

A Technical Overview of Hard Disk Systems on the H/Z89 and H8 Computers

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Introduction

One of the most important advancements in peripherals for the Heath H/Z89 and H8 computers has been the advent of interfaces to connect these machines to high capacity Winchester hard disk drives. However, the prices and lack of thorough software support of these products has traditionally been a serious obstacle for most H/Z89 and H8 owners considering the purchase of such a system.

SigmaSoft and Systems has recently introduced a new product line of complete 10 through 67 megabyte Winchester drive systems with prices that make these products more affordable for H/Z89 and H8 users than ever before. The SigmaSoft Hard Disk packages are not only less expensive, they also feature more recent technology and thorough software support than has been previously available to the H/Z89 or H8 owner.

This article is intended to aid H/Z89 and H8 owners who are considering the addition of a Winchester drive to their system by providing a better understanding of the differences between the various hard disk products that are currently available for these computers. The performance benefits that the user can expect from a hard disk will also be discussed.

Hard Disk Interface Boards

Most hard disk implementations for the H/Z89 and H8 involve two circuit boards, the host interface board and the disk controller board. Usually, the whole purpose of the interface board is to provide communications to the controller board, and one of the expansion bus slots in the host computer is required to accomplish this. In the case of the H8, any bus slot will do. However, the H/Z89 has two differing types of bus slots, the so called "right side slots" which are used primarily by the standard Heath disk controller boards (H17, Z37, Z47, etc.) and the "left side slots" which are generally considered to be less important because there are very few products available for the H/Z89 that can use them.

This is where the first important limitation of many hard disk systems appear, because most of these systems require a right side slot in the H/Z89 and cannot be used with a left side slot. This means that H/Z89 users who currently have two disk controllers (such as the H17 and Z37) must sacrifice one in order to add the hard disk interface board.

The SigmaSoft hard disk systems do not have this limitation since they feature the Universal Parallel Interface Board which only requires one left side bus slot in the H/Z89. In fact, these systems can effectively free up right side slots because they provide functions that may replace boards you are currently using on the right side, such as a Z37 compatible floppy disk controller and two Centronics compatible parallel printer interfaces. The interface to SigmaSoft's Interactive Graphics Controller and Pseudo Disk product is also provided by this same board.

Another important difference between the SigmaSoft hard disk interface and other boards is the type of communication that is used between it and the hard disk controller. The SigmaSoft interface uses a set of eight high speed bidirectional parallel ports that operate so effeciently that no CPU wait states are ever required. Every other hard disk system currently offered for the H/Z89 and H8 uses a SASI or SCSI type communication which are considerably slower since they were originally designed for use in computer systems with DMA (Direct Memory Access) type disk I/O, and not the H/Z89 or H8.

The Universal Parallel Interface is available in two versions, the H8 version which is a half size H8 board, and the H/Z89 version which besides using a left side bus slot, also has a cable to plug into IC socket U553 on the H/Z89's CPU board. Both of these boards feature their own port decoding circuitry with a set of four jumpers that determine the port address of the interface. Also, both boards are designed for up to a 4 MHz CPU clock frequency, and the H8 version can be set for use with either an 8080 or Z80 type CPU board.

Hard Disk Controller Boards

The other circuit board provided in any complete hard disk system is the disk controller. It is this board which controls all of the various functions of the hard disk drive, such as stepping the head motor from track to track (seeking), reading and writing blocks of data to and from the drive, and testing the data that is transferred for any possible errors that may have occurred.

Currently, there are two major types of controllers in use with the H/Z89 and H8. The most common is manufactured by a company named Xebec (pronounced Zee' beck), and it is this controller which requires the SASI or SCSI type communication mentioned earlier.

The Xebec controller physically mounts to the side of the hard disk drive and is connected to the interface board via a 40 or 50 conductor ribbon cable. This board uses a technique of testing for errors in the recorded data as it is read from the disk called CRC (Cyclic Redundancy Checking), which will detect most simple errors that may have occurred in the data and report them. However, these errors can only be detected by this technique and cannot be corrected without rewriting the original information. Furthermore, more serious errors can actually go completely undetected.

The SigmaSoft hard disk systems are unique in that they are not designed around the Xebec controller. SigmaSoft's entire Winchester product line features the Western Digital 1002 controller which is similar to the Xebec board in that it also mounts to the drive physically and is connected to the interface board via a ribbon cable (34 conductors). However, the WD1002 controller has many additional features that set it apart, including its own microprocessor and sector buffering memory that substantially improve system performance.

It is this microprocessor and sector buffering hardware that allow the controller to operate without any CPU interrupts or wait states. The controller features eight programmable registers which are used to control all of its various functions, including error testing. Although the technique used to test for errors is not the same CRC used by the Xebec board, but rather something much more reliable.

The WD1002 controller uses a technique called ECC (Error Correction Coding) which is not only more reliable in detecting errors, it will actually correct most of them so that the information is not lost. This feature greatly improves the dependability of the SigmaSoft hard disk systems over competitive products.

The WD1002 controller also features a double density floppy disk controller which is fully compatible with the Heath Z37 board. In fact, the floppy controller chip on the Heath Z37 board is also a Western Digital component! This insures that any floppy disk formatted on the Heath Z37 board can be read by SigmaSoft's floppy controller and vice versa.

Of course, there are a number of important advantages over the Heath Z37 board. First, the WD1002 floppy controller requires no interrupt states due to the on-board sector buffering hardware. This completely eliminates the loss of characters typed on the keyboard during disk I/O operations which has always plagued the Heath disk controllers. Also, the interface software for SigmaSoft's intelligent floppy controller is much simpler than it is for the Heath Z37 controller. This reduces the size of disk device drivers for the WD1002 controller and frees up system memory for user applications.

Hard Disk Drives

Of course, the most important component of any hard disk system is the drive itself, although comparing Winchester drives can be particularly confusing since the technology is moving so fast in this area. The sizes of drives are shrinking, while their capacity and performances are growing. Just a few years ago Heath offered the 10 megabyte 8 inch (the diameter of the disk or platter) Z67 system for about \$6000.

Since the introduction of the Z67, 5.25 and 3.5 inch drives have predominated since they are just as reliable but are available in 20 megabyte capacities for under \$1000. Today, the latest trend in Winchester drives is the so called "half height" units which can be mounted in half the space as earlier drives.

The four most important specifications the hard disk shopper should know about when comparing Winchester drives are capacity (measured in megabytes), speed (measured in milliseconds per seek, shock rating (measured in G forces), and power requirements (measured in Amps for 5 and 12 Volts). Although the desired storage capacity is primarily up to the individual, it should be noted that 20 megabyte drives currently offer the best value in terms of dollars per megabyte of storage. Care should be taken when comparing the speed ratings of a drive since the controller can affect it greatly as described earlier.

If you are considering a hard disk system that mounts into the front of your H/Z89, then pay special attention to the power supply requirements of the drive and controller since the H/Z89's supply was not designed for these types of loads. Shock ratings on the newer half height drives are usually about 40 G's. This is simply an indication of how large of a drop the manufacturer of the drive specifies it to withstand without damage.

The following chart details the technical specifications for the two types of 20 megabyte drives currently in use by SigmaSoft. Both of these units are half height drives with the very best performance ratings for their price range. The LaPine Titan has been chosen for use with SigmaSoft's internal mount systems for its exceptionally low power consumption and high shock rating. In this configuration, the controller board is powered by a supplemental power supply which taps the AC power line from the H/Z89's cooling fan. Such a power supply upgrade is lacking in competitive products.

SigmaSoft Hard Disk Drive Specifications

<u>Drive Manufacturer and Model</u>	<u>LaPine Titan</u>	<u>Seagate ST225</u>
Formatted Capacity	20.15 MB	20.15 MB
Disk Diameter	3.5 Inches	5.25 Inches
Number of Heads	4	4
Number of Cylinders	615	615
Track Density	835 TPI	580 TPI
Minimum Seek Time	17 ms	20 ms
Average Seek Time	66 ms	85 ms
Maximum Seek Time	154 ms	190 ms
Average Latency	8.33 ms	8.33 ms
Shock Rating	60 G	40 G
Average load on 5 Volts	0.65 Amps	0.8 Amps
Average load on 12 Volts	0.85 Amps	0.9 Amps

Support Software

Support software is where hard disk systems for the H/Z89 and HB have traditionally been the most seriously lacking. Many of the companies currently offering such products supply only the hardware and expect the user to purchase the software elsewhere. This is a very dangerous situation for the user since no single company can be held responsible if there are compatibility problems.

Some systems require that you run a custom version of CP/M, such as that of Magnolia Microsystems, who will not support standard Heath CP/M or HDOS. If a hard disk supplier provides CP/M support but points you to another company for HDOS support, ask them if one drive can be used for both at the same time. Also, be sure that the hard disk is cold bootable under the operating systems you need. Some systems require a floppy drive to boot the hard disk which seriously limits the performance advantages of such a system.

SigmaSoft is dedicated to supporting all H/Z89 and HB users, whether they run HDOS, CP/M, or both. In fact, all SigmaSoft's hard disk systems are shipped with complete support software for both of these operating systems to guarantee complete compatibility between hardware and software and between HDOS and CP/M. SigmaSoft even provides a special hard disk device driver load utility for users of CDR and Magnolia CP/M.

Below is a summary of the two distribution disks that are supplied with each Winchester drive system. In addition to these disks, SigmaSoft also supplies a new boot ROM (MTR-90 replacement) for the H/Z89 to allow cold booting of HDOS and CP/M partitions on the hard disk without the use of floppy drives. For CP/M users who require custom BIOS modifications, the source codes are available separately.

Summary of SigmaSoft Distribution Software

First Disk (CP/M Support)

HDC.DVD	Hard Disk Device Driver for CP/M
WDC.DVD	Combined Hard/Floppy Disk Device Driver for CP/M
UPC.DVD	Universal Parallel Printer Device Driver for CP/M
LOADD.COM	Loads Drivers for Heath, CDR, and Magnolia CP/M
SET.COM	Set Utility for Configuring CP/M Device Drivers
SBIOS1.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk
SBIOS2.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H17
SBIOS3.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H37
SBIOS4.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H47
SBIOS5.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H17, H37
SBIOS6.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H37, H47
SBIOS7.SYS	SigmaBIOS for WD1002 Hard/Floppy Disk, H47, H17
ASSIGN.COM	Assigns up to 4 Partitions by Name to any Drive Units A: Through P: and Shows Partition Directory
CONFIG.COM	Configures the Many New Features of SigmaBIOS
MOVCPM.COM	Creates Bootable CP/M System with SigmaBIOS
HDFORMAT.COM	Formats the Hard Disk for Data Storage
FDFORMAT.COM	Formats Floppy Disks for Data Storage
HDPART.COM	Hard Disk Partition Utility for up to 16 HDOS and/or CP/M Units of Variable Sizes
HDPARK.COM	Parks the Head of the Hard Disk for Shipment
MAKESBC.COM	Creates a New Copy of Software Boot Code on Hard Disk
HDUMP.COM	Hard Disk Sector Read and Modification Utility

Second Disk (HDOS Support)

HD.DVD	Hard Disk Device Driver for HDOS
FD.DVD	Floppy Disk Device Driver for HDOS
UP.DVD	Universal Parallel Printer Device Driver for HDOS
ASSIGN.ABS	Mounts up to 8 Partitions by Name to Units SY0: Through SY7: and Displays Partition Directory
HDFORMAT.ABS	Formats the Hard Disk for Data Storage
HDPART.ABS	Hard Disk Partition Utility for up to 16 HDOS and/or CP/M Units of Variable Sizes
HDPARK.ABS	Parks the Head of the Hard Disk for Shipment
MAKESBC.ABS	Creates a New Copy of Software Boot Code on Hard Disk
HDUMP.ABS	Hard Disk Sector Read and Modification Utility

System Performance Benefits

H/Z89 and H8 users who have never used a hard disk on their system may not fully appreciate all of the advantages of such a device over floppy drives. It's obvious that a hard disk will eliminate hundreds of floppy disks and lead to greater organization of your data. But perhaps more important than this is the fact that a hard disk will dramatically improve the speed of almost every operation that is performed under CP/M and HDOS. It's not only faster to copy files, but most application programs will also run much faster because overlay, and data files will automatically access from the hard disk as well.

To demonstrate the performance benefits that the user can expect after installing a hard disk system, the following benchmark has been prepared. This chart compares the speed of the standard HDOS and CP/M assemblers running on an H17, Z37, and a SigmaSoft hard disk system (WD1002). In each of these tests a common program of 1000 lines was assembled to generate two output files on a single drive system running at a CPU clock frequency of 2 MHz. The step rate used for all of the floppy drives was 6 milliseconds.

SigmaSoft Hard Disk Performance Benchmarks

<u>System Controller</u>	<u>H17 (6 ms)</u>	<u>H37 (6 ms)</u>	<u>WD1002</u>
HDOS Assembly	92 Seconds	87 Seconds	53 Seconds
CP/M Assembly	75 Seconds	72 Seconds	39 Seconds

The most dramatic speed improvements with a hard disk are in operations that are disk I/O bound, such as bootstraps, and file copying. However, note the significant improvement in the execution speed of the HDOS and CP/M assemblers which are not as disk I/O intensive. The user can expect this type of speed improvement over floppy drives for most applications.

Due to the recent gains in hard disk technology and the decline in their prices, all serious H/Z89 and H8 owners should take a close look at upgrading their system with a SigmaSoft hard disk system. It's the perfect way to match the performance of the newer computers on the market, without sacrificing your system investment. No other single upgrade for the H/Z89 or H8 can deliver such a dramatic performance leap.