics, with word processing, page layouts, even some good "audio visual" type applications.

64-128 You are now read for medium to high level graphics and animation - if you have the other necessary hardware. Photo editing, multimedia, word processing, illustration graphics, the whole nine yards!

128+ MB Now you are talking! This is the level for efficient Windows NT Servers with many users. Multimedia and about everything else!

Just remember this: You can have all the RAM memory you can install; but, if you do not have adequate internal and external cache, good video cards, a 32-bit or 64-bit bus, etc., you will still operate somewhat slower.

PURCHASING RAM.

Ask yourself the following questions, and record the answers on paper:

1. What type of memory can my PC accept?
2. 30 pin SIMM, parity or nonparity?
3. 72 pin SIMM, parity or nonparity?
4. 168 pin DIMMs?
5. How much memory do I have?
6. What is the speed of DRAM memory my PC accepts (in nanosecond speed)?
7. Do I have open memory slots on my motherboard? (if not, you will probably have to get larger capacity SIMMs such as a 4MB SIMM rather than multiple1 MB SIMMS).
8. How much memory will my PC accept? Am I "max'd out"? Some machines such as a EDS 386 only had 8 slots for SIMM chips, for a max of 32MB of memory.
9. Am I getting messages from applications (especially Windows applications) indicating there is not enough memory to run applications, save files, etc.?
10. Are your applications which run graphics, games, spreadsheets, etc. performing at a slow rate?
11. Is your harddrive light flashing when running programs and are not saving files?