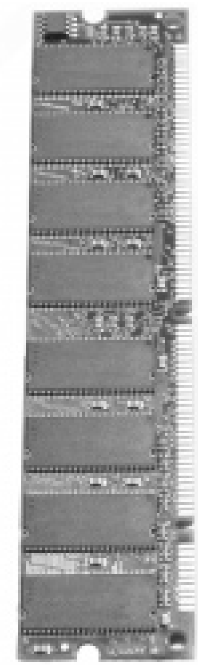
"God gave us memory so that we might have roses in December." - *J.M. Barrie*

Chapter 3: Memory Modes, Modules and More

MEMORY TYPES



The first thing we should do is clear up the difference between memory and storage. When we say storage we mean the disk drives, tape or other ways we keep large amounts of data whether the computer is on or off. It is also sometimes called Mass Storage. Memory on the other hand refers primarily to Random Access Memory.

Here's a handy way to understand the difference in the way the computer uses these two ways of keeping information. You can think of the disk drive as a filing cabinet, and RAM as the top of your desk. The filing cabinet is a good place to keep a file, but if you want to work on it you must take it out of the filing cabinet and put it on your desk. Then when you are done, you put the file, with any changes you've made, back into the cabinet.

In the computer, whatever files you are using must first be copied into the RAM. This includes not only data files, but also the program files for the operating system and any applications being used. When you are done you Save your work, which puts any changes you've made back onto the hard drive. Now, there is one important difference between the hard drive and a filing cabinet: In the computer, the original file remains on the disk, and only a copy is put into RAM. If you don't save the changes, the file on the disk will stay just the way it was when you started.

TYPES OF RAM

DRAM

Since the beginning of the PC (and even before on larger systems) the type of chip used for most random access memory has been of a type called Dynamic RAM, or DRAM. This type of RAM is very simple and compact, because each memory cell needs only one transistor and one capacitor. If the capacitor is charged up (usually to 5 volts) that cell is a 'one'. If the capacitor is at zero volts, that cell is a 'zero'.

As improvements in technology have allowed more and more transistors to be squeezed onto less and less silicon, the storage capacity of DRAM memory chips has gone up and the cost has come down. You can now get DRAM chips that contain over ¼ billion cells for about the same cost as the 1024-cell chips used in early computers.

The problem with DRAM chips is that the capacitor in the memory cell loses its charge very quickly, and must be 'refreshed' several times a second to keep the data from being lost. The system can't read or write to the memory while it is being refreshed, which slows down any CPU cycle that requires access to the RAM data.

There are several variations of DRAM that attempt to work around this slowdown. One is called EDO, for Extended Data Out. With EDO RAM, up to four adjacent memory locations can be accessed in sequence without starting a whole new memory cycle for each one. This results in a big time savings if adjacent locations are being accessed, which is often the case.

Another scheme is SDRAM, or Synchronous DRAM. This one transfers data in high-speed bursts using a synchronized interface.

The latest entry in the DRAM speed wars is called RDRAM, or Rambus DRAM. This one uses a special data bus for the RAM, hence the name Rambus. Theoretically, data transfers should be several times faster than other DRAM types. Because of the separate bus, this design requires its own motherboard design and is not compatible with other types of DRAM. It remains to be seen whether RDRAM becomes widely accepted by the PC manufacturers.

SRAM

One type of RAM chip eliminates the need for refresh altogether. It is called the Static RAM or SRAM. This one uses several transistors to create a latch circuit. As long as power is applied to the chip, the output of the latch circuit will stay as a zero or a one until a new input changes it, so no refresh cycles are needed. This makes SRAM much faster than DRAM. On the other hand, not nearly as many cells can be crammed into a chip, so the size and cost makes it impractical for the large RAM capacity needed in modern PCs. SRAM chips are mostly used for cache, where they provide the CPU with fast access to the small portion of the RAM contents it is most likely to need next.

SRAM chips used as cache will be located either on the motherboard close to the CPU, or mounted on the CPU module itself.

VRAM

The computer's video circuitry needs huge amounts of memory. The contents of every pixel must be stored, and the amount of data for each pixel is multiplied as the color accuracy goes up. Rather than use system RAM for this and compete with all other memory accesses, the video has its own RAM. Some of this RAM may be on the motherboard, and video adapter cards will have much more.

One common version of RAM chips for the video is called VRAM. VRAM is designed to be Dual-ported, meaning it is possible to read and write to it at the same time.

There is a modified form of VRAM made especially for high-end graphics called WRAM, for Windows RAM.

ADDING MEMORY

One thing we skipped when we were talking about SIMMs and DIMMs in Volume 1 was how to add memory to a system. Sometimes you can just stick in another SIMM and sometimes you have to add two or more at a time. It all depends on the width of the data bus and on the type of SIMM.

There are two types of SIMMs and they are very easy to tell apart. One module has 30 pins on the connector that fits into the motherboard's memory slots, and is 8 bits wide, meaning it puts out 8 data bits at a time. The other type has 72 pins on the connector and is 32 bits wide.

Memory must be added one **Bank** at a time. A memory bank is enough memory to put out the same number of bits as the data bus. For instance, the 386 and 486 are 32-bit CPUs, so each 72-pin SIMM, putting out 32 bits of data, would be enough for one bank of memory for these systems. However, the Pentium is a 64-bit CPU, so it would take two 72-pin SIMMs to make a bank of memory in a Pentium system. You can add 2 or 3 banks at once if you wish, but you can never add ½ bank, 1 ½ banks etc.

With the 30-pin SIMMs which put out 8 bits at a time, it would take 4 SIMMs to make one bank of memory in a 32-bit system, so you would always add them 4 at a time or in multiples of four. These SIMMs will be found most often in the older 16-bit systems such as the 286, where it only takes 2 SIMMs per bank.

If you look at a 30-pin SIMM next to the 72-pin version you will notice that both have the same number of memory chips. The difference is that the chips used on the 72-pin SIMM are a newer type, and each chip can read and write 4 bits at the same time.

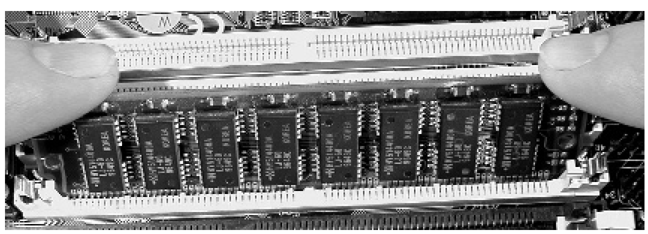
We haven't yet talked about DIMMs, which are just about all you will see in new systems. DIMMs may use the same type of chips as the 72-pin SIMM, but would have twice as many (usually with a second row of chips on the back side), or they may just use higher-capacity chips. DIMMs put out 64 data bits at a time, and have a connector with 168 pins. In the 64-bit Pentium systems, each DIMM is one bank of memory, so you never have to worry about adding ½ bank. At least, not until somebody starts making a 128-bit CPU.

Because DIMMs and SIMMs are such long skinny circuit boards, they are sometimes called sticks. If you ever hear somebody refer to a **Memory Stick**, it's no different than a memory module.

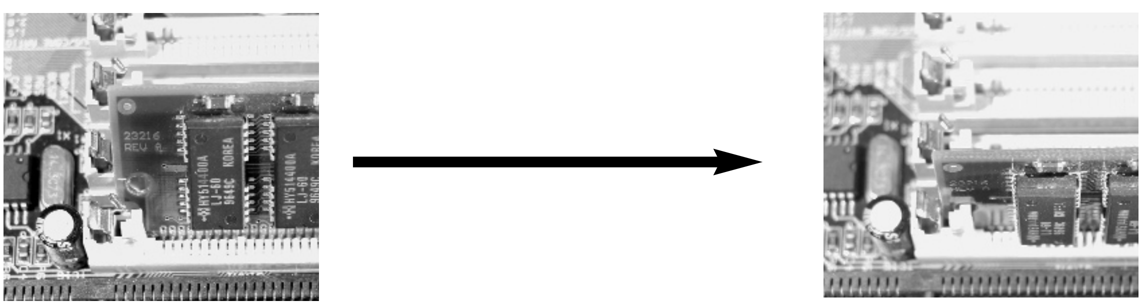
INSTALLING SIMMS AND DIMMS

The procedure is slightly different depending on whether you are installing a SIMM module or DIMM module but one thing is the same for both, and that is protecting them from ESD. Wear your ESD wrist-strap when doing this task, or the lifespan of that new memory module may be all over in a millisecond.

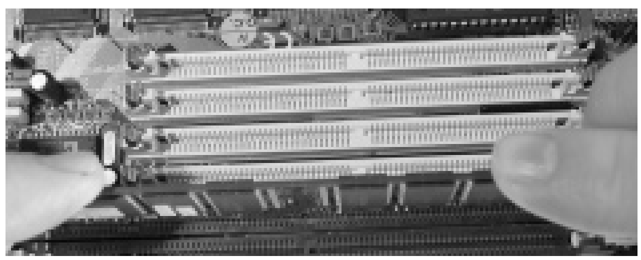
To install a SIMM, tilt the module and insert it into the slot at an angle. It should go in easily, so don't force it. There is a notch at one end that prevents it from going in backwards. Once the module is sitting in the socket, rock it gently forward. As it approaches vertical, a **Locking Clip** on each end will snap into place and hold the module in an upright position. To remove a SIMM, pull the locking clips away from the module and then lift the module out at the same angle it went in.



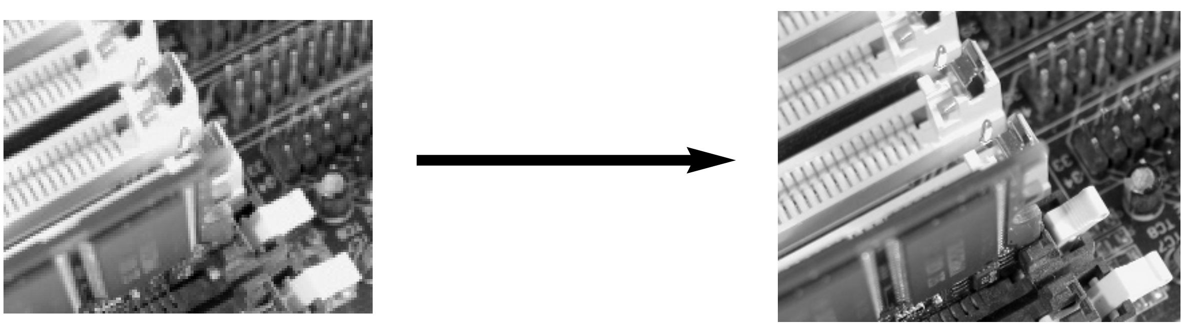
Installing a SIMM module is very easy as illustrated here.



With DIMMs, the notches that prevent incorrect installation are on the bottom connector edge, and they are off-center so that the module will go in only one way. The module goes into the socket in an upright position. Push it gently into the socket until it is firmly seated. As you do this, the Ejector Tabs on each end of the socket will come into an upright position next to th edge of the DIMM. To remove a DIMM, swing the ejector tabs away from the DIMM and it will come loose so it can be lifted out.



DIMM Modules are easy to install because the keyed sockets only allow the modules to be placed in one way removing the possibility of them being inserted in backward (unless you use a hammer).



With both SIMMs and DIMMs, once they are installed you should compare the alignment of the gold connector fingers against the top edge of the socket to make sure that both ends of the module are seated in the socket equally. Improperly seated modules are one of the more unnecessary memory problems a technician should have to deal with.