Heathkit H89 VDIP1 & RTC Board Documentation

Jeff Tranter <tranter@pobox.com>

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**Introduction**

This document contains notes on the Heathkit H89 VDIP board designed by Norberto Collado. I have assembled one and made these notes to assist others who may do the same. Thanks to Joe Travis, Glenn Roberts, and others on the SEHBC Discord channel for providing input on this document.

Note: I built a revision 1.3 board. At the time of writing, the latest board revision is 1.4. My buffer board was V1.0; the most recent is V1.2. I’ve noted differences, where applicable, in the document.

**Board Features**

Similar to an earlier design for the Heathkit H8, the H89 VDIP1 & RTC Interface is a small circuit board that installs into one of the leftmost slots of the H89 CPU board and provides the following functions:

1. An interface using a VDIP1 module that supports file transfers to and from USB flash drives. Software utilities for file transfer are provided that run on a Heathkit H89 running HDOS or CP/M.
2. A real-time clock (RTC) with battery backup that supports maintaining date and time. Utility software is available for HDOS and CP/M.
3. A software reset circuit (only on board revision 1.4 and later). While not required, this can be useful during development to reset a board without power cycling.
4. LEDs to indicate power and USB communication status.
5. The board is compatible with the H89 2/4 MHz speed modification (not covered here).

**Parts List**

| **VDIP Board:** | |
| --- | --- |
| BT1 | Battery holder and battery, type CR1220 |
| C1 | Capacitor, electrolytic or tantalum, 2.2uF, 10V or higher |
| C2 | Capacitor, ceramic, 0.1uF |
| C3 | Capacitor, ceramic, 0.1uF |
| C4 | Capacitor, ceramic, 0.1uF |
| C5 | Capacitor, ceramic, 0.1uF |
| C6 | Capacitor, electrolytic or tantalum, 2.2uF, 10V or higher (47uF on v1.3) |
| C7 | Capacitor, ceramic, 0.1uF |
| C8 | Capacitor, ceramic, 47pF |
| C9 | Capacitor, ceramic, 47pF |
| C10 | Capacitor, electrolytic or tantalum, 2.2uF, 10V or higher |
| C11 | Capacitor, ceramic, 0.1uF |
| C12 | Capacitor, electrolytic or tantalum, 1uF, 10V or higher |
| C13 | Capacitor, ceramic, 0.1uF |
| C14 | Capacitor, electrolytic or tantalum, 1uF, 10V or higher (not present on rev 1.3 board) |
| C15 | Capacitor, ceramic, 0.1uF (not present on rev 1.3 board) |
| D1 | Diode, LED. Optional, duplicates LED on VDIP1. |
| D2 | Diode, BAT42 or BAT48 |
| D3 | Diode, LED, Red (power). |
| D4 | Diode, 1N5819 |
| D5 | Diode, LED. Optional, duplicates LED on VDIP1. |
| D6 | Diode, BAT42 or BAT48 |
| D7 | Diode, BAT42 or BAT48 |
| D8 | Diode, BAT42 or BAT48 |
| D9 | Diode, BAT42 or BAT48 (not present on rev 1.3 board) |
| F1 | Fuse, fusible link, 1.1A. Can use jumper wire if desired. |
| J1 | 2-pin header, right angle |
| J2 | 3-pin header, right angle |
| J3 | Connector, USB. Not currently supported and can be omitted. |
| J4 | Edge connector, 25-pin. See notes. |
| J5 | 7-pin header, right angle |
| J6 | Edge connector, 10-pin |
| J11 | 1-pin header |
| J12 | 1-pin header |
| J13 | 7-pin header, right angle |
| J14 | 3-pin header, right angle |
| J15 | 4-pin header, right angle |
| J16 | 2-pin header, right angle |
| J17 | 2-pin header, right angle |
| JP1 | 2-pin header and jumper |
| JP2 | 2-pin header and jumper (not present on rev 1.3 board) |
| R1 | Resistor, 330R, 1/4W |
| R2 | Resistor, 330R, 1/4W |
| R3 | Resistor, 10K, 1/4W (3.3K on rev 1.3 board) |
| R4 | Resistor, 4K7, 1/4W (3.3K on rev 1.3 board) |
| R5 | Resistor, 330R, 1/4W |
| R6 | Resistor, 4K7, 1/4W (3.3K on rev 1.3 board) |
| R7 | Resistor, 4K7, 1/4W (3.3K on rev 1.3 board) |
| R8 | Resistor, 4K7, 1/4W (3.3K on rev 1.3 board) |
| R9 | Resistor, 330R, 1/4W |
| R10 | Resistor, 10K, 1/4W |
| R11 | Resistor, 330R, 1/4W |
| R12 | Resistor, 10K, 1/4W (not present on rev 1.3 board) |
| R14 | Resistor, 120K, 1/4W (not present on rev 1.3 board) |
| R15 | Resistor, 10K, 1/4W (not present on rev 1.3 board) |
| R16 | Resistor, 150R, 1/4W (not present on rev 1.3 board) |
| R17 | Resistor, 10K, 1/4W (not present on rev 1.3 board) |
| U1 | IC, GAL, Atmel G16V8AS |
| U2 | IC, 74LS04 |
| U3 | IC, 74LS125 |
| U4 | IC, 74LS125 |
| U5 | IC, VDIP1 (Either original VDIP1 or newer V2DIP1-48. See text.) |
| U6 | IC, EconoReset, DS1233, TO92 package (DS1233-5, DS1233-10, or DS1233-15 should all work). |
| U7 | IC, RTC-72421 (Suggested source is eBay. See text.) |
| U8 | IC, 74LS123 (not present on rev 1.3 board) |
| - | IC sockets |

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| --- | --- |
| **Buffer Board:** | |
| C1 | Capacitor, ceramic, 0.1uF |
| C2 | Capacitor, ceramic, 0.1uF |
| J1 | 2-pin header, right angle |
| J2 | 7-pin header, right angle |
| J3 | 2-pin header, right angle (not on v1.0 board) |
| R1 | Resistor, 4K7, 1/4W (3.3K on V1.0 board) |
| R2 | Resistor, 4K7, 1/4W (3.3K on V1.0 board) |
| R3 | Resistor, 4K7, 1/4W (3.3K on V1.0 board) |
| R4 | Resistor, 4K7, 1/4W (not on V1.0 board) |
| U1 | IC, 74LS125 |
| U509 | IC, 74LS241. Can be taken from the H89 CPU board. |
| - | 0.5" SIP machined pin headers, 2x10. See text. |

**Board Assembly and Test**

Install the components on the two boards using the schematic, board layout picture, and PCB silkscreen as guides. See references [1] and [3].

Also build up the VDIP1 U509 buffer board which is on a separate small PCB. It requires two capacitors, four resistors, two ICS, and some header pins. See reference [1]. The 74LS421 IC from location U509 on the H89 CPU board will be removed and installed on the top of the buffer board as indicated on the board silk screen. Header pins on the bottom of the board will insert into the original IC socket on the CPU board. Use 0.5" SIP machined pin headers for the daughter board. I used DigiKey part number ED3864-10-ND. The end of the headers with the smaller diameter pins go into the CPU board socket, the larger diameter pins are soldered into the buffer board PCB. You may need to make sure the board has sufficient clearance when placed in the U509 socket and may need to cut and file the pins on the component side of the board before soldering the 74LS241 over it. I recommend soldering the ICs directly to the board (no IC sockets) to ensure there is sufficient clearance between it and the video board mounting bracket (and the flyback mounting screws in particular). You should also trim the leads of the 74LS125 on the daughter board to avoid contacting the Z80 CPU beneath it.

In general, the recommendation is to install the lowest height parts first, e.g. resistors, small caps, IC sockets. Last to be assembled would be LEDs and electrolytic or tantalum caps, ICs, and the VIP1 module.

Ensure the correct orientation of the electrolytic or tantalum caps, diodes, and LEDs.

The 25-pin Molex edge connectors are no longer available. You can use two 10-pin with one 5-pin in the middle. They are available from Digikey, Newark, Mouser, etc. The part numbers are 5-pin: Molex #22-15-2056, 10-pin: Molex #22-15-2106.

It is highly recommended to use sockets for all ICs (except on the buffer board).

If using any NOS ICs, clean the pins if they look tarnished or oxidized.

The GAL is an Atmel G16V8 and requires programming using a suitable device programmer (I used a Minipro TL866II Plus). The programming files can be found at reference [1].

The RTC chip is an EPSON part which is obsolete but can be obtained from sources like eBay. Make sure it has the EPSON label on the IC as there are fake devices being sold.

The Vinculum VDIP module can be the original VDIP1 or the newer V2DIP1-48. The latter has larger header style pins that require a dual leaf socket. Possible sources for the VDIP are Mouser and Digikey. It is not recommended to use the V2DIP1-48 unless you have the ability to reprogram it – it doesn't have the same firmware as the VDIP1.

You will need to insert a USB flash drive, either directly into the VDIP module or via a USB extension cable from the VDIP module to the outside of the H89 case. The holes H1, H2, H3, and H4 can be used for holding a flash drive or USB cable in place using zip ties.

Connector J3 is for an extra USB port. It can be omitted as is not currently supported and it is not anticipated that it will be.

**Installation**

The VDIP board can be installed in any of the three left slide slots of the CPU board, connectors P501/P507, P502/P508, or P503/P509. Usually the middle slot is used as there is often a RAM card in the rightmost slot and the left slot may interfere with power cables.

If your H89 has a guide bracket on the left side with plastic guide pins for each slot, you should adjust the guide pin for the position of the VDIP board. The three guide pins holes are for boards with components facing left; you can have three different boards. The other holes for the guide pins are only for boards with components facing to the right; you only can have two. You can also have combinations of both setups. Refer to this picture:

<https://github.com/jefftranter/Z80/blob/master/H89VDIP1/pictures/guidebracket.png>

There is no keying on the connectors for the board, so take care not to offset the pins or you may damage the VDIP and/or H89 CPU board or power supply.

The real-time clock circuit is similar to one present on the H89 CF Flash card. The base i/o address of the RTC on the VDIP1 board is 240 octal, and the address on the CF Flash board is 320 octal, so if both are present they will not conflict. The VDIP utility programs use the RTC, if present, to datestamp files on the USB flash drive.

The CPU board IC U509 is removed and installed on the buffer board. The buffer board header pins install where U509 was removed. A 7-pin ribbon cable or Dupont jumper wires connect from the buffer board connector J2 to the VDIP board connector J5.

The two jumpers on the VDIP1 module should be set to J3 (left jumper) upper 2 pins, J4 (right jumper) lower two pins.

Normally, you should set the VDIP board jumpers to JP1 not installed, JP2 not installed.

Connect a FAT-formatted USB flash drive to the VDIP module. If desired, run a USB cable from the VIP1 module to the outside of the case so the flash drive can be external to the computer.

**Jumper Settings Reference**

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| --- | --- | --- |
| **Jumper** | **Normal Setting** | **Description** |
| JP1 | Not Installed | Insert for VDIP at i/o 331Q/332Q, remove for 261Q/261Q.  Remove if you have a modem port at i/o address 330Q. |
| JP2 | Not Installed | Insert for VDIP connected to bus reset (not present on rev 1.3 board). |

**Connector Reference**

|  |  |
| --- | --- |
| **Connector** | **Description** |
| J1 | Can connect to an optional external LED to indicate VDIP1 activity (not present on rev 1.3 board) |
| J2 | RAS signals for a future memory board. |
| J3 | Connector for extra USB interface. Not currently supported and can be omitted. |
| J4/J7/J9 | Connect to CPU board P507/P508/P509. |
| J5 | Control signals to/from the buffer board. |
| J6/J8/J10 | Connect to CPU board P501/P502/P503. |
| J11 | Ground test point. |
| J12 | Ground test point. |
| J13 | Signals to/from a future MSX controller board. |
| J14 | Address decoding for a future memory board. |
| J15 | (J1 on rev 1.4 board). Memory Bank signals for future memory board or use with 2/4 MHz speed mod. |
| J16 | I/O decoding outputs for use with H37/H67. |
| J17 | Can connect to an optional external LED to indicate 2/4 MHz CPU clock speed when using H89 speed mod. |

**Operation**

Install the VDIP1 utilities on the H89 as described in reference [2]. See the docs folder for documentation. Versions for HDOS and CP/M are available, including binaries. You will initially need a way to get the VDIP software onto the H89, such as a serial port transfer using Maple and xmodem. Note that with the recommended VDIP board jumper settings, the i/o address used is 261. At the time of writing the VDIP utilities default to using port 331, so you will need to either pass the command line option -P261 or use a VPORT.DAT file as described in the documentation.

The H89RTCLK program is available which can set or get the date/time using the real-time clock. It works under HDOS or CP/M and can be run on boot to set the operating system time and date. The version included in the operating system images for the CF Flash board is configured to use the RTC on the CF Flash card. If you want to use the RTC on the VDIP1 board you will need to adjust the source code and recompile it. You may also want to check that your version of HDOS has been patched with Y2K fixes.

**Board Images**

Some pictures of the assembled boards can be found at reference [7].

**References**

1. Schematics and board layout: <https://koyado.com/heathkit/New-H8-Website/h89-vdip1_rtc-left-side-slots.html>
2. VDIP Utilities: <https://github.com/sebhc/vdip-utilities/>
3. Image of installed board: <https://www.facebook.com/groups/heathkitcomputers/posts/1576437279671771/>
4. REMarks Article on VDIP: <https://sebhc.github.io/sebhc/REMarks/REMarks%20Issue%206%20%20-%2014%20February%202022.pdf>
5. VDIP board for H8: <https://koyado.com/heathkit/h-8_usb.html>
6. SEBHC Discord Chat (there is a VDIP1 channel): <https://discord.gg/jAg8JcAc>
7. Latest version of this document, as well as images and other files: <https://github.com/jefftranter/Z80/tree/master/H89VDIP1>