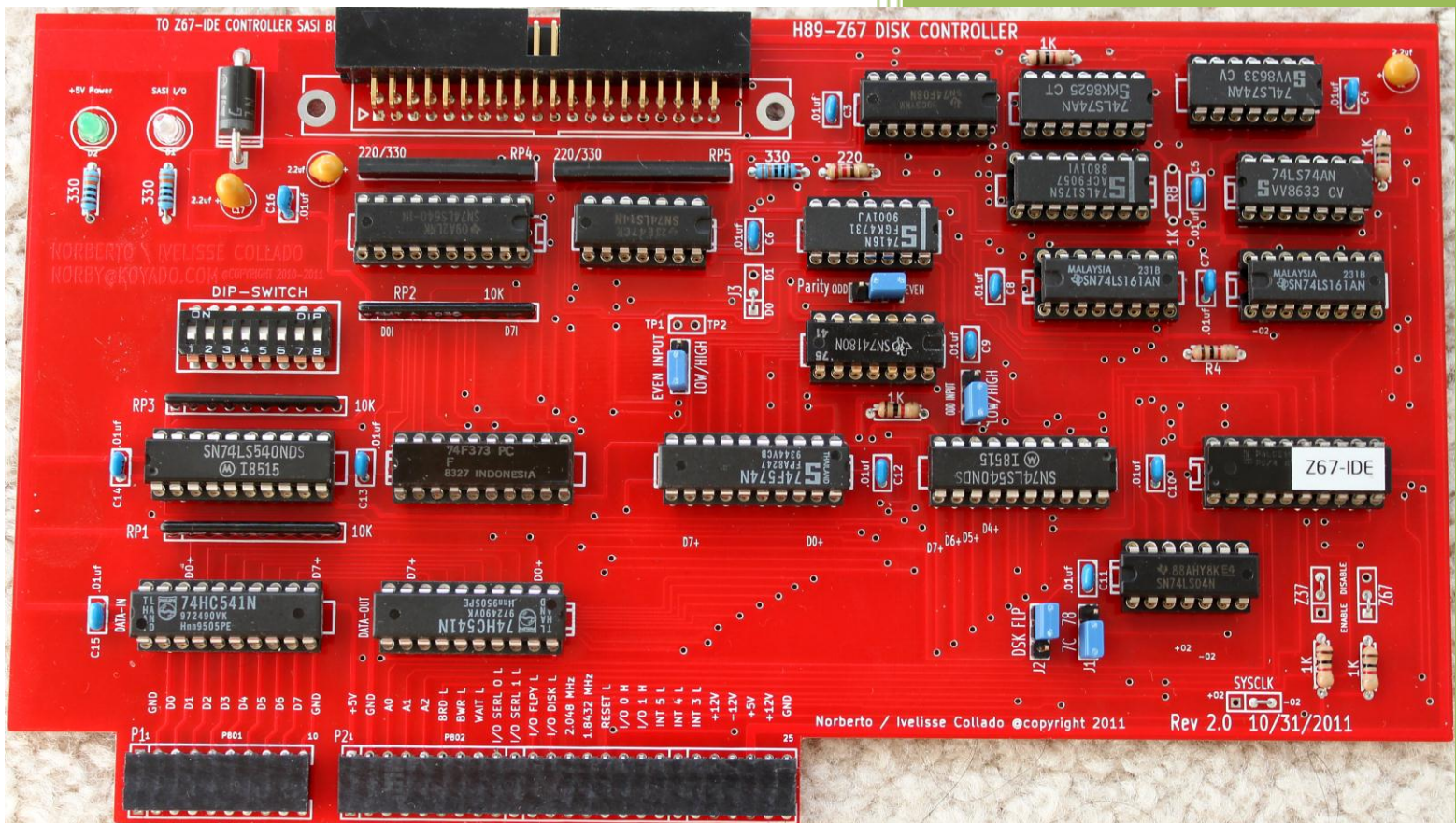


2011

H89-Z67-DISK CONTROLLER



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9/6/2011

Revision History and Disclaimer

Revision History		
Revision	Date	Comments
1.0	03/02/2011	Initial draft by Norberto Collado

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 obtain permission to include them.

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Thank you for your understanding and consideration.



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Introduction

This document provides an overview on the H89-Z67 disk controller board design by Norberto Collado for the Heathkit H89 Computer.

H89-Z67 DISK CONTROLLER

The H89-Z67 controller contains a standard SASI interface bus to boot from the Z67-IDE storage board. The H89-Z67 controller is operable at any CPU speed up to 4 MHz, and it supports two bootable IDE hard drives via the H89 System ROM. The H89-Z67 SASI DISK CONTROLLER mounts inside the H89 computer cabinet while attached to the Z67-IDE controller allowing IDE boot support.

Please refer to the following website to download supported IDE H89 Monitor;

<http://koyado.com/Heathkit/Z67-IDE.html>

[2732a_444_84c_ide_mms_v1.hex.zip](#) (H89 IDE Monitor ROM)

CONTROLLER CARD PORTS CONFIGURATION

The following is a table summary of the controller ports configuration. Please refer to the H89 documentation for switch definition for proper port settings.

Documentation can be obtained at the following website;

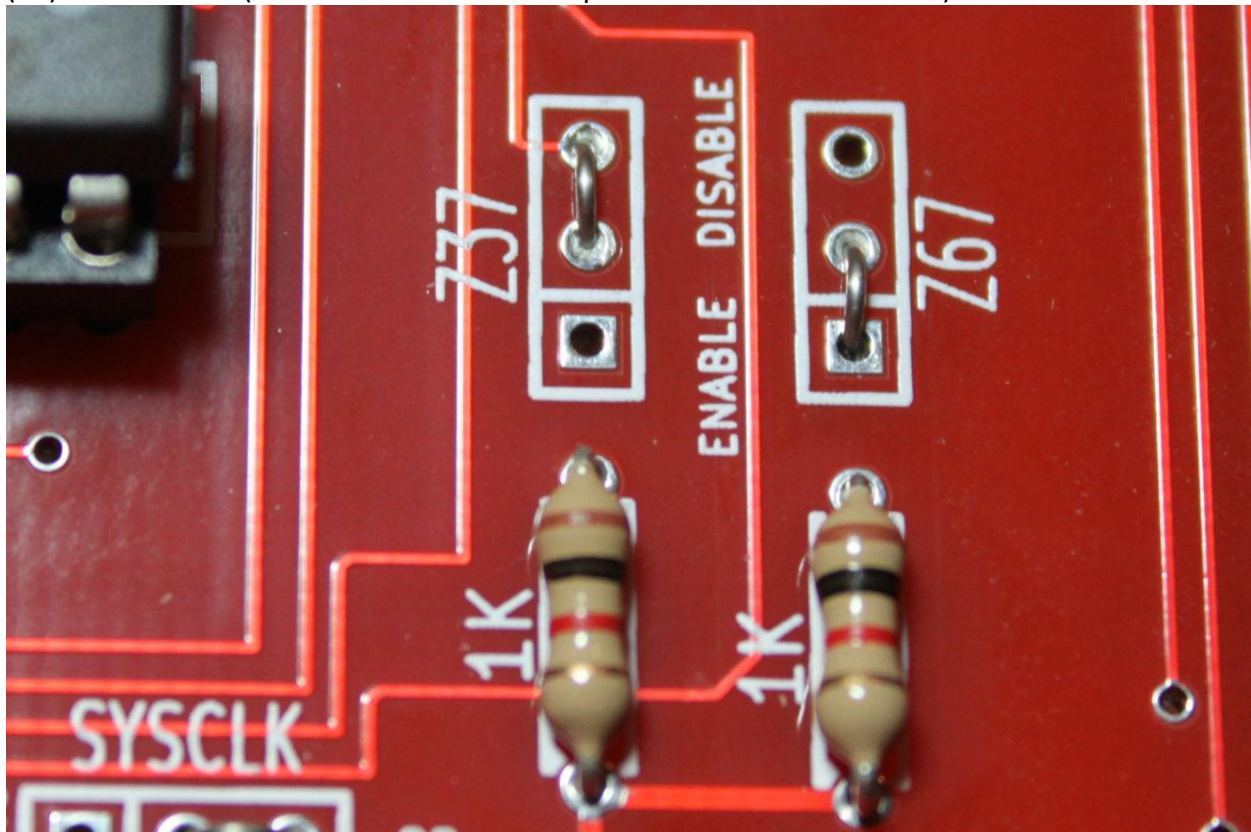
<http://www.lesbird.com/sebhc/index.html>

CONTROLLER CARD	PORT	H89-Z67 PORT
H17	7CH (174Q)	78H (170Q)
H89-Z37	78H (170Q)	7CH (174Q)
H47	78H (170Q)	7CH (174Q)

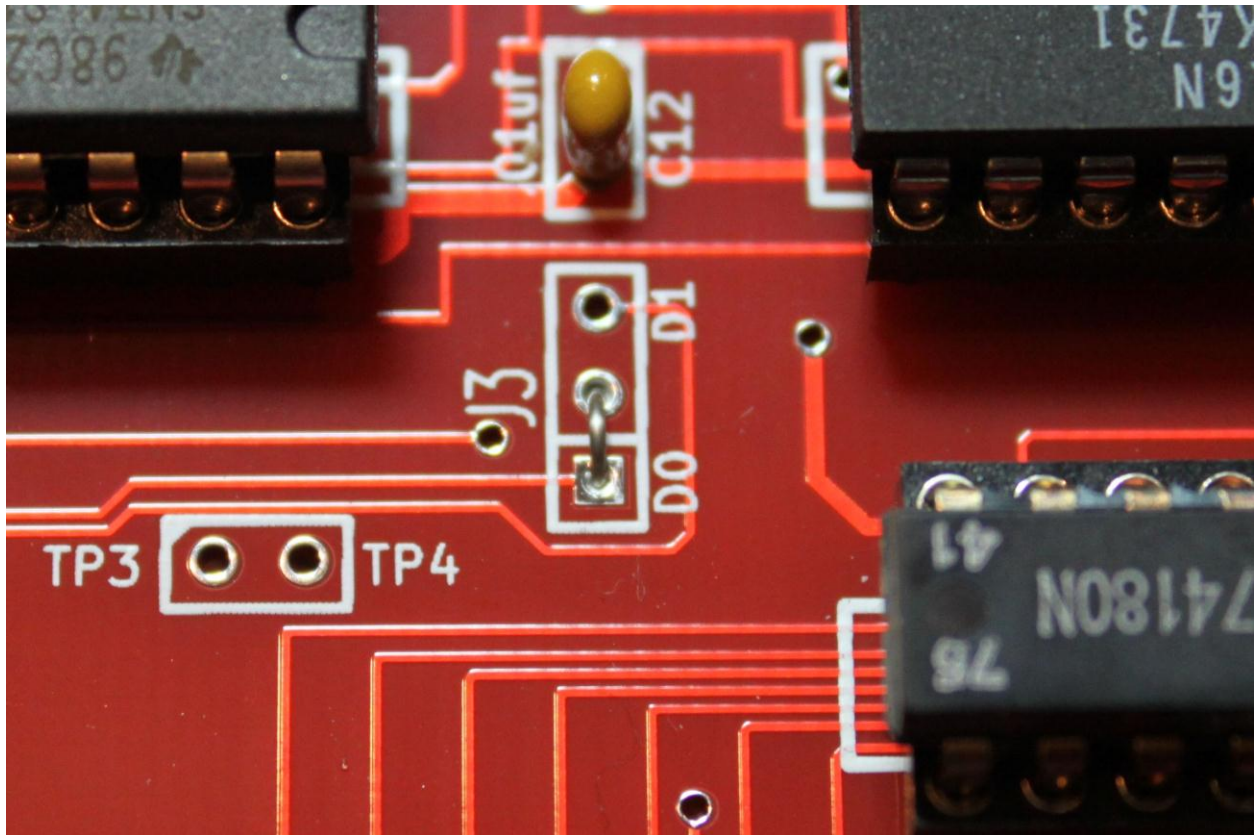
H89-Z67 Jumper Configuration

() Z-37 Disabled (solder a bare wire across pin 2 and 3 as shown below)

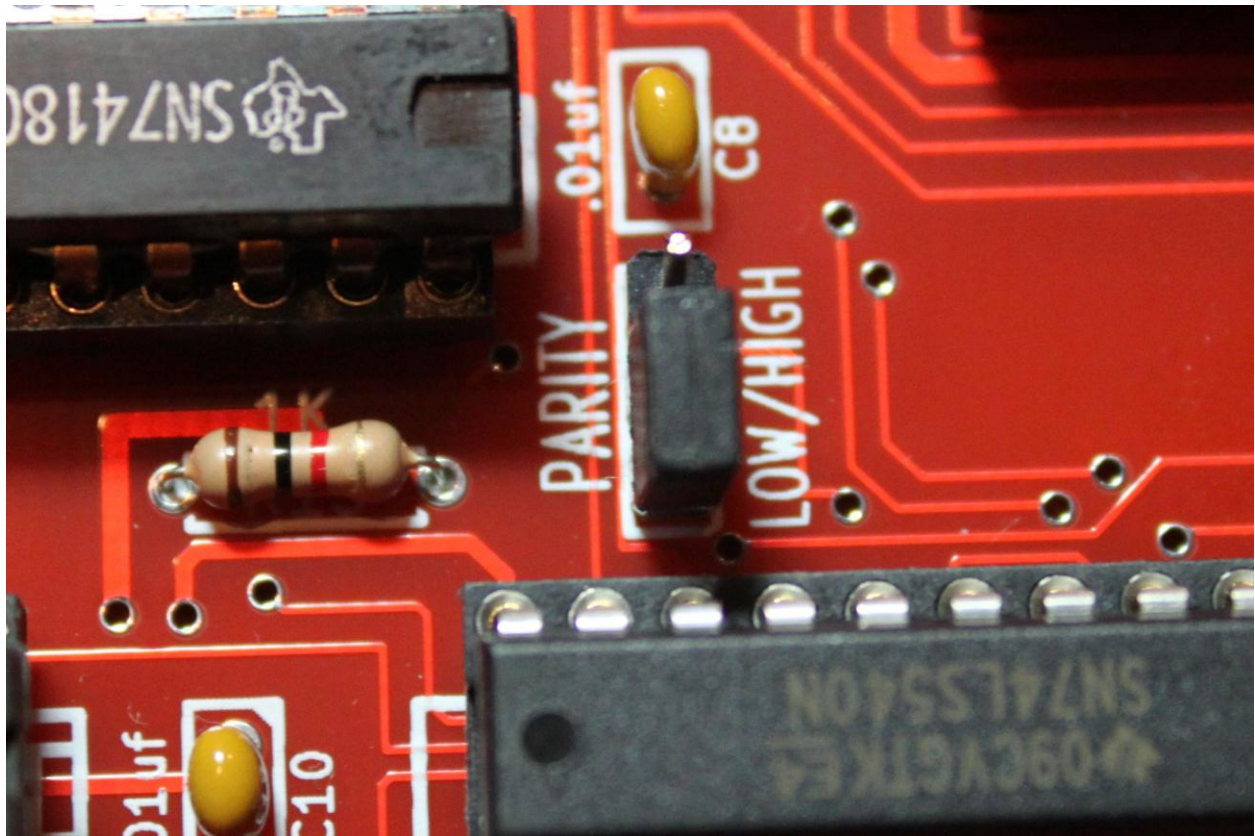
() Z-67 Enabled (solder a bare wire across pin 1 and 2 as shown below)



() Solder on J3 a bare wire across pin 1 and 2 as shown below (D0).

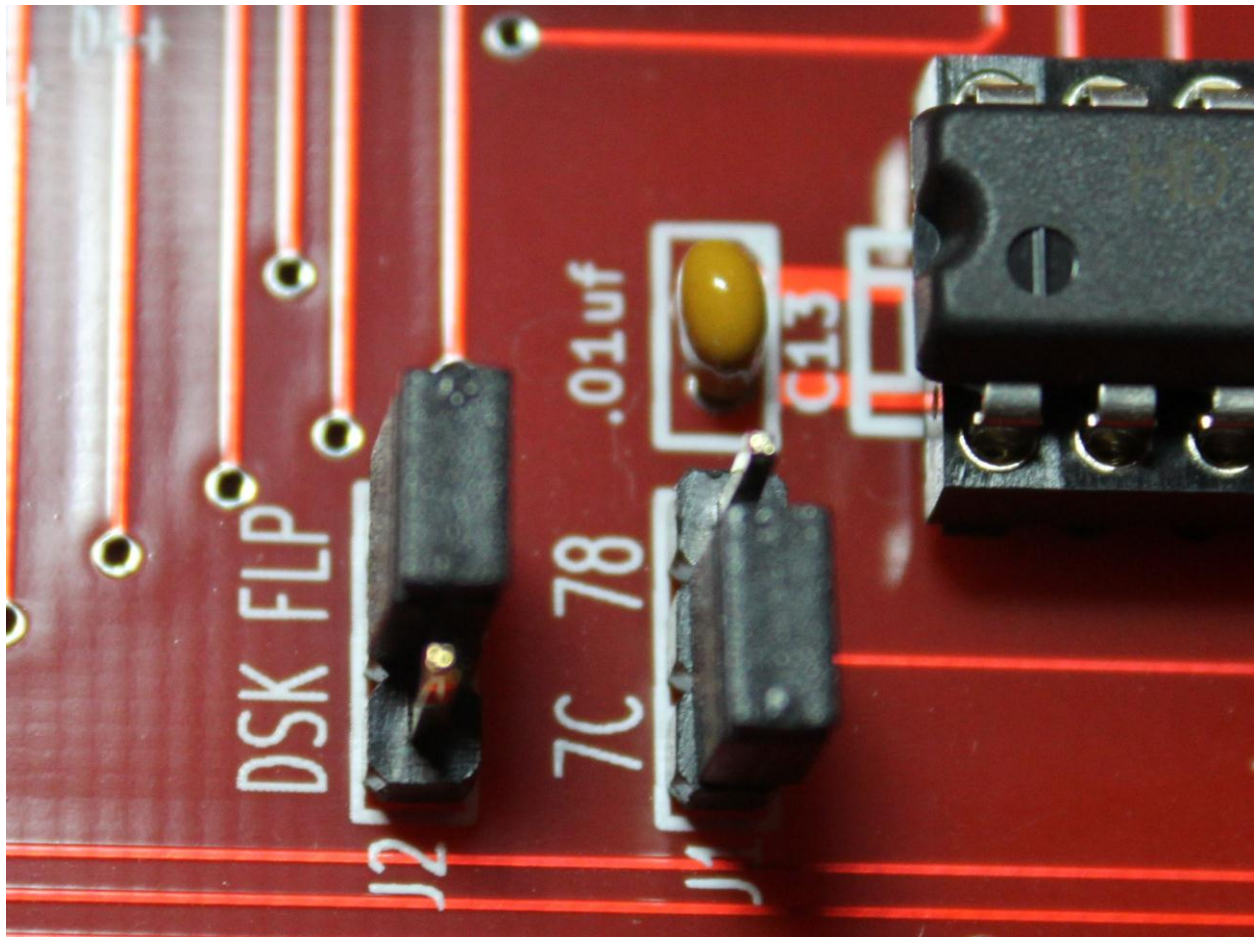


() Insert Jumper across Parity header between pin 1 and 2 as shown (LOW Default).



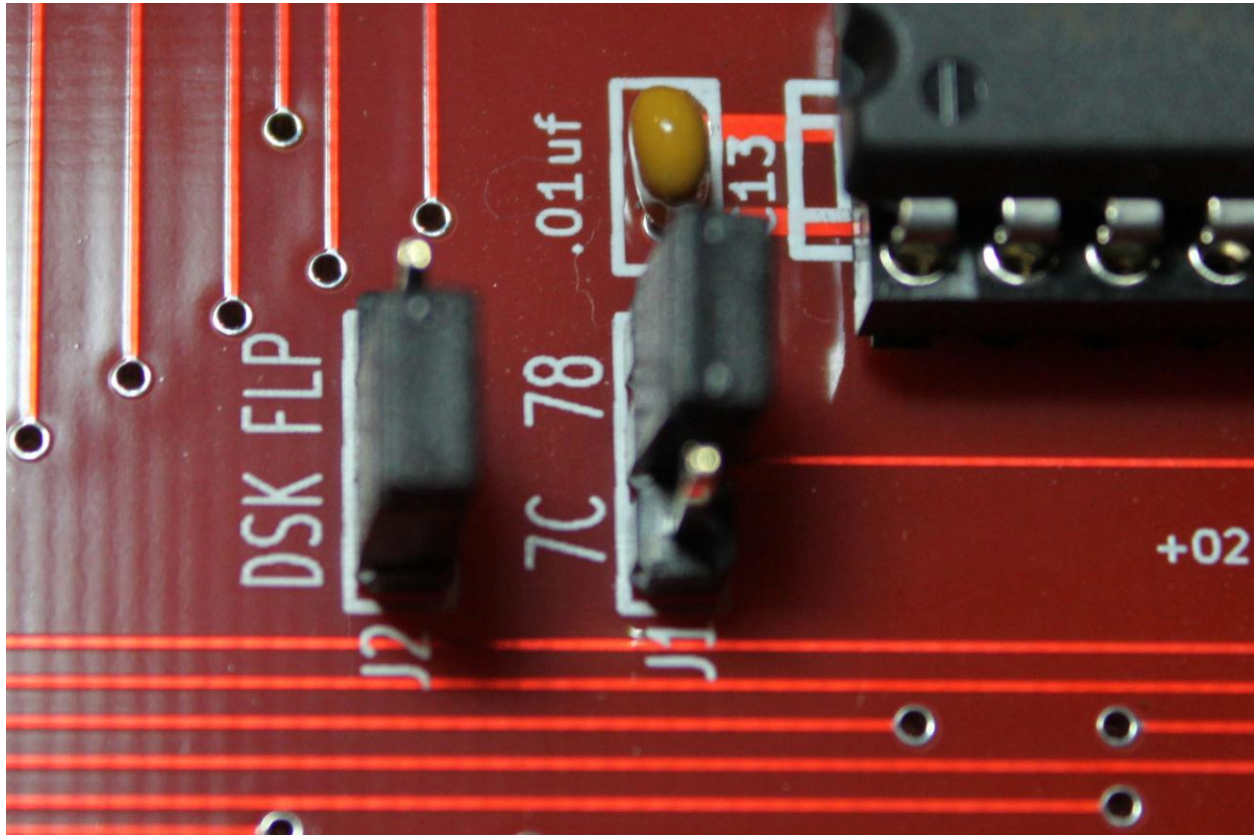
() If inserting H89-Z67 board on P506 and P512 locations, then place a Jumper on J2 across pin 2 and 3 (FLP Signal)

() If inserting H89-Z67 board on P506 and P512 locations, then place a Jumper on J1 across pin 1 and 2 (Address 7C hex)

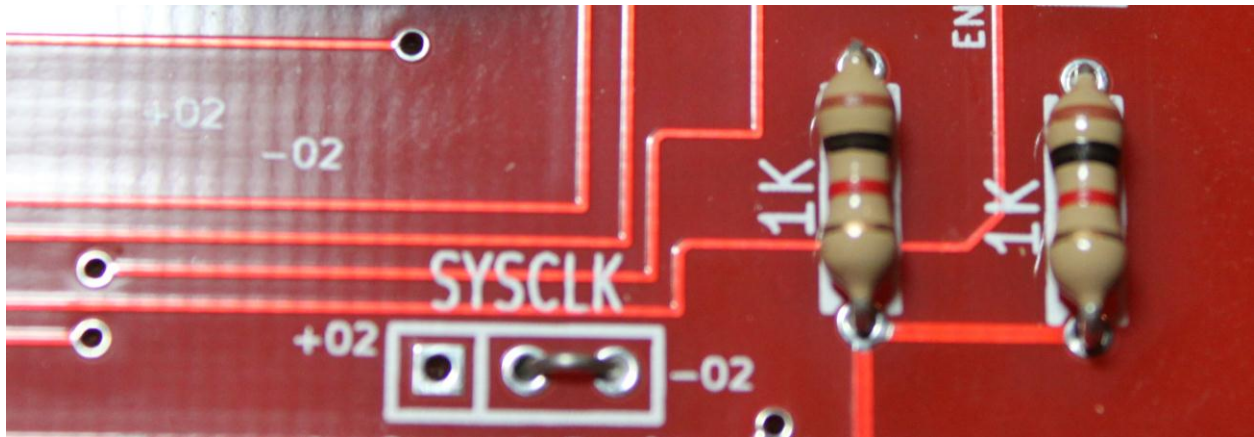


() If inserting H89-Z67 board on P504 and P510 locations, then place a Jumper on J2 across pin 1 and 2 (DSK Signal)

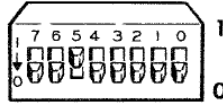
() If inserting H89-Z67 board on P504 and P510 locations, then place a Jumper on J1 across pin 2 and 3 (Address 78 hex)



() Solder on SYSCLK a bare wire across pin 2 and 3 as shown below.



CPU DIP SWITCH SW501 SETUP



CPU DIP Switch SW501, located at the lower right of the Z-89/90 CPU Board, has eight sections (0 to 7) that may be set to either one or zero. These sections have the following functions:

<u>SECTIONS</u>	<u>SETTINGS</u>	<u>SETTING DEFINITION</u>	<u>SECTION DEFINITION</u>
1,0	00 — Hard-sectored 5.25-inch disk. 01 — H/Z-47 eight-inch floppy. 10 — Z-67 Winchester. 11 — No device.		Selects the device located at port 07CH (174Q), plugs P506 and P512.
3,2	00 — Soft-sectored 5.25-inch disk. 01 — H/Z-47 eight-inch floppy. 10 — Z-67 Winchester. 11 — No device		Selects the device located at port 078H (170Q), plugs P504 and P510, or P505 and P511.
4	0 — Primary boot from device at 07CH. 1 — Primary boot from device at 078H.		Determines whether the primary boot device is at port 07CH (174Q) or at 078H (170Q). The port not configured as primary becomes the secondary device.
5	0 — Initiate memory test on power up. 1 — Disable memory test on power up.		Disables/enables memory diagnostic on power up.
6	0 — Set console baud rate at 9600 (normal). 1 — Sets console baud rate at 19,200 (not currently supported).		Sets console baud rate.
7	0 — Normal. 1 — Auto-boot on power up.		Sets auto-boot.

H89-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:

<u>Signal</u>	<u>Pin No.</u>
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.

H89-Z67 Interface Register Definition

When booting from the H89-Z67 Disk Controller and after receiving an interrupt, the H89 computer sends either an **I/O FLPY** signal to pin 11 of P2 or an **I/O DSK** signal to pin 12 of P2 on the H89-Z67 Interface Board. Either of these signals will enable the GAL-Z67 address decoder on the H89-Z67 controller.

If **I/O FLPY** is used, the H89-Z67 controller is mounted in the right I/O port, that is, P512 and P506 on the H89 CPU Board.

If **I/O DSK** is used, the H89-Z67 board is mounted in either of the remaining I/O ports, P511 and P505 or P510 and P504 on the H89 CPU Board.

The registers on the H89-Z67 Disk Controller Board are listed below. The address given assumes that the board is installed at P504, P510 (addresses 170Q - 172Q or 0x78 – 0x7A). If the board is installed at P506, P512, add four to the above address as follows;

$$170Q + 4Q = 174Q = 0x7C$$

$$171Q + 4Q = 175Q = 0x7D$$

$$172Q + 4Q = 176Q = 0x7E$$

The bit definition for each register is described below:

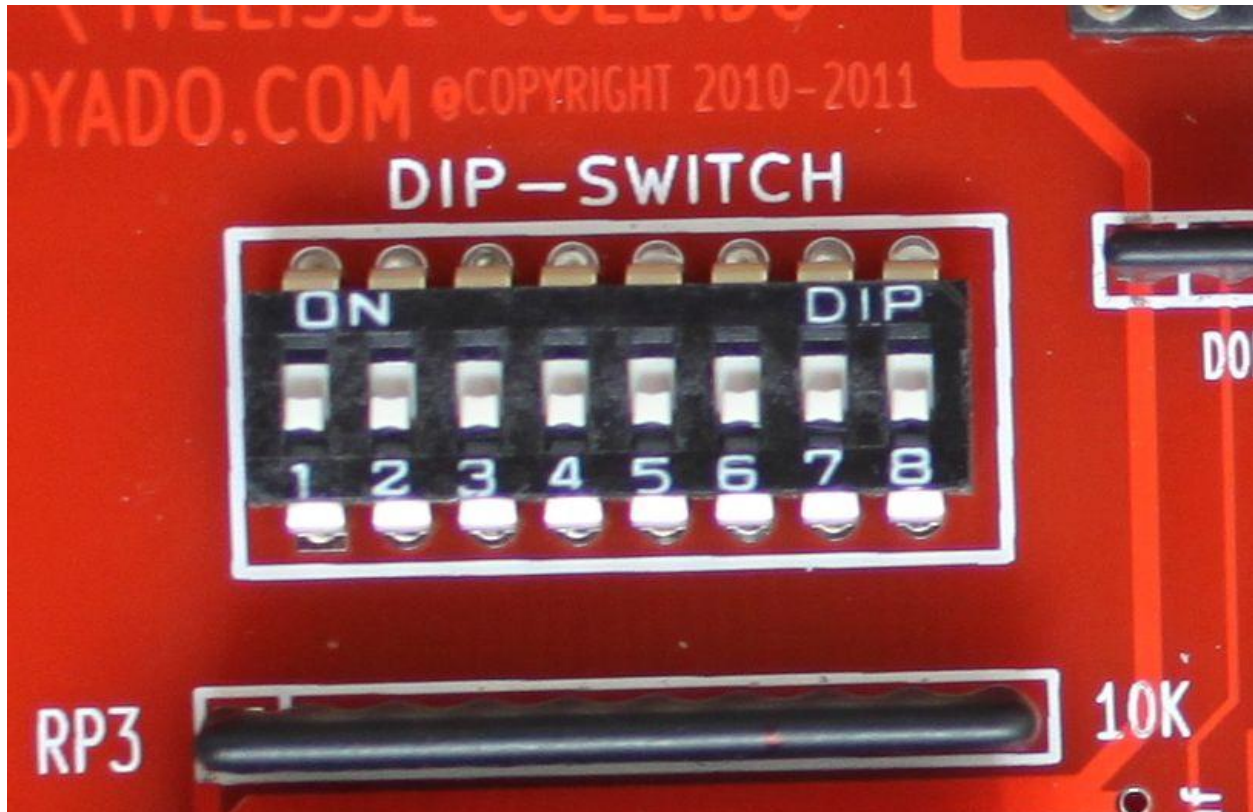
HEX Address	Octal Address	Register	Operation
0x78	170Q	Data In/Out	Read and Write
0x79	171Q	Control Register	Write Only
0x79	171Q	Status Register	Read Only
0x7A	172Q	DIP SWITCHES (DS1)	Read Only

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.

H89-Z67 DS1 Switch Definition

The DIP 8 Switch that is on the H89-Z67 controller is used to define the boot partition from Hard Disk 0 or Hard Disk 1. The QSB BIOS 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	OFF	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

```
H19 Emulator Output
SASI/X Hard Disk Partitioning Utility - Copyright 1983 UltiMeth Corporation
Function: 0 V5504.2222/CC[00] (ANSI:Y)
Port: 7CH Drive: 0 Controller: 0 Sense/ECC data: 00 000000 00
Error-len: 2 Heads: 8 Cylinders: 2002
Seek-type: 4 Wcomp: 2002 Wreduc: 2002 (SASI function successful)

# Name Cat WP Origin Size Category codes: 0 = Unused 1 = Spare
0 DRIVE0 1 2 0 2 125 2 = Heath CP/M 3 = MMS CP/M 4-7 = HDOS
1 DRIVE0 2 2 0 127 125 WP codes: 0 = Read/Write 1 = Read only
2 DRIVE0 3 2 0 252 125
3 DRIVE0 4 2 0 377 125 --- Cursor/Editing Key Functions: ---
4 DRIVE0 5 2 0 502 125 Cursor keys: Unshifted: [Shifted:]
5 DRIVE0 6 2 0 627 125 <- Prev char(BS) [Prev field]
6 DRIVE0 7 2 0 752 125 -> Next char [Next field(CR)]
7 DRIVE0 8 2 0 877 125 ^ Up same field [Prev line]
8 DRIVE0 9 2 0 1002 125 v Down same field [Next line(LF)]
9 DRIVE0 10 2 0 1127 125 HOME First field [Last field]
10 DRIVE0 11 2 0 1252 125 TAB Alternate begin/end field
11 DRIVE0 12 2 0 1377 125 Editing keys:
12 DRIVE0 13 2 0 1502 125 ERASE (to field end) IC Insert char
13 DRIVE0 14 2 0 1627 125 DEL Clear prev char DC Delete char
14 DRIVE0 15 2 0 1752 125

1Write 2Format 3Gen 4Check 5Check 6Read 7Exit 8Start
```

Drive 1 Partitions

```
H19 Emulator Output
SASI/X Hard Disk Partitioning Utility - Copyright 1983 UltiMeth Corporation
Function: 0 V5504.2222/CC[00] (ANSI:Y)
Port: 7CH Drive: 1 Controller: 0 Sense/ECC data: 00 000000 00
Error-len: 2 Heads: 8 Cylinders: 2002
Seek-type: 4 Wcomp: 2002 Wreduc: 2002 (SASI function successful)

# Name Cat WP Origin Size Category codes: 0 = Unused 1 = Spare
0 DRIVE1 1 2 0 2 125 2 = Heath CP/M 3 = MMS CP/M 4-7 = HDOS
1 DRIVE1 2 2 0 127 125 WP codes: 0 = Read/Write 1 = Read only
2 DRIVE1 3 2 0 252 125
3 DRIVE1 4 2 0 377 125 --- Cursor/Editing Key Functions: ---
4 DRIVE1 5 2 0 502 125 Cursor keys: Unshifted: [Shifted:]
5 DRIVE1 6 2 0 627 125 <- Prev char(BS) [Prev field]
6 DRIVE1 7 2 0 752 125 -> Next char [Next field(CR)]
7 DRIVE1 8 2 0 877 125 ^ Up same field [Prev line]
8 DRIVE1 9 2 0 1002 125 v Down same field [Next line(LF)]
9 DRIVE1 10 2 0 1127 125 HOME First field [Last field]
10 DRIVE1 11 2 0 1252 125 TAB Alternate begin/end field
11 DRIVE1 12 2 0 1377 125 Editing keys:
12 DRIVE1 13 2 0 1502 125 ERASE (to field end) IC Insert char
13 DRIVE1 14 2 0 1627 125 DEL Clear prev char DC Delete char
14 DRIVE1 15 2 0 1752 125

1Write 2Format 3Gen 4Check 5Check 6Read 7Exit 8Start
track options MMS drive cntlr table prog over
```

Menu Selectable Boot Partitions



HEATH/ZENITH H/Z67
Software Boot Code (SBC) vers 1.1

Boot Option(s) Menu

Operating systems:	Maximum occurrence number:
HDOS	00
HDOS1	00
HDOS2	00
HDOS3	00
HDOS4	00
HDOS5	00
HDOS6	00
HDOS7	00

Boot String?.....> HDOS

ACTION? <BOOT> BOOT

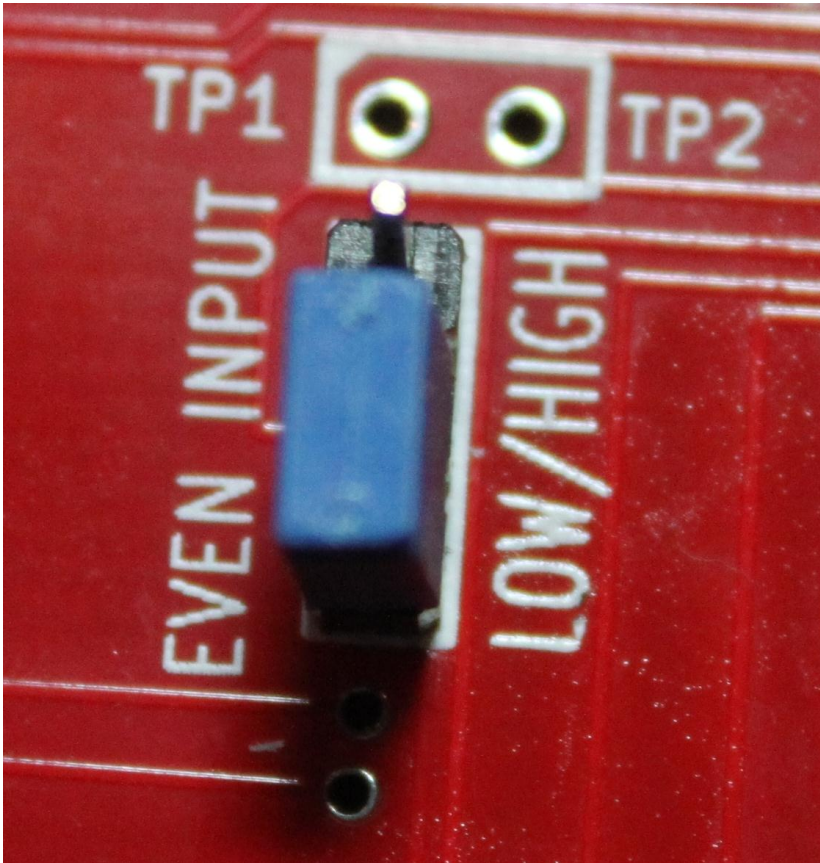
Heathkit H89



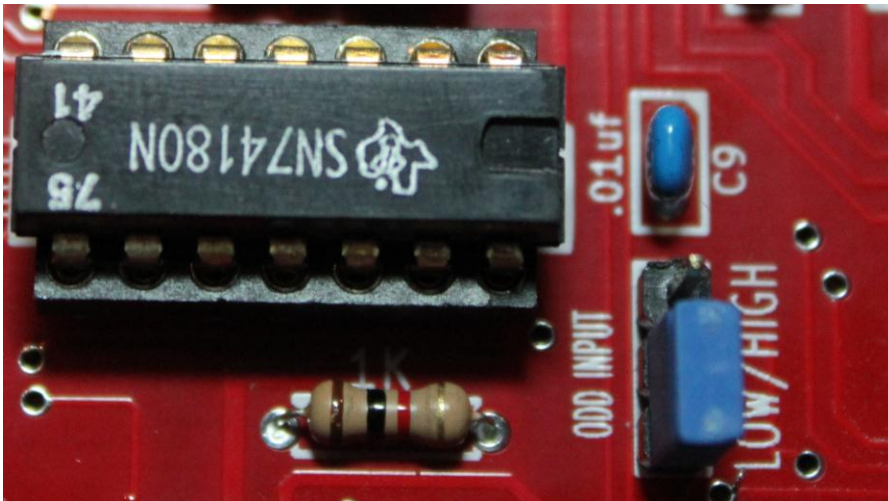


H89-Z67 Configuring Parity for HDOS & CP/M Boot

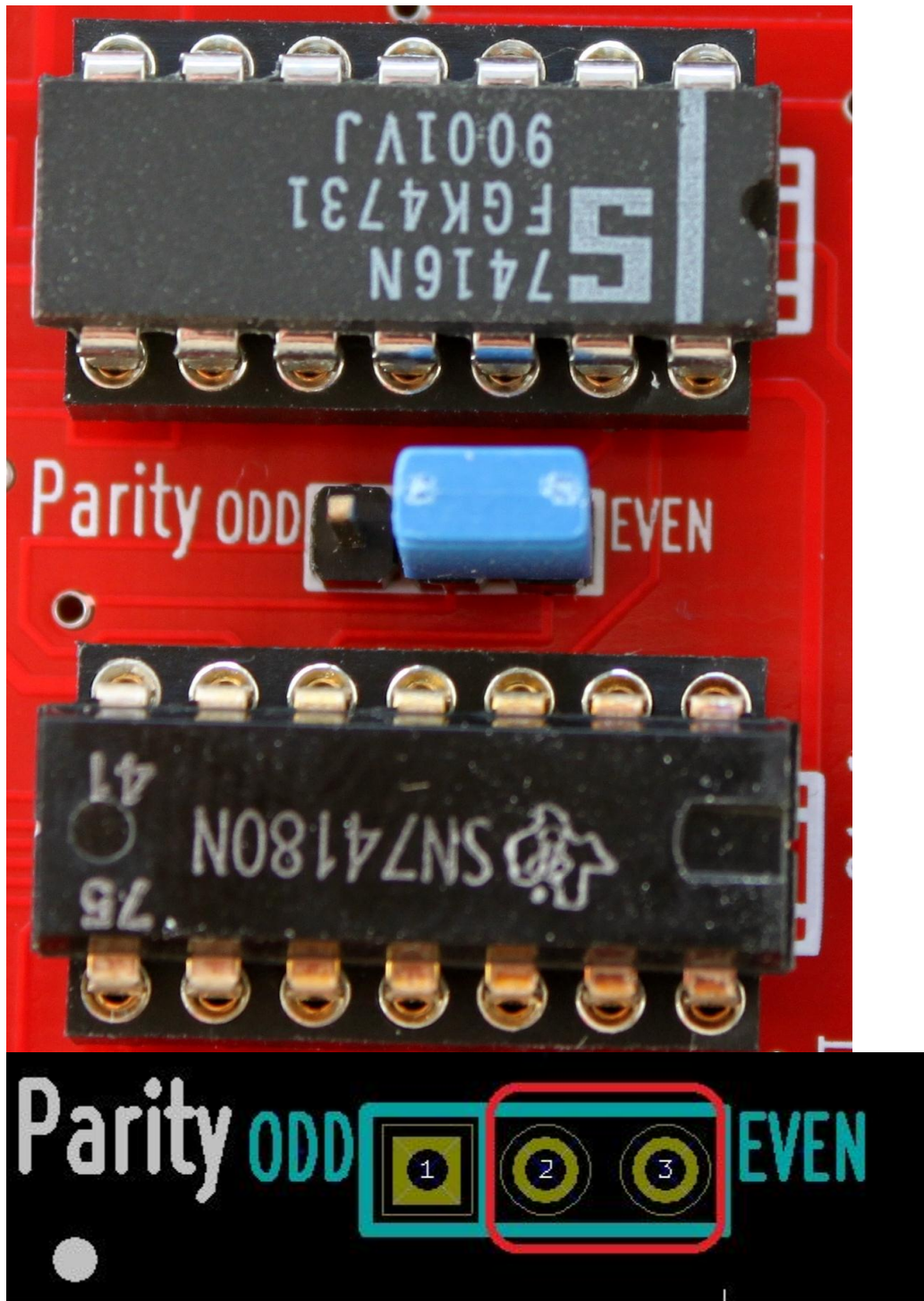
1. Install jumper across pin 1 and 2 on "EVEN INPUT" header (LOW)



2. Install jumper across pin 1 and 2 on "ODD INPUT" header (LOW).



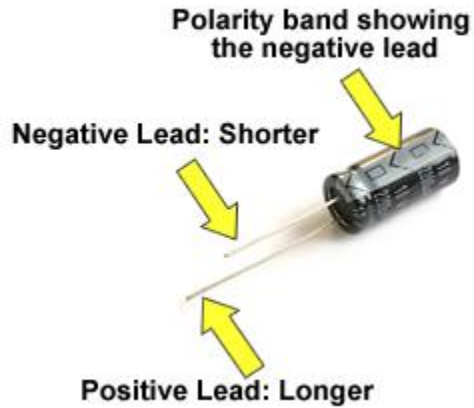
3. Install jumper across pin 2 and 3 on "PARITY" header (EVEN).



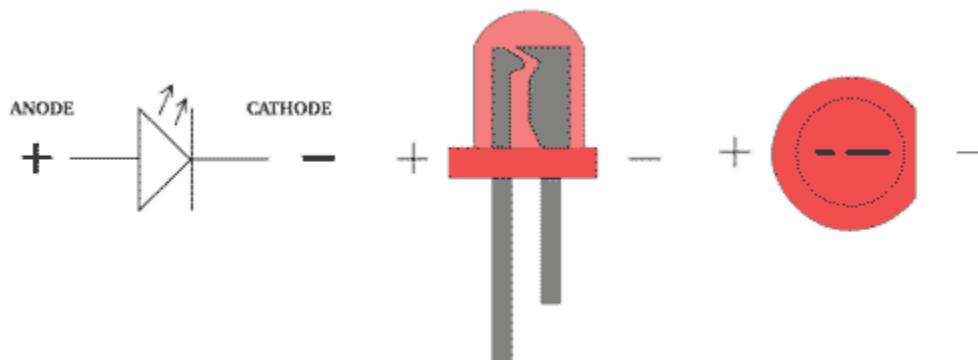
Note: Failure to configure properly will inhibit HDOS boot.

H89-Z67 Board Assembly

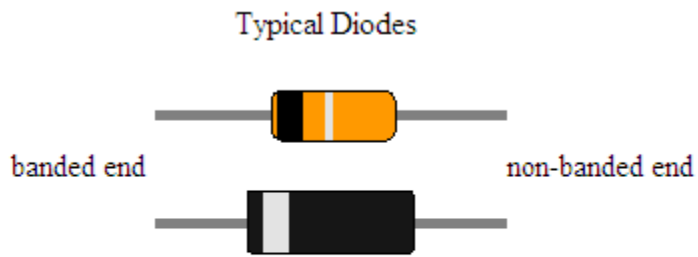
1. Install C3 – C16 - 0.01uF caps.
2. Install C1, C2, and C17 - 2.2uF caps (observed polarity).



3. Install Green LED – D2 (observed polarity).
4. Install Red or Blue LED – D1 (observed polarity).



5. Install D1 – 1N5822 diode.



<u>Resistor Band Color Reference</u>				
<i>Color</i>	<i>Band 1</i>	<i>Band 2</i>	<i>Multiplier</i>	<i>Tolerance</i>
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%

6. Install R6 – 220 OHMS resistor
7. Install R1, R2, and R7 – 330 OHMS resistors.
8. Install R3, R4, R5, R10, R11, R13 – 1K OHMS resistors.
9. Install RP1, RP2 AND RP3 10K BUSSED 10 pin resistor. Pin one is on the left side. If install incorrectly, data corruption might happen.
10. Install the two 220/330 - 10 pin Bus Termination resistors – RP4 and RP5.
11. Install all 14 pin IC sockets.
12. Install all 16 pin IC sockets.
13. Install all 20 pin sockets.
14. Install 40 pin right angle header connector.
15. Install five 3 pin headers.
16. Install DIP-SWITCH
17. Install 10 PIN MB Connector (P1)
18. Install 25 PIN MB Connectors (P2)
19. Install U10 – 74180 or 74LS280 IC.
20. Install U2 – 7416 IC.
21. Install U1 – 74LS14 IC.
22. Install U7 - 74LS08 IC.
23. Install U8 – 74LS74 IC.
24. Install U5 – 74LS74 IC.
25. Install U13 – 74LS74 IC.
26. Install U25 – 74LS04 IC.
27. Install U16 – 74LS175 IC.
28. Install U28 – 74LS161 IC.
29. Install U27 – 74LS161 IC.
30. Install U26 – GALZ67 IC.
31. Install U11 – 74LS640 IC.

32. Install U19 – 74LS540 IC.
33. Install U9 – 74LS574 IC.
34. Install U21 – 74LS373 IC.
35. Install U20 – 74LS540 IC.
36. Install U35 – 74LS541 IC.
37. Install U26 – 74LS541 IC.

