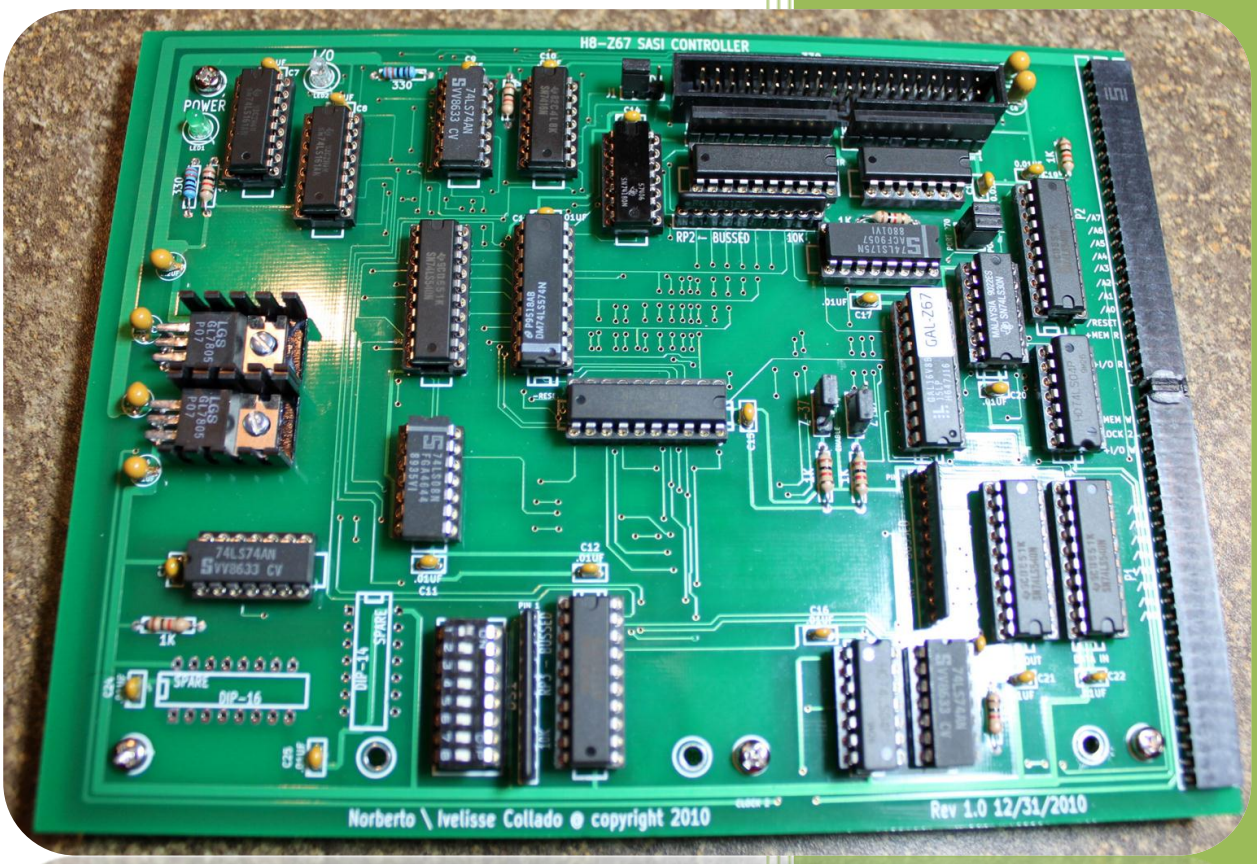
2011

H8-Z67-DISK CONTROLLER



Norberto Collado

norby@koyado.com

4/10/2011

Revision History and Disclaimer

Revision History		
Revision	**Date**	**Comments**
1.0	03/01/2011	Initial draft by Norberto Collado
1.1	04/10/2011	Update document. Added assembly instructions and FP labels by Carroll.

Although we have not obtained written permission to reproduce the information from the Heathkit WH-8-37 Manual, every effort will be made to ensure that credits are posted accurately. The purpose of this document is to “SUPPORT” those who still use these great Heathkit machines and to preserve the information of those who made a difference.

Another purpose of this document is to allow the surviving classic computers to continue to function. Without the proper software support, the hardware cannot be seen in action, and a piece of our digital history is lost. I have not included any material in this document which I believe has current commercial value. Most of the material in this document is the intellectual property of other companies or individuals. However many of the companies are no longer in existence, and I do not have current contact information to obtained permission to include them.

Please don't use any of this material for any purpose other than personal hobby/interest without checking with the owner of the material.

Thank you for your understanding and consideration.

Table of Contents

Introduction

This document provides an overview on the H8-Z67 disk controller board design by Norberto Collado for the Heathkit H8 Computer.

H8-Z67 DISK CONTROLLER

The H8-Z67 controller contains a standard SASI interface bus to boot from the Z67-IDE storage board. The H8-Z67 controller is operable at any CPU speed up to 4 MHz, and it supports two bootable IDE hard drives via the H8 front panel. The H8-Z67 SASI DISK CONTROLLER mounts inside the H8 computer cabinet while attached to the Z67-IDE controller allowing IDE boot support.

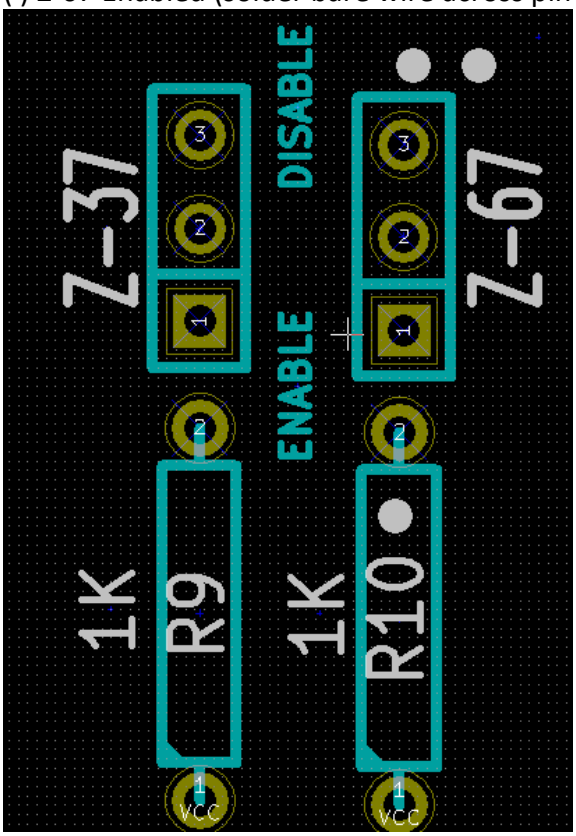
CONTROLLER CARD PORTS CONFIGURATION

The following is a table summary of the controller ports configuration. Please refer to the PAM-37 ROM documentation for switch definition for proper port settings.
Documentation can be obtained at the following website;
http://www.lesbird.com/sebhc/index.html

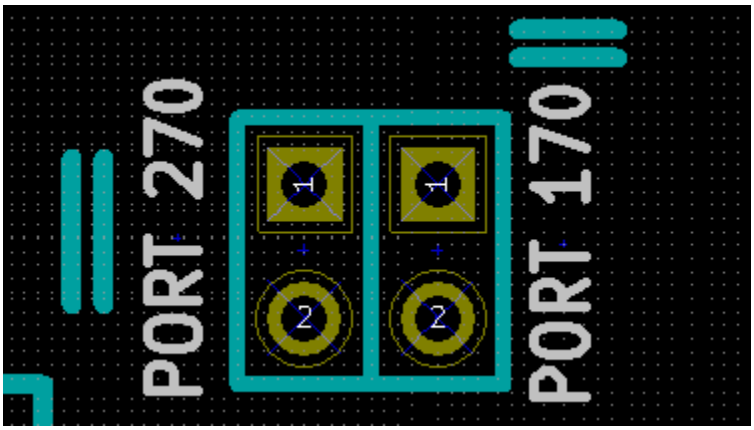
CONTROLLER CARD	PORT	WH-8-Z67 PORT
H17	7CH (174Q)	78H (170Q)
H8-Z67	78H (170Q)	7CH (174Q)
H47	78H (170Q)	7CH (174Q)

H8-Z67 Jumper Configuration

( ) Z-37 Disabled (solder bare wire across pin 2 and 3)
( ) Z-67 Enabled (solder bare wire across pin 1 and 2)

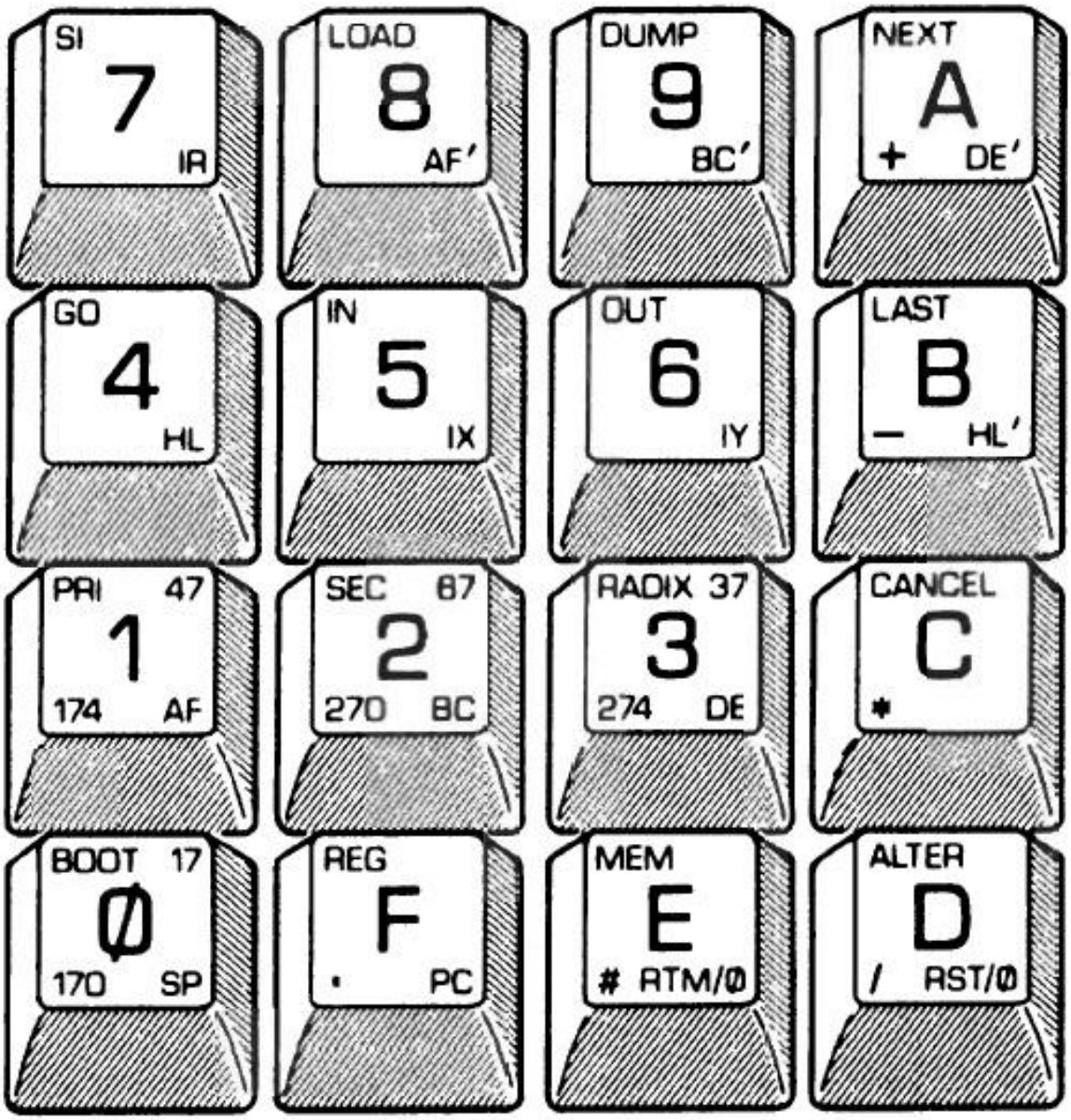


( ) Jumper across pin 1 and 1 and jumper across pin 2 and 2 (default address 170Q)



Front Panel Modifications

The PAM-37 EPROM allows one step booting from the H8-Z67 Disk Controller and their respectively hard drives. Refer to the Pictorial below for the new Front Panel Labels.



Before:


ON
MON
RUN
PWR
ADDRESS
DATA/REGISTER
HEATHKIT
H8
DIGITAL COMPUTER
7 SI
8 LOAD
9 DUMP
+
DE 4 GO
HL 5 IN
PC 6 OUT
−
SP 1
AF 2
BC 3
* CANCEL
Ø
REG .
MEM # RTM/Ø
ALTER / RST/Ø

After:


ION
MON
RUN
PWR
ADDRESS
DATA/REGISTER
HEATHKIT
H8
DIGITAL COMPUTER

Operation

The PAM-37 EPROM contains the code necessary to boot an operating system from the H-17, H/Z-37, H/Z-47, Z67 and the new H8-Z67 controllers.

There are four methods you can boot your system:

1. Primary
2. Secondary
3. Universal
4. Auto

Primary and Secondary Boot allow you to boot from a primary or secondary drive system with one keystroke. The Universal Boot allows you to boot your system from any drive in any device. Auto Boot allows "**turnkey**" operation from drive 0 of the primary device when you turn the power-on.

Primary Operation

Select the primary device by setting switch **SW1** on the HA-8-6 Z80 CPU or on the H8-Z80-64 CPU/GIDE Circuit Board. To boot from this device, Press the "**1**" key. The display will show;

Pri xxx

The **xxx** will display the device name: H17, H37, H47 or H67. To cancel this boot command, press the "**C"** key (Cancel).

Secondary Operation

Select the secondary device by setting switch **SW1** on the HA-8-6 Z80 CPU or on the H8-Z80-64 CPU/GIDE Circuit Board. To boot from this device, Press the "**2**" key. The display will show;

Sec xxx

The **xxx** will display the device name: H17, H37, H47 or H67. To cancel this boot command, press the "**C"** key (Cancel).

Universal Operation

Primary and secondary operation provides one-key-boot operations from IDE drive 0 or 1 of a device. To boot from another drive on a device when it is configured according to the HA-8-6 Configuration (as shown on next page). To Boot follow the steps;

( ) Press the "**0**" key (boot). The display will show;

dEU ("Device")

( ) Press one of the following keys to indicate the device: **0** for H-17, **1** for H-47, **2** for H-67, or **3** for H-37. The display will show;

xxx Por ("Port")

The **xxx** will be the device name (H17, H37, H47, or H67).

( ) Press the key which corresponds to the port address: **0** is for port 170, **1** is for port 174, **2** is for port 270 and **3** is for port 274. The display will show:

xxx pp Uni ("Unit")

The **xxx** is the device name (as stated in step 2) and the **ppp** is the port address in Octal (170 for 0, 174 for 1, 270 for 2, and 274 for 3).

( ) Press the key which corresponds to the hardware unit number of the disk drive (0, 1, 2, or 3). The display will show:

Uni xxx

The **xxx** will be the device name (H17, H37, H47, and H67).

The disk unit will be activated, and the initial boot routine will be read from disk into memory. If an error occurs, the Computer will beep and the display will show:

Err or xxx

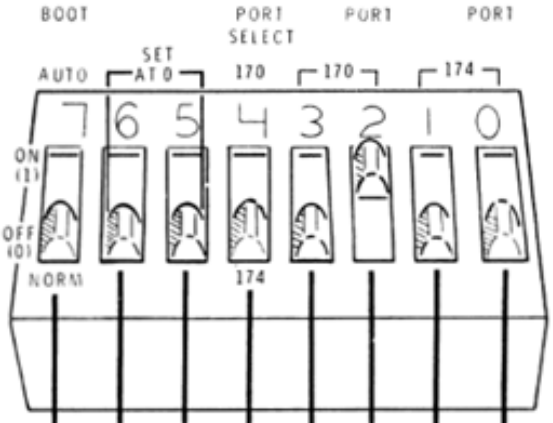
Again, the xxx will be the device name. To cancel the error or stop the operation, press the "**C"** key (Cancel).

Note: By using ports 270 and 274, up to **four** mass storage devices may be used by a single H-8 computer. As distributed, both HDOS and CP/M do not support such use. The QSBIOS will support one H8-Z67, one H17 and two H8-Z37 boards. The QSBIOS will also support two H8-Z67, and one H17 controller. Also it will support two H8-Z67 and two H8-Z37 boards.

Auto Operation

If section 7 of switch SW1 on the Z80 CPU board is set to **1**, the system will automatically boot from hardware unit **0** on the primary device when you turn the power on or perform a master clear (by pressing both the **0** and the **D** keys.

Note: This feature is only to boot from Hard Drives. On floppy drives, the diskette could be accidentally erased during the power-on sequence inside the Computer.



Selects the device located at port 174 (Octal). The settings of these two sections are:

00 — H-17 Controller.
01 — H-47 8" Disk Controller.
10 — Z-67 Winchester Interface.
11 — No controller.

Selects the device located at port 170 (Octal). The settings of these two sections are:

00 — Z-37 Controller.
01 — H-47 8" Disk Controller.
10 — Z-67 Winchester Interface.
11 — No controller.

Determines whether the primary boot device is at port 170 or 174 (Octal). The setting is:

0 — Primary boot from port 174.
1 — Primary boot from port 170.

These two sections are not used by the H-8 Computer at this time.

Determines whether boot is automatically invoked on power up or not.

0 — Normal boot.
1 — Auto boot on power up.

H8-Z67 SASI Bus Pin Assignment

Z-67 Interface Bus Pin Assignment

The Z-67 interface is connected to the Z-67 controller through a 40-pin connector.

The pin assignments are as follows:

Signal	Pin No.
DATA0	2
DATA1	4
DATA2	6
DATA3	8
DATA4	10
DATA5	12
DATA6	14
DATA7	16
PARITY	18
———	20 (spare)
———	22 (key)
———	24 (spare)
BUSY	26
ACK	28
RST	30
MSG	32
SEL	34
C/D	36
REQ	38
I/O	40

NOTE: All signals are active low and all odd pins are connected to ground. The signal lines are terminated with 220 ohms to 5 volts and 330 ohms to ground.

H8-Z67 Interface Register Definition

The registers on the H8-Z67 Disk Controller Board are listed below. The address given assumes that the board is setup at addresses 170Q - 172Q or 0x78 – 0x7A. If the board is jumpered for Port 270, add 100 octal to the address given. If the H8-Z67 is addressed at 174 (or 274), add 4 (or 104) to the address given.

170Q + 4Q = 174Q = 0x7C

171Q + 4Q = 175Q = 0x7D

172Q + 4Q = 176Q = 0x7E

The bit definition for each register is described below:

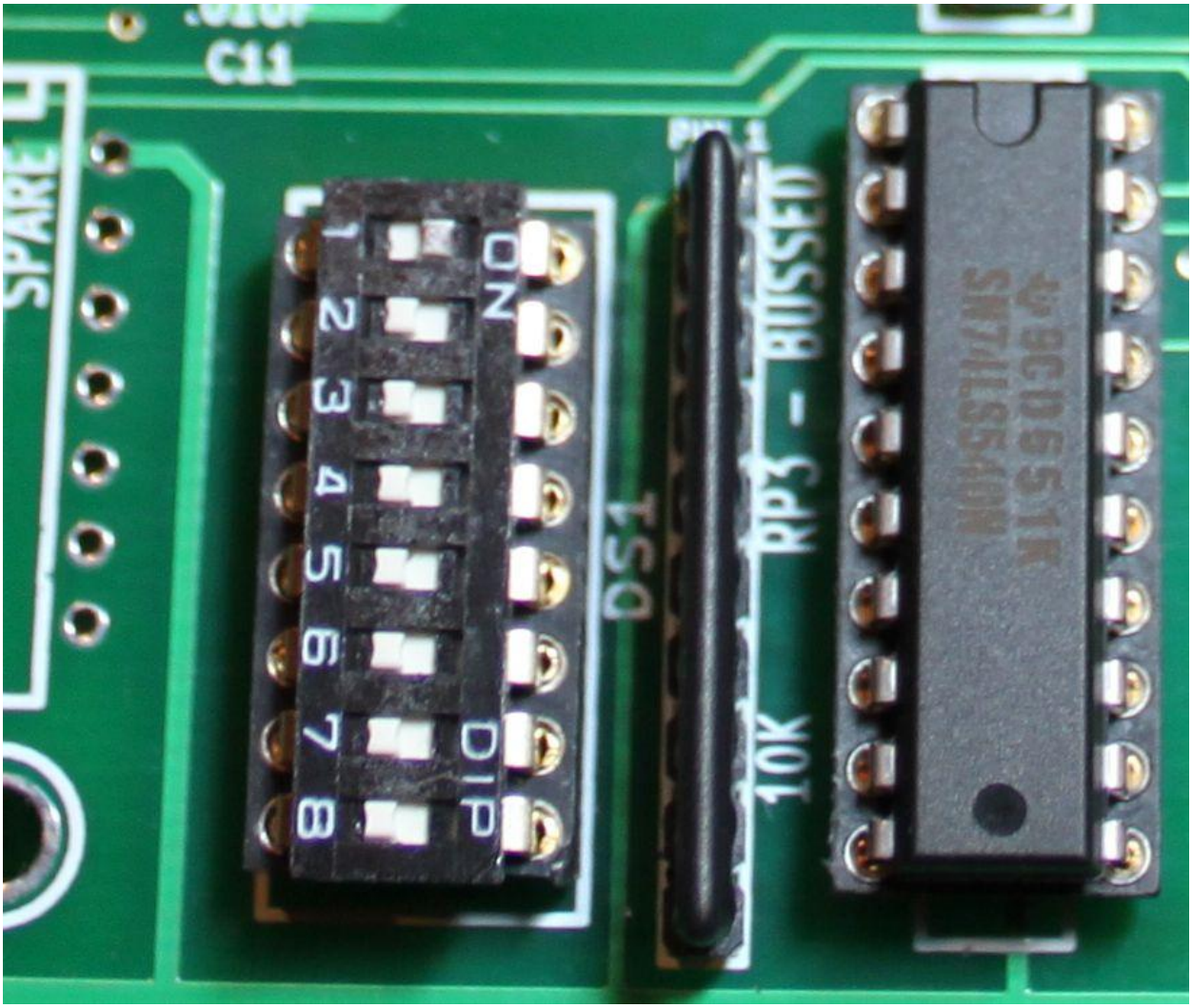
HEX Address	Octal Address	Register	Operation
0x78	170Q	Data In/Out	Read and Write
0x79	171Q	Control Register	Write Only
0x79	171Q	Status Register	Read Only
0x7A	172Q	DIP SWITCHES (DS1)	Read Only

Control Register	Output Address (0x79, 171Q)
bit 7	Data Enable
bit 6	SASI SEL - Assert Select and Data. Bit 0 is hard wire to access the controller.
bit 5	Interrupt Enable - causes interrupt if SASI REQ is present.
bit 4	SASI Reset
bit 3	Not Used
bit 2	Not Used
bit 1	Not Used
bit 0	Not Used

Bus Status	Input Address (0x79, 171Q)
bit 7	SASI REQ - Indicates the Z67-IDE controller either request data or has data for the H89-Z67 Disk Controller.
bit 6	SASI IN/OUT (referenced to controller) - Low indicates data to Interface board. High indicates data to controller.
bit 5	SASI MSG – Indicates last byte in data or command string.
bit 4	SASI COMMAND/DATA - Is high when a command is being sent to the controller, and it is low when data is being sent.
bit 3	SASI BUSY - Indicates that the SASI Bus is busy, no other device can access the SASI Bus.
bit 2	PARITY ERROR - Indicates BAD parity.
bit 1	INTERRUPT IN PROGRESS - Verifies that interrupt has been activated. Reading status port resets interrupt.
bit 0	SASI ACK - Acknowledges request for data.

H8-Z67 DS1 Switch Definition

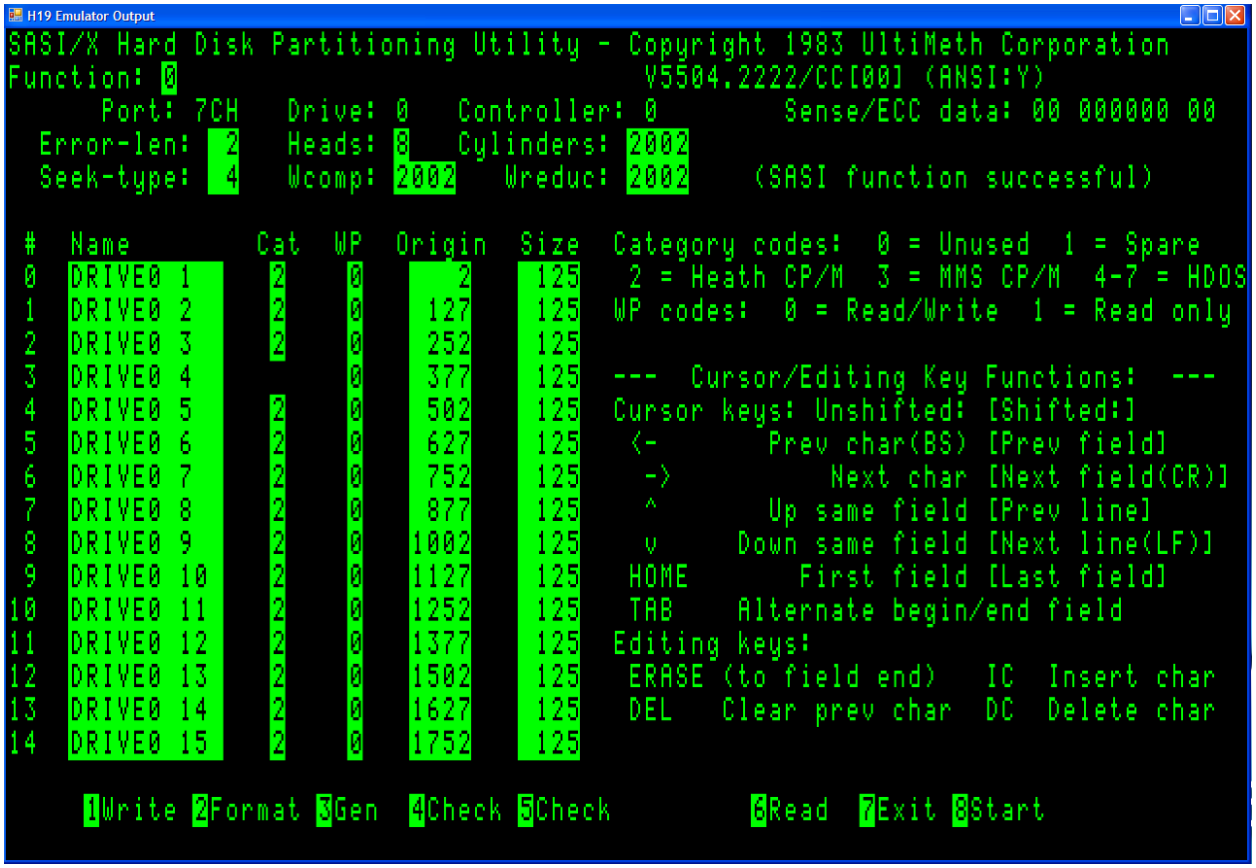
The DIP 8 Switch that is on the H8-Z67 controller is used to define the boot partition from Hard Disk 0 or Hard Disk 1. The QSBIOS supports 15 partitions per drive and all of them are bootable if the QSPUTSYS.COM file was used to enable them. Below are the 15 partitions for Drive 0 and 1, and its assignment per Switch DS1 definition.



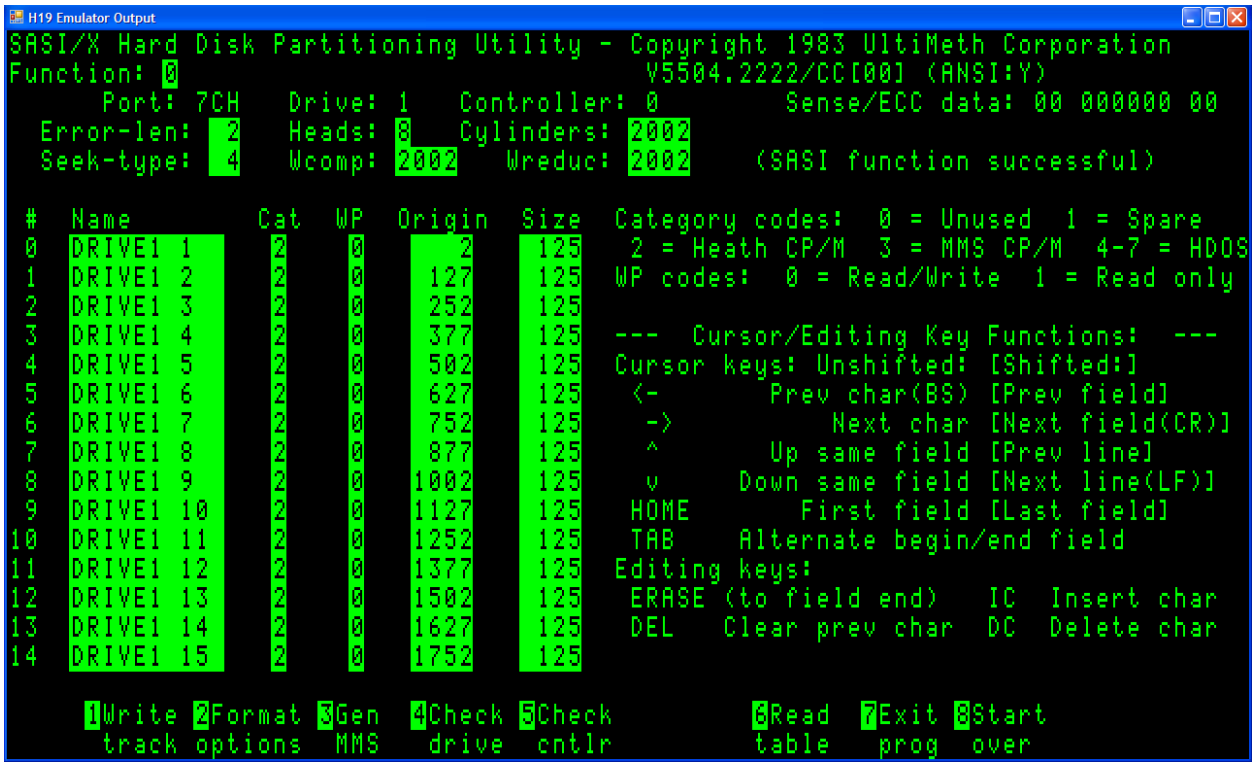
DSI Boot Partitions Assignments

DS1:									
SW 8	SW 7	SW 6	SW 5	SW 4	SW 3	SW 2	SW 1	Boot Partition Drive 0	Boot Partition Drive 1
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	DRIVE0 2	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	DRIVE0 3	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	DRIVE0 4	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	DRIVE0 5	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	DRIVE0 6	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	DRIVE0 7	DRIVE1 1
OFF	OFF	OFF	OFF	OFF	ON	ON	ON	DRIVE0 8	DRIVE1 1
OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	DRIVE0 9	DRIVE1 1
OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	DRIVE0 10	DRIVE1 1
OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	DRIVE0 11	DRIVE1 1
OFF	OFF	OFF	OFF	ON	OFF	ON	ON	DRIVE0 12	DRIVE1 1
OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	DRIVE0 13	DRIVE1 1
OFF	OFF	OFF	OFF	ON	ON	OFF	ON	DRIVE0 14	DRIVE1 1
OFF	OFF	OFF	0FF	ON	ON	ON	OFF	DRIVE0 15	DRIVE1 1
OFF	OFF	OFF	OFF	ON	ON	ON	ON	MENU SELECTABLE	DRIVE1 1
OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 2
OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 3
OFF	OFF	ON	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 4
OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 5
OFF	ON	OFF	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 6
OFF	ON	ON	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 7
OFF	ON	ON	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 8
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 9
ON	OFF	OFF	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 10
ON	OFF	ON	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 11
ON	OFF	ON	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 12
ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 13
ON	ON	OFF	ON	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 14
ON	ON	ON	OFF	OFF	OFF	OFF	OFF	DRIVE0 1	DRIVE1 15
ON	ON	ON	ON	OFF	OFF	OFF	OFF	DRIVE0 1	MENU SELECTABLE

Drive 0 Partitions



Drive 1 Partitions



Menu Selectable Boot Partitions

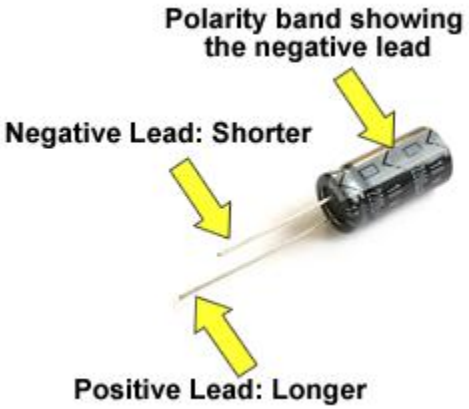
H8-Z67 Board Assembly

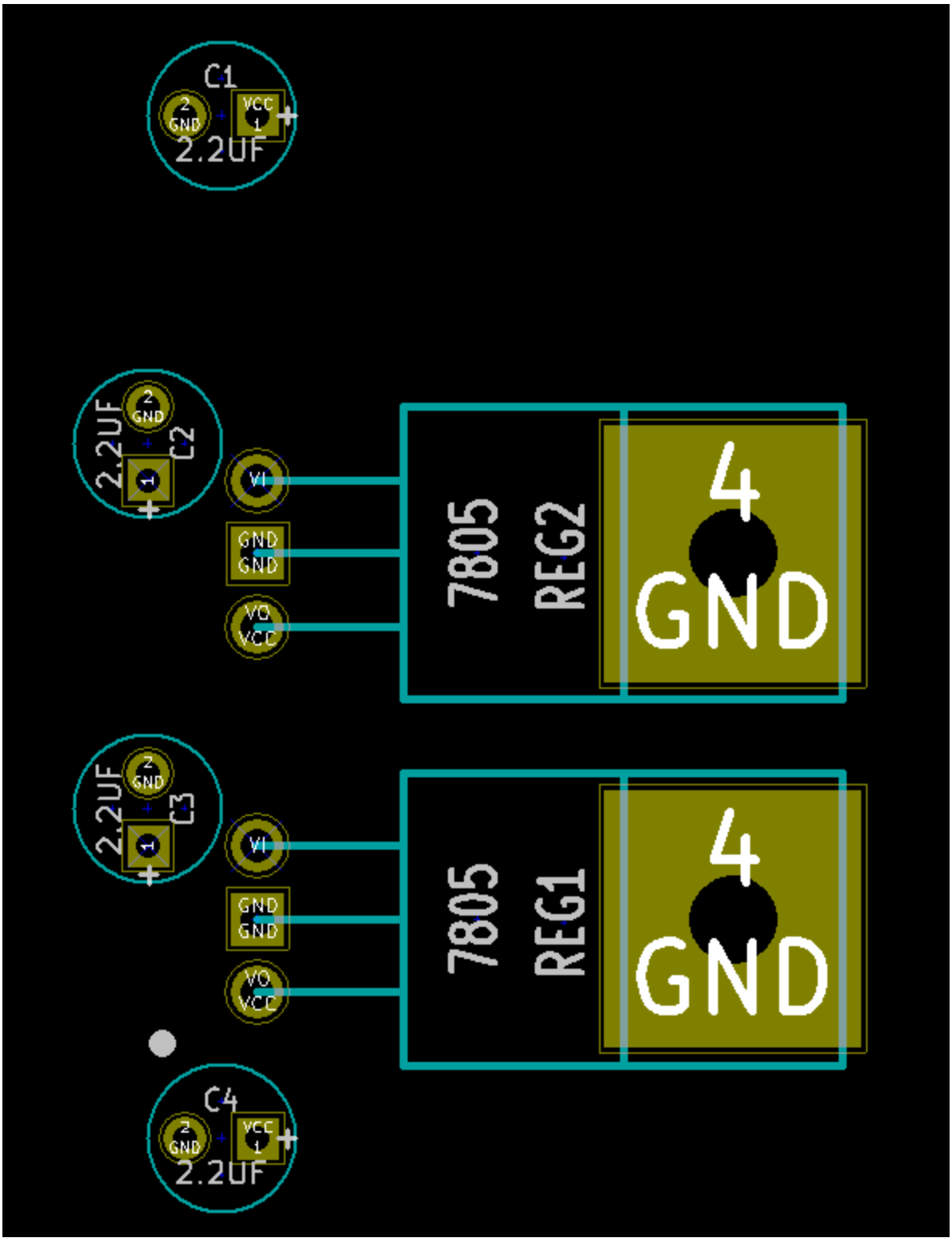
( ) – All the soldering equipment can be found at Radio Shack. A soldering iron drawing 15W is plenty powerful for this job. Don't go any higher or else you'll risk damage to the board and/or components. Make sure you have a narrow tip.

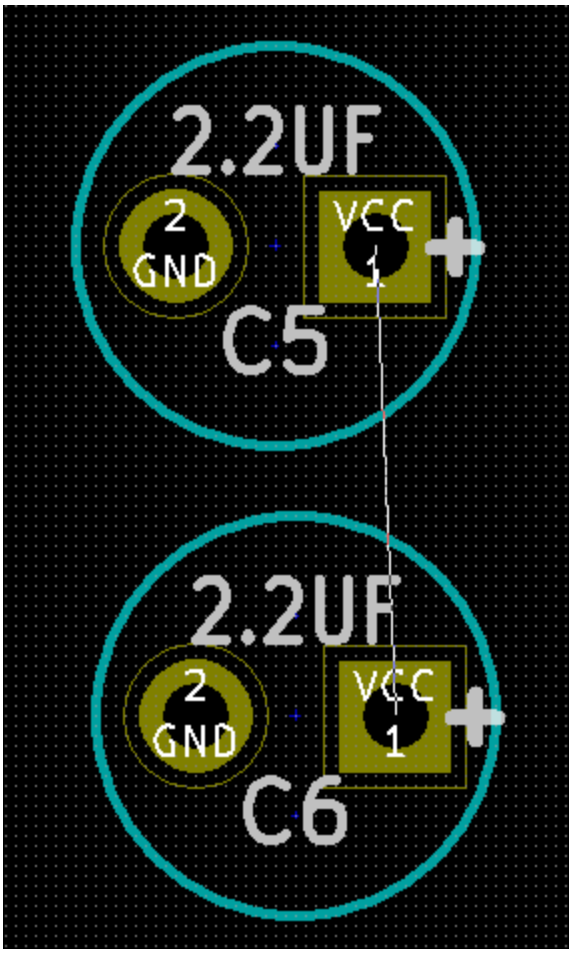
( ) - Latest BOM is at the following website; H8-Z67 Controller parts list Rev 1_3_BOM.xls

( ) – Solder C7, C8, C9, C10, C14, C12, C11, C16, C13, C15, C23, C18, C21, C22, C20, C17, C19, C24, C25, and C26 - 0.01uF caps.

( ) – Solder C1, C2, C3, C4, C5, and C6 - 2.2uF caps (observed polarity)

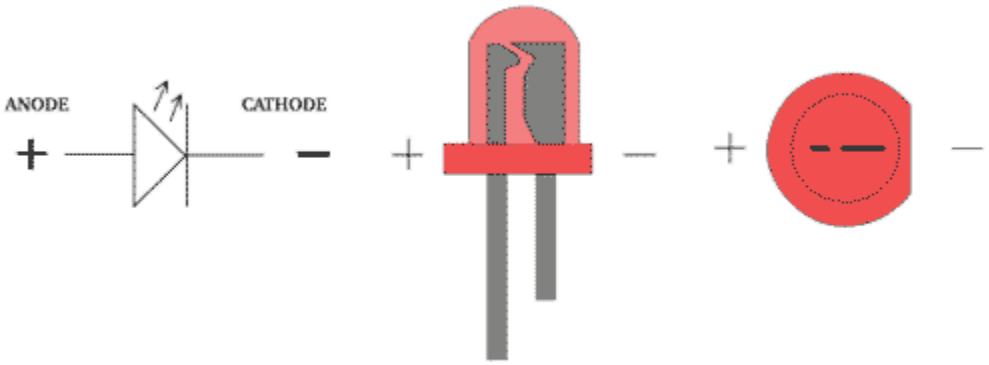


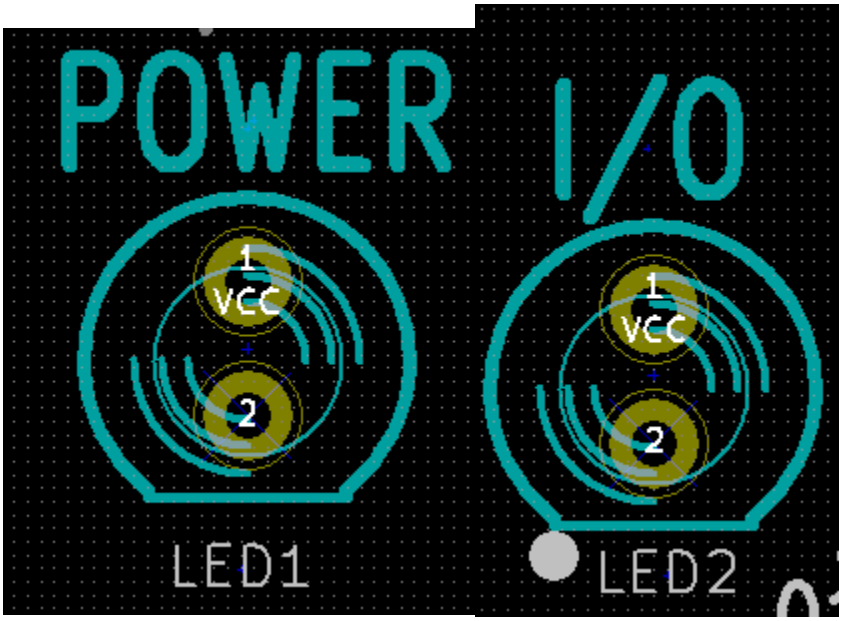

C1
2
GND
VCC
1
2.2UF
2.2UF
2
GND
C2
1
VI
GND
GND
VO
VCC
7805
REG2
4
GND
2.2UF
2
GND
C3
1
VI
GND
GND
VO
VCC
7805
REG1
4
GND
C4
2
GND
VCC
1
2.2UF


2.2UF
2
GND
VCC
1
C5
2.2UF
2
GND
VCC
1
C6

( ) – Solder a Green LED - LED1 (POWER)

( ) – Solder a Red or a Blue LED - LED2 (I/0)





Resistor Band Color Reference				
Color	*Band 1*	*Band 2*	*Multiplier*	*Tolerance*
Black	0	0	x 1	not used
Brown	1	1	x 10	not used
Red	2	2	x 100	not used
Orange	3	3	x 1000 = 1K	not used
Yellow	4	4	x 10000 = 10K	not used
Green	5	5	x 100000 = 100K	not used
Blue	6	6	x 1000000 = 1M	not use
Violet	7	7	not used	not used
Gray	8	8	not used	not used
White	9	9	not used	not used
Gold	not used	not used	divide by 10	±5%
Silver	not used	not used	divide by 100	±10%
None	not used	not used	not used	±20%

( ) – Solder RP1, RP2, RP3 - RESISTOR NET, 10PIN, 10K OHM

( ) – Solder R2, R4, R7 – 330 OHM resistors

( ) – Solder R6 – 220 OHM resistor

( ) – Solder R3, R12, R8, R9, R10, R11, R12, R13, R5, R1 – 1K OHM resistors

( ) – Solder RP4, RP5 - RES NET DUAL 220/330 OHM 10-SIP (Dual Terminator)

( ) – Solder DS1 - SWITCH, DIP, SPST, 8-POS, 16-PIN

( ) – Solder U1, U8, U2, U10, U5, U7, U3, U13, U25, U14 – IC SOCKET, 14PIN

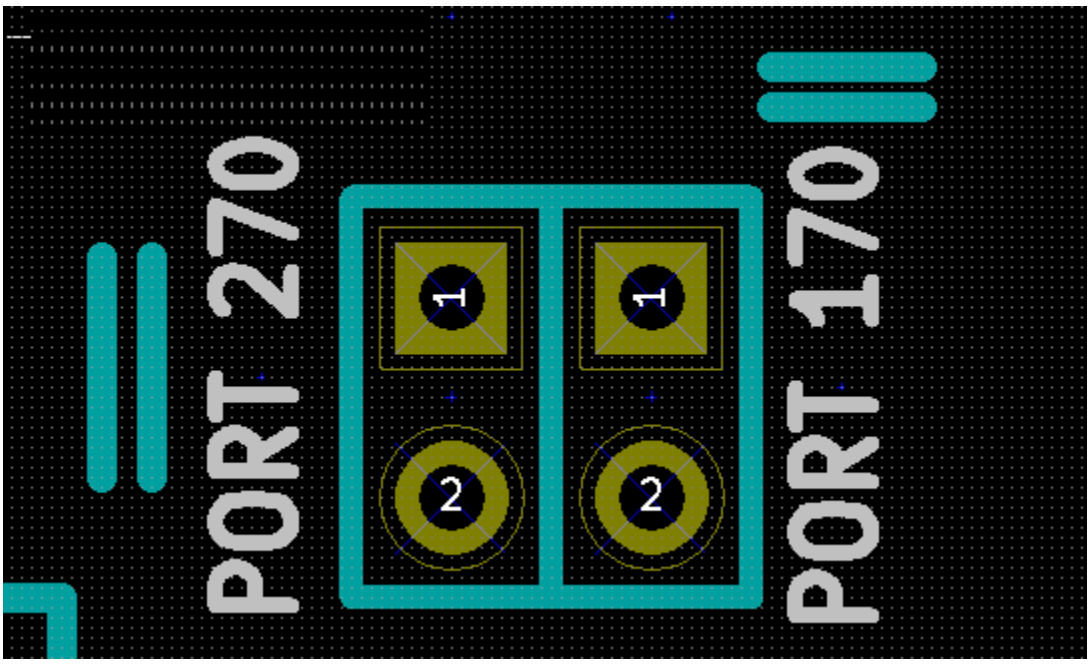
( ) – Solder U27, U28, U16 – IC SOCKET, 16PIN

( ) – Solder U19, U9, U21, U5, U26, U35, U36, U20, U11 – IC SOCKET, 20PIN

( ) – Solder the 7805 Voltage Regulators – REG1 and REG2. Add the heat-sinks, and thermal compound under each heat-sink and under each voltage regulator. These regulators get hot, but they work fine at such temperatures.

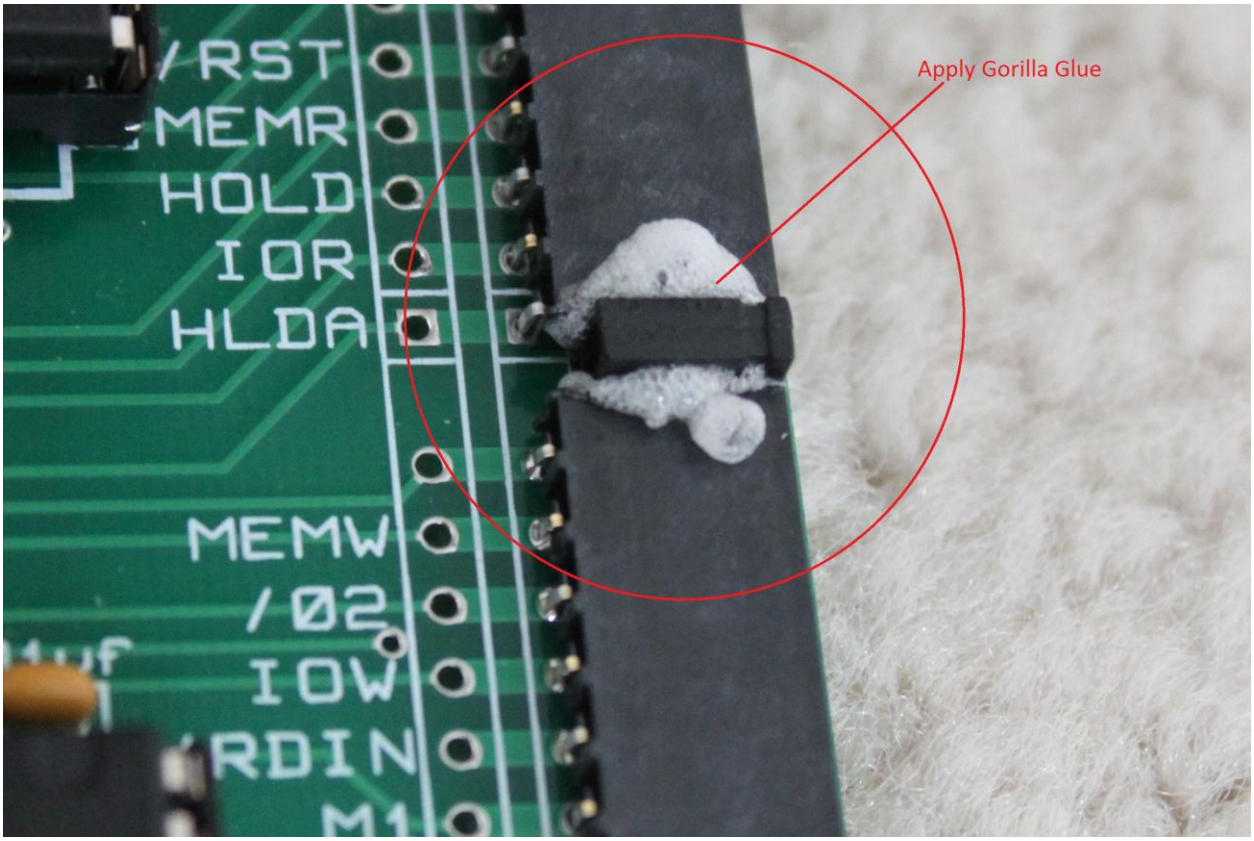
( ) - Solder SASI 40 pin male connector (J2) - HEADER, LP, SHROUDED, 40PIN, MALE

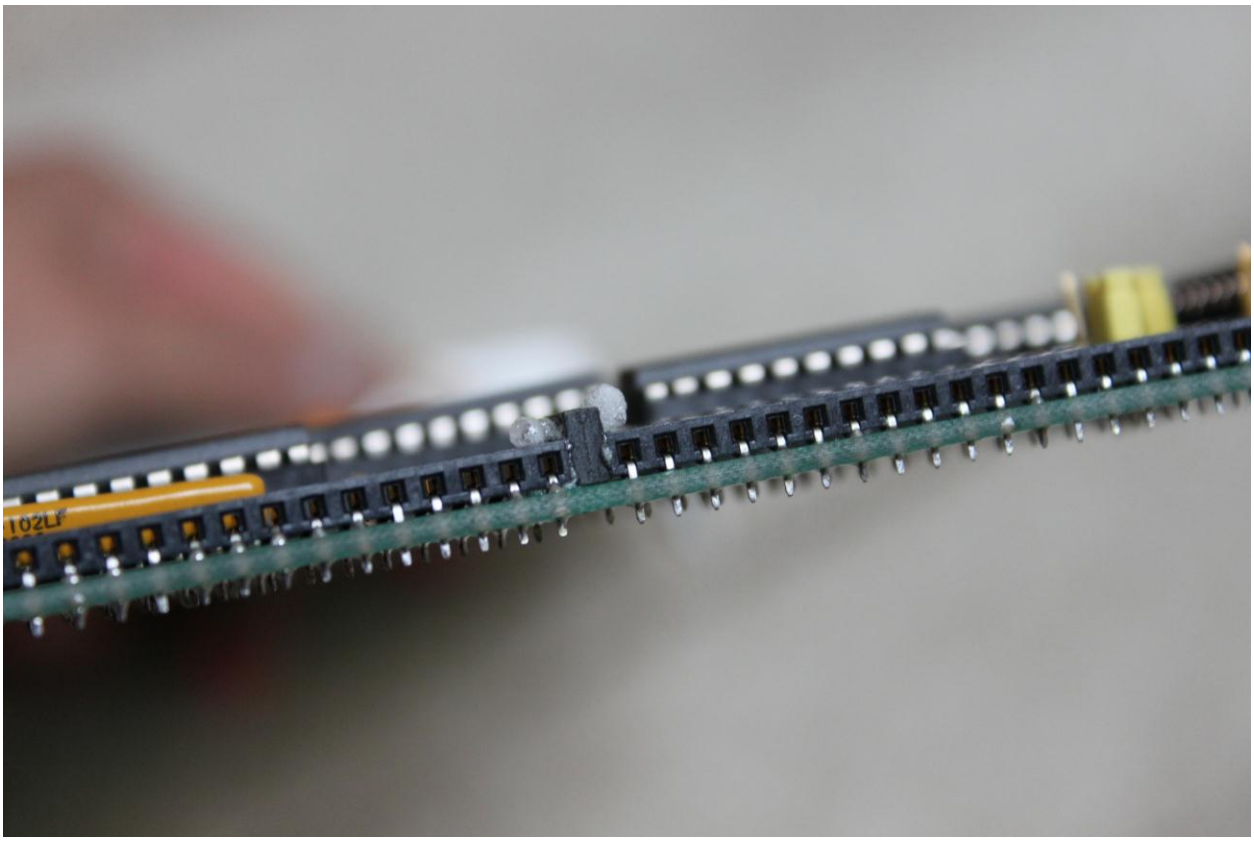
( ) – Solder 2 pin header at the following locations; PORT 270 and PORT 170



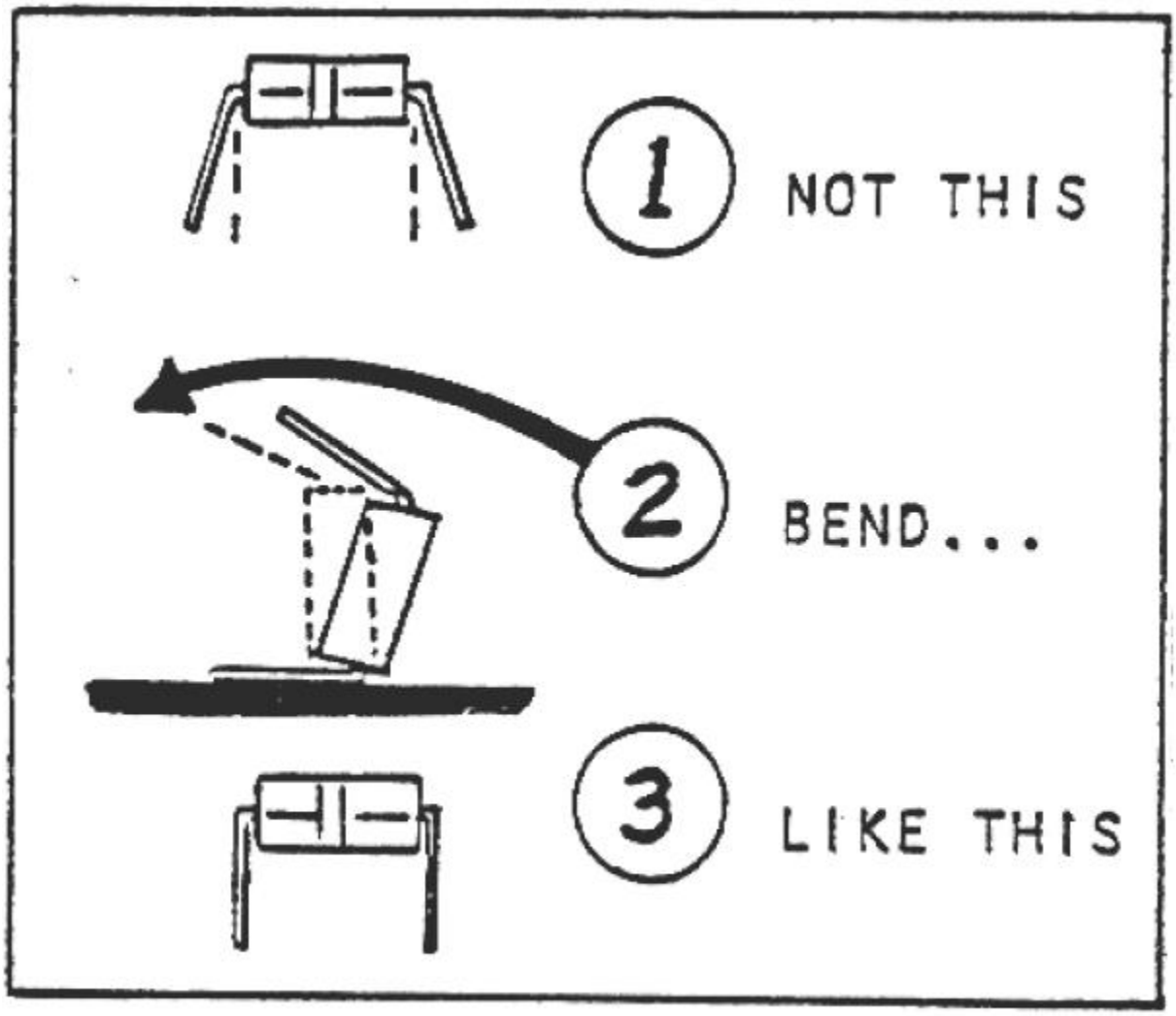
( ) – Solder P1 and P2 25 pin female connectors (SAM1009-25-ND)

( ) – Glue a 2 pin jumper SHORT BLK (Jameco – 19141 – BOM Line 32) to protect the board from shorting the -18V and the +18V to the +8 Volt rail and to the Ground rail as shown below. **If the +-18Volts rails get shorted to ground then the four diodes on the motherboard will burn-out and will also destroy the +-12 Volts regulators on the Serial Communications board.** Please use Gorilla Glue that expands 3 to 4 times; from RADIO SHACK. Please use proper orientation as shown on the picture.



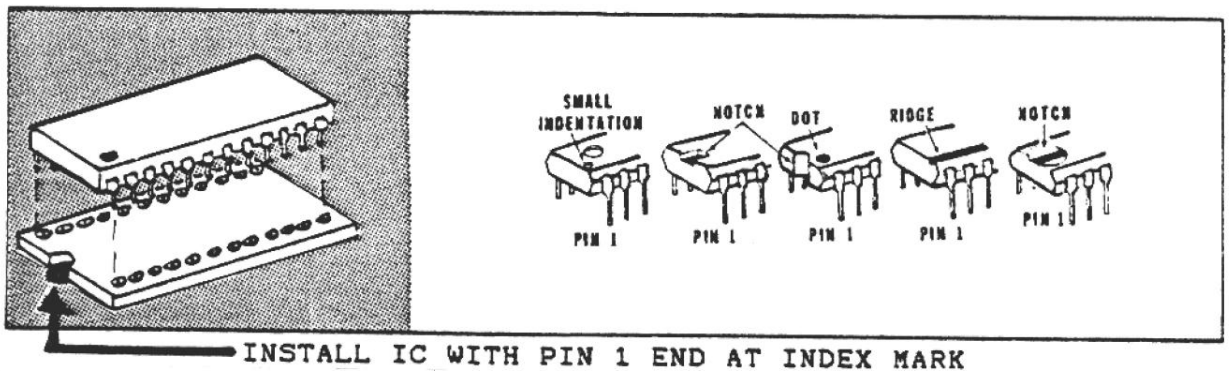


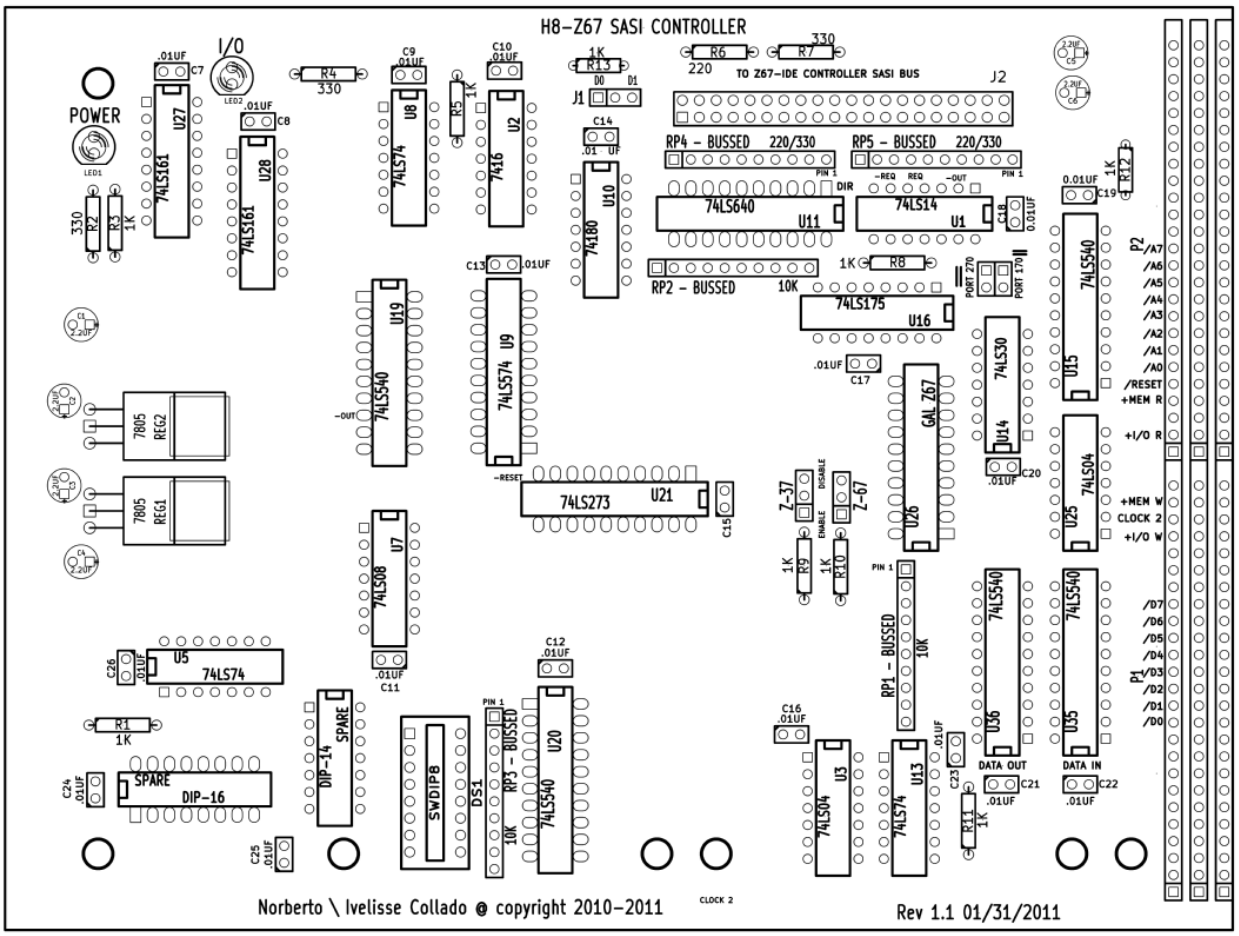
( ) – Straighten any bend pins on the IC's. The pins should be parallel to each other and at right angles to the case. Some IC's may have their pins spread out slight as shown below. If so, align the pins by gently pressing against a table top and bending as shown below.



STRAIGHTEN THE LEADS

( ) – When installing the IC's, align the notch and/or dot with the index mark on the board as shown below. Be sure all the pins enter the holes of the socket, and then press the IC into its socket.





( ) – Install U11 - 74LS640N

( ) – Install U2 – 7416

( ) – Install U1 - 74LS14

( ) – Install U5, U8, U13 - 74LS74

( ) – Install U27, U28 - 74LS161

( ) – Install U10 – 74180

( ) – Install U16 - 74LS175

( ) – Install U7 - 74LS08

( ) – Install U3, U25 - 74LS04

( ) – Install U14 - 74LS30

( ) – Install U5, U19, U20, U35, U36 - 74LS540

( ) – Install U9 - 74LS574

( ) – Install U21 – 74LS373 (Note: apply rework at the following location; http://koyado.com/Heathkit/H8-Z67_files/H8-Z67%20Rework.pdf)

( ) – Install U26 (GAL-Z67) - GAL-16V8-15

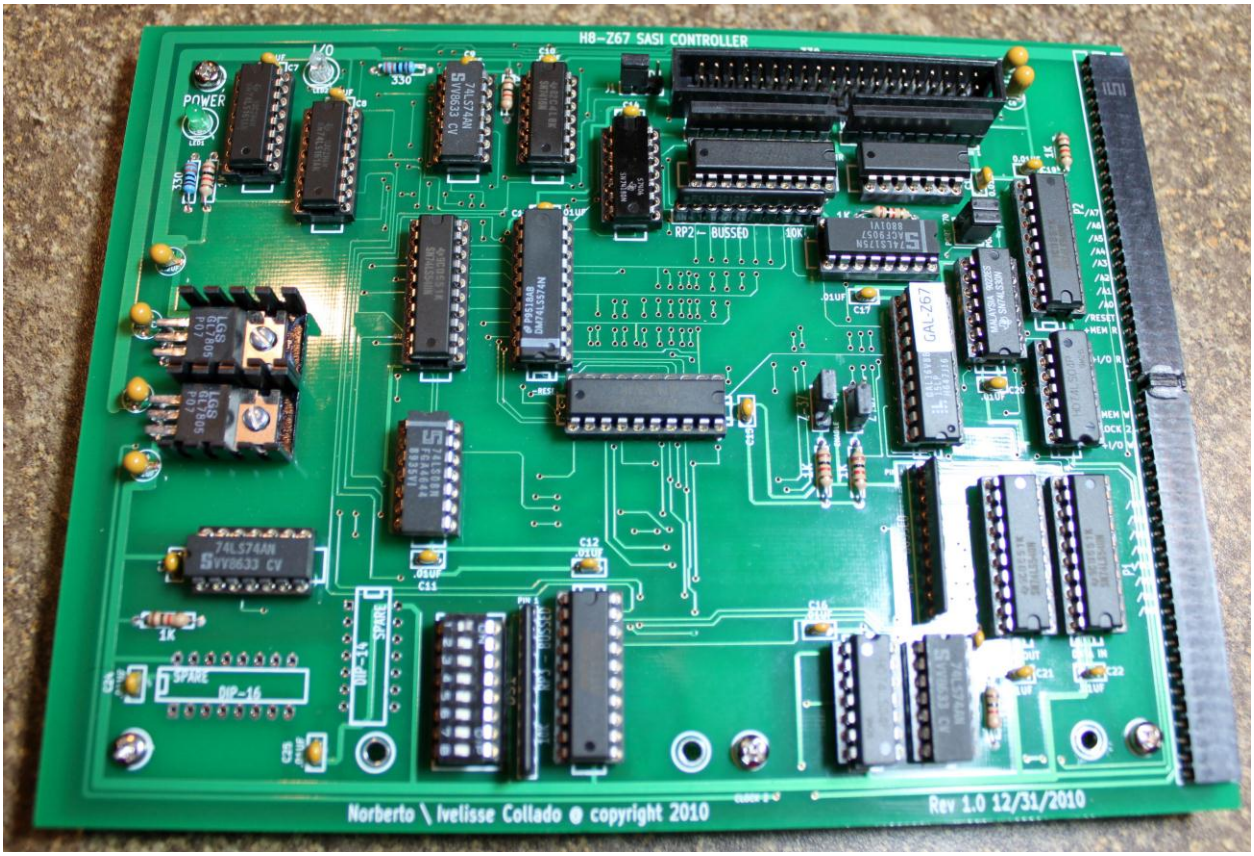
( ) – Carefully plug the H8-Z67 into the H-8 motherboard

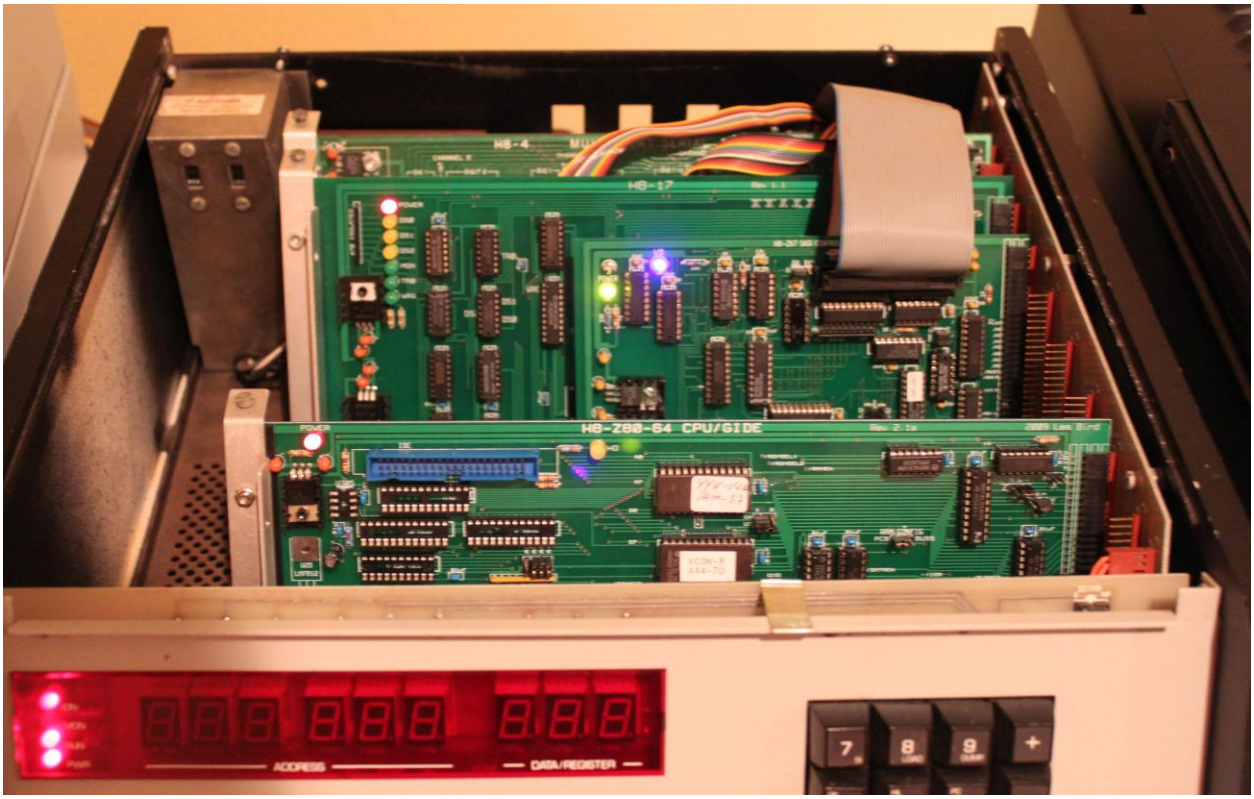
( ) – Carefully plug the H8-Z67-IDE into the H-8 motherboard - http://koyado.com/Heathkit/Z67-IDE.html

( ) – Connect the 40 pin conductor cable from the H8-Z67 board to the H8-Z67-IDE board.

( ) – Apply power to the H-8

( ) – Boot from you CP/M floppy media and configure the IDE drives to boot from the H8-Z67 controller.


H8-Z67 SASI CONTROLLER
POWER
I/O
RP2 - BUSSED
74LS74AN
SYV8633 CV
GAL-Z67
SPARE
DIP-16
DIP-14
Norberto \ Ivelisse Collado @ copyright 2010
Rev 1.0 12/31/2010


H8-Z80-64 CPU/GIDE
ADDRESS
DATA/REGISTER