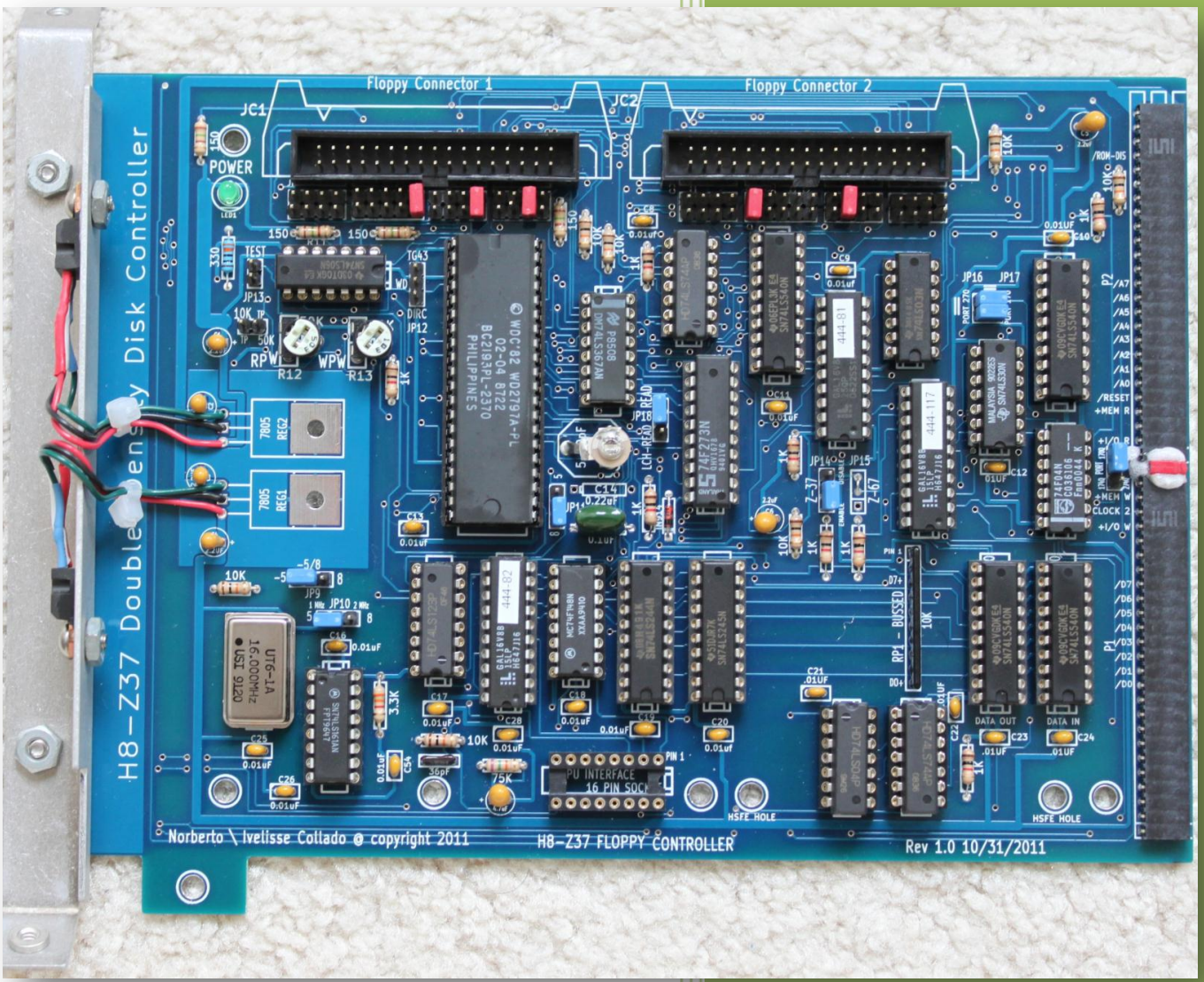
2011

H8-Z37 DOUBLE-DENSITY FLOPPY CONTROLLER



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10/23/2011

Revision History and Disclaimer

Revision History		
Revision	**Date**	**Comments**
1.0	10/01/2011	Initial draft by Norberto Collado

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.

Also 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.

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Introduction

This document provides an overview on the H8-Z37 floppy controller board design by Norberto Collado for the Heathkit H8 Computer.

HOST COMPUTER REQUIREMENTS

Hardware

The H8-Z37 controller Double Density Disk Controller must have a Z80 Circuit Board in place of the 8080 CPU board.

Interrupt Cable

Route the 16-conductor cable from the Z80 CPU board to the H8-Z37 board and plug the loose end into the DIP socket marked CPU Interface. Be sure that pin1 on the 16 pin DIP lines up with pin number one of the socket.

Firmware

1. Boot ROM (444-70)
2. Boot ROM 2 (444-140)
3. Eight to three line priority encoder (74LS148) removed from the Z80 board and placed on the H8-Z37 at location U43.

H8-Z37 DISK CONTROLLER

The H8-Z37 controller contains a soft-sector, double density disk controller for 3.5” and 5.25” disk drives. The H8-Z37 controller is operable at any CPU speed up to 4 MHz, and it supports four bootable floppy drives via the H8 front panel. The H8-Z37 Floppy Disk Controller mounts inside the H8 computer cabinet. It supports double-sided, double-density disk for both 5.25-inch and 3.5-inch floppy drives. This new design uses a WD2797 that is a super set of the WD1797. Three Programmable GAL’s Logic Devices was used to reduce chip count to keep the board size small. The H8-Z37 is fully compatible with HDOS and CP/M operating systems stock drivers. The H8-Z37 hardware also supports 8” floppy densities with the availability of a floppy driver.

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

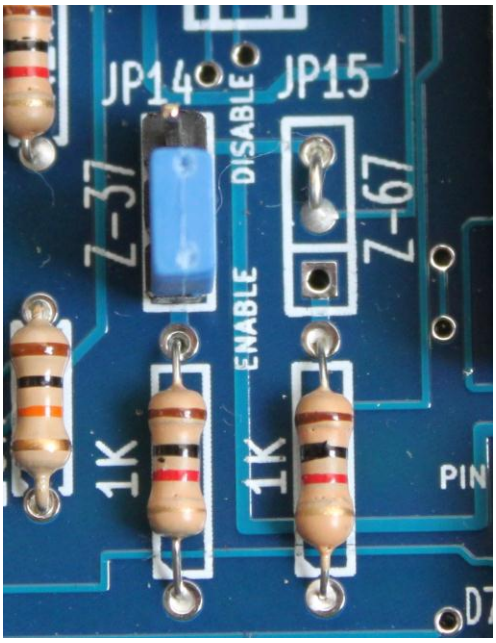
CONTROLLER CARD	PORT	H8-Z67 PORT
H17	7CH (174Q)	78H (170Q)
H8-Z37	78H (170Q)	7CH (174Q)
H47	78H (170Q)	7CH (174Q)

Assembly Notes:

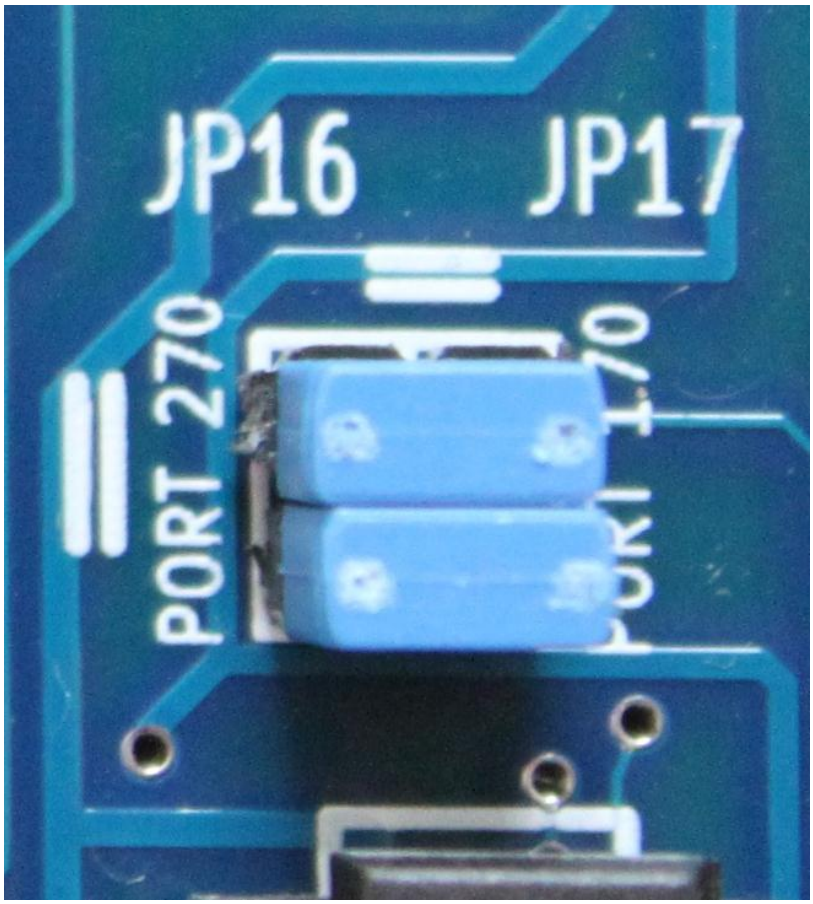
1. Please install the two 34 pin male connector before soldering any other component on JC1 and JC2. In order to insert the 34 pin male connector, just move it from front to back with small rapid movements until the connector is fully inserted. Do not force the connector into the board.
2. The second step is to solder the variable capacitor “C4”. The footprint is the wrong one. Please solder component from side 1, ensuring that all pins are in contact with the designated pads.

H8-Z37 Jumper Configuration

( ) Z-37 Enabled (solder a 3 pin header to be able to enable or disable the board as needed. Insert a jumper between pin 1 and 2 – JP14)
( ) Z-67 Disabled (solder bare wire across pin 2 and 3 – JP15)

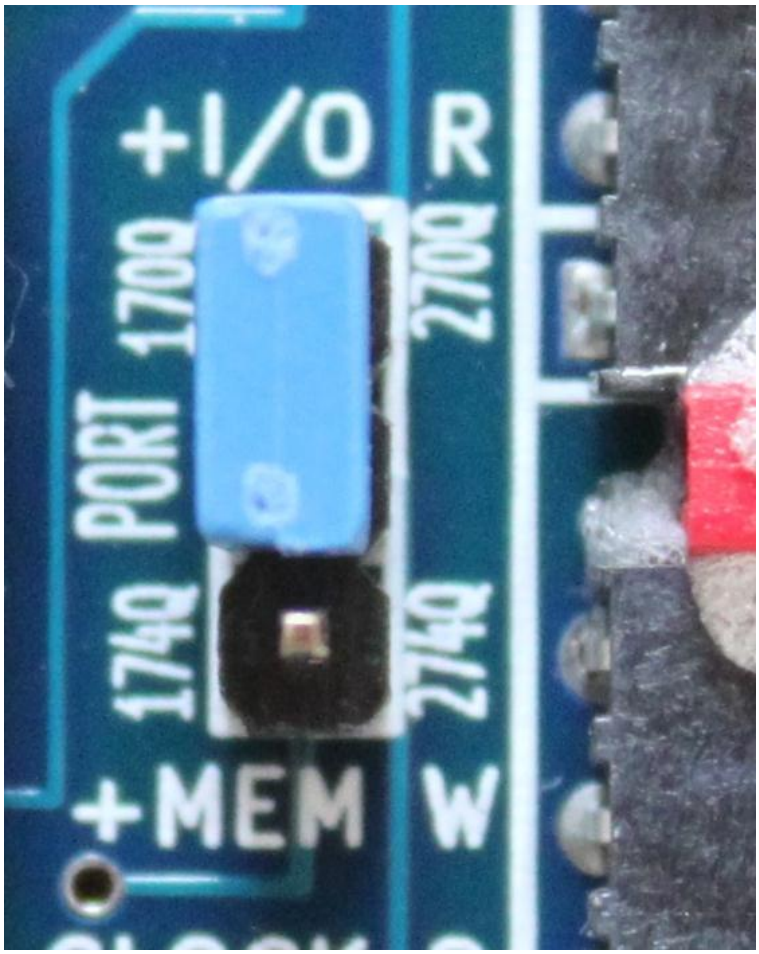


( ) Insert a jumper across pin 1 and 1 and jumper across pin 2 and 2 (default address 170Q) as shown below

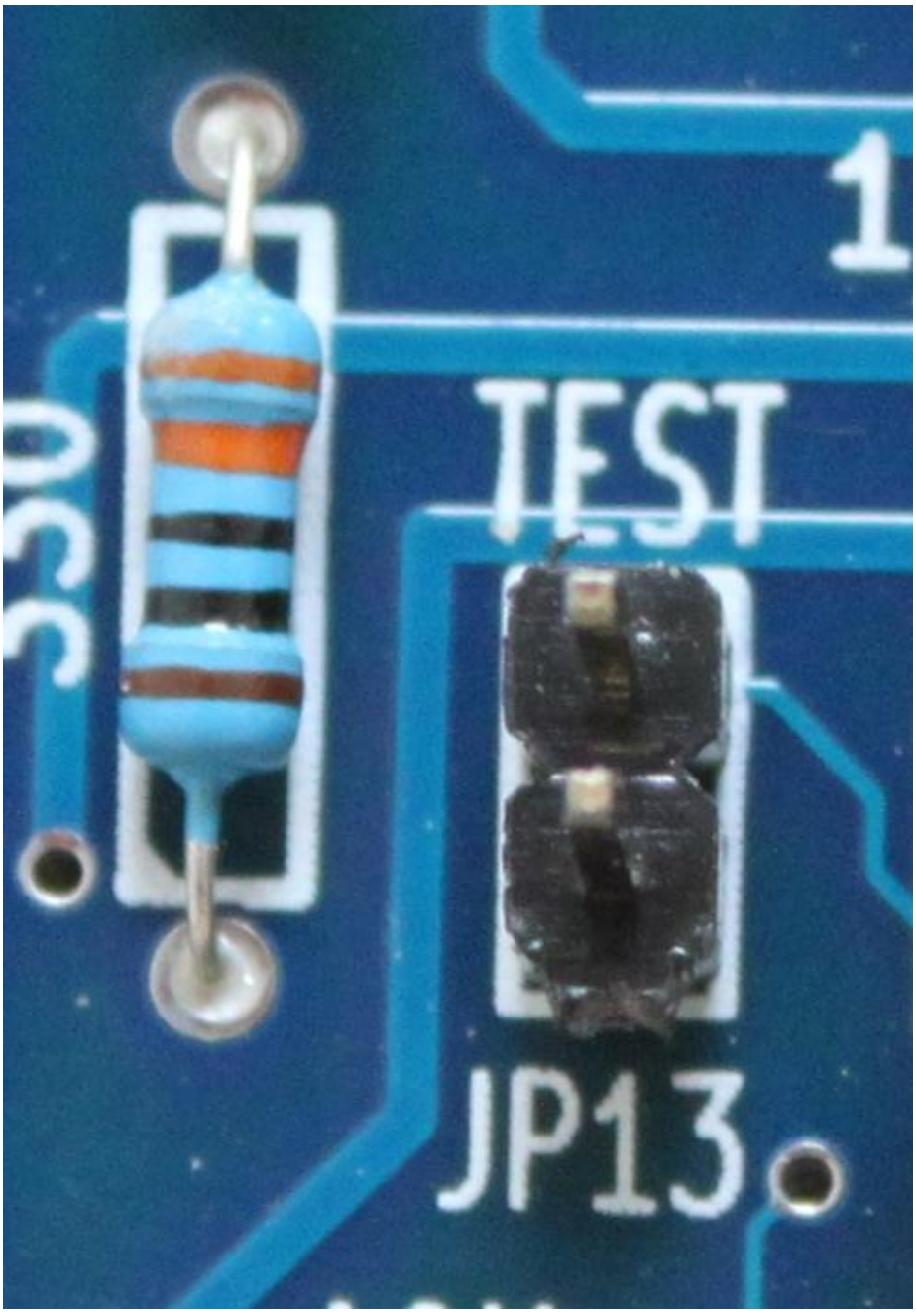


( ) Insert a jumper across pin 1 and 2 to select Port 170Q (Default Configuration) as shown below. This jumper along with “J16” and “J17” jumpers allows the user to select the following port addresses;

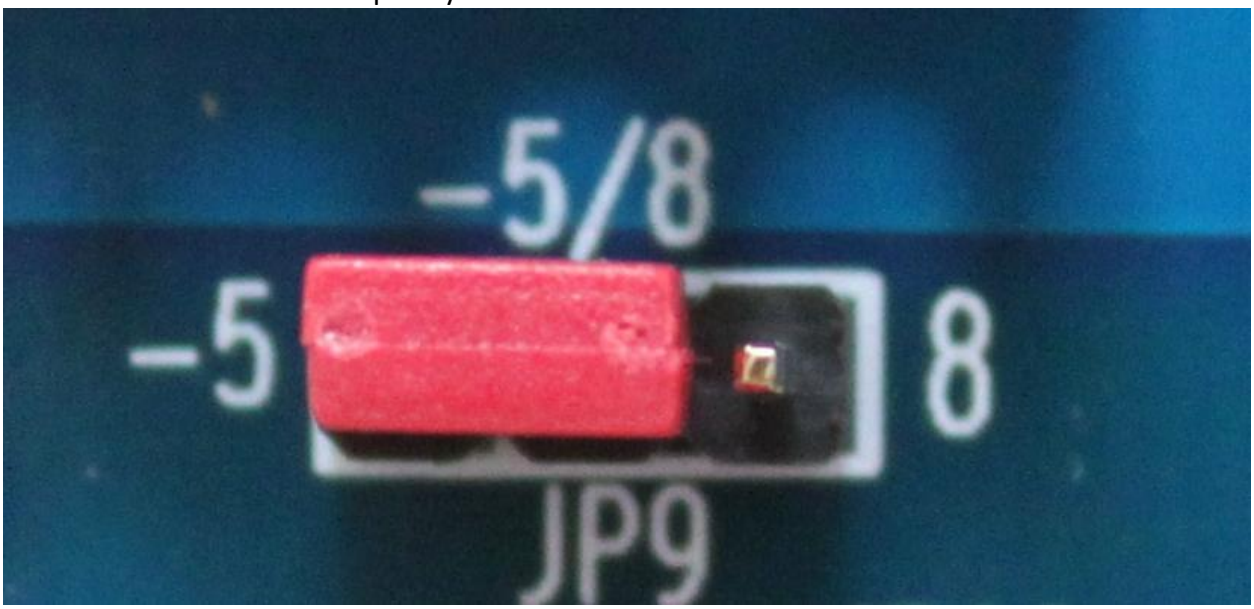
- 170Q
- 174Q
- 270Q
- 274Q



( ) The “TEST” jumper (JP13) is only used when calibrating the board. Refer to the following web site on how to calibrate the H8-Z37 board (koyado.com). Please remove the “TEST” jumper for normal operation.

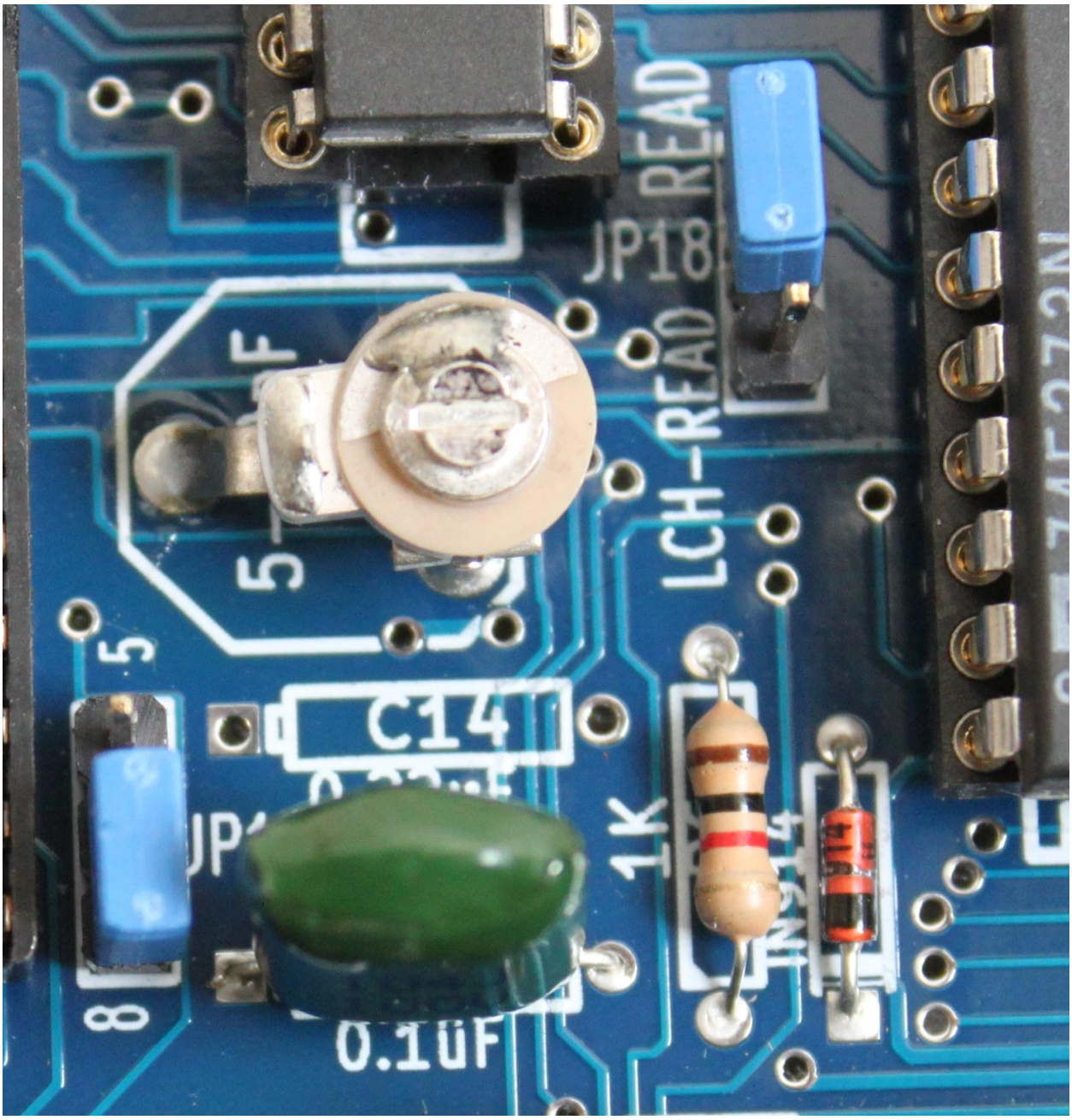


( ) Jumper “JP9” is used for 5 1/4”, 8" select (-5 for 5 ¼ “and 8 for 8” floppy drives). This jumper selects the internal VCO frequency for use with 5 ¼ “drives or 8" drives.



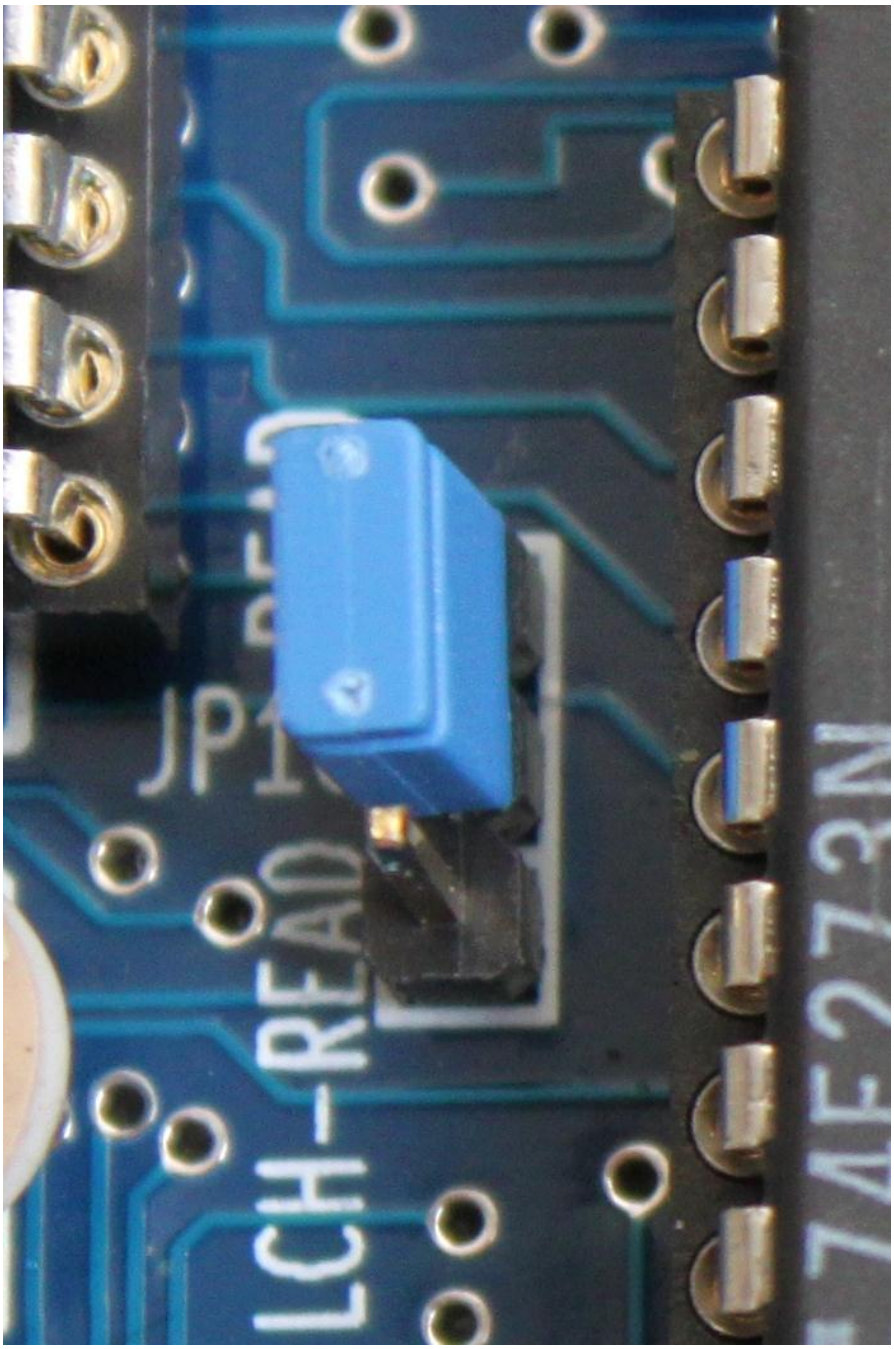
( ) Jumper “JP10” is used to select the Floppy Controller clock. It requires a free-running 50% duty cycle square wave clock for internal timing reference, 2 MHz ± 1 % for 8" drives, 1 MHz ± 1 % for mini-floppies - 5 ¼ “. Default configuration is 1 MHz as shown below to support the mini-floppies.

( ) Jumper “JP11” is used to select the Floppy Controller filter capacitor. The filter capacitor value is 0.1uF since 5 1/4" drives operate at exactly one-half the data rate (250 Kb/sec). Please insert jumper as shown below for normal operation. The same capacitor can handle 5 ¼ “or 8” floppy data rates. Do not install a 0.22uF in location C14 because it is not needed.

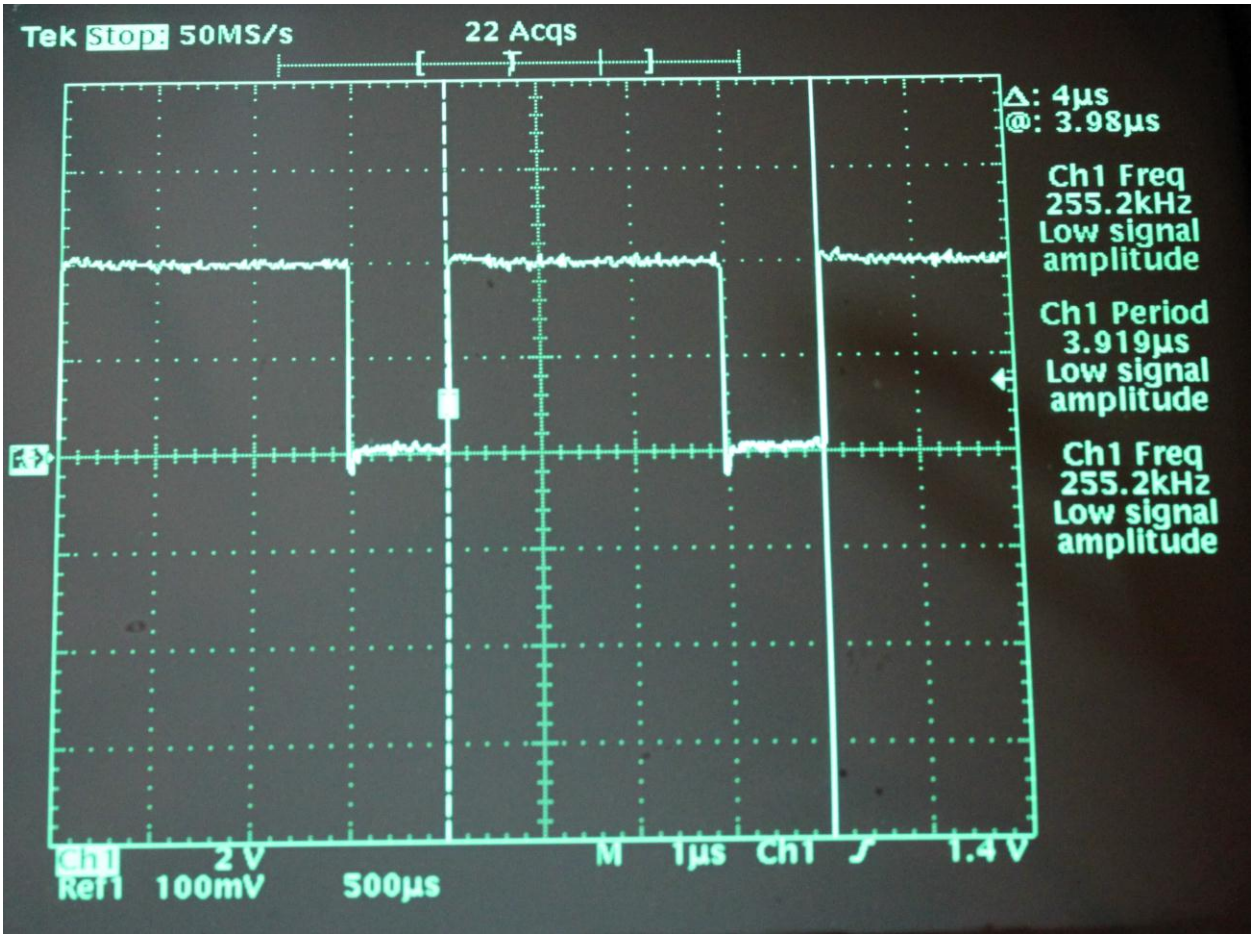


( ) Jumper “JP18” is used to select the Floppy Controller RAW-READ or RAW-READ LATCH data input. The data input signal comes directly from the drive. This signal shall be a negative pulse for each recorded flux transition. The default configuration is to select “READ” with jumper “JP18”.

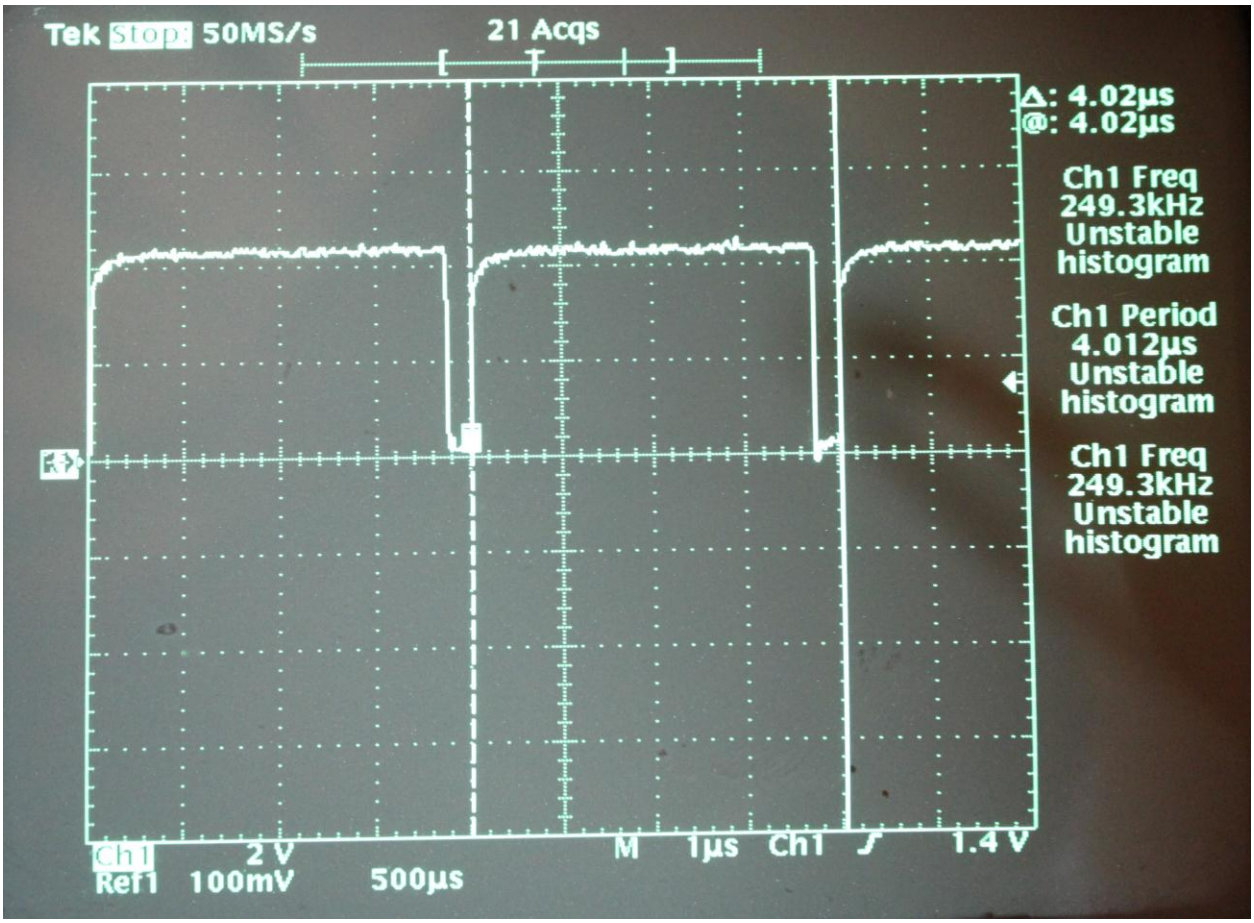
The RAW-READ LATCH (U5) lengthens the raw read pulse from the disk drive electronics to a size readable by the “old” WD1797 controller. This was implemented as a test only feature.



RAW-READ timing



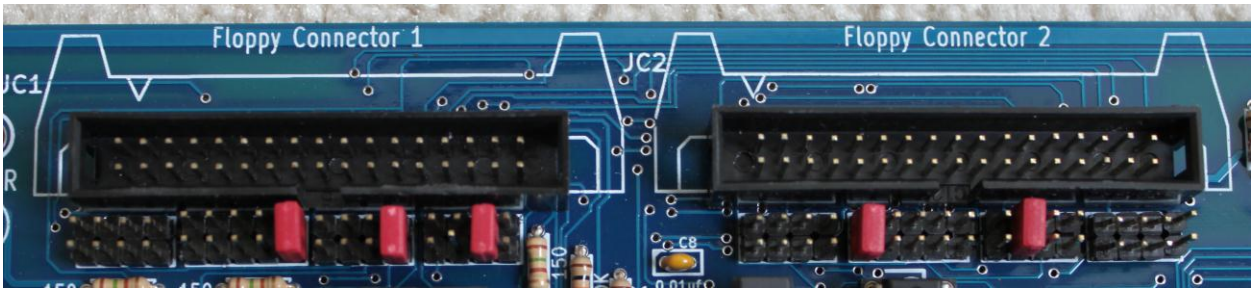
RAW-READ LATCH timing (**update picture – wrong capacitor value installed**)



( ) Jumpers “JP1, JP2, JP3, JP4, JP5, JP6, JP7, and JP8” are for floppy drive selection. It allows two 3.5” floppy drives on any given connector and two 5.25” drives on any given connector (JC1, JC2).

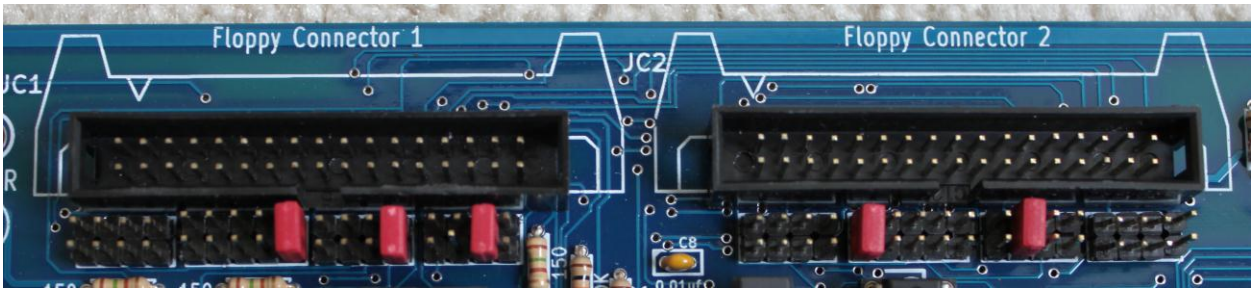
As shown below, the board is configured to use two 3.5” floppy drives on JC1 (left connector) and two 5.25” floppy drives on JC2 connector (right connector).

For further information refer to the following schematic at the following link; koyado.com



Front Panel Drive Selection

In order to setup properly the jumpers “JP1, JP2, JP3, JP4, JP5, JP6, JP7, and JP8” for floppy drive selection, please use the front panel as follows;



Port address = **170**Q

Drive 0 = 020Q

Drive 1 = 040Q

Drive 2 = 100Q

Drive 3 = 200Q

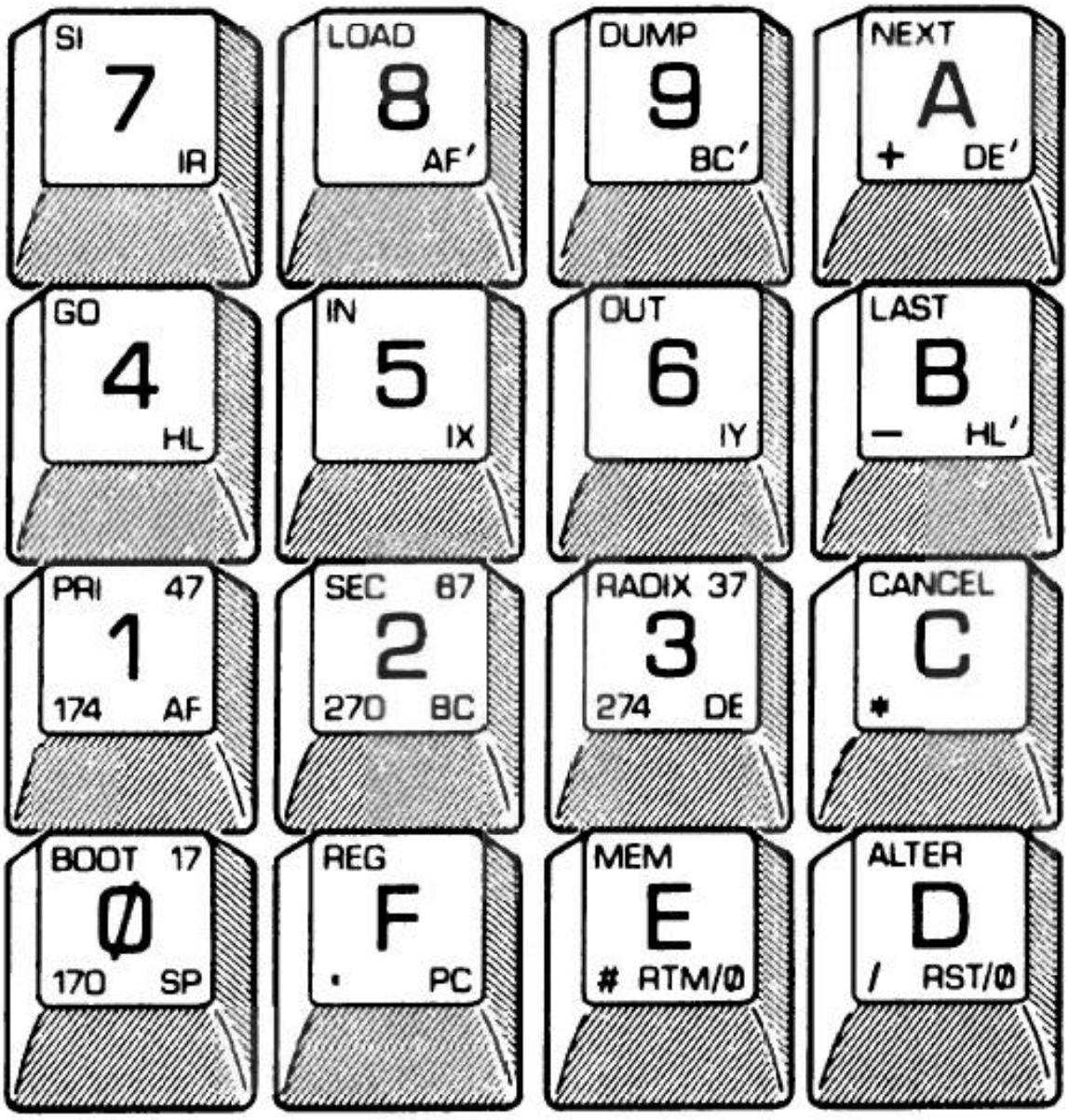
All motors on = 010Q

For example to select Drive 0, the Front Panel sequence is as follows;

1. Press MEM
2. Enter “**020 170**”
3. Press OUT
4. Insert a jumper until Drive 0 floppy drive green LED turns ON as shown below

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/H8-Z37 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

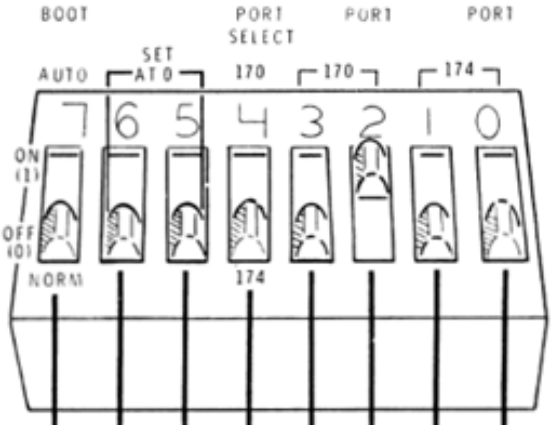
Again, the xxx will be the device name. To cancel the error or stop the operation, press the "**C"** key (Cancel).

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-Z37 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; BOM

( ) – Solder C26, C25, C16, C17, C13, C28, C18, C19, C20, C21, C22, C23, C24, C12, C10, C9, C11, C54, and C8 - 0.01uF caps.

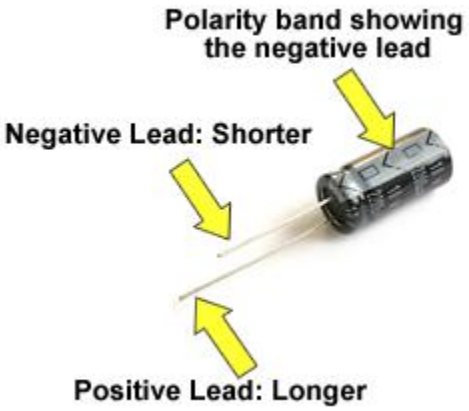
( ) – Solder C14 - 0.22uF

( ) – Solder C4 – 5-60 pF variable capacitor

( ) – Solder C27 – 30 - 36pF Mica

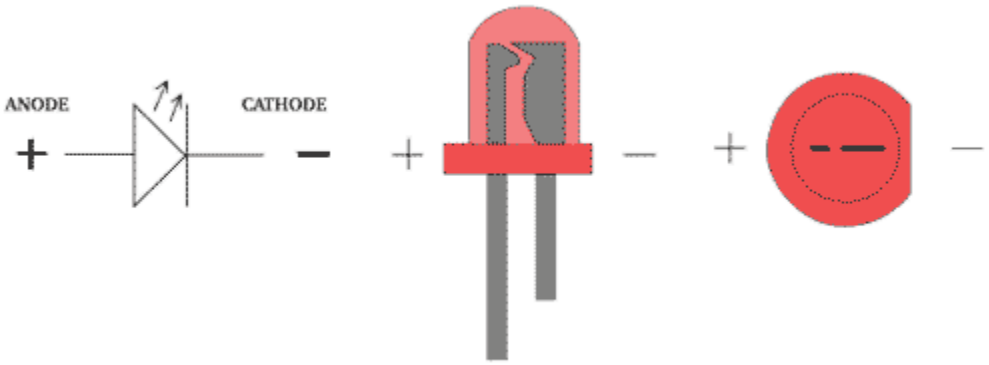
( ) – Solder C1, C2, C3, C4, C5 and C6 - 2.2uF caps (observed polarity)

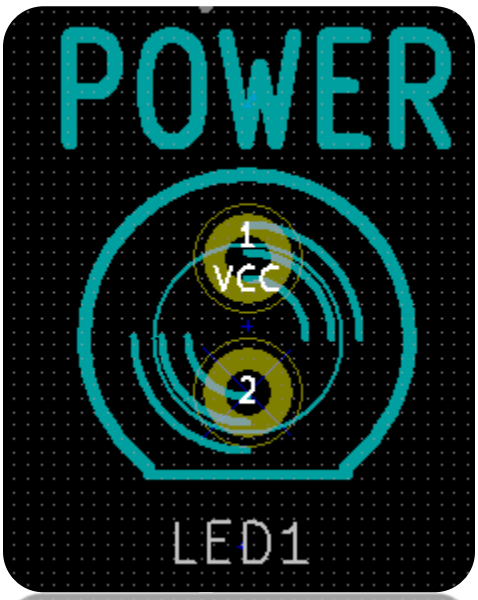
( ) – Solder C7 – 4.7uF cap (observed polarity)



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

( ) – Solder an IN914 diode on D1





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 - RESISTOR NET, 10PIN, 10K OHM

( ) – Solder R2 – 330 OHM resistors

( ) – Solder R20, R15, R16, R12, R14, R6, R7, R5 – 1K OHM resistors

( ) – Solder R18 – 3.3K OHM resistor

( ) – Solder R3, R4, R17, R19, R21, R23 – 10K OHM resistors

( ) – Solder R22 – 75K OHM resistors

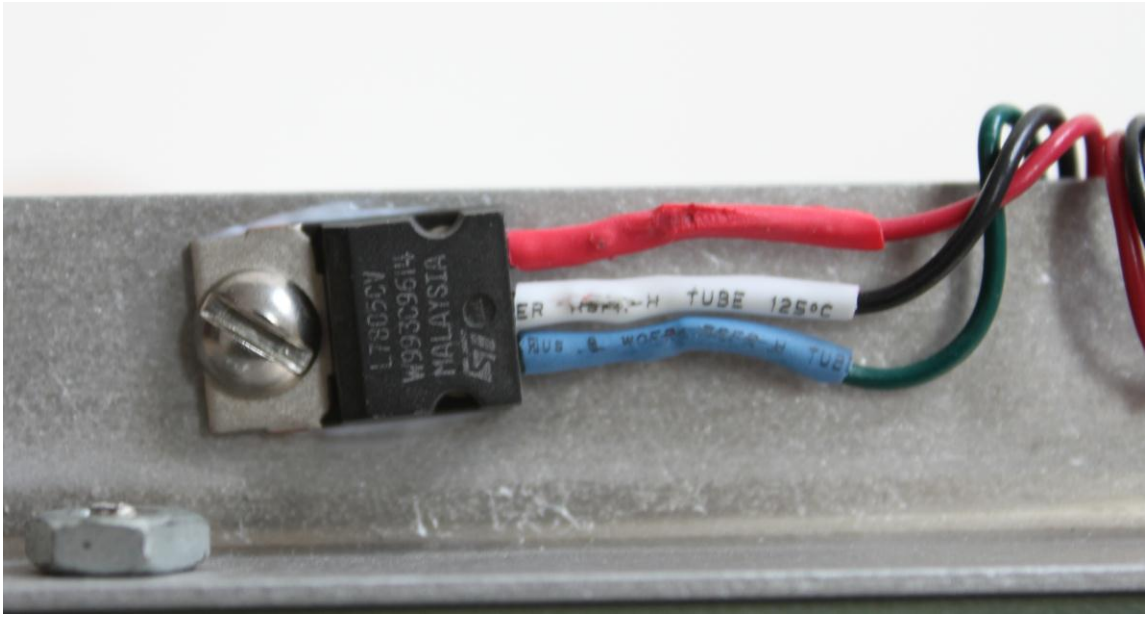
( ) – Solder U7, U22, U3, U13, U23, U14, U25, U33 – IC SOCKET, 14PIN

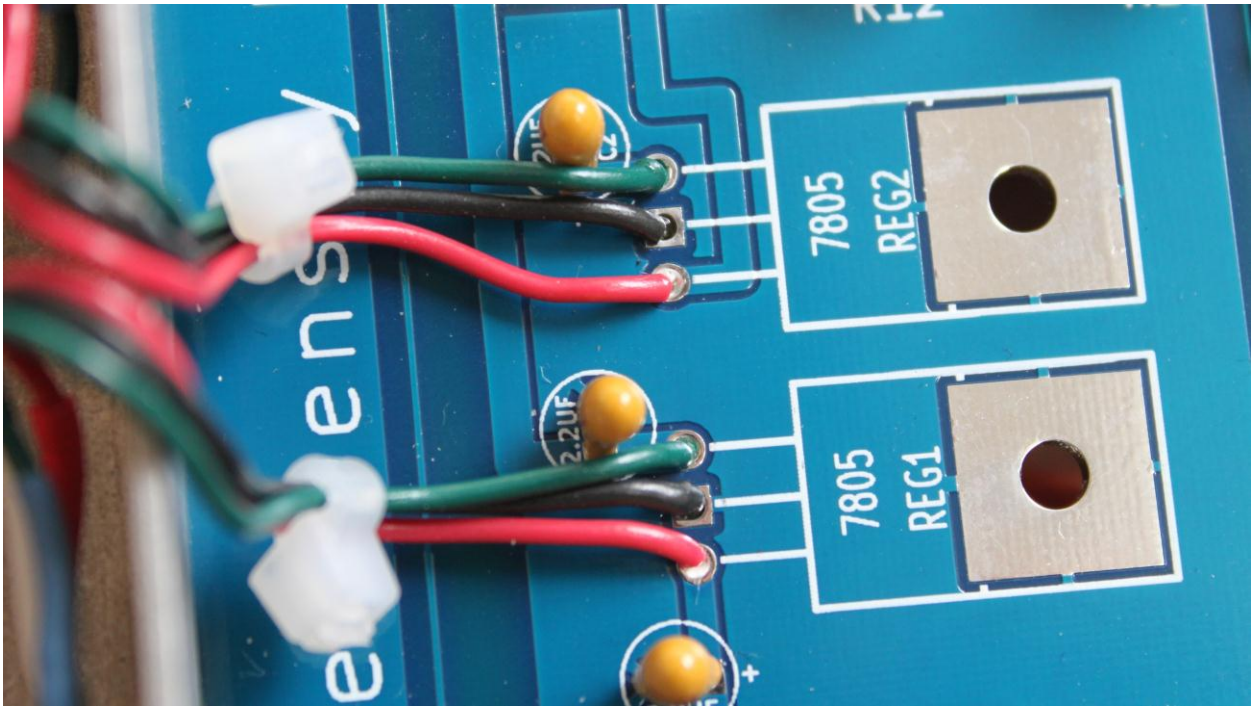
( ) – Solder CPU-INTERFACE, U5, U43, U6, U41 – IC SOCKET, 16PIN

( ) – Solder U35, U36, U34, U26, U37, U24, U42, U20, U8, U15 – IC SOCKET, 20PIN

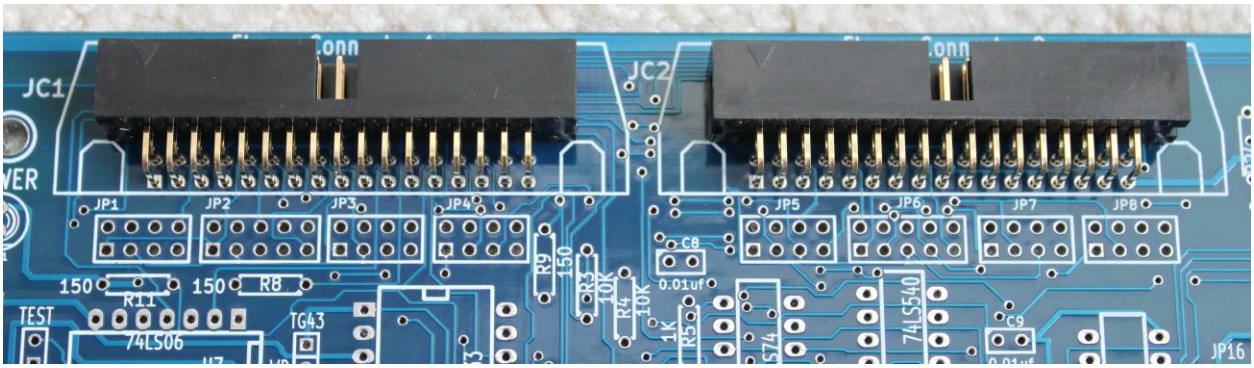
( ) – Solder U33 – IC SOCKET, 40PIN

( ) – Solder the 7805 Voltage Regulators – REG1 and REG2 **if the Heath heatsink is not available**. 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. If using the external H8 heat sink bracket, then move the regulators to such heat sink for proper heat dissipation. See picture below for proper mounting and soldering;

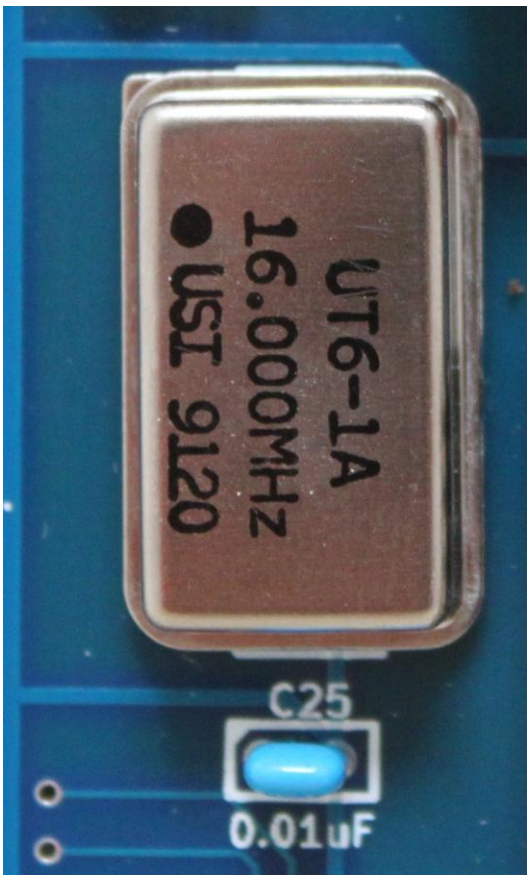




( ) - Solder 34 pin male connectors on JC1 and JC2 locations - HEADER, LP, SHROUDED, 34PIN, MALE (RIGHT ANGLE). Minimum force is required to insert the connectors into the board.

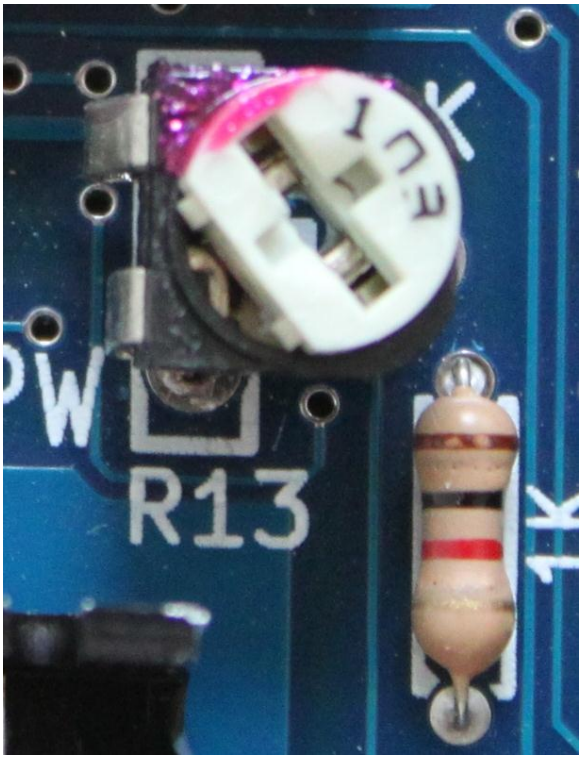


( ) – Solder a 16 MHz OSC

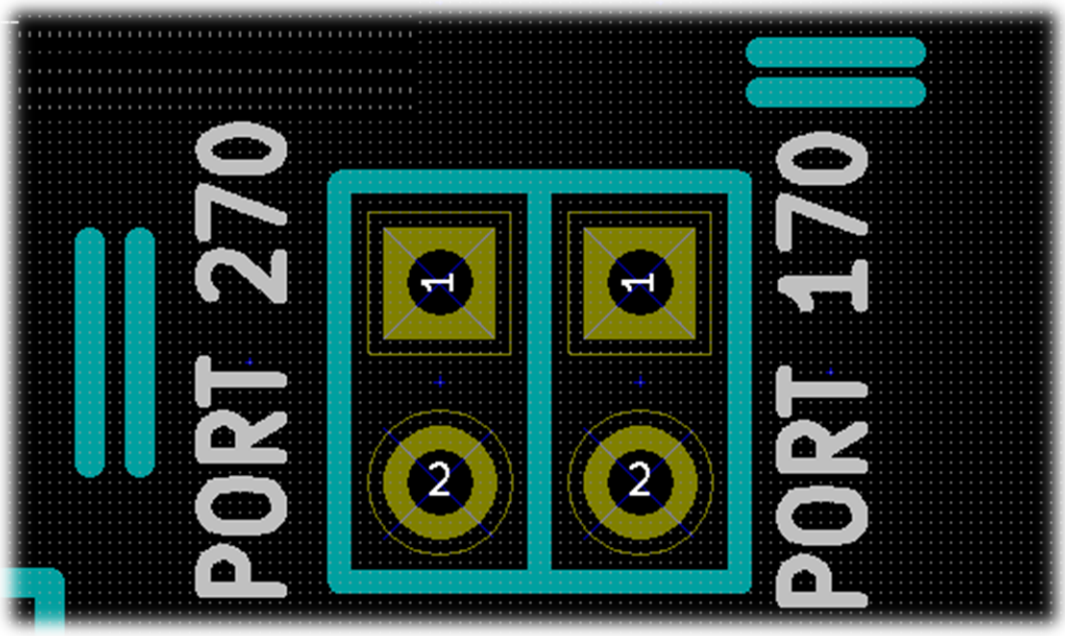


( ) – Solder 50K potentiometer – R12

( ) – Solder 10K potentiometer – R13

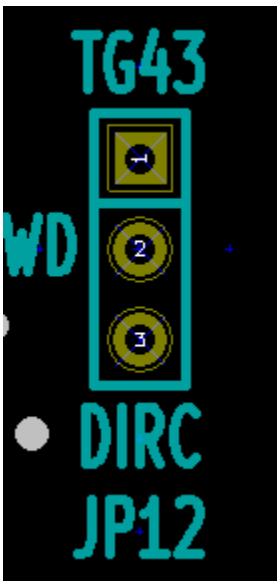


( ) – Solder a 2 pin header at the following locations; PORT 270 and PORT 170

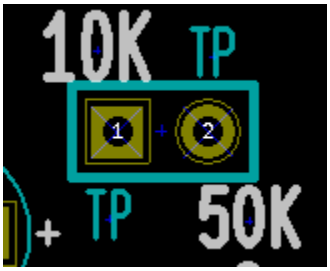


( ) – Solder a 2 pin header at the following location: JP13

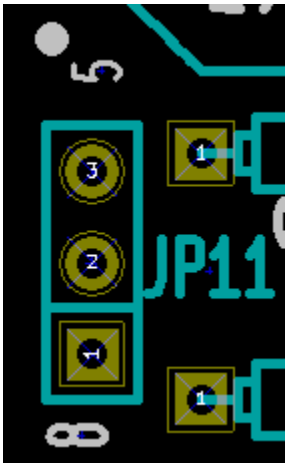
( ) – Solder a 3 pin header at the following location; JP12



( ) – Solder a 2 pin header at the following location; 10K TP and 50K TP



( ) – Solder a 3 pin header at the following location; JP11



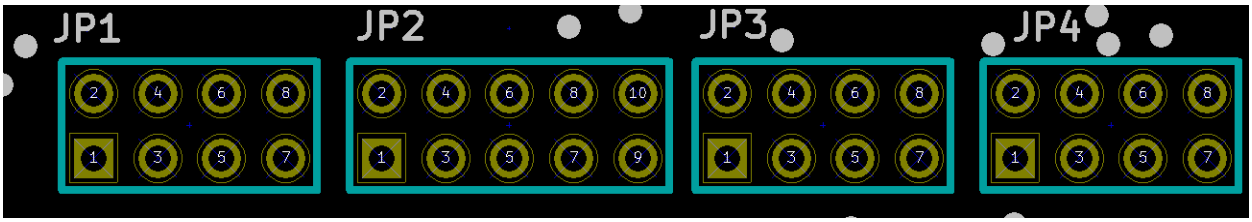
( ) – Solder a 3 pin header at the following location; JP9

( ) – Solder a 3 pin header at the following location; JP10

( ) – Solder a 3 pin header at the following location; PORT 170Q.174Q.270Q.274Q

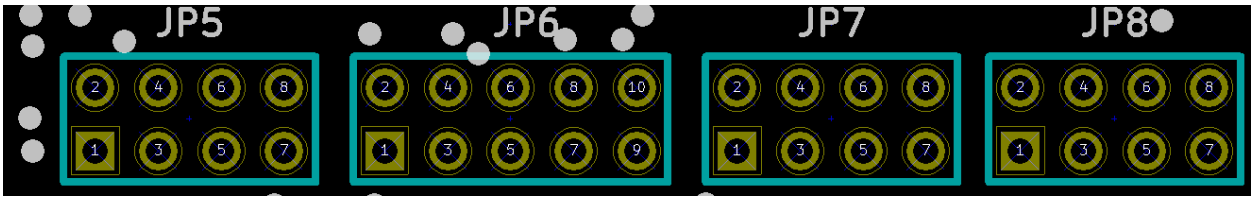
( ) – Solder two 4 pin header at the following location; JP1, JP2, JP3, JP4

( ) – Solder a 2 pin header at the following location; JP2



( ) – Solder two 4 pin header at the following location; JP5, JP6, JP7, JP8

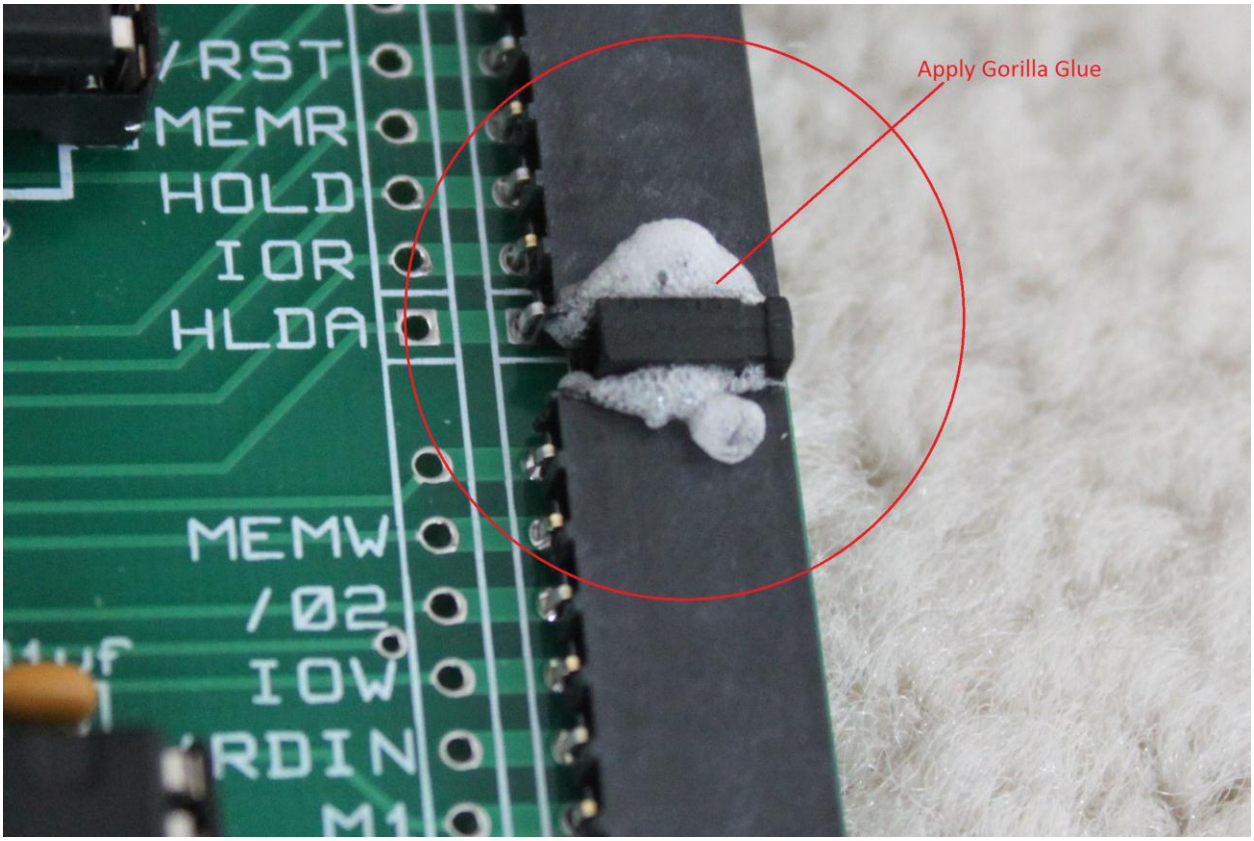
( ) – Solder a 2 pin header at the following location; JP6

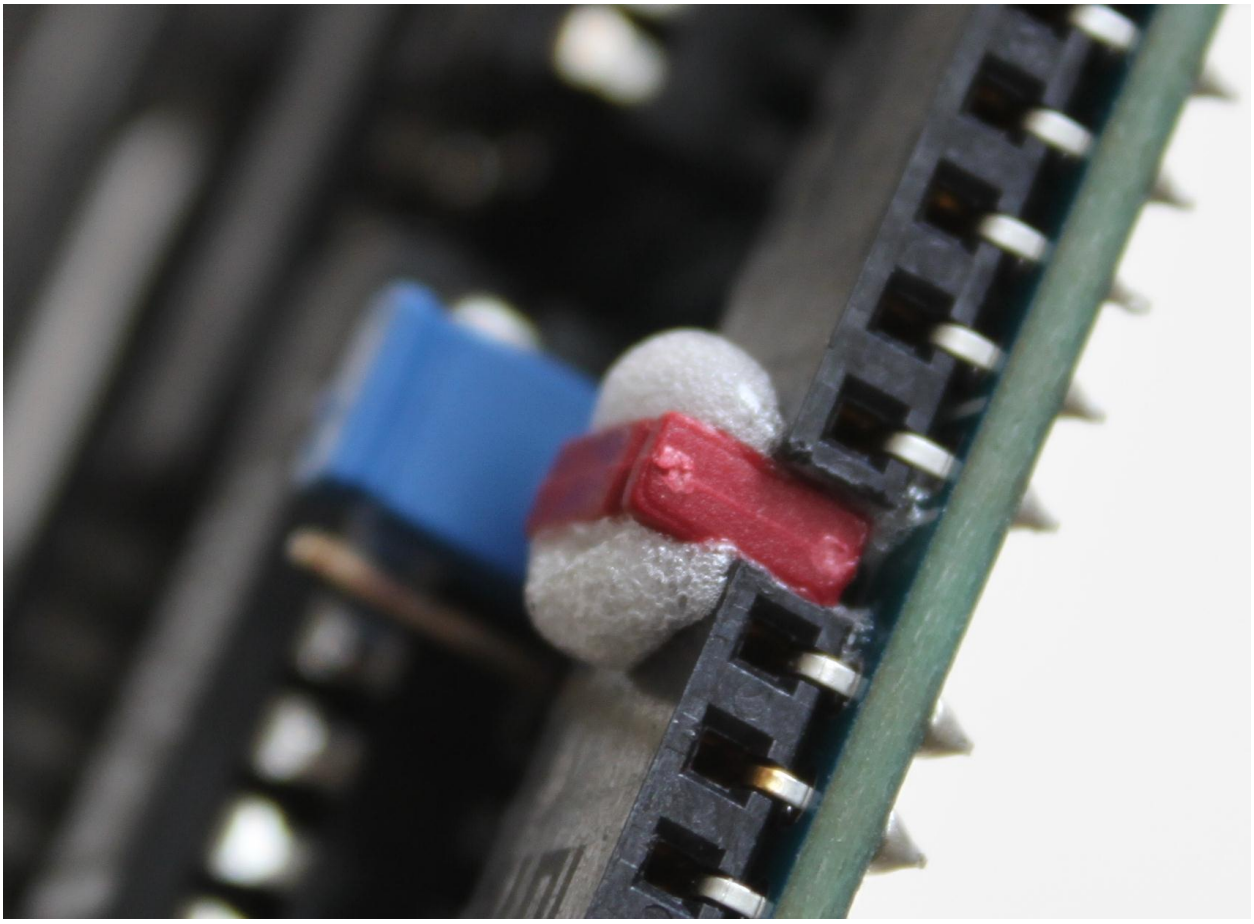


( ) – Build the CPU Interface 16 pin cable connector. Make sure that the cable length is no more than “14” inches to avoid noise on the interrupts lines. Label pin1 on both sides of the 16 pin cable connectors.

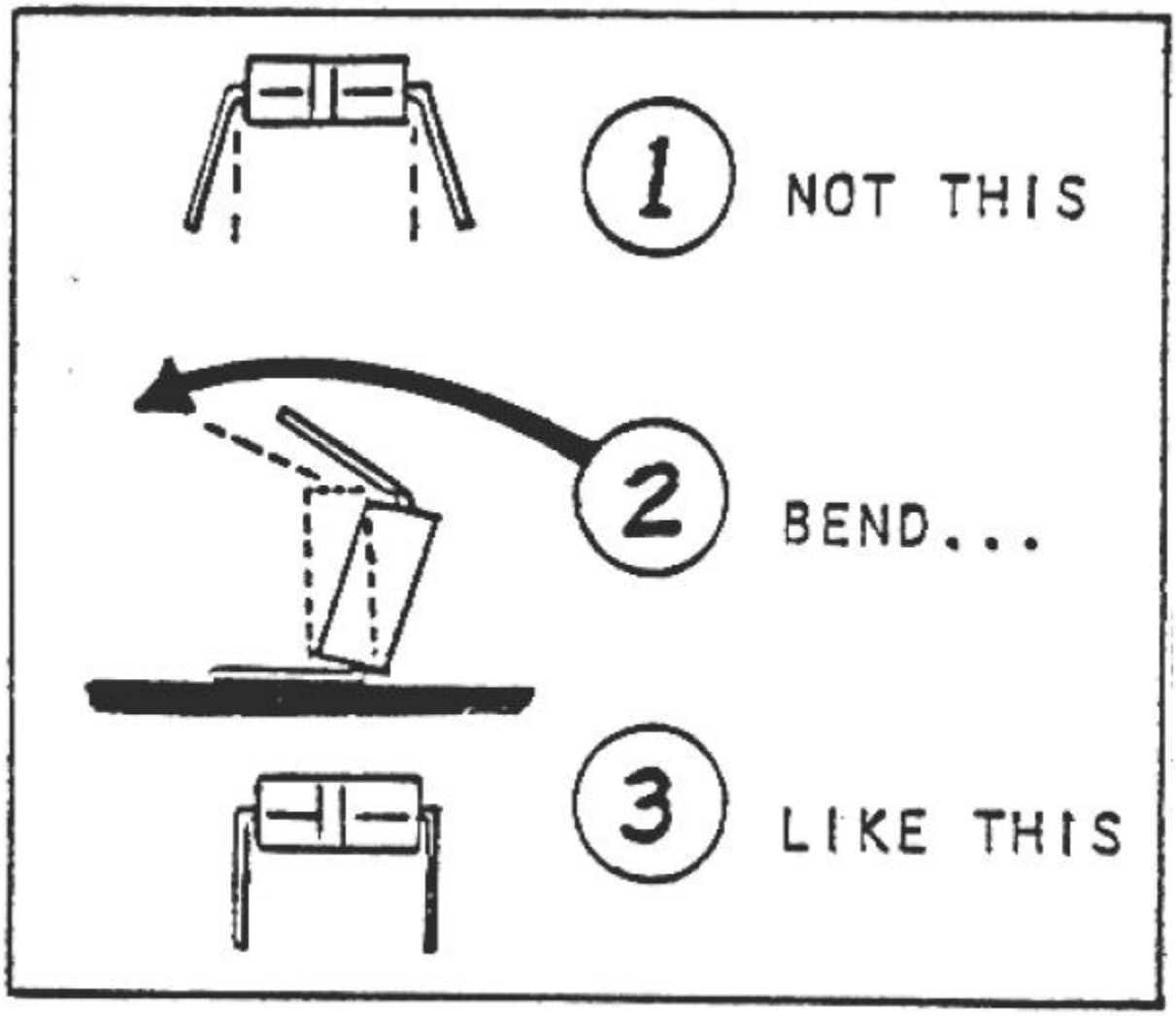
( ) – Solder P1 and P2 25 pin female connectors (SAM1009-25-ND)

( ) – 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.



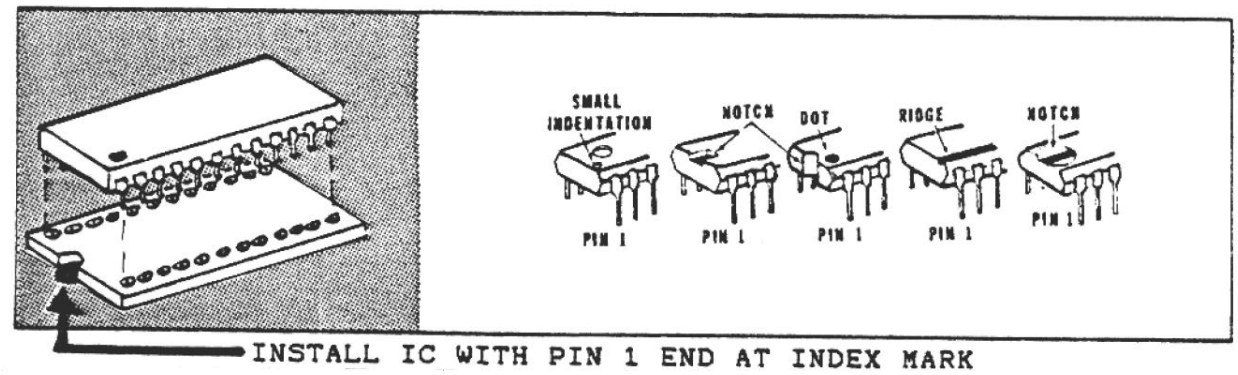


( ) – Straighten any bend pins on the IC's. The pins should be parallel to each other and at right angles to the case. Some IC's may have their pins spread out slight as shown below. If so, align the pins by gently pressing against a table top and bending as shown below.



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 U35 – 74LS540

( ) – Install U36 – 74LS540

( ) – Install U34 – 74LS245

( ) – Install U26 – 444-117 (GAL-16V8-15)

( ) – Install U37 – 74LS244

( ) – Install U24 – 444-81 (GAL-16V8-15)

( ) – Install U42 – 444-82 (GAL-16V8-15)

( ) – Install U20 – 74LS273

( ) – Install U8 – 74LS540

( ) – Install U15 – 74LS540

( ) – Install U5 – 74LS123

( ) – Install U43 – 74LS148

( ) – Install U6 – 74LS367

( ) – Install U41 – 74LS161

( ) – Install U7 – 74LS06

( ) – Install U22 – 74LS74

( ) – Install U3 – 74LS04

( ) – Install U13 – 74LS74

( ) – Install U23 – 74LS03

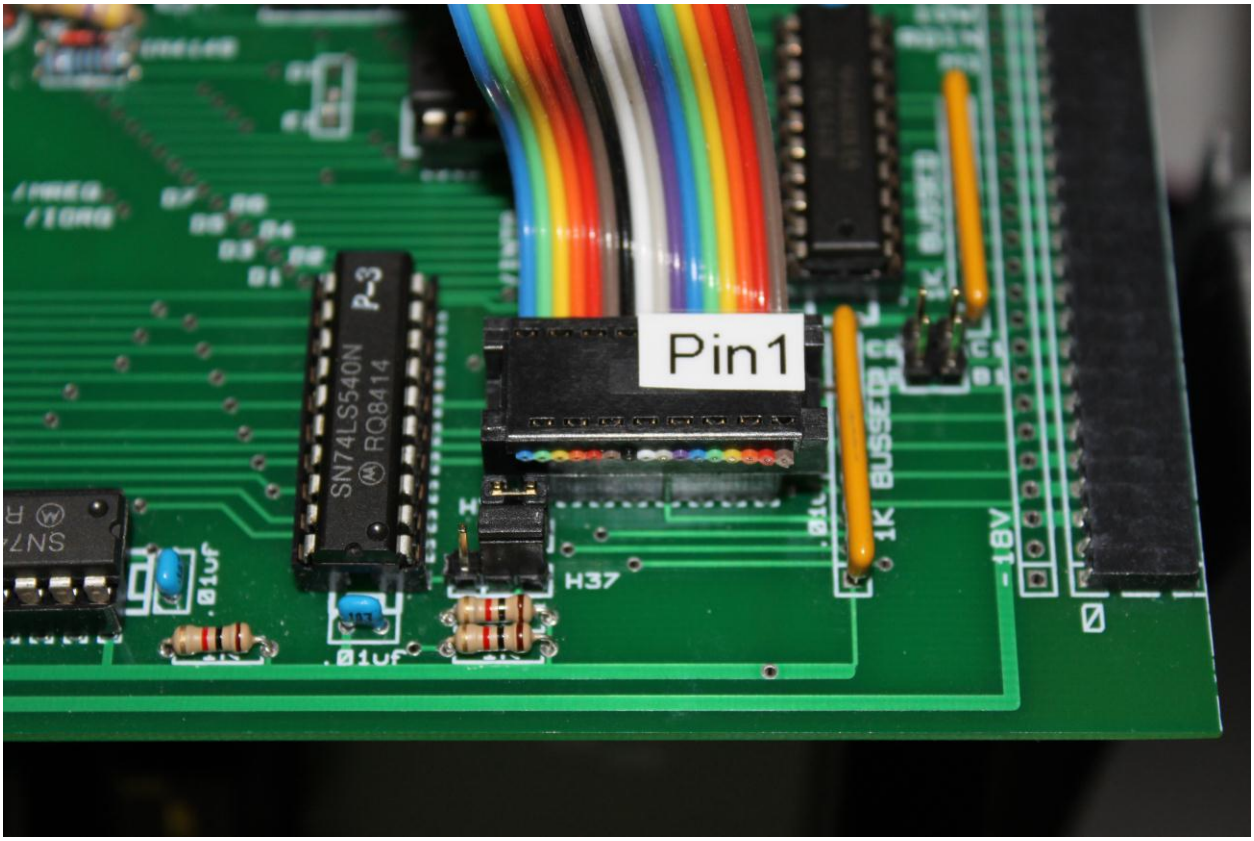
( ) – Install U14 – 74LS30

( ) – Install U25 – 74LS04

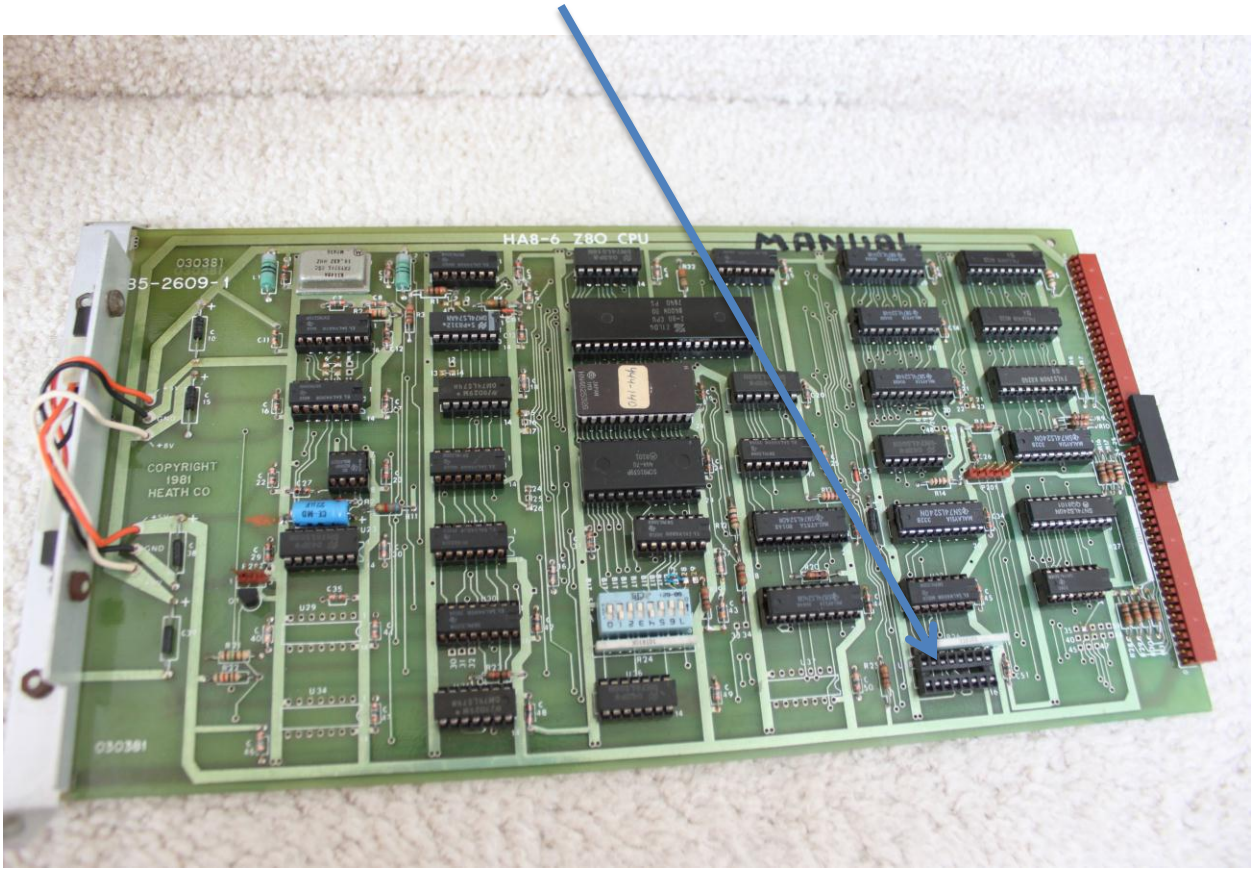
( ) – Install U33 – WD2797 Floppy Controller

( ) – Insert into the Z80 CPU board the 16 pin interrupt cable (New Z80 Board)

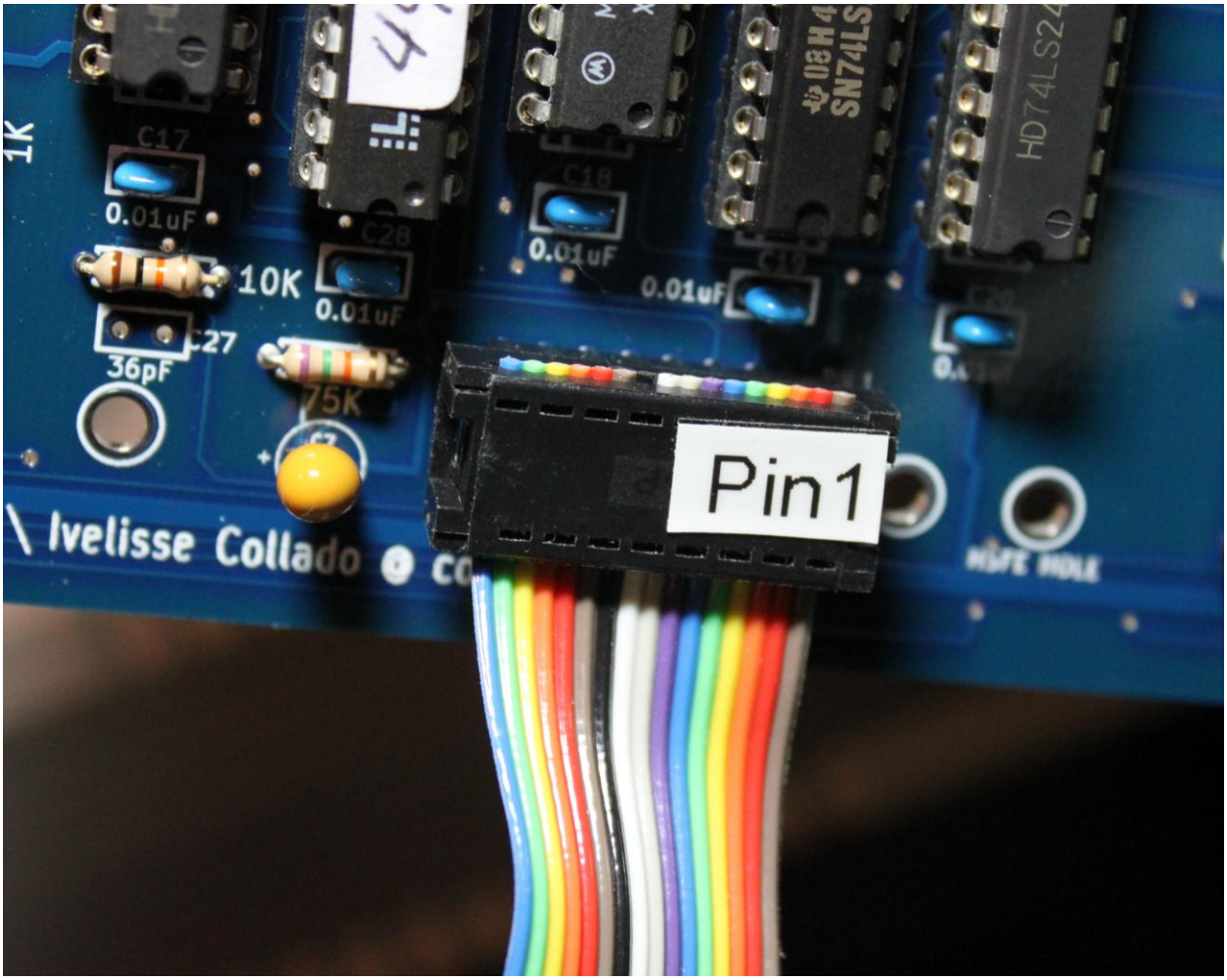
( ) – Rework new Z80 board to support the H8-Z37 board if not already done (Rework.com)



( ) – Insert into the Z80 CPU board the 16 pin interrupt cable (Heath Z80)



( ) - Insert the other end into the H8-Z37 board as shown below.

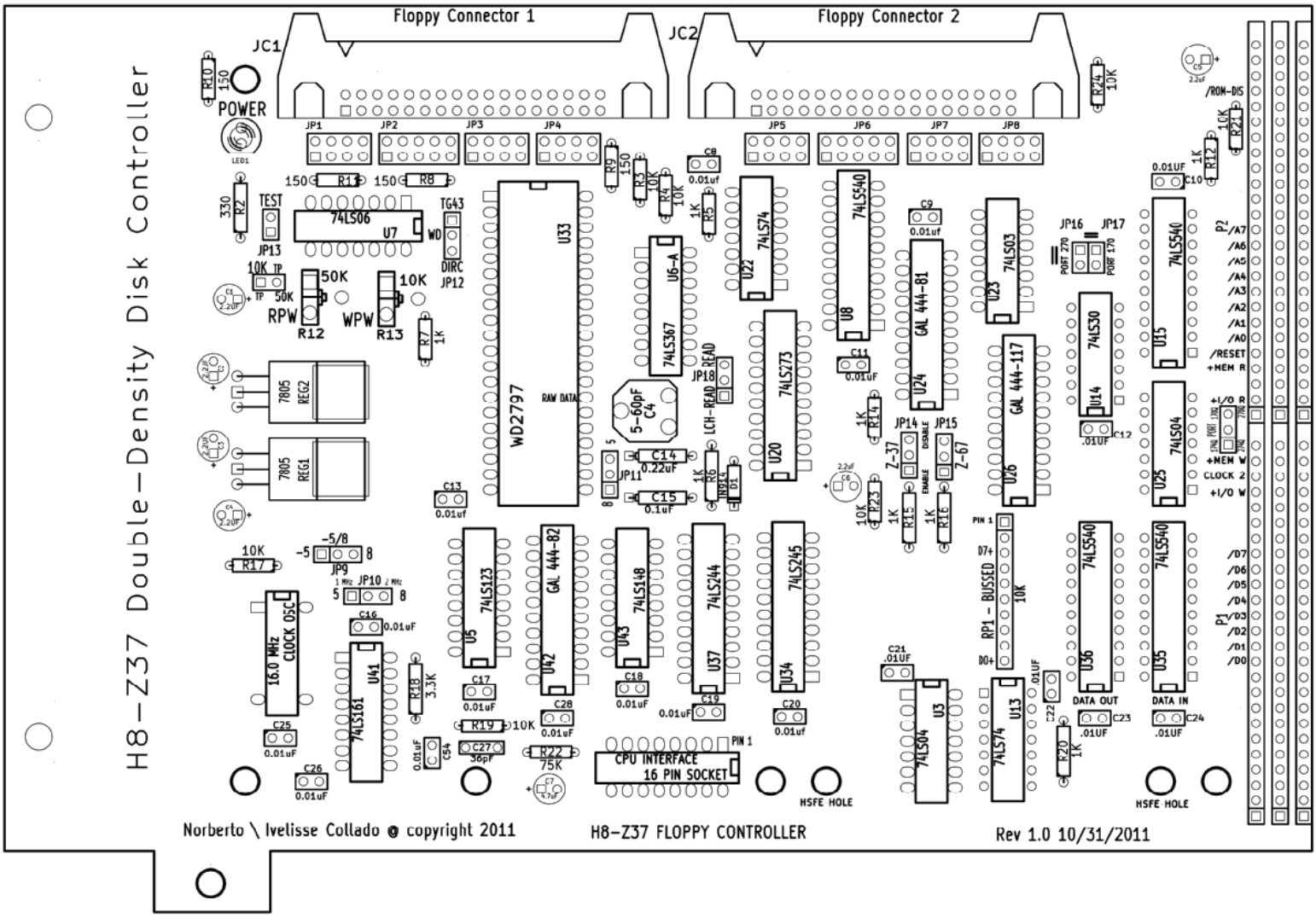


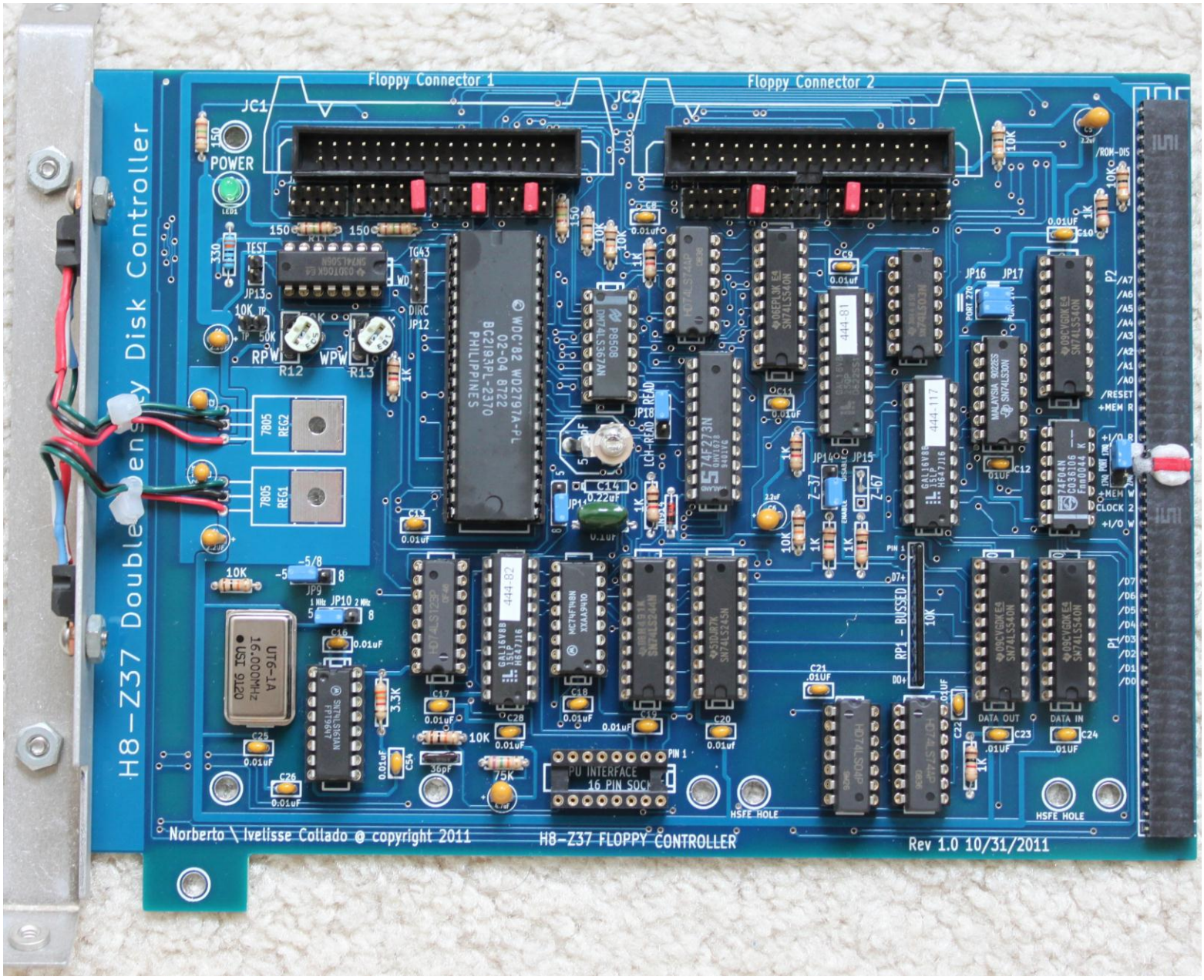
( ) – Connect the 34 pin conductor cable from the H8-Z37 board to the floppy drives.

( ) – Apply power to the H-8 after inserting the H8-Z37 board.

( ) – Calibrate the H8-Z37 board. Follow the instructions at the following link; koyado.com

( ) – Boot from CP/M or HDOS floppy media


H8-Z37 Double-Density Disk Controller
Floppy Connector 1
Floppy Connector 2
JC1
JC2
POWER
WD2797
74LS06
74LS367
74LS74
74LS540
74LS273
74LS30
74LS04
74LS123
74LS148
74LS244
74LS245
74LS161
74LS03
74LS74
GAL 444-81
GAL 444-117
GAL 444-82
16.0 MHz CLOCK OSC
CPU INTERFACE 16 PIN SOCKET
RP1 - BUSSED
DATA OUT
DATA IN
HSFE HOLE
Norberto \ Ivelisse Collado © copyright 2011
H8-Z37 FLOPPY CONTROLLER
Rev 1.0 10/31/2011


Floppy Connector 1
Floppy Connector 2
H8-Z37 Double Density Disk Controller
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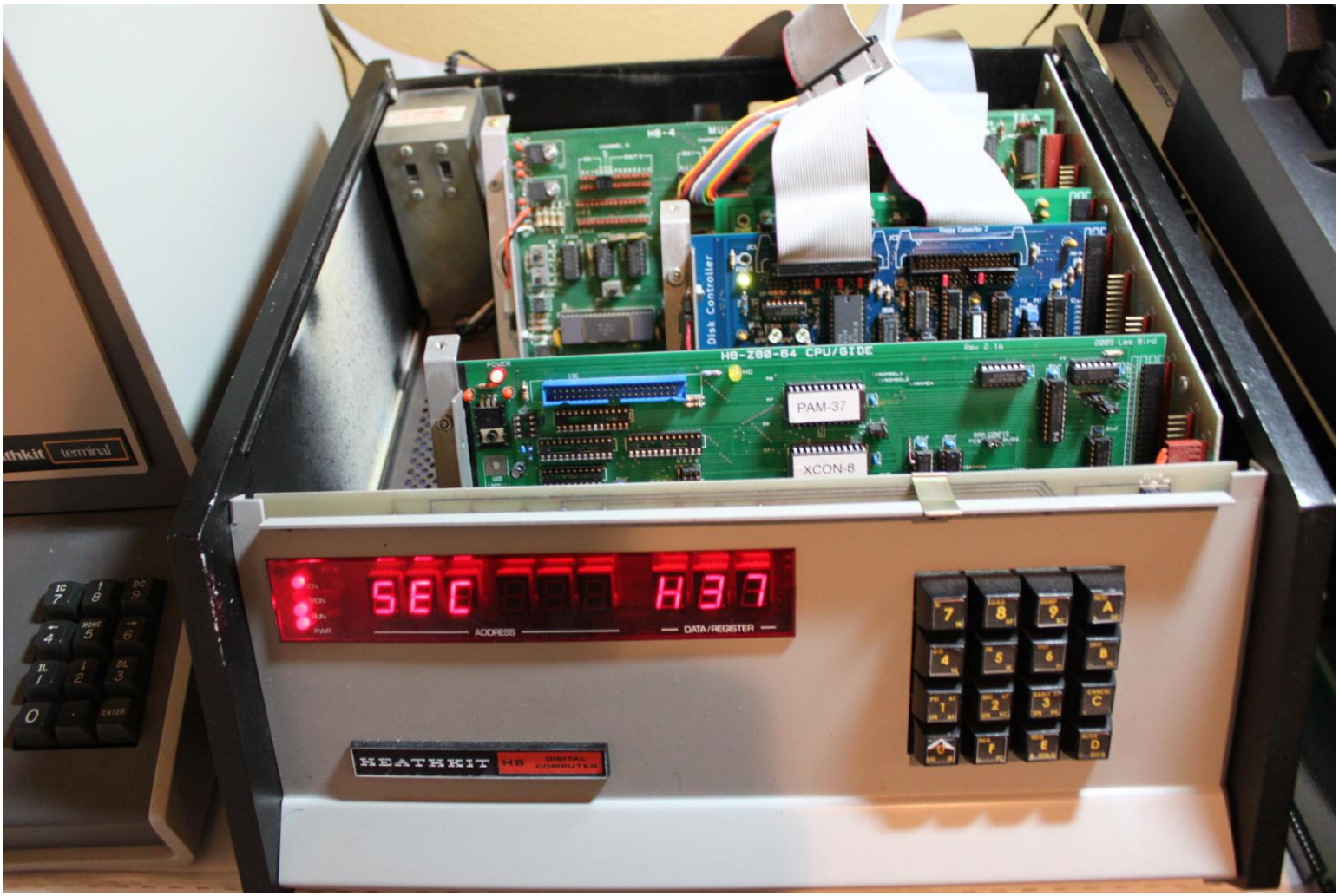
H8-Z37 FLOPPY CONTROLLER
Rev 1.0 10/31/2011


H8-Z60-64 CPU/GIDE
PAM-37
XCON-8
Disk Controller
SEC
A30
ADDRESS
DATA/REGISTER
HEATHKIT
H8

HEATHKIT
data systems