

Z67-IDE Controller Multi-Drive Boot Support

In the late 70's, Heathkit introduced the Z67 Winchester Disk Drive as shown below. It cost about \$5800.00 dollars and its storage capabilities were about 11 megabytes unformatted.



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NEW

**Zenith Z-67
Winchester Disk
System stores nearly
11 megabytes – comes
with \$750 software credit!**

\$5800⁰⁰

- With software, a \$6550 value!
- Features 10.782 megabytes of on-line data and program storage capacity
- 8-inch Winchester disk drive is permanently mounted, hermetically sealed for maximum reliability
- Winchester disk drive provides extremely fast 70 millisecond average data access
- 8-inch double-density, double-sided floppy disk drive allows easy transfer of data between compatible systems
- Floppy disk drive uses standard IBM 3740-formatted 8-inch floppy disks
- Compatible with most current software for the H/Z-89 All-In-One Computer
- Separate write-protect switches are provided for each disk drive



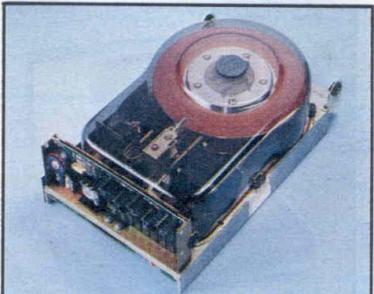
Do you need maximum on-line capacity to store large data bases? Or do you want the vastly better performance of a Winchester disk drive? The Z-67 Winchester Disk System will fill your needs. It represents another "quantum leap" in disk storage capacity – 12.961 megabytes unformatted/ 10.782 megabytes formatted, on an 8" Winchester disk drive and an 8" floppy disk drive!

Get \$750 worth of software, at no extra charge, with this new peripheral. When you buy the Z-67, we'll automatically give you a big \$750 credit toward Heath/Zenith software of your choice. Just order as many software programs as you want, on the same order form with your Z-67 purchase, and deduct \$750 from the total price.

Field-proven, high-capacity Winchester disk drive: This permanently mounted, hermetically-sealed drive is designed to seal out contaminants, thereby reducing the chance of failure in this critical component. The Winchester disk has a track density of 195 tracks per inch, compared to only 48 tracks per inch on an 8-inch, double-sided, double-density floppy disk. The Winchester disk features 244 tracks per surface, x 4 surfaces per disk, for a total of 976 tracks – compared to only 154 tracks per 8-inch, double-sided, double-density floppy disk. The Winchester disk has four recording surfaces – compared to two on a double-sided 8-inch floppy disk, and one on a single-sided 5.25-inch floppy disk (such as those used in the H-17-1 Single-Sided 5.25-Inch Disk Drive). The Winchester disk's data storage capacity is 9.76 megabytes. Average Latency Time for the Winchester disk drive is only 10.06 mS – compared to 83 mS for the floppy disk drive.

High-capacity, 8" floppy disk drive for data portability: You can copy data from the permanently-installed Winchester disk drive onto 8-inch floppy disks, which can be easily transported between compatible computers. You can store up to 1.022 megabytes (in double-density format).

More extra-value features: Front panel switches allow the operator to write-protect either the Winchester disk drive or the floppy disk drive. A front panel LED provides "power on" indication. A switching power supply minimizes



The Z-67 Disk System's Winchester disk drive is a field-proven, highly reliable state-of-the-art design

weight and heat generation. A fuse, EMI line filter and power switch are on the rear panel.

Compatible with most Heath/Zenith software: Most of the programs which presently run on the H/Z-89 Computer will run on systems using the Z-67 Winchester Disk System.

You'll be able to keep many more programs on-line: Imagine having HDOS and CP/M, along with several utility and applications programs, on-line (stored on the Winchester disk) – and still having tens of thousands of sectors available for other functions!

Designed for use with the H/Z-89 All-In-One Computer: It requires an H/Z-89 with 48K RAM and the Z-89-67 Interface (sold below).

The Z-67 Winchester Disk System operates on 120 VAC, 60 Hz power. Draws 190 Watts. Overall Dimensions of the Z-67 are 10.20" H x 18.90" W x 18.0" D (25.90 x 48.00 x 45.72 cm). Net weight is 65.8 pounds (29.9 kilograms).

Z-67 10.782-Megabyte Commercial Winchester Disk System, from Zenith Data Systems. Factory assembled. Includes \$750 of software, at no extra charge (choose from our selection on pages 80-89).

Z-67, Assembled, Shpg. wt. 67 lbs., Motor Freight Collect 5800.00

Z-89-67 Interface. Required to interface Z-67 to H/Z-89 All-In-One Computer. Factory assembled; installs inside H/Z-89 cabinet.

Z-89-67, Assembled, Shpg. wt. 3 lbs. 195.00

Z-67 SPECIFICATIONS: Disks: Capacity: Winchester Disk, 9760 kilobytes (KB); Floppy Disk, 1022 kilobytes (in double density format) or 513 kilobytes (in single density format). Recording Surfaces Per Disk: Winchester Disk, 4; Floppy Disk, 2. Tracks Per Surface: Winchester Disk, 254; Floppy Disk, 154. Recording Density: Winchester Disk, 6100 bytes per inch (bpi); Floppy Disk, 6816 bytes per inch (in double density format) or 3408 bytes per inch (in single density format). Track Density: Winchester Disk, 195 tracks per inch (tpi); Floppy Disk, 48 tracks per inch. Drives: Spindle Motor Speed: Winchester Disk Drive, 2983 rpm; Floppy Disk Drive, 360 rpm. Track-To-Track Move: Winchester Disk Drive, 19.0 milliseconds (mS); Floppy Disk Drive, 3.0 milliseconds. Average Track Access Time: Winchester Disk Drive, 70.0 milliseconds; Floppy Disk Drive, 91.0 milliseconds. Average Latency: Winchester Disk Drive, 10.06 milliseconds; Floppy Disk Drive, 83.0 milliseconds. General: Power Requirement: 120 VAC, 60 Hz. Power Consumption: 190 Watts. Overall Dimensions: 10.20" H x 18.90" W x 18.00" D (25.91 x 48.00 x 45.72 cm). Net Weight: 65.8 pounds (29.9 kilograms).

78/COMPUTERS




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Today we have the Z67-IDE Controller which replaces the original Heathkit Z67 storage solution at a cost less than a \$100.00 with unlimited storage capacity. The Z67-IDE controller presents itself to the H8/H89 Heathkit computers as a Z67 Winchester Hard Drive. It employs two IDE Hard Drives or CF cards with respective IDE adapter and supports up to **“32 bootable logical drives”** per hard Drive or CF card for a total of 64 virtual drives on two 8GB CF cards. For HDOS the total available storage capacity is 15MB (243 cylinders * 240 sectors * 256 bytes = 14,929,920) times 8 drives x (512 bytes/256 bytes) = 240MB. For CP/M the total storage capacity is 8MB times 15 partitions times 8 drives x (512 bytes/256 bytes) = 1920MB. Because we support CP/M on both cards, then the minimum storage capacity supported is 2GB per drive for 8 logical drives per CF card.

To expand beyond 8 logical drives, then replace the 2GB CF card with a 4GB or 8GB card as shown below. Also an IDE hard drive would work as well.

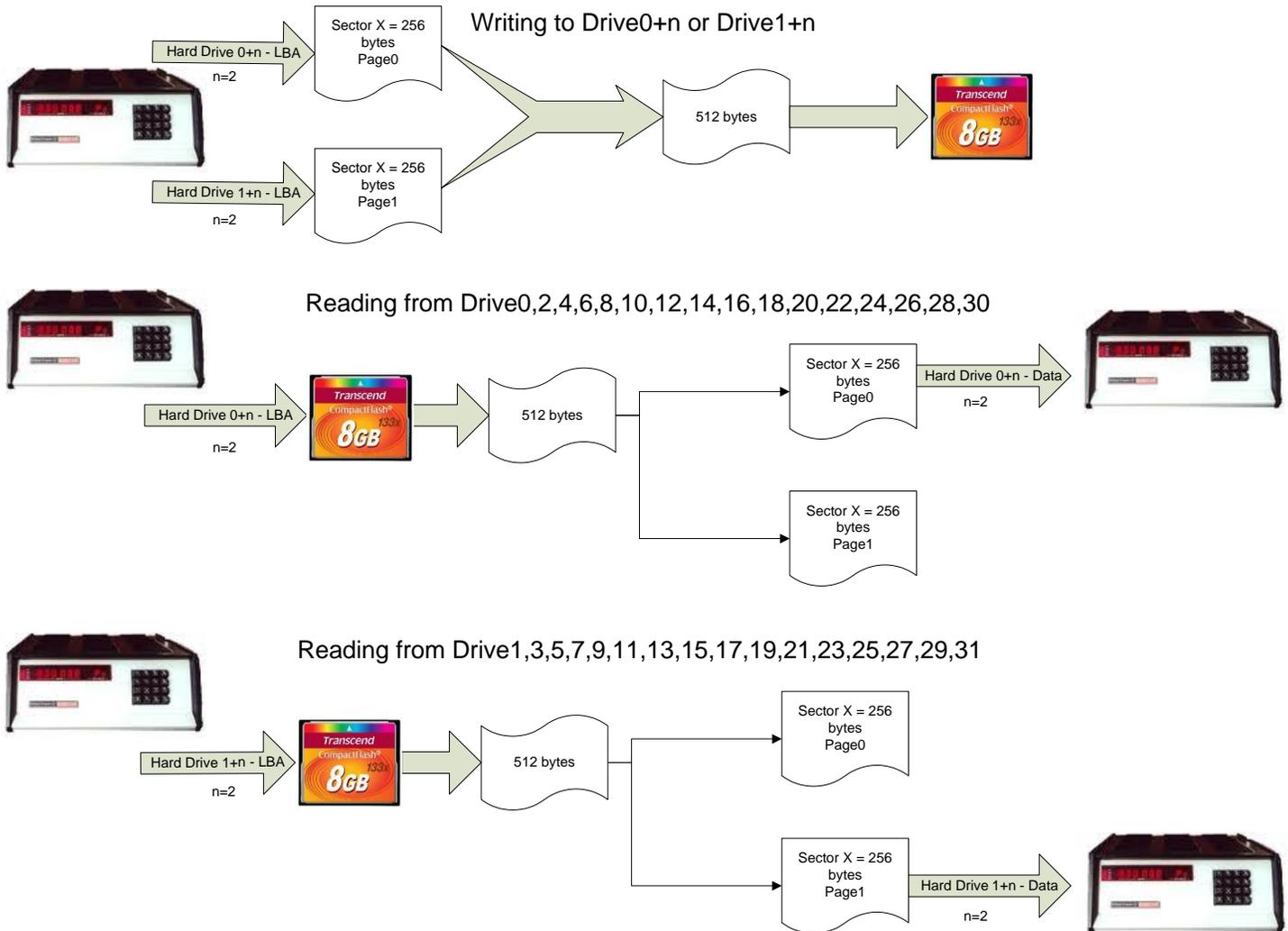
Z67-IDE MultiDisk	
CF Capacity	Logical Drives Supported
2GB	8
4GB	16
8GB	32

IDE drives have a sector size of 512 bytes while the H8/H89 CP/M and HDOS OS’s support 256 bytes per sector. To avoid the time consuming calculation of LBA and sector offset for every block number, the Z67-IDE Storage Controller was designed to support two linear logical drives of 256 bytes per sector. Therefore the space required on the hard disk must be twice the nominal volume size.

To clarify the above statement lets use HDOS as an example. HDOS is trying to write to sector 62001. Sector 62001 converts to megabytes by multiplying by 256 bytes; $62001 \times 256 = 15,872,256$ or 16MB. On the Z67-IDE side it converts as follows; $62001 \text{ sectors} \times 512 = 31,744,512$ or 32MB. So in order for HDOS to be able to write to sector 62001 a 32MB card is needed.

Since only half of the space was being used, there was room for an entire drive in the second half of the 512 byte sector. This could be managed by treating each 512 byte sector as two pages of 256 bytes. The 0 pages (the first 256 bytes) were assigned to the even numbered systems (0, 2, 4, 6, n+2) and the 1 page (the second 256 bytes) were assigned to the odd systems (1, 3, 5, 7, n+2).

IDE-Z67 Multi-Disk Implementation



From the host's point of view, each logical drive is a different hard disk, but as there is only one physical interface, only one logical drive can be accessed at a time. The logical drives are implemented by adding an offset to the logical block number. Logical drive 0 (Drive0) LBA starts at 0x00000000 + offset on the hard drive assigned at page 0 (first 256 bytes of sector 0). Logical drive 1 (Drive1) LBA starts at 0x00000000 + offset on the hard drive assigned at page 1 (second 256 bytes of sector 0), and so on.

Never change the volume number using the BCD switch while the drive is mounted! Always do a System reset to change the drive number, and then boot the OS (CP/M or HDOS). The safe way is to reset the computer to set the BCD switch to the new volume number and reboot the Heathkit Computer.

Configuration example on eight bootable drives when using a 2GB CF card and a BCD switch:

Binary #	BCD SW	Volume#	Page#				BCD SW 0
0000	0	Drive0	Page0	→	→	→	Sector 0, first 256 bytes
0001	1	Drive1	Page1				
0010	2	Drive2	Page0	→	→	→	Sector 0, second 256 bytes
0011	3	Drive3	Page1				
0100	4	Drive4	Page0				BCD SW 1
0101	5	Drive5	Page1				
0110	6	Drive6	Page0				
0111	7	Drive7	Page1				
1000	8	Drive0	Page0				
1001	9	Drive1	Page1				

As shown above, BCD Switch bit 0 is used to control the Page number and bits 1 and 2 are used to control the drive number. Also when expanding beyond 8 logical drives, the BCD switch must be replaced with a hex switch, and an additional switch need to be added to select beyond 16 drives. Please refer to latest Z67-IDE diagrams; <http://koyado.com/Heathkit/Z67-IDE.html>

For selecting the page and volume and to increase the security of the hard drive data, the following operating controls are provided:

- ✓ BCD/Hex Switch to select the active drive. The switch is read at power-on and when reading and writing to the hard drives to calculate sector offset.
- ✓ Write-Protect Switches. These switches are read before performing a sector write operation on the hard drive. If the switch is enabled, it will ignore the write and will report to the OS that the operation was unsuccessful by sending a sense request indicating that the drive is write-protected. It is up to the application to let the user know if the write was successful or not.
- ✓ Replication Jumper or Switch. The switch is read at power-on and if enabled it will do the following;
 - Master Drive:
 - Replicate Drive0 to Drive1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31 (when using an 8GB storage card).
 - Slave Drive:
 - Replicate Drive0 to Drive1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,

19,20,21,22,23,24,25,26,27,28,29,30,31 (when using an 8GB storage card).

Note: The replication routine assumes that the user “only” created a bootable Drive0 system on each IDE hard drive with all required files. This is a time saving routine for HDOS which it takes about 45 minutes just to format a single 16MB partition. Be aware that the Z67-IDE controller is an eight bit controller and 28 bits calculations adds a lot of overhead to the time required to complete the tasks.

Drive Imaging:

Note: Attached Z67-IDE serial port to your PC or H19 terminal

- Drive imaging is activated by pressing the “esc” key after the Z67-IDE FW booted. The following menu will be displayed after detecting the “esc” sequence.

Z67-IDE Manager Menu

=====

- a. Start Replication on Drive 0
- b. Start Replication on Drive 1
- c. Image from Drive 0 to Drive 1
- d. Image from Drive 1 to Drive 0
- e. Display Drive Selection
- f. Display Write Protect Switch Status
- g. Exit

Please enter a Command: G

Z67-IDE Menu disabled. Use the ESC key to enable Z67-IDE Menu.

Description: Warning – Always write protect the source drive.

- Command “a” will start replication only on Drive 0 or CF # 0 or the Master drive. When it starts this process, it will disable the H8-Z67 interrupts, so no reads or writes are allowed. When it completes it will return control back to the Z67-IDE to continue with normal operations. It is normal to see error messages at the end of this process while the utility probes the maximum capacity of the storage device. To exit this process just enable the write protect switch.
- Command “b” will start replication only on Drive 1 or CF # 1 or the Slave drive. When it starts this process, it will disable the H8-Z67 interrupts, so no reads or writes are allowed. When it completes it will return control back to the Z67-IDE to continue

with normal operations. It is normal to see error messages at the end of this process while the utility probes the maximum capacity of the storage device. To exit this process just enable the write protect switch.

- Command “c” will start the imaging process on Drive 0 or CF # 0 or the Master drive. It reads every sector from the master drive and copies it to the slave drive. When it starts this process, it will disable the H8-Z67 interrupts, so no reads or writes are allowed. When it completes it will return control back to the Z67-IDE to continue with normal operations. It is normal to see error messages at the end of this process while the utility probes the maximum capacity of the storage device.
- Command “d” will start the imaging process on Drive 1 or CF # 1 or the Slave drive. It reads every sector from the slave drive and copies it to the master drive. When it starts this process, it will disable the H8-Z67 interrupts, so no reads or writes are allowed. When it completes it will return control back to the Z67-IDE to continue with normal operations. It is normal to see error messages at the end of this process while the utility probes the maximum capacity of the storage device.
- Command “c” will start the imaging process on Drive 0 or CF # 0 or the Master drive. It reads every sector from the master drive and copies it to the slave drive. When it starts this process, it will disable the H8-Z67 interrupts, so no reads or writes are allowed. When it completes it will return control back to the Z67-IDE to continue with normal operations. It is normal to see error messages at the end of this process while the utility probes the maximum capacity of the storage device.
- Command “e” displays Drive Selection based on the BCD/Hex Switch as well as WP status. When it completes it will return control back to the Z67-IDE to continue with normal operations.
- Command “f” displays Write Protect switch status. When it completes it will return control back to the Z67-IDE to continue with normal operations.
- Command “g” is to exit the menu. In order to enable the menu again, please press the “esc” key.

Features no longer supported:

- RTC clock. It makes sense to keep it on the H8 bus and not on the Z67-IDE board.
- Z67-IDE Manager GUI. It requires Windows OS to work, so it is not practical.

Schematics:

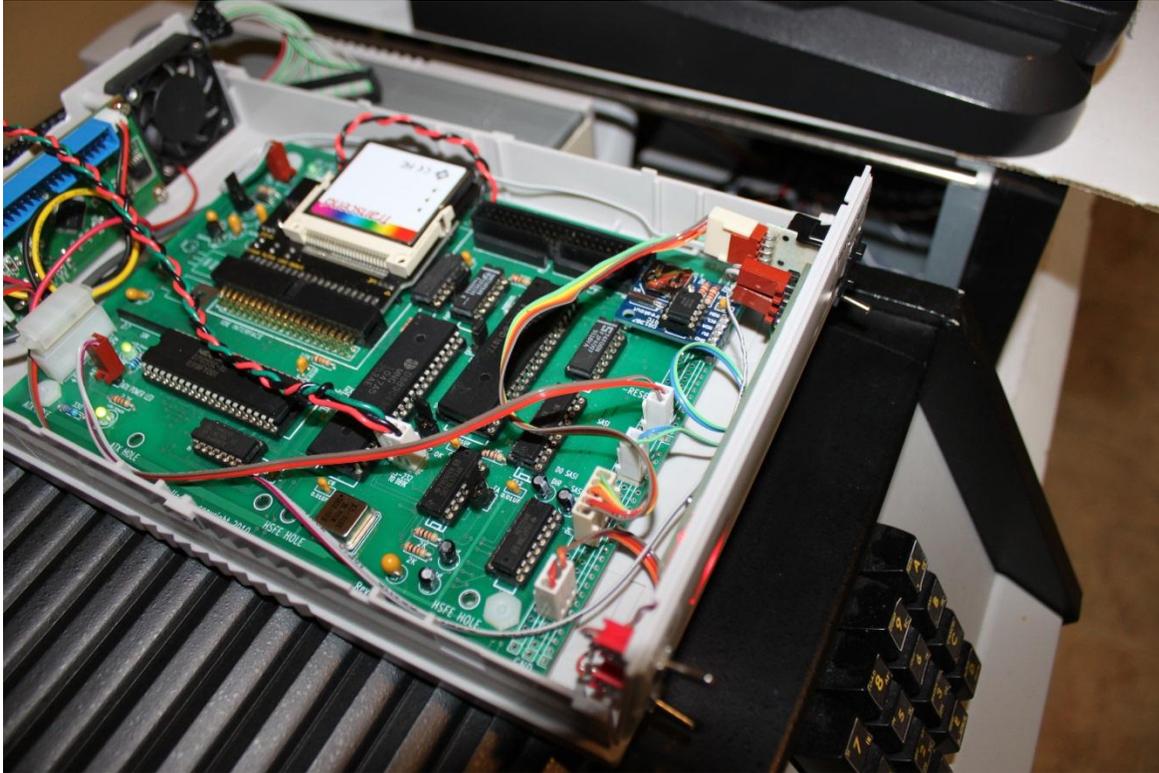
[Z67-IDE 32 Drive Schematics](#)

Please follow-up on the schematics to enable 8, 16 or 32 drive support.

Hex Switch Configuration based on hard drive capacity:

Hex Switch Position	Drive Selected	32 Drive Switch	CF Card Capacity		
0	0	Off	2GB	4GB	8GB
1	1	Off	2GB	4GB	8GB
2	2	Off	2GB	4GB	8GB
3	3	Off	2GB	4GB	8GB
4	4	Off	2GB	4GB	8GB
5	5	Off	2GB	4GB	8GB
6	6	Off	2GB	4GB	8GB
7	7	Off	2GB	4GB	8GB
8	8	Off		4GB	8GB
9	9	Off		4GB	8GB
10	10	Off		4GB	8GB
11	11	Off		4GB	8GB
12	12	Off		4GB	8GB
13	13	Off		4GB	8GB
14	14	Off		4GB	8GB
15	15	Off		4GB	8GB
0	16	On			8GB
1	17	On			8GB
2	18	On			8GB
3	19	On			8GB
4	20	On			8GB
5	21	On			8GB
6	22	On			8GB
7	23	On			8GB
8	24	On			8GB
9	25	On			8GB
10	26	On			8GB
11	27	On			8GB
12	28	On			8GB
13	29	On			8GB
14	30	On			8GB
15	31	On			8GB

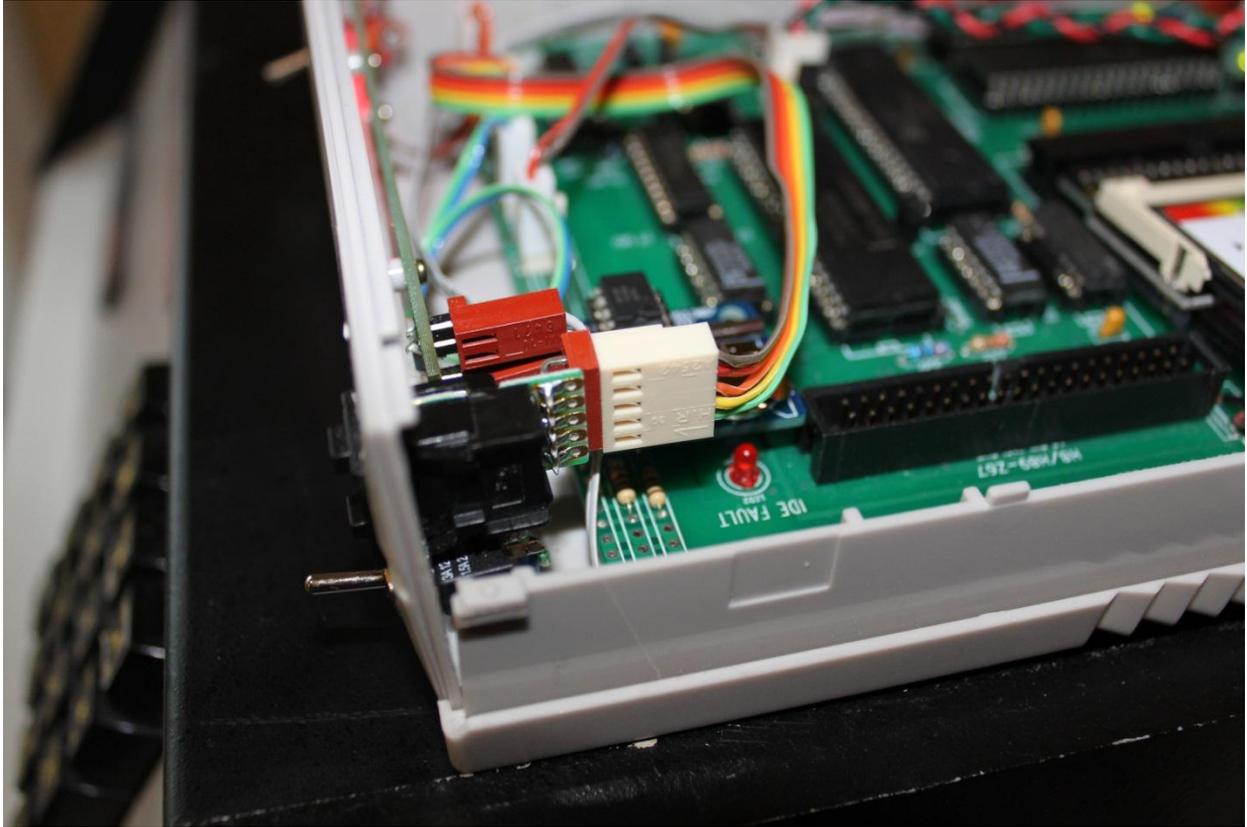
Configuration:



Complete board configuration with I²C RTC clock

Hex Switch: <http://www.allspectrum.com/store/bcd-switch-hex-15-pushwheel-pen-push-type-plaimae-corporation-p-1320.html>





Hex switch connections



Hex switch – Position from 0 to 15 (with 4GB CF card). Switch below is to enable from Drive 16 to 32 with 8GB CF cards, and not required when using 2GB or 4GB CF cards.

References:

FW: [Z67-IDE FW](#)