7

Chapter 7:

Memory

OBJECTIVES

After completing this chapter you will

1. Understand memory-related terminology.
2. Be able to install and remove memory chips.
3. Understand how memory works with different operating systems.
4. Be able to optimize memory under different operating systems.
5. Be able to troubleshoot memory problems.

KEY TERMS

access time
bank
burst EDO
C-RIMM
CAS
cache memory
chipset
conventional memory
DDR DIMM
DDR RAM
DIMM
DIP
DRAM
ECC
EDO
EMS
expanded memory
extended memory
external data lines
flash memory
FPM
HMA
LIM
memory map
nanosecond
non-parity
non-volatile memory
page
parity
parity chip
PC100
PC133
Performance Monitor
Performance utility
pipeline burst cache
pipelining
protected mode
RAM
RAM drive
RDRAM
real mode
refresh
registered SDRAM
reserved memory area
RIMM
ROM
SDRAM
SGRAM
SIMM
SIPP
SO-DIMM
SO-RIMM
SPD
SRAM
swap file
System Monitor
thread
UMA
UMB
VCM
virtual memory
volatile memory
VRAM
WRAM
XMS

MEMORY OVERVIEW

Computer systems need software to operate; the computer is an expensive doorstop without software. For the computer to operate, the software must reside in the computer's memory. Memory is simple to upgrade, but a technician must understand memory terminology, determine the optimum amount of memory for a system, install the memory, fine-tune it for the best performance, and finally, troubleshoot and solve any memory problems.

The two main types of memory are **RAM** (**Random Access Memory**) and **ROM** (**Read Only Memory**). RAM is found on the motherboard and stores the operating system (DOS, Windows 95, Windows 98, or NT Workstation), the software applications (word processing, spreadsheet, database, etc.), and the data being used by all of this software. RAM is also found on adapters such as video cards. RAM is **volatile memory**; the information in RAM is lost when you power off the computer. ROM is **non-volatile memory**; the information is in ROM even when the computer is powered off.

RAM is divided into two major types: **DRAM** (**Dynamic RAM**) and **SRAM** (**Static RAM**). DRAM is less expensive, but slower than SRAM. With DRAM, the 1s and 0s inside the chip must be refreshed. Over time, the *charge*, which represents information inside a DRAM chip, leaks out. The information, stored in 1s and 0s, is periodically rewritten to the memory chip through the **refreshing** process. The refreshing is accomplished inside the DRAM while other processing occurs. Refreshing is one reason DRAM chips are slower than SRAM.

Most memory on the motherboard is DRAM, but a small amount of SRAM can be found on a motherboard or, as is the norm for today's computers, inside the microprocessor. SRAM is also known as **cache memory**. The cache memory holds the most frequently used data so the microprocessor does not return to the slower DRAM chips to obtain the data. For example, on a motherboard with a bus speed of 100MHz, accessing DRAM could take as long as 180 nanoseconds. (A **nanosecond** is a billionth of a second.) Accessing the same information in cache could take as little as 45 nanoseconds.

Some cache memory (L2 cache) is known as **pipeline burst cache**. When computers use this memory technology, it is known as pipelining. **Pipelining** is the process by which microprocessors and memory obtain computer software instructions in a timely fashion.

To understand pipelining, take the example of a fast food restaurant. In the restaurant, say there are five steps (and one employee per step) to making a burger and giving it to the customer: (1) take the order and input it into the computer system, (2) brown the buns and cook the burgers, (3) take the bun and burger and add condiments, (4) wrap the burger, add fries, and insert them into a sack, (5) take the customer's money and give the sack to the customer. Keep in mind that the person taking the customer's order cannot serve another customer until the first customer receives their order. To make this burger process go faster, you could (1) allow the person taking the order serve other customers until the first order is ready to be given to the first customer or (2) allow more registers to be opened so more customers can be served simultaneously.

To relate this to processors, the CPU fetches a software instruction from memory and then the processor sits idle. This is the same as not allowing waiting customers to be served until the first customer has his/her food. With pipelining, the processor is allowed to obtain more software instructions without waiting for the first instruction to be executed. Having more registers is the same as having more pipelines that have the task of fetching instructions. Both techniques are used in today's processors. The bottom line is that the CPU should never have to wait to receive an instruction. Using pipelined burst cache speeds up processing for software applications.

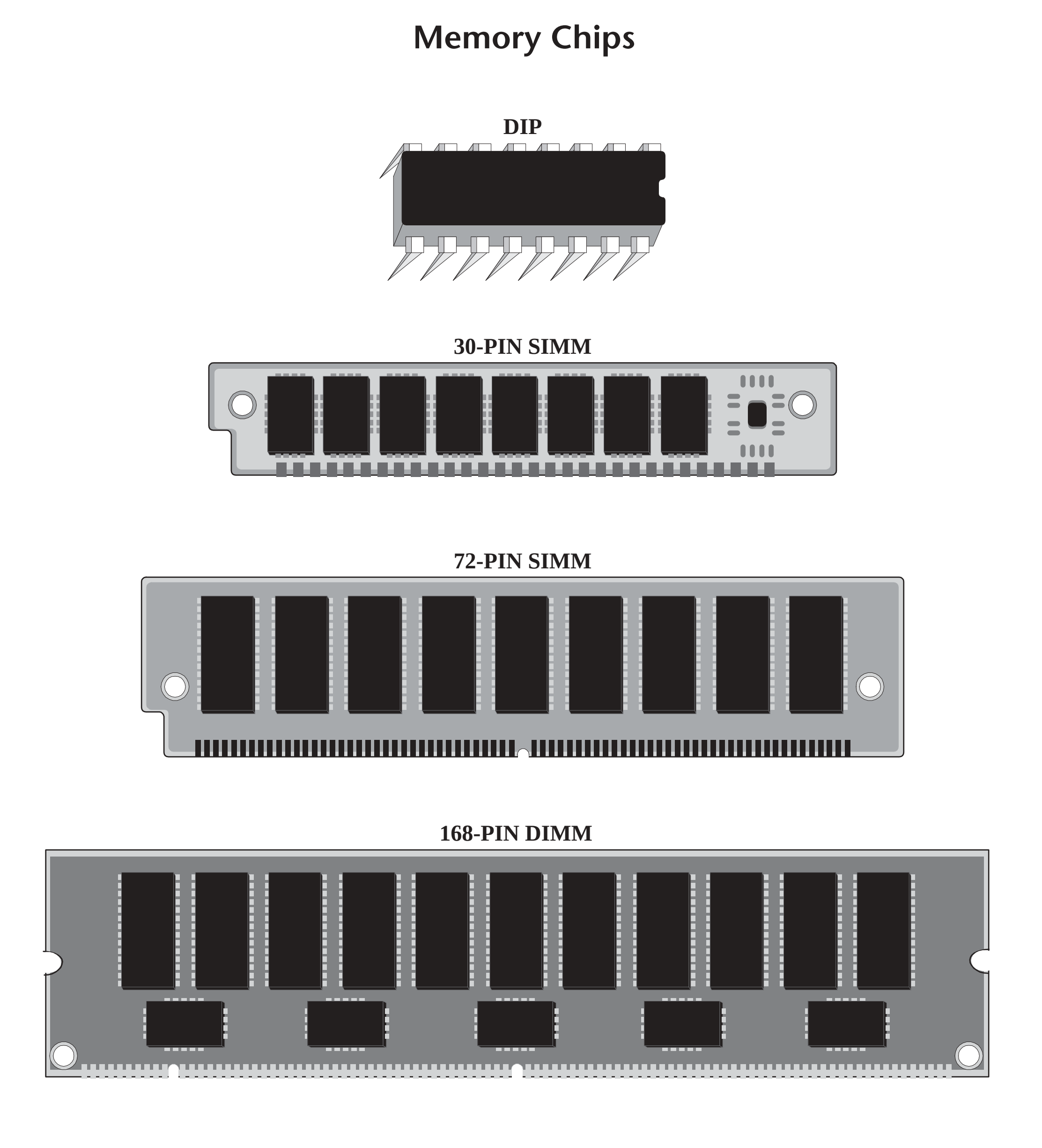
The data or instruction that the microprocessor needs is usually in one of three places: cache, DRAM, or the hard drive. Cache gives the fastest access. If the information is not in cache, the microprocessor looks for it in DRAM. If the information is not in DRAM, it is retrieved from the hard drive and placed into DRAM or the cache. Hard drive access is the slowest of the three. An analogy is the best way to explain this. Consider a glass of cold lemonade, a pitcher of lemonade in the refrigerator, and a can of frozen concentrated lemonade in the freezer. If you are thirsty, you would drink from the glass because it is the fastest and easily accessible. If the glass is empty, you would pour lemonade from the pitcher to refill the glass. If the pitcher is empty, you would go to the freezer to get the frozen concentrate to make some more. The glass of lemonade is like cache memory. It is easily accessible. The pitcher of lemonade is like DRAM. If the glass is empty, you have to get more lemonade from the pitcher. If the 1s and 0s are not in cache, they are retrieved from DRAM. The pitcher holds more lemonade than the glass just like DRAM holds more information than cache memory. The concentrated lemonade is like the hard drive. Concentrated lemonade takes longer to make and get to than the glass or the pitcher. In a computer, it takes roughly a million times longer to access information from the hard drive than it does from DRAM or cache.

Usually the more cache memory a system has, the better that system performs, but this is not always true. System performance also depends on the efficiency of the cache controller (the chip that manages the cache memory), the system design, the amount of available hard drive space, and the speed of the microprocessor. When determining a computer's memory requirements, you must take into consideration what operating system is used, what types of applications are used, and what hardware is installed. DOS computers take a lot less memory than 2000 Professional computers. High-end games and desktop publishing take more RAM than word processing. Free hard drive space and video memory are often as important as RAM in improving a computer's performance. RAM is only one piece of the puzzle. All of the computer's parts must work together to provide good system performance.

MEMORY PHYSICAL PACKAGING

A **DIP** (**Dual In-line Package**) chip has a row of legs running down each side. The oldest motherboards used DIP chips for the DRAM. **SIMM**s (**Single In-line Memory Modules**) came along next. Two types of SIMMs are available: 30-pin and 72-pin. The most popular memory chip, a **DIMM (Dual In-line Memory Module)**, has 168 pins. It works in Pentium, Pentium Pro, Pentium II, or Pentium III motherboards.

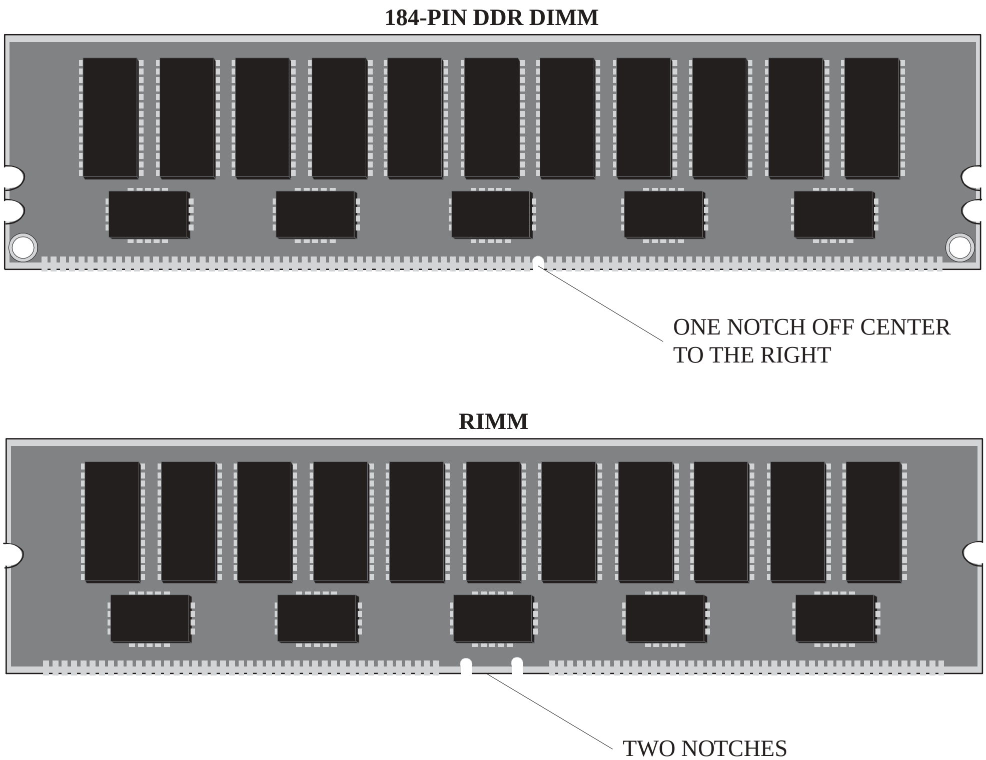
MEMORY – FIGURE #1



Other memory packages available today include the 184-pin DIMM and the 168-pin RIMM. **DDR DIMMs** are used in AMD Athlon computers and higher-end servers. **RIMMs** are used in Intel Pentium 4 computers. Memory Figure #2 illustrates these types. Notice the single notch at the bottom of the 184-pin DDR DIMM. This distinguishes it from the other dual-notched DIMMs. The RIMM has two notches in the center.

MEMORY – FIGURE #2

184-pin DDR DIMM and RIMM



Older 80286- and 80386-based motherboards sometimes held a DRAM chip called a SIPP, but these are rare. A **SIPP** (**Single In-line Pin Package**) is about the same size as a 30-pin SIMM. Instead of a card-edged connector, the SIPP has one row of round legs. Older 8088, 8086, 80286, and even a few 80386 motherboards had DIP chips for the DRAM, but 386, 486, and Pentium computers use SIMMs for the RAM. Newer motherboards (Pentium, Pentium Pro, Pentium II, and Pentium III) use DIMMs.

At the bottom of a SIMM, DIMM and RIMM are metal contacts that transfer the signals and data between the memory chip and the motherboard. SIMMs and DIMMs have tin or gold contacts. If the computer is designed to accept tin memory modules and you install gold ones, over time, a chemical reaction between the metals can damage the connector. The bottom line is this: purchase the appropriate memory module for the computer. This can be determined by referring to the documentation or by examining other chips already installed.

SIMMs, DIMMs, and RIMMs come in parity and non-parity versions. **Parity** is a method for checking the accuracy of data going in or out of the memory chips. For every eight bits of data, one parity bit is used. Parity chips can detect memory errors, but cannot correct them. **Non-parity** memory chips are simply chips that do not use any error checking.

> A computer system that uses parity *must* have parity memory chips installed. Some computers that are non-parity systems can use either parity or non-parity SIMMs. It is best to use the manufacturer-specified memory chips.

If the SIMM is a parity chip, the parity bit is ignored by the non-parity system. However, non-parity memory chips are usually less expensive than parity memory chips. Some motherboards allow a choice of parity and non-parity memory by setting a motherboard jumper or using the SETUP program. Still other motherboards, when checking memory during POST, automatically disable the parity checking if all memory banks do not contain parity bits. Pentium-based microcomputers with Intel's Triton-series chipset do *not* support parity.

How parity functions depends on whether the system uses even parity or odd parity. For example, if the system uses even parity and the data bits 10000001 go into memory, the ninth bit or parity bit is a 0 because an even number of bits (2) are 1s. The parity changes to a 1 only when the number of bits in the data is an odd number of 1s. If the system uses even parity and the data bits 10000011 go into memory, the parity bit is a 1. There are only three 1s in the data bits. The parity bit adjusts the 1s to an even number. When checking data for accuracy, the parity method detects if one bit is incorrect. However, if two bits are in error, parity does not catch the error.

An alternative to parity checking is the ECC method. **ECC** (**Error Correcting Code**) uses a mathematical algorithm to verify data accuracy. ECC can detect up to four-bit memory errors and correct one-bit memory errors. ECC memory checking is more expensive to implement than parity. The motherboard or memory controller must have additional circuitry to process ECC bits generated and compared during each data transfer. ECC is used in computers such as network servers, database servers, or workstations running database applications. These systems need very high quality data for proper operation.

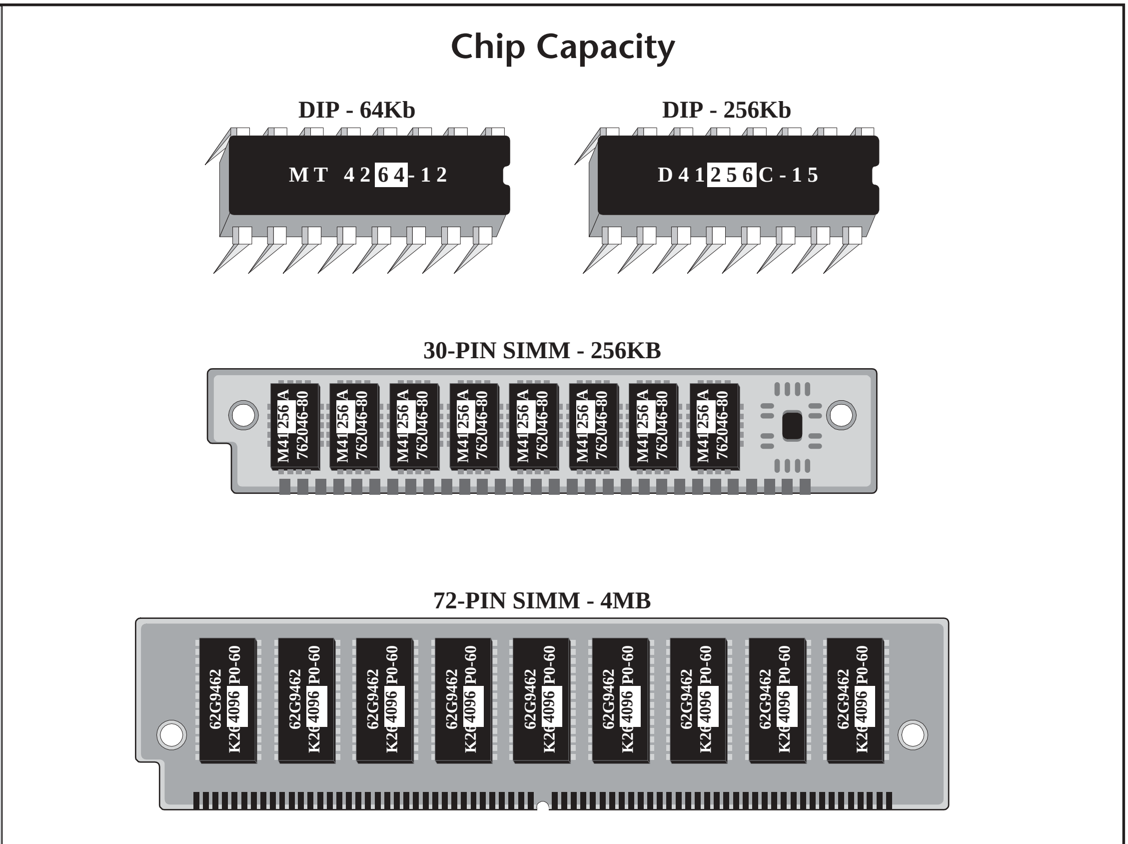
MEMORY CHIP CAPACITY

DIP chips normally have 64Kb, 256Kb, or 1Mb capacities. Notice the lowercase b indicates the size measured in *bits*, not bytes. A 64-kilobit chip holds approximately 64,000 bits. Eight 64Kb DIP chips work together to provide 64KB (the uppercase B indicates bytes) of memory. Thirty-pin SIMM sizes are 256KB, 512KB, 1MB, 2MB, and 4MB, with 1MB and 4MB the most common sizes. Seventy-two-pin SIMM sizes are 4MB, 8MB, 16MB, 32MB, 64MB, and 128MB capacities. DIMM sizes are 8MB, 16MB, 32MB, 64MB, 128MB, 256MB, 512MB, and 1024MB. RIMMs come in 64MB, 128MB, and 256MB capacities.

IDENTIFYING CHIP CAPACITY AND SPEED

Sometimes, you can tell the capacity of a memory chip by examining the numbers printed on it. For example, on a DIP chip, the numbers M41256A indicate a 256Kb chip and the numbers M51004 indicate a 1Mb chip. On a SIMM chip, the numbers K264096P0 indicate a 4MB SIMM and the numbers K268192P0 indicate an 8MB SIMM.

Memory chip numbers can be misleading. The only way to be certain of the capacity is to install the SIMM in a computer or research the manufacturer's number on the Internet. Memory Figure #3 shows a DIP chip and a SIMM.



MEMORY – FIGURE #3

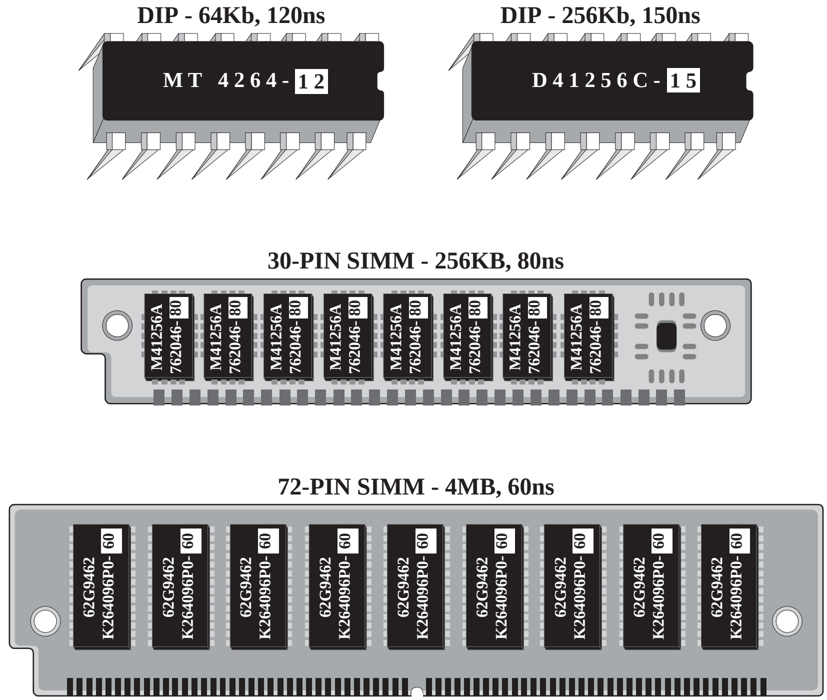
Access time describes how fast information goes into a memory chip or is removed from the chip. DRAM chip access time is measured in nanoseconds, abbreviated ns. A nanosecond is a billionth of a second. DIMMs have access times of 15, 12, 10, 7, and lower nanoseconds. SIMMs have access times of 50, 60, 70, or 80 nanoseconds. Older computers that used DIP DRAM chips have access times of 100, 120, or 150 nanoseconds.

> The lower the number of nanoseconds, the faster the access time of the memory chips. If possible, identify the access time by looking at the numbers on the memory chip or on an attached sticker. On the chip the number(s) following the dash indicate the access time.

Memory Figure #4 shows the access time indicated on different memory chips.

MEMORY – FIGURE #4

Memory Chip Access Time



> Installing memory chips with a faster access time *does not* speed up a computer. The motherboard is designed to operate with memory chips that have a specific access time. Adding faster memory chips does not speed up the motherboard because faster memory chips do not change the motherboard design. Faster memory chips can be added, but the memory will operate at the original access time.

MEMORY CHIP TECHNOLOGIES

Technology has provided faster DRAM speeds without increasing the cost too greatly. These DRAM technologies include Fast Page Mode (FPM) RAM, EDO (Extended Data Out) RAM, BEDO (Burst EDO) RAM, SDRAM (Synchronous DRAM), DDR RAM, and RDRAM (Rambus DRAM). The motherboard must be designed to use one of these technologies or the faster memory *will not* speed up the computer.

Whether a motherboard supports faster memory chips is determined by the chipset, which performs most functions in conjunction with the microprocessor. A **chipset** is one to five electronic chips on the motherboard. The chipset contains the circuitry to control the local bus, memory, DMA, interrupts, and cache memory.

The **FPM** (**Fast Page Mode)**, **EDO** (**Extended Data Out**), and **Burst EDO** technologies speed up DRAM on sequential accesses to the memory chip. For example, if you have a 50ns DRAM SIMM, a 50ns Fast Page Mode SIMM, a 50ns EDO SIMM, and a 50ns Burst EDO SIMM, each type takes 50 nanoseconds to access the first time. On the second try however, the Fast Page Mode SIMM is accessed in 40ns the EDO SIMM is accessed in 25ns, and the Burst EDO SIMM is accessed in 15ns. The follow-on memory technology is SDRAM. **SDRAM** (**Synchronous DRAM**) performs very fast burst memory access, similar to Burst EDO memory. New memory addresses are placed on the address bus before the prior memory address retrieval and execution is complete. SDRAM synchronizes its operation with the microprocessor's clock signal to speed up memory access. SDRAM comes on DIMMs.

Intel created two standards of SDRAM, PC100 and PC133. The **PC100** SDRAM DIMMs are designed for the 100MHz front-side bus. The specification calls for the chips to be 8ns. The **PC133** standard is designed for the 133MHz front-side bus, but will work with 100MHz motherboards. Keep in mind that just because you install PC133 memory does not mean the bus will go 133MHz. If PC133 memory is installed on a 100MHz bus, the bus still communicates with memory at 100MHz. PC133 DIMMs have an access time of 7.5ns. Manufacturers affix a label that certifies the memory chip is PC100 or PC133-compliant. If you mix PC100 and PC133 DIMMs on the same motherboard, all memory and the bus will run at the slower speed (100MHz).

The PC100 and PC133 standards have a new feature called **SPD** (**Serial Presence Detect**). The PC133 DIMMs have an extra EEPROM (similar to the Flash BIOS) that holds information about the DIMM, such as capacity size, voltage, error detection/correction, refresh rates, data width, etc. The BIOS can read and use this information to adjust motherboard timings for the best CPU-to-RAM performance.

Another distinction between SDRAM types is that some are registered and some unbuffered. **Registered SDRAM** is sometimes called buffered SDRAM and is used in network servers and higher end computers. This type of memory delays all data transfers by one clock to ensure accuracy. It also allows for larger capacity DIMMs. Some computers only accept Registered SDRAM. The opposite of Registered SDRAM is unbuffered SDRAM and this is the memory type most often used in home computers and in low- to medium-powered computers.

An alternative to SDRAM is **VCM** (**Virtual Memory Channel**), which was created by NEC Electronics, Inc.). VCM fits in DIMM slots, but the chipset must support it. Intel Chipsets do not support VCM, but VIA chipsets do. The VC133 memory module is designed for the 133MHz front side bus.

SDRAM is a good memory technology for Pentium and higher systems. However, as microprocessors and motherboard components got larger than 200MHz, memory technologies evolved to include RDRAM and DDR RAM. **RDRAM** (**Rambus DRAM**) is technology developed by Rambus, Inc. Intel uses RDRAM in Pentium 4 computers. RDRAM is also used on some video adapters. RDRAM is packaged in RIMMs. (RIMM is not an acronym, but a trademark of Rambus, Inc.) In order for a computer to use a RIMM, the BIOS and the chipset must both support the technology. RIMMs come in 600, 700, and 800MHz versions.

> When RIMMs are used, all memory slots must be filled even if the slot is not needed because the memory banks are tied together. Put a **C-RIMM** (**Continuity RIMM**), which is a blank module, in any empty (unfilled) slot.

RDRAM is proprietary; it is licensed by Rambus, Inc. and has not caught on as previously predicted. Intel now has a chipset (the i845) that allows Pentium 4 motherboards to support DDR RAM. RDRAM is more expensive than DDR RAM.

DDR RAM (**Double Data Rate RAM**) was developed from SDRAM technology. With SDRAM, data is only sent on the rising clock signal. With DDR RAM, data can be transmitted on both sides of the clock signal (rising and falling edges). If this does not make sense, just think of it this way: DDR RAM can send twice as much data as SDRAM. DDR RAM uses 184-pin DIMMs that are different from SDRAM DIMMs. They will not fit in the same socket. The two most popular versions of DDR RAM are PC1600 and PC2100. PC1600 is for the 200MHz front-side bus (it doubles 100MHz) and PC2100 is for the 266MHz front-side bus (it doubles 133MHz). You can mix PC1600 and PC2100 DIMMs on the same motherboard, but the bus will run at the PC1600 speed (200MHz). Some AMD processor-based motherboards (such as for the Thunderbird) use DDR RAM.

Memory technology is moving quite quickly today. Chipsets also change constantly. Technicians are continually challenged to keep up with the features and abilities of the technology so that they can make recommendations to their customers! Trade magazines and the Internet are excellent resources for updates. Never forget to check the motherboard's documentation when dealing with memory. Information is a technician's best friend. Take a look at HSDRAM (High Speed Synchronous DRAM), ESDARM (Enhanced SDRAM), and SLDRAM (Synchronous-Link DRAM) for some interesting memory developments.

Even though video memory is covered in the video chapter, when studying memory and for the A+ Certification, it never hurts to see something twice. **VRAM** (**Video RAM**) is a memory type found on a video card. A closely related type of memory is **WRAM** (**Windows RAM**). Both of these memory technologies are dual-ported, which means that they can read from memory and output to the monitor simultaneously. WRAM is faster and cheaper than VRAM and was developed by Samsung Electronics. Another video memory technology that can deliver data at speeds up to 100MHz is **SGRAM** (**Synchronous Graphic Random Access Memory**). SGRAM memory chips are frequently used on video adapters and graphics accelerators, and have special memory techniques that speed up graphics-intensive functions.

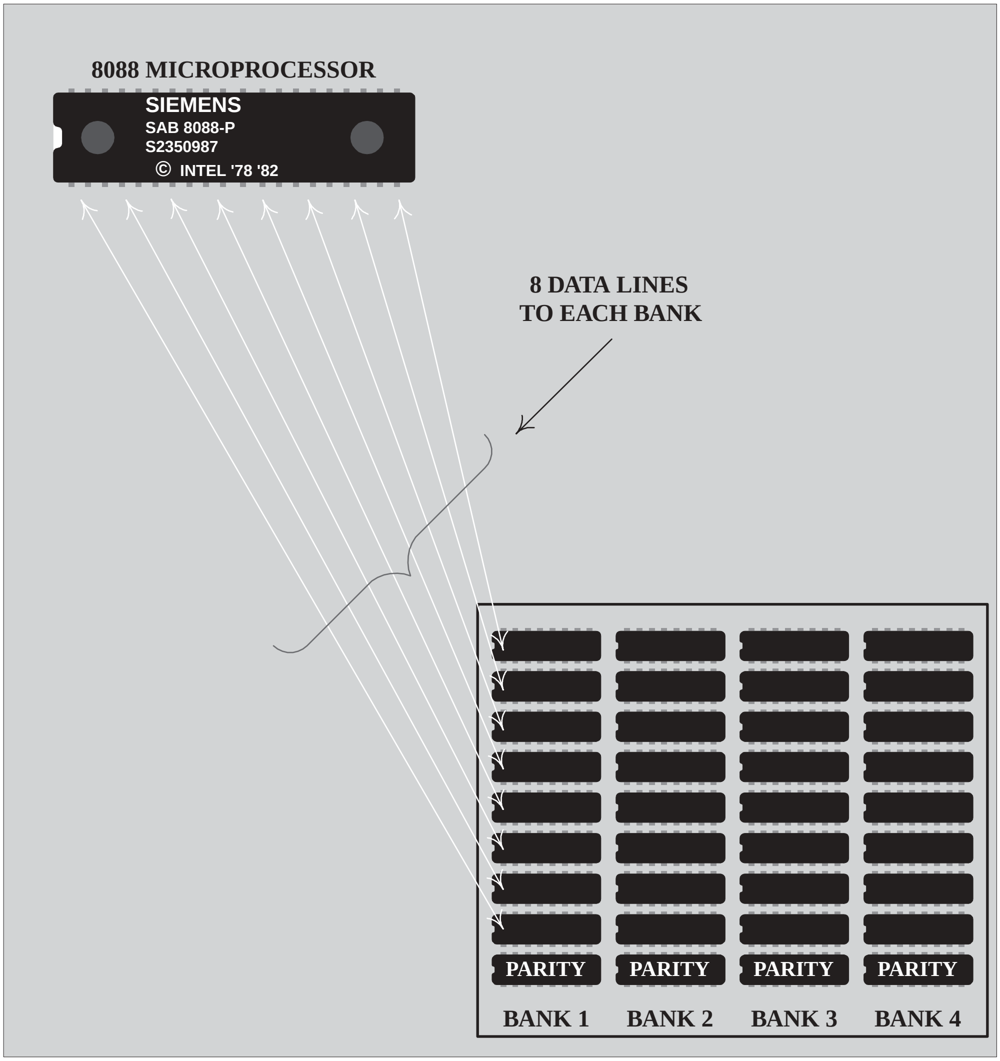
MEMORY BANKS

The process of installing memory in a system is called “populating the memory.” A few basic concepts are important in understanding how to add or remove memory in a system. The best way to explain memory is to begin with how the 8088 microprocessor used on the original IBM PCs addressed memory, and continue to the microprocessors of today.

Memory chips work together in a group called a **bank**. The number of chips in a memory bank depends on how many **external data lines** extend from the microprocessor to the memory chips. Data lines are different from address lines. The address lines pick which memory location on a chip (mailbox) to access. The data lines carry binary 1s and 0s of data (the mail) into the memory location (mailbox). The 8088 microprocessor has an eight-bit external data path. Memory Figure #5 illustrates how the 8088’s external data path connects to the banks of memory.

MEMORY – FIGURE #5

8088 Memory Banks



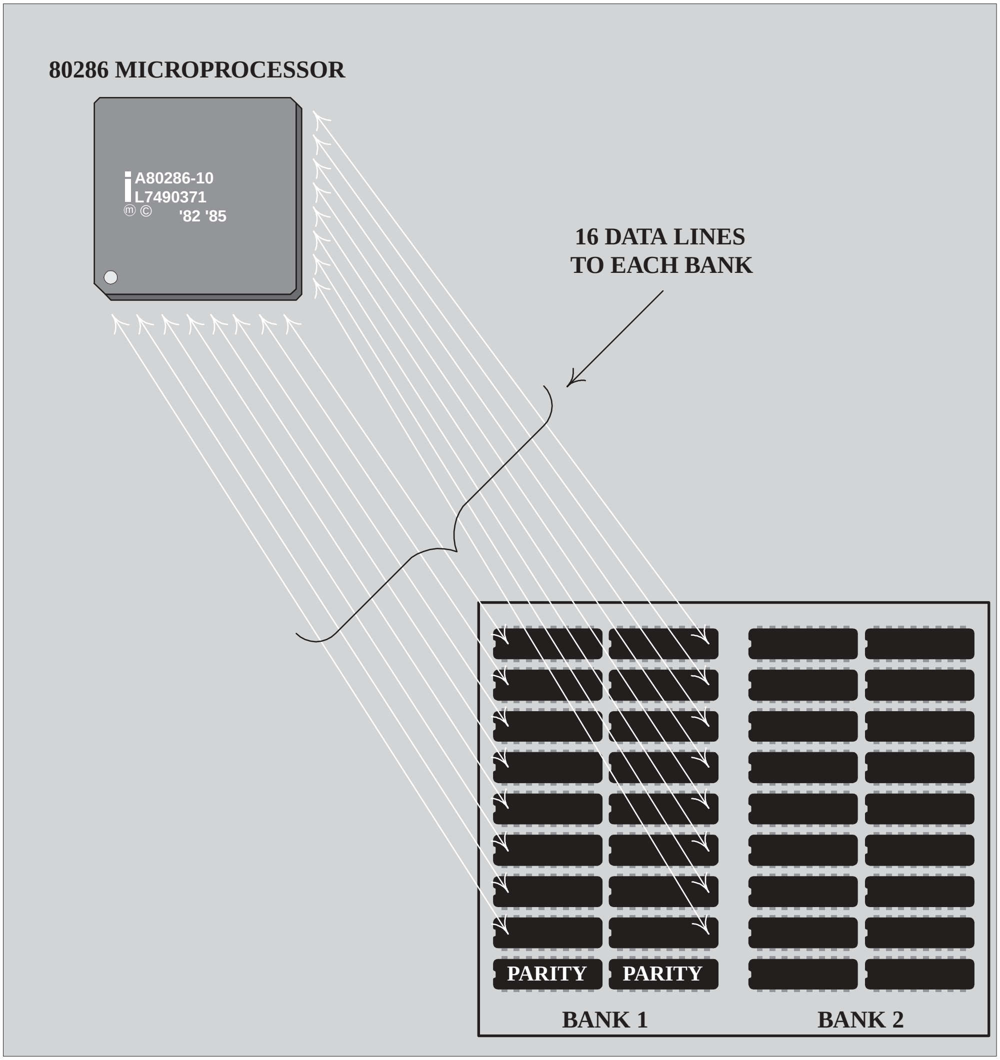
Notice in Memory Figure #5 that the microprocessor outputs or accepts input of eight 1s or 0s at a time. Each data line from the microprocessor connects to one chip in the memory bank. The chips in the bank work together to transfer data to or from the microprocessor. Therefore, a bank of memory chips for an 8088 accepts eight bits of data at a time. On most 8088-based computers, a bank of memory contains *nine* DIP chips. The ninth chip is a **parity chip**. The parity chip checks the accuracy of the eight bits transferred into the bank of memory together. Look at Memory Figure #5 and notice the last chip in the bank is labeled *parity*.

Also notice in Memory Figure #5 that there are four banks of memory labeled Bank 1, Bank 2, Bank 3, and Bank 4. A different manufacturer might label the banks Bank 0, Bank 1, Bank 2, and Bank 3; nevertheless, the concept is the same.

The 80286 microprocessor used on IBM ATs and compatibles had an external data bus of 16 bitsæ16 separate lines that carry a 1 or a 0. Because 16 bits of data transmit from the microprocessor simultaneously, each bank of memory processes 16 bits at a time. Therefore, on an 80286 motherboard, one bank of memory normally contains 16 DIP chips, or 18 DIP chips if the motherboard uses parity. Memory Figure #6 shows memory banks on an 80286 motherboard.

MEMORY – FIGURE #6

80286 Memory Banks

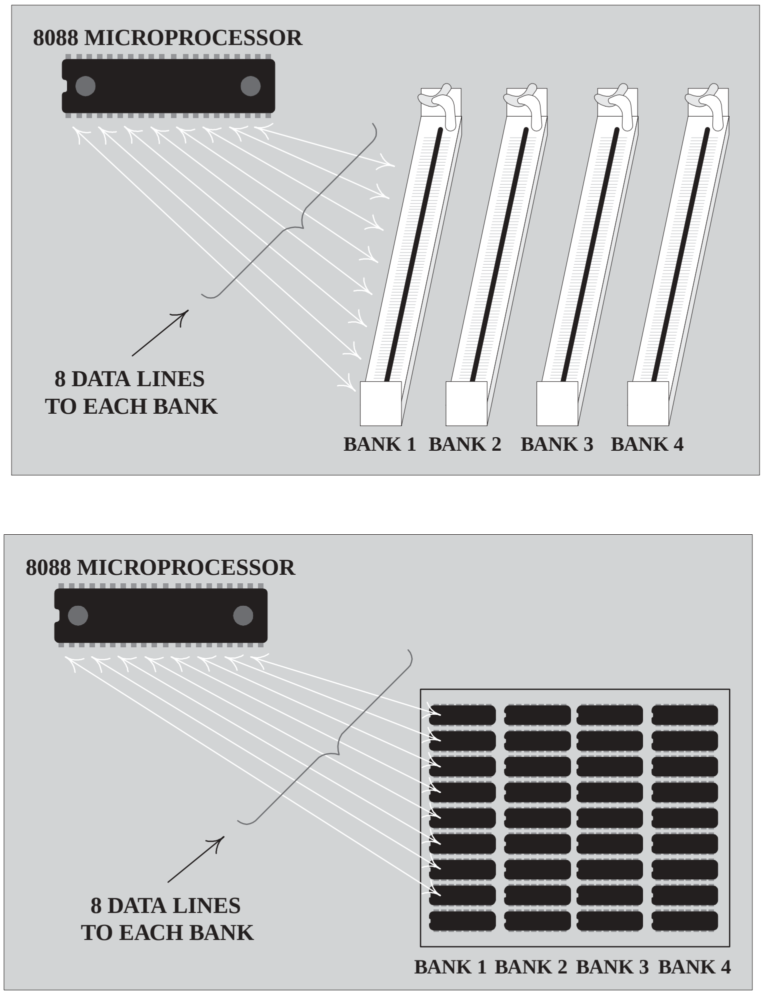


Notice in Memory Figure #6 how each bank of memory contains two rows of chips instead of just one row of chips as on the 8088 motherboard. Each bank contains two rows of chips because the 80286 microprocessors have 16 external data lines. Each chip connects to one data line. The 80286 microprocessor could handle more RAM on the motherboard, so memory chip manufacturers started making 1 megabit (1Mb) DIP chips. 1Mb memory chips are two pins longer than the 64Kb and the 256Kb DIP chips. Many motherboards accepted both physical sizes of DIP chips.

When the 80386 came out with 32 address lines and 32 external data lines, manufacturers started using 30-pin SIMMs on the motherboard. These accept eight bits of data from the microprocessor at one time. Therefore, one 30-pin SIMM is like one entire bank of memory in a XT. Memory Figure #7 shows this concept.

MEMORY – FIGURE #7

How a 30-Pin SIMM Compares with a Bank of DIP Chips

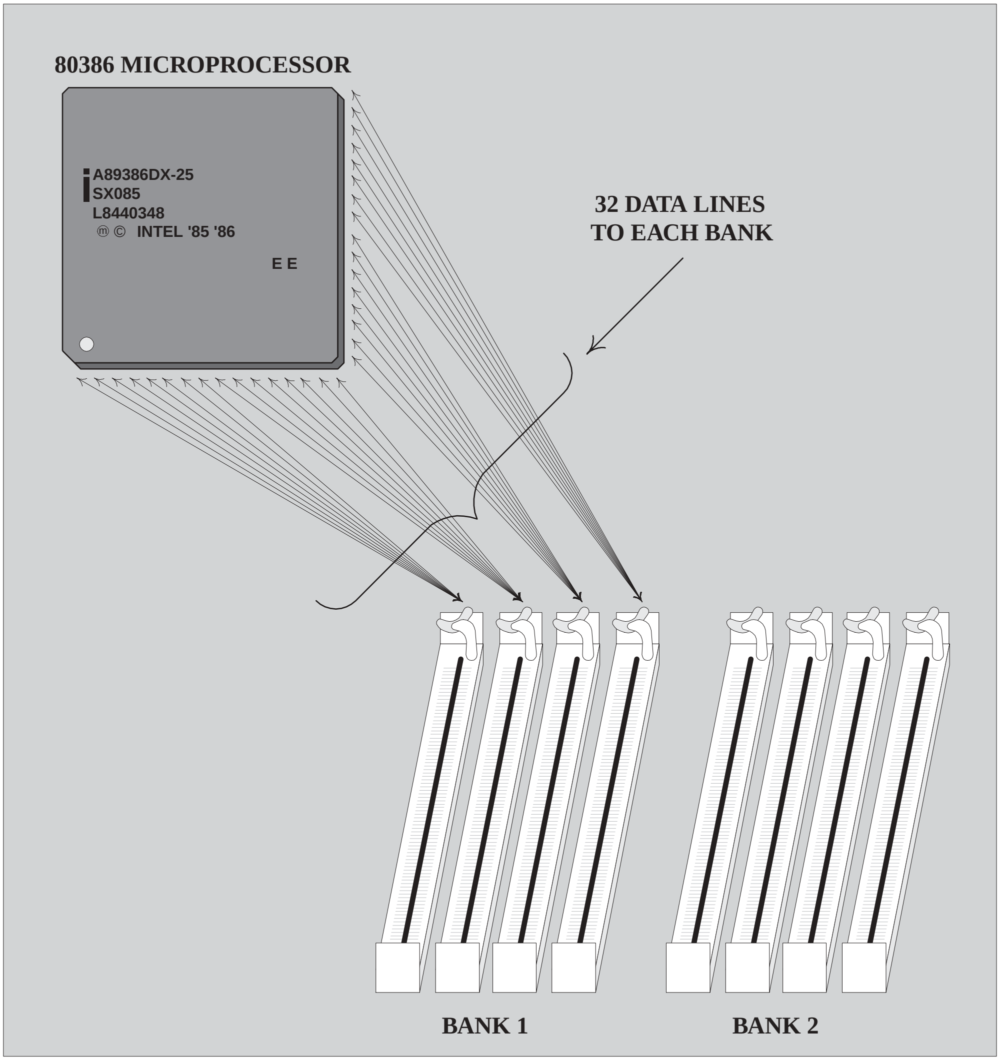


Notice that even though Memory Figure #7 shows a comparison of how the data lines connect to each SIMM, the 8088-based motherboards did not use SIMMs. Memory Figure #7 simply illustrates how the SIMM replaced eight or nine chips by placing them on a small circuit board, making memory easier to install, easier to manage, and easier to troubleshoot.

Because the 80386 microprocessor has a 32-bit external data path, four 30-pin SIMMs are normally found in each bank of memory. Refer to Memory Figure #8 for an illustration of a 80386 motherboard with SIMM sockets instead of DIP chips.

MEMORY – FIGURE #8

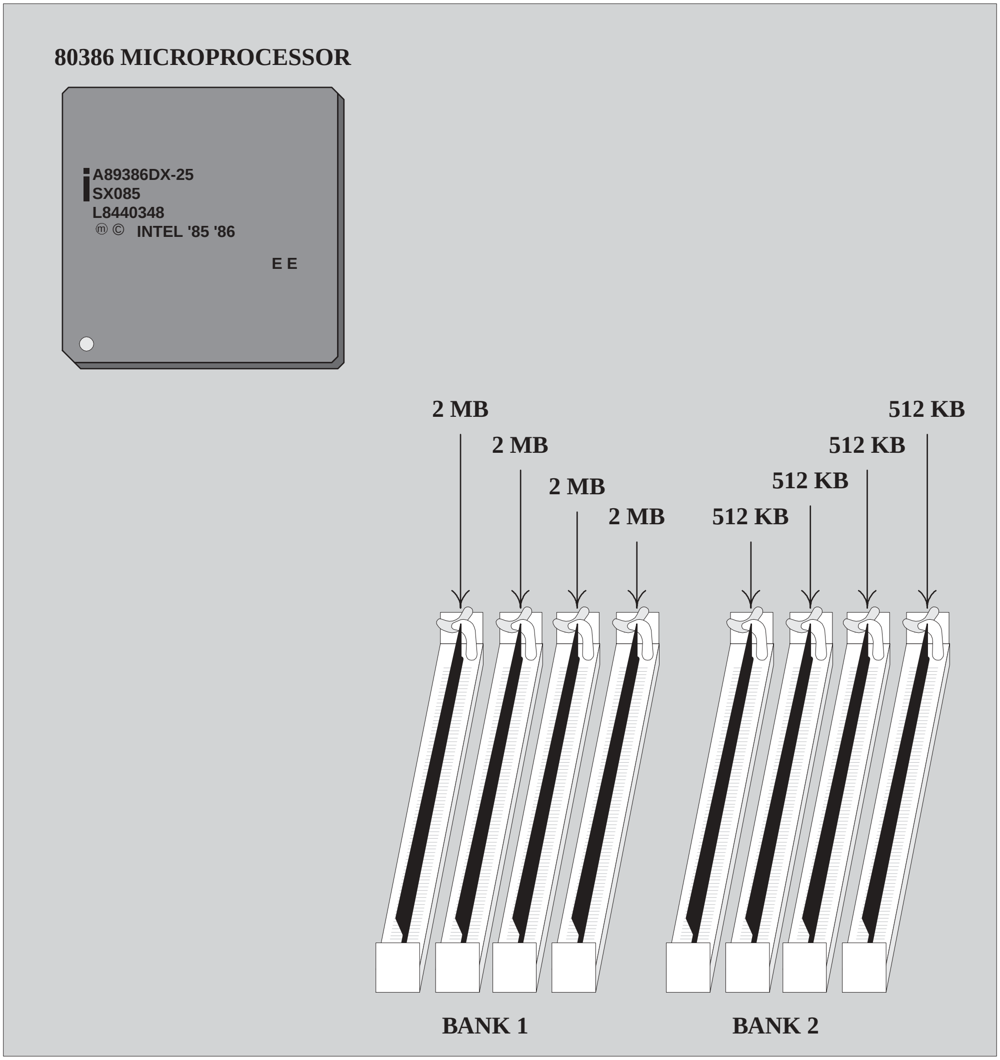
80386 Memory Banks



30-pin SIMM sizes are 256KB, 512KB, 1MB, 2MB, and 4MB, although the 1MB and the 4MB are most common. Exactly which SIMM can be used on a motherboard depends on the manufacturer of the motherboard. Memory Figure #9 illustrates an 80386 motherboard populated with 10MB of memory using 2MB and 512KB SIMM chips.

MEMORY – FIGURE #9

80386 with 10MB of RAM



Memory sales advertisements and technical manuals list 30-pin SIMMs in different ways. Understanding the different lists can be difficult. Memory Figure #10 shows three different memory advertisements.

MEMORY – FIGURE #10

Sample of 30-Pin SIMM Advertisements

ADVERTISEMENT # 1

STANDARD MEMORY

30-PIN SIMM

1 x 3 - 70/60
1 x 9- 80/70/60
1 x 8 - 70
1 x 9 - 100
4 x 9 - 70
4 x 9 - 60
4 x 8 - 70

ADVERTISEMENT # 2

STANDARD MEMORY

30-PIN SIMM

256 x 9
1 Meg x 9 (3 chip)
1 Meg x 9 (9 chip)
4 Meg x 9
16 Meg x 9 (9 chip)

ADVERTISEMENT # 3

STANDARD MEMORY

30-PIN SIMM
Non-Parity/8-Bit

1 MB x 8 - 60ns
1 MB x 8 - 70ns
4 MB x 8 - 80ns
4 MB x 8 - 70ns
4 MB x 8 - 60ns

30-PIN SIMM
Parity/9-Bit

1MB x 9 - 70ns (9 chip)
4MB x 9 - 70ns (3 chip)
4MB x 9 - 60ns (3 chip)
4MB x 9 - 80ns (9 chip)

Notice that each advertisement in Memory Figure #10 has a different SIMM chip highlighted. Ad #2 shows a “1Meg x 9 (9 chip) 30-pin SIMM.” The “x 9” portion of the ad means the SIMM chip uses parity. If the SIMM was a non-parity chip, the highlighted listing would say “x 8” as it does in Ad #1.

When purchasing SIMMs for a microcomputer, be sure if the computer uses parity that you buy parity SIMMs. The documentation included with the motherboard should state whether or not the system uses parity. If a computer system does *not* use parity, SIMMs with the extra parity chip can be installed. The parity chip will simply be ignored.

In Ad #3, a “4MB x 9 70ns (3 chip)” line is highlighted. Some 9-bit SIMM chips have nine individual memory chips mounted on the SIMM while other 9-bit SIMM chips have only three individual memory chips mounted on the SIMM. Each of the three memory chips on the SIMM handles three bits at a time.

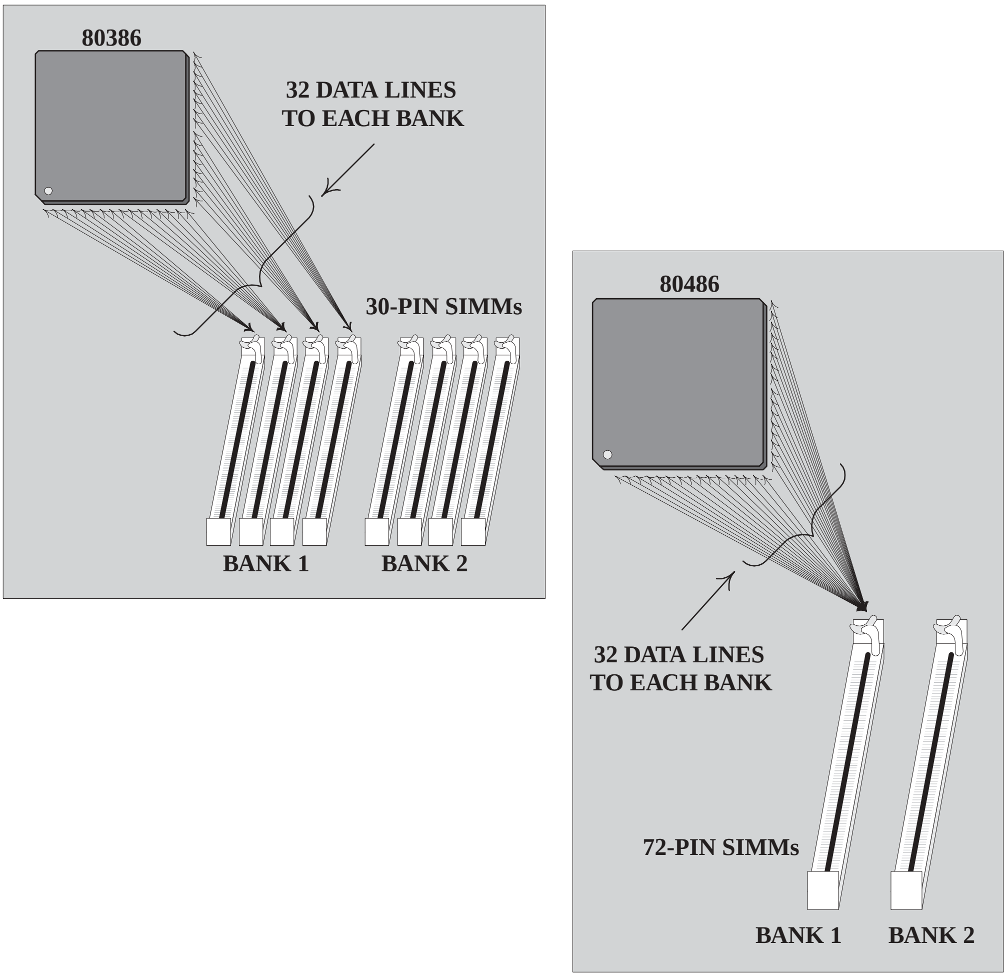
Some motherboards are very particular about the type of SIMM installed (how many chips are mounted on the SIMM). Systems that already have nine chips on a 30-pin SIMM have been known to lock up when upgraded to SIMMs with only three chips on the SIMM. Not all memory retailers specify in their advertisements if the SIMM is a three-chip or a nine-chip SIMM.

When upgrading a system that uses 30-pin SIMMs, open the system and look inside at the existing memory SIMMs. Order the appropriate type of SIMM, three-chip or nine-chip, to match what is already in the system. If you are installing 30-pin SIMMs on a motherboard without SIMMs, refer to the documentation included with the motherboard.

Manufacturers started using 72-pin SIMMs on the 80486-based motherboards. A 72-pin SIMM accepts 32 bits of data at a time from the microprocessor. Therefore, one 72-pin SIMM takes the place of four 30-pin SIMMs. See Memory Figure #11 for a comparison of banks of memory for 30-pin SIMMs and 72-pin SIMMs.

MEMORY – FIGURE #11

30-Pin SIMM vs 72-Pin SIMM Banks



Notice in Memory Figure #11 that a bank of four 30-pin SIMMs on an 80386-based motherboard equates to a bank of one 72-pin SIMM on an 80486-based motherboard. Some 80386-based motherboards use 72-pin SIMMs or a combination of 30-pin and 72-pin SIMMs to give consumers the choice of which to buy and the ability to use older SIMMs from another machine.

BUYING THE RIGHT 72-PIN SIMM

72-pin SIMMs are available in 1MB, 2MB, 4MB, 8MB, 16MB, 32MB, and 64MB capacities. As with 30-pin SIMMs, advertisements of 72-pin SIMMs can be very confusing. Refer to Memory Figure #12 for samples.

MEMORY – FIGURE #12

Sample of 72-Pin SIMM Advertisements

ADVERTISEMENT # 1

STANDARD MEMORY

72-PIN SIMM

1 x 32 Pin
2 x 32 Pin
2 x 32 Pin - EDO
4 x 32 Pin
8 x 32 Pin

ADVERTISEMENT # 2

STANDARD MEMORY

72-PIN SIMM

1MB x 32 - 60ns
1MB x 32 - 70ns
1MB x 32 - 60ns - EDO
1MB x 32 - 70ns - EDO
2MB x 32 - 60ns
2MB x 32 - 60ns - EDO
4MB x 32 - 60ns
4MB x 32 - 60ns - EDO
8MB x 32 - 60ns
8MB x 32 - 60ns - EDO

1MB x 36 - 60ns
1MB x 36 - 70ns
2MB x 36 - 60ns
2MB x 36 - 70ns
4MB x 36 - 60ns
4MB x 36 - 70ns
8MB x 36 - 60ns
8MB x 36 - 70ns

ADVERTISEMENT # 3

STANDARD MEMORY

72-PIN SIMM

256 x 36 - 70 (1MB)
512 x 36 - 70 (2MB)
1 x 36 - 70/60 (4MB)
2 x 36 - 70/60 (8MB)
4 x 36 - 70/60 (16MB)
8 x 36 - 70/60 (32MB)
16 x 36 - 70/60 (64MB)

72-PIN SIMM
Non-Parity

1 x 32 - 70/60 (4MB)
2 x 32 - 70/60 (8MB)
4 x 32 - 70/60 (16MB)
8 x 32 - 70/60 (32MB)
16 x 32 - 70/60 (64MB)

Notice in Memory Figure #12 that Advertisement #1 highlights the 1 x 32 pin. This particular advertisement does not list the memory chip's access time, which a technician needs to know when installing memory. The “1” in 1 x 32 stands for 1 megabit. The “32” in 1 x 32 stands for 32 bits. The chip accepts 32 bits at one time. The total capacity for this chip is found by multiplying 1 megabit by 32 bits, which is the same as 4 megabytes. (Approximately 1,000,000 bits times 32 bits equals 32,000,000 bits. 32,000,000 bits divided by 8 equals the number of bytes.) So, an advertisement that lists 1 x 32 for a 72-pin SIMM reveals a capacity of 4MB.

A “x 32” is a non-parity SIMM chip. If the SIMM is a parity 72-pin SIMM, some advertisements list “x 36” instead of “x 32”. Remember, there is one parity bit for every eight bits. With 32-bits, four additional bits are needed for parity, one for every eight bits, totaling 36 bits. Every chip shown in Advertisement #1 is a non-parity 72-pin SIMM.

Notice in Advertisement #2 that the memory chips are divided into non-parity SIMMs at the top and parity SIMMs at the bottom. Also, this particular company sells EDO memory. Another good feature of Advertisement #2 is the list of access speeds. However, as in Advertisement #1, Advertisement #2 does not list the total capacity of the SIMM. Also, the “MB” listed in the highlighted “2MB x 36-60ns SIMMs” line of Advertisement #2 is a misnomer. The correct listing should be “2M***b*** x 36-60ns SIMMs.” Most manufacturers and retailers do not list the SIMMs in the correct format. A 2MB x 36-60ns SIMM has a total capacity of 8MB with four bits used for parity.

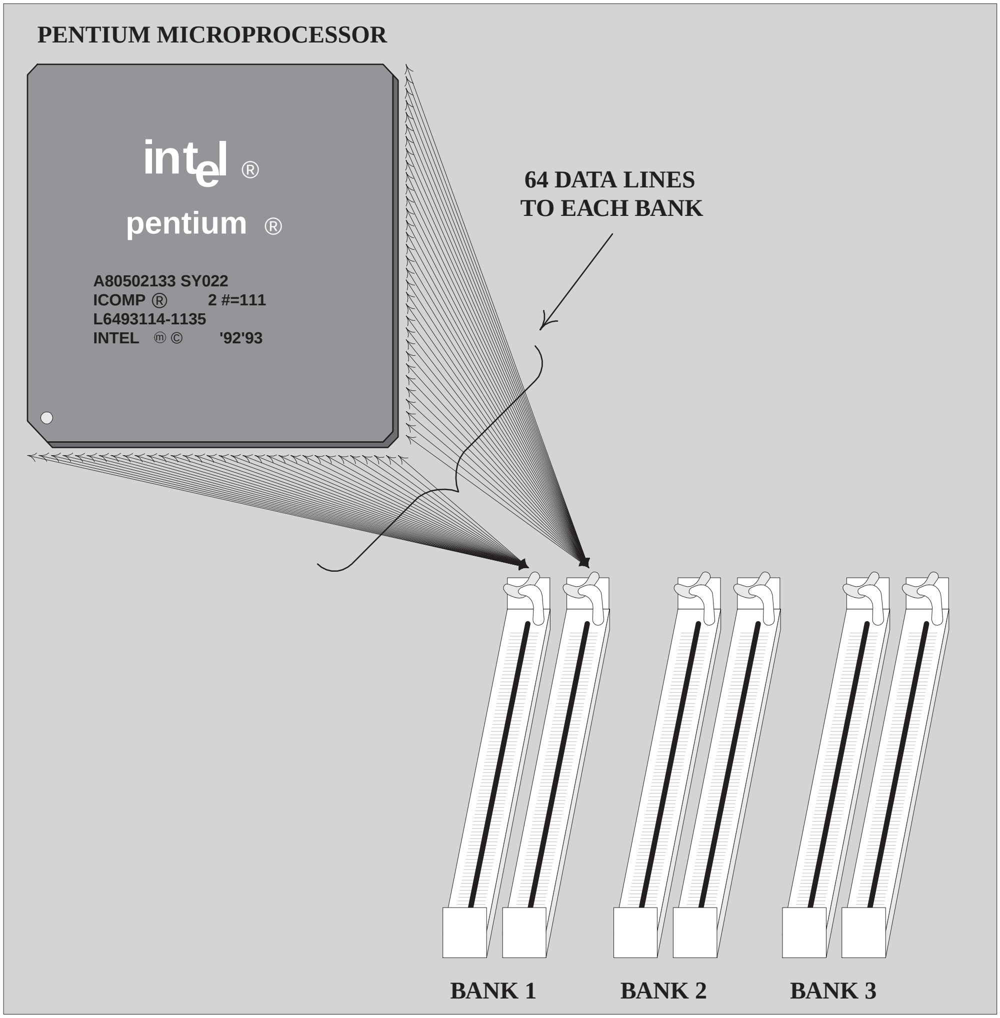
Memory Figure #12’s Advertisement #3 is the best of these three. The retailer lists the total capacity of the chip in parentheses beside each SIMM. The access time is given to the right of each chip in the advertisement. Notice the highlighted “1 x 36-70/60 (4MB) chip.” The 70/60 is the access times available for this particular model of SIMM. Finally, this particular advertisement separates parity and non-parity SIMMs.

POPULATING PENTIUM AND HIGHER MOTHERBOARDS

Intel's Pentium, Pentium Pro, Pentium II, Pentium III, and Pentium microprocessors have an external data path of 64 bits. So do the AMD processors. If the system uses 72-pin SIMMs, each bank of memory has two 72-pin SIMM sockets. See Memory Figure #13 for a layout of the 72-pin memory sockets on a Pentium-based motherboard.

MEMORY – FIGURE #13

Pentium Memory Banks

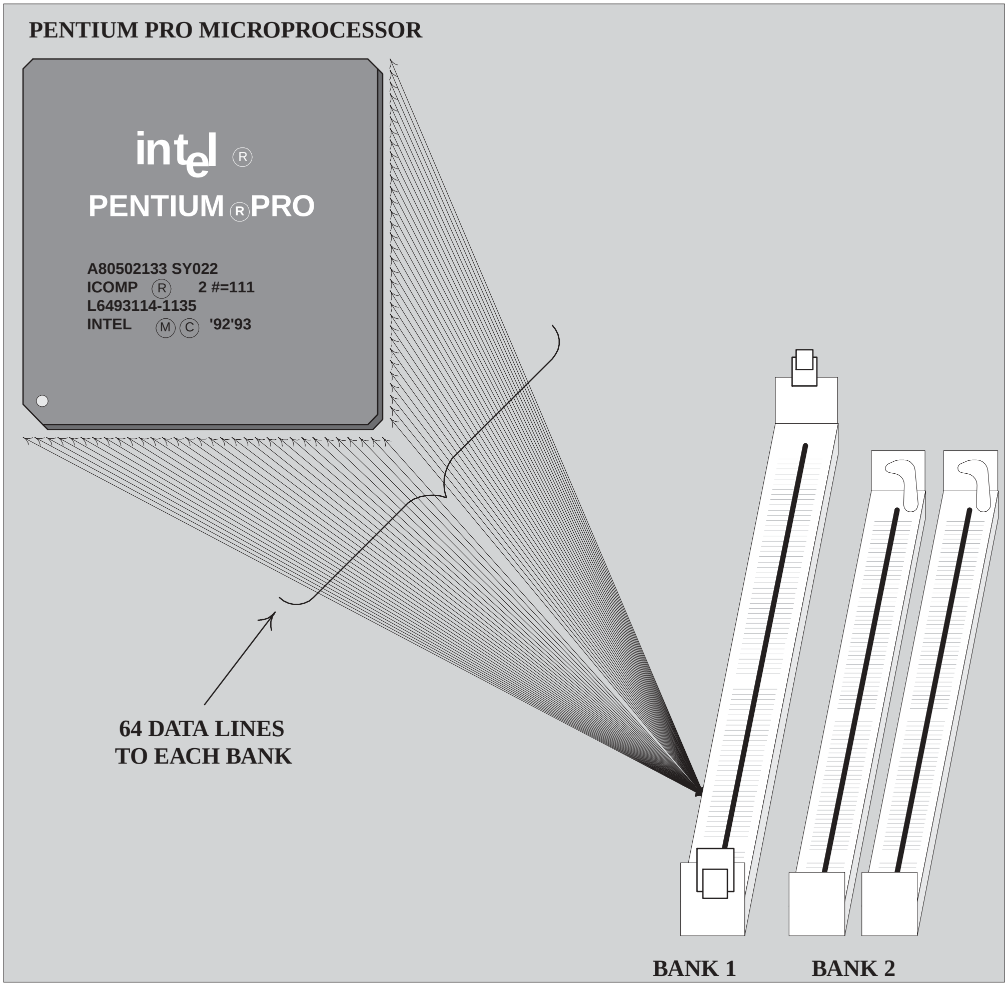


On a machine that uses a Pentium microprocessor and SIMM sockets, two SIMMs must be inserted into at least one bank for the computer to operate. Pentium and higher motherboards also use DIMMs (Dual In-line Memory Modules).

Some manufacturers produce motherboards that contain 72-pin SIMM sockets and 168-pin DIMM sockets. Memory Figure #14 shows a Pentium Pro-based motherboard that has both a DIMM socket and SIMM sockets. Bank 1 contains one DIMM socket and Bank 2 contains two 72-pin SIMM sockets.

MEMORY – FIGURE #14

Pentium Pro Memory Banks



As seen in Memory Figure #14, a DIMM socket is one bank of memory for the motherboards. Most Pentium, Pentium Pro, Pentium II, and Pentium III motherboards ship with only DIMM sockets. Pentium 4s ship with DIMM or RIMM sockets (but not both).

BUYING THE RIGHT DIMM OR RIMM

DIMMs have capacities of 8MB, 16MB, 32MB, 64MB, 128MB, 256MB, 512MB, and 1024MB (although larger capacities are sure to come). DIMMs have parity and non-parity versions. The 8MB parity DIMM lists as 1MB x 72 and the non-parity 8MB DIMM lists as 1MB x 64. The 72 on the parity DIMM is calculated by adding one parity bit for every eight bits. There are 64 bits on the DIMM, so it needs eight extra bits to handle parity checking. 64 + 8 = 72 total bits. Be careful when dealing with DIMMs. ECC DIMMs are also shown with 72 bits. Memory Figure #15 shows sample ads for DIMMs.

MEMORY – FIGURE #15

Sample 168-Pin DIMM Advertisements

ADVERTISEMENT # 1

STANDARD MEMORY

168-PIN SDRAM

32MB 4x64-10
64MB 8x64-10
128MB 16x64-10
64MB 8x64-7 PC100
128MB 16x64-7 PC100
256MB 32x64-7 PC100

ADVERTISEMENT # 2

STANDARD MEMORY

DIMMs

128MB EDO Buffered
32MB EDO 3.3 Unbuffered
64MB EDO 3.3 Unbuffered
32MB SDRAM PC 100MHz BX
64MB SDRAM PC 100MHz BX
128MB SDRAM PC 100MHz BX

ADVERTISEMENT # 3

STANDARD MEMORY

SDRAM 66MHz	
4 x 64	32MB
8 x 64	64MB
16 x 64	128MB
SDRAM ECC 66MHz	
4 x 72 ECC	32MB
8 x 72 ECC	64MB
16 x 72 ECC	128MB
PC100 SDRAM 100MHz	
8 x 64-100	64MB
16 x 64-100	128MB
32 x 64-100	256MB
PC100 ECC SDRAM 100MHz	
8 x 72-100 ECC	64MB
16 x 72-100 ECC	128MB
PC100 CAS2 SDRAM 100MHz	
8 x 64-100 CAS2	64MB
16 x 64-100 CAS2	128MB
PC133 SDRAM 133MHz	
8 x 64-133	64MB
16 x 64-133	128MB

Memory Figure #15 Advertisement #1's highlighted portion shows the total capacity of the chip, "64MB"; the amount of bits transferred at a time, which is 64 bits, "8 x 64"; followed by the speed of the chip, 10ns, "-10." Many DIMM advertisements omit the speed of SDRAM chips, as shown in Advertisement #2. The advertiser in this ad is more specific about the type of chip offered, but no speed is listed. The highlighted DIMM in Advertisement #2 is a 128MB SDRAM DIMM that runs on a 100MHz system bus speed motherboard. The BX denotes that the DIMM is compatible with an Intel chipset. In

Advertisement #3, a SDRAM ECC DIMM that runs on a 100MHz-system board is shown. The “8 x 72” in the advertisement shows that it uses ECC memory checking. An ECC chip might also be listed as a “x 80.” If the advertisement shows “x 72” and it does not say ECC, it could mean that it is a parity chip. In the advertisement, the total capacity for the chips is shown at the end of each line. The highlighted DIMM is a 64MB PC100 SDRAM chip.

Memory Figure #16 lists advertisements for DDR RAM DIMMs and RIMMs.

MEMORY – FIGURE #16

30-Pin SIMM vs 72-Pin SIMM Banks

ADVERTISEMENT #1

DDR DIMM
PC1600 (200MHz Bus) 128MB 16x64 (184-pin)
PC2100 (266MHz Bus) 128MB DDR 16x64 (184-pin)
PC2100 (266MHz Bus) 128MB ECC DDR 16x72 (184-pin)
PC1600 (200MHz Bus) 128MB ECC DDR 16x72 (184-pin)
PC2100 (266MHz Bus) 128MB DDR 16x64 (184-pin) unbuffered CAS 2.5
PC2100 (266MHz Bus) 256MB DDR 32x64 (184-pin)
PC2100 (266MHz Bus) 512MB ECC Registerd DDR 64x72 (184-pin)

ADVERTISEMENT #2

RDRAM RIMMs
600MHz Non-ECC 4-Device
600MHz ECC 4-Device
700MHz Non-ECC 4-Device
700MHz ECC 4-Device
800MHz Non-ECC 4-Device
800MHz ECC 4-Device

Notice in Memory Figure #16 that the highlighted item in Advertisement #1 has the letters CAS. **CAS** (**Column Address Strobe**) actually is CAS latency, which is the amount of time (clock cycles) that pass before the processor moves on to the next memory address. RAM is made up of cells where data is held. A cell is the intersection of a row and a column. Think of it as a spreadsheet application. The CAS signal picks which memory column to select and a signal called RAS (Row Address Strobe) picks which row to select. The intersection of the two is where the data is stored. A CAS latency of 2 is better than a CAS latency of 3 (fewer clock cycles to wait). PC133 SDRAM modules normally have a

CAS latency (sometimes called simply CAS or CL) of 2. PC1600 and PC2100 DDR DIMMs normally have a CAS latency of 2.5.

Advertisement #1 shows a 128MB DDR module as "16 x 64." 16 bits times 64 million bits equals 1,024,000,000 bits. 1,024,000,000 bits divided by eight equals 128MB (the memory capacity of the chip). Also, notice how the advertiser lists that it is a 184-pin module. All DDR RAM modules are 184-pin DIMMs.

Advertisement #2 shows the different RIMM modules—600, 700, and 800MHz. All three come as either ECC or non-ECC. The highlighted line in Advertisement #2 has the words "4-Device." According to the RIMM specifications, a RIMM can be designed for 1 to 16 RDAM devices (chips). A RIMM advertised as a "4-Device," has 4 RDRAM devices (chips) on that module.

The exercises at the end of the chapter help you understand how to populate memory banks for different microprocessors. Before memory chips are installed into a system, you must make a plan of action and refer to the documentation.

MEMORY INSTALLATION RULES

When installing memory in banks, a few rules must be observed. They are listed below with their explanations.

1. When you start a bank, fill a bank.
2. Use memory chips of the same capacity in a memory bank.
3. All the chips in a bank should have the same access speed, if possible.
4. All the chips in a bank should be of the same type , if possible.
5. Some manufacturers require that higher capacity chips be placed in the first bank.

START A BANK, FILL A BANK

> When installing memory chips into a bank, whether DIPs, SIMMs, or DIMMs, do not leave any slot or socket of the bank empty. This does not mean that all banks have to be filled. Rather, if you start putting memory chips into a bank, fill that bank. The number of bits of memory must equal the number of bits the data bus will support. Do not forget that with RIMMs, empty banks must be filled with C-RIMMs.

Memory chips in the bank work together to transfer data to and from the microprocessor and the entire bank must be completely filled with memory chips if it is to operate correctly. For example, if a motherboard has banks of memory with two memory chips per bank, then you must install two memory chips at a time. You cannot put one memory chip into a bank and expect it to work. Remember, the memory bank works as a single unit transferring information to and from the microprocessor.

SAME CAPACITY CHIPS IN A BANK

Because memory chips in a bank work together, each chip in the bank must be able to hold the same number of bits as other chips. In 8088-based computer systems, 64Kb and 256Kb chips were the most common. Bank 1, for example, might contain nine 256Kb chips, totaling 256KB of memory.The ninth chip, the parity chip, must be the same capacity as the memory chips so it can check the accuracy of data transferred into the eight memory chips. With later microprocessors, a bank with two SIMM sockets requires two equal capacity SIMMs. On today's motherboards, there is only one DIMM per memory bank because each DIMM transfers 64 bits at a time. Matching DIMM size will not be an issue until 128-bit data path microprocessors are released.

SAME ACCESS SPEED

Memory chips *should* have the same access speed as other chips in the bank. Mixing in chips with faster access times may work, but this simply depends on the motherboard. If you are working on a system that requires an 80ns DRAM memory chip, a faster chip may work as a replacement for a failed DIP or SIMM chip.

> Never use a slower access speed chip as a replacement chip!

SAME CHIP TYPE

Some motherboards allowing mixing different chip technologies, such as FPM and EDO SIMMs. The Triton FX chipset allows FPM and EDO chips to be installed in the same bank. However, when you mix technologies, the bank will run at the slower speed. For example, if you install FPM and EDO chips in the same bank, the bank will run at the speed of the slower FPM chip(s).

> For best performance, use the same chip technology with all of the memory chips installed.

Another thing to watch out for is motherboards that accept SIMMs and DIMMs. Some motherboards require that if DIMMs are to be installed, all SIMM banks must be empty. Others require that all SIMM banks be fully populated before any DIMMs can be added. Always refer to the motherboard documentation before purchasing memory chips.

HIGHER CAPACITY CHIPS

Some manufacturers require that higher capacity memory chips be placed in the lower banks such as Bank 0 or Bank 1. The only way to know if this is a requirement is to check the documentation included with the motherboard or computer system.

> If no documentation exists, experiment! Try the higher capacity chips in the lower banks. If that does not work, swap the memory chips and try the lower capacity chips in the lower bank numbers.

Installing memory chips into a system can be broken down into three steps:

Step 1. Obtain the proper type, size, and capacity of chip(s) needed for the system.
Step 2. Remove and/or install the memory chips.
Step 4. Configure the computer for the new memory.

MEMORY TYPE, SIZE, AND CAPACITY

Step 1 involves research and planning using the documentation included with the motherboard or the computer system. Determine for the memory chip: the proper type (gold lead or tin lead; DIP, SIPP, SIMM, or DIMM); the proper size (30-pin, 72-pin or 168-pin); the proper capacity (4MB, 8MB, 16MB, 32MB, etc.); and the proper access speed (50ns, 60ns, 70ns, etc.). Many frustrations, headaches, and problems can be avoided when this first step is taken.

> If you are upgrading a computer's memory and no documentation exists, look at the memory chips already installed for clues to access speeds, type, and size. Trial and error can also be helpful. Many vendors will allow the return or swap of memory chips if you ordered the wrong type or size. The Internet is a great source for motherboard documentation.

LAPTOP MEMORY

Portable computers are a major part of today's business environment. The memory chips used with laptops are different than the ones used in desktop or tower computers. Portables that use DIMMs use a special type called **SO-DIMM** (**Small Outline DIMM**) and those that use RIMMs use **SO-RIMM** (**Small Outline RIMM)**. Some laptop manufacturers require proprietary memory modules, but that is not as common as it once was. Many laptops only have one memory slot, so when you upgrade, you must replace the module that is installed. Always refer to the manufacturer's documentation when doing this. Laptops can also be upgraded with PC Cards, but this type of memory is not as fast as the memory installed on the motherboard.

FLASH MEMORY

Flash memory is a type of non-volatile memory that holds data even when the computer power is off. Flash memory is popular with laptops because it is small, fast, and consumes little power. This is especially important when running a computer off a battery. PCs also use flash memory as a replacement for the BIOS chip. Network devices use flash memory to store the operating system and instructions. Digital cameras use flash memory to store pictures; scanners use flash memory to store images; printers use flash memory to store fonts. Flash memory does not have to be refreshed like DRAM and it does not need constant power like SRAM. A drawback to flash memory that it is erased in blocks rather than by byte like RAM.

INSTALLING MEMORY CHIPS

The best method to determine which memory chips to install in each bank is described in the following steps:

1. Determine which chip capacities can be used for the system. Look in the documentation included with the motherboard or the computer for this information.
2. Determine how much memory is needed. Ask the user which operating system is installed and which applications they are using. Refer to documentation for each application to determine the amount of RAM recommended. Plan for growth!
3. Determine what capacity chips go in each bank by drawing a diagram of the system, planning the memory population on paper, and referring to the documentation of the system or motherboard.

REMOVING/INSTALLING MEMORY CHIPS

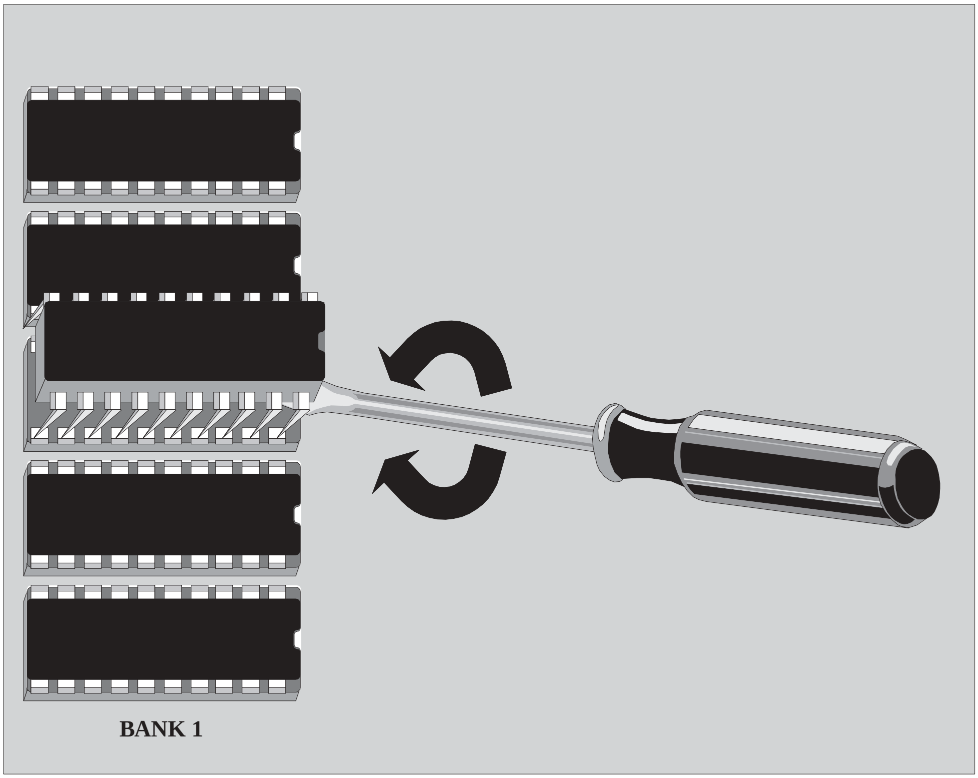
Depending on the type of motherboard, the number of banks available on the motherboard, whether the computer memory is being upgraded, or whether the memory is a new installation, some memory chips may need to be removed to put higher capacity chips into the bank. Look at what is already installed in the system, refer to the documentation, and remove any banks of memory necessary to upgrade the memory. Use an anti-static wrist strap when removing or installing memory chips.

REMOVING A DIP CHIP

For A+ certification, the recommend DIP chip removal tool is a DIP chip extractor. However, when using this tool, students frequently bend the DIP chip legs. A small flat-tipped screwdriver is the most practical tool to use when removing a DIP chip. Carefully insert the small screwdriver under one end of the DIP chip. Rotate the screwdriver back and forth *gently* until the end of the chip rises slightly above the socket. Carefully, insert the screwdriver under the *opposite* end of the DIP chip. Rotate the screwdriver back and forth a few times until this end of the chip starts to rise above the socket. Keep inserting the screwdriver into alternate ends of the DIP chip until it gently lifts from the socket. Refer to Memory Figure #17 for an illustration of how to remove a DIP chip.

MEMORY – FIGURE #17

DIP Chip Removal



REMOVING A SIMM

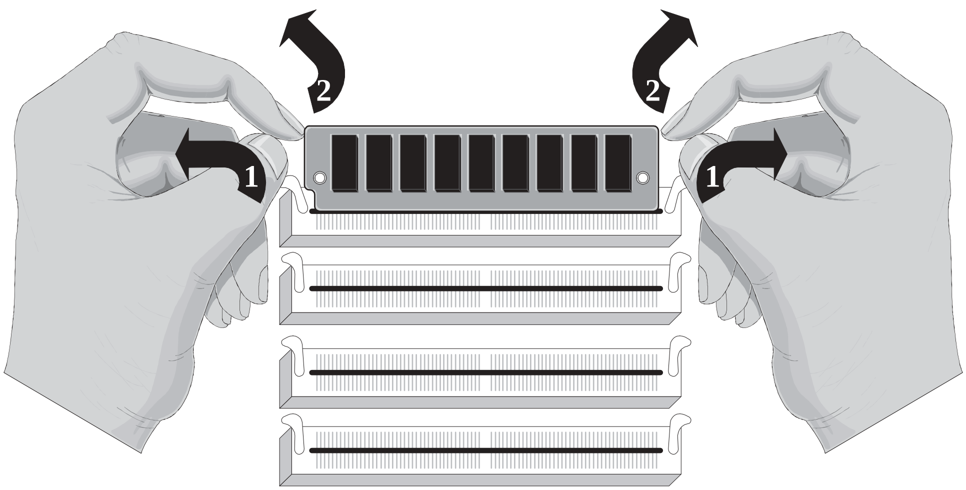
Removing a SIMM or a DIMM is much easier than removing a DIP chip. A SIMM socket has two clasps, one on either side of the socket. These hold the memory chip into the socket. A metal or plastic clasp is normally used with SIMM sockets.

Be extremely careful when working with plastic clasps. If they break, they are expensive to replace and sometimes you have to purchase a new motherboard. Memory Figure #18 shows how the clasps are *gently* pulled away from the SIMM to remove the memory module from the socket.

Grasp the two clasps on either side of the socket with your thumbs resting on the inner side of the clasps. Gently pry the clasps out and away from the memory module. With your index finger, press the SIMM forward until it pulls away from the clasps.

MEMORY – FIGURE #18

SIMM Removal

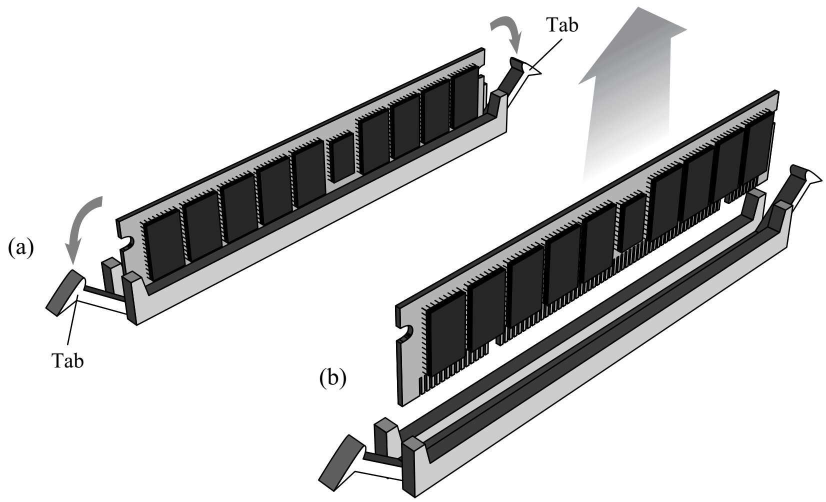


REMOVING A DIMM/RIMM

Removing a DIMM or a RIMM is very similar to removing a SIMM except that you push *down* on the outside edges of the DIMM's retaining tabs. The DIMM/RIMM lifts slightly out of the socket. Lift the module out of the socket once it is released. Memory Figure #19 shows how to remove a DIMM/RIMM.

MEMORY – FIGURE #19

DIMM/RIMM Removal

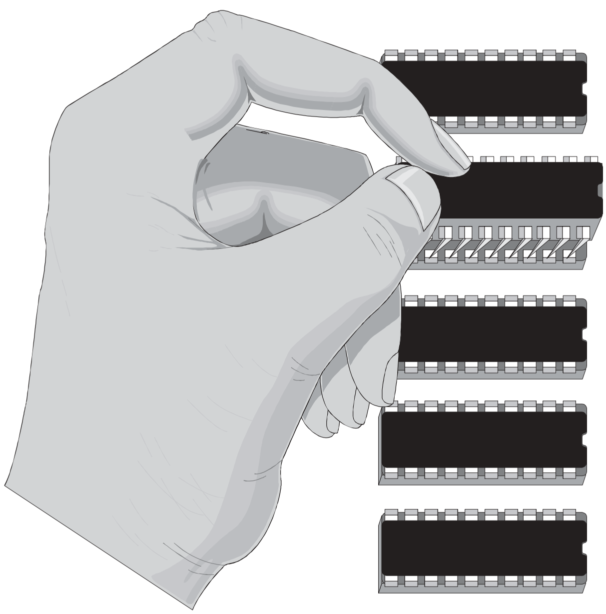


INSTALLING A DIP CHIP

To insert a DIP chip, verify that all legs on the DIP chip are straight and even before installing. If the legs are bent, use a pair of small needlenose pliers to straighten and align the legs before inserting the chip into the socket. Place the DIP chip over one side of the chip socket, *barely* placing each leg into the holes on one side of the socket. Be sure the DIP chip orients properly in the socket. All DIP chips have a notch on the end and usually all notches of the DIP chips face in the same direction on the motherboard (or any adapter for that matter). Press gently on the DIP chip's opposite side legs. At the same time, press the chip into the socket. One advantage to using your hands rather than a chip insertion tool to install a DIP chip, is you can feel the legs going into the socket properly after practicing this technique a few times. By the same token, with practice, you can feel if a leg bends backward as it inserts into the socket. Reference Memory Figure #20.

MEMORY – FIGURE #20

DIP Chip Installation

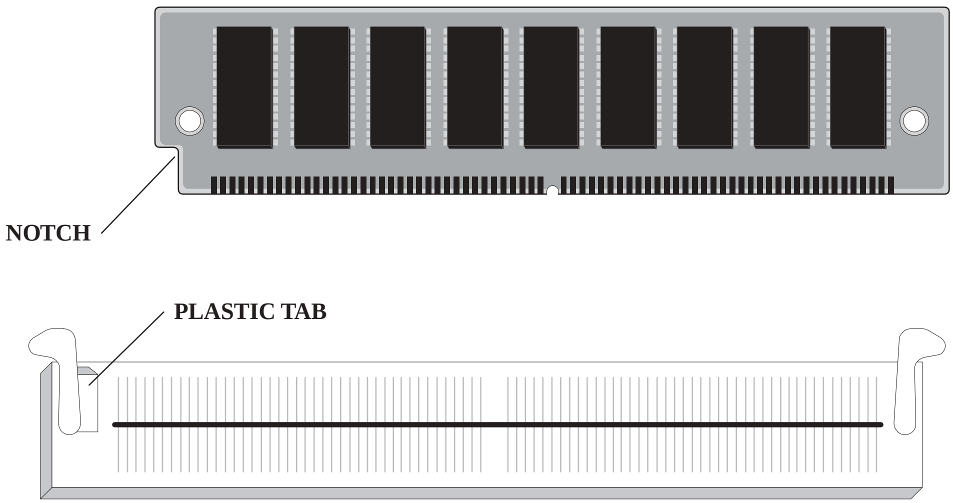


INSTALLING A SIMM

A SIMM inserts only one way into the socket, so it cannot be inserted improperly (oriented the wrong way) as the DIP chip can. The SIMM has a notch on one side. If you look carefully at the socket, you can see a plastic tab on one side. The notch on the memory module lines up with the side of the socket with the plastic tab. See Memory Figure #21 for a picture of a SIMM notch and the SIMM socket.

MEMORY – FIGURE #21

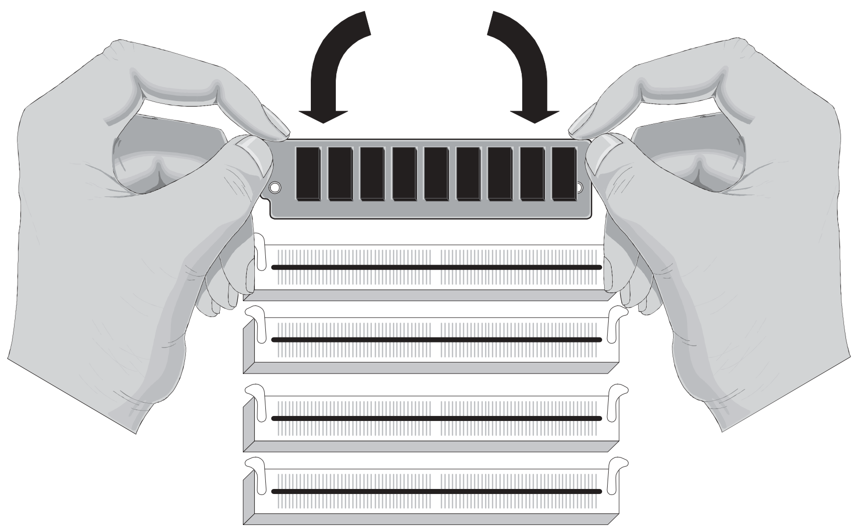
SIMM Notch and Socket



Insert the SIMM memory module at a tilt into the socket. Insert the chip's metal contacts *firmly* into the socket. Press the memory module backward into the socket until the two clasps clamp against the memory module. Memory Figure #22 shows this procedure. Notice in Memory Figure #22 there is a hole on either side of the memory module. A plastic pin on each side of the memory socket inserts into the memory module's holes when the module inserts properly into the socket.

MEMORY – FIGURE #22

SIMM Installation



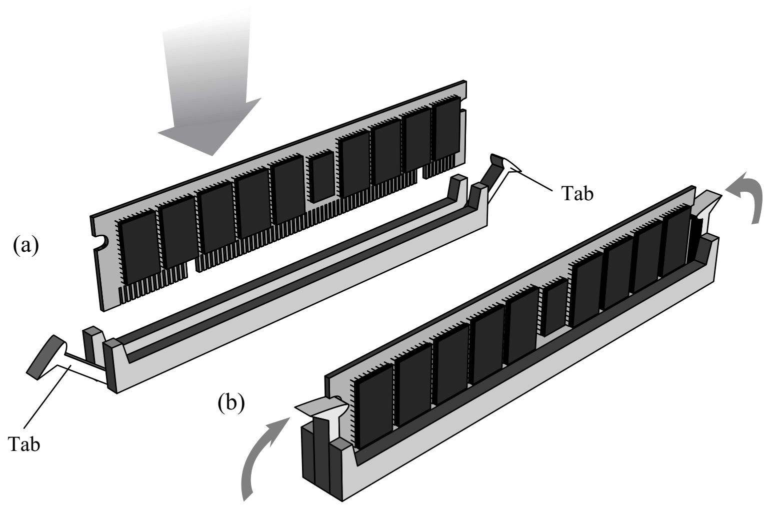
INSTALLING A DIMM/RIMM

A DIMM/RIMM has one or more notches on the bottom where the gold or tin contacts are located. Refer back to Memory Figures #1 and #2 for illustrations of DIMMs. The DIMM only inserts into the memory socket one way. The DIMM memory socket has two tabs that align with the DIMM notches. Look at the DIMM and notice where the DIMM notches are located. Look at the DIMM socket and notice where the tabs in the socket are located. The DIMM will not insert into the memory socket unless it is oriented properly.

A DIMM/RIMM is inserted straight down into the socket, not at a tilt like the SIMM. Make sure the side tabs are pulled out before you insert the DIMM and close the tabs over the DIMM once it is firmly inserted into the socket. Memory Figure #23 illustrates how to insert a DIMM or a RIMM.

MEMORY – FIGURE #23

DIMM/RIMM Installation



A lot of information has been presented so far, but these concepts are important. The following memory tips summarize the most important memory installation steps.

1. Always refer to the motherboard or computer documentation before purchasing or installing memory.
2. Install SIMM into Pentium or higher computers in groups of two.
3. When installing DIMMs, install one DIMM per bank.
4. When installing RIMMs, install one RIMM per bank and fill the empty banks with C-RIMMs.
5. When installing PC100 and PC133 SDRAM DIMMs, install one DIMM per bank.
6. When installing DDR SDRAM DIMMs, insert one DIMM per bank.

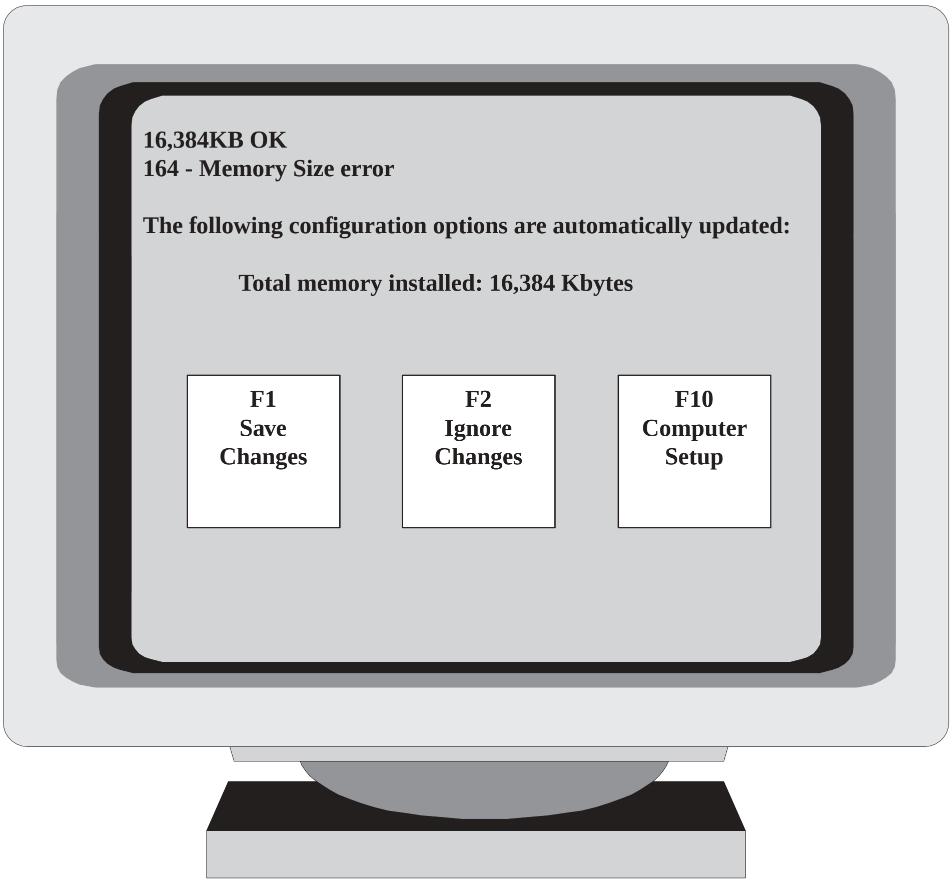
CONFIGURING THE COMPUTER

Older motherboards require setting of jumpers or switches to denote how much memory installs on the motherboard, but newer ones automatically recognize new memory. Still other computers require no setting except through CMOS SETUP. Always refer to the motherboard or the computer system's documentation for this information.

After you install the memory, power the computer on. Some computers show a POST error message or automatically go into the Setup program. This is normal. The important thing to notice during POST is that the memory count should equal the amount of memory installed. Refer to Memory Figure #24 for an example of the memory configuration screen, keeping in mind every BIOS chip is different and different messages appear depending on which one is installed. This is only a sample.

MEMORY – FIGURE #24

Sample Memory Configuration Screen



With the system illustrated in Memory Figure #24, the F1 key is pressed to configure CMOS and save the memory installation changes.

HOW MUCH MEMORY?

The amount of memory that can be installed on the motherboard depends on two things: (1) the motherboard manufacturer and (2) the microprocessor.

> RAM system memory should *always* be installed on the motherboard and not on a memory expansion adapter because *the memory on the motherboard will slow down to the adapter memory's speed*. The adapter memory's speed is at the speed of the adapter bus (ISA, MicroChannel, EISA, VL-bus, or PCI), which is always slower than the motherboard.

Microprocessors have a specific number of address lines connecting each memory chip with the CPU. Each memory location is like a mailbox for data to be placed into it or retrieved from it. The processor can connect to only a limited number of mailboxes or addresses. A mathematical relationship exists between the number of address lines and the total number of addresses the CPU recognizes. A simple (but non-realistic) example is that if a microprocessor had three address lines (and each address line can be a binary 1 or a binary 0), the different mailbox addresses the microprocessor can have are 000, 001, 010, 011, 100, 101, 110, or 111. With three address lines, eight different addresses are possible. The mathematical relationship is 2***X*** where ***x*** is the number of address lines from the microprocessor. (The number "2" comes from the fact that address lines have one of two possible states, a 1 or a 0 binary digit. Memory Table #1 recaps the Intel microprocessors, giving the number of address lines for each, along with the total number of addresses the microprocessor can access.

MEMORY – TABLE #1

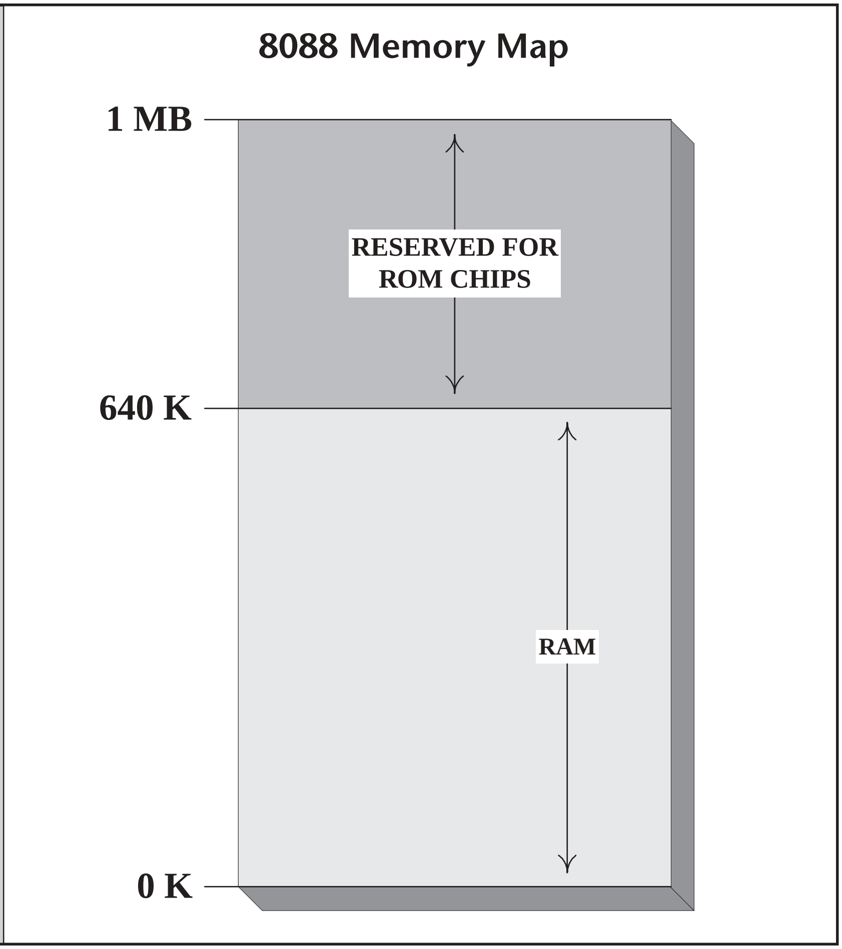
Server-Based Network

Processor	Number of Address Lines	Max. Amount of Memory Addresses
8088	20	1MB
80286	24	16MB
80386DX	32	4GB
80486DX	32	4GB
Pentium	32	4GB
Pentium Pro	36	64GB
Pentium II	36	64GB
Pentium III	36	64GB
Pentium 4	36	64GB

Notice that the 8088 microprocessor can address up to approximately one million different addresses because 2^{20} = 1MB (1,048,576 addresses to be exact). The 80286 was the first Intel microprocessor allowing access to memory above 1MB. It was the first CPU to support protected mode. **Protected mode** allows applications to access memory above 1MB. Applications must be specifically written for protected mode in order to use it. **Real mode** describes early computers that could not access memory above 1MB. Most DOS applications were written for real-mode microprocessors. The Pentium Pro, Pentium II, Pentium III, and Pentium 4 processors can address up to 68,719,476,736 (64GB) different addresses. However, not all memory address locations are for RAM chips. The microprocessor uses the address lines for all memory chips including ROM chips on the motherboard and on various installed adapters.

To look at the whole picture of the address lines' usage, a **memory map** is used. It makes things easier to see. Memory Figure #25 illustrates the memory map for the 8088 microprocessor's address space, as designated by IBM on the first PC.

MEMORY – FIGURE #25

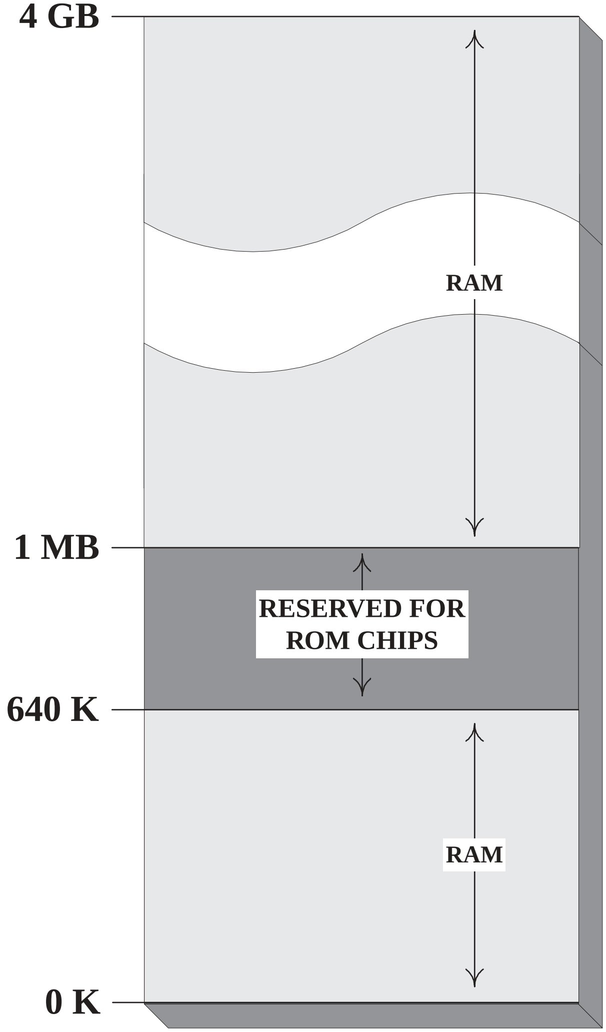


Notice that the 0KB to 640KB space is for RAM chips. The upper addresses are for various ROM chips in the system. This address space is frequently defined as the **reserved area** or the **UMA** (**Upper Memory Area**). On an Intel 8088 microprocessor-based IBM compatible computer, the maximum amount of memory on the motherboard is 640KB.

Today's applications and operating systems need much more than 640KB of RAM. Later microprocessors allow for this increase. Memory Figure #26 shows the memory map for an 80386, an 80486, and a Pentium.

MEMORY – FIGURE #26

Memory Map for 80386 Through Pentium



Notice that the area above 1MB in Memory Figure #26 allows for more RAM to be installed in a system. Just because the microprocessor supports the additional address lines does not mean a computer system has 4GB of RAM (less the 360KB reserved for ROM chips). This is where the manufacturer of the motherboard comes into the picture. The amount of

RAM placed on the motherboard depends on the manufacturer. Most manufacturers of Pentium-based motherboards do not allow the full amount of RAM because few computers need 4GB of memory. This information is usually in the documentation that comes with the computer or motherboard. The Intel Pentium Pro through Pentium 4 processors have a similar memory map; however, the map extends further, to 64GB at the top.

MEMORY AND SOFTWARE CONSIDERATIONS

Physically installing memory in the computer is fine, but not all applications can use the available memory. Whether or not an application can use all the RAM in a system depends on the operating system/environment installed on the computer and the operating system for which the application is written. Three examples include:

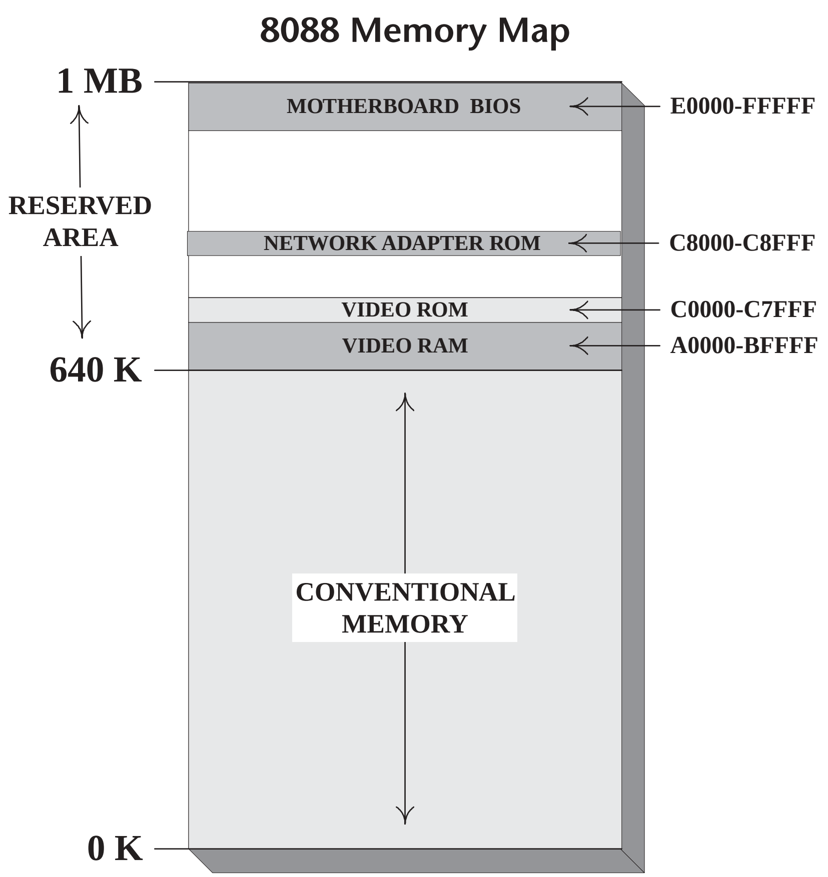
1. An application specifically written for the DOS/Windows environment running on a system with Windows 9x, NT, or 2000 behaves as if it was installed on a system with DOS.
2. An application specifically written for Windows NT will not operate in a Windows 9x or DOS/Windows 3x environment.
3. An application specifically written for Windows 9x will not run in the DOS/Windows environment.

DOS/WINDOWS 3.X AND MEMORY

To understand the memory limitations of DOS, start with the 8088 microprocessor of the original IBM PC. From there we can move forward because all computers, even today's computers, are backwards compatible with older microprocessors. Microprocessor designers want consumers to be able to run the software that ran on their old computers.

The 8088 microprocessor has 20 address lines for a total of 1,048,576 possible addresses. Keep in mind that all memory chips, RAM and ROM alike, have different memory addresses that fit into a memory map for a specific microprocessor. Memory Figure #27 illustrates the 8088 memory map.

MEMORY – FIGURE #27



CONVENTIONAL MEMORY

The area from 0 to 640KB is for the RAM chips installed in the 8088-based computer and is normally called **conventional memory**. DOS and all DOS applications written for the 8088 computers ran in conventional memory. The application, such as a word processor, would load into the RAM chips. Any document created within the application, such as a letter, was also kept in the RAM chips and mapped into the 0 to 640KB area of the memory map. Windows 9x also uses conventional memory.

UPPER MEMORY AREA (RESERVED MEMORY)

The area of the memory map designated *Reserved* is for the ROM chips in the computer. The Reserved area is also known as the Upper Memory Area or UMA. Refer back to Memory Figures #25, #26, and #27 to see this memory area. The Reserved area is subdivided into blocks of memory that are illustrated with hexadecimal memory addresses. Hexadecimal is easier to process than the computer's binary 1s and 0s. The area from E0000 to FFFFF is used by the BIOS chip(s) on the motherboard. The hard drive controller in 8088-based computers has ROM chips on the adapter that normally use the memory address range of C8000 to CBFFF. If the computer has an EGA monitor installed, the ROM chip on the EGA adapter fits into the memory map at C0000-C3FFF. All ROM chips in the system must fit in a space on the memory map not occupied by any other ROM chip.

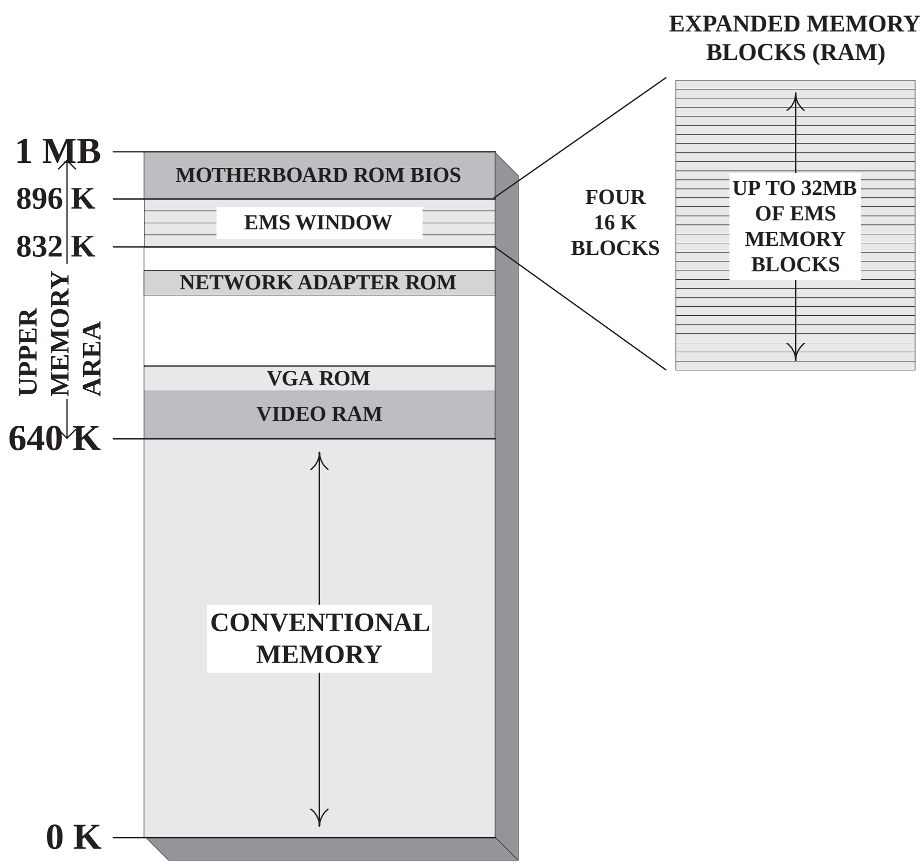
Computer users, especially the ones who created large spreadsheets in spreadsheet software such as Lotus, frequently ran out of conventional memory due to the 0 to 640KB limitation. Lotus, Intel, and Microsoft worked together to develop a new memory standard called LIM (Lotus, Intel, Microsoft) which solves the limitation of conventional memory. The **LIM memory standard** is also known as **expanded memory** or **EMS** (**Expanded Memory Specification**).

EXPANDED MEMORY

To break the 640KB memory limitation with 8088-based microprocessors, users had to buy an expanded memory adapter with more RAM chips. For the microprocessor to communicate with this RAM, the memory chips had to fit in the memory map, but the 8088 had only 20 address lines. The EMS standard occupies a 64KB portion of the Reserved area in the memory map not used by any ROM chips, such as the 832KB to 896KB range. The 64KB block of memory map space is divided into four 16KB blocks used to address the memory chips on the expanded memory adapter. The EMS standard allows up to 32MB of EMS memory. Refer to Memory Figure #28 for an illustration of how EMS memory fits into the 8088's memory map.

MEMORY – FIGURE #28

Expanded Memory



The spreadsheet data or any other data using expanded memory loads into the RAM chips on the expanded memory adapter. The microprocessor accesses this data by swapping it into the four 16KB blocks of memory in the Reserved area. If more data is needed, the original data is taken out of one of the four 16KB blocks and placed into the expanded memory block. The new data is then swapped or paged into the old data's slot in the Reserved area. Expanded Memory is also known as paged memory because it pages (swaps) the data in and out of the reserved area in four 16KB chunks. Expanded memory is *very* slow because it pages in and out of the memory map.

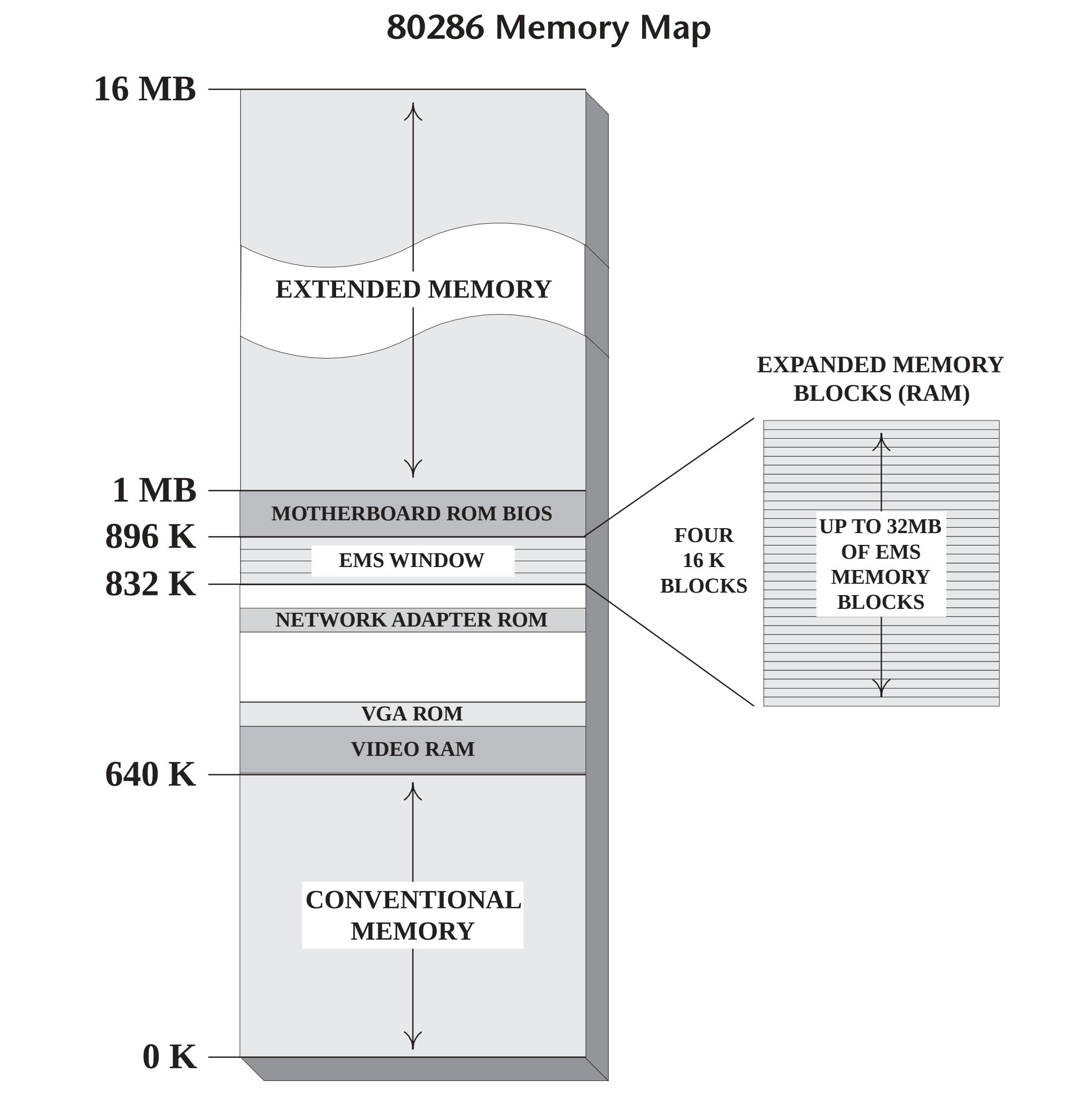
Not all applications can use expanded memory. The application must be specifically written for it. Years ago, a disk containing software, sometimes called a driver, was included with the purchase of an expanded memory adapter. When the software driver was loaded into the CONFIG.SYS file, a 64KB window was made available in the memory map for use as expanded memory.

Expanded memory no longer requires a separate adapter. Instead, if an older application requires expanded memory, a specified amount (up to 32MB) of the RAM on the motherboard can be specified as expanded memory. The rest is for extended memory covered in the next section. In this scheme, even though the memory is on the motherboard, data is still paged in and out of the memory map through the 64KB window to access the RAM chips. A driver is still needed in the CONFIG.SYS file. DOS and Windows both have an expanded memory manager, called EMM386.EXE, for 80386 and higher microprocessors.

EXTENDED MEMORY

A better alternative to expanded memory is extended memory and it became available with the 80286 microprocessor. **Extended memory**, also known as **XMS** (**Extended Memory Specification**), is the area of the memory map above the 1MB mark. The 80286 microprocessor has 24 address lines with 2^{24} (16,777,216) different addresses available to the microprocessor. Refer to Memory Figure #29 for an illustration of the memory map for an 80286 microprocessor.

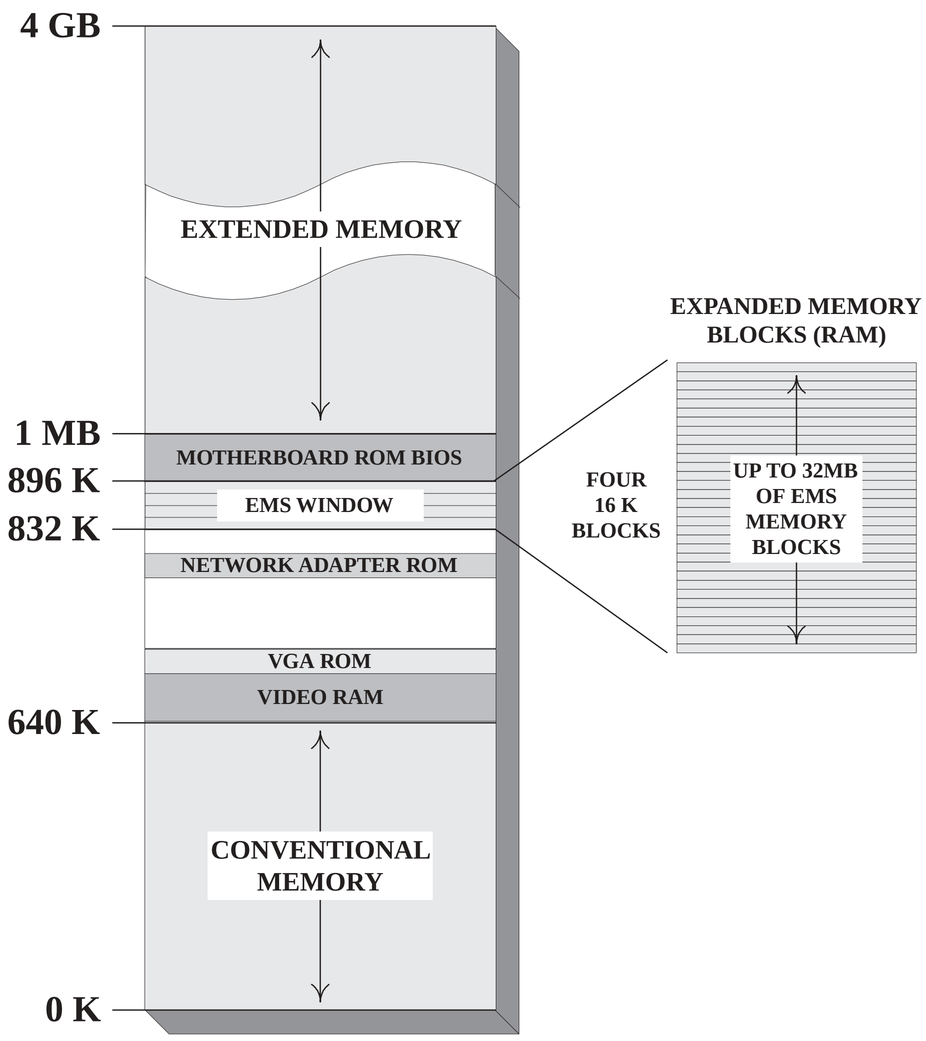
MEMORY – FIGURE #29



Extended memory is much faster than expanded memory. With the 80386, 80486, and Pentium-based systems the same memory map exists, except that the extended memory range is from 1MB to 4GB (4,294,963,296 different addresses). Refer to Memory Figure #30 for the memory map of the 80386, 80486, and Pentium microprocessors.

MEMORY – FIGURE #30

80386, 80486 and Pentium Memory Map



The Pentium Pro through Pentium 4 processors have 36 address lines. The memory maps for the Pentium Pro and Pentium II look exactly like the illustration in Memory Figure #30 except the highest memory address extends beyond 4GB to 64GB.

For a system to use extended memory, a driver must be installed in the CONFIG.SYS file. The driver used to access extended memory that comes with DOS and Windows is HIMEM.SYS. Windows 95 and higher operating systems do not require a driver in the CONFIG.SYS file because HIMEM.SYS loads automatically.. All operating systems today use extended memory.

FREEING MEMORY SPACE IN THE DOS/WINDOWS ENVIRONMENT

Insufficient memory errors occur frequently in the DOS/Windows environment due to conventional memory limitations. These errors also occur when running DOS applications under the Windows 9x operating system. A close look at the CONFIG.SYS file is necessary to understand memory. The first line of the CONFIG.SYS file normally lists the software driver for extended memory, HIMEM.SYS. The line looks like this:

DEVICE=C:\WINDOWS\HIMEM.SYS

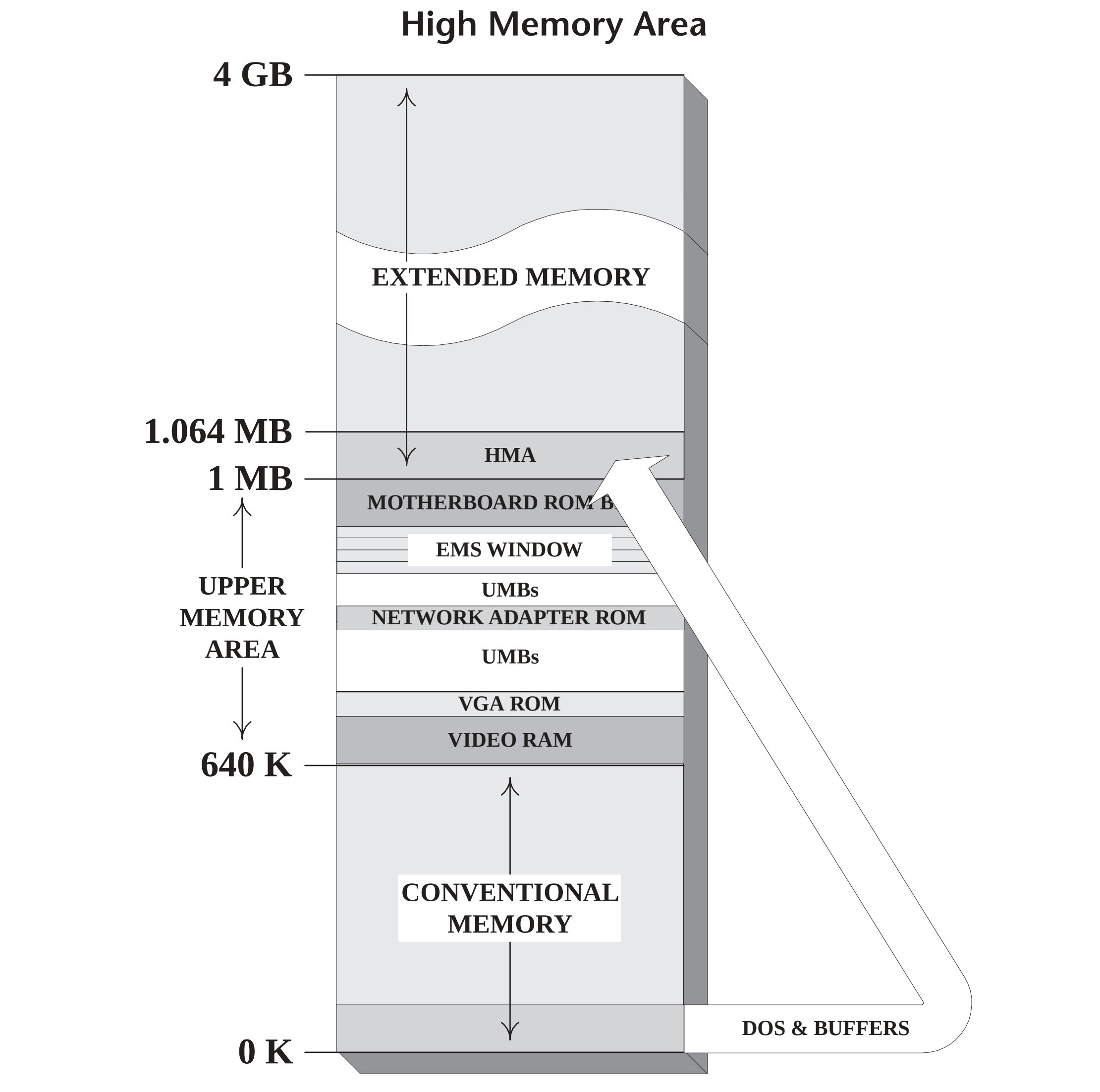
The command DEVICE= loads a device driver. The path, C:\WINDOWS, may be named C:\DOS or C:\ to indicate the correct driver location. HIMEM.SYS is the program name. When this driver is loaded, the area above 1MB is made available to the operating system for applications able to use it. The first 64KB above the 1MB mark is the High Memory Area (HMA). This area is important because the system can use it as an extended portion of conventional memory. DOS, normally one of the first pieces of software loaded into conventional memory, can load into the HMA if the following special line is in the CONFIG.SYS file: DOS=HIGH.

The BUFFERS= statement in CONFIG.SYS allows for speeding up data transfer between two devices. The memory space reserved for buffers also goes into the High Memory Area with DOS if the number of buffers is below 42 (with DOS 6x). Up to 47KB of conventional memory is saved by loading DOS and the buffers into the High Memory Area. Therefore, the two CONFIG.SYS lines necessary to place DOS and the buffers in the High Memory Area that must load before the BUFFERS= command are these:

DEVICE=C:\WINDOWS\HIMEM.SYS
DOS=HIGH

See Memory Figure #31 for an illustration of the High Memory Area.

MEMORY – FIGURE #31



Another conventional memory saver occurs when the unused blocks of memory in the Reserved area are available for use with files normally loaded in conventional memory. The blocks of memory in the Reserved area that can be used for software other than ROM chips are also known as the **Upper Memory Blocks** or the (**UMBs**). The UMBs are part of the Upper Memory Area. To make the UMBs available to the system, two lines are needed in the CONFIG.SYS file:

```
DEVICE=C:\WINDOWS\EMM386.EXE
DOS=UMB
```

These two lines must follow the extended memory manager CONFIG.SYS line:

DEVICE=C:\WINDOWS\HIMEM.SYS
DEVICE=C:\WINDOWS\EMM386.EXE
DOS=UMB

The DEVICE=C:\WINDOWS\EMM386.EXE line loads the expanded memory driver, which allows the system to *see* the upper memory blocks as part of DOS. The DOS=UMB line allows the system to *use* the upper memory blocks. A more common use of the DOS=UMB line is to combine it with the DOS=HIGH line, as illustrated in this example:

DEVICE=C:\WINDOWS\HIMEM.SYS
DEVICE=C:\WINDOWS\EMM386.EXE
DOS=HIGH,UMB

After these lines are placed in the CONFIG.SYS file, any other device drivers (lines that begin DEVICE=) can load into the upper memory blocks, if space is available, by changing the statement to DEVICEHIGH=. Also, any lines in the AUTOEXEC.BAT file that load TSR (Terminate and Stay Resident) programs can be preceded by the LOADHIGH or LH command to load the software into the upper memory blocks, not into conventional memory. The switches (numbers or letters following the program name) available for use with the EMM386 command change the way the system accesses and/or uses the upper memory blocks. Memory Table #2 lists the proper switch to use with the EMM386 command.

MEMORY – TABLE #2

EMM386.EXE Switches

Do You Need Expanded Memory?	Do You Need UMB Access?	EMM386 Switch
NO	NO	N/A
YES	NO	N/A
YES	YES	*XX* where *XX*=amt of mem in KB (64 to 32,768)
NO	YES	NOEMS

Most applications do *not* require expanded memory. The most frequently used EMM386 switch is NOEMS. If this switch is needed, the line in CONFIG.SYS is:

DEVICE=<path>EMM386.EXE NOEMS

The NOEMS switch is popular because expanded memory is *not* needed by most applications. 64KB of UMB space is needed to load software normally found in conventional memory, therefore freeing precious space in the conventional memory range. The MSD and the MEM programs can be used to view the Upper Memory Blocks. Exercises at the end of the chapter show how.

All this memory management has now been automated with the latest DOS versions. Microsoft's memory management utility is MEMMAKER and IBM's memory management utility is RAMBOOST. A technician always needs to know the basics of memory management. The memory exercises at the end of the chapter help you understand the techniques.

ADDING MORE CACHE/RAM

Most computers today have cache built into the processor. The motherboard manufacturer determines if any L3 cache can be installed. Check the documentation included with the motherboard or computer to determine the correct amount of cache (SRAM).

Adding more RAM can make a noticeable difference in computer performance (up to a point, of course). When a computer user is sitting in front of a computer waiting for a document to appear, or waiting to go to a different location within a document, it might be time to install more RAM. Do not purchase a computer today if it has less than 128MB of RAM.

DISK CACHE

With older computers, a technician could increase computer speed by installing a disk cache program. A disk cache will set aside a portion of memory (RAM to be used when applications or data are read from the disk drive (which is inherently slow). Under these circumstances more data than requested is read and placed in RAM, where the disk cache is located. Some hard drives have their own caching controllers. Caching hard drive controllers have memory installed that speeds up the system by using memory chips on the adapter rather than the motherboard RAM for the disk cache.

DOS, Windows 3x, and Windows 9x have a disk caching program called SmartDrive (SMARTDRV.EXE). This program caches data from floppy disks, CD-ROMs, hard drives, and InterLink drives. Windows 98 includes the SmartDrive program to be backwards compatible with some older devices. Normally, this program is not used with Windows 98 and higher operating systems.

Windows 9x, NT, and 2000 have an integrated caching program for CD-ROMs that works better than SmartDrive. Refer to the hard drive and CD-ROM chapters for more information on caching programs.

> The Windows 95 SETUP program sometimes hangs if SmartDrive double buffering is not enabled. Some hard drives require double buffering. Use the SETUP */C* command to prevent SmartDrive from loading during the Windows 95 installation process. If , the installation process hangs after running SETUP from Windows 3x, try disabling 32-bit disk access from the 386 enhanced control panel before starting the SETUP program again. If that does not work, run the SETUP program from the DOS prompt.

WINDOWS 9X/NT/2000 DISK CACHING

Windows 95 has disk caching built in to the operating system through the use of the VCACHE program. Even though SmartDrive is used to load Windows 95, VCACHE is used during normal Windows 95 operations.

Windows 98/NT/2000 have a more efficient memory management through VMM (Virtual Memory Manager). **Virtual memory** is a method of using hard disk space as if it were RAM. The disk cache is dynamicæit increases or decreases the cache size as needed. If the system begins to page frequently and is constantly swapping data from RAM to the hard drive, the cache size automatically shrinks.

Windows 9x uses a temporary swap file, WIN386.SWP, that increases or decreases in size as necessary based on the amount of RAM installed in the computer and the amount of memory needed to run the application(s). A **swap file** is a block of hard drive space used like RAM by applications. Other names for the swap file include page file or paging file. For optimum performance in any Windows operating system, set aside as much free hard disk space as possible to allow ample room for virtual memory and caching. As a default, the swap file is on the same hard drive as the Windows 95/Windows 98 directory.

If multiple hard drives are available, a technician might want to move the swap file to a different drive. Always put the swap file size on the fastest hard drive unless that hard drive lacks space. NT and 2000 Professional allow you to have the swap file on multiple hard drives. It is best to keep the swap file on a hard drive that does not contain the operating system.

In Windows 9x, to adjust the virtual memory swap file size

1. Open Control Panel;
2. Double-click on the System control panel icon;
3. Click the Performance tab;
4. Click the Virtual Memory button;
5. Click the Let me specify my own virtual memory settings option;
6. Click the down arrow in the area to the right of the Hard disk option;
7. Choose a different hard drive from the list;
8. Click OK. The settings for the minimum and maximum size of the swap file can also be changed.

In NT, to adjust the virtual memory size

1. Open *Control Panel*;
2. Double-click on the *System* control panel icon;
3. Click on the *Performance* tab;
4. Click on the *Change* button;
5. In the area designated as *Paging File Size for Selected Drive*, change the size parameters;
6. Click on the *OK* button.

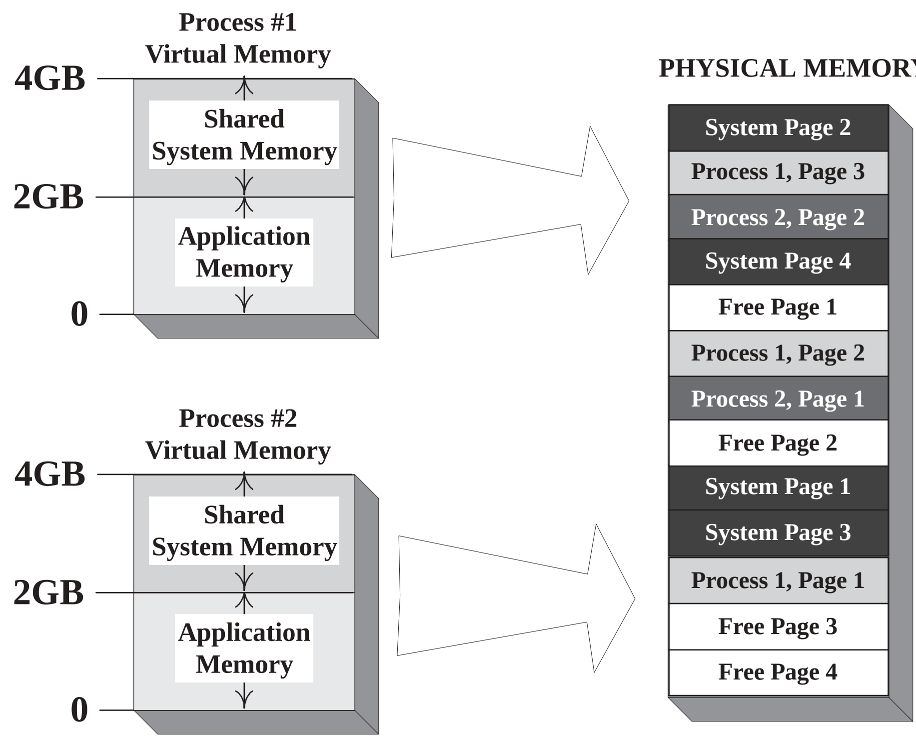
In 2000 Professional, to adjust the virtual memory size

1. Open *Control Panel*;
2. Double-click on the *System* control panel icon;
3. Click on the *Advanced* tab;
4. Click on the *Performance Options* button;
5. Click on the *Change* button;
6. Change the size parameters and click on the *OK* button.

Windows 98, NT, and 2000 Professional use virtual memory differently than Windows 3x. With Windows 3x, memory is divided into different sized segments each up to 64KB. Windows 98/NT/2000 use 32-bit demand-paged virtual memory and each process gets 4GB of address space divided into two 2GB sections. One 2GB section is shared with the rest of the system while the other 2GB section is reserved for the one application. All the memory space is divided into 4KB blocks of memory called **pages**. The operating system allocates as much available RAM as possible to an application. Then the operating system swaps or pages the application to and from the temporary swap file as needed. The operating system determines the optimum setting for this swap file; however, the swap file size can be changed. Memory Figure #32 illustrates how Windows 98, NT, and 2000 Professional uses virtual memory.

MEMORY – FIGURE #32

Windows 98/NT/2000 Virtual Memory Usage



In Memory Figure #32, notice how each application has its own memory space. The Memory Pager maps the virtual memory addresses from the individual processes' address space to physical pages in the computer's memory chips.

A great freeware utility to use for virtual memory (as well as other computer components) is Sisoftware's Sandra at www.sisoftware.demon.co.uk/Sandra. Download the *Sandra Standard*. Install the software according to the instructions. Load a lot of games and applications into memory, then access the Sandra program by clicking on *Programs*, pointing to *SiSoft Utilities*, and clicking on the *SiSoft Sandra 2001te Standard* option. Click on the *OK* button to clear the utility tip. Double-click on the *Windows Memory Information* icon. Write down the number listed to the right of the Current Page File; this is how much of your hard drive space has been reserved for virtual memory. Locate the Free Page File setting; it shows how much of the set aside hard drive space is being used at this point. The Free Physical Memory setting is how much (if any) of your RAM chips are still available for use.

MONITORING MEMORY USAGE UNDER WINDOWS 95/98/NT

System Monitor is a utility that comes with Windows 9x; NT's utility is called **Performance Monitor** and with 2000 Professional, the **Performance utility**. To access System Monitor, click on the *Start* button, point to the *Programs* selection, point to *System Tools*, and click on *System Monitor*. In NT Workstation, click on the *Start* button, point to *Programs*, point to the *Administrative Tools* selection, and click on *Performance Monitor*. In 2000 Professional, access *Control Panel*, double-click on the *Administrative Tools* control panel icon, and double-click on the *Performance Utility*.

Each of these tools allows you to evaluate different performance areas: the file system, the IPX/SPX compatible protocol, the kernel, the memory manager, Microsoft Client for NetWare Networks and Microsoft Network Client, Microsoft Network Server, and Microsoft Network Monitor Performance Data. In regards to memory, the areas of particular interest are the Kernel Monitor (the *Processor Usage* and *Threads* settings) and the Memory Manager Monitor (the Page-Outs, Discards, *Locked Memory*, *Allocated Memory*, and *Page Faults* settings). You can access the System Monitor program by selecting *Programs, Accessories, System Tools,* and clicking on *System Monitor*.

The processor usage setting within the Kernel monitor provides a percentage of time the microprocessor is busy. If the Processor Usage values are high (even when you are not doing anything with an application), check to see which particular application is using the microprocessor. Close an application and note the difference in the Processor Usage settings.

A **thread** is a unit of programming code that receives a slice of time from Windows 95, 98, or NT so it can run concurrently with other units of code or other threads. The *Threads* setting within the Kernel monitor indicates the current number of threads within the operating system. This number indicates whether a particular application is starting threads and not reclaiming them. The operating system closes threads when exiting an application. If you can identify a thread left by a closed application that still shows as being open in the task list, that application may need to be restarted then exited again so the thread closes.

The Memory Manager's *Discards* setting is the number of pages of memory discarded per second. The pages of memory are not swapped to the hard disk because the information is already stored there. The *Page-outs* setting is the number of pages of memory swapped out of memory and written to the disk per second. If these two values are high and indicate a lot of activity, more RAM may be needed.

The Memory Manager's *Locked Memory* setting shows the amount of memory, including the disk cache, that cannot be paged out. To determine the exact amount of locked RAM, subtract the disk cache size amount from the locked memory amount. The *Allocated Memory* setting in the Memory Manager indicates the total amount of allocated memory not stored in the swap file (*Other Memory*) and the number of bytes in use from the swap file (*Swapable Memory*). If the *Locked Memory* values are a large portion of the *Allocated Memory* value, then the system does not have enough free memory and this affects performance. Also, an application might be locking memory unnecessarily and not allowing the memory to be paged out. This comes from poorly written software or software that needs to be re-loaded.

The Memory Manager's *Page Faults* setting shows the number of page faults occurring each second. If this value is high, the application currently in use has memory requirements higher than what is installed in the computer. In this case, recommend that the customer purchase more RAM for the computer.

USING A RAM DRIVE

A **RAM drive** is a virtual (not real) hard disk drive created from RAM. It's the opposite of virtual memory. The RAM set aside for a RAM drive is not available to the system as normal memory. A RAM drive can be created out of conventional, expanded, or extended memory, but extended memory is preferred. A RAM drive is located in memory and operates much faster than retrieving data from a hard drive. The drawback to a RAM drive is that anything written to this area of memory will be lost when the computer restarts or shuts down. Therefore, permanent data should not be stored in a RAM drive. Also, because the memory allocated to the RAM drive is no longer available to the system, a RAM drive should only be created if there is RAM to spare in a system.

In older DOS versions, the RAM disk device driver was VDISK.SYS. In today's DOS, the RAM disk driver is RAMDRIVE.SYS. To create a RAMDRIVE from extended memory, insert the following line into the CONFIG.SYS file:

DEVICE=[path]RAMDRIVE.SYS /e [size]

[path] is the directory where you find the RAMDRIVE.SYS file. *[size]* is the size of the RAM drive in kilobytes. The default is 64KB and the possible range is 16KB to 4,096KB.

DOS APPLICATIONS UNDER WINDOWS 9X

Most DOS applications run fine under Windows 9x, but those with problems can be run in the Windows 9x's MS-DOS mode. In MS-DOS mode, the operating system removes almost all of itself from memory, finishes all tasks currently running, loads a real-mode copy of MS-DOS into memory, uses a customized CONFIG.SYS file and a customized AUTOEXEC.BAT file, then turns over the computer resources to the DOS application. When the DOS application finishes running, Windows 9x restarts and loads itself back into memory. DOS applications require ample available conventional memory, just as a non-Windows 9x computer does. Therefore, a DOS application that executes using the Windows 9x MS-DOS mode should have a customized CONFIG.SYS containing the HIMEM.SYS; DOS=HIGH,UMB; and EMM386.EXE statements. Load all possible device drivers and TSRs into the UMBs.

When a DOS application is started with Windows 9x's RUN utility (from the Start button), the DOS application appears in a window as any application does. Windows 9x's memory management and task management features are still in effect when DOS applications are started this way.

Another alternative is to run the DOS application after starting Windows 9x in the Command Prompt Only mode. To start Windows 95 in a different mode, press the *F8* key when the "Starting Windows 95" message appears on the screen as the system first boots. Then, choose the *Command Prompt Only* option from the menu that appears. For Windows 98, hold the *CTRL* key down while Windows 98 boots. When the Startup menu appears, select the number for the *Command Prompt Only* option.

DOS APPLICATIONS UNDER NT WORKSTATION/2000

Each DOS application runs in an NT/2000 process called NT Virtual DOS Machine (NTVDM). The NTVDM process simulates a 486 computer running DOS. Each DOS application runs in its own address space. However, 16-bit applications share address space in the NT environment. Many DOS applications do not operate in the NT/2000 environment. DOS applications frequently make direct calls to hardware, which neither NT nor 2000 allows. If DOS applications are still being used, you might want to recommend a different operating system to the user until all applications are 32-bit.

TROUBLESHOOTING OTHER MEMORY PROBLEMS

You can get out of memory errors with any operating system. System resource errors were more common in Windows 3x than they are with current operating systems because these systems use hard drive space more efficiently. No matter which operating system or environment is being used, check the amount of free space on the hard drive. Delete files that are no longer needed. Empty the recycle bin to free up more hard drive space. Change the virtual memory settings so that the hard drive has more space. Finally, closing applications that are not being used can help with memory problems. Sometimes you must close all applications, reboot the computer, and open only the application that was running when the out of memory error occurred because some applications do not release the memory space they held. Windows 9x, NT, and 2000 have memory troubleshooting wizards that can help with this task. Click on the *Start* button, click on the *Help* option, click on the *Index* tab, and type in *Memory*. Select the option under this heading for troubleshooting. Keep in mind that sometimes there is nothing to do but buy more RAM—but try the aforementioned tips first. The following tips help with memory management.

1. Add more RAM. Nothing helps memory performance as much as adding physical memory to the computer. To see the amount of physical memory (RAM) installed, right-click on the *My Computer* desktop icon and click on the *Properties* item.
2. Adjust virtual memory size. Refer to the previous steps for adjusting this setting for various operating systems.
3. Turn off the screen saver or use the *Blank* option. Screen savers do not protect monitors from burn-in anymore; instead, they take up memory.
4. Remove the desktop wallpaper scheme or use a very plain one. Wallpaper schemes take up memory.
5. Put the swap file on the fastest hard drive.
6. Do not put the swap file on multiple partitions that reside on the same hard drive. Use multiple hard drives if possible.
7. Put the swap file on a hard disk partition that does not contain the operating system.
8. Adjust your Temporary Internet Files setting. From Internet Explorer, click on either the *View* or the *Tools* menu option (depending on your operating system). Click on *Internet Options* and click on the *Settings* button. A slide bar allows you to adjust how much disk space is set aside for caching web files. To increase the amount of disk space (faster access), move the sliding bar to the right. For those who do not have a lot of free hard disk space, move the sliding bar to the left. Adjust this setting as necessary.
9. Defragment the hard drive. See the hard drive chapter for steps.
10. Remove (uninstall) unnecessary files and applications from the hard drive to free up hard drive space.
11. Empty the Recycle Bin to permanently remove deleted files and free up hard drive space.

POST usually detects a problem with a memory chip and most BIOS chips show a "2XX POST" error code. Some computers have the CMOS option to disable extended memory checking. This is not a good idea. Endure the few seconds it takes to check the memory chips to get an early warning of a memory failure. When POST issues a memory error, turn off the computer, remove the cover and press down on any DIP memory chips. If SIMMs or DIMMs are installed, clean out the sockets with compressed air and reseat the chips in the memory sockets. Also, gold contact swabs can be used to clean the SIMM/DIMM sockets. Reseating memory chips often corrects memory errors.

If this does not work, turn the computer on again and watch the memory count in the upper left corner of the screen. The memory count is an excellent clue for where to start troubleshooting a memory problem. For example, on a computer with 16MB of RAM installed, if the memory in the upper left corner gets to 8,378KB and a POST memory error appears, then the memory problem is on a chip somewhere after the first 8MB of RAM. If the system is a Pentium with two 8MB, 72-pin SIMMs installed, the problem is probably in the second SIMM socket. Swap the SIMM in the first socket with the SIMM in the second socket. If the POST error code appears more quickly as the first 8MB of memory counts on the screen, the problem is the SIMM that was in the second socket, but later moved to the first socket.

The key to good memory chip troubleshooting is to divide and conquer. Narrow the problem to a suspected bank of memory, then start swapping memory chips (SIMM/DIMMS). Keep in mind most memory problems are not in the hardware, but in the software, especially if operating in the DOS/Windows environment.

Most DOS memory problems are attributed to the lack of conventional memory. Use the MEM command to view and verify as many programs as possible load into the Upper Memory Blocks. TSRs and device drivers in the AUTOEXEC.BAT and CONFIG.SYS files can be re-ordered. Sometimes more programs can be loaded into the Upper Memory Blocks just by re-ordering the programs. You can still run MEMMAKER under Window 9x to load real-mode drivers into the Upper Memory Blocks. For Windows 98, the program is located on the CD under the TOOLS\OLDMSDOS directory.

ROM address conflicts are a frequent source of problems for the technician. The ROM chips on some adapters have addresses that are selectable while others are pre-set and cannot be changed. All ROM chips throughout the computer system must have a separate, unique ROM address to operate within the memory map. See the System Configuration chapter for more information on memory addresses.

One of the first symptoms of a ROM address conflict is if a particular adapter will not function. Or, when a new adapter is installed in a system and the computer will not boot off the hard drive, a ROM conflict is the likely culprit. Do not forget to consider interrupt and I/O address conflicts also.

For DOS or Windows 3x computers, MSD (Microsoft Diagnostics) is a good place to begin checking the currently used ROM locations *before* installing any new adapters. There are other programs and utilities that perform the same function, but MSD ships with Microsoft DOS and Windows. For Windows 9x and 2000 computers, the Device Manager is used to see the various ROM addresses. For NT computers, use NT Diagnostics located under *Programs, Administrative Tools* option.


Name ______________________

Some of these (3,6, & 48) had commas. I changed them to be consistent. If this is wrong, let me know.

MEMORY REVIEW QUESTIONS

1. Describe the difference between RAM and ROM.
2. What is meant by "memory chip refreshing"?
3. Which types of memory chips require constant refreshing? (Pick all that apply.)
ROM \ DRAM \ SRAM \ SDRAM \ EDO \ FPM \ Burst EDO
4. T / F Most memory on the motherboard is SRAM.
5. Describe how cache increases computer speed.
6. What motherboards commonly use DIMMs? (Pick all that apply.)
386 \ 486 \ Pentium \ Pentium Pro \ PentiumII \ Pentium III
7. T / F A non-parity system can use parity memory chips.
8. Describe how to determine a memory chip's access time.
9. T / F An 8ns memory chip is faster than a 10ns memory chip.
10. T / F Installing faster memory chips always increases computer speed.
11. At what speed do PC100 DIMMs operate?
12. How can you tell if a DIMM is PC100 or PC133-compliant?
13. What is SPD and how is memory different with SPD?
14. What is the difference between buffered and unbuffered SDRAM?

15. What speeds do RDRAM RIMMs come in?

16. What are the two versions of DDR RAM modules?

17. Describe the difference between address lines and external data lines.

18. T / F entium-based motherboards commonly use DIMMs.

19. T / F A 2MB X 32 72-pin SIMM has a total capacity of 8MB.

20. T / F A 2MB X 36 72-pin SIMM does not use parity.

21. Explain how the 168-pin DIMM replaces two 72-pin SIMMs.

22. A DDR DIMM memory chip is advertised as 256MB CAS 2.5. What does the CAS 2.5 mean?

23. Which is better CAS 2 or CAS 2.5?

24. A RIMM is listed as 700 MHz ECC 4-Device. What does the 4-Device mean?

25. Which of the following are rules for populating memory? (Pick all that apply.)
    A. If a bank of memory is to be used, it must be filled entirely with memory chips.
    B. All memory chips in a bank must be the same capacity.
    C. Every bank on a motherboard must be filled with memory chips to operate properly.
    D. Memory chips in the same bank should have the same access speed.
    E. The memory chips in every memory bank on the motherboard must be the same capacity.

26. Describe how you can determine how much memory to install in a system.

27. T / F Laptop memory is best upgraded with a PC Card.

28. T / F Flash memory contents are lost when power is removed.

29. What is the best tool for removing a DIP memory chip?

30. Which is easier to install a SIMM or a DIP and why?

31. How is a DIMM installation different from a SIMM?

32. T / F There is normally one DIMM per bank.

33. T / F A POST error message is normal after upgrading memory on some computers.

34. Which area of the 80286 memory map is the area from 0 to 640KB?
Conventional \ Expanded \ Upper Memory Blocks \ High Memory Area \ Extended

35. Which area of the 8088 memory map is a maximum of 32MB divided into 16KB blocks and pages in and out of a 64KB space?
Conventional \ Expanded \ Upper Memory Blocks \ High Memory Area \ Extended

36. Which area of the 80386 memory map is the area from 640KB to 1MB?
Conventional \ Expanded \ Upper Memory Area \ High Memory Area \ Extended

37. Which area of the 80486 memory map is the area from 1MB to 4GB?
Conventional \ E\xpanded \ Upper Memory Area \ High Memory Area \ Extended

38. Which area of the memory map operates the slowest because it pages in and out of the memory map?
Conventional \ Expanded \ Upper Memory Area \ High Memory Area \ Extended

39. Which area of the Pentium memory map is the first 64KB of memory above the 1MB mark?
Conventional \ Expanded \ Upper Memory Area \ High Memory Area \ Extended

40. Which type of memory is faster, conventional or expanded?

41. What DOS command provides access to extended memory?
EMM386.EXE \ HIMEM.SYS \ DOS=HIGH \ DOS=UMB

42. Which of the following CONFIG.SYS lines will load most of DOS into the HMA?
EMM386.EXE \ HIMEM.SYS \ DOS=HIGH \ DOS=UMB

43. Which of the following CONFIG.SYS lines allows the use of the UMBs for loading device drivers and TSRs?
EMM386.EXE \ HIMEM.SYS \ DOS=HIGH \ DOS=UMB

44. T / F Processors today have cache built into them.

45. Explain how virtual memory works.

46. Which control panel is used in 2000 Professional to set personalized virtual memory settings?

47. T / F Each 32-bit application running within 2000 Professional is allowed 4GB of address space.

48. Which of the following is Windows 95/98's performance monitoring tool, useful in troubleshooting memory problems?
VCACHE \ VIRTUAL \ My Computer \ System Monitor

49. What is a RAMDrive?

50. What is the difference between running a DOS application using the RUN utility and running the application under Windows 95's MS-DOS mode?

51. T / F All DOS applications operate in the NT environment.

52. List four things to help with memory performance.

53. Which screen saver takes the least amount of memory?

54. Describe how to allocate memory for Internet Explorer.

55. What is a common POST error code for memory?

56. What is a symptom of a ROM address conflict?

Name ______________________________

MEMORY FILL-IN-THE-BLANK

1. The two main types of memory are __________ and __________.

2. An example of non-volatile memory is __________.

3. The major types of RAM are __________ and __________.

4. The SRAM chips on the motherboard are also known as the __________.

5. __________ is the process of performing more than one instruction at the same time.

6. The *type* of memory chip used for RAM in today's systems is __________, with either tin or gold contact edges.

7. The RAM memory chips used on older motherboards and for cache memory are known as __________. These have one row of legs down each side of the chip.

8. Athlon motherboards can use __________ DIMMs, which have 184-pins.

9. Pentium 4 motherboards use __________, which hold RDRAM.

10. __________ is a method of memory error checking in which an extra bit is used to check a group of 8 bits going into the bank of memory.

11. Most SIMMs have capacities measured in __________.

12. DIMMs have capacities measured in __________.

13. Memory access time is measured in __________.

14. Whether a system can use Fast Page Mode, EDO, or Burst EDO RAM chips depends on the __________ and the chipset used on the motherboard.

15. __________ was developed by Rambus, Inc. and is used on Pentium 4 motherboards.

16. All unused RIMM slots must contain a __________.

17. __________ transmits data on both sides of the clock signal and uses 184-pin DIMMs.

18. Two dual-ported video memory types are __________ and __________.

19. All the memory chips that must transmit simultaneously to the microprocessor are called a __________.

20. The number of sockets in a bank of memory is determined by the number of bits in a microprocessor's __________.

21. A SIMM advertised as 4x36 has a total capacity of __________.

22. A DIMM advertised as a PC100 chip runs on a motherboard that has a bus speed of __________.

23. The absolute maximum amount of RAM that can be connected to a microprocessor is determined by the number of __________ from the microprocessor.

24. The maximum number of address lines in a computer with a Pentium microprocessor is __________.

25. A laptop DIMM is called __________ because its form factor is smaller.

26. The maximum amount of addressable RAM and ROM in a Pentium II computer is __________.

27. __________ mode applications can access memory above 1MB.

28. DOS applications traditionally use __________ mode.

29. A graphical representation of how a system uses memory is known as a __________.

30. The area from 640K to 1MB on an 8088 memory map is known as the __________ or the __________.

31. In the memory map between 640K and 1MB are ROM chips and __________ RAM.

32. The area between 0 and 640K is known as __________.

33. __________ is also known as LIM or EMS memory.

34. __________ is located above the 1MB mark in the memory map.

35. The first 64K above the 1MB line on a memory map is known as __________.

36. The __________ file loads memory management drivers for the DOS environment.

37. A __________ file is the use of some hard drive space by applications because there is not enough RAM.

38. Windows 98, NT, and 2000 Professional have memory space divided into __________.

39. NT's utility for monitoring memory performance is called __________.

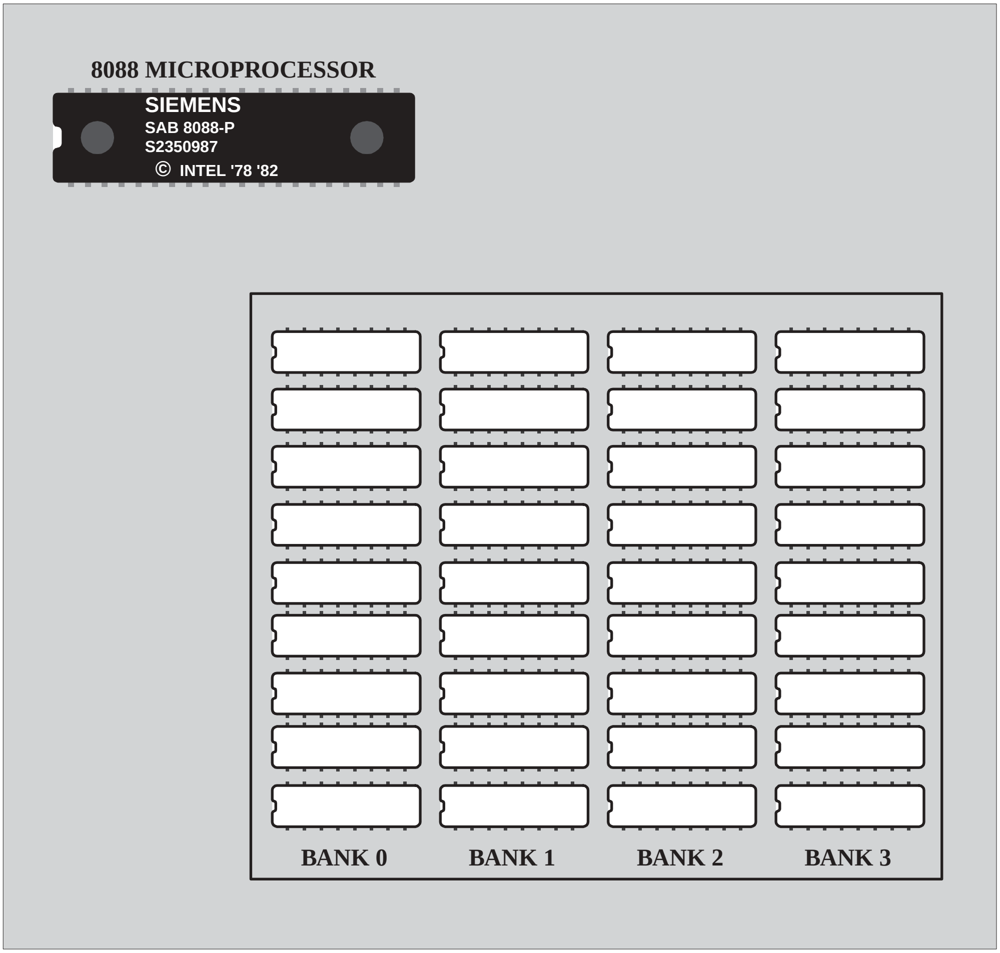
Name ______________________________

PAPER MEMORY POPULATION EXERCISE FOR 8088-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #1 to populate the motherboard with 640KB of memory. The DIP memory chips to use with this motherboard are 64Kb and 256Kb.

MEMORY EXERCISE – FIGURE #1

8088 System with 640KB of RAM



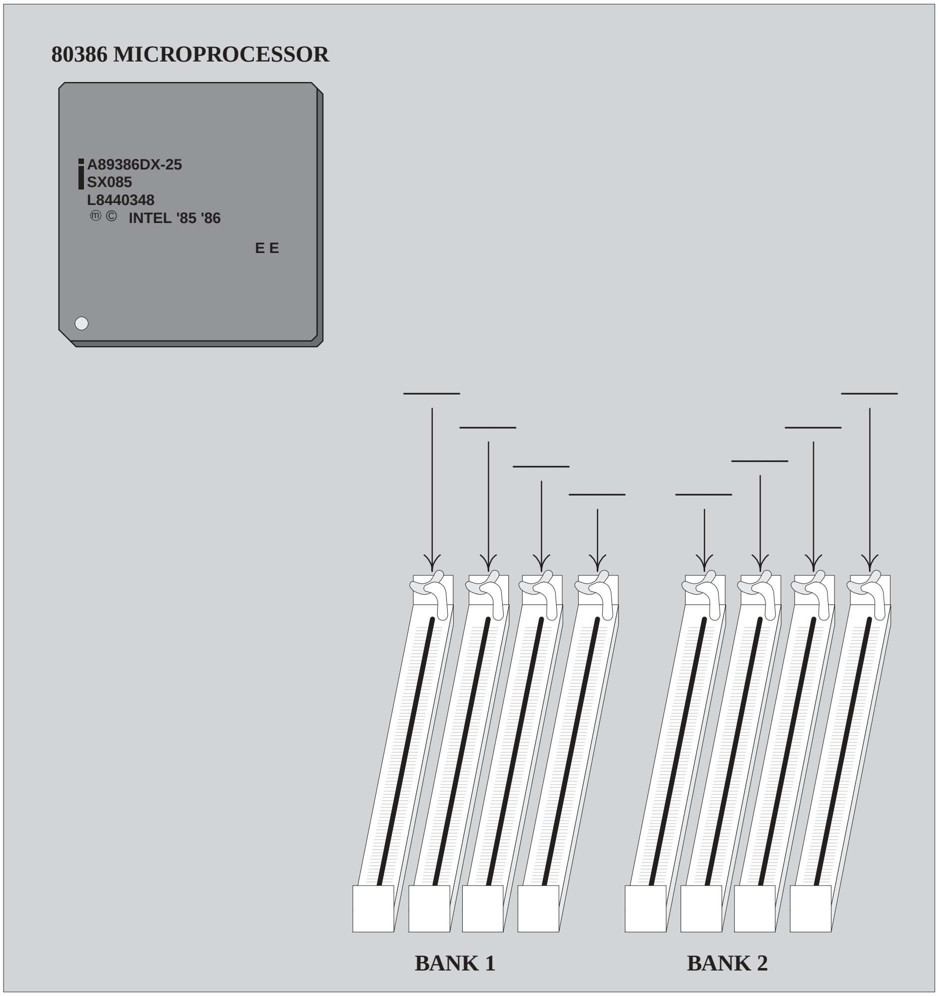
Name ______________________________

PAPER MEMORY POPULATION EXERCISE FOR 80386-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #2 to populate the motherboard with 5MB of memory. The 30-pin SIMMs available to use with this motherboard are 256KB, 512KB, 1MB, and 4MB.

MEMORY EXERCISE – FIGURE #2

80386 wih 8MB of RAM



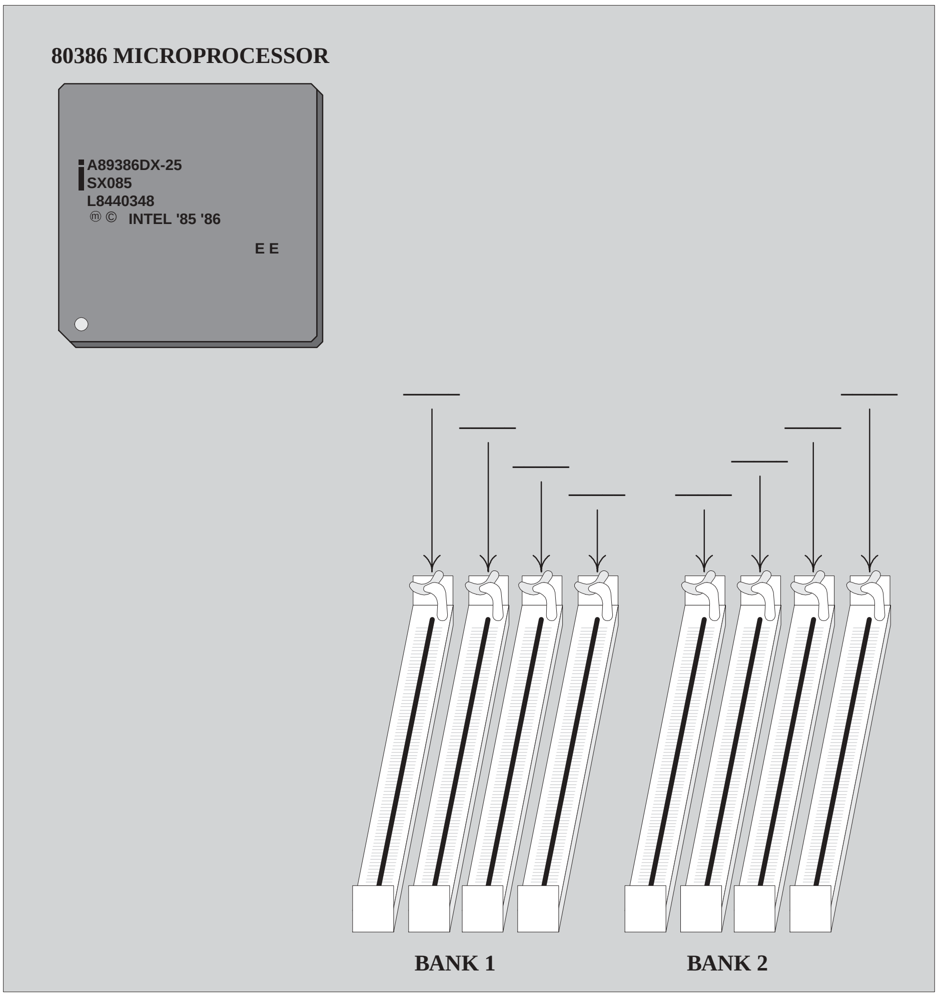
Name ______________________________

SECOND PAPER MEMORY POPULATION EXERCISE FOR 80386-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #3 to populate the motherboard with 5MB of memory. The 30-pin SIMMs available to use with this motherboard are 256KB, 512KB, 1MB, and 4MB.

MEMORY EXERCISE – FIGURE #3

80386 with 5MB of RAM



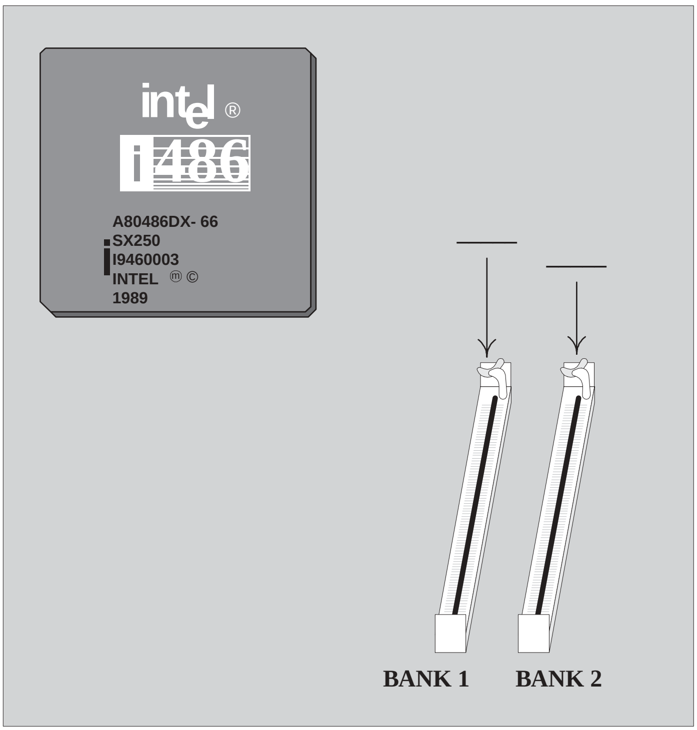
Name ______________________________

PAPER MEMORY POPULATION EXERCISE FOR 80486-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #4 to populate the motherboard with 8MB of memory. The 72-pin SIMMs available to use with this motherboard are 2MB, 4MB, and 8MB (these are the total capacities of the memory chips).

MEMORY EXERCISE – FIGURE #4

80486 with 8MB of RAM



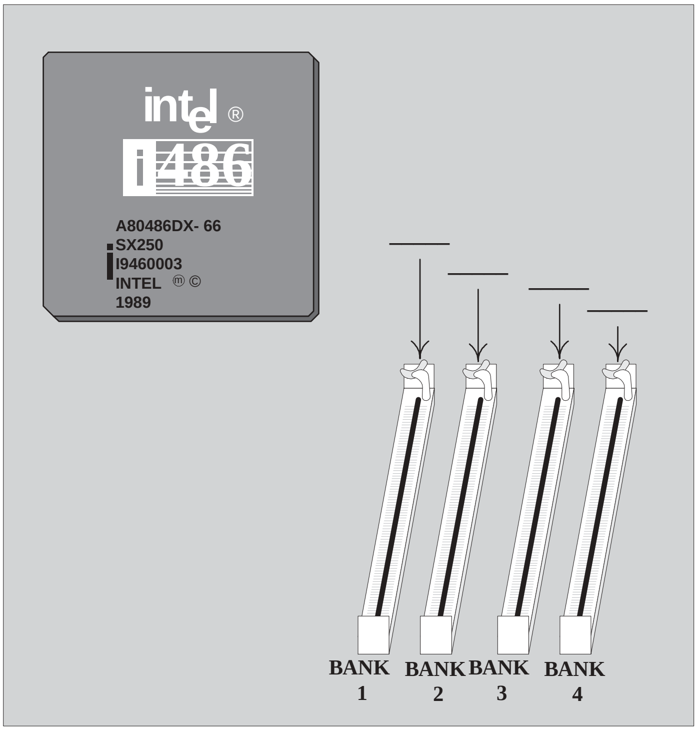
Name ________________________________

SECOND PAPER MEMORY POPULATION EXERCISE FOR 80486-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #5 to populate the motherboard with 16MB of memory. The 72-pin SIMMs available to use with this motherboard are 1MB x 36, 2MB x 36, 4MB x 36, 8MB x 36, and 16MB x 36.

MEMORY EXERCISE – FIGURE #5

80486 with 16MB of RAM



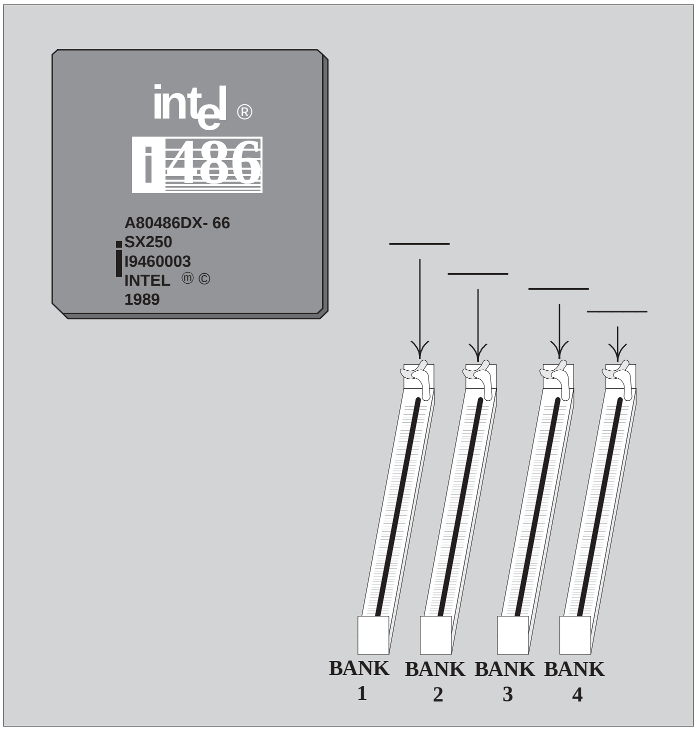
Name ________________________________

THIRD PAPER MEMORY POPULATION EXERCISE FOR 80486-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #6 to populate the motherboard with 20MB of memory. The 72-pin SIMMs available to use with this motherboard are 1MB x 36, 2MB x 36, 4MB x 36, 8MB x 36, and 16MB x 36.

MEMORY EXERCISE – FIGURE #6

80486 with 20MB of RAM



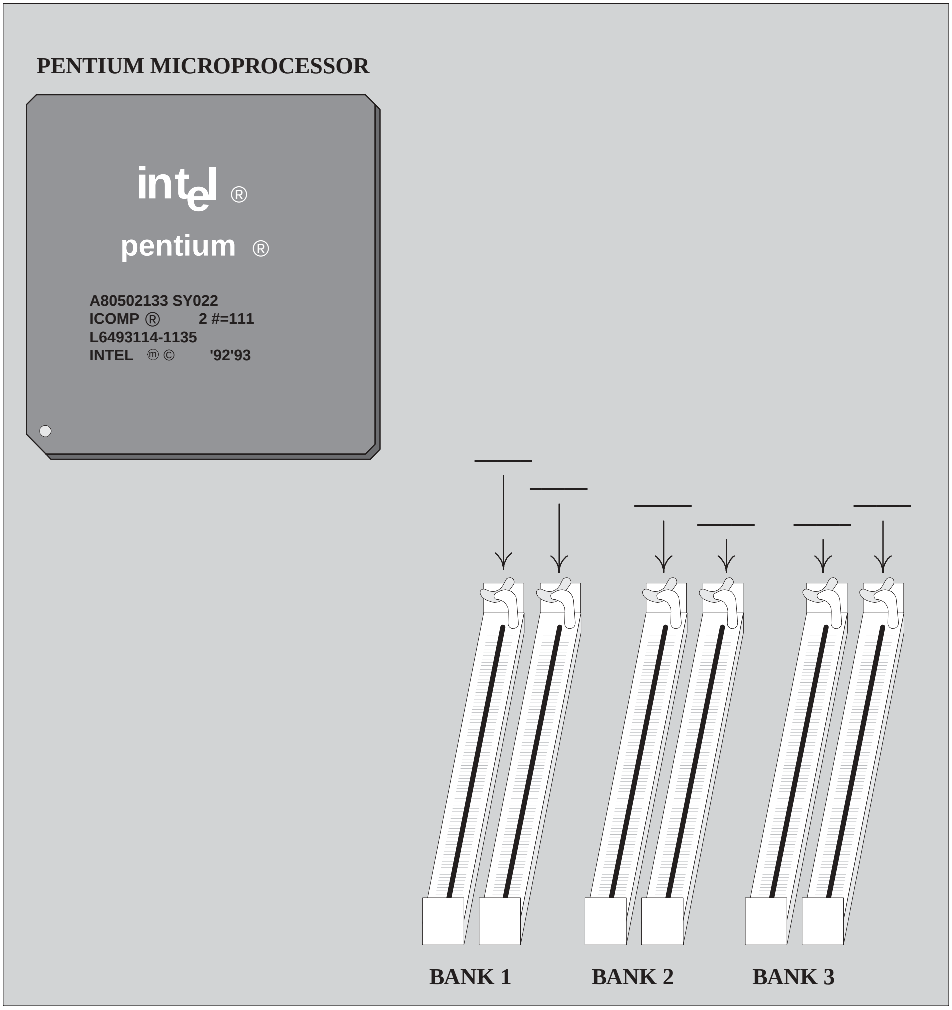
Name ________________________________

PAPER MEMORY POPULATION EXERCISE FOR PENTIUM-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #7 to populate the motherboard with 16MB of memory. The 72-pin SIMMs available to use with this motherboard are 1MB x 36, 2MB x 36, 4MB x 36, 8MB x 36, and 16MB x 36.

MEMORY EXERCISE – FIGURE #7

Pentium with 16MB of RAM



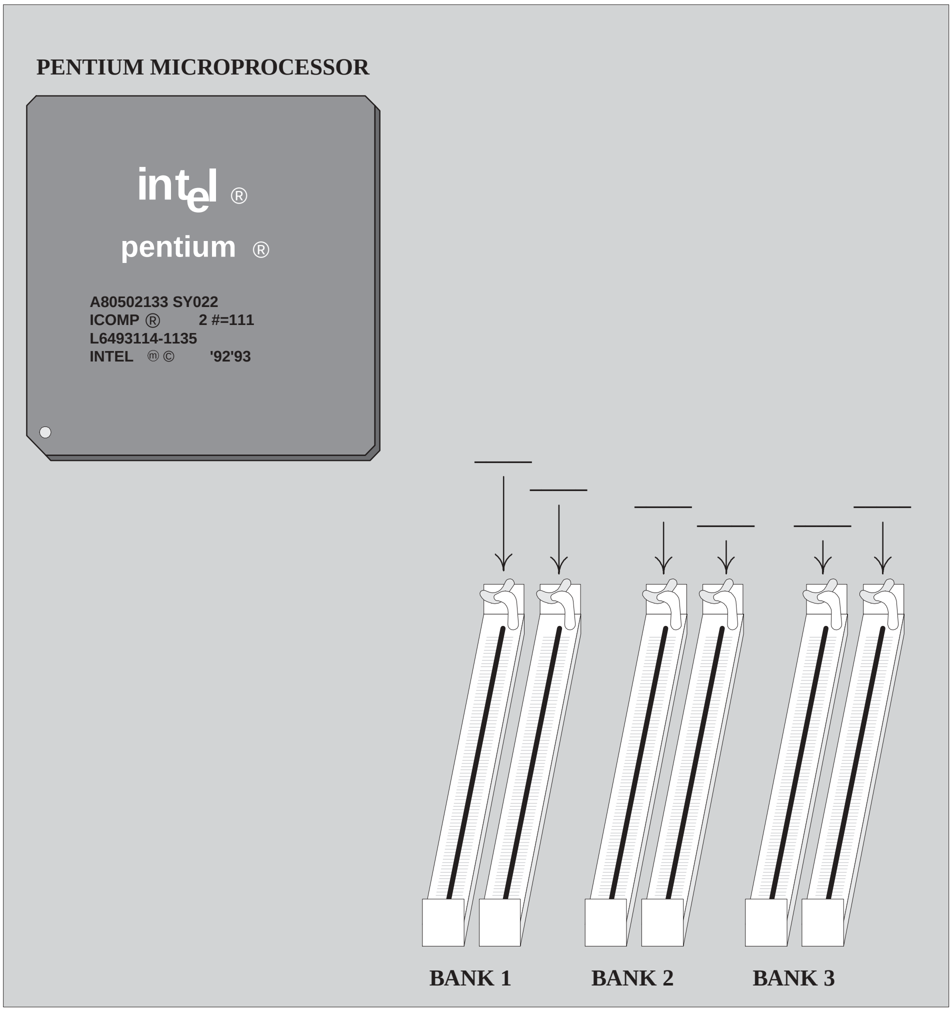
Name ________________________________

SECOND PAPER MEMORY POPULATION EXERCISE FOR PENTIUM-BASED MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #8 to populate the motherboard with 40MB of memory. The 72-pin SIMMs available to use with this motherboard are 1MB x 36, 2MB x 36, 4MB x 36, 8MB x 36, and 16MB x 36.

MEMORY EXERCISE – FIGURE #8

Pentium with 40MB of RAM



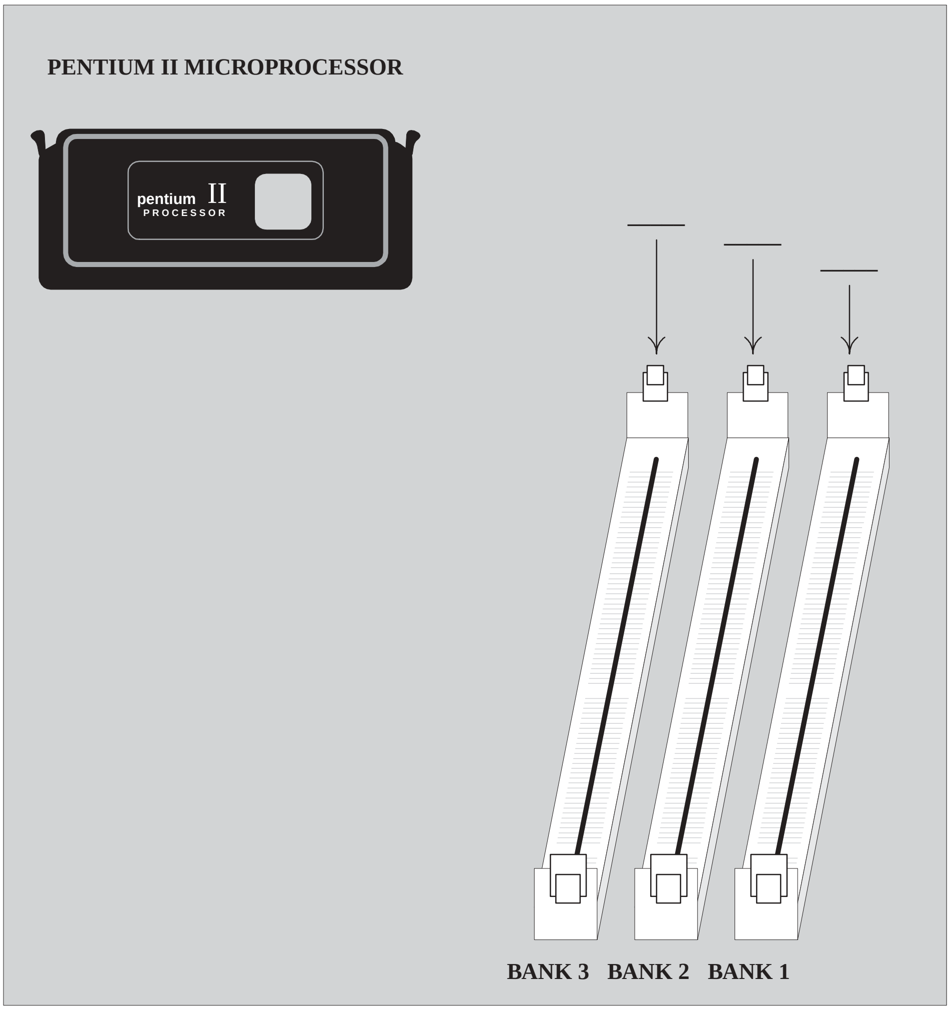
Name ________________________________

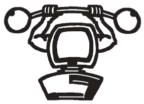
PAPER MEMORY POPULATION EXERCISE FOR PENTIUM II AND HIGHER MOTHERBOARDS

Use the drawing shown in Memory Exercise Figure #9 to populate the motherboard with 176MB of memory. The 168-pin DIMMs available to use with this motherboard are 1MB x 64, 2MB x 64, 4MB x 64, 8MB x 64, and 16MB x 64.

MEMORY EXERCISE – FIGURE #9

Pentium II with 176MB of RAM





Name ______________________________

MEMORY INSTALLATION EXERCISE

Objective: To correctly install memory into a computer

Parts: Memory chips
Anti-static strap
Documentation for the motherboard

Step 1. Plan the memory installation. Determine what size, type, capacity, and access speed memory chip(s) you need. Determine if any memory chips are to be removed. Refer to the motherboard documentation if possible.

Step 2. Power off the computer.

Step 3. Remove the cover from the computer.

Step 4. Put on the anti-static strap and attach it to the computer.

Step 5. Remove any memory chips necessary for the upgrade or installation if needed.

Step 6. Install the memory chips.

Step 7. Set any jumpers or switches necessary for a computer memory change.

Question 1: What microprocessor is installed in the computer?

Question 2: How many address lines does this microprocessor use?

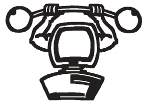
Question 3: What is the size (in bits) of the external data path of this microprocessor?

Step 8. Power on the computer.

Step 9. Configure the computer's CMOS SETUP.

Step 10. Reboot the computer and verify that POST errors do not appear.

_____ ***Instructor's Initials***



Name ________________________________

SEEING THE RESULTS OF MEMORY MANAGEMENT

Objective: To see how software affects conventional memory and how to load software into the Upper Memory Blocks

Parts: One blank disk
A computer with DOS 6x loaded
Optional software from the instructor

Step 1. Make a bootable disk with the version of DOS currently on the computer. For DOS skills, refer to Appendix A.

Step 2. Create a CONFIG.SYS file that contains the following lines:

FILES=20

BUFFERS=20

Step 3. Reboot the computer from the bootable disk.

The system is at the A:\> prompt after rebooting.

Step 4. Go to the C: drive by typing

C:

The prompt changes to C:\>.

Step 5. Type

Prompt PG

Step 6. Go to the DOS directory by typing

CD\DOS

The prompt changes to C:\DOS>

Step 7. The MEM command allows you to view memory information on the computer. Type

MEM

Question 1: How many bytes of total conventional memory are available?

Question 2: What size is the largest executable program?

Step 8. The MEM /C command allows you to see a memory summary with details of the different memory classifications such as conventional and UMBs. Type

MEM /C

Question 3: What is the first program to load into conventional memory?

Question 4: How much space (in bytes) does this program occupy?

Question 5: How much conventional memory is available?

Question 6: How much contiguous extended memory is available? (Contiguous memory is not broken up; it is adjacent to other memory locations.)

Step 9. No matter how much contiguous extended memory is available, none is usable without a memory manager, such as the HIMEM.SYS program, shipped with DOS, Windows 3x, and Windows 95. Modify the CONFIG.SYS file and insert the HIMEM.SYS file in the first line. Verify that the correct path statement directs the system to the HIMEM.SYS file.

Question 7: Write your CONFIG.SYS file in the space below:

Step 10. Create an AUTOEXEC.BAT file that contains the following files:

PROMPT PG

PATH=C:\DOS

Step 11. Reboot the computer with the bootable disk inserted in the A: drive.

Step 12. At the prompt, type

MEM /C

Question 8: How much conventional memory does the HIMEM.SYS file take?

Step 13. Modify the CONFIG.SYS file on the boot disk to add the line **DOS=HIGH** after the DEVICE=C:\WINDOWS\HIMEM.SYS statement.

Step 14. Reboot the computer with the bootable disk inserted into the A: drive.

Step 15. At the prompt, type

MEM

Question 9: How many bytes of free conventional memory are available?

Step 16. Modify the CONFIG.SYS file on the boot disk to include the **EMM386.EXE** expanded memory manager after the HIMEM.SYS statement.

Step 17. Reboot the computer with the bootable disk inserted in the A: drive.

Question 10: Using the MEM command, how much conventional memory does the EMM386.EXE file require?

Question 11: Using the MEM command, how much extended memory is available for use?

Step 18. Modify the CONFIG.SYS file to add **,UMB** to the DOS=HIGH line so that the line reads: DOS=HIGH,UMB.

Step 19. Reboot the computer with the bootable disk inserted into the A: drive.

Question 12: Using the MEM command, how much UMB space is now available?

Question 13: How much extended memory is now available?

Question 14: Why did the total amount of free extended memory reduce in size by adding ,UMB to the DOS=HIGH statement?

Step 20. Modify the CONFIG.SYS statement on the bootable disk to include the NOEMS switch on the EMM386.EXE line.

Step 21. Reboot the computer with the bootable disk inserted in the A: drive.

Question 15: Using the MEM command, how much Upper Memory Block space is now available (in bytes)?

Question 16: How much extended memory is now available?

Note: Steps 22 through 30 are optional. Check with the instructor to see if these steps are to be completed.

Step 22. Using a device driver supplied by the instructor, load the device driver by modifying the CONFIG.SYS file on the bootable disk.

Question 17: Write the CONFIG.SYS statements now contained on the bootable disk in the space below:

Step 23. Reboot the computer with the bootable disk inserted in the A: drive.

Step 24. Type

MEM /C/P

Question 18: Using the MEM command, how much space in conventional memory does the driver loaded in Step 22 require?

Step 25. Modify the CONFIG.SYS file on the bootable disk to load the driver installed in Step 22 to the Upper Memory Blocks.

Step 26. Reboot the computer with the bootable disk inserted in the A: drive.

Question 19: Did the driver loaded in Step 25 go into the Upper Memory Blocks? How can you tell? If the driver did not load correctly, redo Steps 25 and 26.

Step 27. Obtain a TSR (Terminate and Stay Resident) program from the instructor.

Step 28. Modify the AUTOEXEC.BAT file on the bootable disk to load the TSR into the Upper Memory Blocks using the LOADHIGH (LH) command.

Step 29. Reboot the computer with the bootable disk inserted in the A: drive.

Step 30. Verify that the TSR loaded in Step 27 loads in the UMBs.

Question 20: Did the TSR load high? Explain how you determined if it loaded high.

______ ***Instructor's Initials***

Name ______________________________

USING MICROSOFT'S MEMMAKER (EXPRESS) EXERCISE

Objective: To see how software affects conventional memory and how to load software into the Upper Memory Blocks

Parts: A computer with MS-DOS 6x loaded

Question 1: Using the MEM command, determine the amount of free conventional memory. Type **MEM** from the command prompt. For DOS skills, refer to Appendix A. Write the amount of free conventional memory in the space below:

Step 1. From the C:\> command prompt, type
MEMMAKER
For DOS skills, refer to Appendix A. The screen displays a choice of Express or Custom SETUP.

Step 2. Express SETUP is the default option. Press **Enter** to accept the default. A screen appears asking you to specify if any programs require expanded memory.

Step 3. Because most applications today do *not* require expanded memory, the default option of **No** is the most common answer. Press **Enter** to accept the default.

Optional Step 4. If MemMaker cannot find your Windows 3x, MemMaker might prompt for the location of these files. If so, type in the directory where Windows 3x is located. Contact the instructor if you are unsure.

Step 5. Later, MemMaker displays a screen stating the computer must be restarted. As the screen instructs, press **Enter** to restart the computer. After restarting, MemMaker determines the optimum memory configuration. MemMaker determines the order for loading the device drivers and TSRs into the Upper Memory Blocks to free up the most conventional memory. This process may take a few moments depending on the complexity of the AUTOEXEC.BAT and CONFIG.SYS files.

Step 6. After determining the optimum configuration, MemMaker changes the CONFIG.SYS and AUTOEXEC.BAT files. If the computer does not respond after a long period of time, press **Ctrl+Alt+Del** to restart MemMaker, then choose the "Try again with conservative settings" option. Follow the directions on the screen. If the computer performs correctly, it still must be restarted for the changes to take effect. When prompted to do so, press **Enter** to load MemMaker to optimize the CONFIG.SYS and AUTOEXEC.BAT files.

Step 7. Watch carefully for any errors that appear during the restart process. MemMaker displays a question as to whether or not any errors appear. If no error messages appear, press **Enter** to accept the default of YES. If errors appear or you suspect problems, press the spacebar once to change the default to NO, then press **Enter**.

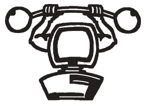
Step 8. If everything boots successfully, MemMaker displays the amount of memory available before and after running MemMaker.

Question 2: How much free conventional memory is now available?

Step 9. Press **Enter** to quit MemMaker.

_____ ***Instructor's Initials***

Optional *Step 10.* Contact the instructor to see if the configuration changes made by MemMaker are to be undone. If so, type **MEMMAKER /UNDO** at the command prompt. Press **Enter** to restore the original AUTOEXEC.BAT and CONFIG.SYS files.



Name ______________________________

CONFIGURING WINDOWS 3X FOR 32-BIT DISK ACCESS AND VIRTUAL MEMORY

Objective: To correctly configure Windows 3x 32-bit disk access and set the virtual memory type

Parts: A computer with Windows 3x loaded in the 386 Enhanced mode

Step 1. Power on the computer.

Step 2. Run a disk compacting utility such as DEFRAG.

Step 3. Start Microsoft Windows 3x.

Step 4. Open the **Main** window.

Step 5. Open the **Control Panel** window.

Step 6. Double-click on the **386 Enhanced** icon.

Step 7. Click in the **Virtual memory** box.

Step 8. Click once in the **Change** box.

Step 9. At the bottom of the window is a checkbox for 32-bit disk access *if* Windows determines the hard disk controller is WD1003-compatible. If the 32-bit disk access checkbox is available, click once inside the checkbox. If the checkbox is not available, skip to Step 12.

Step 10. Save the settings by clicking in the **OK** box.

Step 11. A prompt appears stating Windows must be restarted for the changes to take effect. Click in the box that says **Restart Windows**.

Question 1: What is an advantage of using 32-bit disk access?

Step 12. After Windows restarts, open the **Main** window.

Step 13. Open the **Control Panel** window.

Step 14. Double-click on the **386 Enhanced** icon.

Step 15. Click in the **Virtual memory** box.

Step 16. Click once in the **Change** box.

Step 17. Click in the **Type** box **down arrow** (which either says permanent or temporary).

Step 18. Ignore the Recommended size and set the Permanent Swap file New Size to the settings given in Memory Exercise Table #1 according to the amount of RAM installed on the motherboard.

MEMORY EXERCISE – TABLE #1

Server-Based Network

Installed RAM	Permanent Swap File Setting
8MB	1024K
16MB	2048K
32MB	4096K

Step 19. Click on **OK**.

Step 20. A dialog box appears asking, "Are you sure you want to make changes to the Virtual-memory settings?" Click in the **Yes** box.

Step 21. A dialog box appears stating, "You need to quit and restart Windows so that the changes you made will take effect. Do not press Ctrl+Alt+Del to restart Windowsæ this will result in loss of information. Restart Windows now?" Click in the **Restart Windows** box.

Step 22. Verify that Windows 95 starts properly after changing the virtual memory settings.

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WINDOWS 3X MODE AND SYSTEM RESOURCES

Objective: To determine Windows 3x operation mode and what percentage of system resources is available

Parts: A computer with Windows 3x loaded

Step 1. Power on the computer and start Microsoft Windows.

Step 2. From the **Program Manager**, click on **Help**.

Step 3. Click on **About Program Manager**.

Question 1: What percentage of system resources is available?

Question 2: In what Windows mode is the machine running?

Question 3: How much memory does the machine have available?

Step 4. Click on **OK**.

Step 5. Open up the **Accessories** Program Group window.

Step 6. Open the Microsoft **Write** application.

Step 7. Click in the **Program Manager** window, leaving the Write application running.

Step 8. Click on **Help** within the Program Manager window.

Step 9. Click on **About Program Manager**.

Question 4: What percentage of system resources is now available?

Step 10. Click on **OK**.

Step 11. Return to the Microsoft **Write** application and **Exit** the program.

Question 5: Which memory heap, USER.EXE or GDI.EXE, handles the size of the Microsoft Write application document?

Question 6: Which memory heap, USER.EXE or GDI.EXE, handles the printing of a Microsoft Write document?

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USING MSD FOR ROM ADDRESS CONFLICTS

Objective: To use MSD to view ROM addresses

Parts: A computer with MS-DOS or Windows 3x loaded

Step 1. Power on the computer.

Step 2. Change to the directory where the MSD.EXE program is located. For DOS skills, refer to Appendix A.

Step 3. At the command prompt, execute the Microsoft Diagnostics by typing **MSD**.

Step 4. From the Main Menu, press **M** for Memory.

Step 5. Using the scroll bars on the right side of the screen, examine the memory areas from A000 to FFFF. Look for areas that contain Fs in the blocks of memory. They are the areas of memory that are available. Any new adapter with a ROM chip must have the ROM address set to one of the available areas shown in MSD.

Question 1: List at least two memory address ranges available for use by a new adapter.

Question 2: If a new adapter does not have an option available for one of the ROM addresses listed in Microsoft Diagnostics, what could you as the technician do?

Step 6. Exit the MSD program by pressing **Alt**, then **F**, then **X**.

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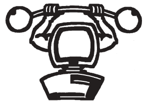

Name ________________________________

INSTALLING AND RUNNING WINDOWS 95 SYSTEM MONITOR

Objective: To install and properly use System Monitor

Parts: A computer with Windows 95 loaded, or a Windows 95 CD or installation disk

Step 1. Power on the computer and start Microsoft Windows 95.

Step 2. Click on the **Start** button. For Windows 95 skills, refer to Appendix B.

Step 3. Click on the **Settings** button.

Step 4. Double-click on the **Control Panel** option to open the Control Panel window.

Step 5. Double-click on the **Add/Remove Programs** icon.

Step 6. Click on the **Windows SETUP** tab.

Step 7. In the **Components** list, be sure **Accessories** is enabled or checked. If Accessories is not checked, click on it to enable it.

Step 8. Click on **Accessories**.

Step 9. Click on **Details**.

Step 10. In the **Components** list, verify **System Monitor** is enabled or checked. If System Monitor is not checked, click on it to enable it.

Step 11. Click **OK**. The screen returns to the Windows SETUP window.

Step 12. Click **OK**. A prompt may appear asking you to insert the Windows 95 CD-ROM disk or a Windows 95 installation disk.

Step 13. Click **OK** after inserting the proper CD or disk into the appropriate drive.

Step 14. Close the Control Panel window.

Step 15. Click the **Start** button.

Step 16. Click on the **Run** option.

Step 17. Type **SYSMON** and press **Enter**.

To Use the System Monitor Utility to Track Performance Problems:

Step 1. Click the **Edit** menu.

Step 2. Click on **Add Item**.

Step 3. In the **Item List**, click on the resource(s), such as Kernel or Memory Manager, to be monitored. To select more than one resource, press and hold **Ctrl** while clicking on the resource.

Step 4. Click **OK**. The System Monitor window appears with the various options checked in *Step 4.* Open and close various applications to see the effects on memory usage.

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To be more consistent, this could be a second Objective: and use that style, e.g.:
Objective: To Use the System Monitor Utility to Track Performance Problems:

Name ______________________________

ADJUSTING MEMORY FOR A MS-DOS APPLICATION RUNNING IN THE WINDOWS 9X MS-DOS MODE

Objective: To adjust the memory configuration for a DOS application in the Windows 9X MS-DOS mode

Parts: A computer with Windows 9X loaded
DOS application

Step 1. Power on the computer and start Microsoft Windows 9x.

Step 2. Double-click on the **My Computer** icon.

Step 3. *Right*-click on the drive icon that contains the DOS application.

Step 4. Click once on the **Explore** option.

Step 5. Find the appropriate DOS application .EXE or .COM file which starts the application.

Step 6. *Right*-click the DOS application's **.EXE** file.

Step 7. Click on the **Properties** option.

Step 8. Click on the **Memory** tab. If the DOS application is configured in the Advanced settings for MS-DOS mode, not the Suggest MS-DOS Mode as Necessary option, memory cannot be configured for the application.

Step 9. Adjust the conventional, extended, or MS-DOS Protected Mode (DPMI) memory as needed. MS-DOS Protected Mode memory is automatically provided by Windows 95 as expanded memory if the EMM386 statement is included in the CONFIG.SYS file. Do not use the NOEMS switch if you want to use MS-DOS Protected Mode memory.

Question 1: Because DPMI (DOS Protected Mode) memory access is provided by the EMM386 statement, where on the memory map is DPMI memory located?

Step 10. Click **OK** when all properties are set.

Step 11. Close the Exploring window.

Step 12. Close the My Computer window.

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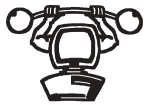

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USING WINDOWS 9X'S DEVICE MANAGER FOR VIEWING VARIOUS MEMORY AREAS

Objective: To use Device Manager to help avoid memory conflicts

Parts: A computer with Windows 9x loaded

Step 1. Power on the computer and start Microsoft Windows 9X.

Step 2. *Right*-click on the **My Computer** icon. A sub-menu appears.

Step 3. Click on the **Properties** menu option. The System Properties window appears.

Step 4. Click on the **Device Manager** tab.

Step 5. Verify that the Computer option is highlighted. If not, click once on the Computer option.

Step 6. Click on the **Properties** button. The Computer Properties window appears. Currently listed are the system's interrupts or IRQ in use.

Step 7. Click on the **Memory** radio button. The system's ROM addresses used by motherboard ROM chips or ROM chips on various adapters are listed on the screen. Keep in mind that no two ROM chips can share the same memory map space.

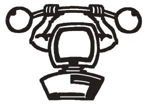
Step 8. Click on the **Performance** tab.

Question 1: What is the amount of RAM installed?

Question 2: What percentage of system resources is available?

Question 3: What, if any, recommendations can you make for this machine in regard to memory management?

Step 9. Click on the close box in the upper right corner.



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USING WINDOWS 98'S SYSTEM INFORMATION TOOL

Objective: To use Microsoft's System Information to see how memory is being used by the system

Parts: A computer with Windows 98 loaded

Step 1. Power on the computer and start Microsoft Windows 98.

Step 2. Click on the **Start** button.

Step 3. Select the **Programs** option.

Step 4. Select the **Accessories** option.

Step 5. Select the **System Tools** option.

Step 6. Click on the **System Information** option.

Step 7. Three components are listed in the left window: Hardware Resources, Components, and Software Environment. Notice how the words "System Information" are highlighted in the left window and general information is available in the right window. If this is not shown, click on **System Information** in the left window.

Question 1: What percentage of system resources is available for other programs to use?

Step 8. Click on the **Start** button.

Step 9. Select the **Programs** option.

Step 10. Select the **Accessories** option.

Step 11. Click on the **WordPad** option. If WordPad is not available, select any accessory that ships with the system.

Step 12. Click on the **Microsoft System Information** button on the toolbar at the bottom of the screen. The System Information application reappears on the screen.

Step 13. Click on the **View** menu option.

Step 14. Click on the **Refresh** option.

Question 2: What percentage of system resources is available now that WordPad or another application has started?

Step 15. Click on the **plus sign** (+) by Hardware Resources.

Step 16. Click on the **Memory** option available under Hardware Resources in the left panel.

Question 3: List one memory address range and its purpose.

Step 17. Click on the **plus sign** (+) by Software Environment.

Step 18. Click on the **plus sign** (+) by Drivers. Kernel Drivers, MS-DOS Drivers, and User-Mode Drivers appear under the Drivers section.

Step 19. Click on the **Kernel Drivers** option in the left window.

Step 20. Locate the **PAGESWAP** driver in the right window.

Question 4: Using the horizontal scroll bar at the bottom of the window, determine from where the PAGESWAP driver is loaded. Write your answer in the space below.

Step 21. Click on the **MS-DOS Drivers** option in the left window.

Question 5: How many DOS drivers are currently loaded?

Step 22. Click on the **Running Tasks** option in the left window.

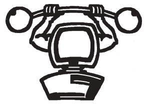
Step 23. Locate the **EXPLORER.EXE** program in the right window.

Question 6: Using the horizontal scroll bar at the bottom of the window, determine from which directory the EXPLORER.EXE program loads.

Question 7: How do you think the System Information program could help you solve a memory problem?

Step 24. Close the Microsoft System Information program.

Step 25. Click the WordPad program or whatever program loaded in Step 11.



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VIEWING MEMORY AREAS IN WINDOWS 2000 PROFESSIONAL

Objective: To use the System Information utility to view memory area assignments in Windows 2000 Professional

Parts: Computer with Windows 2000 Professional installed.
At times, it may become necessary to view memory area assignments in order to troubleshoot and/or configure your system

Step 1. Turn the computer on and verify that Windows 2000 Professional loads.

Step 2. Logon to Windows 2000 Professional using the userid and password provided by the instructor or lab assistant.

Step 3. From the **Start** menu, choose **Programs, Accessories, System Tools,** and then select **System Information**. The System Information utility opens.

Question 1: What system information is available through the System Information utility?

Step 4. Expand the **Hardware Resources** folder, and then expand **Memory**. The System's memory assignment information will be displayed.

Question 2: Which memory area is assigned to your video adapter?

Step 5. Close the **System Information utility**.

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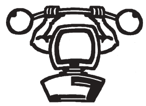

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MEMORY TROUBLESHOOTING EXERCISE

Objective: To correctly identify and solve a memory problem

Parts: A computer with a memory problem

Step 1. Power on a computer that has a memory problem inserted.

Question 1: What is the first indication that there is a memory problem?

Question 2: List all troubleshooting steps taken to solve this problem.

Question 3: Were there any CONFIG.SYS or AUTOEXEC.BAT errors? If so, list the errors in the space below in the order the errors occurred:

Question 4: Describe the solution to the problem.

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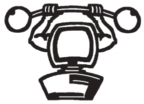

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INTERNET DISCOVERY

Objective: To become familiar with researching memory chips using the Internet

Parts: A computer with Internet access

Step 1. Power on the computer and start the Internet browser.

Step 2. Using any search engine, locate three different vendors that sell memory chips.

Step 3. Fill in the table below based on your findings at each of the memory sites.

Internet Site	Smallest Capacity 72-pin SIMM	Largest Capacity DIMM	Pros of Web site	Cons of Web site

Question 1: Of the three Internet sites you found, which one was your favorite and why?

NOTES