Z-100 LifeLine
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March 2022

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Note: This article was originally published in issue #59, October 1998.

Z-100 MFM Hard Drives

PRELIMINARY INFORMATION:

With the proliferation of older computers at swap meets and electronics surplus houses, now is a good time to upgrade your Z-100 with a second hard drive, or if you don't have any yet, replacing one of the floppy drives in your machine with a hard drive, though some special circuit boards are needed.

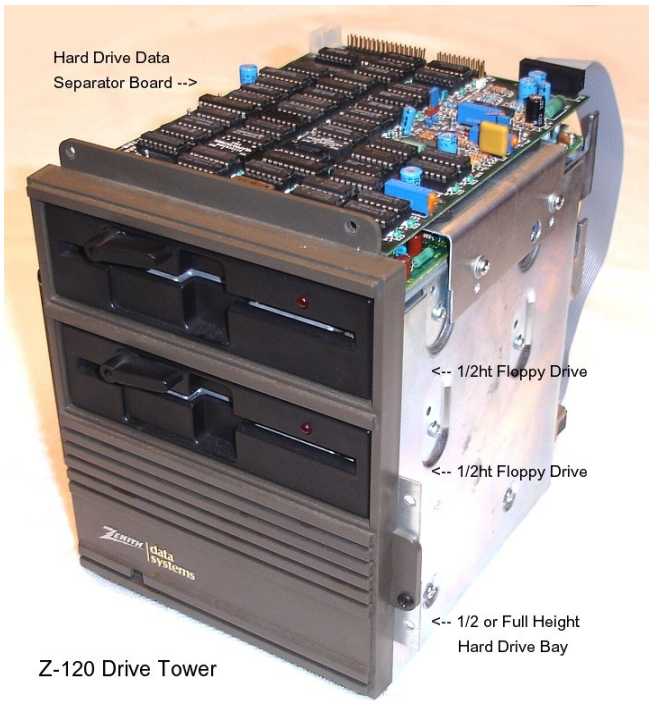
Since the first 5, 10, or 12 meg hard drives (called Winchester Drives by Heath/Zenith were placed in the Z-100 in the mid-80s, there have been several types developed - MFM, RLL, SCSI, IDE and others. The drives usually found in the Z-100 were the first type - MFM - and the subject of this article. For more information on the other types of hard drives, I have attached the article, **"Driving Us Crazy, But For a Reason"**, by Alan Brenden at the end of this article.

Another drive type - SCSI - with considerably larger capacities, became available for the Z-100 in the late 80s with a SCSI Controller marketed by CDR. Paul Herman, editor and publisher of the "Z-100 LifeLine" at the time, tried to get a special order of boards from CDR adapted specifically for the Z-100. However, it soon became evident to Paul, and several volunteers working as his staff, that they needed to develop their own controller, and the new Z-100 LifeLine SCSI/EEPROM board was created.

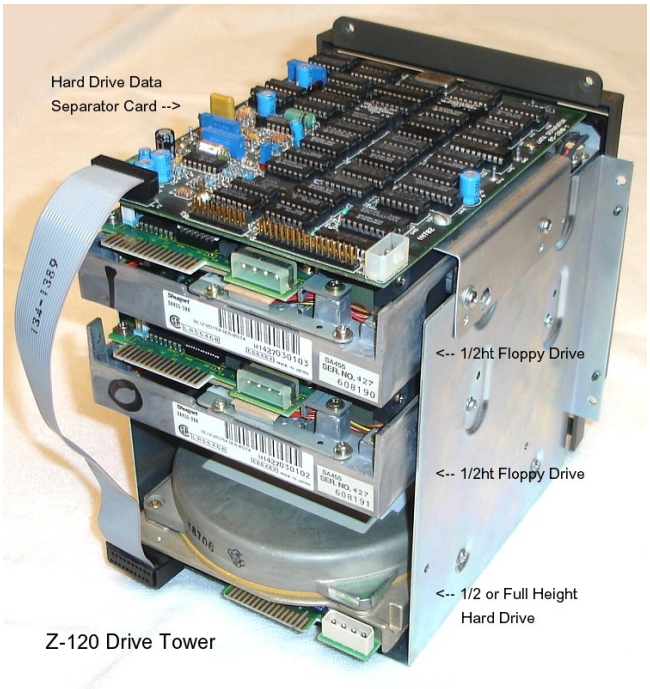
As the MFM and newer SCSI systems became more scarce, attention turned to the newer IDE technology and another group of volunteers; John Beyers, Charles Hett, and I. We researched and developed the new Z-100 LifeLine IDE NvsRAM board, shipped in late 2008.

You can find additional information on these newer systems elsewhere on this site. This article will concentrate on the use of the initial Winchester hard drive.

The Heathkit/Zenith MFM hard drive installation was comprised of a Z-217 Winchester Controller Card in the card cage, a separate, unique Data Separator Board that was normally mounted near or over the hard drive and the MFM hard drive itself. These pictures show the drive tower configuration possible for the Z-120 All-In-One Computer ==>



Z-120 Drive Tower



Z-120 Drive Tower

Other hard drive kits were available, but were less popular and therefore less available now.

Note: Be sure your computer operates properly BEFORE you begin the following modifications. If your Monitor Rom is a version prior to 2.5, you'll probably need to upgrade some parts on the motherboard, including the Monitor Rom (U190). If your motherboard is the old version, 85-2653, some circuit modifications may also be needed. See the following text.

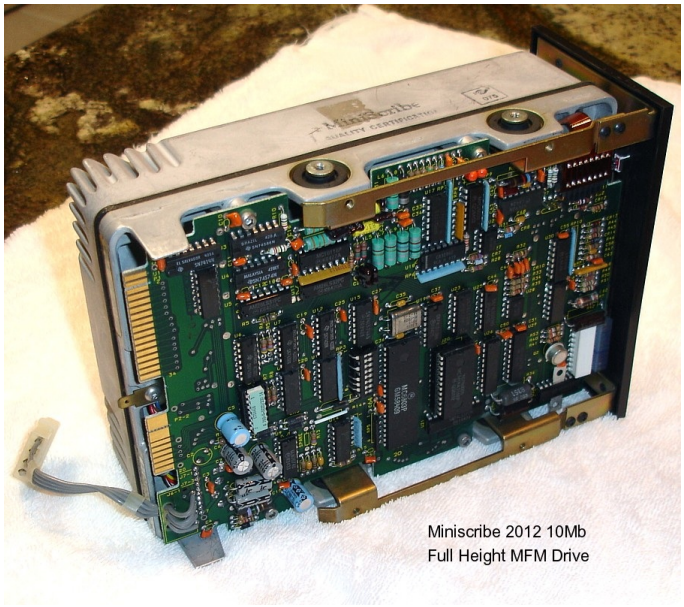
Note: The term 'Z-100' in this article and others published in the "*Z-100 LifeLine*" refers to the class of Heathkit/Zenith computer and may apply to either the Low-Profile H/Z-110 model, which used a separate monitor, or All-in-One H/Z-120 model, where a monochrome monitor was self-contained.

The MFM 'Winchester' Hard Drive:

The following instructions cover installation in both models of the Z-100 computer. The diagrams will carefully show which model applies, when necessary.

Important: Early MFM hard drives are fragile and can be damaged easily. In all hard drives, while the drive's platter is spinning, the read/write heads float on a very thin layer of air, separating the heads from the platter's surface. However, the read/write heads on these early drives came to rest on the surface of the disk platter when rotation stopped. Any bumping, knocking, or dropping may cause the heads to bang against the surface of the platter. A severe bump, especially while the platter is spinning, could actually damage or gouge out a small area in the platter and cause a "crash", where an important portion of a program is unreadable and lost because the disk surface was damaged. Further, the read/write head may also be damaged.

For early hard drives, it is CRITICAL to run a disk utility that parks the heads in an unused portion of the disk - a storage or parking area - before the heads come to rest. Such a utility is SHIP, an external command packaged in CP/M and MS-DOS operating systems. Later MFM drives had an auto-park feature that placed the heads down after the last usable sector of the drive, in an unused area. But even then, the heads could be damaged from a sudden drop.



MFM drives are recognized by their two ribbon cable card edge connectors, one with 34 conductors and the other with 20 conductors. RLL drives also have these but the drive model number includes an R. For example, an ST-138 is an MFM drive, while an ST-138R is an RLL drive, with different formatting, capacities, and controller boards. ESDI drives also have similar cable connections, but cannot be used.

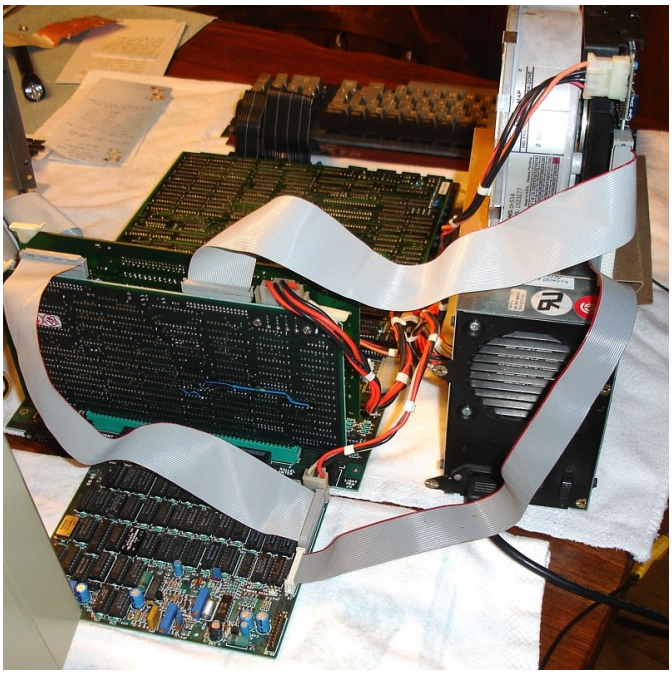
MFM drives are becoming available from Ebay and the used market, sometimes at ridiculous prices and there is no guarantee that any of these will work.

But let's assume that you find one with possibilities and want to try it. What is involved?

Caution: You cannot just slap an MFM drive from another computer into your Z-100 and expect it to work, without completely reformatting the drive. It will require low level formatting using the Z-100 PREP command, partitioning using the PART command, and a high level formatting of each partition using the FORMAT command. These commands are unique to the Heath/Zenith CP/M and MS-DOS (now referred to as Z-DOS) operating systems.

There are numerous manufacturers of MFM drives, each with different sets of programming plugs, jumpers, and terminating resistors. If you have a specific brand that you can not figure out, try emailing me at the "Z-100 LifeLine".

Here are views of my hard drive setup on my test bed Z-100 (note the cabling):



The Hard drive here is the Disctron D-514.

Here are a few installation precautions:

* Try to install the new drive alone and boot to a floppy to run the Winchester Disk Utilities. It can be run from another hard drive, but you would hate to accidently PREP the wrong drive!

* If the new drive is installed alone, insure the terminating resistor pack is installed. If it is the second drive, only install the terminator resistor on the hard drive installed last on the 34-pin connector ribbon.

* Double check that the ribbon cables are installed per the directions given later. Insure all connectors are fully seated and that pin one of each ribbon connector (the ribbon cable may also have a red edge) is at the correct end of the connectors on the drive, controller, and data separator. The 20-pin cable connector can go to either location on the Data Separator Card.

* Before running PREP on a hard drive, you must install the **Format Enable Jumper** on the Z-217 Controller Card. It is located under the power connector in the upper left corner of the Z-217 Hard Drive Controller, and may be stored any where along the top row of pins of the VI* jumpers, when not in use. See the **Software Programming** section for more on this.

* Check for a programming plug on the new drive before installation and make a note of the position of any jumpers. Try this setting first and if unsuccessful, try the other positions before giving up.

Hint: Drive Select (DS) pins may be labeled DS0 through DS3 or DS1 through DS4, if labeled at all. If this is the lone drive, DS0 (or DS1) will become drive unit 0 and after programming, drive E:.

Hint: Before changing any positions on the programming plug, install the hard drive temporarily, boot up the computer, and run ASGNPART 0:. If the drive is already setup as drive 0: the drive LED should light. If it does not, check ASGNPART 1: and even 2: and 3: before giving up. If the LED will not light in any position, check the cables for an improper connection and finally try a different position on the programming plug.

Note: If partition info is displayed after running ASGNPART, do not proceed with PREP until you have tried other options. For example:

- Try running ASGNPART X:(Partition name) E:, where X: is the drive unit number. Then do a directory listing on E:.

- Try running DETECT or VERIFY to see how many bad sectors are found.

- Try reformatting the partition with FORMAT to isolate those bad sectors.

MFM Hard Drive Installation

DISASSEMBLY:

Installation of a hard drive requires partial disassembly of your computer. As disassembly and reassembly are beyond the scope of this article, please refer to your Z-100 Users' Manual or the **'About Z-100 Computer'** on this website for these procedures.

Caution: In the All-In-One Computer, high voltages are present around the large wire attached to the top of the picture tube.

For the Z-110 Low-Profile Computer, remove the cover and drive assembly. For the Z-120 All-In-One Computer, remove the cover and the CRT/drive assembly. Set these aside.

From here down internally, both models are the same. The card cage, with its removable vertical boards, such as the Z-205 RAM Board or Floppy Controller Board, is to the rear of the computer. A large motherboard fills nearly 3/4 of the computer's bottom with a much smaller video logic board mounted horizontally on 3 standoffs on the motherboard.

One or two smaller boards, such as a Gemini PC-Emulator Board or an 8087 co-processor board, may be sandwiched between the two.

Before attempting to install a hard drive in a Z-100 computer, ensure that the power supply has the proper cables for the Data Separator and the Z-217 Winchester Controller Boards. These may be folded up and stored to the side.

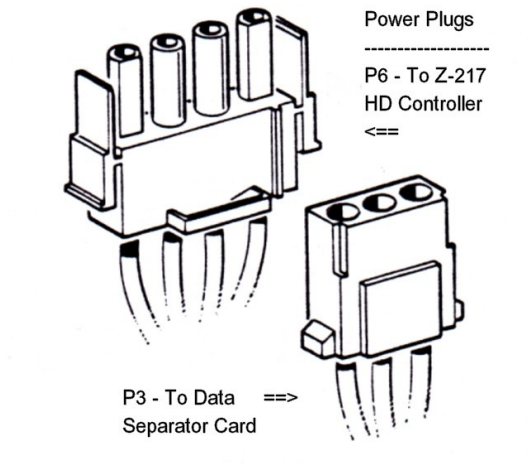


Figure 1.
Power Supply Connectors

Also ensure the proper PAL and ROM integrated circuits are installed, using the following procedures:

Caution: Refer to the Z-100 Users' Manual for the proper procedures on handling integrated circuits (ICs). Many ICs are metal oxide semiconductors (MOS) which can be damaged by static electricity.

[ ] Remove the three small screws attaching the video logic board horizontally across the motherboard and swing it upward onto its back edge (carefully lean it against the card cage).

Note: Read the following steps carefully. You may already have the correct ICs installed in your motherboard.

[ ] Locate the PAL IC (U161) on the motherboard. If the part number on this IC is lower than 444-129-1 (such as 444-129), the IC must be replaced before installing a hard drive.

[ ] Locate the Monitor ROM (MTR-ROM or ZROM) IC (U190) on the motherboard. If the part number on this IC is lower than 444-87-5 (such as 444-87, 444-87-1, -2, -3, or -4), the IC must be replaced before installing a hard drive.

Note: Newer power supplies, hard drive boards, PALs and ROM chips are available from the "*Z-100 LifeLine*".

[ ] If you are installing a ZROM v3.x monitor ROM (or later) at U190, locate the programming jumper J102 on the left edge of the motherboard, about half way from the front to the card cage. Unplug it from the 0 position and reinstall it in the 1 position, if this has not already been done. This jumper recognizes the higher capacity of the newer ROM chip. Be careful not to disturb the setting of programming jumper J101.

[ ] Locate switch S101 on the motherboard and set each switch to the 0 position (toward the card cage or rear of the computer), if this has not already been done.

Note: Section 7 of this switch sets the refresh rate of the display RAM and is normally set to the zero position for 60 Hz (in the U.S.). If you live overseas and your AC line frequency is 50 Hz, you must set this switch section to 1.

[ ] Locate the part number on the motherboard (near U190). If this part number is 85-2653 (disregard any other number that may follow, such as 85-2653-1), you have an older motherboard that will require several modifications. These modifications are available from the "*Z-100 LifeLine*", but involve soldering on the board.

Note: The "*Z-100 LifeLine*" has plenty of the newer motherboards at reasonable prices (See the pricelist on the "For Sale" page of the Website.

[ ] Reinstall the Video Logic Circuit Board on its three standoffs and secure it with the three screws.

PREPARING THE MFM HARD DRIVE:

Note: While the hard drive may be installed first, I find it is best to prepare the hard drive and ensure it is working properly BEFORE taking the time to install it. Earlier, I showed two pictures showing how the hard drive may be placed temporarily on the power supply during preparation.

The PREP and PART utilities were available on a special disk entitled 'Winchester Utilities Disk', distributed separately from the earlier MS-DOS versions. The disk and instructions are available from the "*Z-100 LifeLine*" Library.

Caution: Using PREP is the last resort. It will destroy all the files that may exist on the hard drive. If the disk is from another Z-100, you may need to use PREP only if you consistently encounter an unreasonable number of disk access errors. Do NOT use PREP until you have backed up all important files you wish to keep to floppy disks.

PREP has been updated by John Beyers in the Z-100's Z-DOS v4 that allows it to be much more flexible in its operation - another reason to upgrade.

All versions of the PREP utility enable you to:

* Initialize the surface of the hard disk.

* Test the data retention capabilities of the hard disk.

* Isolate questionable disk sectors.

* Divide the surface of the hard disk into 2 partitions (Z-DOS and CP/M).

PREP takes a long time to run. Expect it to take about 1.5 hours for every 10 megabytes in hard drive size. It runs seven surface passes to check the media and locate bad sectors. These locations are placed in a Bad Sector Table and can no longer be used.

Note: With the version 4 PREP, you can set the number of passes to make.

If the hard disk does not contain initialization information (from a prior PREP operation), PREP will prompt you to enter characteristics (in hex) in order to identify the type of hard drive that is being installed in the computer.

Please see the file MFMHardDriveSpecs.PDF on the Website for a list of common drives that were used in the Z-100. I have updated this information for many more manufacturers.

Note: Several of the drives are too large for normal use in the Z-100. Early hard drives and Z-DOS versions in the Z-100 were limited to 32Mb. Later, with the addition of the PREP /k switch (which uses 1024 byte sectors rather than 512 byte sectors), the limit was extended to 64Mb. As I understand it, Z-DOS version 4 can go higher, though I do not recall the limit. Just remember, larger than 64Mb will ONLY work with Z-DOS v4. To be able to use these larger hard drives, the fix is easy - just reduce the number of heads being used by PREP until the number of megabytes is where you want it.

Once PREP has completed, if you run ASGNPART 0: you will see the two partitions created: Z-DOS and CP/M. If you are satisfied with these two partitions, you will not need to repartition the disk with PART.

However, if you wish to change this partition information, you must run the PART utility.

The **PART** utility is self explanatory. Just follow the procedures as given to change the partition names and sizes as necessary, then choose a default boot partition and save the configuration to the hard drive.

When complete, you may need to reboot the computer to the floppy drive again.

Next run ASGNPART 0: to confirm the partitions are as you required.

Before we can use the new partitions, you need to assign drive letters to them and then run FORMAT to do a high level format of each new partition. Run ASGNPART 0:(partition name) E: to assign the drive letter E: to the first partition. Likewise, assign succeeding drive letters (F:, G:, H:) to the remaining new partitions (up to four at a time). Run FORMAT X:/s/v to format and load the system files on each new partition, where X: can be E:, F:, G:, or H:.

If successful, you are now in business. Email me if you have any difficulty. I hope this helps clarify the use of Z-100 MFM hard drives.

Important: Hard drives, especially these early MFM hard drives are fragile and can be damaged easily.

In all hard drives, while the drive's platter is spinning, the read/write heads float on a very thin layer of air separating the heads from the platter's surface. However, when stopped, the heads come to rest gently on the surface of the disk platter.

Any bumping, knocking, or dropping causes the heads to bang against the surface of the platter. A severe bump, especially while the platter is spinning, could actually damage or gouge out a small area in the platter and cause a "crash", where an important portion of a program is unreadable and lost because the disk surface was damaged.

For early hard drives, it is CRITICAL to run a disk utility that parks the heads in an unused portion of the disk - a storage or parking area - before the heads come to rest. Such a utility is **SHIP**, an external command packaged in CP/M and early MS-DOS operating systems.

Later disk drives have an autopark feature that automatically parks the heads upon power loss.

This article concentrates on MFM drives, which used the standard hard drive boards found in most Z-100 computers. MFM drives are recognized by their two ribbon cable card edge connectors, one with 34 conductors and the other with 20 conductors.

RLL drives also have these but the drive model includes an R. For example, an ST-138 is an MFM drive, while an ST-138R is an RLL drive, with

different formatting, capacities, and controller boards.

The same number drive may even have a different number of heads or cylinders. So, to my knowledge, there is no way to change a RLL drive into an MFM drive by just swapping boards attached to the drive.

ESDI drives also have similar cable connections and cannot be used, but these drives are rare.

While new MFM hard drives are very rare now, some remanufactured or repaired hard drives can still be purchased from drive repair shops. Also, look for older computers at garage sales, shops, swap meets, etc.

Caution: You cannot just slap an MFM drive from another computer into your Z-100 and expect it to work, without completely reformatting the drive. It will require low level formatting using the **PREP** command, partitioning using the **PART** command, and a high level formatting of each partition using the **FORMAT** command. These commands are unique to the Heath/Zenith CP/M and MS-DOS operating systems.

There are numerous manufacturers of MFM drives, each with different sets of programming plugs, jumpers, and terminating resistors. If you have a specific brand that you can not figure out, try calling me at the "*Z-100 LifeLine*".

PROGRAMMING PLUGS:

The most popular drive in the Z-100 seems to be the 10 megabyte Miniscribe model 2012 pictured here:

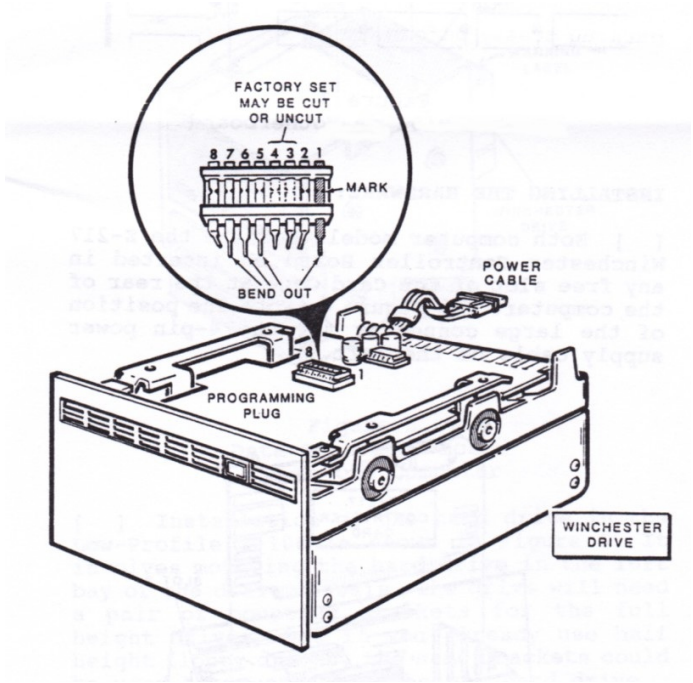


Figure 2.
Programming Plug on the Miniscribe 2012.

Other popular drives were the 10 meg Seagate model ST-412 and the 10 meg Computer Memories, Inc. model CM 5412. These were all full height, 5-1/4" drives. Later drives were available as half-height and/or 3.5" wide and had higher capacities.

[ ] Locate and check the setting of any programming plugs or pins on the hard drive.

Programming plugs may take many forms on floppy and hard drives. On the Miniscribe 2012 and the Seagate ST-412, it takes the form of that shown in the picture - a flat pack of 8 shorted pairs of pins. Although meant to simply break the connection between pairs with a sharp pointed object, a less permanent method is to simply bend out one of the pins to open that pair, as shown.

On the Miniscribe 2012, the drive configuration is:

Pin Pair	Sect Nbr:	Note	Hardware Unit 1	Hardware Unit 2
1-16	1		Open	Open
2-15	2		Short	Short
3-14	3		Factory Set	
4-13	4		Factory Set	
5-12	5	DS4	Open	Open
6-11	6	DS3	Open	Open
7-10	7	DS2	Open	Short
8- 9	8	DS1	Short	Open

Note: Pin pairs 3-14 and 4-13 (section 3 and 4) are set at the factory; the programming plug is properly configured for the drive it is installed in. If you change or move programming plugs, you should check the following table and set these two sections according to the phase code of the disk drive. The phase code is printed on a label on the disk drive case.

Pin Pair: / Section Number:	3-14 / 3	4-13 / 4
Phase Code C	Open	Open
Phase Code D	Open	Short
Phase Code E	Short	Open
Phase Code F	Short	Short

On the Seagate, the programming information is slightly different:

Pin Pair	Sect Nbr:	Note	Hardware Unit 1	Hardware Unit 2
1-16	1	R	Short	Short
2-15	2	NC	Open	Open
3-14	3	NC	Open	Open
4-13	4	NC	Open	Open
5-12	5	DS4	Open	Open
6-11	6	DS3	Open	Open
7-10	7	DS2	Open	Closed
8- 9	8	DS1	Closed	Open

Where: DS1, DS2, DS3, DS4 = Drive Select #

R = Radial Operation

On the Computer Memories drive, the programming is accomplished by pairs of pins and removable jumper plugs. DS1 is the pair of pins closest to the front of the drive, with DS2, DS3, and DS4, in order, toward the rear of the drive.

I have no information on the remaining two pairs of pins.

TERMINAL RESISTOR PACK:

Looking at the Miniscribe picture again, you can also see the location of a Terminator Pack or Terminal Resistor Pack. This resistor pack serves the same purpose as on the floppy drives and needs to be installed ONLY in the drive at the end of the 34-conductor ribbon cable.

PROGRAMMING TIPS:

How should my strange drive be configured? How can I program a drive if it doesn't have a programming plug?

- A great temporary programming plug can be a dip switch with the proper number of sections.

- The drive number may begin at one end or the other of the plug or row of jumper pins. Leaving the other pins open, short one end or the other and start the computer. If the light flashes as the computer attempts to boot, you have the drive select pins identified. Odds are, the first four pairs of pins are the drive select sections for 4 drives, working from the outside toward the center.

- After finding the drive select pins, attempt to program the drive with no other switches/pins shorted. If an error develops, short a pair of pins and try again.

[ ] If this is your only hard drive, leave the resistor pack installed. If this hard drive will be an external drive, of a pair of hard drives, install the resistor pack only on the last hard drive on the 34-pin connector.

[ ] If the hard drive is replacing one of the floppy drives, ensure the remaining floppy drive has a terminal resistor pack and the drive select is properly set, DS0 or DS1, as needed.

As with the floppy drives, it is the drive select position on the programming plug that determines the drive number or letter and it doesn't matter if the first drive letter is first or last on the cable. Therefore, drive 0 (E:) of a two drive system can be first or last on the ribbon cable. It is always the last drive on the ribbon cable that has the terminator resistor installed.

MOTHERBOARD DIP SWITCH:

After the initial testing and programming of the hard drive, the computer can be set to auto boot from the hard drive by changing the positions of switch S101, Figure 3.

Note: The positions 1 and 0 are not labeled on all motherboards. The position 1 is always toward the front of the computer, 0 is toward the card cage.

Switch sections 0, 1, and 2 select the type of drive that the system will boot from:

Section:			Device
0	1	2	Type:
0	0	0	5-1/4" Floppy Drive
1	0	0	8" Floppy Disk Drive
0	1	0	Winchester Hard Drive
1	1	0	SCSI/EEPROM Board

And Switch section 3 selects Auto or Manual Boot, where:

1 = Auto boot
0 = Manual boot

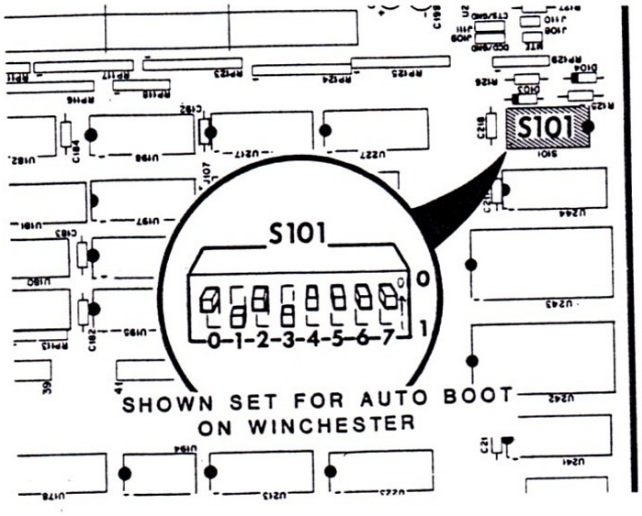


Figure 3.
Switch S101 on the Motherboard

INSTALLING THE HARDWARE:

[ ] Both computer models require the Z-217 Winchester Controller Board be inserted in **any** free slot of the Card Cage at the rear of the computer. See Figure 4. Note the position of the large connector for the 4-pin power supply cable on the left.

[ ] Installation of the hard drive in the All-In-One Z-100 is shown in Figure 5. It involves mounting the hard drive in the upper or lower bay of the drive chassis, depending upon the type of faceplate you have available.

If your hard drive has its own faceplate, you may be able to cut a large opening in your existing faceplate.

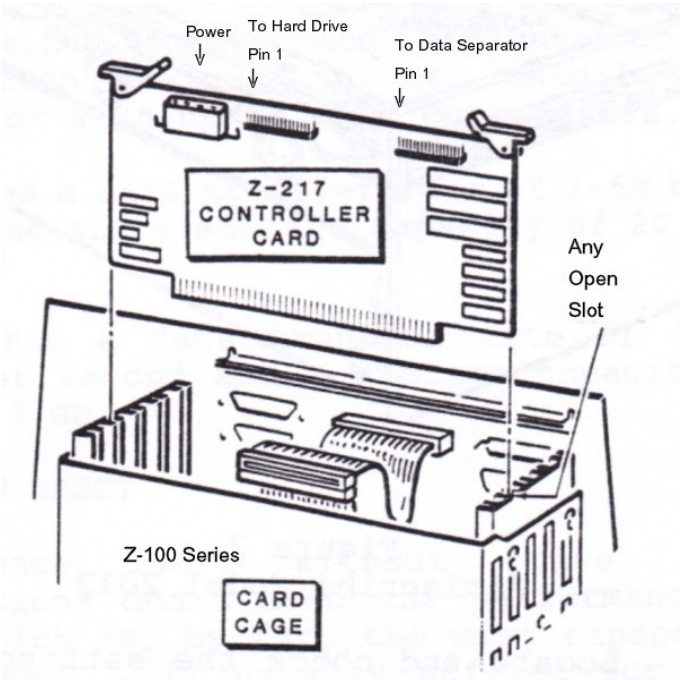


Figure 4.
Inserting Z-217 Controller Card

[ ] The Data Separator Circuit Board is mounted on the top of the drive chassis with two brackets.

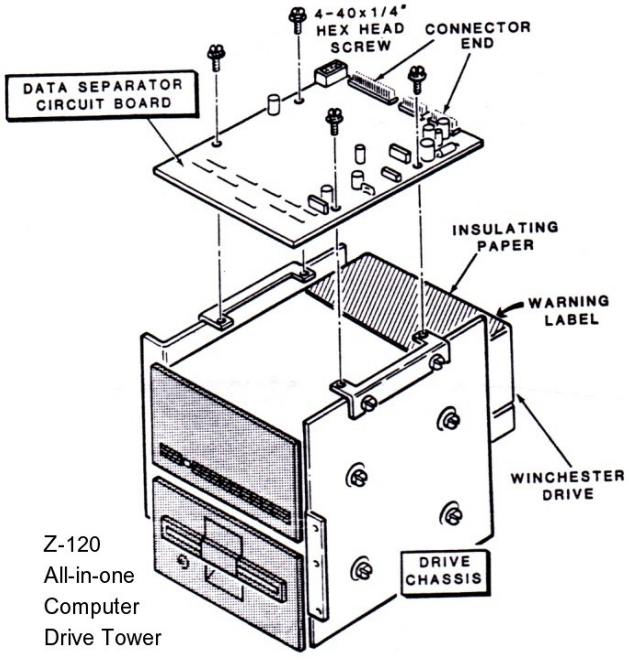


Figure 5.
Data Separator Board
All-In-One Computer

[ ] Installation of the hard drive in the Low-Profile Z-100 is shown in Figure 6. The hard drive is mounted in the left bay of the drive chassis. The drive will need a pair of mounting brackets for the full height drives, but if you already use half height floppy drives, the same brackets could be used to mount a half height hard drive. The Data Separator Board is mounted over the drive.

If your hard drive has its own faceplate, you may be able to cut a large opening in your existing faceplate.

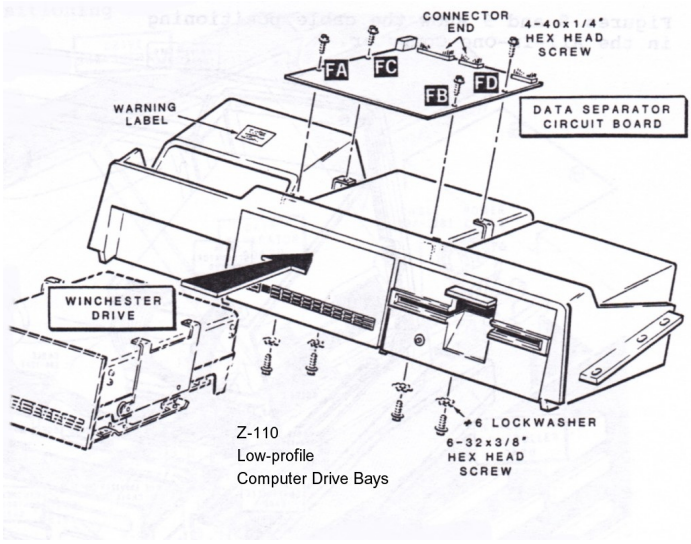


Figure 6.
Data Separator Board
Low-Profile Computer

CABLE CONNECTIONS:

Figure 7 shows the various cable connections on the rear of an MFM hard drive.

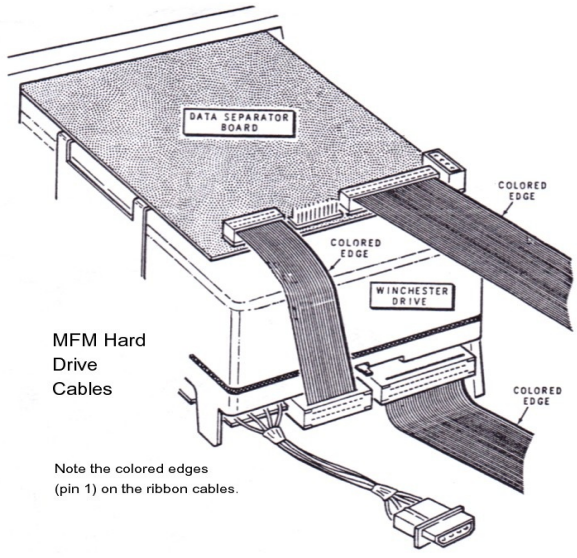


Figure 7.
Hard Drive Cables

Figures 8 and 9 show the cable positioning in the All-In-One Computer.

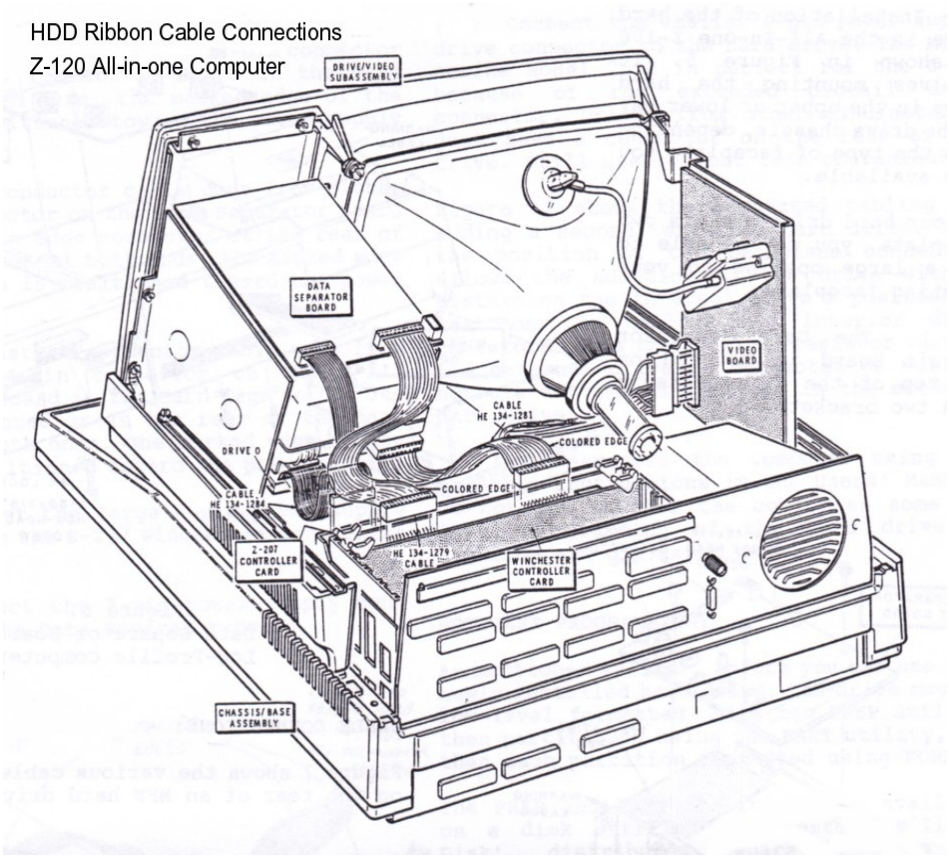


Figure 8.
Ribbon Cables
All-In-One Computer

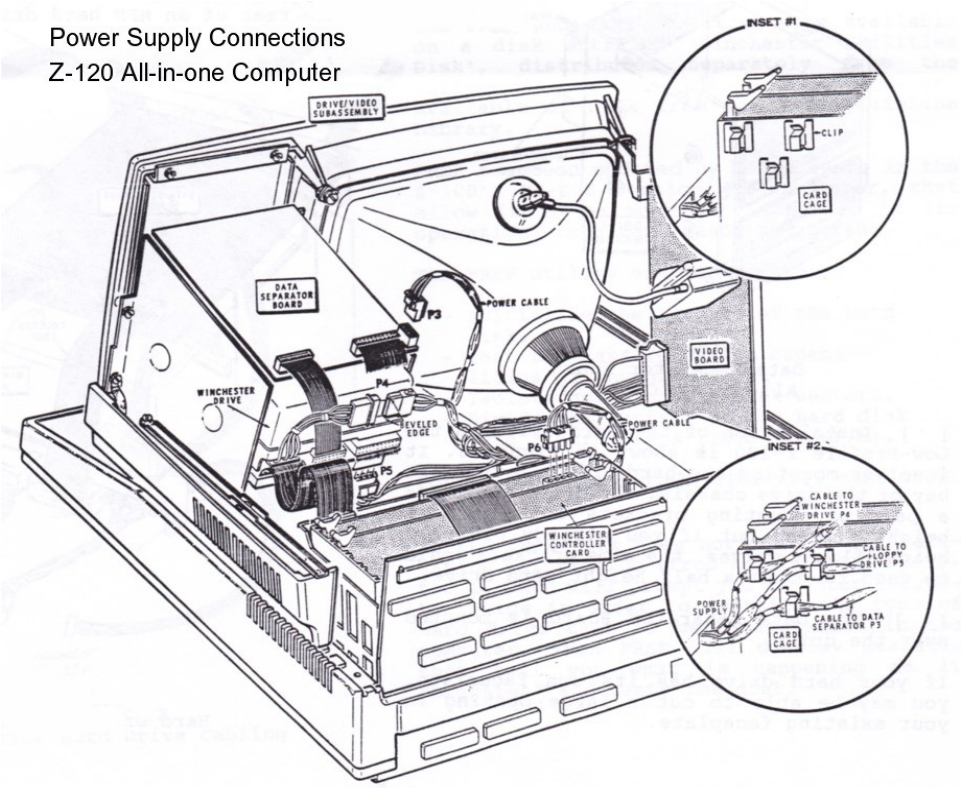


Figure 9.
Power Supply Connectors
All-In-One Computer

Figures 10 and 11 show the cable positioning for the Low-Profile Computer.

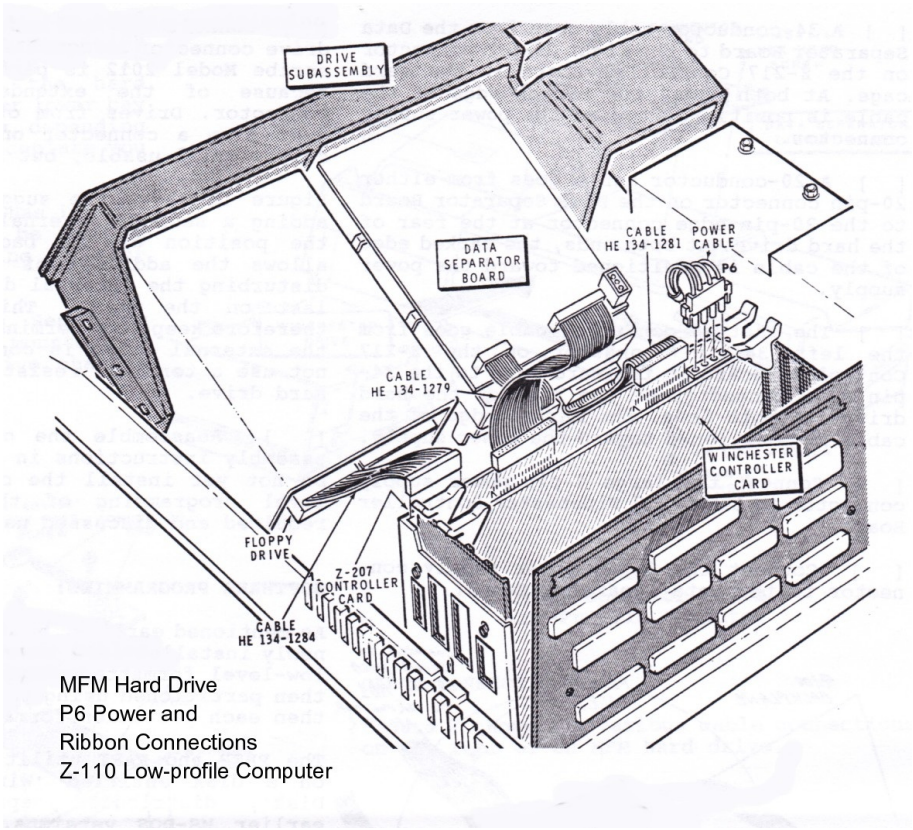


Figure 10.

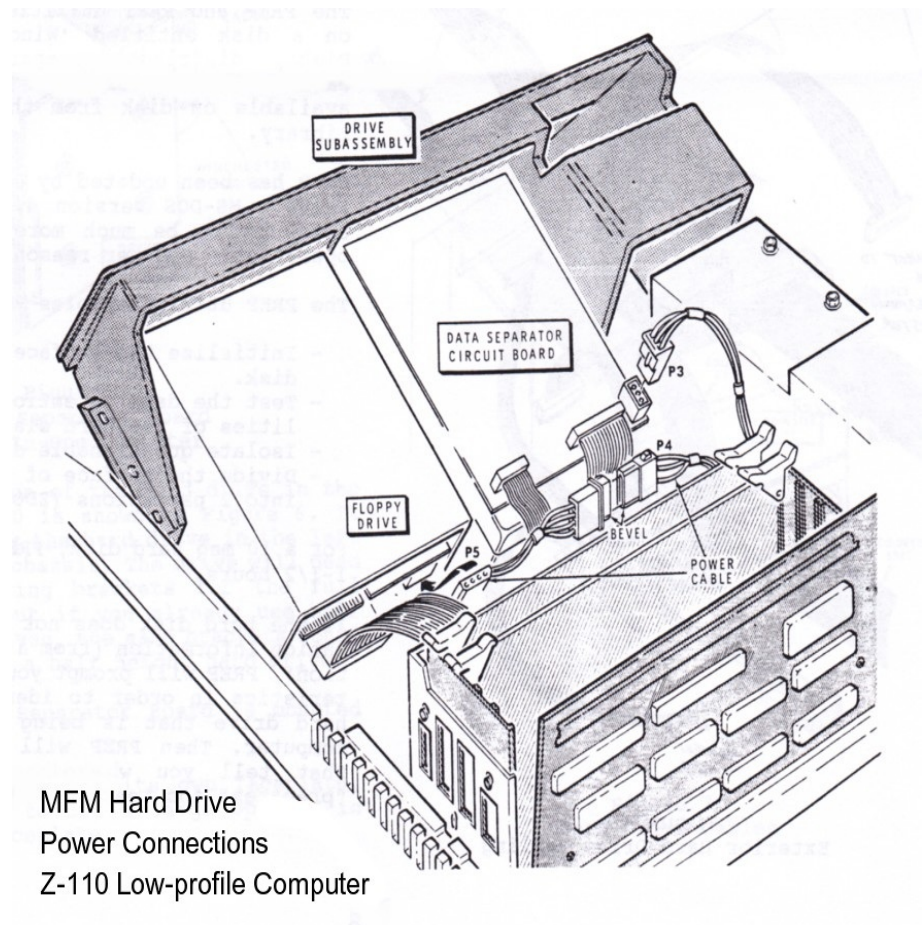


Figure 11.

[ ] A 34-conductor cable goes from the Data Separator Board to the right 34-pin connector on the Z-217 Controller Board in the card cage. At both ends, the marked edge of the cable is positioned toward the power supply connector.

[ ] A 20-conductor cable goes from either 20-pin connector on the Data Separator Board to the 20-pin edge connector at the rear of the hard drive. At both ends, the marked edge of the cable is positioned toward the power supply.

[ ] The last 34-conductor cable goes from the left 34-pin connector on the Z-217 Controller Board in the Card Cage to the 34-pin edge connector at the rear of the hard drive. At both ends, the marked edge of the cable is positioned toward the power supply.

[ ] Connect the large 4-pin power supply connector to the Z-217 Winchester Controller Board.

[ ] Connect the 3-pin power supply connector to the Data Separator Board.

[ ] Connect the smaller 4-pin power supply drive connector to the hard drive. The Mini-scribe Model 2012 is perfect for the Z-100 because of the extended pigtail drive connector. Drives from other manufacturers just have a connector on the rear of the drive. Still usable, but less convenient.

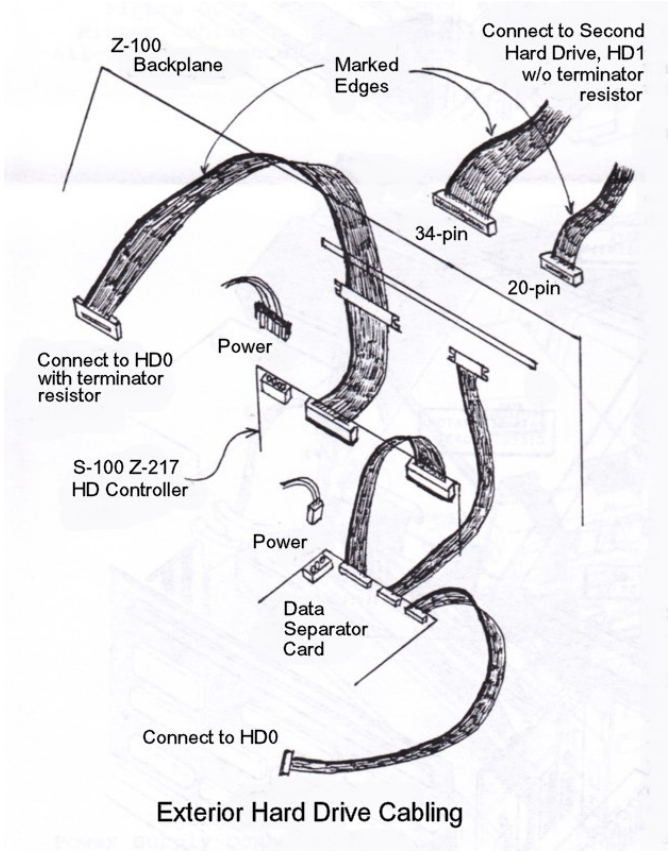


Figure 12.
Exterior Hard Drive Cabling

Figure 12 shows the suggested cabling for adding a second, external hard drive. Note the position of the backplane connectors allows the addition of the drive without disturbing the internal drive's position as last on the cable. This interior drive therefore keeps the terminal resistor whether the external drive is connected or not! Do not use a terminal resistor in the external hard drive.

[ ] Reassemble the computer using the assembly instructions in the Users' Manual. Do not yet install the cover, as some low level programming of the hard drive is required and discussed next.

SOFTWARE PROGRAMMING:

As mentioned earlier, before you can use your newly installed hard drive, the drive must be low-level formatted using the PREP utility, then partitioned using the PART utility, and then each partition formatted using FORMAT.

The PREP and PART utilities were available on a disk entitled 'Winchester Utilities Disk', distributed separately from the earlier MS-DOS versions. Instructions are available on disk from the Z-100 LifeLine Library.

The actual procedures to run PREP are beyond the scope of this article. However, before running PREP, a Format Enable Jumper must be reposi-tioned on the Z-217 Winchester Controller Board.

Note: The Format Enable Jumper provides protec-tion against the complete, unintentional erasure of your hard drive, so once you have completed PREP, make sure you reposition the jumper to its harmless storage position.

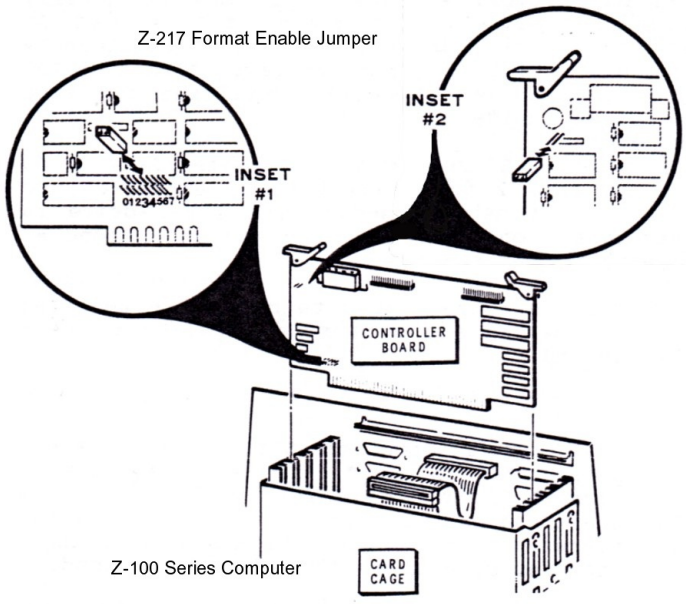


Figure 13.
Format Enable Jumper

Perform the following:

[ ] Referring to Figure 13, remove the Z-217 Winchester Controller Board from the card cage far enough to remove the Format Enable Jumper from its storage position between pins 3-4 at the lower left corner of the card and install it just below the power supply connector. You may have to disconnect some cables to do this.

[ ] Replace the board in the card cage and reconnect any cables that had to be disconnected to remove the board. Make sure that all cables and boards are fully seated in their respective connectors.

[ ] If the computer is a Low-Profile model, be sure to connect the monitor to the computer and turn it on.

[ ] Connect the line cord and apply power to the Computer.

Caution: High voltages are present at locations around the CRT in the All-In-One computer (See Figure 8). Avoid touching the picture tube at the large, single cable attached to the top surface of the tube!

[ ] Insert the Winchester (Hard Drive) Utilities Disk in floppy drive A and Boot the computer. Proceed with PREP.

Note: I have created a paper listing the PREP specifications for nearly every hard drive that could be used in the Z-100. Please see the file, MFMHardDriveSpecs.PDF, that accompanies this article.

Once PREP has been completed, you must turn off the computer, disconnect the line cord, and reposition the Format Enable Jumper back to its storage position on the Winchester Controller Board. Proceed with the following:

[ ] Referring to Figure 13, remove the Z-217 Winchester Controller Board from the card cage far enough to remove the Format Enable Jumper from its programming position just below the power supply connector and install it in its storage location between pins 3-4 at the lower left corner of the card. Again, you may have to disconnect some cables to do this.

[ ] Replace the board in the card cage and reconnect any cables that had to be disconnected to remove the board. Make sure that all cables and boards are fully seated in their respective connectors.

[ ] Install the cover on the computer.

[ ] Connect the line cord and apply power to the Computer.

[ ] Reboot and proceed with the PART and FORMAT utilities.

[ ] Copy the desired operating systems onto the hard drive.

DRIVING US CRAZY, BUT FOR A REASON

by (C) Alan Brenden, 7/09/92

In the early days of the PC, there wasn't much involved in deciding when a new hard disk was to be bought or repaired. The first hard disks used Seagate's ST506 technology and that was your choice.

Times and technology have changed and today's high-performance systems make it necessary to match the needs of the system to the storage technology. This article will try to explain what's behind these drives that drive us crazy - MFM, RLL, ESDI, IDE, and SCSI.

ST506/412 (MFM & RLL) Interface:

Originally, the ST506 drives used an encoding method know as Modified Frequency Modulation (MFM).

As the need for bigger drives evolved, a new encoding method was developed to pack data tighter together. Known as Run Length Limited (RLL), this method involved looking at groups of 16 bits rather than each individual bit. This achieved a kind of compression of the data that allowed roughly 50% more on a disk than MFM. The trade off was that you needed a higher grade of media and timing was more critical.

As prices for media dropped, RLL drives have just about wiped MFM drives from the market place. ESDI, SCSI, and IDE also use a type of RLL encoding.

ST506/412 drives have 2 cables, a 34 pin control cable and a 20 pin data cable.

ST506 MFM has a data transfer rate of 625K bytes per second and a storage capacity of 5 - 100 MB.

ST506 RLL has a data transfer rate of 937K bytes per second and a storage capacity of 30 - 200 MB.

ESDI:

ESDI (Enhanced Small-Device Interface) was developed to allow faster transfer rates and high disk capacities. Greater intelligence reduced the amount of communication between the drive and the controller. The transfer of data between the drive and the controller used a pulse code that wasn't required to return to zero between pulses, as did ST506. This was therefore known as Non Return to Zero (NRZ) and increased data transfer.

ESDI uses the same cables as the ST506 but the two can not be mixed. ESDI is CPU controlled and is suitable for single tasking environments. ESDI has a data transfer rate of 1-3M bytes per second and a storage capacity of 80 MB - 2 GB. One controller can handle up to 2 drives with multiple controllers possible.

IDE:

As the name implies, IDE (Integrated Drive Electronics) combines both the disk and the controller on the same unit. Only a simple interface is needed and typically it is built directly into the motherboard. If the interface is not built into the motherboard, a simple paddle-board is used and, because so little electronics are needed, an additional serial and parallel port is sometimes included.

The IDE drive transfers only data and doesn't need to send format and sector information as does ESDI. Therefore, the data transfer rate can be 3-4 times faster then ESDI.

The IDE drive is not a device level interface and has the ability to lie to the BIOS and give the logical appearance of a known device type, while physically it may be totally different. You won't see bad tracks on an IDE drive, because the drive hides them. Because of this, you can not low level format an IDE drive without specific utilities for that drive.

IDE uses a single 40 pin cable. Limited to a 2 foot cable length and 2 addresses, no termination is needed. The first drive is configured as the master and the second as the slave.

IDE has a transfer rate of .625 - 2M bytes per second and a storage capacity of 20 - 500 MB.

SCSI:

SCSI (Small Computer Systems Interface), pronounced "scuzzy", is a more general version of the IDE interface. SCSI hard disks boast the fastest transfer rates of all the discussed technologies, with SCSI 2 having a transfer rate up to 40M bytes per second.

SCSI implements 2 ways of boosting transfer rates, fast and wide. FAST SCSI doubles the clock speed, and WIDE SCSI increases the bus width.

SCSI also implements other performance features, including controller based RAM caching and tag command queuing. By queuing commands, the SCSI controller can free up the CPU to do other tasks while it finishes its task. SCSI also has the ability to transfer data to another SCSI device without CPU involvement.

SCSI uses a single 50 pin cable with devices daisy chained together and terminated on both ends. Seven devices can be installed per controller with up to four controllers.

SCSI 1 has a data transfer rate of 1-5M bytes per second and a storage capacity of 20 MB - 1.5 GB.

SCSI 2 has a data transfer rate of 1-40M bytes per second and a storage capacity of 40 MB - 3 GB.

WHICH IS BEST?

Performance isn't without price. Many applications don't need the performance of SCSI, which is, by far, the most expensive. IDE or ESDI will usually suffice for most applications. IDE is presently the cheapest of the three. SCSI, however, has the added advantage of the greatest expandability. So, if you need SCSI, the money is well spent.

Thanks Alan.

Well, good luck with your Z-100 MFM Hard Drive installation. If you have questions or comments, I can be reached at z100lifeline@swvagts.com.

Cheers,

S.W. Vagts