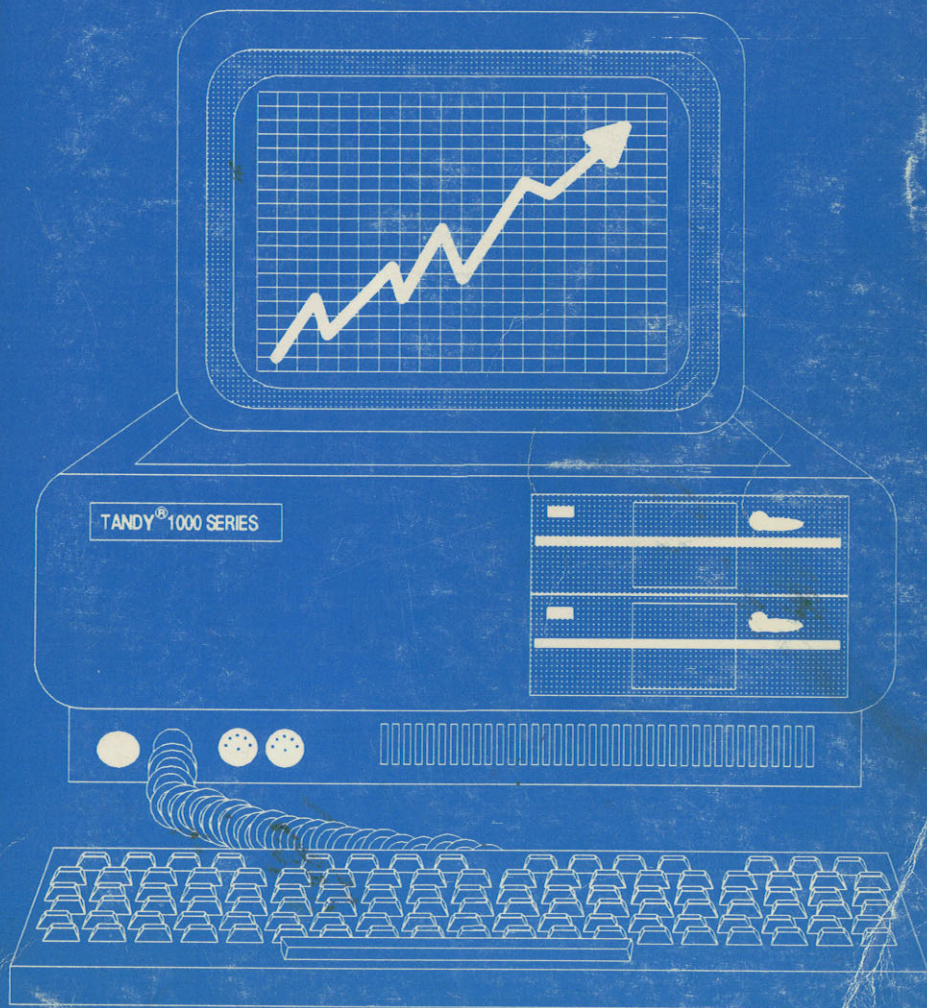


Upgrading Your TANDY®

For Users of the 1000, A, EX, HX, SX, TX, SL, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX



A DCS Publication

Upgrading Your Tandy

A source for users seeking to increase the abilities of their 1000 series Tandy Computer.

Published by DCS Industries

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Preface

The original Tandy 1000 computer was introduced in 1984, shortly after the IBM PC. It and following models of the 1000 series have established their maker as a major player in the personal computer marketplace. These machines, along with lines of more powerful 80286, 80386, and 80486 machines as well as notebook models are sold through Tandy's thousands of corporate owned and franchised dealers in the U.S. and abroad. Tandy also manufactures and sells computers through its Grid subsidiary and has engaged in ventures with several other companies including Panasonic. Though often thought of as conservative, Tandy is at times a market innovator. The Tandy 5000 was for example was the first Microchannel compatible for the IBM PS/2 line.

The personal computer market continues to change swiftly, with machines rapidly becoming more powerful and

less expensive, leaving many manufacturers by the wayside. Though the 1000 series machines may not be as high powered as others, many users feel that Tandy's size, stability, and large network of stores for support more than compensate.

Upgrading Your Tandy

Covering the 1000, A, EX, HX, SX, TX, SL, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX

INTRODUCTION

This book tries to provide users of Tandy 1000 series computers who wish to upgrade with a look at what is available for their particular model. Many are happy with their computer but dissatisfied with what they consider to be the relatively small selection and high prices of upgrades from Tandy Corporation. Advanced Transducer Devices (ATD), which marketed a number of very successful upgrades under its Zuckerboard line, advertised that "Tandy Is Dandy Until You Want More."

Uncertainty often exists as to how the Tandy 1000 series machines differ from the IBM PC/XT, and AT, as well as other brands of compatibles, and how this effects their potential for upgrades. An attempt will be made to give the user a clearer picture of these differences and how upgrades which take them into account can be made. They may find that their machine is more compatible than they thought and that it can be enhanced using products not offered by Tandy Corporation itself.

The chapters are based around components such as DRAM, hard drives, graphics, and clock/calendars. A general discussion of the component is first, followed by specifics on usage in each model of the 1000 series.

A short chapter is included which attempts to summarize the compatibility of the 1000 series and another on the tools that may be needed to work on the computers and how to open them. Chapter consists of diagrams of the motherboards, showing important components and locations for upgrades.

This book is not intended as a "hard-core" technical manual. Chapter 20 lists sources of more information on these Tandy computers. Users wishing for more technical information might also consider writing to the manufacturer of the product which they wish to know more about. If you are unsure, write or call DCS and we will do our best to provide you with a phone number or address of the company which you need information from.

The 1000 series has over a dozen models at this point, and any book about it is bound to leave something out. A user who has an upgrade or tip which they think should be included, can write out a description and send it to us. We'll send them a check for \$25.00 if we decide to use it in the book. It is our intention to revise this book as new information on upgrades becomes available .

All potential upgrades presented in this book should be carefully studied before being attempted. Always check with a Tandy dealer to see how installing components not purchased from Tandy may affect the computer's warranty. If uncertain about the particular upgrade, consult someone with more experience in that area, or contact DCS.

Remember to always turn off the system while making any upgrade.

It is not the purpose of this book to provide a legal or professional service. DCS and its employees disclaim liability for any loss or damage claimed to have been caused by using the information in this book. DCS is not affiliated with Tandy Corporation, and makes no claims to represent said corporation in any way.

CHAPTER 1

DRAM

General Information

All models of the Tandy 1000 series contain DRAM (Dynamic Random Access Memory) in varying amounts when purchased. It is commonly understood that this DRAM memory is what a computer uses to store information while “thinking” as opposed to longer term storage media such as floppy and hard disks. A DRAM chip is a random access memory chip that represents memory wait states through the use of capacitors that store electrical charges. These wait states are periods in which the central processor unit (CPU) chip does nothing. They are programmed into the CPU chip to allow the DRAM chips to catch up as it is running faster than they are. Since the electrical capacitors in the DRAM chip quickly lose their charge, they must be refreshed continually and thus are referred to as “dynamic”.

The speed of DRAM chips is a measure of the time which is required for the CPU to access the information which is encoded within them. The speeds of DRAM chips are measured in billionths of a second or nanoseconds. For an example, a 256-15 chip has an access time of 150 nanoseconds while a 256-12 has an access time of 120 nanoseconds. Both of these chips are 256 Kilobit (256,000 bits) usually referred to as 256K DRAM. The writing on them will say 41256-15 or 41256-12. The capacity and speed of DRAM chips is imprinted on their top, usually along with the maker's name or logo and a code giving the date of

manufacture.

The DRAM in the first several models of the 1000 are installed in rows of eight, and later models may also have one or more rows of eight of these chips. These 256K chips are also called 256 X 1 (256 by 1) and have 16 address lines or "legs". Each of these chips handles one bit of information at a time. Machines using processors which communicate with the DRAM eight bits at a time such as the 8088-2 in the 1000 SX, thus need eight of these chips in a row to give them 256K of memory. The TX, TL, TL/2, TL/3, and RLX have an Intel 80286 CPU chip which handles information 16 bits at a time, and thus need a minimum of two rows of eight of these chips (a total of 512K) to function. The 1000 RSX has an 80386SX CPU chip which addresses the DRAM 16 bits at a time. This machine uses one or four megabyte SIMMs (Single In Line Memory Modules) which consist of DRAM chips surface mounted on a small circuit board which plugs into a specialized socket on the motherboard. (Figures 1.14 and 1.15)

Beginning on the boards which add extra memory to the EX and HX, and continuing on the motherboards of later 1000 series computers, the ability to use a type of 256K DRAM known as 64 X 4 (64 by 4) was begun. The writing on them says 4464 then a dash and their speed. Each of these chips can handle four bits at a time, so that as few as two can be used in a row in eight bit machines and four to a row in 16 bit machines. The extra address lines make it necessary to have two more legs for a total of 18, so that it is easy to distinguish these chips from 256 X 1's which have 16.

It still takes eight of these 64 X 4 chips to add 256K of DRAM, but 128K can be added with only four of them.

For some of their memory the TL/2, RL, TL/3, RLX, and RSX use 256 X 4 DRAM (256 by 4), a type of one megabyte chip which can handle four bits at a time.

The primary difference in the usage of DRAM in all of the 1000 series but the RSX, and that of the IBM PC as well as other compatibles can easily be seen by comparing the rows of DRAM chips within the two. The Tandy machines have rows of eight chips while other types of personal computer generally have nine in a row. This ninth chip is for what is known as "parity checking." This technique consists of the computer adding up the number of bits in a one-byte data item, and if the parity bit disagrees, with the sum of the other bits, the computer will report an error. A bit is a fundamental yes/no piece of information represented on an electrical level by a high current or low current. A byte is eight contiguous bits, the fundamental data words of personal computers' and is the equivalent of one character (such as the letter "A" for example). The ninth chip in the row is often referred to as the "parity chip". Most of the 1000 series computers by contrast, do not use parity checking and thus do not need the "parity chip".

All of the 1000 series use DMA or Direct Memory Access. DMA circuits allow the transfer of information directly between the DRAM chips and the floppy or hard disk storage without tying up the CPU chip. The 1000, A, EX, and HX do not have a built in DMA chip, though it will be found on the memory boards which can be added to these machines to increase their DRAM above the base amount. This addition will also increase the speed of the machines' processing by decreasing the demands on the CPU chip. An additional bonus of this memory board installation in these

four machines is it's enabling them to use a hard drive which cannot be accessed without the DMA chip. (Some new IDE "Smartdrive" controllers do not need DMA) Starting with the 1000 SX and continuing with the present machines, the DMA chip is on the motherboard so that it need not be added later. Thus a hard drive can be installed and booted without having to add a memory board with the DMA chip.

The 640K DRAM Limitation of DOS

As versions of MS-DOS ranging from 1.0 to 5.0 are only able to use up to 640K of DRAM, many personal computers were designed to accept this amount of DRAM memory. Though some of the 1000 series will hold 768K of DRAM on their motherboards, the extra 128K above 640K is reserved for use by the machines' built in video graphics adaptor. Machines with a VGA card installed do not need this 768K, as VGA cards have their own memory. The 1000 RLX will hold one megabyte on the motherboard and the RSX nine megabytes. Following is a discussion of how more memory can be added to the 1000 series through memory boards or by plugging additional DRAM chips into sockets provided in some of the machines.

Installing DRAM Chips

DRAM chips or SIMMS modules of the correct capacity and speed should be used. Faster versions will take the place of slower ones, but the reverse is not true. As an example, it is okay to use 100NS DRAM in the place of

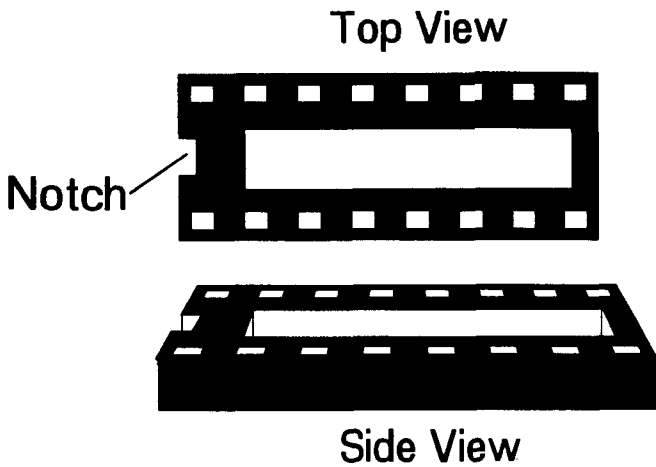


Figure 1.11 DRAM Socket

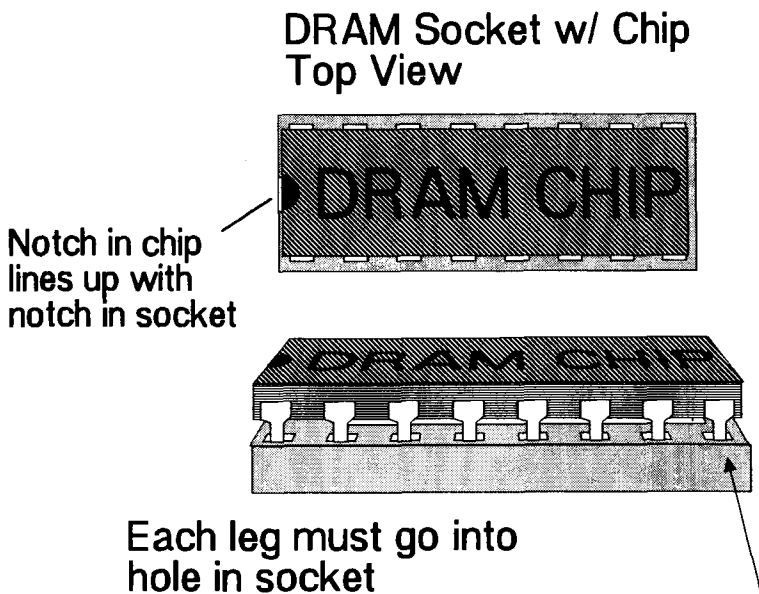


Figure 1.12 Correct DRAM insertion

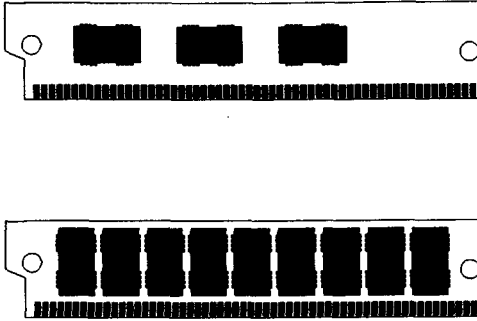


Figure 1.14 Three and nine chip SIMM modules



Figures 1.15 Inserted SIMM module

150NS but not vice versa. Installing faster DRAM in a computer designed for slower ones will not increase the rate at which they are accessed by the CPU, and thus, will not speed up the computer. It is not a good idea to mix chips from various manufacturers in the same row, though using complete rows of different brands is usually not a problem.

The computer should always be turned off when installing DRAM chips. Before starting, ground yourself by touching something metal to dissipate any potentially damaging static charges. Make sure that the notch or indentation at one end of the chip is toward the notched end of the socket which it is going into. Line up all of the legs and press down firmly but gently. Be careful of your fingers as the legs of chips' are quite sharp. Chip insertion tools as well as chip pullers, and leg straighteners are available from Tandy and others. Many users choose to do without an inserter, putting the chips in by hand. When all of the chips are inserted, turn the computer on. If the amount of memory displayed is not changed or an error message or blank screen is shown, you may be experiencing one of the problems discussed in the following section. Figures 1.11 and 1.12 show a socket and a properly inserted DRAM chip.

Potential Problems When Installing DRAM Chips

The most commonly problem with adding DRAM is a chip's leg(s) not going in correctly. In this case, it is necessary to turn off the computer, remove the chip and straighten the leg(s) before making another attempt (needle nose pliers are good for this task). You may want to ask the vendor the chips were purchased from to include a chip

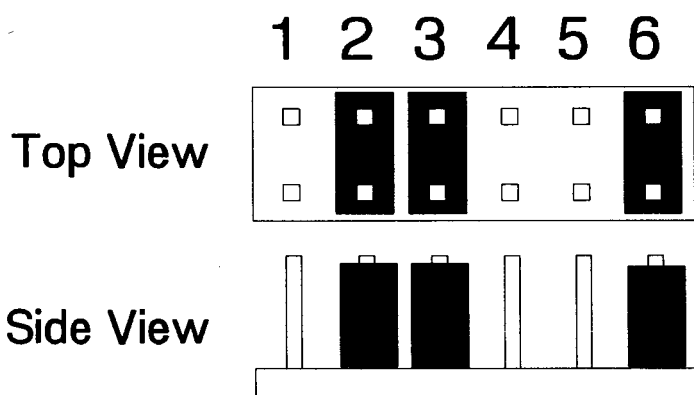


Figure 1.21 Sample of jumper or shorting blocks

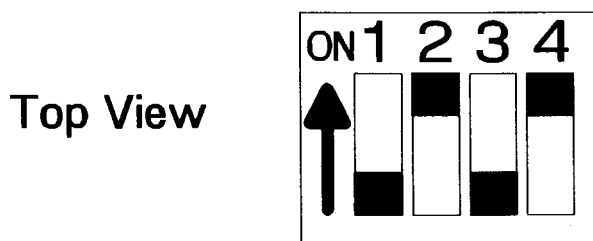


Figure 1.22 Sample of dip switches

puller. Working a flat blade screwdriver alternately under each end of the chip will also usually work if no chip puller is available. When the chip(s) are reinserted correctly, turn the machine on again and check if the desired amount of memory is now displayed. If there is no change, check the legs of the chip(s) again very carefully. A leg can curl under so it appears to be inserted but actually isn't. Also, be careful that one or more of the chips is not in backwards. The writing on all of the chips should be facing the same way.

There may also be jumpers or dip switches on the motherboard and/or memory board which need to be set for the extra memory to be acknowledged. These should be discussed in the computer or memory board manuals. Figure 1.21 illustrates jumpers (or shorting blocks), and 1.22 dip switches. The failure rate of DRAM chips is very low, but if all other possibilities are eliminated, contact the vendor to see about returning the chips for testing and possible replacement.

1000 and 1000 A

These machines came with a base memory of 128K installed on the system board in the form of two rows of eight 64K 150NS DRAM chips. When installing extra memory in these systems, it is not necessary to change any jumpers or switches on the motherboards, though the additional memory board may have these that need to be set.

Tandy itself seems to have made four different memory upgrade boards for these systems. The first has four rows of eight chip sockets which can hold 64K 150NS DRAM chips, for a total of 256K on the expansion board. Filled with chips

and added to the 128K base memory on the motherboard, it will give the user a total of 384K of DRAM memory. This board has a DMA (Direct Memory Access) chip as well as a Tandy "Plus Style" 62 pin connector to which can be attached a special Tandy internal 1200 baud modem or a Tandy Plus serial port attachment. The second memory board by Tandy for these machines has two rows of eight chip sockets which will take either 64K 150NS DRAM or 256K 150NS DRAM chips. Filling the board with 64K chips will add 128K to the system bringing it to 256K and using the 256K chips will add 512K bringing it to 640K. Two jumper blocks near the bottom edge can be removed to set the board for the type of DRAM chips and one or two rows installed. Removing the E3-E4 jumper will set it for 256K chips and removing the E1-E2 will set it for two rows of chips instead of one. This board also has the DMA circuit enabling a hard drive to be used, and a Plus option connector for a special modem or serial card.

Another board from Tandy is like the previous one but can only accept two rows of 64K DRAM chips, not having the option of being switched to 256K chips. When fully populated, this board adds 128K giving the user a total of 256K of memory. This board also has the DMA chip.

A fourth board has four rows of 64K 150NS DRAM for up to 256K on the board, but no DMA circuit. This board was intended for machines which have been brought to 384K using the first board. Fully populated, and inserted in a second expansion slot, it will bring the system to a total of 640K DRAM. This may not be very practical as each board will use an expansion slot in these machines which only have a total of three slots.

To the best of our knowledge, Tandy no longer produces any of these boards, though some stores may still have them in stock.

A number of other companies have also made memory expansion boards for the Tandy 1000 and 1000 A. The most popular of these were the Zuckerboards. Manufactured by Advanced Transducer Devices (ATD) of Sunnyvale California, they were sold in copper colored boxes emblazoned with the chagrined face of the company's founder Mathew Zuckerman who billed himself as Doctor Doctor Zucker.

Two models of this board were produced. The first is simply a memory card with room for two rows of 256K chips, so that the machines' memory can be brought to 384K or 640K with one or two rows of DRAM chips installed on the board. A jumper on the board is set depending on the amount of DRAM installed. This board contains a DMA circuit and also has a socket for the optional clock/calendar chip manufactured by ATD.

The second, Zuckerboard produced by ATD for these two machines was the Zuckerboard multifunction card. This card has two rows for 256K chips, a 20 year clock/calendar/battery chip, and a 25 pin serial port. The board came with the software necessary to access the clock/calendar as well as RAM disk and print spooler software. With these, part of the DRAM can be used as a disk drive, and programs can be run while material is being printed out. This board also has a DMA chip. The combination of memory, clock/calendar, and serial port on one board made this an enormously popular product.

ATD was acquired by Televideo corporation in 1987. The company produced a number of other products for the

Tandy and general PC markets, but none had the success of it's memory boards for the 1000 and 1000 A. ATD has currently ceased all production of boards for 1000's, and apparently no longer services these products, despite the five year warranty given on them.

Some users are finding that the clock/calendar chip on their Zuckerboard is not lasting the 20 years it was intended to, and need a replacement. The Tandy SmartWatch or other chip clock intended to go under an EEPROM chip (see the chapter on clock/calendars) works in the socket vacated by pulling the bad clock chip out of the Zuckerboard. A user who makes this switch should replace the Zuckerboard clock software with that which comes with the new clock chip.

Other companies that produced basic memory boards and multifunction cards for the 1000 and 1000 A included Hard Drive Specialists, PBJ, Southwestern Digital, and Micromainframe. Some of these boards even have memory to bring the machine from 128K to 640K and the capacity for several megabytes of EMS (discussed later) memory on the same board. All of these companies are apparently out of business, with the exception of Micromainframe. This company produces the 5150T EMS board which provides above 640K memory for many of the machines of the 1000 series, though it no longer sells a board to bring the 1000 and 1000 A to 640K. To the best of our knowledge, the only boards currently available to raise these machines to 640K are the multifunction boards produced in the Far East and sold by DCS.

1000 EX and 1000 HX

These machines both come with 256K of DRAM in the form of eight 256K chips in the well hidden sockets on their motherboards. Boards to add memory to these systems have been made by several companies, including Tandy, DCS, Zuckerboard by ATD, and Micromainframe. Of these, DCS continues to manufacture memory boards for the EX and HX some of which are sold to Tandy corporation for resale.

Some of these boards have sockets for four 64 X 4's and eight 256K 150NS DRAM chips. Filling only the group of four sockets and setting the jumpers on the board will give the machine another 128K for a total of 384K of DRAM. Filling the bank of eight sockets also and changing the jumper will bring the system to its maximum 640K of DRAM. The settings on the Tandy board are E1-E2 for 384K and E2-E3 for 640K of system memory. The DCS board uses four 256 X 4 DRAM instead of the rows of eight 256K X 1 and four 64K X 4 DRAM of the other boards. The XTRA-K card by PC Enterprises uses memory like this as well. It also has two sockets which may be filled with one or four megabyte SIMMS modules to provide up to eight megabytes of Expanded memory (discussed later in the chapter.) DCS is also beginning production of a board with this feature.

These memory boards are installed by sliding open the cover on the left hand side of the machines' top, exposing a compartment with a Plus Style slot at it's bottom. The screws securing the back panel of this compartment should then be removed along with the panel. Align the female connector on the bottom of the memory board with the Plus connector and gently press the memory board into place.

When the board is firmly seated, secure the metal bracket attached to the memory board to the back of the machine with the screws which are provided.

The Tandy and DCS boards for the EX and HX both have two of the 62 pin Plus expansion slots on top of them, while the Zuckerboard has only one. Tandy made internal 1200 baud modem and serial cards for this type of slot as well as a mouse interface board and mouse. DCS sells single and dual RS232 (serial) boards which provide one or two serial ports which mice or external modems may be connected to. A number of companies assemble hard drive systems whose controllers use one of the Plus slots. The single slot on the Zuckerboard is notorious for being difficult to plug options into as the plastic rim around the connector is too high. Several companies still manufacture and/or sell memory expansion boards for the 1000 EX and HX based on this design, usually at very low prices. A user wishing to upgrade their machine further, may wish to be careful of these boards because of their limited expansion capability.

1000 SX

The 1000 SX was a major step for Tandy in that it was the first machine of the 1000 series to have the capacity for 640K of DRAM memory on the motherboard with no need for expansion boards. The machine came with one bank of eight 256K 150NS and one bank of four 64 X 4 150NS DRAM chips installed giving a total of 384K of memory. A bank of eight empty chip sockets is located on the motherboard under the edge of the floppy drive bays where 256K 150NS chips can be inserted, bringing the system to 640K.

ATD produced a Zuckerboard multifunction board for the SX with 256K of memory, clock, and serial port, but this board was regarded by many as unnecessary because of the memory sockets provided on the motherboard, and did not sell well.

1000 TX

The Tandy 1000 TX came with 640K of memory installed on the motherboard in the form of two rows of eight 256K DRAM and one row of four 64 X 4 DRAM. Some machines have 150NS, 120NS, and even 100NS speed DRAM chips installed. 120NS DRAM chips would seem to be the best speed to run in this system with the faster 100NS being fine but costing more. 150NS DRAM chips may prove to be too slow for this computer.

Another 128K of memory can be added by inserting four more 64 X 4 DRAM chips in the sockets provided for them near the expansion slots in the back of the machine. These four chips will bring the total system memory to 768K. This memory above 640K is for use by the built in video graphics controller and cannot be used by DOS or programs. Installing these extra four chips will however, make available some of the below 640K memory that was being used by the video controller. This is not necessary in machines with a VGA card installed as these boards have their own DRAM.

1000 SL

This machine came with 384K installed on the motherboard in the form of one row of eight 64 X 4 chips, and

another row of four 64 X 4 chips of 120NS speed. There are eight empty sockets which can also be filled with 64 X 4 chips to give a total of 640K on the motherboard. Chips of 120NS or 100NS speed will work the best.

1000 TL

This machine was sold with 640K installed. There are three rows of eight chips on the motherboard, two of standard 256K 100NS or 120NS DRAM. The third row has four 64 X 4 chips installed and four empty sockets which can also be filled with 64 X 4 100NS or 120NS DRAM chips. Installing these four 64 X 4 chips will raise the machine to 768K. As with the other models of 1000 with this feature, the 128K memory above 640K can only be accessed by the machine's built in video graphics, and are not necessary in machines with VGA installed.

1000 SL/2

This machine came from Tandy with 384K installed. The memory is installed in the form of 64 X 4 120NS DRAM chips. There is one row of eight of these chips toward the back of the machine near the power supply, with a row of eight empty sockets next to it. Four more of these DRAM chips are in the front of the machine near the speaker. The empty row of eight sockets may be filled with 64 X 4 120NS DRAM chips to give the machine 640K of memory.

1000 TL/2

The TL/2 uses an interesting combination to achieve the 640K of memory which is standard when purchased. 512K of the memory is in the form of four 256 X 4 chips mounted in sockets on the motherboard in front of the expansion slots. Another 128K is achieved through four 64 X 4 DRAM chips "surface mounted" into the motherboard under the right 3.5" floppy bay itself rather than socketed. Four empty sockets next to the 256 X 4 chips may be filled with 64 X 4 120NS or 100 NS DRAM chips to give the machine another 128K above 640K for a total of 768K. As in the TX and TL, this extra memory cannot be used by DOS or programs, being reserved for use by the machine's built in video graphics. If a VGA card is being used, these chips are not necessary as VGA boards have their own DRAM installed.

1000 RL

This machine follows the lead of the TL/2 in that the 512K of DRAM which it comes with is surface mounted into the motherboard itself. There are four 64 X 4's behind the right floppy drive bay. Another four 64 X 4's and two 256 X 4's are surface mounted behind the left bay. Next to the 256 X 4's are sockets for two more 256 X 4's of 120NS speed or lower which will bring the machine to 768K of DRAM. The 128K above 640K is reserved for use by the machine's built in video graphics.

1000 TL/3

This computer comes with 640K installed. Four 256 X 4's are surface mounted behind the left hand 3.5" drive bay and four 64 X 4's under the power supply. There are also four empty sockets behind the drive bay which can be filled with 100NS 64 X 4 DRAM to add 128K which can be used by the built in graphics though not DOS or programs. If VGA is being used, these chips are not needed as VGA boards have their own memory.

1000 RLX

This machine comes with 512K or 1024K (one megabyte) of DRAM installed when purchased. The version purchased with a hard drive installed by Tandy has the larger amount of memory. The base 512K in both configurations is in the form of four 256K X 4 100NS chips surface mounted onto the motherboard. The hard drive version has four more 256K X 4 100NS Zig Zag In Line Package or "ZIP" DRAM chips mounted into sockets provided for them. These space saving chips which have two staggered rows of conducting legs along one edge are also used in engineering graphics boards and laser printer memory boards. Four of them may be added to the 512K model of the RLX purchased without a hard drive to bring it's DRAM to one megabyte. The sockets for the four ZIP DRAM chips are provided behind the built in hard drive connector, to the right of the battery for the built in clock/calendar. It is easy to put these chips in as the staggering of the chip's legs and the connectors in the sockets make it difficult to insert them incorrectly.

There are several ways in which the 384K of memory above 640K in RLX machines which have one megabyte of DRAM can be used. DOS 5.0 can make use of these "upper blocks." Programs such as Quarterdeck's QRAM can also use this memory. Though the RLX has built in VGA graphics, they do not use any of this memory.

10000 RSX

This machine comes with one megabyte (1024K) of DRAM installed in the form of four 256 X 4 DRAM chips surface mounted onto its motherboard. Two sockets are also provided which SIMMS may be inserted into. These Single In line Memory Modules are DRAM chips surface mounted to a small circuit board with a standardized card edge connector which is inserted into the SIMM socket. Diagrams 1.14 and 1.15. They are now used in most personal computers and memory boards because of their space saving advantages over DRAM chips. SIMM sockets are provided on the RSX mother board and may be filled with one megabyte or four megabyte SIMMS. These sockets give the machine a total of three or nine megabytes of DRAM as the same type of SIMMS must be used in both of the sockets. The 80386SX CPU chip of the RSX addresses memory 16 bits at a time so both sockets must be filled with a SIMM strip representing eight bits.

Expanding The 1000 Series Above 640K of DRAM

The previous section discussed how to bring the 1000 series computers to a total of 640K of DRAM. Five of them,

the TX, TL, TL/2 , RL, and TL/3, can even go to 768K of DRAM on the motherboard, though the 128K above 640K is used by the video graphics controller and not directly accessible. The RLX can be expanded to 1024K on the motherboard with the extra 384K "upper blocks" of memory being available to DOS 5.0 and special software such as Quarterdeck's QRAM. The 1000 RSX can be expanded up nine megabytes on the motherboard the memory above 640K available as extended or expanded. Many users of the 1000 series machines as well as other compatibles and IBM personal computers with limited DRAM capacity on their motherboards, have found that 640K of DRAM is not enough for their spreadsheets, databases, Cad-Cam, and desktop publishing programs which use large amounts of memory.

In response to this need, the LIMM EMS (Lotus, Intel, Microsoft Memory, Expanded Memory Specification) was devised to enable machines running DOS to use more than 640K of DRAM. LIMM EMS, often simply called "EMS" is software that functions through a programming trick. A 64K "peephole" is created in the 640K of memory which the machine's processor is normally able to address while running DOS. As the program needs extra memory, blocks of 16K are shifted in and out of this "peephole" from the memory provided either in additional sockets on the motherboard or on an EMS memory board as in the case with the 1000 series. Some EMS software packages can even use a hard drive for expanded memory, albeit at a slower speed.

Since multiple blocks can be alternately shifted down into the 64K "peephole" as they are needed, personal computers can address large amounts of EMS memory.

LIMM EMS is software and must be installed each

time the DOS is loaded by the user who wishes to run programs which require EMS. The command to load the EMS software may be copied into the Config.sys file of the DOS so that it is loaded automatically with the DOS.

It should be noted that not all software packages can use EMS. Also, LIMM EMS has different versions including 3.2 and 4.0 just as other software packages do. It is a good idea to review a program's documentation or contact the manufacturer to see if the program supports LIMM EMS and if so, what version.

A number of expanded memory boards have been manufactured, most of them for computers with 16 bit slots which of the 1000 series, only the RSX has. Though boards for eight bit slots are available, most of them are too long for the 10" case of the 1000 series machines'. There are four eight bit expanded memory boards which will fit the cases of these Tandy computers which we are aware of. The first of these, is the Micromainframe 5150T which has been available for some time through a number of sources including DCS and Tandy.

The 5150T is packaged with LIMM EMS 3.2 software with an upgrade to 4.0 available, usually at an additional charge. This board uses an eight bit data bus so it can be plugged into the expansion slots on any of the 1000 series with the exception of the Plus Style slots on the EX and HX. It will also work in the IBM PC/XT and compatibles though EMS boards designed for them will not work in the 1000 series. Figure 1.30

The 5150T board has eight banks for 256K DRAM, each bank consisting of eight chip sockets. Each of these banks will add 256K of memory to the board when filled.

A 'bank' consists of eight 256K DRAM, and adds 256K of RAM. Filling all eight banks gives 2 Meg (2048K).

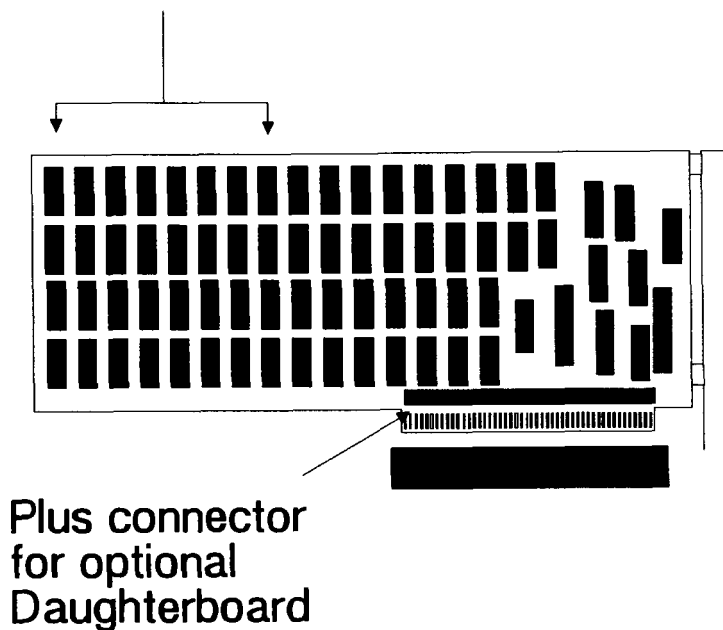


Figure 1.30 Micromainframe Board in Slot

Filling all banks requires 64 chips to give a total of 2048K or "two megabytes" of memory on the board. The banks are numbered 0 through seven, and are filled in ascending order. This board uses all 256K chips on it as 150NS chips even if the board is in a machine which has faster chips on the motherboard. Faster chips such as 120NS or 100NS will function on the board but are not necessary and usually more expensive than 150NS DRAM chips.

On the same side of the 5150T board as the DRAM chip sockets, there is a Plus Style 62 pin connector. The Micromainframe 5150T daughterboard can be attached to this connector. This daughterboard will hold up to two megabytes of DRAM memory in the same fashion as the 5150T. Thus, up to four megabytes of LMM EMS can be added by using these two boards in a single expansion slot. The Micromainframe LMM EMS software actually allows up to eight megabytes of EMS so that two fully populated "clusters", could be installed in a computer should the user have a need for this large of an amount of EMS memory. Most however, find that the single board is sufficient for their needs, populated with one megabyte (four rows) or two megabytes (eight rows) of 256K DRAM chips.

The 5150T works in all of the 1000 series except for the EX and HX as it cannot attach to their Plus style expansion slots and they have no internal room for the board. However, memory boards holding up to eight megabyte of DRAM are available from DCS and PC Enterprises for these machines, and a Micromainframe 5150T functions with these two machines in a Slot Box (discussed in chapter 16) attached to them. Following is a list of the 1000 series computers and their compatibility with the Micromainframe

5150T memory board.

Computer	EMS Board Compatible?	Notes
1000	Yes	Only three expansion slots
1000 A	Yes	Only three expansion slots
1000 EX	No*	EX and HX have the wrong type of expansion slots and are too small
1000 HX	No*	
1000 SX	Yes	
1000 TX	Yes	150NS DRAM okay on 5150T
1000 SL	Yes	
1000 TL	Yes	150NS DRAM okay on 5150T
1000 SL/2	Yes	
1000 TL/2	Yes	150NS DRAM okay on 5150T
1000 RL and RLX	Yes	Will use the only expansion slot
1000 TL/3	Yes	150NS DRAM okay on 5150T
1000 RSX	Not Needed	Has memory Capacity on board.

*These machines can use the 5150T inserted into a Slot Box attached to them (discussed in chapter 16.)

The Acculogic RAMPAT Plus memory board will also function in the 1000 SL, TL, SL/2, TL/2, RL, RLX, and RSX, but not with the other machines for as a yet undetermined reason. This board offers the advantage of using one or four megabyte SIMM modules (discussed earlier) instead of the

DRAM chips of the 5150T. The board has four SIMM sockets which can be used to fill the board with two, eight, 10, or 16 megabytes of DRAM. Each set of two of the SIMM sockets is called a "bank". SIMM sizes cannot be mixed within a bank, though complete banks of different capacities may be used. The RAMPAT Plus has a sixteen bit connector which can be used in eight or sixteen bit expansion slots like VGA cards which function the same way (see the diagram on page 101.) The Acculogic board comes with LIMM EMS 4.0 software and offers an advantage over the 5150T in that it also supports LIMM 4.0 in the design of the board itself (hardware support) and is thus compatible with a wider range of software. The XTRA-K Card by PC Enterprises is similar to the Acculogic board in its use of four SIMM sockets as well as software and hardware support for LIMM EMS 4.0. Unlike the RAMPAT Plus, the EXTRA-K board has an eight bit only connector for eight bit slots, though it will most likely also function in sixteen bit slots, though only in an eight bit mode. This board is advertised as holding up to 64 Megabyte of DRAM (By using 16 Megabyte SIMMS) and is being tested by DCS.

The Invisible Software Expanded Memory board is also manufactured for the 1000 series. This board is still being tested by DCS. As previously mentioned, most eight bit LIM EMS boards are too long for the case of the Tandy 1000 series computers. DCS has been testing other brands of eight bit boards such as DFI in the Slot Box expansion chassis attached to the 1000 series, as this chassis will accommodate the longer boards possibly providing low cost expanded memory to 1000 series users. In testing, these boards function in the Slot Box with 256K or 512K installed but

begin to fail when more memory is installed. This seems to be due to the increased amount of RF (Radio Frequency) coming from the added chips. DCS is still seeking to solve this problem to enable brands of EMS boards other than the four made for the 1000 series to be used in the SLOT BOX attached to the 1000 series machines.

Extended Memory

A user may find that the program that they wish to use such as Lotus release 3.0 requires not expanded but extended memory. Extended memory is a feature of the 80286 and 80386 processor chips which take advantage of their "protected mode" as opposed to the "real mode" used by DOS. The real mode of the 80286 emulates the 8088 and 8086 in that it can address up to one megabyte of memory, which DOS uses 640K of. In their protected modes, the 80286 and 80386SX CPUs can address up to 15 additional megabytes of memory and the 80386 up to four gigabytes (four billion bytes). Also, multiple programs can be run at the same time, without interfering with each other. This is possible as unlike the real mode, programs are not assigned a definite memory location and are not allowed direct access to peripheral devices. IBM's OS/2 is intended to take advantage of extended memory, and programs such as Quarterdeck's QUEMM-386 and Lantana's Turbo EMS already exist. The 1000 TX, TL, TL/2, RLX, and TL/3 all have the 80286 CPU chip which has the protected mode necessary for extended memory. However, since these machines have only eight bit expansion slots, they have only enough address lines for one megabyte of memory. This means that an expanded memory

board such as the Micromainframe or Acculogic will not enable applications such as Windows 3.1 which need extended memory. Windows 3.0 can use this type of memory in its real mode, though this may be of limited usefulness. The 80386SX CPU in the 1000 RSX is able to address extended memory and up to eight megabytes can be added by inserting one or four megabyte SIMMS modules into the sockets on the machine's motherboard. This memory may be used by Windows 3.1 and other applications needing extended memory. The 1000 RLX and RSX are the only models of the 1000 series of computers which can use extended memory, though the RLX is limited to the 384K of extended memory between 640K and one megabyte of DRAM.

CHAPTER 2

FLOPPY DRIVES

General Information

A floppy diskette is a removable storage medium for computers that uses a flexible, magnetically sensitive plastic disk inside of a flexible sleeve or a rigid case. During the formatting procedure, the surface of the floppy disk is organized into circular rings called tracks. These are further broken down into units called sectors into which data is encoded and read from by the read/write heads of the floppy disk drive. Floppy drives use a motor to spin diskettes around a spindle. This gives the read/write heads access to the entire surface of the diskette as the heads themselves can only move in a straight line between the inner and outer rim of the diskette. Originally, only one side of the plastic diskettes was used, hence the term "single sided" disks. Now most floppy drives use both sides and the majority of diskettes are "double sided".

There are four floppy drive and diskette capacities which have become industry standards. The two 5.25" drives are the 360 Kilobyte and 1.2 Megabyte drives commonly called the 360K and 1.2 Meg. The two 3.5" drives are the 720 Kilobyte and 1.44 Megabyte or 720K and 1.44 Meg. Each diameter of drive has a standard and high capacity version, sometimes referred to as double and high density. Density refers to the packing of tracks and sectors. 360K diskettes have 40 tracks with 9 sectors per track 1.2 Meg, 720K, and 1.44 Meg diskettes have 80 tracks with 15, 9, and 18 sectors per track respectively. The original single-sided single

density diskettes have been replaced by double-sided double-density and double-sided high density versions. The high density versions of 5.25" and 3.5" drives will usually work with double density diskettes, though a command may need to be entered to set the drive for the lower capacity.

Using Drives from other Sources

Tandy sells a complete line of floppy drives for the 1000 series. These drives may be functionally identical to other drives, but have small physical quirks which tailor them to fit particular models of the 1000 series. A user who wants to install a drive from a "second source", perhaps to save money, will need to overcome these quirks.

Beige colored floppy drives to match the cases of the 1000 series computers are available only from Tandy. Drives from other sources are usually grey or black. There is no practical way to change the color of these drives'. Other differences which need to be overcome are discussed in the following two sections of this chapter.

Second Source Drives in the 3.5" Bays of The TL, SL/2, TL/2, RL, TL/3, RLX, and RSX

Two obstacles confront users wishing to install 720K or 1.44 Meg floppy drives not purchased from Tandy in the 3.5" drive bays of these machines. (Note, all machines except the TL/3, RLX, and RSX need a secondary controller for the 1.44 Meg drives). The case of these computers' covers the front of the 3.5" bays with holes for the diskette slot and ejection button. Figure 2.11.

Note button must be
in correct location
in order to fit through
cover in some models

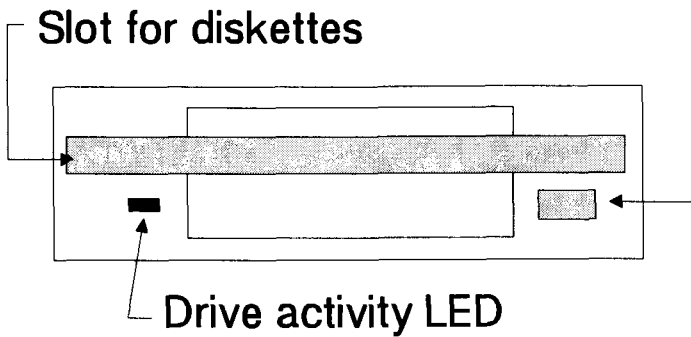


Figure 2.11 Front of 3.5" Floppy Drive

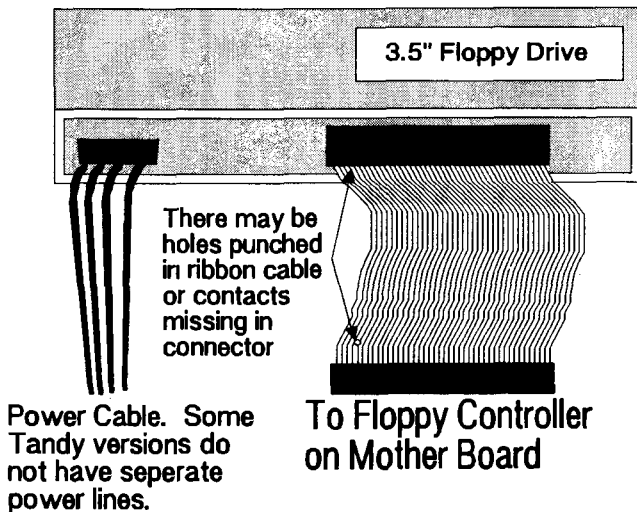


Figure 2.12 Back of 3.5" Floppy Drive

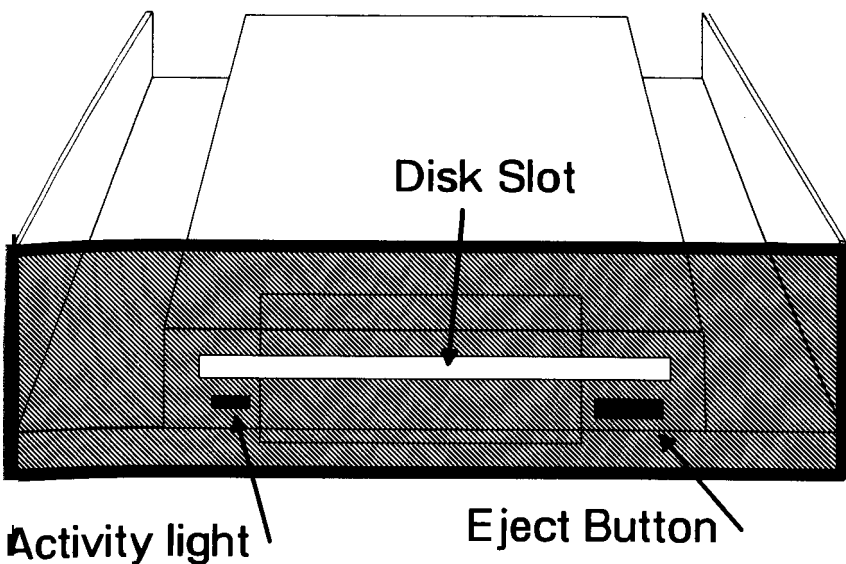


Figure 2.21 Front of 3.5" Floppy in 5.25" Frame

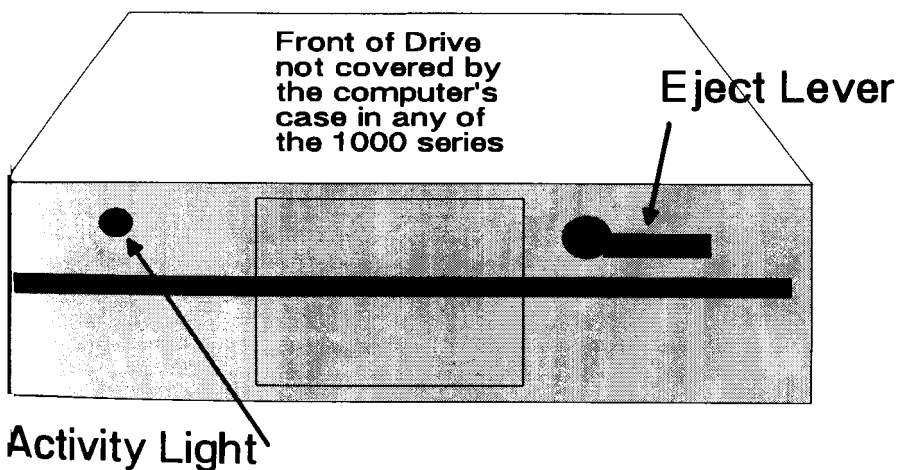
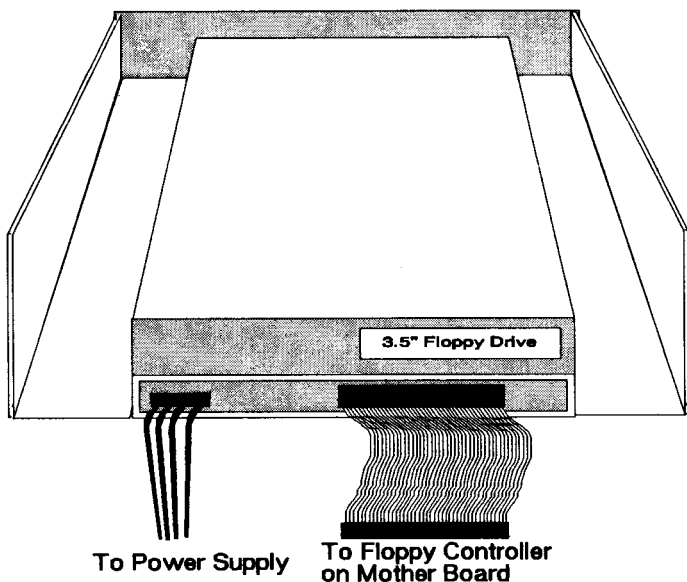


Figure 2.22 Front of 5.25" Floppy Drive



**Figure 2.31 Rear of 3.5" Floppy Drive
Mounted in 5.25" Frame**

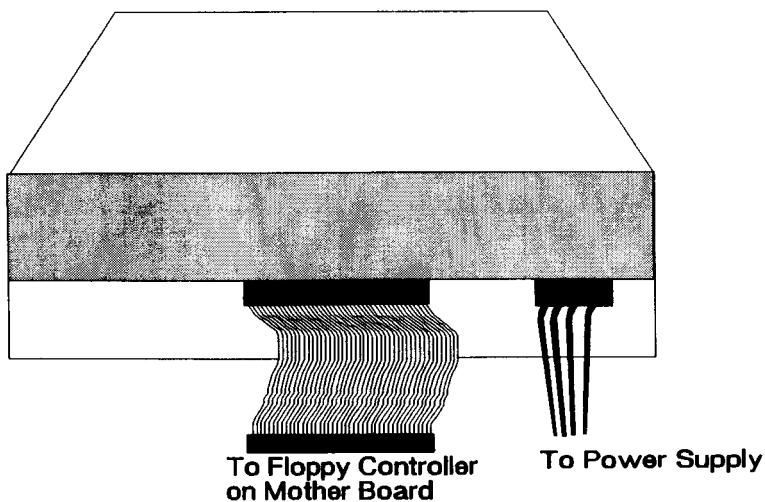


Figure 2.32 Rear of 5.25" Floppy Drive

This removes the problem of the front of the drives' not matching the machine in color, but creates one of finding a drive with the ejection button in the proper place to utilize the hole provided for it in the case. Two drives in which it lines up are the Teac FD-235F 720K and FD-235HF 1.44 Meg. When installed, the button on these drives is in the correct position, but may not protrude through the case far enough to be used properly. The button sold by Tandy as a replacement repair part for it's 3.5" Teac drives may be purchased and installed to solve this problem. Some vendors sell these drives with the taller button already installed.

The second obstacle stems from the way in which these computers send power to the 3.5" drive bays. Most floppy drives have two cables attached to them for signal and power. The signal cable is a flat, 34 strand, and the power a four strand version. Figure 2.12 These models of the 1000 series however, send power to the 3.5" drives through the signal cable so that only one cable is attached to the drive. The 5.25" drive bays of the models which have them are still supplied with separate signal and power leads. Figure 2.32 3.5" Floppy drives other than those sold by Tandy specifically for these machines cannot take power through the signal cable. Other types of drive, such as the Teac models, need to have the power in the signal cable disabled and another source provided. This is a problem with 720K floppies in the TL, SL/2, TL/2, RL, TL/3, and RLX and with 1.44 Meg floppies in the TL/3, RLX, and RSX. The other machines require a separate controller card with its own signal cable to support high density drives.

The simplest way of overcoming this problem is to install an adaptor which will convert the connector on the

3.5" drive from a pin type to a card edge type. These adaptors usually come with the 5.25" mounting kits for the drives, though the larger frame is not used in this case. Figures 2.21 and 2.31 A floppy signal cable should then be made or purchased which also has a card edge connector rather than a pin type for the 3.5" drive being added, all other connectors remaining the same. This cable should be longer, having about five inches or so more of space between the connectors for the new 3.5" drive and the next. It is now necessary to disable the lines in the cable carrying the power to the drive. A close examination will reveal that these lines are cut by holes near the connector for the 5.25" drive on the old cable as it does not draw power from the signal cable. In the new cable, locate the teeth in the card edge connectors for the 5.25" drive and new 3.5" drive which correspond to these cut lines and remove them. The power in the signal cable is now unable to reach these drives. The new 3.5" drive may now be powered by a "Y" shaped splitter cable which can be installed in the separate power feed lines provided for the 5.25" floppies and hard disk drives. Vendors familiar with Tandy computers may sell the Teac drives with the necessary cabling included.

Second Source Drives in the 5.25" Bays of the 1000 Series

The front of the computer does not cover the 5.25" drive bays in any of the 1000 series. Figure 2.22 Other drives will fit though none but those sold by Tandy will match the beige color of the cases. All of these drive bays have separate power and signal feeds. Figure 2.32 It is the short length of this signal cable that must be overcome. The only 360K

floppy drive which we have found to have the connectors in the right place for installation in all of the 1000 series, is the Teac FD-55BR. Users of other drives may need to obtain a longer signal cable. The TL/3 and RSX are the only machines with built in support for 1.2 Meg high density drives and users installing a "second source" 1.2 Meg floppy drive in the TL/3 machine will probably need a longer signal cable for all but the Teac FD-55GVR. (The RSX has no bay for an internal 5.25" drive, and can support only external versions.) The SL, TL, SL/2, TL/2, RL, and RLX can also support high density drives but only with secondary controllers which come with their own cabling. By using an adaptor kit, 3.5" drives can also be installed in the 5.25" bays of the 1000 series machines. Installing any 720K drive we have tested this way requires a longer signal cable as does a 1.44 Meg installed in the same manner in the TL/3. The other machines with 5.25" bays need secondary controllers to support high density drives which have their own signal cable and do not encounter this problem.

High Density Floppy Drives

The TL/3 and RSX have a built in floppy controller which can support 1.2 Meg or 1.44 drives, and that of the RLX , 1.44 Meg drives. Many users want to use these drives in other models of the 1000. Rumors occasionally surface that this can be done simply by installing a high density floppy drive and creating a special Config.sys file in the MS-DOS being used. These rumors are not true.

Some of the other 1000 series machines can use the high density floppy drives, but only with the addition of a

special secondary floppy controller card in one of their expansion slots. Internal floppy drives of double or high density can be connected to these controllers and some have a DB 37 female port to attach external drives to as well. They may support two or four drives.

Drives added this way cannot be used as the A or "boot" drive as the controller card they are attached is secondary to the one built into the machine. Included among these secondary controllers are the SUN 4311 by Sunix, the Compaticards I, II, and IV by Microsolutions, and the LCS 6812F by Longshine Corporation. In tests at DCS, only the Compaticard controllers function consistently in the 1000 series. Other brands have only worked sporadically, apparently due to conflicts with the built in floppy controllers of the 1000 series. The Megamate version of the Compaticard II controller includes easily used software. Though it comes with only a port for external floppies, an internal floppy drive connector is easily added with a dual row 34 pin header strip and a soldering iron. Many companies selling upgrades for the 1000 series offer it with the internal floppy drive connector already installed.

It is important to note that double density or high density drive connected to a secondary controller are not included in the Setup programs for machines such as the 1000 TL which have them. Thus, when adding a drive which is attached to a secondary floppy controller rather than the built in one, it is not necessary to modify the Setup.

Common Problems When Installing Floppy Drives

One problem that sometimes occurs when installing a

new floppy drive in the 1000 series is attaching the drives to the floppy controller cable in the wrong order when more than one floppy drive is being used. The 1000 series manuals explain the order in which the floppy drives attach. If the drive is purchased from a source other than Tandy and a new floppy cable is included, there should be documentation explaining the connection order.

The controller cable may also be connected to a floppy drive upside down. Floppy drives running constantly is a good sign that at least one connector is upside down. On some machines, the connector on the cable and drive are notched so that there is only one way they will fit together. If not, several other guides may be used. Floppy drives which have card edge connectors usually have a gap in the "teeth" of the card edge. The connector in the floppy controller cable should be attached so that the edge of the cable which has a darker stripe is toward this notch. A card edge or pin type connector on a floppy drive may also have a number "1" at an end to designate the first pin. The stripe on the floppy controller cable should be toward this "1". This can also be used in attaching the cable to the controller connectors on motherboards or floppy controller cards if they are numbered in this way.

As previously mentioned, the 34 conductor signal cable may not be long enough to reach the connectors on some drives. In this case, it is necessary to make or buy a longer cable, disabling the power carrying conductors if necessary.

1000, A, and SX

These machines have two 5.25" floppy drive bays and a floppy controller built onto their motherboards. Installing a 5.25", 360K floppy is as simple as sliding the drive into a bay, securing it with screws, then connecting the power and signal cables to the drive. Popular brands are the Fujitsu, Teac, Toshiba, and Mitsubishi. Black drives to match the original in the 1000 and 1000 A are easy to find, but a user buying a 360K drive for the SX will have to settle for grey unless they purchase the drive from Tandy.

A 3.5" 720K floppy can also be installed and used in these machines, but only as a "B" drive if the computer does not have a hard drive or hard drive card, and an "A" or "B" drive if it does. A 5.25" mounting kit should be purchased for the drive, and a longer signal cable will also probably be needed. It is necessary to use DOS 3.20 or higher because with these MS-DOS versions, it is possible to make a Config.sys file in DOS that will enable a 720K floppy to be used instead of a 360K. To do this, boot the DOS version 3.20 or higher and type:

```
copy con config.sys      (press Return)
device=driver.sys/d:1    (Press F6 and then Return)
```

The computer will now read, write, and format, the "B" floppy as a 720K. If this Config.sys file is not created, the machine will treat it as a 360K.

If a hard drive or hard drive card is installed in the computer, a 720K floppy can be used as the "A" drive, if the DOS of version 3.20 or higher is loaded from the hard drive.

To create the proper Config.sys, load the DOS, and go through the same procedure as above, but use a "0" instead of the "1" in the second line.

The secondary controllers for high density drives will not work in the 1000 or A for 1.2 or 1.44 megabyte floppy drives. This appears to be due to a conflict with the BIOS (Basic Output System) of these machines. There is no BIOS upgrade which will solve this problem. These secondary controllers will however, support 360K or 720K floppy drives in the systems, which may be of use to those who have a hard drive in one of their floppy drive bays. A secondary controller card can be installed in one of the expansion slots and connected to an external 360K or 720K floppy.

The Megamate version of the Compaticard II will function with 1.2 and 1.44 megabyte, 360K, and 720K floppy drives when installed in the 1000 SX.

1000 EX

This computer came with one 5.25", 360K floppy drive installed in the right side of the machine. It also has a connection in the rear where a 360K or 720K external floppy drive made by Tandy or DCS can be connected. This is the only way to install a second floppy drive, as there is no room for another internal.

If an expansion chassis such as the Slot Box is attached to the EX, the Megamate version of the Compaticard II can be inserted in to control 1.2 and 1.44 megabyte floppy drives as well as 360K and 720K, in addition to those attached to the EX.

1000 HX

This computer comes with one 3.5" 720K floppy disk drive installed at the front of the machine. There is space for a second internal floppy drive of the same capacity directly to the right of the first. Because of the slightly larger than usual physical size of the drive bays, there is no 3.5" 720K floppies which we know of that will fit, other than the Teac model sold exclusively by Tandy for this machine. There have been reports of cost conscious users purchasing the external 720K sold by Tandy for this system, removing it from its case, and installing it internally as it apparently fits also.

As on the 1000 EX, there is a port on the rear of this machine where a Tandy or DCS 360K or 720K external floppy can be attached. After installing another internal or external floppy drive, the SetupHX file included on the DOS diskettes with machine should be run, and the floppy drive or EEPROM chip to load DOS from selected. The 1000 HX can support a total of three floppy drives.

Though there are no standard expansion slots to use a secondary high density floppy drive controller in the HX. Such controllers will support 1.2 and 1.44 megabyte drives as well as 360K and 720K when inserted in an expansion chassis attached to the HX.

1000 TX

This machine was sold with a 720K floppy in the top one of its two 5.25" drive bays. Tandy sells 360K and 720K drives which can be installed in the lower bay, both with

matching beige colored faceplates. Users who want to save some money and don't mind a grey or black faceplate have a large number of choices in drives with popular drives being Teac, Toshiba, Fujitsu, and Mitsubishi all of which work well. A longer signal cable is needed for all 720K drives mounted in 5.25" frames that we have tried, and all 360K drives but the Teac FD-55BR.

The TX will automatically recognize a 360K or 720K drive installed as a secondary floppy with no hardware or software changes necessary. The installation process consists of opening the machine up, securing the floppy drive with screws, then connecting the power and signal cables to the drive.

The built in floppy controller in the TX will not support high density 1.44 or 1.2 megabyte floppy drives, but will coexist with secondary high density controllers in an expansion slot. The Megamate version of the Compaticard II works well. These controllers will support double or high density drives in the TX mounted internally or externally. Some vendors sell the drives and controller as a complete kit.

1000SL

This machine came with a 360K drive installed in the top one of its two 5.25" drive bays. Tandy sells both a secondary 360K floppy drive and a 720K floppy for the SL. These are the only drives which we know of that are the beige color that matches the SL. A user who is willing to use a drive with a black or grey faceplate may save money by buying one of a number of other drives that will work in the SL. A popular internal 360K is the Teac FD-55BR. This floppy

drive has the connector for the signal cable in the middle of the back portion of the drive where it can be reached by the relatively short cable of the SL. Other 360K drives may have the signal connector off to one side making it necessary to purchase or make a longer signal cable. The 5.25" mounting kits for 720K floppies usually have the signal connector where it cannot be reached by the cable of the SL. It is thus usually necessary to obtain a longer cable for a 3.5" drive mounted this way. The 1000 SL does not supply power to any of the drives through the floppy signal cable, as do some of the other models of the 1000 series, having a separate four conductor power lead for each floppy bay.

When a new internal 360K or 720K floppy drive is installed in the SL, SetupSL should be run and changed to reflect the number and capacity of the floppy drives attached to the system.

Secondary floppy controllers can be installed in the 1000 SL to use both double and high density floppy drives. The Compaticard controllers seem to function best in the SL. It is not necessary to modify SetupSL when installing a drive attached to one of these secondary controllers, though it may be necessary to modify the Config.sys file of the DOS being used.

1000 TL and TL/2

We discuss these machines together because their floppy drive setup is identical. Both machines have a base configuration of a single 720K floppy drive installed in one of the two 3.5" floppy bays which sit side by side with a 5.25" bay beneath them. The built in floppy controller will support

any combination of these 720K and 360K drives, both of which are sold by Tandy. The case of these machines' covers the 3.5" drive bays and the power to these bays is supplied through the signal cable. Adapting 3.5" drives purchased from sources other than Tandy is discussed near the beginning of this chapter.

The front of the 5.25" bay in these systems is not covered by the computer's case and it is possible to use drives from a number of manufacturers if a grey faceplate is acceptable on the drive. The Teac FD-55BR 360K drive is a popular choice as the signal cable connector on the drive is in the center where it can be reached by the floppy signal cable. Other models of 360K drive may have the connector off to one side, making it necessary to obtain a new, longer signal cable.

When a new 720K or 360K is connected to the built in controller of these systems, it is necessary to run the SetupTL or SetupTL2 that comes with the machines and set it for the new drive.

The secondary controller cards which add double or high density floppy drives to those connected to the built in controller will work in these systems. Those which function the best are the Compaticards I, II, and IV, with the Megamate version of the Compaticard II being a popular choice. There have been numerous reports of "lock ups" when the Sunix and Longshine Longshine controller cards are used.

A user who wishes to install a 1.44 Meg floppy drive internally might use a Compaticard controller connected to a drive installed in one of the machines' 3.5" floppy drive bays. The Teac FD-235HF 1.44 Meg drive is a popular

choices as it's eject button is in the right place to exit the hole provided in the case. This is discussed in a section near the beginning of the chapter. A user who wishes to install a 1.2 Meg drive internally, may do so by sliding it into the 5.25" floppy bay and connecting it to a Compaticard controller inserted in one of the expansion slots. Since the cases of these two computers do not cover the 5.25" floppy drive bay, almost any 1.2 Meg drive will work in these systems when connected to the Compaticard.

Users who have all of their internal floppy bays full may wish to attach a high density external drive to these systems. These often use the Megamate version of the Compaticard II which has a female DB37 port for external floppy drives. Power can be supplied to the drive through the cable connected to the DB37 along with the signal, or by another source such as a power supply within the box which the external floppy is mounted in. Complete internal and external high density and double density floppy drive assemblies are available from a number of sources.

1000 SL/2

This machine came from Tandy with one 3.5" 720K floppy disk drive installed. The floppy controller built onto the motherboard of the SL/2 will support three 360K or 720K floppy drives though there are only two drive bays, a 3.5" with a 5.25" below it. As with the TL and TL/2, the SL/2 supplies power to the 3.5" floppy bay through the wide, flat controller cable, rather than a separate cable. The computer's case also covers the front of the 3.5" drive bay in this machine. A user wishing to install a 720K drive from a source

other than Tandy in the 3.5" drive bay (perhaps to replace a drive that has failed) may find the Teac FD-235F 720K a good choice. As with the TL and TL/2, the strands carrying power to the drive need to be severed, or a new controller cable made. See the earlier section of this chapter on adapting drives not purchased from Tandy.

The SL/2 also includes an empty 5.25" drive bay for a 360K drive. A user who doesn't mind looking at a drive with a grey faceplate instead of the beige that Tandy uses may save some money buying a 360K drive from another source. A good choice is the Teac FD-55BR as the connectors on it are positioned so that the signal and power cables can reach them. A user willing to make or buy a longer floppy control cable can use almost any brand of 360K drive. A second 720K drive can also be purchased, along with a 5.25" wide adaptor frame and put into the lower floppy bay.

When a new 360K or 720K drive is secured into place and the cables connected, the user needs to run SetupSL2 which comes on the DOS diskettes for the machine, and enter the new drive and it's capacity.

The built in floppy controller in the SL/2 will operate simultaneously with secondary floppy controllers connected to high or double density drives mounted internally or externally. The Compaticard controllers yield the best results. A 1.44 Meg drive in a 5.25" frame or a 1.2 Meg drive can be mounted in the lower drive bay and connected to such a controller. It is important to note that DOS can not be loaded from either of these. As with all systems using a secondary controller, the system needs to be booted from a drive attached to the built in controller or a hard disk drive.

By using the female DB37 plug on the back of some

of these secondary controllers, external high or double density external drives can be attached to the SL/2. Complete drive and controller combinations are available from a number of vendors.

1000 RL and RLX

The base configuration of these two machines includes one 3.5" floppy drive installed in the right hand bay of the two available. This drive is 720K in the RL and 1.44 Meg in the RLX. The controller built onto the motherboard will support up to three floppy drives of 360K or 720K capacities in the RL and two floppies of 1.44 Meg or 720K in the RLX. Though the controller in the RL will support 360K 5.25" drives, the two drive bays in this machine are both 3.5" as are those in the RLX. Tandy sells a second 720K drive for the RL and RLX and a 1.44 Meg drive as well for the RLX. These may be installed in the second floppy bay of the machines, that do not have an internal hard drive. As with the other "L suffix" machines of the 1000 series', the front of the 3.5" drive bays is covered by the computers' case and power is supplied through the signal cable rather than a separate lead. Overcoming these obstacles to use internal 3.5" 720K floppy drives in the RL and 720K or 1.44 Meg drives in the RLX purchased from sources other than Tandy is discussed earlier in this chapter.

Though the internal drive bays of the RL are both 3.5", external drives can be attached which take advantage of the built in controller's support of 360K drives. The signal cables for these external drives exit through the rear of the one expansion slot. They may have their own power supplies

or take power from the computer. External 360K floppy drives for the RL are available through DCS and a number of others specializing in 1000 series upgrades. External 720K floppies can also be added to the RL in this way and 720K or 1.44 Meg drives to the RLX. The RLX's built in floppy controller does not support 360K drives. If a floppy drive is attached to the built in controller of either of these two machines, SetupRL or SetupRLX which comes on diskettes with the computer's should be run and changed to reflect the number and capacities of floppy drives installed.

A user who wants to attach a high density 1.2 Meg or 1.44 Meg drive to their RL as well as a 360K or 1.2 Meg to their RLX faces several problems. These machines will support secondary floppy drive controllers such as the Compaticard II Megamate, which seems to work well, but they have only one expansion slot to install such a card in. Those wishing to use such a controller may have to forgo an internal modem, or VGA card for example. The Slot Box, a way of avoiding this conflict is discussed in chapter 16.

A user who does not want to purchase an expansion chassis and is willing to give up the single expansion slot inside the RL or RLX may install a secondary controller for a number of floppy drive combinations. The 3.5" floppy bay of the RL may be used for a 1.44 Meg drive with the disk slot and eject button in the proper place. One model that meets these criteria is the Teac FD-235HF. If the extra controller card supports external drives, 1.2 Meg, 1.44 Meg, 360K, or 720K drives may be attached to it in either of these machines. It is not necessary to modify SetupRL or SetupRLX when installing drives attached to a secondary controller.

1000 TL/3

This computer has a base configuration of a single 720K floppy drive mounted in one of the two 3.5" drive bays which sit side by side above a 5.25" bay. The TL/3 like the RSX has a built in floppy controller which will support 1.2 and 1.44 Meg floppy drives as well as 360K and 720K. Tandy sells a model of each of these for this machine.

A Teac FD-235F 720K or FD-235HF 1.44 Meg drive will work in the two 3.5" bays though the user will have to deal with the ejection button and power connection problems discussed near the beginning of this chapter. The Teac FD-55BR 360K and FD-55GVR 1.2 Meg will function in the 5.25" bay as will a large number of other brands. The Teac models have the advantage of the signal connector on the drive being where the cable can reach it. Using another brand may make it necessary to obtain a longer cable. When installing any of these drives, it is necessary to change Setup TL/3.

1000 RSX

This computer comes with a 1.44 Meg floppy mounted in the one 3.5" bay available. The built in controller will support two 360K, 1.2 Meg, 720K or 1.44 Meg drives and a second floppy drive of any of these capacities may be attached using the built in controller. Such drives are sold by DCS. The setup program of the RSX must be modified to reflect the new drive when one is connected in this way.

CHAPTER 3

HARD DISK DRIVES

General Information

Often, owners of Tandy 1000 series computers are not sure what a hard disk drive can do and if it is useful to their particular application. Some are afraid that installing such a drive will be too difficult for anyone but a trained technician, and EX and HX owners are not even sure whether or not there is a drive which can be used with their systems. Some are told that they should buy a "Winchester" drive, not realizing that this was the code name of IBM's 1973 project to develop the first hard disk drive, and thus all hard disk drives are Winchester drives.

A hard disk drive, also called a fixed disk is like a floppy disk in that it is a secondary storage medium as opposed to the machine's DRAM, the primary storage. Hard drives have inside of them, several non-flexible metal disks stacked in a column. These disks are coated with magnetically sensitive material and are hermetically sealed along with the recording head mechanism in the hard disk shell or "bubble". There is a recording head, usually simply referred to as a head, for the top and bottom surfaces of each disk. Though it is actually the metal disks inside the drive which are used to store information, this book will refer to them simply as hard drives.

Hard drives are much more complicated than this, also containing an electronic interface that controls the connection between the drive and the computer. There are

several types of hard disk interface. The ST506, SCSI (Small Computer System Interface), ESDI (Enhanced System Device Interface), and the new IDE (Intelligent Drive Electronics) are the four major interfaces. Originally, most drives for the 1000 series used the ST506 interface. SCSI drives are available for these systems and an eight bit IDE interface (controller) is built into the TL/2, RL, TL/3, and RLX. The RSX has a built in sixteen bit IDE interface. Tandy also sold some hard drive combinations for the 1000 series which use an eight bit IDE controller and drive. The ESDI interface is a sixteen bit interface only and cannot be used in the eight bit expansion slots of most of the 1000 series. The discussion on formatting will focus on ST506 interface drives with MFM and RLL encoding. A new type of IDE controller for the 1000 series is discussed at the end of this chapter.

Interface types should not be confused with RLL (Run Length Limited) and MFM (Modified Frequency Modulation) which are both methods of encoding onto and retrieving information on a hard disk. MFM records digital information on hard disks or magnetic tapes by doing away with blank areas. This doubles the storage capacity of its predecessor FM (Frequency Modulation). RLL achieves at least 50 percent more storage than MFM by translating data into a new digital format that can write more information onto the same disk surface area of a hard drive. When RLL first reached the market several years ago, problems sometimes occurred due to the inability of the disk media or the read/write heads to deal with the new digital format. Technological advances however, have made these problems mostly a thing of the past, and drives that use RLL encoding are very popular.

A hard drive's access time is defined as the time that elapses between the operating system sending an order to retrieve data and the data being ready for transfer from the disk. Access times are measured in milliseconds (thousandths of a second), abbreviated as "ms". A very fast access time is nine ms and a very slow one 100 ms.

The data transfer rate of a hard drive is the number of bytes transferred from the drive to the computer per second, after the drive's heads have been moved to where the data is located on the disk's surface. The data transfer rate of most ST506 drives used in the 1000 series is about 180 kilobytes (180,000 bytes) per second.

A hard drive can be further accelerated by the use of disk caching software. This loads the information from parts of the hard drive which are accessed often, into a portion of the DRAM assigned to this by user. As DRAM can be accessed much more quickly, the overall performance of the hard drive is accelerated. A user considering such a program should remember that it may use a sizeable portion of the DRAM and thus interfere with programs. The actual acceleration effect of caching software will depend on how much a particular program which it is being run with (assuming this program is compatible with the caching) makes repetitious accesses of the hard drive. Some IDE interface drives have DRAM just for caching built onto the drive.

Hard drives also need a controller card. This card, which fits into one of the computer's expansion slots, serves to connect the hard drive and its interface to the computer. ST506 hard drives are attached to their controller by two cables, of 34 and 20 strands., and one 40 pin cable for IDE "Smartdrives." Figure 3.11

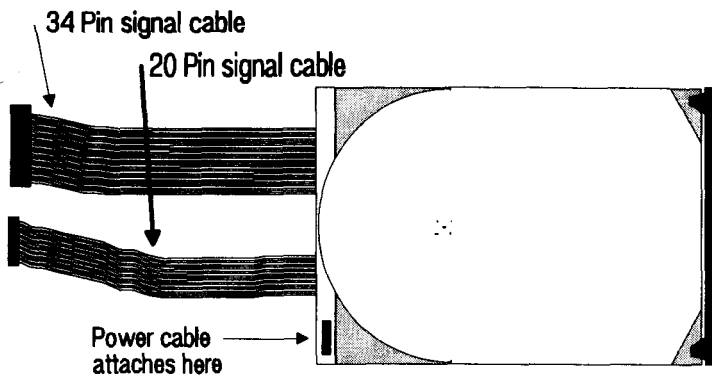


Figure 3.11 ST506 Drives have 20 and 34 Pin Ribbon Cables

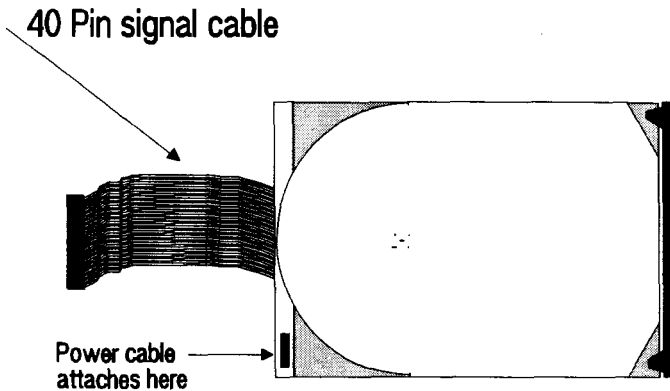


Figure 3.12 IDE Drives have one 40 Pin Ribbon Cable

The storage capacity of hard drives is measured in megabytes. A megabyte is approximately one million bytes (actually 1,048,576 or two to the twentieth power), a byte being eight contiguous bits, which are the fundamental data words of computers. A much simpler way of looking at this is that a letter of text such as this "Y" is the equivalent of one byte. A double spaced type written page requires about 1500 bytes, so one megabyte of hard drive space would be able to hold about 670 of these pages. Another comparison is that one megabyte is roughly the equivalent of three 360K diskettes, or one and a half 720K diskettes.

From the previous paragraph, it is evident that even a 20 or 30 megabyte hard drive is able to store a large amount of information. Yet 2000 megabyte or two gigabyte, (giga meaning billion) hard drives are already being made for some of the more powerful personal computers. The average 1000 series user will probably be satisfied with a drive in the 40 to 210 megabyte range. With such a drive, programs that occupy more than one floppy disk can be copied onto the hard drive and used without having to change floppies. The disk access time is lower, and data transfer rate higher for hard drives than those of a floppy drives, enabling programs to run faster and more smoothly.

To obtain a rough determination of the size of hard drive needed, a user should calculate the drive space needed by the programs and data files which they would like to install on the hard drive and convert this to megabytes. They should give themselves some leeway for their estimated future growth in storage needs.

There are many manufacturers of hard drives. The majority of them have begun to concentrate their production

on larger drives with a 16 bit IDE, SCSI or ESDI interface rather than the eight bit ST506 interface drives for machines such as the 1000 series. Popular ST506 interface drives for these computers have been made by Toshiba, Seagate, Kalok, and PTI. Miniscribe Corporation no longer manufactures this type of drive following its absorption into Maxtor, a company specializing in large hard drives. A way of using the 16 Bit IDE drives in the Tandy machines with eight bit expansion slots is discussed at the end of the chapter.

Formatting A Hard Drive

The formatting of a hard or floppy disk is the operation which establishes the pattern for the storage of data. The formatting process of hard drives is divided into three steps, the low level or physical format, the partitioning, and the high level or logical format. Floppy drives do all of these at once.

The Low Level Format

The low level format establishes the physical pattern of tracks and sectors. A track is one of a number of concentric rings which are encoded onto the drive. A group of tracks which all occupy the same position on each of the drive's metal disks are called a cylinder. A sector is a single segment of a track.

The interleave is also set during this stage of the formatting. The interleave is the ratio of the number of physical sectors that the computer skips for every one that is actually used for writing information. Most models of the 1000 series use an interleave of 3:1 which means that the

computer skips three sectors for every one written. Interleave factors greater than 1:1 slow down the data transfer rate of the hard drive so that the computer can keep up. A copy of DOS 3.20 or higher is best to begin the physical format of a hard drive. DOS versions of the 2.XX series can be used, but have limitations discussed in the section on partitioning. Tandy DOS versions 3.20.21 or 3.20.22 have their own formatting procedure which many consider difficult and is not included in this book. Users of these may want to consider purchasing another version such as 3.30 or 5.0.

1. To begin the physical format of the drive, locate and run the "Debug" file from the DOS diskettes.

2. A minus sign "-" will appear on the screen. Right beside it, type G=C800:5, then press return. This should activate the BIOS on the hard drive controller card and questions will be asked concerning the formatting procedure. If not, try G=CA00:5 instead.

3. You will be asked which drive you wish to initialize. The first hard drive connected to the system is drive "0", the second is drive "1". Choose the correct number and press return.

4. You may now be shown various numbers concerning the drive's parameters and asked if they are correct. If so, answer yes after each question and press return. Other controller cards will ask if you are dynamically configur-

ing the drive. For 20 megabyte drives connected to MFM versions of these controllers, and 30 megabyte drives connected to the RLL, the answer is usually "No" as the controller already "knows" these drives dynamic configuration. For larger drives you will need to answer "Yes", to the question of whether you are dynamically configuring the drive, then enter the parameters of the drive as asked for them. Parameters are characteristics of the drive such as the number of cylinders and heads or the number of sectors per track.

5. You will now be asked if you wish to enter the defects from the drive. These are the locations of unusable spots on the surface of the drive. They are usually printed on the top of the hard drive mechanism by head and cylinder number in what is known as the defect map. On some controllers such as the Seagate ST11M and ST11R, it is not necessary to enter defects as the controller will do it automatically as it formats the drive. Users of these controllers should answer "N" to entering the defects, and press enter. On other controllers, such as the Western Digital WD 100427X, the defect map should be entered by typing the cylinder and head of a defect in then pressing enter, for each one.

6. After the defects are entered, you will be asked if you wish to format the drive. The

process will usually take five to fifteen minutes. If this process runs more than half an hour, it is good indication that the formatting procedure has been done incorrectly, or there is something wrong with the drive, controller, or cables.

Partitioning

In partitioning, a section of the hard drive is separated from the rest of the drive and treated by the operating system as a separate drive. A user might have a single hard drive installed, and yet their DOS would treat it as "C" and "D" drives. Important for users of the 1000 series is that DOS versions of the "2.XX" series can only address up to 16 megabytes per partition. A user of a 32 megabyte drive would thus need to partition the drive as two 16 megabyte drives or some other combination of two or more drives adding up to 32 megabytes. One solution open to users of any of the 1000 is to purchase a DOS version of the 3.XX series which will address up to about 32 megabytes per partition. DOS versions of the 4.XX or 5.XX series might also be considered for any of the 1000 series with an 101 key enhanced keyboard as these DOS series will address up to 512 megabytes per partition, meaning that even large hard drives can be used as a single partition.

1. To start the partitioning process, the user should locate a file on their DOS 3.20 version or higher called "Fdisk" and run it.
2. A menu of choices will appear on the screen

concerning the creation and deletion of partitions. To create the first partition, the choice from the menu should be “create DOS partition”.

3. You will now be asked if the partition which you wish to create is the primary or extended partition, the first partition is of course the primary one.

4. For drives of under 32 megabytes, you will now be asked if you wish to use the entire drive for the partition, as they are under the maximum partition limit of the 3.XX series DOS versions. DOS versions 4.XX and 5.XX will ask this question for drives of up to 512 Megabytes. Most users choose to assign the smaller drives to one partition, though they can be broken down into multiple partitions. For drives larger than 32 megabytes, formatted with a 3.XX series of DOS, you will be asked if you wish to make the partition as large as possible. A user may choose to do this or answer “No” and choose some portion of the total number of the drive’s cylinders to assign to the first partition. As an example, if 400 cylinders were assigned to the first partition of a 40 megabyte drive that has a total of 800 cylinders, the first partition would be 20 megabytes.

5. When the first partition is completed, return

to the main menu, and again choose “Create DOS partition.” On the second menu, this time choose “Create extended partition.”

6. You will now be asked how many cylinders of the drive you wish to assign to the second partition. Some controllers may even fill in the number of cylinders remaining on the drive, assuming that you want to use the rest of the space for the second partition. As with the first, partition, dividing by the total of the cylinders on the drive shows the portion of the drive that is assigned to the second.

7. It is now necessary to define the second partition as a logical drive. Assign the same number of cylinders to the logical drive as you did the second partition.

The High Level Format

The high level format creates what are termed the “housekeeping” sections on the hard disk. They include the boot record, file allocation table or “FAT”, track free, and in use areas. The high level format cannot be done until the low level format and partitioning have been completed. The formatted capacity of a hard drive is the amount of space available on the drive after this format is completed. Running the DOS file “Chkdsk” will tell the user the total amount of space on the hard drive, how much is used by programs, and the amount of available space. Hard drives will format out larger than their advertised capacity. For

example, a 20 megabyte drive holds over 21 million bytes and a 40 megabyte about 42 million. This is due to a megabyte being somewhat more than a million bytes, as previously mentioned.

1.) The high level format is the simplest of the three steps. Each partition on the hard drive must be formatted separately. To format the first partition, type "Format C:/S" then press return. The format will finish in a few minutes. If there are other partitions, a system is not put on them so the "S" is not in the command. For example, "Format D:", or "Format E:".

It is important to note that all of the floppy drives connected to a computer, including those attached to secondary controllers, as well as the EEPROM chips that store DOS in the later 1000's also count as logical drives. An example of this is an HX with three floppy drives and a 40 megabyte hard drive which has been partitioned as two 20 megabyte drives. The floppies would be "A", "B", and "C" while the EEPROM chip would be "D". The hard drive would be "E" and "F". Sometimes the EEPROM chip may be "between" the partitions of the hard drive, such as being "D" while the hard drive partitions are "C" and "E".

The files for all three stages of formatting a hard drive exist in complete copies of DOS. The DOS manual tells how to use them and often the manual that comes with the hard disk will also. A formatting program such as Ontrack Software's Disk Manager may be sent with the drive or can be purchased separately. These programs are menu driven and will do most of the work for all three formatting steps. Many companies selling hard drives for the 1000 series ship

them with the physical format already done so that the customer needs only to do the partitioning and high level format. The IDE "SmartDrives" now used on many drives and hard cards are low level formatted at the factory and this does not need to be done by the user. A company which does the high level format or includes a copy of DOS on the hard drive is committing software piracy unless the licensed DOS diskettes are sent along with the drive.

Organizing A Hard Drive

Purchasers of a hard drive may be uncertain as to how to use the space the most effectively. Programs may simply be copied onto the drive as if it were a floppy disk, but this may lead to confusion as all of the files in the programs will show up when a directory of the hard drive is taken. A few large programs copied onto the drive could lead to a jumble of hundreds or even thousands of files, making sorting things out very difficult. The key to simplifying this are directories and sub-directories.

The main directory is called the "root" directory. Simply booting a drive and running the DOS file "Dir" will show the root directory. An example of a directory within the root directory would be copying a hypothetical program called "Work Right" into a directory called WR. First the DOS is loaded from the hard drive, then type "MD WR" and press return to tell the machine that you want to make a directory called WR. The Work Right diskette(s) can then be put into the "A" floppy drive and copied into the WR directory on the C partition of the hard drive by typing Copy A:*. * C:/WR. A user looking at the root directory of the drive would see only WR.

To get into a directory, type CD “the name of the directory”, then press return. For our previous sample this would be CD WR. Taking a directory while within the WR directory would show all of the files of the Work Right program, and the program could now be run. While within a directory, a sub-directory file can be created with the MD command once again. An example of this would be to create a sub-directory called JUNE within the WR directory for data gathered during that month.

Often, programs come with an “Install” section built into them, which when run, will create a directory on the hard drive, and copy the program into it. The creation of directories and sub-directories is explained in detail in the manuals for DOS and a number of books.

Many hard drive users purchase a menu program. These can be used to further organize the information on the drive. They may show a list of all programs within directories on the hard drive and make it possible to run any of them with a single keystroke as well as performing a number of other functions.

Hard Drive Problems and Precautions

Hard drives sometimes fail or “crash”. A user in such a situation should first make every effort to determine if the problem involves software. The copying onto the drive of the “Command.com” file from a DOS version other than the one the drive was formatted with is an example. If the problem persists, turn off the computer, and check the power and signal cable(s) connections to the drive, as well as the signal cable(s) connection to the controller card and its seating in the expansion slot. If the drive still will not

function and there is data on it which must be recovered, call in a professional who can help or recommend a data recovery service. If the data and programs on the drive are replaceable, the user may want to consider trying to completely reformat the drive.

If a drive is still functioning, but experiencing errors such as in reading and writing, or there are a large number of unusable bytes on the it's surface, a hard drive utility program may be useful. One of the most popular of these is SpinRite by Gibson Research Corporation. The ability to diagnose and repair low level format and data damage as well as detecting surface defects, and realigning drives are among the features of this program. Before purchasing this or any other hard drive utility program, find out if it will work with the model of drive which is experiencing problems.

When a hard drive is moved or jostled, there is a risk that the heads of the drive will touch the surface of the metal disks which they are normally very close to but do not touch. This is known as "head crash" and can damage or destroy the data on those sections of the disks' where the crash occurs. Parking a hard drive refers to the positioning of the drive's heads above sections of the disks where no data is stored, reducing the risk of damage by head crash. Many hard drives do this automatically when their power is shut off and are referred to as autoparking. The "Shiptrak" file included in some DOS versions will park drives that do not have this feature as will a number of programs. A Config.sys file can be created in the DOS being used which will park the drive after it is not used for a set period of time.

Hard drives use magnetism to record information, and exposure to magnetic fields of any sort should be avoided as they can cause data loss.

Hard drives have expected lifetimes measured in average thousands of hours of active operation called Mean Time Between Failures of MTBF. The better the drive, the higher the MTBF. No matter how good the drive, duplicate copies or "backups" should always be made of important programs and files. The most common way of making backups is onto diskettes and DOS has "Backup" and "Restore" files to help do this. A number of backup programs exist, one of the most popular of which is Fifth Generation's Fastback. These are often considerably faster than just using the DOS utility.

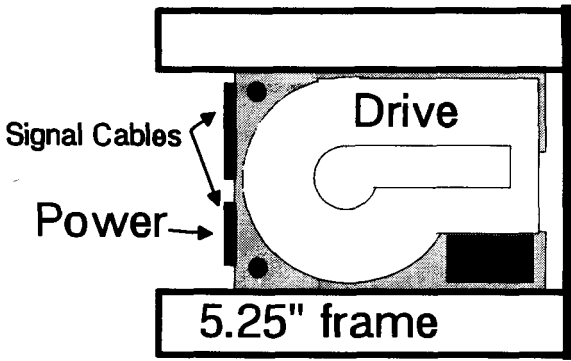
Another option is a tape backup. This is an internal or external system which uses specialized cassette cartridges to form backups of large amounts of information. A small cartridge can hold many megabytes of data and is erasable and reusable. These tape backups usually come with the software which enables them to form a copy of the information on a hard drive, and to restore it to that drive or another. The internal versions are often controlled by the computer's floppy controller and take the place of a floppy drive though they may have their own control board which uses an expansion slot. External tape backup usually run from their own controller board and thus use an expansion slot. A 1000 series user wishing to install a tape backup with its' own controller board should make sure the board is an eight bit version which will fit their machine's expansion slots (except RSX users) and 10" case length.

Hard Drive Cards

Many Tandy 1000 series users are uncertain as to the difference in a hard drive card and a hard drive and whether

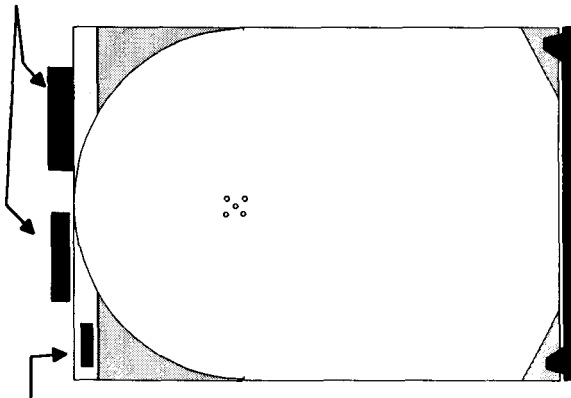
they are as reliable as hard drives. Most early hard drives for the IBM PC/XT and compatibles were 5.25" wide and about four inches high as were the original 360K floppy drives. These drives were mounted in the same bays as the floppy drives in the front of the computer and both were powered by leads directly from the power supply. The drives were connected to a controller card which went into one of the computer's expansion slots, and was the same length as the computer's chassis, about 13 inches. Signals were sent between the drive and controller through a pair of ribbon cables. Soon, hard and floppy drives, were reduced to half height (about two inches), and then decreased in width to 3.5 inches, though storage capacities actually increased. Technological advances also reduced the length of hard drive controller cards to about five inches. It thus became possible to bolt the controller card and the smaller 3.5" hard drive onto a metal frame which would make them one unit or "hard drive card." Figures 3.20 and 3.30 This entire unit can be plugged into one of the computer's expansion slots, invisible from the outside. Plus Development Corporation pioneered this way of mounting hard drives and has trademarked the term "Hard Card", though it does not make any for the 1000 series.

Inserted in the far right hand expansion slot, of the 1000 series (as the machines are viewed from the front), the bulk of a hard drive card will hang into the empty space by the floppy drives and will not block any of the other expansion slots. Users of the Tandy SmartWatch or other "chipstyle" clock/calendars should take care that the clock does not raise the chip which it fits under too high and interfere with the proper seating of the hard drive card. If so,



3.5" hard drive in 5.25" frame.
 frame can be removed and drive
 mounted on hard drive card.

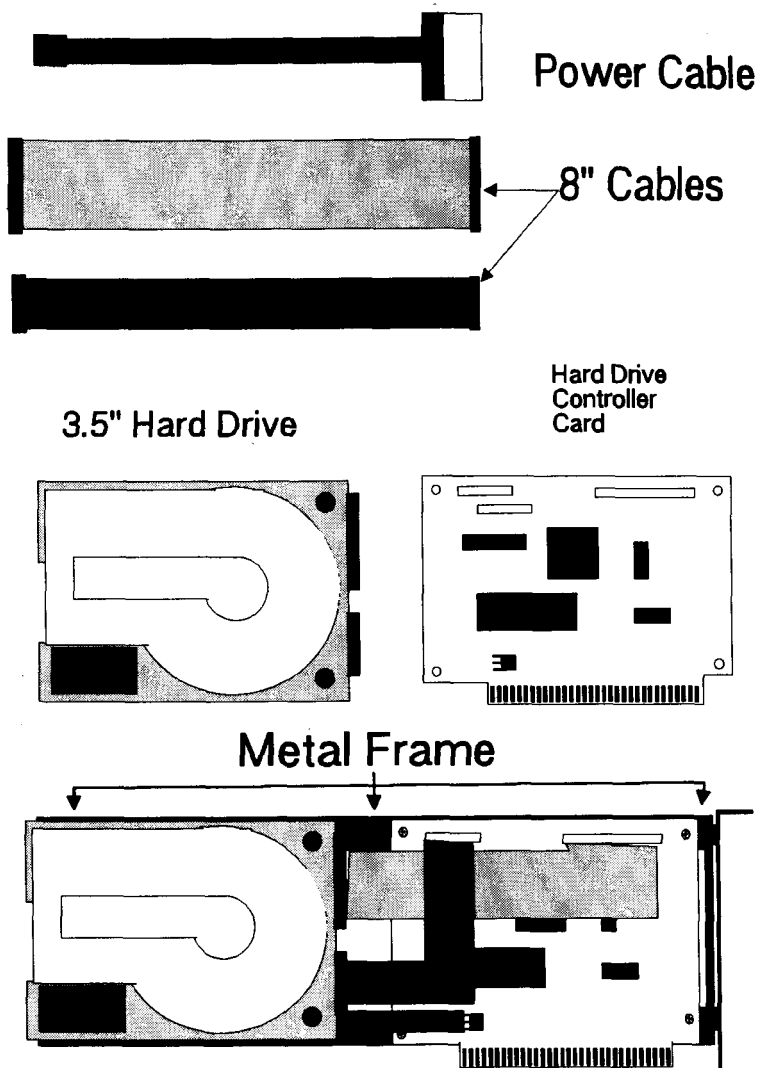
Signal cables



Power

5.25" hard drive such as seagate ST225
 cannot be put on hard card. Must be
 mounted in place of a floppy drive.

**Figure 3.20 3.5" Hard Drive in 5.25" Frame, and
 5.25" Hard Drive**



Hard card controller and drive on metal frame makes a hard card.

Figure 3.30 Making a Hard Drive Card

they may want to consider a different type of clock/calendar, discussed in a later chapter.

The hard drive card gets its power through the expansion slot it is plugged into without the necessity of a separate lead from the power supply. Such units are a boon to users of the 1000 series, as they do not have to give up a floppy drive to install a hard drive. There is no room for a hard drive card in the 1000 EX, HX, RL, RLX, or RSX, though other hard drives are available for these machines. From our experience, there is no significant increase in the failure rates of hard drives used on cards as opposed to being mounted horizontally in one of the floppy drive bays.

Many users believe that Tandy 1000 series computers use special hard drive controllers. This is true only for the 1000, A, EX and HX. In these machines, the hard drive controller is assigned hardware interrupt two also known as IRQ2 while the IBM PC and other compatibles assign the hard drive controller IRQ5. A hardware interrupt is a microprocessor instruction that halts processing temporarily so that input/output operations can occur as the computer's control unit manages the flow of various signals within the machine. Users soon discovered that cutting a solder trace and adding two jumpers to the Western Digital 1002 27X RLL and 1002 WX1 MFM controllers would enable them to occupy IRQ2. Seagate Technologies' introduction of its ST11R RLL and ST11M MFM controllers removed the need for this modification, as these controllers automatically switch themselves to the proper interrupt. In addition to using IRQ2, the EX and HX also have nonstandard Plus expansion slots, which a controller must have an adaptor to fit. New IDE "Smartdrive" controllers may not even use an interrupt.

Beginning with the SX and continuing up through the RLX, the 1000 series assigns IRQ5 to the hard drive controller like the rest of the PC compatible world. Thus, almost any eight bit hard drive controller can be used in these machines.

Tandy 1000 series owners who wish to purchase a hard drive card (Except for the EX, HX, RL, RLX, and RSX, which cannot use them) should make sure that the card that they purchase is 10" in length, not the 13" length used by the IBM PC, XT, and most compatibles. Otherwise, it will not fit inside their computer. It is usually best to purchase from a firm which has experience with the 1000 series of computers.

Two Hard Drives In One Computer

Tandy 1000 series owners often purchase one hard drive card, fill it to capacity, and then consider installing a second hard drive in the same system, either internally or externally. Since the first hard drive card should be installed in the far right hand slot, any second card would have to be installed in one of the other slots where it would protrude across the slots beside it and interfere with them. Two hard drive cards would also risk putting a strain on the computer's power supply. It is thus not practical to install two cards in the same computer.

Because of space and power supply consideration, a user may decide to install an external hard drive in it's own chassis with an independent power supply. Since most hard drive controllers (including those on hard drive cards) will support two hard drives, the user may choose to control both drives from the controller of the drive already installed. If ST506 interface drives are being used, they will need to

obtain a 34 strand controller cable with connectors for two hard drives, and a second 20 strand cable, both of the correct length. ST506 interface hard drive controller cards have one connector for the wider cable and two for the 20 pin. IDE "SmartDrive" controllers need one 40 pin cable with connections for two hard drives.

Most hard disk controllers will include instructions on how to set the controller for two drives though the Seagate ST 11R and ST 11M do not need to be set. The drives themselves may have a jumper near the cable connections which needs to be set to designate drive zero and drive one. It should be remembered that RLL and MFM drives cannot be controlled by the same card, so that both of the drives attached to one controller must use the same type of encoding.

A second option in installing a secondary external hard disk is to use a second controller card for the external drive. Drive controller instructions will tell the user how to set the controller as a secondary, usually assigning the second controller a higher BIOS address than the first. RLL, MFM, or IDE controllers can be used simultaneously in a pair in the same computer. Once again, the drive itself may have jumpers which need to be set to designate drive zero or one. Whether running two drives from one controller, or dual controllers, a formatting program such as Ontrack Software's Disk Manager can be very valuable in setting up two drive systems.

Because of the complexity and potential problems of running two hard drives in the 1000 series, users wishing to increase their storage space may want to simply purchase a single larger drive.

Following are specifics on hard drive installation in

each of the 1000 series.

1000 and 1000A

As previously noted, these first two machines of the 1000 series assigned hardware interrupt two (IRQ2) to the hard drive controller. This made it necessary to modify IRQ5 controllers such as the Western Digital 1002 WX1 MFM and 1002 27X RLL for interrupt two. To modify these controllers, the solder trace is cut between pins one and two of W7 and a connection made between pins two and three instead. On jumper block S1, jumpers are added to pin sets five and six. The 1002 versions of these controllers has been replaced by the 1004, which this modification does not work on. The new automatic interrupt switching controllers such as the Seagate ST11M MFM and ST11R RLL do not need it.

Owners of the original 1000 need to be sure that the ROM BIOS in their computer has been upgraded from 1.000 in 1.010. This is a simple procedure of changing two chips and can be done by any authorized Tandy dealer. When the new BIOS is installed, the screen will read "Phoenix ROM BIOS version 1.010" when the machine is turned on. If the original 1.000 version of the BIOS is left in, the user will not be able to "boot" or load their DOS from the hard drive, though it is possible to use the drive by booting on the floppy drive and then switching to the hard drive by typing "C:", and then pressing return.

Both the 1000 and 1000 A need more than the base memory of 128K to use a hard drive of any sort. The reason for this is that the machines' ability to use a hard drive depends on the DMA (Direct Memory Access) chip on the

boards which add memory. This chip controls transfers between the floppy and hard drives to the DRAM, speeding up the system as it relieves the CPU chip of the burden of regulating this flow. A DMA chip is built onto boards such as the Tandy memory expansions, Zuckerboards, and the multifunction board sold by DCS.

Most users choose to install a hard drive card in the 1000 or 1000 A instead of a hard drive and controller. There are several reasons for this. The 3.5" hard drives installed on hard drive cards pull less power than 5.25" hard drives such as the ST225. It should be noted though, that the smaller drives used on hard drive cards can be put in a 5.25" frame and mounted in the place of a floppy drive. Many users would like to keep both of the two available bays open for floppies, often choosing to install one 360K and one 720K. A hard drive card does not use a floppy drive bay, and makes this possible. A final reason is the ease of installation of hard drive cards as compared to hard drives. A hard drive card is installed by simply removing one of the screws of the back plane over an expansion slot and snapping the card in, and then replacing the screw. A hard drive is more time consuming to install, requiring that both the drive and the controller be secured in the machine separately.

1000 SX

This machine was the first of the 1000 series to assign hardware interrupt five to the hard drive controller which means that ordinary PC compatible eight bit hard drive controllers can be used. Hard drive cards are the most popular method of installing a hard drive in the 1000 SX.

Virtually any 10" drive card will work. When installed in the far right hand slot, the bulk of the card will be in the empty space next to the power supply and will not block any of the other expansion slots.

If the user chooses to give up a floppy bay, it is possible to install a hard drive there. This may not be desirable with the SX's 54 watt power supply and 5.25" hard drive, though a 3.5" drive in a 5.25" frame will fill a floppy bay without causing a power problem.

1000 EX and HX

Tandy Corporation has never sold a hard drive system for the 1000 EX and HX. Rumor has it that Western Digital developed a hard drive controller for these machines that was never marketed because of too much radio frequency interference (RF) or a cancellation of the project. A number of companies assemble and sell external hard drive systems for the Tandy 1000 EX and both internal and external for the 1000 HX.

There are no miracles involved in the production of hard drive systems for these machines. None of the manufacturers actually produce a special controller card or hard drive. Ordinary hard drive controllers will work in the EX and HX if they can use IRQ2 which is assigned to the hard drive controller, and have an adaptor to enable them to be inserted in the Plus Style expansion slots of these machines' rather than the card edge expansion slots of other PC's. Controllers which use IRQ2 are discussed in the earlier section on the 1000 and 1000 A. Eight bit IDE "SmartDrive" controllers which can be adapted to control 16 bit IDE drives in these

machines are discussed at the end of this chapter.

Plus slots do not consist of a slot with 31 conductor pins on each side, but instead consists of two upright rows of 31 pins surrounded by a plastic rim. Standard PC "card edge" boards cannot be inserted into this slot. These slots were also included on some of the memory boards made by Tandy for the original Tandy 1000 and 1000 A as a way of attaching add ons such as serial cards and modems, without using one of these machines' expansion slots.

The key to making a hard drive system for the EX and HX is a bus adaptor which converts one of the Plus slots on top of the memory expansion board that increases the computers' memory above the base 256K, into an ordinary 62 pin card edge expansion slot. An eight bit hard drive controller that uses IRQ2 can then be plugged into the system. Figure 3.40

It is important to note that the base EX and HX with 256K have one Plus expansion slot which a 62 pin adaptor can be plugged into, but many hard drive systems will not function when plugged into an EX or HX with 256K of DRAM. Instead, an additional memory board must be plugged into the Plus slot and the hard drive adaptor plugged into one of the Plus slots on the top of the memory board itself. The reason for this is that the additional memory board has the Direct Memory Access (DMA) circuit on it which enables transfers between the drive and the DRAM.

DCS and PC Enterprises are two companies currently manufacturing memory boards for the EX and HX. A number of other companies such as Zuckerboard have done so in the past. DCS and PC Enterprises boards have two of the Plus slots on their surfaces while some such as the

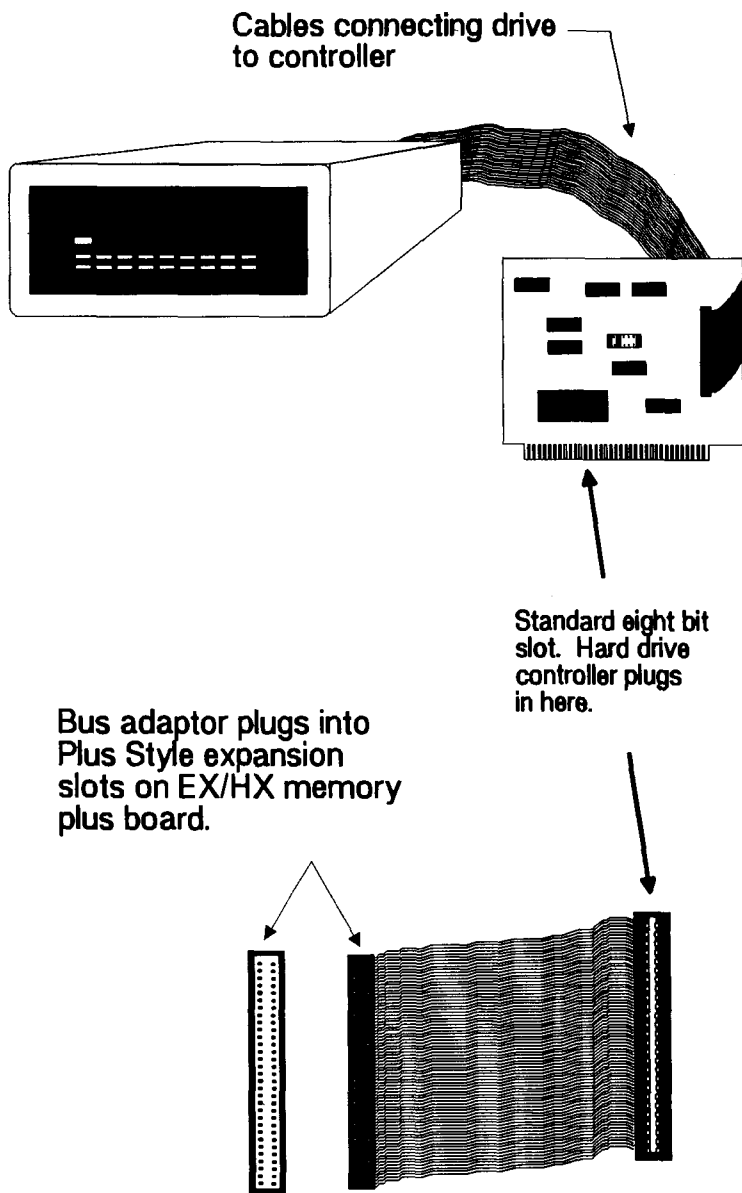


Figure 3.40 Hard Drive and Bus adaptor for EX and HX

Zuckerboard have only one.

To install an external hard drive in the EX and HX, the panel on top of the machine covering the memory board compartment is removed, and the controller card with the card edge to Plus adaptor is connected to one of the slots on top of the memory expansion board. The plastic panel at the rear of the memory board compartment is removed, and the controller cables exit there. The hard drive itself is in a separate cabinet at the end of the controller cables .

Most of the hard drives for the EX and HX draw power from the computer through a cable bundled with the controller cables. This is usually fine if the system is running one or two floppy drives. However, if three floppy drives are attached, (This is only possible on the HX) it may be necessary to purchase a hard drive system with it own power supply that runs from wall current. Users who suspect they don't have enough power for all of the add ons to their EX or HX may also want to consider such a drive. Most vendors offer the power supply as an option.

Internal hard drives are also available for the EX and HX. In the HX, the controller is installed in one of the slots on the memory board, and the hard disk drive in one of the 3.5" floppy drive bays. The drives which we have found to fit best are the 1" high 16 bit IDE versions using the 16 to 8 bit IDE conversion controllers discussed at the end of this chapter. Popular models include the 42 megabyte Connors CP3000 and Seagate ST 351A/X, Western Digital 85 megabyte 280A, Connors 120 megabyte CP3120, and Maxtor 130 Megabyte 7120A. These drives are all 1" high models and will fit in the place of the B" 3.5" floppy drive in the HX. Some SCSI drives are also available in 1" height. Many 3.5"

hard drives are taller than 1" some times called "half height". Installation of these drives in the 1000 HX may require modification or replacement of the support rack for the floppy drives in order to make space for the hard drive.

One internal hard disk system which we have seen for the EX installed the hard drive in the machine's one 5.25" floppy drive bay, and mounted the displaced floppy in an external box with its own power supply which came with the hard drive along with a cable to attach it to the computer. PC Enterprises advertises versions which fit into the memory board compartment, though they have not been evaluated by DCS.

The EX was sold with a 2.11 DOS version on diskettes and the HX has the 2.11 DOS in EEPROM (Erasable Programmable Read Only Memory) chips as well. This DOS will load automatically if the user configures it to do so with SetupHX. As discussed in the section on formatting, the 2.XX series DOS versions can use hard drive partitions of up to 16 megabytes, while those of the 3.XX series up to about 32 megabytes. DOS 4.01 and 5.0 can use partitions of up to 512 megabytes but DOS 4.01 and DOS 5.0 do not run well on the EX and HX because of their lack of a 101 keyboard. A user who wishes to install a hard drive on their EX and HX may simplify it's operation by making sure that it is formatted with a 3.XX series DOS. As previously mentioned, Tandy's versions of DOS 3.20.21 and 3.20.22 have a formatting procedure which is different from others and rather complicated, so it may be helpful to use another version.

A hard drive which has been formatted and has DOS installed on it will boot that DOS on an EX which does not have a floppy diskette in the "A" drive. For an HX with a

hard drive, the user needs to run setupHX and set the machine to boot from a floppy disk not the built in EEPROM and set the start-up program as DOS not Deskmate. If the "A" floppy drive is empty, the HX will boot from the hard drive.

1000 TX

Most users choose to put hard drive cards in this machine which is based around an eight megahertz Intel 80286 chip, with five eight bit expansion slots rather than 16 bit as with most 80286 machines. The same hard drive cards used in the other models of the 1000 series work in this machine. Installation in the far right hand slot will put the bulk of the card in the empty space beside the floppy drives, so that none of the other expansion slots are blocked. Some users may choose to give up one floppy drive for the slight cost savings of an internal hard drive.

1000 SL and SL/2

These machines follow the lead of the HX with DOS in EEPROM chips where it need not be loaded from a floppy disk, though they have a 3.21 version while the HX has a 2.11. They also have a "Setup" in the EEPROM chips which can be accessed by running the files SetupSL or SetupSL2 on the DOS diskettes which come with the machine. Through this Setup, the user can set certain features of the machines such as the number of floppy drives installed, their capacity, and which drive to boot from. When installing a hard drive, the user should go into Setup and set the initial start up device as "disk", rather than the built in EEPROM and also change

the initial start up program to DOS instead of Deskmate. As mentioned before, these machines come with DOS 3.21 and will also run other 3.XX series DOS versions as well as the 4.XX and 5.XX series from a diskette or hard drive.

Hard drive cards are by far the most popular form of hard drive in the SL and SL/2. Installed in the right hand expansion slot, they will not block the other slots. The cards will leave both of the floppy drive bays open, a situation found desirable by users who wish to install two floppy drives internally.

1000 TL

As with the HX, SL and SL/2, this machine includes DOS in EEPROM chips. The TL, like the TX, has five eight bit expansion slots, but more versatility in hard drive expansion as it has two 3.5" drive bays and one 5.25", rather than just the two 5.25" bays of the TX. A 3.5" hard drive can be installed in one of the two smaller drive bays, still leaving room for one 3.5" and 5.25" floppy drives in the machine. Most TL owners however, still choose to install a hard drive card because of the ease of installation. Since the TL assigns hardware interrupt five to the hard drive controller, like most compatibles, almost any hard drive card which is not longer than the 10" chassis will function. When a hard drive is being installed, the SetupTL program should be run and the start-up device set as disk and the start up program set as DOS.

1000 TL/2 and TL/3

The TL/2 was the first of the 1000 series to have an

IDE (Intelligent Drive Electronics) hard drive controller built onto its motherboard and the TL/3 follows suit. Tandy calls these drives SmartDrives. These drives are controlled through a single 40 pin cable. Figure 3.12

In this type of hard disk interface, most of the control circuitry is built onto the drive itself, with the external controller consisting of only a few chips. These drives can give significantly lower access times and higher data transfer rates at a lower cost, particularly with the 16 bit IDE drives. Ironically, Tandy chose to build an eight bit IDE controller onto the motherboards of these machines' which cannot control 16 bit IDE drives of which there are a large number of brands and capacities being sold.

Miniscribe Corporation was manufacturing eight bit IDE hard drives including the M8225XT 20 megabyte and M8450XT 40 megabyte drives. Production of these drives ceased around the time that Miniscribe was acquired by Maxtor Corporation.

Western Digital Corporation also produced eight bit IDE drives. These drives, which work in the TL/2 and TL/3 as well as the RL and RLX are the WD95028-X-11R 20 megabyte, WD95038-X-11R 30 megabyte, WD93044-X-11R 40 megabyte, all with 40 ms access times. These drives are no longer being manufactured. Seagate Corporation has begun manufacturing the ST325X 20 megabyte drive and the ST351A/X 40 megabyte with 28 ms access times. The ST351 A/X can be switched between eight and sixteen bit function by jumpers on the drive so that it can work with the eight bit controller of the TL/2, RL, TL/3, and RLX as well as the sixteen bit controller in machines such as the RSX. These hard drives can be mounted in a 3.5" floppy drive bay.

Another option is to put a 5.25" frame on the drive and mount it in the lower floppy drive bay. Tandy also sells a frame which will mount the drives to the left of the floppy drive bays while not occupying any of them. The IDE controller in these machines can support two drives at the same time, so a user willing to sacrifice a floppy bay or mount the drive in an external box can attach two drives, though few choose to do this.

Tandy sold the Western Digital IDE "SmartDrives" with installation and formatting software. Some users have reported problems with this software, the most common complaint being that the 40 megabyte IDE drives format out to only about 27 megabytes, as if there were only seventeen tracks per sector and not the correct twenty six. Users may instead format the drive using the DOS diskettes that come with the system.

To begin the physical format, run the "Hsect" file. When asked if the drive information displayed is correct, type "N" then enter 5 heads, 977 cylinders, and 26 sectors then press enter. Type "Y" when asked if these new settings are correct. Answer "N" to the question on displaying flagged defects and use an interleave of two. It may be necessary to do this procedure twice. The drive can now be partitioned and high level formatted using the steps discussed at the beginning of this section on hard drives.

The TL/2 and TL/3 will also support "standard" ST506 interface MFM and RLL hard drives, though only the Western Digital controllers will function simultaneously with a SmartDrive. The controllers for MFM drives which seem to work the best in the TL/2 are the western digital WX1 series and those for RLL the Western Digital 27X series.

When other MFM and RLL controllers are used in the TL/2 problems such as the machines booting over and over may be experienced, though the TL/3 can use the Seagate controllers. The 16 to eight bit conversion controller discussed at the end of this chapter will also work even as a secondary to a "SmartDrive" attached to the built in eight bit IDE controller. Many users choose to install a hard drive card in the far right hand expansion slot. Hard drive cards are easier to install than the eight bit IDE drives. They are also available in capacities higher than the 42 megabytes of the ST351 A/X the largest drive made for the built in eight bit IDE controller's.

1000 RL and 1000 RLX

These machines, like the TL/2 and TL/3, come with a built in eight bit IDE hard drive controller. The drives sold by Tandy and others for these machines are the Seagate ST 325-X 20 megabyte and ST351 A/X 40 megabyte . These fit in the left hand 3.5" floppy drive bay. A popular story is that plugging in another eight bit IDE drive such as the 40 Meg Western Digital 93044-X will destroy the drive and possibly damage the computer. This did not happen in a test machine. Unscrewing the hard/floppy drive support rack from the computer, turning it upside down, and then putting it back in makes an adequate seat for the Western Digital drive which is taller than the Seagate. The screw holes in the drive line up with those in the rack. The drive vendor may include the necessary screws and they can also be obtained from most hardware stores. After re-connecting the signal and power cables, the drive can be formatted with the same procedure as when installed in the TL/2 and TL/3, discussed in the

previous section. Before considering installing the 40 megabyte Western Digital IDE drive in your RL or RLX make sure to discuss the affect on the machine's warranty with a Tandy dealer.

The RL and RLX have a single eight bit expansion slot, and standard eight bit ST506 MFM and RLL hard drive controllers will work though only the Western Digital models can be run simultaneously with a SmartDrive installed. The 16 to eight bit IDE conversion controllers discussed in the next section will also work in these systems alone or as a secondary controller. By flipping the 3.5" inch floppy drive mounting rack on the left over, a 3.5" half height hard drive can be installed in it and connected to a controller card in the expansion slot. This rack does not need to be flipped for 1" high drives. An external hard drive can also be attached to a controller card in the machine's expansion slot. Users who need a drive with a higher capacity than the largest 40 Meg SmartDrives may want to consider such a drive and controller combination.

1000 RSX

This is the only model the 1000 series to include a built in sixteen bit IDE "SmartDrive" controller. The drive, usually included when purchased with the machine is a 1" high Quantum brand 52 megabyte model, though a large number of other drives can be substituted. Almost any 16 bit, 3.5" IDE hard drive can be used if the machine's Setup is run and the drive's parameters (heads, cylinders, etc.) entered in. Both 1" high and half height drives can be installed on the drive mounts. It should be noted that the drives higher than

1" may prevent one or two longer cards from being installed in the machine's expansion slots, as it is perpendicular to the slots.

16 to 8 Bit Conversion IDE Controllers

A major drawback of the eight bit expansion slots of all of the 1000 series but the RSX, has been that they are unable to use the 16 bit or "AT Bus" IDE drives many of which are inexpensive and fast. The ADP 50 controller from Silicon Valley Computer and the 1/16 from Acculogic which will enable 16 bit IDE drives to be used in the eight bit expansion slots of the 1000 series computers. Besides lower access times, these controllers have a data transfer rate of about 350-400 kilobytes per second, almost twice that of standard ST506 interface types. Many of these IDE hard drives have DRAM caching memory built onto them, further accelerating their performance.

DCS and others are selling a variety of hard cards as well as EX/HX hard drives based around this technology and it is rumored that Tandy will sell the ADP 50 as well. These drives offer lower access times and higher data transfer rates. Another advantage is that a user who upgrades to a 80386 or 80486 computer can easily remove the drive and attach it to the 16 bit IDE controller found in many of these machines, and have a drive more suited to their speed than MFM or RLL models.

The original ADP 50, distinguished by six function setting jumpers on its surface seemed to only work when paired with certain drives in the 1000 series, two of which were Connors and Fujitsu. The introduction of a new model

having seven jumpers and a BIOS version 2.18T for Tandy 1000 computers has largely eliminated these problems. Drives which have been tested to work on this controller include Connors, Fujitsu, Seagate, Maxtor, Toshiba, and Kalok. All Western Digital Models tested worked except for some of the 42 megabyte 93044A drives. Quantum drives do not seem to function when attached to the controller, possibly because of an incompatibility with the drive's reset signal.

The ADP50 will function in the 1000 series, even if another drive is also in the system attached to another controller such as the Western Digital MFM WX1 or RLL 27X. It will work in the TL/2, RL, TL/3, RLX and RSX even if a hard drive is already attached to their built in IDE "SmartDrive" controllers. The ADP50 will function in the EX and HX when inserted into a Standard-to-Plus slot adaptor or the Slot Box discussed in chapter 16 though certain proprietary DCS modifications may also need to be done to the controller.

The Acculogic 1/16 will not work as purchased in 1000 series machines. For the controller to work with these computers, or certain drives with the other machines, proprietary DCS modification must be made to it. Juko and Centos also make eight to sixteen bit IDE conversion controllers which are currently being tested by DCS.

CHAPTER 4

GRAPHICS

General Information

Software packages generate commands which a PC's graphics adaptor interprets and sends signals through a cable to the monitor. These signals determine the scanning of the monitor's picture tube by its electron gun(s). The interior of the tube is coated with a compound that glows very briefly when struck by an electron beam. Images are created, by the scanning of the screen one horizontal line at a time, from top to bottom very quickly. The number of times which the screen is scanned from top to bottom per second is the vertical scanning frequency, usually stated in Hertz (Hz). A monitor with a 35 Hz vertical frequency scans the screen from top to bottom 35 times each second. The vertical frequency is sometimes known as the "refresh" rate. The horizontal frequency is roughly the number of horizontal lines scanned per second, usually measured in kiloHertz (kHz). This is a greatly simplified explanation of how graphics are displayed by PC's, including the 1000 series.

The ability of the 1000 series computers to generate and display graphics, and how this can be improved is an area of interest to many users. In contrast to many other compatibles, all of the 1000 series have a graphics adaptor built onto their motherboards whose output can be shown on the appropriate monitor.

There are three requirements to display better graphics on these machines or any other PC. The first, is getting

a new graphics adaptor that is compatible with the computer and is capable of producing the type of graphics desired. This is usually in the form of a card that goes into one of the expansion slots. In the 1000 series it may be necessary to set this adaptor as a secondary one or to disable the machines' built in graphics.

The second step is obtaining a monitor which can display the output of the new card. As an example, a common misconception is that installing a VGA card will enable VGA graphics to be run on the Tandy CM-5, CM-11 or other non VGA monitor. This is not so. The monitor must be of the correct type to display the signals generated by the graphics adaptor.

The third step is to make sure that the software being used will support the same type of graphics as the adaptor and monitor. For example, an older game or spreadsheet loaded on a machine with a VGA card and monitor will not necessarily be displayed in VGA. The software must be able to take advantage of the more advanced graphics capabilities. The user can check the setup section in the software which will show the graphics standards which it supports. This information should also be available from the software's manual and the manufacturer. As new graphics standards are developed, manufacturers may release new versions of their software which supports these standards. Software "drivers" may also be made available for which a command to load may be installed in the DOS config.sys file, and enable the older software packages to take advantage of new types of graphics. It should be noted, however, that these drivers to push a program to a higher resolution are usually specific to a particular version of the software and brand of graphics card.

Graphics Standards

Many early PC compatibles had a color graphics adaptor (CGA) which offered 320 wide by 200 high (320 X 200) pixels of resolution with four colors and 640 X 200 in monochrome when paired with an RGB (Red Green Blue for the three color guns) monitor. A pixel is the smallest element or dot that can be displayed on a monitor. It is from these pixels that images are constructed. This type of graphics card and monitor combination is still available, but not very popular.

All of the 1000 series but the RLX and RSX have built into them an improved Tandy Color Graphics mode which we will refer to as TCGA. TCGA can display 320 X 200 resolution with 16 colors and 640 X 200 resolution with four colors as well as the regular CGA modes. IBM had its own version of this type of graphics called MCGA which was used in it's PCjr computer. The Tandy CM-11 monitor is the only CGA monitor which we know of which will run the improved Tandy modes. The Tandy CM-5 and CGA monitors by other manufacturers are only capable of the standard CGA modes. Monitors capable of achieving varying resolutions by altering the rate at which their electron guns scan the picture tube and accept digital input such as the NEC Multisync 3D or CTX 5468 can also display the TCGA graphics. The TCGA output of the 1000 series is accessed through a nine pin female port in the machines' rear.

The 1000, A, SX, EX, HX, and TX also have another type of graphics called composite. The SL, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX do not have this output. In composite, the red, green, and blue signals are mixed to-

gether to form the picture. This type of video is used by televisions and is accessed through an "RCA" plug output on the back of the computer similar to that on stereos and VCRs. The display quality of composite monitors is not as good as that of RGB monitors. A number of companies offer composite monitors which display only green, or amber, even when color software is being run. These monitors may be an inexpensive solution for using software which requires color graphics, if the colors themselves are not important to the user. Two such monitors are the Tandy VM-4 and the Goldstar MBM-2105G. Some CGA monitors are able to display composite input. These monitors can be identified by the RCA jack on the back.

Beginning with the SL, and continuing with the TL, SL/2, TL/2, RL and TL/3, high resolution Hercules compatible monochrome graphics were built into the 1000 series in addition to TCGA. The built in VGA RLX and RSX is also able to emulate this form of graphics on a VGA monitor. This standard gives 320 X 748 resolution on TTL (Transistor-Transistor Logic) monochrome monitors such as the Tandy VM-5 and Goldstar 1401A. A large variety of TTL monochrome monitors are available in both green and amber, some for less than \$100 retail. They usually measure 12" diagonally. The Hercules output of the 1000 series is provided through the same nine pin female port as the TCGA, and the 15 pin VGA port of the RLX and RSX. To enable this type of output, the Setup program which comes on the DOS diskettes of these machines' should be run, and the monochrome option chosen. The RLX and RSX will automatically display this type of graphics on a VGA monitor when the software calls for it, without any changes to their Setup

program.

Many spreadsheets and CadCam programs can take advantage of this graphics mode though very few games use it. Hercules and Hercules compatible graphics cards are also available. These cards can be installed in any 1000 SX or TX with an open expansion slot and will provide high resolution monochrome graphics on a TTL or multiscan monitor connected to the nine pin port on the card. The 1000 and 1000 A cannot support Hercules graphics as their BIOS chips will not allow the built in graphics to be disabled. The EX and HX will support this standard, but do not have the correct type of expansion slots to plug the cards into. This form of graphics can be added to these two machines with the Slot Box expansion chassis discussed in chapter 16.

Most 1000 series users want to upgrade to color graphics, or a higher standard of color graphics. Since the introduction of VGA, sales of EGA systems have dwindled, and the choice for most users is between different VGA standards. Still, some find that lower prices of EGA cards and monitors offset their more limited graphics.

The EGA or Enhanced Graphics Adaptor was created by IBM several years ago because of dissatisfaction with the low resolution and color selection of standard CGA. By digitally representing information, this standard offers a choice of 16 colors on the screen at one time from a palette of 64, with a resolution of 640 X 350 pixels when paired with an EGA, or multiscanning monitor. These cards will also output CGA and Hercules compatible graphics and most EGA and multiscanning monitors will display these types of graphics also. All of the outputs are accessed through a nine pin female port on the card. EGA cards cannot display

TCGA graphics.

EGA adaptors have also been made which support resolutions of 640 X 480, 800 X 600, and even 1024 X 768 which can be displayed by multiscanning monitors. Such EGA cards should come with diskettes containing software drivers which are installed in the Config.sys file of the DOS. These are usually for popular programs such as Lotus, WordPerfect, and AutoCad, and will push the programs to the higher EGA resolutions. The EGA cards which seem to work best in the 1000 series are made by Paradise or have a Paradise chip set on them. Few EGA cards are now sold, having been almost entirely supplanted by VGA.

When IBM introduced its PS/2 line of computers, it also created a new graphics standard, VGA, or Video Graphics Array. VGA, as introduced by IBM, is capable of 640 by 480 pixels of resolution while displaying 16 of 256 colors simultaneously or 320 X 200 resolution with 256 colors from a palette 262,144. These are the two most often used standard VGA resolutions, though there are actually a total of 17. Figures 4.11 and 4.12

VGA's use of analog technology rather than the digital used by EGA makes possible an unlimited number of continuously variable colors rather than having a fixed number of color intensity levels as with EGA. Analog devices accept continuously variable input rather than creating digital representations by digitizing the information. In application, this means that analog monitors are able to display a large number of colors on screen at once, with smooth, continuous, variations. VGA systems, can thus show much more detail than previous graphics modes, as in the reproduction of photographs for example.

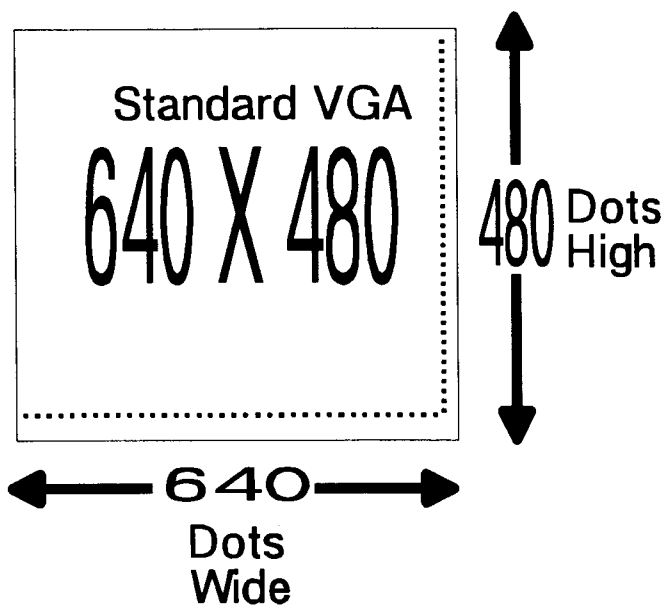


Figure 4.11 Resolution

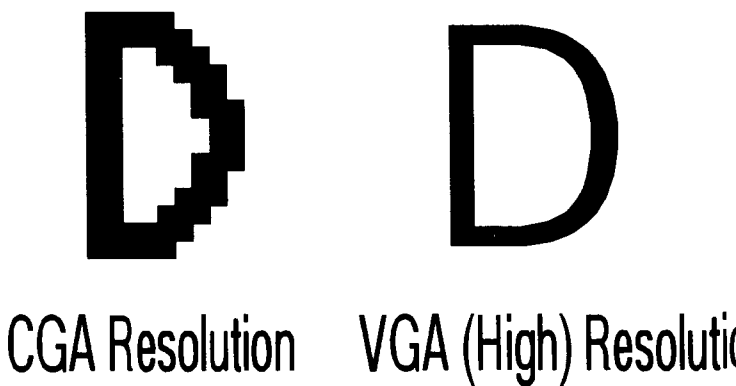


Figure 4.12 CGA vs VGA

Once VGA was introduced, graphics cards manufacturers began to produce cards which would run VGA not only in the basic mode, but also at 800 X 600 resolution, then 1024 X 768, both with a choice of 16 colors from 256. This highest resolution is known as Super VGA. Soon, adaptors were reproduced which would output resolutions of up to 1024 X 768 with 256 colors on the screen at one time. This is sometimes known as the IBM 8514/A standard. A large number of companies make the "control" chip sets for VGA cards. These include Trident, Paradise, Cirrus Logic, and Tseng labs. Testing at DCS seems to indicate that the cards based around the latest version of the Trident chip set function best in the 1000 series computers. Paradise has been acquired by Western Digital Corporation, users wanting this chip set may save money by purchasing a card from a company which has licensed the Paradise or Western Digital chip sets for their own brand of VGA card. As the resolution and number of colors which can be displayed by VGA cards has increased, so has the amount of DRAM on the cards. Most basic VGA adaptors have 256K of DRAM, Super VGA cards 512K, and IBM 8514/A compatible cards one megabyte (1024K). Higher resolution mean that more detailed images are constructed using a greater number of the smaller pixels, each of which requires a memory location. Greater color selections also require more memory locations. These two factors make more DRAM necessary on high resolution VGA cards. The VGA output is accessed through a fifteen pin female port on the card. Most VGA cards can also run CGA, EGA, and Hercules software on VGA monitors. They cannot display on TTL monochrome, CGA, or EGA monitors unless they have a separate nine pin digital output port.

Many early cards had this second port, but now, most do not. VGA cards cannot display TCGA.

Software which is written to run in the 640 X 480 standard mode may not automatically take advantage of the higher VGA resolutions. If the software cannot be configured in it's setup section for these, software drivers may need to be installed. The command to load these drivers is installed in the Config.sys of the DOS being used. High resolution VGA cards include drivers for popular programs such as Lotus, Windows, and AutoCad. Generally, better cards have drivers for more software packages. These are usually written for a specific brand of VGA card and are not interchangeable

Though a user may wish to run only basic 640 X 480 VGA on the 1000 series, they are not restricted to purchasing only an eight bit VGA card with 256K of memory. Most 16 bit VGA cards will work in the eight bit slots of the Tandy 1000 series or other compatibles. As a sixteen bit connector consists of two parts, the first, a standard eight bit connector, a sixteen bit board can thus be plugged into an eight bit slot with the second part of the connector hanging over unattached. Figures 4.21 and 4.22 VGA boards connected this way will function, though many other types of 16 bit boards such as hard drive controllers will not. Some VGA boards have a jumper or switch that needs to be set to define eight or sixteen bit operation, others automatically switch themselves.

A user intending to run only basic VGA graphics on an eight or sixteen bit board which will hold 512K, or 1024K perhaps intending to upgrade to higher resolution later, needs only 256K of memory installed on the VGA card. Some

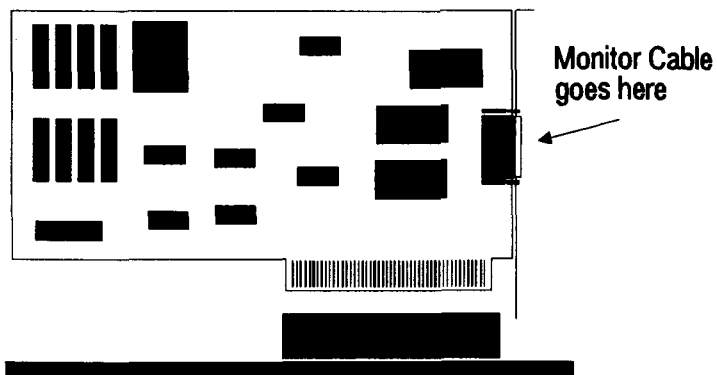


Figure 4.21 8 Bit VGA Card in 8 Bit Slot

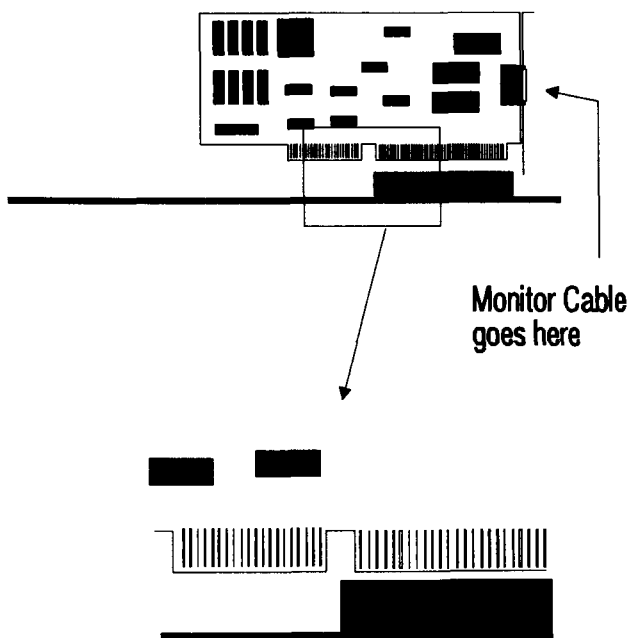


Figure 4.22 16 Bit VGA Card in 8 Bit Slot

VGA cards will display 800 X 600 resolution as well with only 256K of DRAM installed. The other video memory, 64 X 4 or 256 X 4 DRAM chips 80 ns or faster can be installed at some time in the future if the card is connected to a monitor capable of higher resolution.

Those wishing to run 1024 X 768 VGA resolution may purchase a 512K VGA card. These cards usually achieve this resolution through interlacing which is discussed in the next section on monitors, and offer a choice of 16 colors from a palette of 256 at this resolution. They most often offer a choice of 256 colors in the 640 X 480 and 800 X 600 VGA modes. Though eight bit cards have been manufactured which will hold 512K the great majority of cards are 16 bit and will function in eight or sixteen bit slots. These cards can also display CGA, EGA, and Hercules on the appropriate VGA monitor. They will not display on TTL monochrome, CGA, or EGA monitors unless they have a separate digital output connector and cannot run TCGA graphics.

VGA cards which will hold one megabyte of DRAM are growing in popularity. When fully populated, these cards can display a maximum VGA resolution of 1024 X 768 on interlaced or noninterlaced monitors, with 256 colors on the screen at the same time. This is sometimes called the IBM 8514/A standard. They can also display the two lower VGA resolutions with 256 colors, as well as CGA, EGA, and Hercules compatible graphics, though like the other cards, they cannot display TCGA.

Monitors

Two of the most emphasized qualities of color monitors are resolution and dot pitch. As previously mentioned, the resolution, is the number of horizontal and vertical pixels or "dots" that a monitor can display. Figure 4.11 These dots glow or "fluoresce" when struck by the beam(s) from the electron gun(s) of the monitor. Color monitors have red, green, and blue pixels, which when struck selectively, serve to construct a wide range of other colors. Monochrome monitors have pixels which fluoresce in only one color.

Dot pitch is the size of the smallest dot that a monitor can display measured in millimeters, and it, not the graphics adaptor, determines the monitor's maximum resolution. To keep the electron gun(s) from activating dots other than the one aimed at, color monitors have what is known as a shadow mask. This is a metal sheet which has small holes in it, arranged so that each corresponds to a dot on the monitor's screen. Smaller openings in the shadow mask mean a higher resolution and lower dot pitch. Figure 4.31. Monitors with lower dot pitches will display "crisper" images as the smaller holes in the shadow mask make activation of dots other than those aimed at unlikely. Most VGA monitors such as the Tandy VGM-300 have a dot pitch of .31 mm usually stated as simply .31. Monitors with dot pitches as low as .25 are available. Generally, the lower the dot pitch, the higher the price of the monitor. Buyers may want to beware of monitors with dot pitches of .39 or higher being offered at bargain prices.

Most color monitors are 14" in size, measured diagonally from corner to corner. Larger versions such as 17" and

20" are available, at higher prices. Factors which may be considered in the evaluation of a monitor include whether it's controls are positioned in the front for easy access, does it have a tilt and swivel base, and is the screen antiglare coated.

Very few EGA monitors are currently sold. Most vendors seem to be selling their off inventory, and their future is doubtful due to the popularity of VGA. A user who has an EGA card and doesn't have the money for both a new card and monitor, may want to consider a multifrequency monitor such as the NEC Multisync 3D or CTX 3436 which will display both EGA and VGA, being able to accept both digital and analog inputs. As mentioned before, most VGA card and monitor combinations can display EGA graphics.

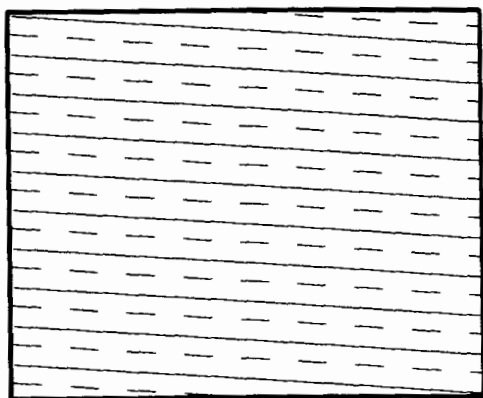
The number of monitors being marketed which display standard 640 X 480 VGA is extremely large. Popular models include the Tandy VGM-300, CTX 5432, Goldstar 1430, and Magnavox 9CM082. Also available are monochrome VGA monitors which with a VGA card run 640 x 480 VGA graphics in 64 shades of grey. These may be an option for users who want VGA but don't need the colors, as they are much less expensive.

There are two approaches to achieving VGA resolutions greater than 640 X 480 on monitors. The first of these is known as interlacing. In this method, every other horizontal row of pixels on the screen is scanned, then the monitor goes back and fills in the rows which were skipped. The odd number rows may be scanned first, then the even ones. Since this is done very quickly, the dots scanned in both passes will seem activated to the eye of the viewer. Figure 4.32 Interlacing requires monitors with less sophisticated electronics



Dot pitch is the visual size of the smallest dot that can be individually lit up. The smaller the dot pitch, the sharper the image.

Figure 4.31 Dot Pitch



Interlaced scans all odd lines first, then starts again and scans even lines. Non-Interlaced Scans all horizontal lines in just one pass from top to bottom.

Figure 4.32 Interlaced Monitor

as the vertical scanning frequency need not be extremely high. Basic VGA monitors and most 800 x 600 models are not interlaced.

Interlacing became popular when multiscanning monitors such as the NEC Multisync were introduced in which, the rate at which the monitor's electron guns scans the screen is variable. Multifrequency monitors have a range of scanning frequencies, which are the upper and lower limits of how fast their electron guns can scan the picture tube. These monitors will usually run resolutions of up to 800 X 600 without interlacing, and 1024 X 768 interlaced. They may have connectors for both analog and digital inputs or a single connector which can accept either type of input by using an attachable adaptor. They, like the CM-11 can display TCGA. The original Multisync has been replaced by the Multisync 2D and 3D. Others include the CTX 3436, Panasonic C1391, and Mitsubishi DiamondScan.

Monitors sometime referred to as "triscans" are now becoming popular. These monitors run the three VGA resolutions, the lowest two noninterlaced, and 1024 X 768 interlaced. These monitors can usually emulate CGA, EGA, and Hercules graphics as well when attached to a VGA card. They can accept only analog input, not having a digital connector, and are not true multiscans. Popular models include the CTX 5468, AAmazing CM 8428SX and Supercom SX1486.

Though both multiscan and triscan monitors will run 1024 X 768 resolution when paired with the appropriate VGA card, a commonly reported problem with interlaced displays is flickering. This problem can be particularly noticeable under fluorescent lights where the cycle of the

lights interacts with the scanning of alternate lines of the tube in the monitor.

A user needing 1024 X 768 resolution can avoid the potential flickering problems of interlacing by purchasing a monitor which when paired with the proper VGA adaptor, can display this resolution without interlacing. These monitors scan all of the line of the screen in one pass and thus have much higher vertical scanning frequencies. Such monitors are made by a number of companies and include the NEC Multisync 4D, Sony 1304, Seiko CM 1450 and Acer Acerview 35. Most of them are multifrequency monitors, able to do the lower resolutions as well. Because of the more sophisticated electronics needed for the higher scan rate, these monitors cost more than interlaced models, though the difference is decreasing.

Potential Problems

As discussed at the beginning of this chapter the graphics card, monitor, and software must all be compatible with the same graphics standard for an upgrade to work. Make sure that the graphics card is well seated in the expansion slot, and the cable firmly secured to the card and monitor. If a sixteen bit card is being used in an eight bit slot, it may need to be set for eight bit operation. The card may also need to be set to operate as a secondary adaptor, or for the amount of memory installed on it. There may be changes to be made in jumpers or switches on the computer's motherboard to disable the built in graphics or otherwise enable the machine to recognize the new card. These changes are detailed for the 1000 series in later sections of this chapter.

If a multiscan monitor is being used, it may have to be

set for connection to an analog (VGA) or digital (CGA, Hercules, EGA) adaptor. If there is trouble getting a display on any monitor, check the brightness and contrast controls. More than a few users have spent several hours trying to get a blank monitor to show a display, only to discover that the brightness was turned down too low.

If when turning the system on or trying to get a particular software package to run, an error message appears, there may be a conflict between the graphics card and the video portion of the BIOS in the computer. These messages may tell you that the wrong graphics driver is being used or that there is no VGA card present. There may also be a problem, particularly in the TX, with the screen simply remaining blank. VGA cards using the Trident chip set seem least likely to experience these problems.

PCM magazine, discussed in chapter 20, ran a very short program listing in its September 1990 issue which can cure many of these problems. This program is printed in both BASIC and assembly language and is also available from PCM on diskette.

By creating the proper Autoexec.bat file on the DOS being used, this program can be loaded when the computer is booted.

If difficulty is experienced in getting a software package to run in the higher VGA modes, make sure that any software drivers being used are correctly installed for that package and the type of VGA card being used.

For some reason, the VGA drivers for DeskMate have been left out of versions sold with some of the 1000 series. A message may appear on the screen that the VGA driver file cannot be found. For the 3.02 version of DeskMate, this file is DMVDVGA.Res, and for the 3.30 version

DMVSVGA.Res. Most Tandy dealers will copy these files onto a customer's DeskMate diskettes for them.

1000 and 1000 A

Both have built in TCGA and composite outputs. The graphics on these two machines cannot be upgraded as their BIOS will not allow the built in graphics to be disabled. It is sometimes thought that the 1.01 BIOS upgrade for the original 1000 that enables it to use a hard drive will allow graphics upgrades. This is not true. Trionix, the maker of the math coprocessor board for the 1000, made the only attempt which we are aware of to create a new BIOS for the 1000 and 1000 A which would support graphics upgrades. This project was discontinued some time ago.

1000 EX and HX

These machines have built in TCGA and composite outputs. They will support more advanced graphics, but because of their nonstandard Plus expansion slots, have no place to attach graphics cards. DCS and PC Enterprises are marketing VGA cards which will attach to the Plus Slots. With an expansion chassis such as the Slot Box (discussed in Chapter 16) Standard VGA cards may be used with these systems.

1000 SX, SL, and SL/2

All have built in TCGA, the SX also having composite, and the other two Hercules compatible graphics. The SX will accept Hercules upgrades, and this output can be enabled

on the SL and SL/2 by running the machines' Setup and choosing monochrome.

All of these machines will accept EGA and VGA upgrades. In the SX, the dip switch labelled "1" should be in the off position when one is installed. A jumper should be on the E2-E3 position in the SL and on E7-E8 in the SL/2.

1000 TX, TL, TL/2, and TL/3

All of these machines have built in TCGA and the TX also has composite. All but the TX also have Hercules compatible graphics, though it will accept Hercules upgrades. To enable this output on the other three, run the machines' Setup and select monochrome.

All four will accept EGA and VGA upgrades. As mentioned in the section on potential problems, the TX seems the most likely to have problems with graphics upgrades and the VGA fix program run by PCM magazine in September of 1990 may be helpful. As in the SX, dip switch one in the TX should be in the off position when making a graphics upgrade. In the TL, the jumper should be on E2-E3 and in the TL/2 on E7-E8. No changes are necessary in the TL/3

1000 RL

With built in TCGA and Hercules compatible outputs, this machine also accepts EGA and VGA upgrade cards. There are no dip switches or jumpers to change. Users wishing to install several different upgrades may have to choose the most important as this machine has only one expansion slot. The Slot Box expansion chassis, discussed in

Chapter 16, may help resolve this dilemma.

1000 RLX and RSX

These computers come with built in 256K VGA capable of displaying 640 X 480 resolution with a choice of 16 colors from a palette of 256. By adding two 256 X 4 DRAM chips to the sockets provided in the RSX, its video memory can be increased to 512K and Super VGA displayed at 1024 X 768 resolution with a choice of 16 colors from 256 colors. These outputs are accessed through a 15 pin female port in the rear of the machines. The built in VGA can also emulate CGA, EGA, or Hercules graphics on a VGA or multiscan monitor, though it cannot display TCGA. Tests at DCS have shown that a higher resolution VGA card can be inserted in the RLX's single expansion slot or a Slot Box (discussed in chapter 16) which is attached to the computer. To disable the built in VGA, set the Video BIOS Disable jumper at the left hand rear of the motherboard on E11-E12. Also completely remove the VIDIRQ jumper at the right side of the motherboard's front. Installing a higher resolution VGA card and an appropriate monitor will enable the RLX to display the higher levels of graphics. Users who desire 1024 X 768 SuperVGA resolution in the RSX with 256 simultaneous colors instead of 16 may disable the built in graphics by moving the jumper block behind the VGA connector on the motherboard from E1-E2 to E2-E3, and install a one mega-byte VGA card in an expansion slot.

CHAPTER 5

SOUND BOARDS

General information

All of the Tandy 1000 series computers came with built in sound generation capabilities which is considerably better than that of the original IBM PC which has only a single voice. The Tandy sound is capable of four voices, actually three voices and a beeper. These voices are the number of simultaneous wave forms or "instrument" which can be generated at once from which more complex sounds are constructed. As the complexity of multimedia and game software has increased, so has the need for more sophisticated sound generation capabilities and thus sound boards have come into being for use in Tandy and other personal computers. These boards often have 10 or more voices and other features such as voice synthesis and a MIDI (Musical Instrument Device Interface) interface.

The two standards in sound boards were created by the Sound Blaster and the Ad Lib boards. Creative Labs currently makes the Sound Blaster, Sound Blaster Pro Basic, and Sound Blaster Pro listed in order of increasing features and cost. The Sound Blaster Pro has both built in MIDI interface and stereo capability as well as a CD-ROM controller. The Pro Basic model is like the Pro except that it lacks a MIDI interface. Ad Lib filed bankruptcy then reorganized to begin manufacturing the Ad Lib Gold 1000. A main consideration of 1000 series owners deciding on a sound should be whether the model they are interested in is an eight

bit model which will fit the expansion slots of their computer. Owners of the 1000 RSX or machines expanded with the DCS 80386 and 80486 replacement motherboards may choose from eight and sixteen bit versions. The boards which work well with Windows such as the Pro Audio Spectrum 16 or the Sound Blaster Pro are made for 16 bit expansion slots. A great variety other sound boards exist such as Thunderboard and Sound Master. A user contemplating a purchase should carefully evaluate the features of the respective boards.

Sound boards can be inserted in all of the 1000 series with the exception of the EX and HX with their nonstandard Plus style expansion slots. PC Enterprises is marketing a VGA card for these machines with Soundblaster compatible sound, and standard sound boards can be used in a Slot Box expansion chassis (Chapter 16) attached to these machines.

The only problems which we are aware of between these Tandy machines and sound boards are with the original 1000. The expansion slot voltages on this machine may be incorrect to use some sound boards though no clear solution has been proposed for this.

CHAPTER 6

CD-ROM DRIVES

General information

Many Tandy users wonder what these drives can be used for and whether or not they can be added to their computer. The name of this type of drive means "Compact Disk Read Only Memory". The disks for these systems are 4.75" in diameter and hold up to 650 megabytes of information which is encoded when the disks are produced at the factory as pits and grooves in their surface. The drive reads by shining a laser at the surface of the disk and interpreting the differing reflections from the pits and smooth areas. Some models of drive may be designed so that disks are inserted directly into the drive while others have a disk caddy which the CD's are first inserted into before the caddy itself is placed within the drive.

As the name implies, CD-ROM drives can only read CD disks containing information, they cannot write new information. Though CD drives do exist which can write information they are much more expensive. CD-ROM drives load data into the computer in the same way that a hard drive does though their access times are generally much higher, making the drives slower. CD-ROM disks are useful for storing applications which take up a lot of space such as large databases. CD disks are available with complete encyclopedias, maps of the world, many photographs, and large numbers of shareware programs.

Many think that CD ROM drives will be useful in

multimedia applications. This growing field involves the presentation of information through the use of graphics, animation, text and sound. CD disks with their large storage capacities have many applications in this area. They may also have many applications in CAI or "Computer Aided Instruction" which is predicted to grow in popularity as a teaching tool.

CD-ROM drives come in internal and external models. The internal models are the size of a 5.25" floppy drive and can be installed in one of computer's 5.25" drive bays. A controller card is inserted in an expansion slot and connected to the CD-ROM drive through a provided cable. The drives take power through one of the leads provided in the computer for floppy or hard disk drives. Figure 6.10

External drives have their own cabinet and sit outside the computer. Like the internal models, they have a controller card which goes into an expansion slot and a provided cable which goes from this card to the drive. Power is usually provided through a wall plug adaptor. Some of these drives have disk caddies that are able to hold several CD disks at a time ready for play. Figure 6.11

Both internal and external models may have audio jacks on the controller card or drive and be able to play music CD's as well as read those which have data encoded upon them.

The way in which the CD drive communicates with the computer is its interface type. Most drives use either a SCSI (Small Computer Systems Interface) type or a proprietary one (such as the Tandy CDR-1000) created by the manufacturer. SCSI offers the advantage of being able to "daisy chain" several drives to the same computer, though

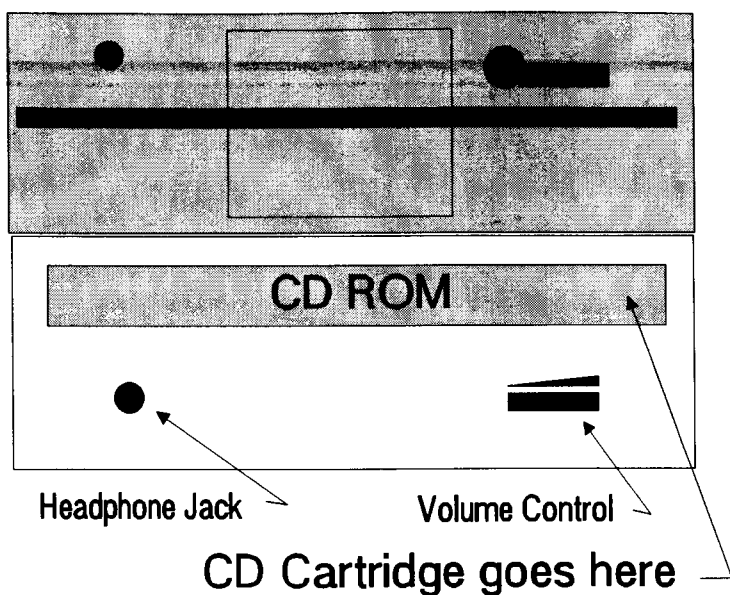


Figure 6.10 Internal CD ROM

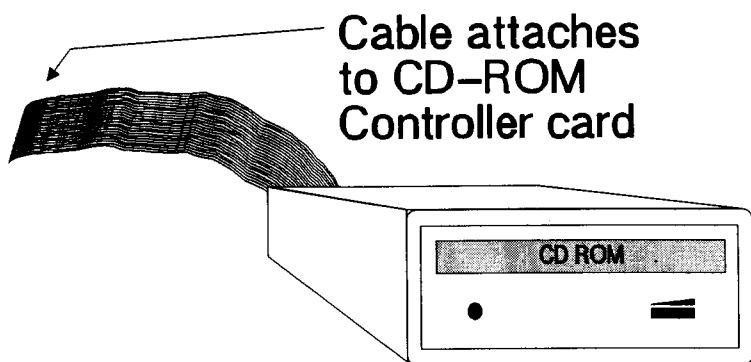


Figure 6.11 External CD ROM Drive

proprietary interfaces may also be able to do this.

Two important features of CD drives are their access times and data transfer rates. The access time is how fast in thousandths of a second (milliseconds) it takes the drive to locate data which a program has given the command to find. The data transfer rate is how fast the data is retrieved from the drive once found, measured in kilobytes (thousands of bytes) per second. One way of evaluating drives is whether they meet or exceed Microsoft's multimedia standard of 150K bytes per second of data transferred. A higher data transfer rate ensures that animation and games being used from the drive will be smoother and less "jerky". The Tandy CDR-1000 is a drive with a high access time which makes it slow in finding information but a high data transfer rate which compensates somewhat. Following is a list of the 1000 series and notes on using CD-ROM drives with each of them. DCS has tested only a small number of the types of CD ROM drives available and their compatibility with each model of the 1000 series. Potential purchasers should ask the vendor if the drive has been tested in their computer.

1000, A, SX, TX, and SL

All of these machines have two 5.25" floppy drive bays which internal CD-ROM drives can be installed in or put into an expansion chassis such as the Slot Box discussed in Chapter 16. External CD-ROM drives may also be attached to these machines or an expansion chassis connected to them. The Tandy CDR-1000 will not work with the BIOS of the 1000, A, or SX, though drives with SCSI interfaces such as some Sony models seem to function with all five machines.

1000 EX and HX

These machines have no standard expansion slots to attach a CD-ROM controller card to or empty 5.25" expansion bays to put an internal drive into. If an expansion chassis such as the Slot Box is attached to these machines, internal or external drives may be used with the chassis. The CDR-1000 will not work with the EX because of incompatibilities with the BIOS though it does function with the HX. Drives which use a SCSI interface card such as some Sony models seem to work with both of these machines.

1000 TL, SL/2, TL/2, and TL/3

These machines have one 5.25" floppy drive bay which an internal CD-ROM drive can be installed in with a controller card inserted in one of the expansion slots. A user who does not want to give up their 5.25" floppy drive bay can use an external CD ROM drive. If an expansion chassis such as the Slot Box is attached, internal and external drives can be used in the chassis. All models tested seem to work with this machine.

1000 RL, RLX, and RSX

These computers have one or two expansion slots and no 5.25" floppy drive bays so that internal CD-ROM drives cannot be used. A controller for an external drive can be inserted in an expansion slot, and most models seem to work well. If a slot adding expansion chassis like the Slot Box is attached, internal and external CD drives can be used with it.

CHAPTER 7

SPEED

Defining Speed, the Clock Rate

One of the most commonly asked questions of 1000 series users is how they can increase the rate of which their machines process. To answer this, it is first necessary to arrive at a definition of a personal computer's speed. One widely accepted measurement is the clock rate. This is the frequency of the internal clock of the microprocessor that determines the pace at which the computer's processing circuitry conducts operations. This frequency is measured in millions of cycles per second or megahertz, (MHz). It should not be confused with a clock/calendar, which keeps the time and date within the system. The clock frequency is generated by a "clock crystal" on the motherboard and sent to the CPU (Central Processing Unit) chip. Usually, the frequency is divided before it reaches the microprocessor. For example, the crystal in the eight MHz TX generates a 16 MHz signal. As more powerful microprocessors have been developed, clock rates have constantly risen higher.

The 1000 TL and SL both have a maximum clock rate of eight MHz. Yet the TL will perform a given operation several times faster. There must then, be factors other than the clock rate which determine speed.

The machines of the 1000 series are based around a number of Intel Corporation Central Processing Unit (CPU) microprocessor chips. The letters "AMD" may also be on the chip as Advanced Micro Devices has apparently obtained

a license to make some of them from Intel. The 1000 and 1000A use the Intel 8088. The SX, EX, and HX use the 8088-2. The SL and SL/2 the 8086-2, and the RL the 8086-1. The TX, TL, and TL/2 use the 80286-8, the TL/3 and RLX the 80286-10. The RSX uses the 80386SX-25 CPU chip. The number after the dash may represent the chip's clock rating or model designation, depending on the CPU type.

The 8088 and 8088-2 process data in 16 bit blocks, though they transfer eight bits at a time. The 8088-2 can run at a higher clock rate than the 8088 and the machines using it are faster. The 8086 chip processes sixteen bits at a time, and can transfer at this rate, but as used in some of the 1000 series, transfers at an eight bit rate. Still, it is internally faster than the 8088 and 8088-2.

The 80286 chip processes and transfers at a 16 bit pace as well as being faster in its internal design. It also includes more interrupts, which are pauses for outside input, enabling the system to operate more smoothly and faster overall. The 80386SX chip processes at a 32 bit rate but transfers at 16 bits.

Replacement CPU Chips, The NEC V20 and V30

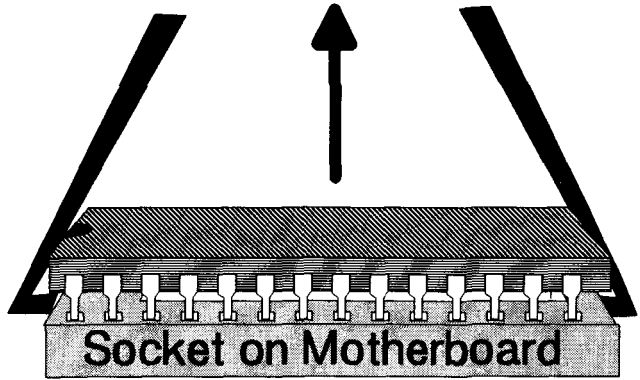
Speeding up the processing speed of the 1000 series follows two basic lines. In the machines using the 8088, 8088-2, or 8086, it may be possible to remove the Intel CPU chip and replace it with one of two chips manufactured by NEC (Nippon Electric Corporation). The NEC V20 is a replacement for the 8088 and 8088-2 and the NEC V30 can be substituted for the 8086. These chips process faster, even at the same clock rate. A simple explanation of this is that

they are able to read, decode, and execute an instruction which is sent to them simultaneously while the Intel chips do these things one step at a time.

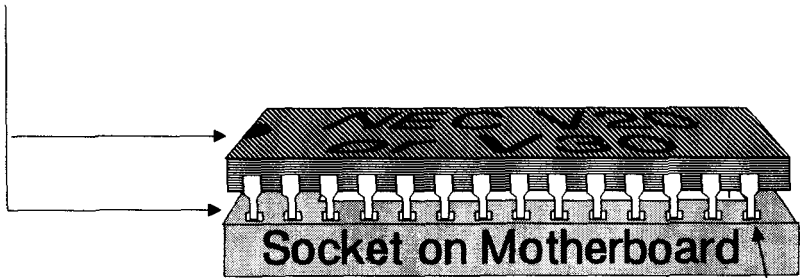
There are five, eight, and ten MHz versions of the NEC chips. A chip with the same clock rating as the one being replaced should be used. A faster chip can be used in place of a slower one, but not vice versa. Using an NEC CPU which can run at a higher clock rate than the machine generates will not speed up processing any more than one rated the same. There are no jumpers or switches to be set when performing this replacement. The machine should be turned off and the CPU chip removed, then the replacement installed with the notched end toward the end of the socket which also has a notch. Figure 7.10 Vendors who specialize in upgrades for the 1000 series may include a diagram and/or a chip puller for this. Chapter 19 shows the CPU locations of the 1000 series. The NEC chips seem to be completely software compatible and some machines such as the Tandy LT 1400 are sold with them instead of an Intel model. The processing speed increase achieved by the replacement is usually between 30 and 50 percent, though the results of different tests may vary.

There is no NEC replacement chip for the Intel 80286. NEC developed such a chip called the V50, but was prevented from marketing it by legal pressure from Intel. The V20 and V30 will not increase the speed of machines running the 286 Express board discussed in the next section. There is no replacement CPU chip for the 80386SX in the 1000 RSX.

First remove old CPU
(8088,8088-2,8086)



All Notches Line up with
notch in Socket on
Motherboard



Side View
Each leg must go into
hole in socket

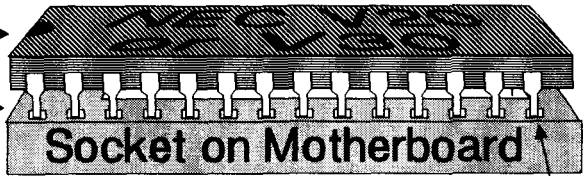


Figure 7.10 **Inserting V20 or V30**

Accelerator Boards

The second way of speeding up some of the 1000 series is to exchange the microprocessor for one which can handle more bits of information at a time. Because many of the other components or "support chips" on the motherboard are specific to the microprocessor it is not possible to simply plug such a new CPU in place. DCS currently makes and sells complete 80386 and 80486 motherboards for some of the 1000 series which are discussed in the next section of this chapter.

Another way of installing such a microprocessor is an accelerator card. The only such board developed for the 1000 series was the 286 Express by the now defunct PC Technologies of Ann Arbor Michigan. One version of this board was designed to be plugged into an expansion slot of the 1000 and 1000 A, another in the SX. The CPU chip is removed from the motherboard (a chip puller is provided) and inserted into a socket provided on the Express card. A plug attached to a cable extending from the card is inserted into the vacated CPU socket. The eight MHz Intel 80286 on the card is thus connected to the system and instructions are routed through it instead, yielding an approximately sevenfold speed increase. This card also has a socket for an 80287 math coprocessor.

Though the 286 Express appears to be a good solution it has some problems which may have contributed to its manufacturer's going out of business. Lock ups of a machine with the board installed after several hours of operation are the most common. Addition of peripherals seems to increase these problems, particularly more "exotic" ones such as copy boards. One explanation for these lock ups is that 80286

accelerator boards use memory caching to simulate 16 bit transfers on systems designing to handle eight bit transfers. In this method, frequently accessed information from the DRAM chips is stored in the cache memory on the board, where it can be accessed much more quickly. In the 1000 series, transfers by the DMA from the floppy disks to the DRAM which bypass the CPU chip cause what is in the cache not to match what is in the DRAM memory and the cache "goes stale". The caching feature on the 286 Express can be turned off, but this negates most of the speed increase given by the board.

The 286 Express was the only accelerator board made for the 1000 series. Such boards were a good idea for the rest of the compatible market when motherboard prices were much higher. Now, prices of replacement motherboards have fallen as well as those of complete systems, and the market's interest in accelerator boards has cooled. It is unlikely that anyone else will produce such an accelerator board for the 1000 series. From time to time, rumors circulate that a particular brand of accelerator will work in the 1000 series, often the SOTA 80286 and 80386 boards. DCS has not found this to be true.

Replacement Motherboards

This way of increasing the speed of a personal computer has been available for other models for some time and is now available for some of the Tandy 1000 series. In this method, the entire horizontal sheet of electronics which compose most of the computer (the motherboard) is taken out and replaced with a new one containing a more powerful processor.

This type of replacement is currently available from DCS in 80386SX-33, 80386DX-40, and 80486SX-25 models as well as 33, 50, and 66 megahertz 80486DX models. The 80386SX CPU chip is not capable of the true 32 bit operation of the 80386DX CPU. The 80486SX chip does not have the built in math coprocessor abilities which the 80486DX CPU does. These replacement motherboard are currently available for the 1000 SL, SL/2, TL, TL/2, and TL/3 Models for the 1000, A, SX and TX are currently being developed.

When the user ships the computer to DCS for installation the original Tandy motherboard is removed and the new one mounted in its place. Peripherals, such as hard and floppy drives, modems, VGA cards, are removed then re-attached to the new motherboard. Memory boards such as the Micro-mainframe are not necessary as the replacement motherboards have capacities of 16 to 32 megabytes of DRAM directly on the boards using SIMMs modules. Included is a card which can control 16 bit IDE "SmartDrive" hard drives, as well as 360K, 1.2 Meg, 720K, and 1.44 Meg floppy drives. This hard drive controller enables the larger 16 Bit IDE hard drives to be used, taking advantage of their low access times and high data transfer rates. Two standard serial ports are also included of the nine and twenty five pin types, as well as standard parallel and game ports. These motherboards provide four or five sixteen bit expansion slots for add-ons rather than the eight bit versions of the original motherboards. All of them have a built in clock/calendar, and a socket for a math coprocessor chips is provided on the 80386SX and DX models as well as the 80486SX boards, (80486DX does not use one, since the math coprocessor is built into the chip.)

The DCS replacement boards do not have the built in

features of the original Tandy models such as the enhanced Tandy CGA graphics though a standard CGA card capable of the same resolution with a smaller selection of colors is included when needed at no additional charge. A VGA card and monitor may be preferred by many users and eight or sixteen bit VGA cards will work in the expansion slots of the DCS motherboards. The built in Deskmate is not included in the upgrade board and users wishing for this feature may want to buy the IBM compatible version and install it on their hard disk, or choose new software such as Windows or OS/2. A sound board such as the Sound Blaster or Pro Audio models inserted into an expansion slot will more than compensate for the missing Tandy sound capabilities and advanced sound boards needing a 16 bit expansion slot may now be used.

The DCS motherboards do not change the case, power supplies, or keyboards of the machines they are installed in. The upgraded computers look the same from the outside, and new technology which uses much less electricity makes the 67 watt power supply of these models of the 1000 series more than adequate for providing current to them. PCM Magazine in its December 1992 review of these upgrade motherboards says "the system runs like a screaming eagle" and calls them "A viable alternative that will help carry our Tandy 1000's into the next decade of computing."

As previously mentioned, DCS is currently attempting to design upgrade motherboards for the 1000, A, SX and TX as well. It is unlikely that upgrade models will be made for the 1000 EX, HX, RL, RLX, and RSX because of space restrictions imposed by the size of their chassis. Users of these computers as well as the 1000, A, SX, and TX who need a faster machine may consider transferring their periph-

erals such as hard and floppy drives, VGA cards, modems , etc. , into a new clone chassis or box of a more standard layout. A number of companies such as DCS or Micro Systems currently provide this type of upgrade.

Other Ways of Increasing Speed

Many users become frustrated with the relatively few options available for speeding up the processing of the 1000 series computers. Overall computing speed can also be increased by acceleration in other areas of the machines' operation.

Hard disk access is one such area. A hard disk with a relatively low average access time will reduce the amount of time spent finding data on the drive. A hard disk with a high data transfer rate will also help. Disk caching software may also be installed. These programs load frequently accessed information from the hard drive into DRAM where it can be accessed much more quickly. Caching uses DRAM however, and a large cache may not leave enough memory for the programs themselves. An expanded memory board such as the Micromainframe 5150T EMS board discussed in Chapter One can help to relieve this memory shortage. Some IDE or "SmartDrives" have DRAM just for caching built onto the drive. Speed may also be increased by RAM disk software with which DRAM is treated as a floppy drive, meaning that programs can be loaded into it and run faster as DRAM chips have lower access times than drives.

If the built in video graphics adaptor of any of the 1000 series is being used to drive the monitor, speed may be increased by making sure that it's memory usage does not conflict with that of programs'. In machines with 640K or

less of memory, the video makes use of some of the lowest 128K and programs may have to “wait” for the video to finish. DOS uses part of this, helping to force programs into the upper memory. If RAM disk or print spooler software is being used, it can be configured to load into the lowest 128K, using it up. Installing the extra chips in machines which will hold up to 768K of memory on the motherboard will alleviate this problem, as the additional 128K is used by the video graphics. The conflict in memory usage will not occur if an additional graphics card such as VGA is being used which has it's own DRAM. The built in VGAs of the RLX and RSX have their own DRAM on the motherboard.

Math coprocessor chips, discussed in the next chapter, can offer significant increases in the speed of programs which are floating point calculation intensive.

Following is a list of the 1000 series computers and what is available to increase their processing speed.

1000 and 1000 A

Users of these two machines which come with an Intel 8088 running at 4.77 MHz may replace it with an NEC V20 for a 30 to 50 percent speed increase.

A second option is the PC Sprint. This device, created by DAS Technologies is the most popular speed upgrade for these machines. The PC Sprint's primary parts include a new CPU chip. A V20 and 8088-2 are included with the PC Sprint as some 1000s with an older ROM BIOS have trouble with the NEC V20. Also included are several different frequencies of clock crystal, so that the one with the highest clock rate which the machine will support can be found and used. Normally, the 1000 will be raised to 7.38 MHz and the 1000

A to 9.54 MHz. The PC Sprint also includes a toggle switch that can be mounted on the outside of the computer so that the user can switch back into normal speed for software that will not run at the higher rate. The PC Sprint comes with a good manual and does not require any soldering to install. A novice, should take approximately an hour to install it. The PC Sprint board measures about two by three inches and does not use one of these machines' precious expansion slots, mounting on the motherboard itself.

The 286 Express is still available from some vendors. Considering the problems which have been reported with this board, and the fact that the manufacturer is out of business, potential buyers should be extremely cautious. A good idea would be to take the machine to the place of purchase, install the board, and test it with a number of software packages. Tests should be run with the board's caching enabled. Obtaining a clearly written refund and warranty policy is also wise, as is thoroughly using the board before the warranty expires.

1000 SX

This machine has an Intel 8088-2 CPU chip which is switchable between 4.77 and 7.16 MHz. The PC Sprint does not work in this system. An option is to install an eight MHz NEC V20 chip in the place of the original CPU chip for a 30 to 50 percent speed increase.

There is a version of the 286 Express board for the SX and an adventurous user may consider this product if they get it at an attractive price. Once again, it is a good idea to test the machine thoroughly in the store with the board installed and it's caching enabled. Make sure to keep all of the

warranty materials. DCS is currently developing a motherboard upgrade for this system and a user may also choose to transfer their peripherals to a new base system.

1000 EX and HX

Both of these machines use the Intel 8088-2, switchable between 4.77 and 7.16 MHz speed. Opening either machine to replace the CPU is a tedious job. (See Chapters 18 and 19) The user should be careful when removing the silvery RFI (Radio Frequency Interference) shielding foil which is over the motherboard of the EX, as it is easily torn. This upgrade will give the user an approximately 30 to 50 percent increase in speed.

There are no 80286 or 80386 accelerator boards or replacement motherboards manufactured for the EX or HX. A current DCS project is to develop a PC Sprint type accelerator for these machines.

1000 SL and SL/2

Both of these machines use an Intel 8086-2 processor which runs at four and eight MHz. The 8086-2 can be replaced with an eight MHz NEC V30 chip to give a 30 to 50 percent increase in processing speed.

DCS sells replacement 80386 and 80486 motherboards for these systems (discussed earlier in this chapter).

1000 TX, TL, TL/2 , TL/3 and RLX

We discuss these systems as a group because they all

use the Intel 80286 operating at eight MHz in the first three and 10 MHz in the TL/3 and RLX. The NEC V20 and V30 do not work in these systems. As previously mentioned, NEC's V50 chip, a replacement for the 80286, wasn't marketed.

DCS currently sells replacement 80386 and 80486 motherboards for the TL, TL/2 and TL/3, with boards currently under development for the TX though no such boards are likely to be made for the RLX with its small case. Users of the TX or RLX may choose to transfer their hard and floppy drives, and other peripherals over to a new base computer system as sold by DCS and others. For users choosing not to buy a replacement motherboard or a new base system and not using VGA, some speed may be gained by installing the DRAM chips which bring the memory to 768K in TX, TL, TL/2, and TL/3 models which are using the built in graphics, relieving the conflict with programs for memory. Users of calculation intensive programs may consider a math coprocessor to gain speed. A fast hard disk and disk caching software may also help.

1000 RL

This machine uses an Intel 8086-1 processing at a selectable 4.77 and 9.54 MHz. Normally, it would be possible to replace the CPU with an NEC V30 but the CPU chip is surface mounted onto the motherboard. What this means, is that instead of being an oblong chip which can be pulled from its socket, the 8086-1 is instead a tiny black square which is mounted directly into the motherboard itself as are most of the other components. There are no working

80286 or 80386 accelerator boards for this system or any plans to develop them to our knowledge. Installing the chips which take the system up to 768K may relieve the conflict between the video controller and programs for the memory below 128K in machines using the built in graphics , speeding up the machine's operation. The RL does not have a socket for a math coprocessor. A user needing faster performance may choose to transfer their peripherals such as hard and floppy drives, keyboard, etc., to a new, faster base computer system of a more standard design as sold by DCS and others.

1000 RSX

There is no replacement motherboard for this 80386SX-25 machine and no way of inserting a replacement CPU chip. Adding more DRAM memory to the motherboard or a math coprocessor may increase the speed of some software packages.

CHAPTER 8

MATH COPROCESSORS

General Information

A math coprocessor, also called a numeric coprocessor is a support chip for the CPU chip that performs mathematical computations which use binary coded decimal and floating point calculations at much higher speeds than the CPU can on it's own. Intel Corporation produces a math coprocessor version for each of its processors. The 8087 is for the 8088, the 8087-2 for the 8088-2 and 8086, (it should also be used with the NEC V20, and NEC V30) while the 80287 is for the 80286, and the 80387SX for the RSX and the 80386SX DCS Powerboard. The 80387DX and 80487SX math coprocessors are for the 80386DX and 80486SX DCS Powerboards. The coprocessors for eight, 16 and 32 bit CPUs are not interchangeable. Like the microprocessors, math chips have a maximum clock rate at which they can perform.

At one time, all math coprocessors for it's family of processors were also made by Intel, but now, several other companies have also entered the market. These include Weitek, Cyrix, IIT, AMD, and ULSI.

Applications and Installation

Math coprocessors can greatly increase the speed of spreadsheets, CadCam, or other applications that are calculation intensive. AutoCad for example requires one to run.

When installing a math coprocessor in any system, the power should be turned off. The chip should be inserted so that the end with a notch is at the notched end of the socket. Figure 8.11 Insertion should be done very carefully as breaking a leg on the chip will make it useless. If unsure, have someone with more experience insert it. There are no jumpers or switches to be set when installing a math coprocessor in the 1000 series, and it is not necessary to modify the built in Setup of the machines' which have it.

Increasing the Coprocessor's Speed, the Math Sprint

Because of the way in which they use the frequency generated by the clock crystals, 80286 based computers usually run their math coprocessor at two thirds the speed of the processor. As an example, the math coprocessor in the eight MHz TX functions at about 5.7 MHz. Thus, a six MHz 80287 can be used, though faster ones will work also, albeit at 5.7 MHz. The Math Sprint by DAS Technologies is a socket which goes under the math coprocessor in 80286 machines such as the TX, TL, TL/2, and TL/3. Figure 8.12 It adjusts the incoming clock frequency so that the math chip will run at the same speed as the processor or even higher. Thus, eight, ten, or even 20 MHz math chips can be run at their top speed. Using the Math Sprint with these chips in the TL would result in respective math processing speed increases of approximately 40, 75, and 250 percent as compared to using an eight MHz 80287 without the Math Sprint.

Following is a summary of math coprocessor usage in each of the 1000 series.

Notch lines up with
notch in socket on
motherboard

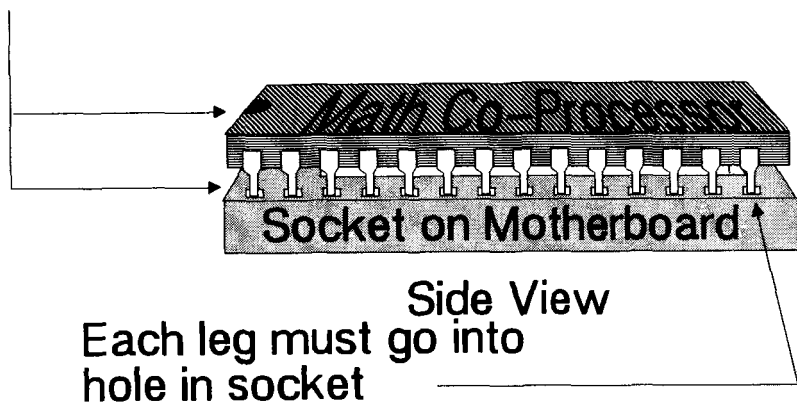


Figure 8.11 Math Coprocessor

Notch lines up with
notch in socket on
motherboard

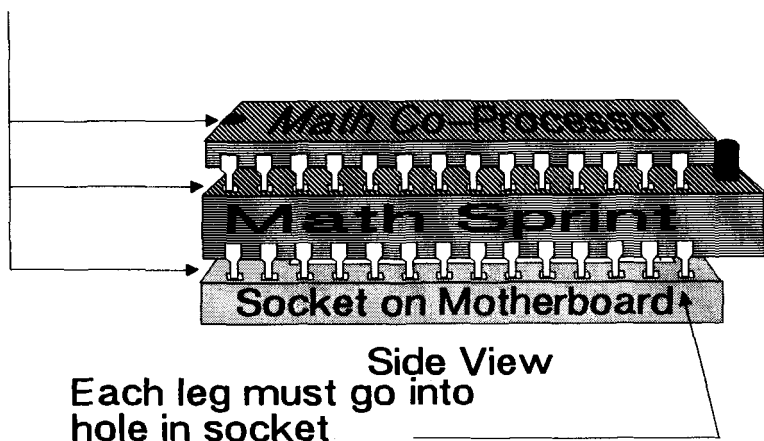


Figure 8.12 Math Sprint with Coprocessor

1000 and 1000 A

The 1000 has no math coprocessor socket to go along with its Intel 8088 processor. Trionix Corporation manufactures a socket sold by Tandy which attaches to the motherboard without using an expansion slot, and enables the machine to use an Intel 8087 sometimes referred to as an 8087-5. The 1000 A has a socket on the motherboard for this chip.

Machines with the PC Sprint installed need an 8087-2. If a 286 Express board is being used an 80287 of six MHz or higher can be installed in the socket provided on the board.

1000 SX

A socket is provided for an Intel 8087-2 math coprocessor, also sometimes called an 8087-8. Users of the 286 Express board should use a 80287 of six MHz or higher.

1000 EX and HX

Neither of these machines have a socket for a math coprocessor. DCS has designs for an adaptor to enable these machines to use a math chip, which may be marketed.

1000 SL and SL/2

Both of these machines have a socket which accepts the Intel 8087-2, sometimes called the 8087-8.

1000 TX, TL, TL/2, and TL/3

All of these machines use an Intel 80286 running at eight MHz in the first three and 10 MHz in the TL/3 as their microprocessor. Since the math coprocessor socket is run at two thirds the speed of the processor, a six MHz 80287 will function in the eight MHz machines, and an eight MHz in the TL/3. Users interested in speeding up their calculation intensive applications may want to consider the Math Sprint.

As mentioned before, Intel, IIT, AMD, and ULSI are making 80287 math coprocessors which can be used in these systems.

1000 RL and RLX

Tandy did not include a math coprocessor socket with these systems. There is no adaptor which we are aware of which will enable them to use the 8087-2 which would be necessary with the 8086-1 CPU chip of the RL or the 80287 which would work with the 80286 of the RLX. Thus, there is no way which we are aware of to add a math coprocessor to these two machines.

1000 RSX

This computer has a socket for an 80387SX-25 readily available from Tandy, DCS, and a number of other sources.

CHAPTER 9

MODEMS

General Information

A modem is a device which enables a computer to communicate through telephone lines with other personal computers or larger computers. A modem works by converting the digital signals generated by the computer to the modulated analog signals necessary for transmission over telephone lines. Conversely, the modem also changes the analog signals coming in, to the digital format equivalent. The word MODEM stands for MODulator/DEModulator. As telephone lines are designed to handle the general frequency range of the human voice which is 300 to 3000 Hz, the signals are transformed to and from this range.

The speed at which modems transmit is measured in bits per second. This term is often used interchangeably with the term, "baud rate", though in a technical sense, they are not exactly the same. The baud rate is defined as the maximum number of changes per second in the electrical state of a communications circuit. Under the RS-232C communications standard (discussed in the next chapter) the bits per second and baud rates are likely to be close to equal at lower transmission rates, while at higher levels, the bits per second is usually higher than the baud rate. This is because the electrical change which defines a baud may represent multiple bits of data. As an example, 2400 bits of data per second can be sent at 600 baud.

Standards for modems include 300, 1200, and 2400

baud with 2400 being the most popular, though models up to 19200 baud are available. Modems are usually "downwardly compatible" which means for example, that a 2400 baud modem will also function at 1200 and 300 baud. For a transmission to be conducted, the sending and receiving modems must both be operating at the same rate.

Modems are compatible with one or more communications standards. The Hayes/Bell 103 and Bell 212A are used in the U.S., Canada, and Mexico. The CCITT V.21 and CCITT V.22 are international standards.

When Hayes Corporation began producing modems for the IBM PC and compatibles, it set a standard which has been adopted by a great many others. Hayes compatible means that a modem follows the set of software commands created by Hayes to control its modems.

Modems require some sort of communications package to operate. This software, which is often sold with the modem, includes the Hayes command set and enables the user to send and receive. Popular packages include Procom and Bitcom. The Deskmate package sent by Tandy with its computers also has a communications section. Other features of such software include setting the baud rate and the telephone number to be dialed, as well as storage of often dialed numbers. Most modems have a speaker built into them so that the dialing, and the pickup of the "carrier wave" or busy signal can be heard. It is not necessary for the sending and receiving modems to use the same communications software.

Modems which can use MNP software are becoming popular. This is an error checking and data compression package which can greatly increase the speed of transmis-

sions, and is often sold with modems which can support it. To function, MNP must be in use by the sending and receiving modems. This software has various release versions like DOS which are downwardly compatible. As an example, if one machine is using MNP level two software and the other level seven, the transmission will be conducted at the lower level.

Internal and External

Almost any Hayes compatible modem made for personal computers will work in the 1000 series. Users installing an internal modem should remember that these are counted as COM ports and their COM numbers and those of any serial ports, mouse cards, scanner cards, etc. should be set so as not to conflict. (COM numbers are discussed in the next chapter on serial ports) It may also be necessary to change the interrupt request line (IRQ number) of the modem, if the communications software requires it. Usually, COM and IRQ numbers can be set through jumpers or switches on the modem in accordance with it's manual. Internal modems are installed in an expansion slot and they take their power directly from the slot. The vast majority are eight bit models and will work in the expansion slots of all of the 1000 series except for the Plus slots of the EX and HX. Though some older modems were quite long, most current models will fit easily within the 10" chassis of the 1000 series except many of the 9600 baud and higher models which are more electronically complicated.

Two phone jacks in the back plate of an internal modem are accessible at the rear of the computer. Telephone

cable, usually sent with the modem runs from one of these to the wall jack of the telephone line being used. The phone is then plugged into the second jack. The modem is thus “in the line” on the way to the telephone. When the phone is not in use, the modem can be used. Figure 9.11

Internal modems are less expensive than external versions of the same baud rate. They are considerably neater than external models as they take up no desktop space of their own and do not need serial or power cables.

An external modem has its own case and sits outside of the computer attached by a cable to a serial port. A user wishing to install such a modem should make sure that they have an available serial port and serial cable with the proper number of pins and gender on each end. If not, serial cards, nine to 25 pin adaptors, and gender changers are available from many sources. Power for the modem is obtained through an AC adaptor which is usually sold with the modem. Figure 9.12 An external modem may be chosen because of the activity lights on the outside which enable its functioning to be monitored closely. A single external modem can also be easily transported to and used with several computers instead of purchasing a separate internal unit for each.

Fax/Modems

These devices are as their name implies able to function both as fax machines and modems. Most transmit as modems at a 2400 baud rate and fax at 9600 baud. Some are able to only send fax and a user needing send and receive fax should make sure that the model they purchase can do both of these. The fax/modem is able to transmit whatever is in the

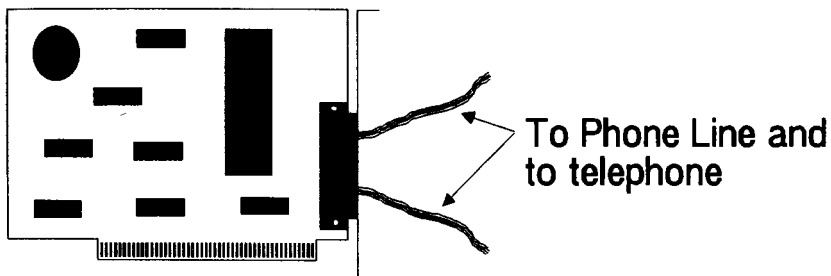
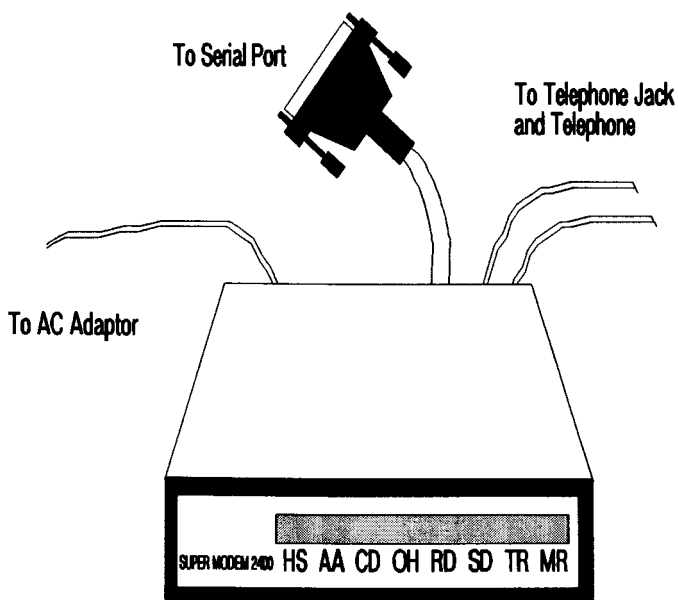


Figure 9.11 Internal Modem (Takes up a slot)



**Figure 9.12 External Modem
(Attaches to serial port)**

computer to other machines equipped with a fax/modems or to fax machines. A disadvantage compared to fax machines is that the document (such as a drawing) must first be entered into the computer. Though text may be typed in, drawings and pictures can only be entered by devices such as hand or desk top scanners. Fax transmissions received by a computer equipped with one of these boards can be printed out on an attached printer. Fax/modems exist in both internal and external form. They look much like modems and need software, usually sent with them to operate. The internal models like internal modems, occupy a COM number and different devices must be set so as not to conflict in number.

Following are notes on problems which may have to be overcome to use a modem with some of the 1000 series.

Original 1000

Some users have reported problems using internal modems in this computer as there do not seem to be the correct voltages in the expansion slots to enable the modem to function. One way of solving this is to attach an external modem to a serial port installed in the computer.

1000 EX and HX

A special note should be made for the EX and HX. Many users would like a 2400 baud or faster internal modem for these systems. Unfortunately, the only internal modems available which are able to connect to the Plus slots in these machines is the 1200 baud model sold by Tandy, though PC Enterprises advertises internal 2400 Baud modems and FAX/

Modems for these machines, which have not been tested by DCS. A user who installs a single or dual Plus serial port card in these systems can attach almost any make and speed of Hayes compatible external modem with the proper serial cable. Those who are limited to one serial port and have several add-ons may consider a serial switchbox discussed in the next chapter. Standard internal or external modems and fax/modems may also be used with the Slot Box expansion chassis (discussed in Chapter 16) attached to these computers.

CHAPTER 10

SERIAL PORTS

General Information

A serial port makes asynchronous communication easier between a computer and devices such as modems, printers, and other computers. Asynchronous data is transmitted and received by the port in a bit after bit stream as the term “serial” implies. Parallel ports, in contrast, transmit several bits simultaneously in “parallel”. A serial port also negotiates with the receiving device to make sure that transmission and reception do not suffer data loss. Asynchronous means that characters are transmitted individually as opposed to synchronous where they are transmitted in blocks.

Most serial ports for personal computers conform to the RS-232-C standard recommended by the Electronic Industries Association (EIA) for the asynchronous transmission of computer data, and are often referred to as RS-232 ports. Transmissions between the components inside a computer are usually in parallel form. Outgoing data is transformed from parallel to serial format and incoming from serial to parallel by the Universal Asynchronous Receiver/Transmitter (UART) of the serial port.

Installing Serial Cards and Assigning COM Numbers

PC compatibles will usually support several serial ports, though most users stop at two. Serial ports, internal modems, bus mice control boards, and some other input/

output control boards are assigned a COM number and must be set so that none have the same number to avoid conflicts in operation. This usually involves switches or jumpers on the board itself as well as setting the software being used such as the communications package of a modem. As an example, the serial card could be set as COM1, the built in serial port as alternate or COM2, the internal modem as COM3, and the bus mouse card as COM4 in a 1000 TL with these installed. Serial ports exist in nine and 25 pin form, and both function the same. Figure 10.11

The early models of the 1000 series did not have a built in serial port, while the later ones do. Serial ports can be added to these machines, including those with one built in if they are set not to conflict in COM number. Often, single serial port expansion cards can only be used as COM1. In machines such as the TL, which have a built in serial port, the user must go into the Setup and set the built in port as the alternate which corresponds to COM2.

Users who have a serial device which they wish to attach to their computer should make sure they have the proper cabling to connect the serial port on the computer to the one on the device. Cables with all types of ends are available as are gender changers and nine to 25 pin adaptors.

Those who wish to install a dual serial port card in their system, should make sure that the card can be set so it's ports, existing serial ports, and other add ons do not conflict in COM numbers. Dual serial cards usually have one port on the card while the second uses a cable coming from the card with the port at the end, mounted in a cover plate intended to replace the back plate in a second expansion slot next to the

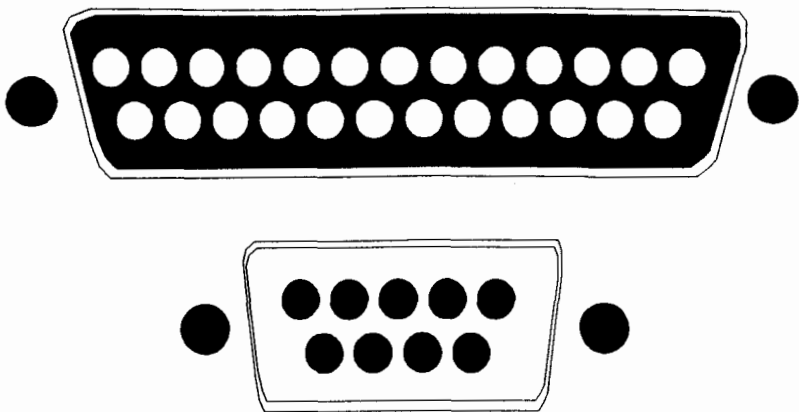


Figure 10.11 Nine and twenty five pin Serial Ports

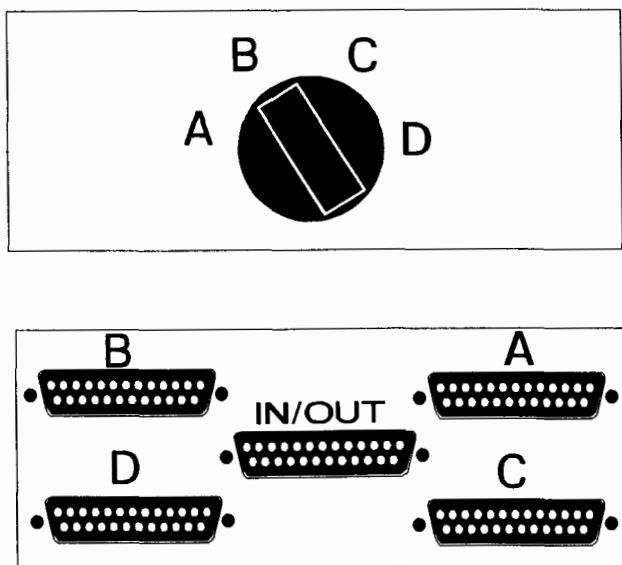


Figure 10.12 Serial Switchbox

one the serial card itself is occupies. Users who do not wish to do this sometimes let the second port protrude on it's cable unattached from the rear of the computer. The vast majority of serial port cards, use eight bit expansion slots like those in the 1000 series.

Many cards are available with a combination of serial, parallel, and game ports, often at attractive prices. A problem will arise with these, unless the game port(s) on them can be disabled to prevent conflicts with those built into the 1000 series which cannot be disabled themselves. Serial/clock cards were popular at one time, but are now hard to find. A user wishing to install both of these options in a single expansion slot may consider the Sideclock discussed in the chapter on clock/calenders.

Following is a listing of the 1000 series, what serial ports they come with and how others can be installed.

1000, A, SX, and TX

These machines have no built in serial ports. Users of the 1000 and 1000 A may choose to install a multifunction memory board which brings the system to 640K of DRAM with a serial port and clock/calendar on the same board. Several companies manufactured these boards, including Zuckerboard, PBJ, Southwestern Digital, and Hard Drive Specialists. DCS is the only company which is still selling such a board. Tandy Corporation sold a serial attachment which fits onto the Plus connector on some of it's memory expansion boards for the 1000 and 1000 A. Most PC compatible single and dual serial cards will work in the expansion slots of these systems'.

1000 EX and HX

The best known serial attachment for these machines was the one made by Tandy. This board, whose manufacture was discontinued, attaches to one of the Plus Style expansion slots on top of the memory board which is used to increase the systems' DRAM above 256K. The port on this serial board is a 25 pin female. Micromainframe, the maker of the 5150T expanded memory board also made serial ports for these systems as did Hard Drive Specialists. Though most other companies have discontinued their serial boards for these machines, DCS produces single and dual models. These provide either one twenty-five pin or two nine pin male serial ports.

An alternative to a dual serial card is to purchase a serial switchbox. A cable can be run from the serial card in the machine to the box, and devices attached to the serial ports on it. Such boxes usually have two or four serial ports. Figure 10.12 When a particular port needs to be used, the indicator on the box is turned to that one. A disadvantage is that only one of the ports can be used at a time.

1000 TX, SL, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX

All of these machines have a single built in nine pin male serial port in the back. By going into Setup, the port can be set as the primary or alternate port which means COM1 or COM2. In the TX, a jumper on E3-E4 sets the port as COM2 as this machine has no Setup. As an example, a user who installs a single serial card and also has an internal modem can use the serial card as COM1, the built in port as COM2

(or alternate) and the modem as COM3. Installing a dual serial card will not be possible unless one of it's ports can be set to a COM number other than one or two. Most brands of PC compatible serial cards will work in the expansion slots of these machines'.

CHAPTER 11

PARALLEL PRINTER PORTS

General Information

In parallel transmissions, an entire byte is sent at once, each bit along a separate line. Personal computers use this method to transfer information to most printers, though serial printers do exist.

The parallel printer port in the majority of the 1000 series is not the standard 25 pin female version of most personal computers, but instead a flattened "card edge" connector. Figures 11.11 and 11.12. This type of port functions the same, but requires a cable with a special end to attach to the computer. These are available through Tandy and other vendors. Only the RL, TL/3, RLX, and RSX have a standard 25 pin "DB25" female port.

Though an adaptor to change the parallel port on the 1000 series to a standard type could be useful, none has been marketed. A user needing a standard printer port may choose to install a parallel port card. Such a card can be inserted in an open expansion slot of any of the 1000 series with the exception of the EX and HX, though it can be used in a Slot Box expansion chassis attached to them. Parallel ports are referred to by LPT numbers in personal computers. Since there is no way that we know of disabling the built in port of the 1000 series' which is set as LPT1, the second port must be set as LPT2 so as not to conflict. A user purchasing a parallel printer port card, should make sure that the port can be set as a secondary one. Software should also be config-

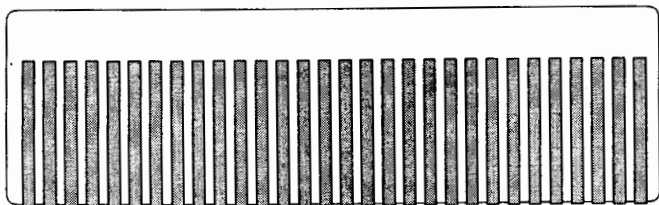


Figure 11.11 Tandy Parallel Printer Port

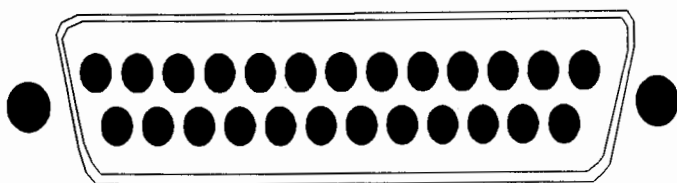


Figure 11.12 DB25 IBM Parallel Printer Port

ured appropriately for whichever port is being used.

If more than one parallel port is needed, but another cannot be installed in the machine, a switchbox may be considered. Such a box may have one Centronics style parallel port for input, and two or more for outputs (they may also have pin style ports.) Centronics parallel ports are like those found on most printers, the Tandy DMP 130 for example. To use such a box, a parallel printer cable with card edge (or standard depending on the 1000 series model) and Centronics ends attaches the computer to the switchbox. Cables with Centronics connectors on both ends run from the box to the printers. The printer to be used can be selected by the knob on the switchbox. Assuming that the computer has only one parallel port, software should be configured for LPT1 to be used no matter which port on the switchbox is being used. These boxes can also be used to connect more than one computer to the same printer.

CHAPTER 12

MICE

General Information

A mouse is an input device, with one to three control buttons in a small case designed to be rolled about next to the computer. As the mouse is moved, signals are relayed through a wire connecting it to the computer (cordless mice exist) and thus, a pointer is moved on the screen. Various commands can be sent by pressing the buttons, according to how the mouse is used by the software package being run. Mice have a measure of resolution called dots per inch or dpi that is the number of times the mouse sends a signal to the computer when moved an inch. Mice with higher dpis will move the cursor in a smoother motion and give greater control than those with lower dpis.

Mechanical

This type of mouse has a rubber coated ball set in it's underside. As the mouse is moved, the ball rotates, and optical sensors within detect the motion. Figure 12.11 Some merchants may be slightly misleading by advertising this type as optomechanical. Mechanical mice can be used on any surface which they will roll on, though a mouse pad will give the greatest control and the most consistent results, Mechanical mice can get dirt in them due to the rolling nature of the ball. Usually, with the computer turned off or the mouse disconnected, they can be opened by twisting the ring

that keeps the ball within the mouse and the ball removed. Dust can then be blown from the empty chamber and the ball itself cleaned using a cotton swab and rubbing alcohol before being put back in.

Optical

Optical mice send their changes in position to the computer, not through the rolling of a ball, but instead by detecting the reflections from a Light-Emitting Diode (LED) that shines from the inside of the mouse downward. Figure 12.12. This type of mouse requires a special pad to reflect the beam back in a manner that the internal sensors can detect, and the mouse cannot be used off the pad.

Interface Types: Bus, Serial, Game Port, PS/2

There are four ways of connecting mice to the 1000 series. Serial mice attach to a nine or 25 pin serial port and many come with adaptors for both types. An adaptor can be added to a nine pin mouse to enable it to be attached to a twenty five pin serial port. Bus mice have their own eight bit adaptor card which plugs into one of the computer's expansion slots, the mouse attaching to a special port on the card. Bus mice are treated as a COM port by the machine and should be set along with serial ports, internal modems, etc., to avoid conflicts. Tandy also markets a mouse which can be plugged into the built in game port of some of the 1000 series machines. The RL, TL/3, RLX and RSX have a built in mouse port of the same type used in IBM's PS/2 line of computers and include this type of mouse when purchased.

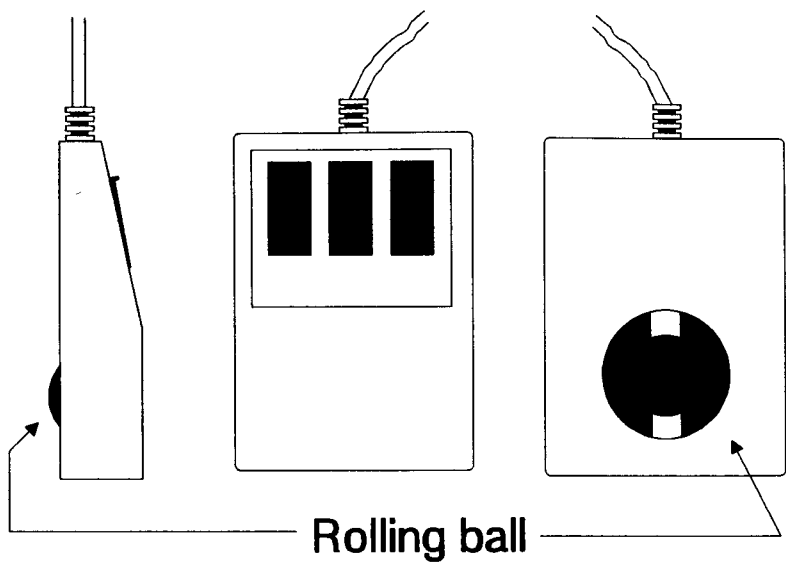


Figure 12.11 Mechanical Mouse

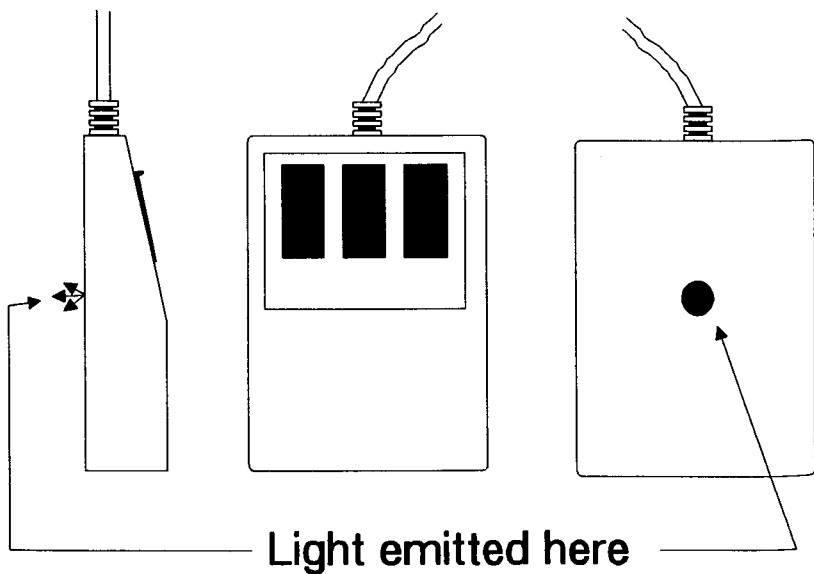


Figure 12.12 Optical Mouse

Whenever a mouse is attached to this port, the machines' Setup should be changed to show that a mouse is installed.

Mouse Software and Standards

Using a mouse is not as simple as plugging it into the computer. Mice need driver software, which is usually specific to the type of mouse and must be loaded for the mouse to run. A command may be put in the Config.sys file of the DOS being used so that the mouse driver is loaded each time the computer is booted. The software which comes with mice will usually have a file which when run will install the mouse software in the Config.sys file.

To use a mouse with a particular program, that program must be written so as to support the use of a mouse. To determine this, read the documentation, check the program's setup, or contact the manufacturer. Software which will support a mouse, usually functions with several of the major mouse types such as Microsoft, PC Mouse, Logitech and Z-Nix. If your mouse is not included in the types listed, check it's documentation or contact the seller to see if it emulates one of these major brands and set the software for that model.

There are literally dozens of serial and bus mice on the market which will work in any of the 1000 series equipped with a serial port or an open expansion slot. Tandy made a special bus mouse for the Plus slots of the EX and HX (the Digimouse) and is the only company which makes a mouse for the game ports of the 1000 series. A large number of companies now manufacture mice which use PS/2 style connectors like those on the RL, TL/3, RLX and RSX. A user considering a purchase should review features such as

interface type, optical or mechanical, compatibility with a major mouse type, dpi, whether their applications require a two or three button mouse, and if a mouse pad and the proper serial adaptor are included. Some brands may include extras such as paint program software and a holder to attach the mouse to the side of the computer when not in use.

CHAPTER 13

CLOCK/CALENDARS

General Information

Clock/Calendars, usually referred to simply as clocks, are devices that keep the correct time and date within a personal computer. They do this even when the machine is off, as they have their own battery. Clocks are accessed through software which comes with them, usually a very simple program which can be installed in the Config.sys file of DOS. It is thus possible to bring up the time or date by typing "clock". This command may also be put in the Autoexec.bat file of DOS, so that the time and date are displayed when DOS is booted. Some programs such as "Andrew Tobias's Managing Your Money" find a clock/calendar essential as the time and date of tasks are an important part of the program's function. The battery on most clock/calendars has a two or three year life.

The Tandy 1000 TL, TL/2, RL, TL/3, RLX, and RSX all have a clock/calendar built onto their motherboards. Users of other models can install one in a number of ways.

Chip clocks such as the Tandy SmartWatch and Delkin Slotless Clock Chip are one method. This type of clock is a rectangular module with 28 legs made to plug into a socket on the computer's motherboard. The clock mechanism and battery are both contained within this module. The battery in this type cannot be replaced. In some models of the 1000 series an EEPROM chip can be pulled from the motherboard, the chip clock plugged into the vacated socket

and the EEPROM chip plugged back into a socket on top of the clock. Figure 13.11 In other models, an empty socket has been left on the motherboard for a chip clock. These clocks are inexpensive and easy to install. A potential problem when this type of clock chip is installed under an EEPROM chip is the height of the clock and chip interfering with the correct seating of a hard drive card also installed in the system. The hard drive card can be moved to a slot other than the one on the far right, but then it will block other slots. Users experiencing this problem may want to consider one of the other clocks discussed in the following sections.

The Sideclock by Innoventions attaches through another method. It fits around the base of an expansion slot and leads from the clock make contact with the proper pins inside the slot, but the slot is still open for the installation of an expansion board. Figure 13.12 An advantage is that this type does not interfere with the seating of hard drive cards. The NiCad "button battery" on the Sideclock can be replaced.

The dClock II by Microsync attaches to a floppy drive. To install this clock, the wide grey ribbon cable is removed from one of the floppy drives, and the clock snapped onto the connector on the rear of the drive. The cable is re-attached to a connector on the dClockII. It is also possible to install this clock in a cable connector which is not being used by a floppy drive. The dClock II installs only in standard 34 pin card edge floppy connectors. It will not install in the pin socket connectors used on the 720K floppy drives in the new models of the 1000 series, or the connector for external floppies of the 1000 EX and HX. The clock claims a battery with a 100 year life. Microsync however, seem to have changed it's location or gone out of business.

All Notches Line up with notch in Socket on Motherboard

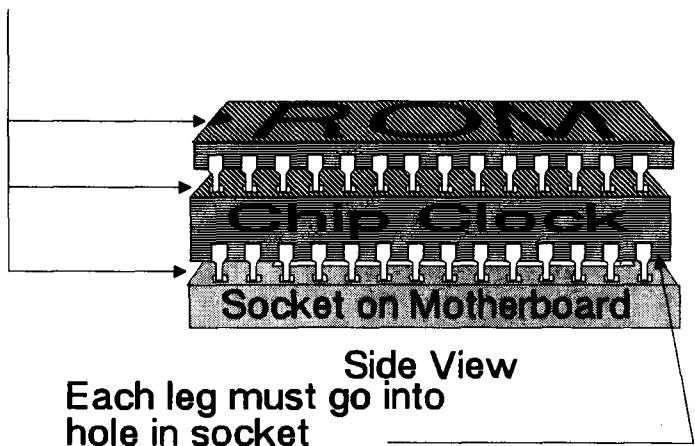


Figure 13.11 Chip Clock

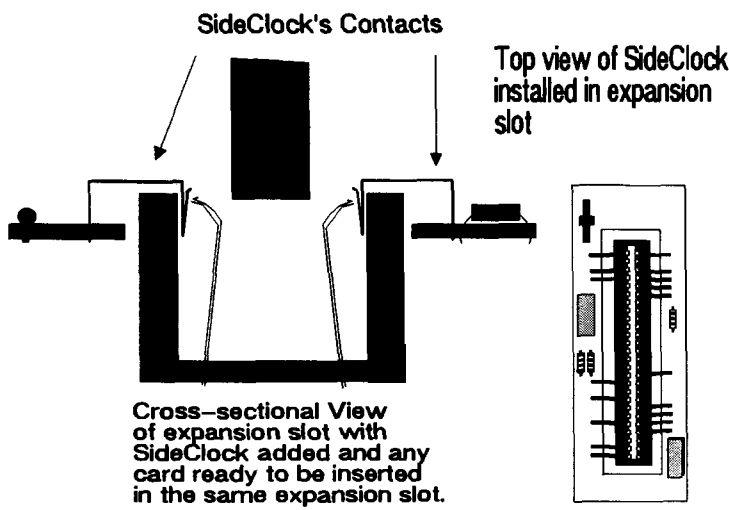


Figure 13.12 Side Clock

There are also a number of expansion boards with clocks and a combination of serial, parallel, and game ports on them. Most of these work in the 1000 series, but a user should check to see if the ports can be set or disabled so as not to conflict with the ones already in the machine. This can particularly be a problem with game ports as those built into the 1000 series cannot be disabled.

A user with a clock which is not working may try replacing the battery if this is possible. On some models, especially the chip style clocks, the replacement of the entire clock is the only recourse. Following is a listing of the 1000 series and how clock/calendars can be installed.

1000, A, SX, TX, SL, SL/2

Some models of memory board for the 1000 and 1000A such as the Zuckerboard multifunction card have a built in clock. A bad clock on a Zuckerboard can be replaced with a chip clock such as the Delkin Devices model, inserted in it's place on the board. The user should be sure to replace the software with that of the chip clock. All of these machines will accept the Sideclock and dClock II. Chip clocks can be plugged under an EEPROM chip. The SL and SL/2 have an empty 28 pin socket provided on the motherboard near the floppy drive bays to plug a chip clock into. This socket is far enough to the right that the clock doesn't interfere with the seating of hard drive cards. The 1000 SL is unable to use the clock software of any chip clock we have tested. Instead, the SLClk.com file which comes on the diskettes with the SL must be used. The SL/2 has the same problem though no such file seems to have been included

with it. The SL Clk.com also works on the SL/2 and a user may ask their Tandy dealer for a copy.

1000 EX and HX

These are the systems that frustrate users the most when trying to install clock/calendars. They cannot use the Sideclock as it will not fit onto their Plus expansion slots. There is no room inside the case to fit the dClock II to the internal 5.25" floppy drive of the EX, and the internal 3.5" drives of the HX have the wrong type of connector for it. The external floppy drive connector of these systems' is too wide for the dClock II. Unless an expansion chassis is attached, the only solution is to install a chip clock under an EEPROM chip. Though tedious, the 1000 EX and HX can be opened, and a chip clock installed. Chapter 18 details this process.

Machines with an expansion chassis such as the Slot Box can also use the Sideclock and clock cards.

1000 TL, TL/2, RL, TL/3, RLX, and RSX

All of these machines come from Tandy with a clock/calendar built onto their motherboards.

CHAPTER 14

KEYBOARDS

General Information

The original 1000 used an 84 key keyboard which was continued in the 1000 A, EX, HX, SX, and TX. In this version, all of the keys are clustered together in a fashion similar to the IBM PC/XT keyboard. Figure 14.11 This keyboard uses an eight pin connector which is specific to these machines.

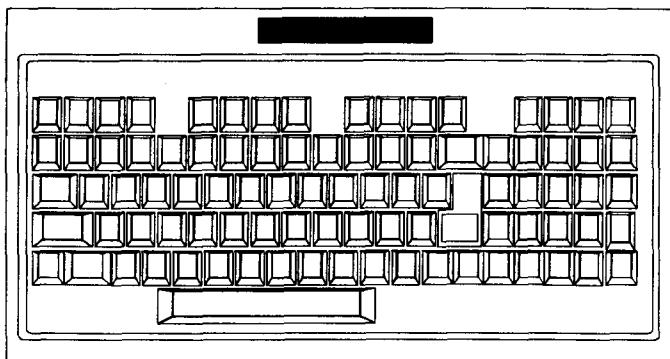
The SL, TL, SL/2, and TL/2 come with a 101 key keyboard like that of the IBM AT. In this type, several groups of keys are separate from the main body. The function keys are in a row across the top and there is a separate cluster for the arrow keys and a numeric keypad on the right. The five pin connector which attaches the keyboard to these models of the 1000 series is like that of the IBM PC/XT. Figure 14.12

The 1000 RL, TL/3, RLX, and RSX have 101 keyboards but the connector has been changed to the small six pin style similar to that of IBM's PS/2 line of computers. Figure 14.12

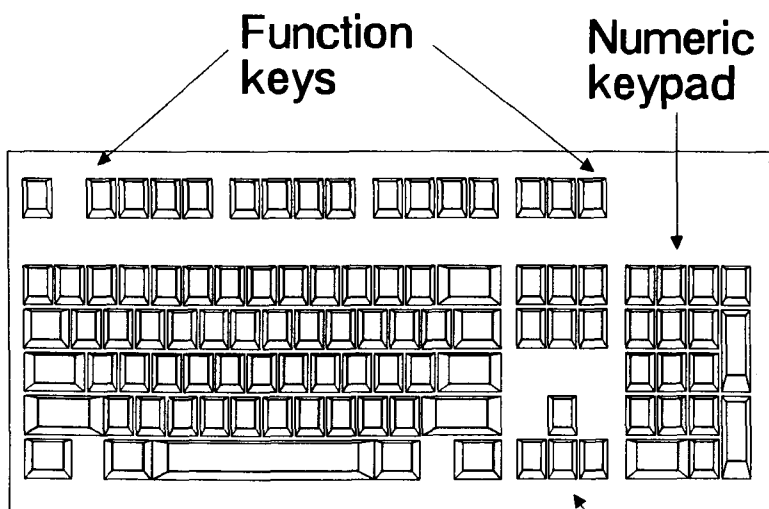
Replacement Keyboards

1000, A, SX, TX

Standard keyboards for the IBM PC, XT, AT and most compatibles will not work in these systems. With their different number of pins in the plug, they cannot even be



**Figure 14.11 Old Tandy Keyboard of
1000, A, EX, HX, SX, TX**



**Figure 14.12 101 Keyboard.
SL, TL, SL/2, TL/2, RL, TL/3, RLX, RSX
Datadesk T1000, Northgate Omnikey 101**

**Arrow
keys**

attached. Two companies make replacement keyboards for them. The models of these keyboards for the 1000 series do not function exactly the same as those for other PC compatibles, as the BIOS of the Tandy machines was not designed to support them.

The Datadesk Turbo T1000 has been produced for several years. This keyboard, available directly from Datadesk and a number of mail order outlets, is a 101 key model which will attach directly to these machines without any sort of special adaptor. Figure 14.12 The purpose of some of the keys' of the T1000 can be changed by means of switches to make it more comfortable to the user who can't quite break away from the original Tandy keyboard's layout. These changes include swapping the Caps Lock with the left Ctrl key. The T1000 has a three year warranty.

Northgate Computers, well known for its line of IBM compatible computers, also makes versions of its keyboards for these four models of the 1000 series. The Omnikey 101NI is a standard layout 101 key model. The Omnikey 102 has the function keys on the left instead of the top. The Omnikey/ Ultra takes this even further, with the function keys on the left, and a row of switchable special function keys across the top. The version of the Northgate keyboards for these machines are "plug compatible" not needing any sort of special adaptor. As previously mentioned, some of the keys will not function the same on the Tandy machines as on other compatibles. The Northgate keyboards have a five year warranty.

The Datadesk and Northgate models feature tactile feedback in the action of the keys which is a complicated way of saying that the feel is "crisper".

Tandy also manufactured a keyboard adaptor for these machines. This box shaped device is plugged into the computer's keyboard jack, and the keyboard plugged into the adaptor. It will accept almost any 101 keyboard with an IBM PC/XT compatible mode. This adaptor also includes software drivers which need to be copied into the Config.sys of DOS being used, so that the keyboard will function each time the computer is booted. The complexity of this method, the cost of the adaptor and a keyboard, along with the availability of the Datadesk and Northgate models have kept it from becoming very popular.

1000 EX and HX

There are no replacement keyboards for the 84 key version built into these two machines. There is no external keyboard jack to support such a replacement.

1000 SL, TL, SL/2, TL/2

The five pin keyboard outlet of these machines will accept most 101 keyboards with a PC/XT mode. A user who desires a new keyboard, perhaps because of damage to the original, has a large number of choices. Fujitsu and Maxiswitch make popular models. A user looking for a more sophisticated keyboard might consider the Northgate Omni-key/Ultrakey with its function keys on the left and switchable special function keys across the top. When purchasing a replacement keyboard for these models of the 1000 series, it is important to specify one that will function on the IBM PC/XT not the older Tandy 1000 models.

1000 RL, TL/3, RLX, and RSX

The 101 keyboards of these machines are similar in layout to those of the SL, TL, SL/2 and TL/2 but use a small six pin connector similar to that of the IBM PS/2s' to attach to the computer. A user looking for a keyboard with more features might consider the Northgate Omnikey/Ultrakey discussed earlier, making sure that they specify the model with a PS/2 type connector when placing the order.

CHAPTER 15

OPERATING SYSTEMS

General Information

All of the Tandy 1000 series are sold with a version of the Microsoft Disk Operating System referred to as MS-DOS or simply DOS. This is on diskettes, and ranges from 2.11 for the original 1000 to 5.0 for the latest model, the RSX. Beginning with the 1000 HX, and continuing with the SL, TL, SL/2, TL/2, RL, TL/3, and RLX the DOS is also in EEPROM chips on the motherboard where it can load automatically when the machine is turned on without using a floppy drive. The DOS 5.0 of the RSX is already installed on the hard drive when the machine is purchased.

Many users believe that the DOS version of their system cannot be upgraded to a higher level, or that only Tandy versions can be used. Neither of these is true, although loading a Tandy DOS version on another brand of computer may give an error message. Complete Microsoft and Phoenix (this company has a license to produce DOS) versions are readily available from a number of sources. Using another version of DOS is as simple as loading it from a floppy or hard disk drive. If the machine is one of the models which have a version of DOS built in, the Setup program which comes with it should be run and changed so that the initial start-up device is disk and the initial start up program DOS not Deskmate. A popular rumor is that there exist replacement EEPROM chips to upgrade the built in DOS of those machines. To our knowledge, no such chips exist.

Users of the older models of the 1000 series may choose to upgrade their DOS when they install a hard disk drive. This is because DOS versions of the 2.XX series can only handle logical drives of up to 16 megabytes. What this means, is that a 20 megabyte drive being formatted with a 2.XX series DOS, will need to be partitioned so the machine views it as two drives or more, each of 16 megabytes or less, that add up to 20 megabytes, perhaps two of 10 megabytes each. The 3.XX series DOS versions can address up to about 32 megabytes per logical drive so a 20 megabyte drive could have all of its space allocated to one partition. A 40 megabyte drive however, would need to be split up, perhaps into two 20 megabyte partitions or a 32 and a eight. All of the 1000 series machines will run the 2.XX and 3.XX series DOS versions. As discussed in the chapter on hard disk drives, the Tandy DOS versions 3.20.21 and 3.20.22 have a formatting procedure for hard disks which is more complicated than other versions of the 3.XX series.

Many 1000 series users are tempted by the DOS 4.01 or DOS 5.0 which can address up to 512 megabytes in a single hard drive partition and have operating shells to interface with the user somewhat like the Macintosh computer. They may have trouble with the 1000, A, EX, HX, SX, and TX keyboards. The addition of a 101 keyboard will usually solve most of these for the SX and TX though less so for the 1000 and 1000 A, indicating possible BIOS conflicts. There is no way of upgrading the keyboards of the EX and HX. A user may want to carefully evaluate whether or not they should use DOS 4.01 or DOS 5.0 on the 1000, A, EX, or HX.

DOS 5.0 can use the memory between 640K and

1024K (one megabyte) in an RLX which has this amount installed and the memory above 640K in the RSX. This DOS can also be "loaded high" in machines using the DCS replacement 80386 and 80486 motherboards discussed in Chapter Seven.

Many 1000 Series users would like to load DOS 5.0 into the memory provided by an expanded memory board such as the Micromainframe 5150T. This cannot be done, as board is expanded not extended memory. As previously discussed, extended memory can only be installed in the RSX.

As far as we know, OS/2, the new operating system introduced by IBM for it's PS/2 line of computers does not work on any of the 1000 series machines except the RSX. Microsoft Windows 3.0 works on the TX, TL, TL/2, TL/3, and RLX which have an 80286 processor, albeit somewhat slowly though 3.1 will not. Users may find it helpful to install the Micromainframe 5150T EMS memory board discussed in Chapter 1 to use Windows 3.0 in these machines. Both OS/2 and all versions of Windows will run on the 1000 RSX and machines with the DCS upgrade motherboards.

CHAPTER 16

ADDING EXPANSION SLOTS

General Information

All of the 1000 series with the exception of the RSX have at least one eight bit expansion slot for attaching upgrades such as memory boards, hard drive controllers, secondary floppy drive controllers, modems, etc. The majority have standard eight bit 62 pin card edge slots like those in the IBM PC/XT. The TX, TL, TL/2, TL/3, and RLX use a 16 bit 80286 microprocessor, yet unlike most other machines of this class, have only eight bit expansion slots rather than 16 bit. The slots of the EX and HX are a form of eight bit unique to Tandy machines called Plus style. Only the RSX has sixteen bit expansion slots of which it has two. Figure 16.10 illustrates these slot types.

By integrating functions such as graphics, floppy controllers, and printer ports onto the motherboards of it's systems, Tandy has relieved some of the need for slots in the 1000 series. Still, as the power and variety of upgrades grow, users seek ways to attach them to what in several cases are the very limited expansion slots of the 1000 series.

The Slot Add Card

Developed by Merak Industries and sold by several mail order vendors, this card plugs into the far right hand slot in the 1000, A, and SX. Four eight bit slots are set into it's surface and expansion cards up to seven inches long can be

Eight Bit Slot
Tandy 1000, A, SX,
TX, TL, TL/2, RL, SL,
SL/2, TL/3, IBM PC/XT



Sixteen Bit Slot, RSX, DCS Motherboard
Upgrades, IBM AT or compatibles



Eight bit plus style
expansion slot
Tandy EX & HX



Figure 16.10 Different Types of Expansion Slots

plugged into them, sticking out horizontally in front of the machines' fan. Figure 16.20 This card retails for less than \$100, though it may now be discontinued.

Perhaps the biggest drawback to this card is that it needs to be plugged into the far right hand slot. This is also the slot where a hard drive card needs to be so that it's bulk can protrude into empty space and not interfere with access to other expansion slots. Thus the Slot Add Card can not be used in the same computer with a hard drive card. A user can circumvent this by installing a hard drive in place of one of the floppy drives or externally.

It may also be difficult to use boards which need to be attached to external cables, such as an internal modem, in the Slot Add Card, as no holes are provided in the computer's case for this. The Add Card has a hole in its back plate for this, but it is still not possible to use some boards which need connection to external cables in it. As the card has no power supply of its own, running too many boards can overtax the power supply of the machine it is installed in. Using an external hard drive with it's own power supply can help to alleviate this.

Expansion Chassis

The most sought after yet elusive slot adding device for the 1000 series is the almost mythical expansion box, or expansion chassis. It seems that every year a company announces such a device, takes orders and sometimes credit card numbers, then abruptly, callers are informed that they have reached a number that has been disconnected. Users often begin to wonder if such boxes do in fact exist, and if so,

You will install any Tandy/IBM compatible card up to eight inches in length in any of the four expansion slots provided by the Add Card.

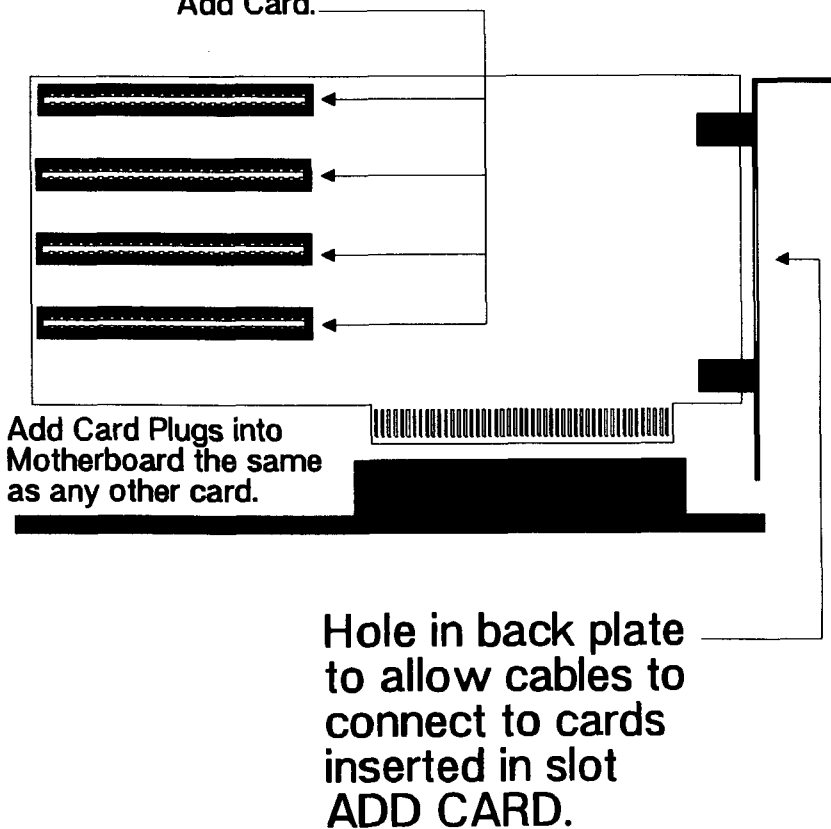


Figure 16.20 Slot Add Card

why aren't they sold for the 1000 series.

What many 1000 series owners have desired is a device with it's own cabinet which connects to their machine by a cable which plugs into an expansion slot. This device, would have five or more expansion slots of it's own which would effectively be added to those within the computer. Preferably, it would also have a power supply and at least one bay for floppy or hard drives. Users whose expansion slots were all full could attach such a box to add devices such as modems, memory expansions, serial cards, hard drives, and graphics cards.

The primary problem which would be expansion box tycoons have had to deal with is enabling the Tandy computers to communicate consistently with the added slots. The signals coming from the expansion bus of the 1000 series and most other PCs for that matter, isn't strong enough to travel through a great length of cable. It is possible to add what are known as "line drivers" to each end of the cable to boost the strength of the signal, but these greatly increase the cost. Problems in the timing of signals to and from the added slots may also arise, as they have to travel through a length of cable.

Sophisticated expansion boxes with line drivers have existed for some time, and are even available in eight bit versions, though most are 16 bit. These boxes are designed to be used primarily in industrial and laboratory environments where there is a need to attach a number of boards for controlling or monitoring to a single computer. Two companies selling expansion systems like this are Kiethley Metrabyte and Personal Computing Tools. Both of them retail for over \$1,000 which is prohibitively high to most Tandy users who

may have paid less than that for their entire computer system.

Another approach is taken by PC Horizons which deals with the signal strength problem by making the cables between the computer and their expansion box only about two feet in length. This box, which retails for \$549 has five expansion slots and a 60 watt power supply. Grounding problems between the box and the computer are reduced by plugging the box into the wall and the computer into the box through an included adaptor. The PC Horizons box seems to work in all of the 1000 series with eight bit expansion slots except for the 1000 EX and HX. In tests at DCS with these two machines, the box performs erratically. A hard drive installed in the box will sometimes be accessible, sometimes not. PC Horizons does not sell its expansion box to be used with these systems and does not include an adaptor to attach it to them. A disadvantage of this box is that it has no bays for floppy or hard disks, though a hard disk card can be installed.

As the EX and HX are the two machines for which an expansion box is most desired, the inconsistent results of such boxes connected to them is very frustrating. Testing has shown that a cable like that used in the Plus to standard slot adaptors of the hard drive controllers for these systems can only be about nine inches in length. At distances greater than this, the signals reaching the additional slots are too weak, and performance sporadic. A nine inch cable would not be long enough to reach an expansion box.

Currently available from DCS is the Slot Box expansion chassis with seven slots for all of the 1000 series, with eight bit expansion slots including the EX and HX, with a 36 inch cable length. This chassis, which seems to solve many

of the previously discussed problems, has a 200 watt power supply with cooling fan, two 5.25", and one 3.5" drive bay. Figure 16.30. Devices tested in the Slot Box include hard drives, floppy drives attached to secondary controllers, above 640K EMS board, serial cards, CD-ROM drives, and VGA cards. Below is a table summarizing what products can be used in a Slot Box attached to the models of the 1000 series. Another models of Slot Box is currently under development for the RSX and other machines (80386s, 80486s, etc.) with 16 bit expansion slots. Below is a table summarizing the products which can be used in a Slot Box attached to the models of the 1000 series.

Hard Drives-

1000, A, EX, HX, SX, TX, SL, TL, SL/2, TL/2, RL, TL/3, RLX. Drive controllers for the 1000, A, EX and HX need to be able to use interrupt two (IRQ2).

360K, 1.2 megabyte, 720K, or 1.44 megabyte floppy drives attached to a controller such as the Compaticard II Megamate by Microsolutions-

EX, HX, SX, TX, SL, TL, SL/2, TL/2, RL, TL/3, RLX.

VGA Cards,

EX, HX, SX, TX, SL, TL, SL/2, TL/2, RL, TL/3, and RLX. Cards using the Trident chipset produce the best results.

CD-ROM Drives-

All models of the 1000 series. The Tandy CDR-1000 will not work with the 1000, A, EX, or SX.

Micromainframe 5150T above 640K memory board-

All models of 1000 series.

Serial Cards-

All models of the 1000 series.

Accelerator boards-

Not compatible with any models of 1000 series using the Slot Box cannot be used in the computer or an attached Slot Box because of RFI (Radio Frequency Interference) put out by this accelerator board.

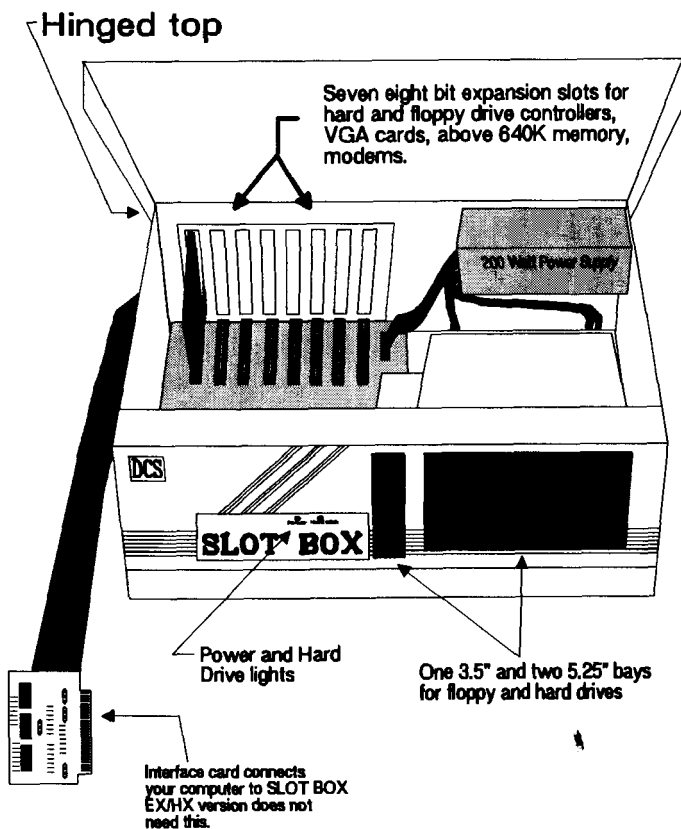


Figure 16.30 SLOT BOX

CHAPTER 17

A SUMMARY OF COMPATIBILITY

Users considering the purchase of a computer often ask how compatible the machines of the 1000 series are, using the IBM PC/XT, and AT as a standard for comparison. The ROM BIOS (Read Only memory Basic Input/Output System) of the 1000 series is designed by Phoenix Technologies a company which is generally considered to have set the standard. The 1000's are thus as compatible if not more so than most machines in being able to run the same software as IBM personal computers.

Compatibility in the ROM BIOS does not necessarily translate into compatibility in use. A discussion of compatibility in other areas follows.

Hard Disk Drives-The 1000 A, EX, and HX use hardware interrupt two (IRQ2) for the hard disk controller. All other models of the 1000 series use IRQ5 like the IBM PC. The BIOS on the original 1000 needs to be upgraded to 1.01 to use a hard drive. Hard drive cards must be a shorter 10" in length rather than 13".

Floppy Disk Drives-Those of the 1000 series are standard 360K or 720K types. Only the TL/3, RLX, and RSX have built in support for high density drives, the TL/3 and RSX for 1.2 and 1.44 Meg versions (though the RSX has no internal 5.25" Drive bays), the RLX for only the 1.44 Meg. All of the other machines with the exception of the 1000 and 1000 A, will support the secondary floppy controllers necessary to

add high density drives, though the EX and HX need an expansion chassis to put the controllers in. The HX, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX supply power to their 3.5" drives through the 34 pin signal cable unlike most machines which have a separate power lead.

Graphics-All of the 1000 series except the RLX and RSX, the have a built in improved version of CGA sometimes called Tandy Color Graphics Adaptor (TCGA) with greater color selection and resolution. The 1000, A, EX, HX, SX and TX also have composite output, while the SL, TL, SL/2, TL/2, RL, and TL/3 can generate Hercules compatible graphics in addition to TCGA. The RLX has built in standard 640 X 480 VGA, the RSX 1024 X 768 SuperVGA (with 512K of video memory installed.) The graphics on the 1000 and A, cannot be upgraded because of their ROM BIOS. The graphics of all other models can be upgraded though the EX and HX must have an expansion chassis attached to insert the new graphics board into.

Memory-Use standard DRAM chips except for RLX which can add a second 512K of DRAM using four Zig Zag In Line Package or "ZIP" chips and the RSX which uses SIMM strips. All can use L1MM EMS expanded memory though the EX and HX need an expansion chassis to add the standard expansion slots to put such a memory board into. Only the RLX and RSX can use extended memory, though the RLX is limited to 384K of extended memory.

Keyboard-The 1000, A, SX, and TX use a unique five pin connector. The EX and HX have a built in keyboard and no

place to attach another. The SL, TL, SL/2, and TL/2 use an eight pin connector like the IBM PC. The RL, TL/3, RLX , and RSX use a six pin connector like that of the IBM PS/2s. The keyboard layout of the first six machines (1000, A, EX, HX, ST, TX) is like the 84 key IBM PC keyboard. The others have a 101 keyboard similar in layout to that of an IBM AT and PS/2s'. Upgrade keyboards are available for all but the EX and HX.

Expansion Slots-With the exception of the RSX, all of the slots in the 1000 series are eight bit versions, even those of the TX, TL, TL/2, TL/3, and RLX with their 16 bit 80286 processor. The 16 bit slots of the RSX will accept both 16 and eight bit expansion boards.

The EX and HX have Tandy's Plus style slots which will not accept standard add-ons. The slots in the other machines will accept standard eight bit cards up to 10" in length, compared to the IBM PC/XT's 13". The 1000 series machines have from one to five slots while other compatibles and IBM PC/XT usually have up to eight.

CHAPTER 18

OPENING THE MACHINES

General Information

Getting inside most of the 1000 series is as simple as removing two Phillips head screws. On the 1000, A, SX and TX, these are located in the left and right sides of the computers' front panel. The SL, TL, SL/2, TL/2, RL, TL/3, RLX, and RSX have them in the sides of the case toward the rear. By removing these screws and sliding the cases off, access can be gained to the motherboards and expansion slots of these systems. Chapter 19 includes diagrams of the motherboards of the 1000 series. If the upgrade is being installed in an expansion slot, of any machine but the EX and HX, the flat metal peg covering the opening at the rear of the slot should be removed. This is done by removing the Phillips head screw holding it, then lifting the peg free. The screw, should be saved and used to secure the upgrade (such as a hard drive card) in place. Always turn the computer off before opening it. Work on a surface with as little static as possible and touch something conductive to dissipate any charges before beginning work.

The 1000 EX and HX have a sliding panel on the top left hand side of the case. Removing, this will give access to the compartment where the memory board to raise the machines above 256K can be attached as well as other upgrades. Horizontal plastic panels cover the backs of the expansion slots in these machines, and must be removed to make room for upgrades.

Gaining access to the EX and HX motherboards for the installation of clock chips and NEC V20 speed up chips is a rather complicated process which is detailed on the next several pages. The tools you will need are medium size Phillips and straight edge screwdrivers and a pair of needle nose pliers.

1000 EX

1. Turn the machine off, and unplug it. Set it upright on a static free surface with the keyboard facing forward as if to use it.
2. Remove the sliding plastic cover of the memory board compartment. This is on the left hand side of the machine's top.
3. This compartment may hold a memory board that raises the machine above 256K. It may also have other boards in it such as a serial card, modem, or hard drive controller. All of these boards, including the memory board, need to be removed from the compartment. Some of them may be secured to the rear of the computer by screws. These screws should be removed before gently pulling the boards free.
4. In the plastic braces on the left hand side of the bottom of the compartment are two screws with rounded Phillips heads. Remove them and set aside.

5. Now, carefully turn the machine bottom side up. There are nine Phillips head screws sunk into screw wells along the outer edge. Six of these are short, three long. Remove all nine and set them aside. The top half of the case is now disconnected.

6. Carefully turn the machine upright again. Grip the edge of the memory board compartment, remove the top half of the case and set aside.

7. It is now necessary to remove the aluminum case with the floppy drive in it. First, disconnect the wide ribbon cable and power cables from the rear of the drive. Note that the side of the ribbon cable with a stripe is toward the front of the machine for re-assembly. There are two rounded Phillips head screws holding the rear of the floppy drive case down and one holding the front. A fourth screw holds an aluminized grounding strip against the front of the floppy drive case. Remove all of these and set them aside. Now lift the enclosure with the drive inside out of the machine and set aside.

8. Locate where the wide floppy controller cable connects to the bottom of the computer and pull it free. Notice that the edge of the cable with the stripe on it goes toward the front of the machine for re-assembly.

9. It is now necessary to remove the keyboard. Locate the two wide cables coming from the keyboard and going to black connectors on the bottom of the computer. By pressing in on the ends of these connectors and pulling upwards, the flat cables will be released. The connectors themselves stay on the bottom of the machine. Next to the wide cables is another cluster of smaller wires from the keyboard. Unplug these from the bottom of the computer also. There is one screw with a rounded Phillips head at each end of the keyboard. Remove and set aside. The keyboard can now be lifted out and set aside.

10. Locate the power supply in the left rear corner of the machine. Unplug the two clusters of cables which come out of it from the bottom of the machine. Do NOT remove the power supply.

11. The silvery RFI (Radio Frequency Interference) shielding over the motherboard must now be removed. Three small hexagonal nuts with washers are set near the middle of this shielding and one toward the front. Remove all four of the nut/washer combinations and set aside. A tab connects the shielding which was under the keyboard to that over the motherboard. Disconnect the two. It will probably be

necessary to slowly peel the copper strip, which also connects them, free from the main part of the shielding. The shielding over the motherboard is secured by three straight edge flat head screws along its right hand side. Remove these and set aside. It is not necessary to remove the screws on the left side of the shielding. Carefully lift the right side of the shielding. The small piece of shielding for the back of the machine may come loose from the main portion and have to be re-attached during re-assembly. With the shield folded back to the left, the motherboard is now exposed.

1000 HX

1. Turn the machine off, and unplug it. Set it upright on a static free surface with the keyboard facing forward as if to use it.
2. Remove the sliding plastic cover of the memory board compartment. This is on the left hand side of the machine's top.
3. This compartment may hold a memory board that raises the machine above 256K. It may also have other boards in it such as a serial card, modem, or hard drive controller. All of these boards, including the memory board, need to be removed from the compartment. Some of them may be secured to the rear of the

computer by screws. These screws should be removed before gently pulling the boards free.

4. In the plastic braces on the left hand side of the bottom of the compartment are two screws with rounded Phillips heads. Remove them and set aside.

5. Now carefully turn the machine bottom side up. There are nine Phillips head screws sunk into screw wells along the outside edge, six of them short, three long. These are easy to locate as there is a diagram of a screw next to each. Remove all nine and set aside.

6. The plastic top of the case is now detached from the bottom, so carefully turn the machine upright again. Grip the case at the edge of the memory board compartment and pull the top free. Any resistance may indicate that all of the nine screws have not been removed from the bottom of the machine. Set the top of the case aside. The EEPROM chip under which a chip clock can be installed is now exposed, protruding through the metal near the memory board connector. If this is the only upgrade to be done, it can be installed and the machine closed. Those needing more access to the motherboard, perhaps for installation of a NEC V20 chip, should continue to step seven.

7. It is now necessary to remove the aluminum enclosure which houses the floppy drive(s). At the rear of this enclosure, next to the back of the machine are two screws with flat, Phillips heads. Remove them and set aside. You will notice that these screws are covered by an aluminum tube on the top part of their length. Do not try to remove this tube. Now, grip the rear of the floppy drive enclosure and tilt it forward, but do not remove. This will give access to the flat ribbon cable going to the back of the floppy drive(s). Detach this cable. Since the HX supplies power and signal to the floppy drive(s) through a single cable, there is only one cable to detach from the drive(s). It is now possible to remove the aluminum enclosure, floppy drives and all, by pulling the front lip of the enclosure from the slot it is inserted into. Set the enclosure with the drive(s) in it aside.

8. Two screws with flat Phillips heads hold the metal lip which the front of the floppy drive enclosure was inserted into. Remove these screws and the metal lip.

9. Locate where the flat cable for the floppy drive(s) attaches to the bottom of the machine and detach it. Note that the edge of the cable with the stripe on it goes toward the rear of the machine for re-assembly.

10. The power supply of the machine is an aluminum box in the rear left hand corner. Six wires come out of it and go to a plug which is attached to the bottom of the machine. Pull this plug loose from bottom of the machine. Do NOT remove the power supply.

11. It is now necessary to detach the keyboard. Locate the two flat ribbon cables going from it to black connectors on the motherboard. Grip the ends of these connectors between thumb and forefinger, press, and pull the ribbon cables free. The connectors will remain on the motherboard. There is a group of smaller wires to the right of flat ones which connect the keyboard lights to the motherboard. There is also a plug for the wires which go to the speaker. Unplug both of these groups of wires. There is one flat Phillips head screw at each end of the keyboard. Remove them and set aside. The keyboard can now be lifted free and set aside.

12. The metal plate which covers the motherboard of the machine is now exposed. The plate is secured by six flat head Phillips screw at each of the four corners, and in the center of the left and right hand edges'. There is also a hexagonal nut near the rear left corner. Note: By removing only the screws, the right side of the metal plate can be carefully lifted with the

hex nut still attached, gaining access to the motherboard without breaking the sticker on the left which voids the warranty. If this is not a concern, remove the hex nut also. The metal plate can now be lifted free, exposing the motherboard.

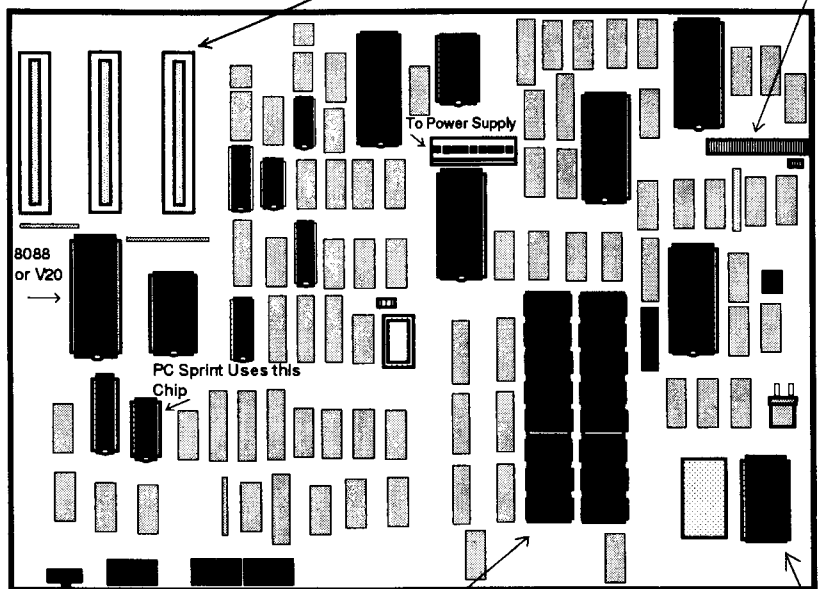
CHAPTER 19

MOTHERBOARD DIAGRAMS

This chapter shows the layout of the 1000 series motherboards, labelling the components which are important in doing upgrades. Some models have more than one version of motherboard and users should check carefully to determine which their machine matches. If you have a version not listed here, contact us as we'd like to add it to the book.

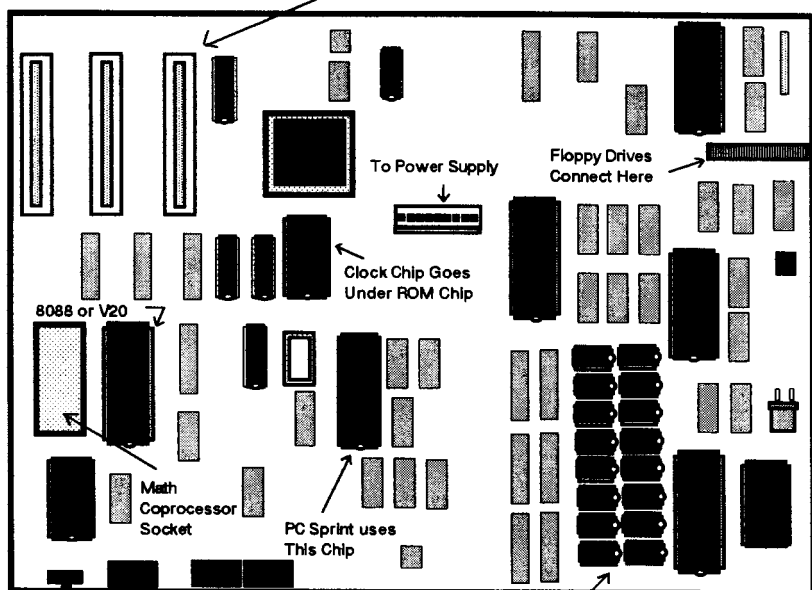
Three Expansion Slots. Hard Drive Card Goes Here

Connects to Floppy Drives

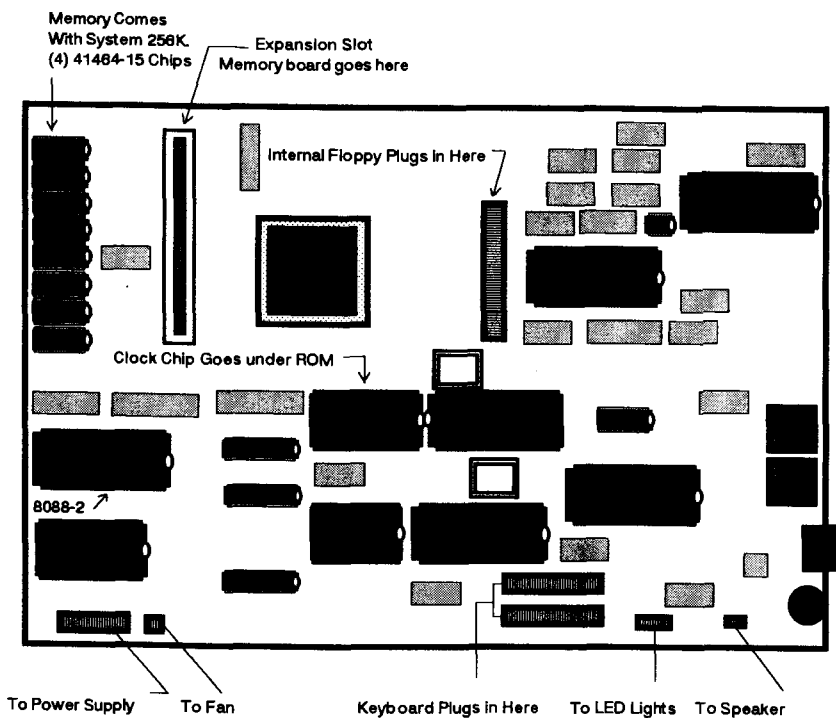


1000

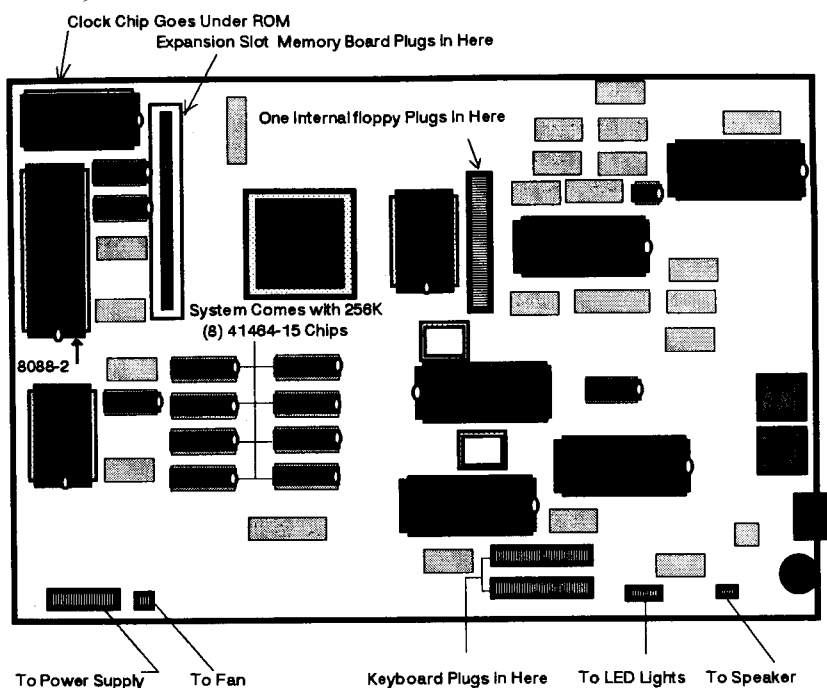
Three Expansion Slots. Hard Drive Card Goes Here



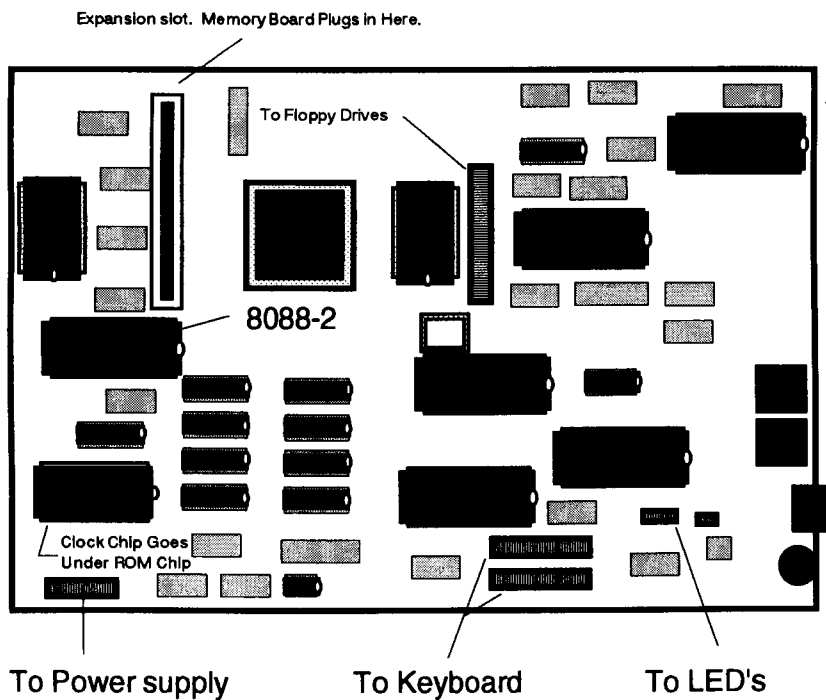
1000 A



1000 EX version 1

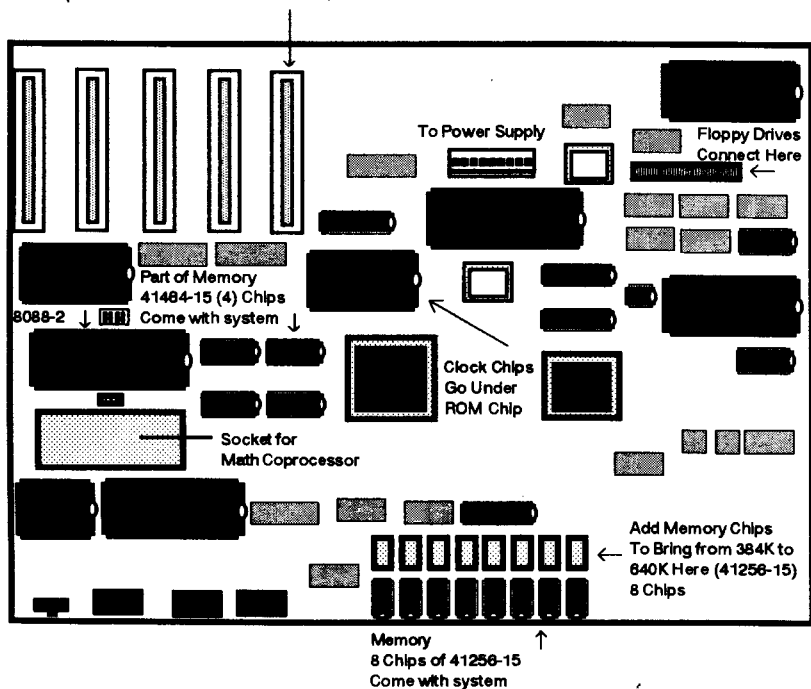


1000 EX Version 2

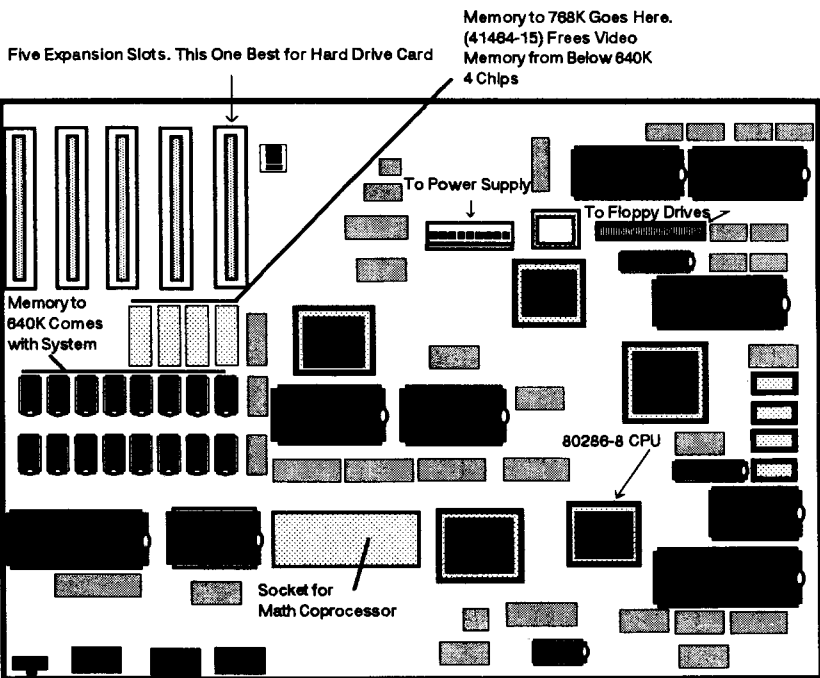


1000 HX

Five Expansion Slots. This one best for Hard Drive Card

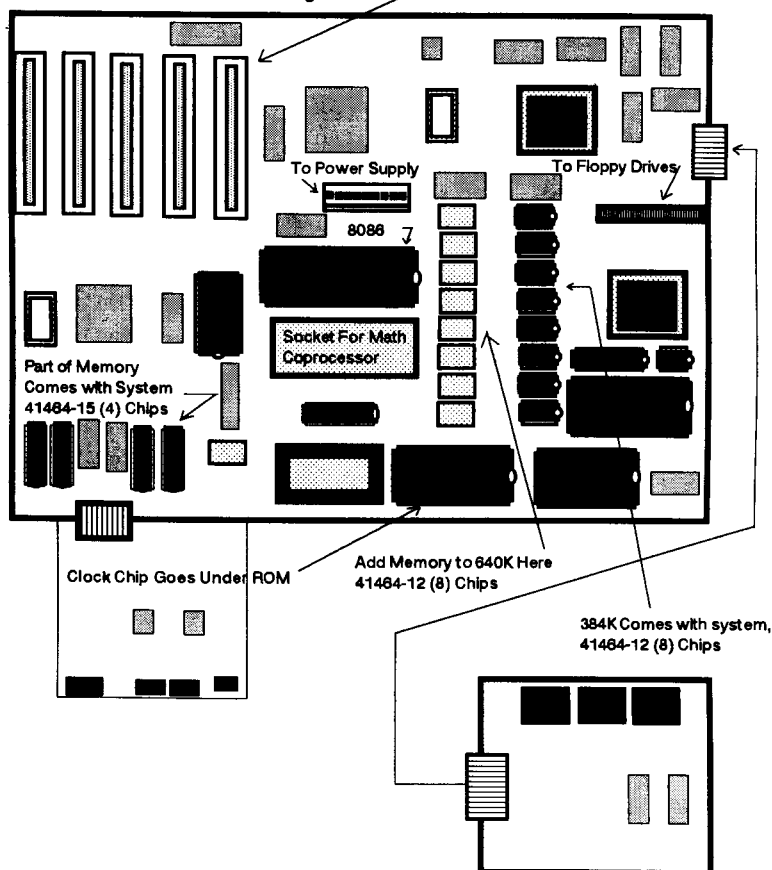


1000 SX



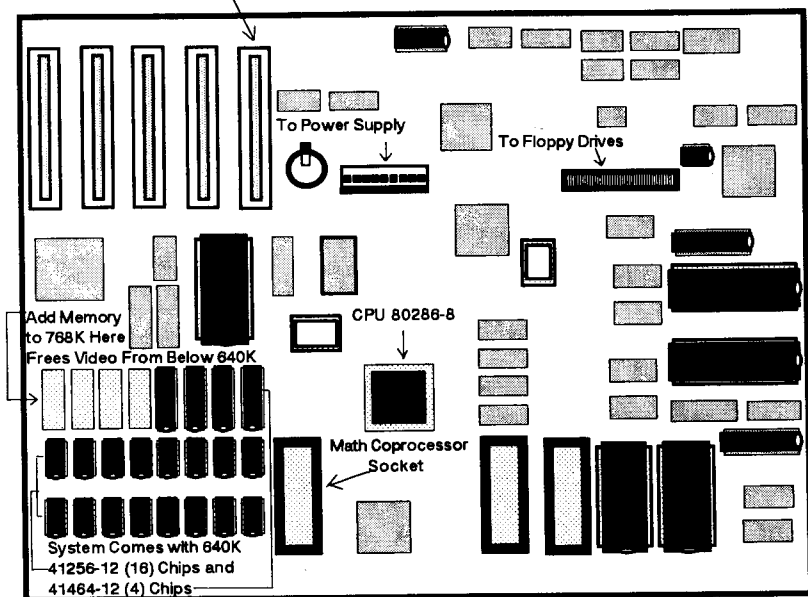
1000 TX

Five Expansion Slots. Hard Drive Card goes Here.



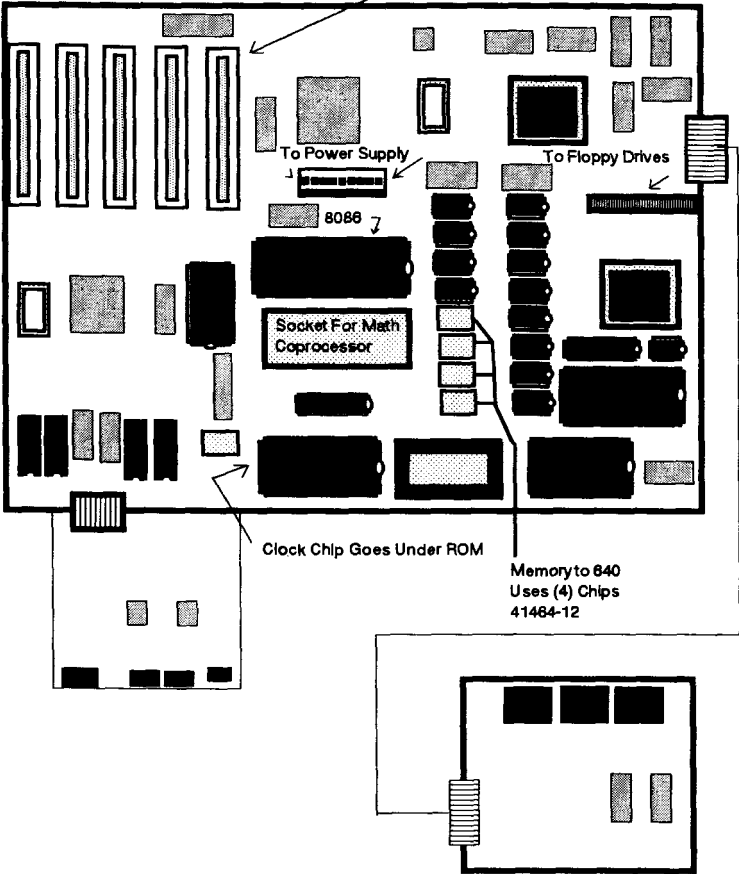
1000 SL

Five Expansion Slots. This One Best for Hard Drive Card



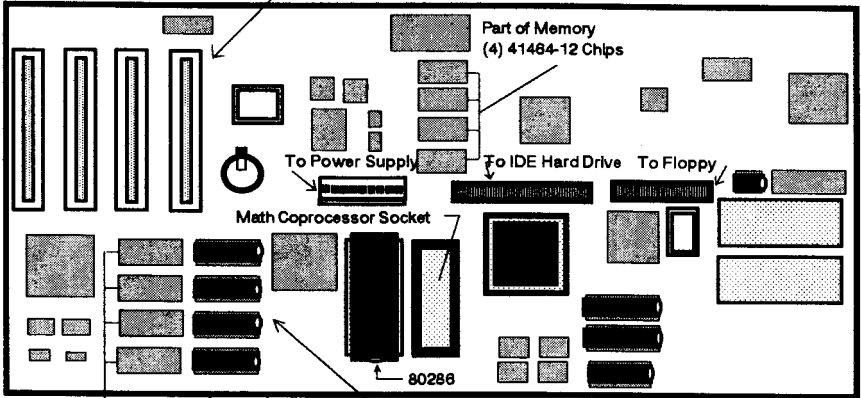
1000 TL

Five Expansion Slots. Hard Drive Card Goes Here.



1000 SL/2

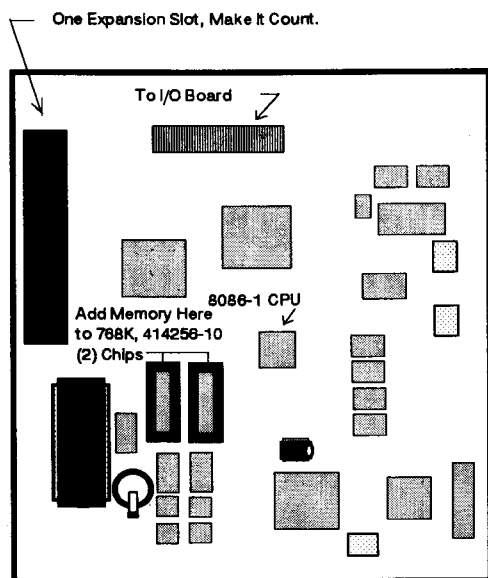
Four Expansion Slots. This One Best for Hard Drive Card.



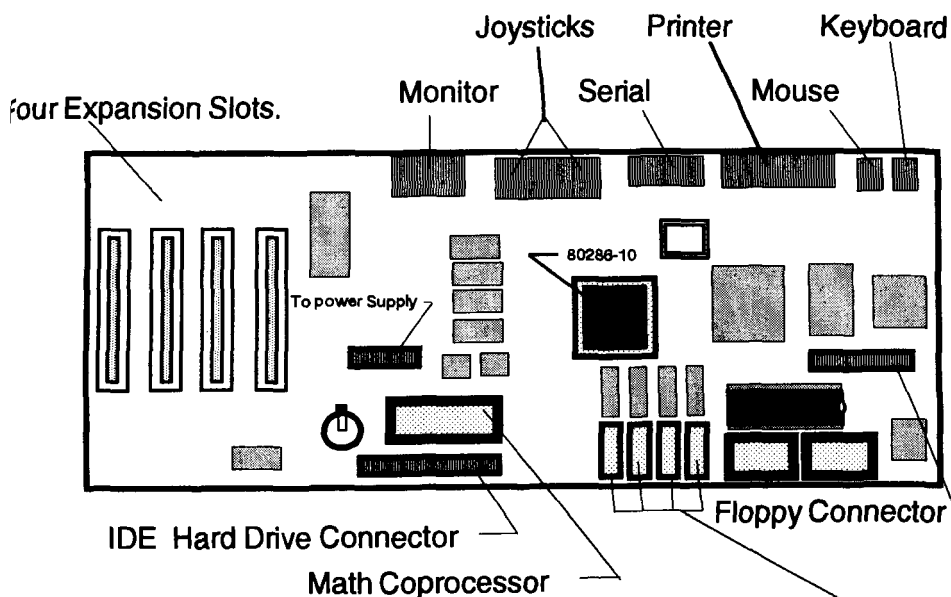
Add Memory Here
to 768K. Frees Video
From below 640K.
(4) 41484-12 Chips

System Comes with 640K
(4) 414256-12 Chips

1000 TL/2

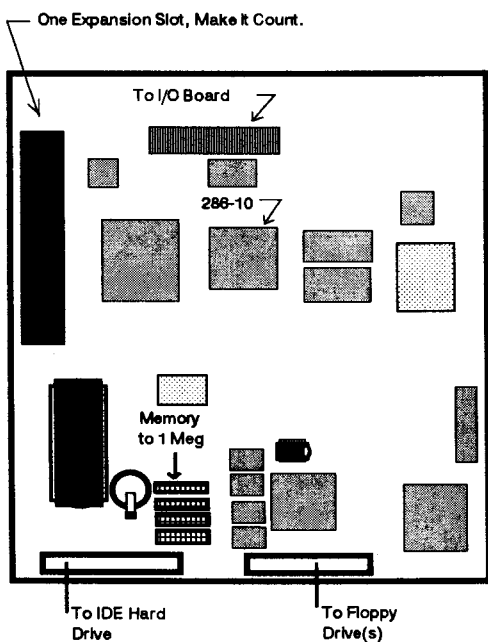


1000 RL

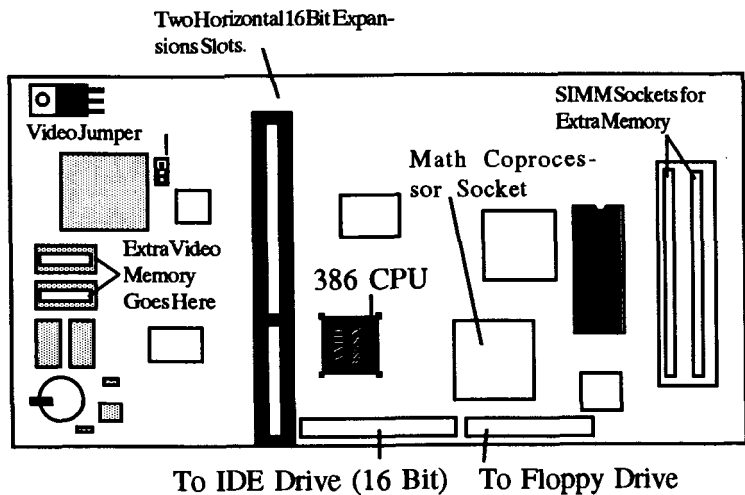


System Comes with 640K, Add 41464-12's to Make 768K Here

1000 TL/3



1000 RLX



1000 RSX

CHAPTER 20

Where to Get Information

There are two magazines which concentrate solely upon Tandy Computers. The larger of these is PCM, published by Falsoft, Inc. This publication is a good source for operational tips, such as the VGA fix software in the September 1990 issue. The second, smaller magazine, is One Thousand, published by Symbiotics Inc. This is another source of information for users who want to increase the abilities of their 1000 series machines. The products discussed in this book are available from DCS and other vendors who advertise in these publications.

Those interested in more in depth technical information may purchase the Technical Reference Manual published by Tandy for each of it's machines at a cost of about \$90. The Computerfacts Technical Service Data, published by Howard W. Sams & Company, is also available for some models of the 1000 series. This manual costs about \$40 and includes black and white photographs rather than the drawings of the Tandy version. DCS also publishes a free catalog of upgrades for the 1000 series and other Tandy models. A copy of which may be obtained by calling or writing DCS.

PCM Magazine

Published by Falsoft Inc.

The Falsoft Building

P.O. Box 385

Prospect, KY 40059

Phone 502-228-4492

FAX 502-228-5121

1000 Magazine
Published by Symbiotics Inc.
P.O. Box 1688
St. Louis, MO 63043-0688
Phone 314-521-9080

Technical Reference Manual
Published by Tandy Inc.
Available through Tandy stores

Computerfacts Technical Service Data
Published by Howard W. Sams & Company
4300 W 62nd St.
Box 7092
Indianapolis, IN 46206
Phone 800-428-SAMS

Catalog "Enhance your Tandy"
DCS Industries
5265 Hebbardsville Road
Athens, Ohio 45701
Phone 800-537-3539
FAX 614-592-1527
Foreign 614-594-4180

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