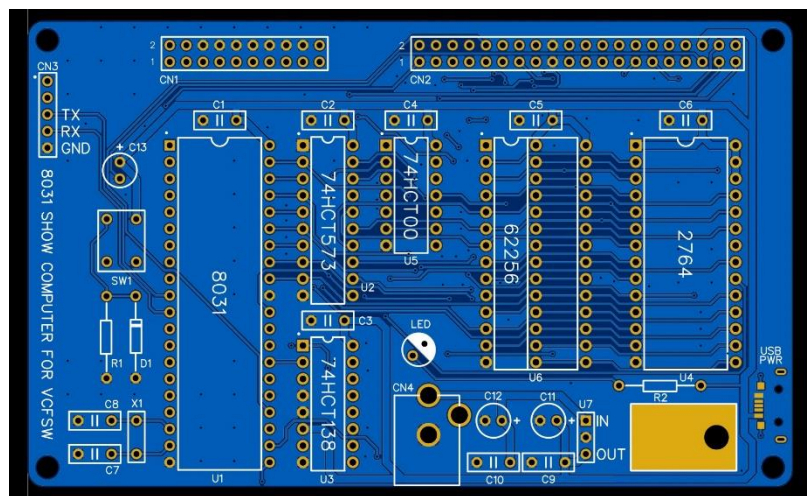


8031-Based Single Board Computer

June 2023



Brought to you by:

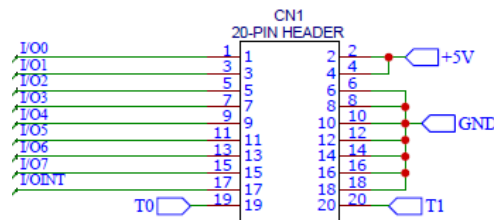


Welcome to the show computer kit for the 2023 Vintage Computer Festival Southwest expo! This PCB was designed for the show with a few goals in mind:

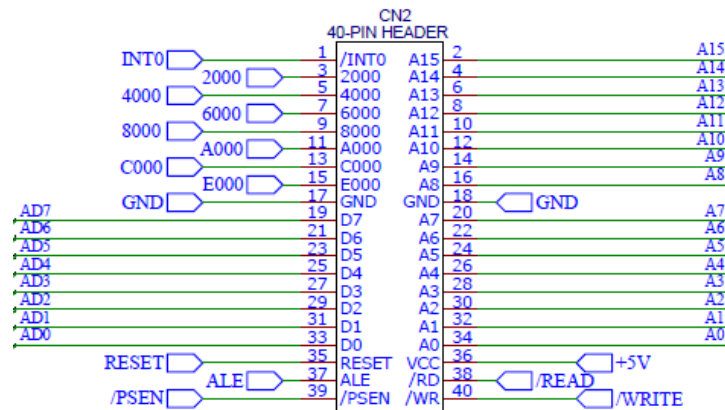
- Use a vintage CPU and easy to find parts
- Reusable parts
- Easy to build: No surface mount parts
- Flexible power requirements
- Easy to program
- Easy to interface
- Expandable

Most of these requirements were easy to meet. The PCB uses a simple 8 to 12v DC, 1A wall wart with a positive center barrel connector, but there was one surface mount connector as an option for those who wanted an alternate power jack to use +5v DC regulated. Using BASIC made it easier to accommodate novice programmers instead of requiring knowledge of assembly or machine code.

The unused pins of the microcontroller were brought out to a 20-pin header, labeled CN1, to make for easy expansion. The pins can do both input and output so their use is limited only by your imagination. Latches can be used to hold outputs at a fixed level, transistors can be used to switch larger loads such as relays, and optoisolators can be used to safely interface to the outside world.



The expansion interface, labeled CN2, uses a 40-pin header and allows for additional circuitry to be connected to the address and data busses. It includes control signals and decoded chip selects at 8K boundaries to simplify interfacing to the microcontroller.



The reusable parts goal was easy to meet with the idea to use what was on-hand and minimize ordering of new parts from distributors such as Mouser and Digi-key. For example, half of the 8031 microcontrollers were from Vegas style slot machines, arcade games, and industrial computers and the rest from eBay. The EPROMs and static RAMs were salvaged from Computer Reset in Dallas and the PCB will take RAMs of either .600" or .300" wide. Much of the rest came from surplus stores in Silicon Valley, a few estate sales, and local stores that closed in the Dallas area such as Tanner Electronics and BG Micro. The tape on the boxes was Fry's Electronics own in-house tape.

I would like to give a shout out to Will Tooker from the DFW Retro Computing group for interpreting my hand-written schematics and doing the board layout. Also, many thanks to the late Joey Carruthers of New Life Games, Bryan Gressett, and Pete Young for the 8031 Microcontrollers supplied for this project, and Bryan Gressett for the power cables that were going to be melted for copper. A special thanks goes to the late Richard Byron and his daughter Noelle Yingling for the amazing place called Computer Reset.

This project will be placed on GitHub after the show for anyone to build. One item I'm going to attempt to add to this computer is a small board with 8K of EPROM and 8K of SRAM to run Camel Forth. It will attach to the 40-pin expansion bus.

Good luck with the build!

Raymond Jett
Owner, Arcadecomponents.com

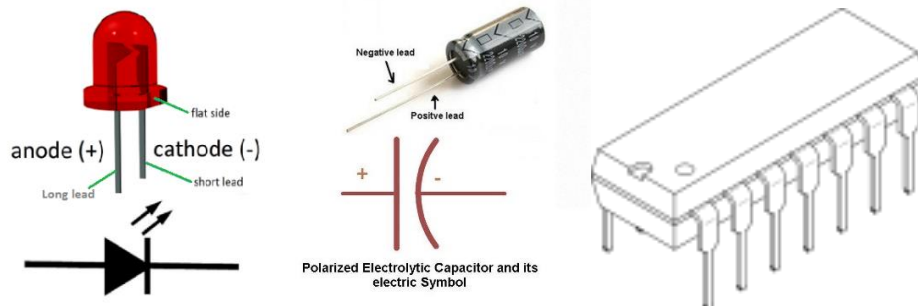
The 8031 kit for the 2023 VCF Southwest show includes the following parts:

- 1 Printed circuit board
- 1 8031 CPU
- 1 Pre-programmed 27C64
 - BASIC-52 version 1.2a
- 1 32K x 8 Static RAM
- 1 74HCT00 Quad NAND Gate
- 1 74HCT138 3-to-8 Decoder
- 1 74HCT573 Octal Latch
- 1 7805 voltage regulator
- 1 40-pin dual-wipe socket
- 2 28-pin dual-wipe sockets
- 1 20-pin dual-wipe socket
- 1 16-pin dual-wipe socket
- 1 14-pin dual-wipe socket
- 8 .1uf monolithic capacitors
- 1 4.7uf electrolytic capacitor
- 2 10uf electrolytic capacitors
- 2 18uf ceramic capacitors
- 1 11.0592MHz crystal
- 1 180 ohm 1/4w resistor
- 1 Red LED
- 1 6mm tactile switch
- 1 82.5K 1/4w resistor
- 1 1N914 / 1N4148 diode
- 1 5.5 x 2.1mm DC Barrel Jack
- 4 2x8 .100 headers
- 1 1x5 .100 header
- 1 9v AC adapter
- 1 M3 screw, washer, and nut
- 1 USB to TTL Serial Adapter

You will need some simple tools to build this computer, including a soldering iron, solder, multimeter, Philips screwdriver, and small diagonal cutters to trim component leads. To fix any mistakes a spring and plunger desoldering tool or desoldering braid can be used, but a desoldering iron will make it easier. Please ensure that your solder matches the capabilities of the soldering iron – use lead or lead-free with an iron designed for it. Don't use lead-free solder with an old iron as it won't provide enough heat to properly solder the components to the PCB. A temperature-regulated iron is preferred and will make the build easier, but the idea behind the kit is to use what you have.

The only software needed for this build will be a terminal emulator program. If you do not have one on your computer, download the free Tera Term program from the OSDN web site at <https://osdn.net/projects/ttssh2/releases/>

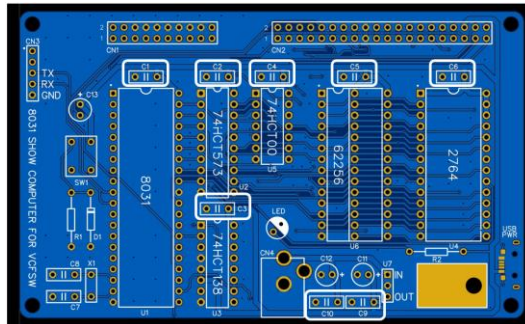
Some of the parts are polarized and must be installed in the circuit in the correct orientation or they may be damaged when power is applied. These parts are the IC chips, electrolytic capacitors, the diode, and the LED. The IC chips will have a notch on one end and both the PCB silkscreen and the socket have those notches. The chip may also have a dot signifying pin 1. Line up the notches and they can be installed correctly. The diode will have a dark band on one end that will also line up with the silkscreen on the PCB. The electrolytic capacitors have two indicators, the first is a longer leg for the positive lead and for the second, the negative lead will be marked on the side of the capacitor. The LED will have a longer leg for the positive lead and a flat side on the plastic base signifying the negative lead.



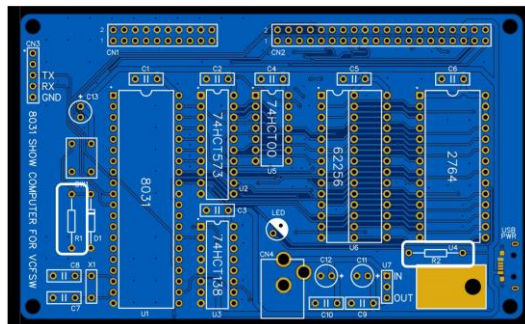
LED image from Circuits DIY. Capacitor image from Instructables.com. IC image from PNGEgg.

All components included in this kit will be installed from the top side of the PCB and soldered on the bottom. Please note that the USB power jack is not included in this kit. If you wish to purchase one, it is made by Tensility, part # 54-00283 and can be ordered from DigiKey.

1. (____) Install the 8 .1uf monolithic capacitors at C1, C2, C3, C4, C5, C6, C9, and C10. Carefully trim the excess leads after soldering. Take care when doing this as the leads can fly across the room when clipped.

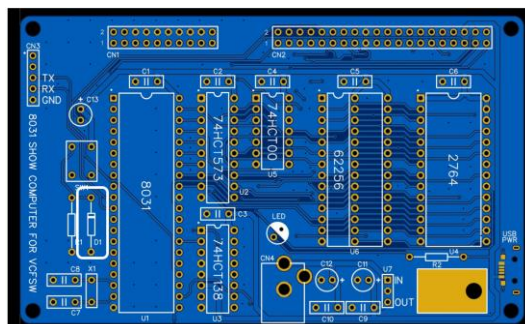


2. (____) Install the 82.5K resistor at R1 and the 180 ohm resistor at R2 and trim the excess leads after soldering.

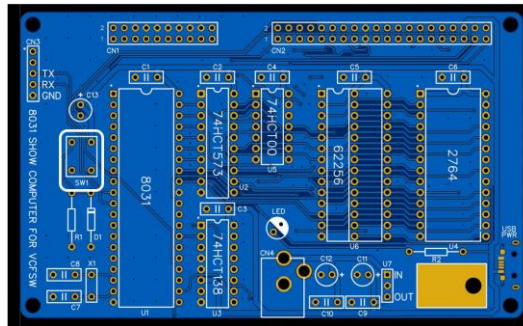


From this point forward, you will not be told to trim the excess leads from components, but this still must be done.

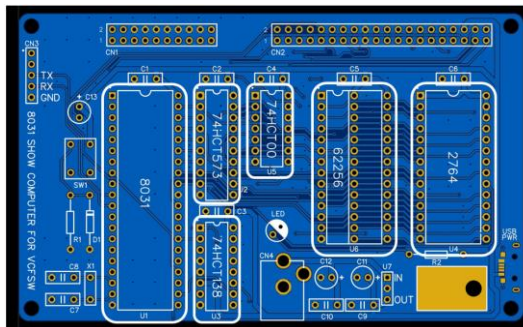
3. (____) Install the 1N914 / 1N4148 diode at location D1. Be sure to install it in the proper orientation.



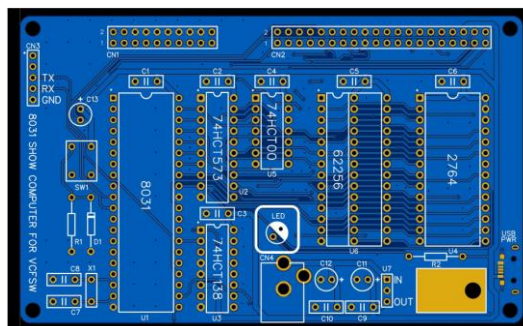
4. (___) Install the snap switch at SW1.



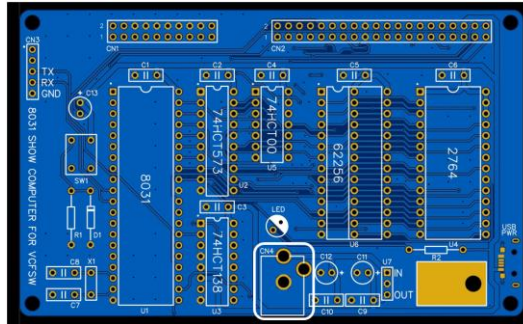
5. (___) Solder in each of the six sockets. Be sure to orient the notch in the end of each socket with the notch on the PCB silk screen.



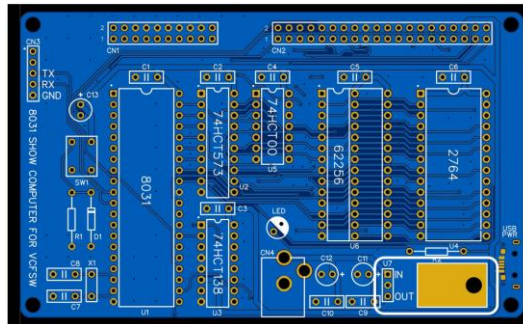
6. (___) Install the LED. The flat side of the base goes towards the solid white part of the silk screen.



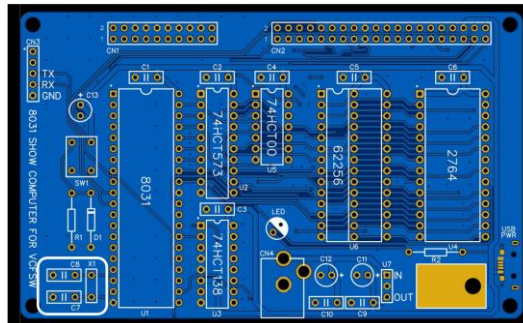
7. (____) Install the DC power jack.



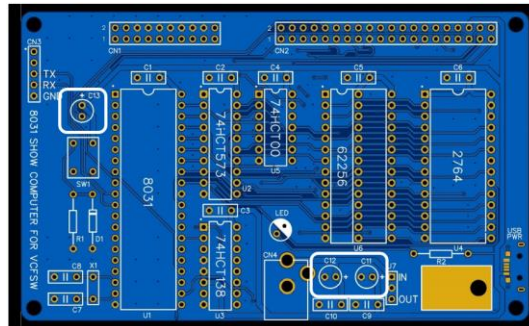
8. (____) Install the 7805 voltage regulator and fasten it to the board. The screw should be installed upwards from the bottom, through the hole in the regulator tab, then the lock washer and nut installed finger tight. There is no need to install heat sink compound for this application.



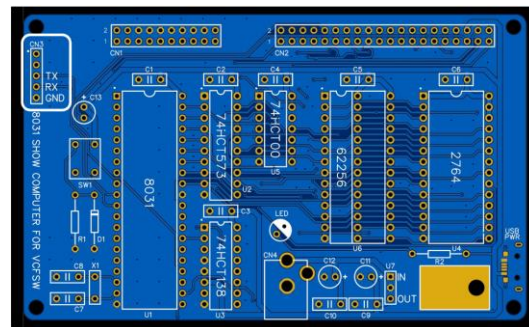
9. (____) Install the 33pf capacitors at C7 and C8. Install the crystal at X1.



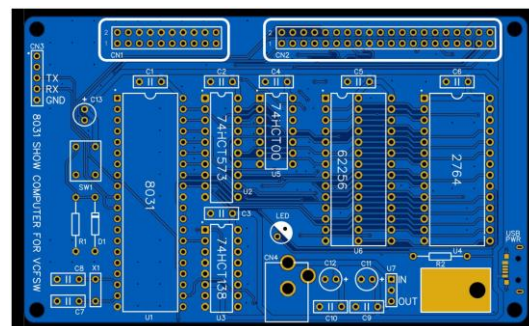
10. (____) Install the 4.7uf capacitor at C13 and the 10uf capacitors at C11 and C12. Note that the capacitors have their – pin marked. The longer leg is the + side and matches to the + on the PCB silkscreen.



11. (____) Install the 1x5 header at CN3.



12. (____) Install the double-row header pins at CN1 and CN2.



The supplied headers are 2x8 and one will need to be trimmed off into a 2x2 and a 4x2 section to finish out the headers. Look closely and there are small lines in the plastic body that mark where they can be cut apart with small diagonal cutters.

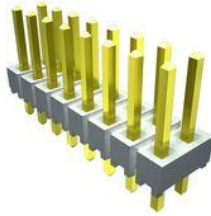


Image from Newark.com

Ensure all the component leads are properly trimmed. Look the board over for solder shorts, poor solder joints, and improperly installed components. Use a multimeter to verify there are no shorts between +5 and ground.

Power up the PCB with the included DC adapter and verify +5v output on the voltage regulator. Power down the PCB and insert the IC chips into their sockets. Some ICs will have legs that bend slightly outward from vertical and may need careful coaxing to plug into the sockets. Be careful to orient them correctly to the notch on the sockets and to not bend the pins on the ICs to where they fold under the chip instead of going into the sockets. Connect the USB to TTL adapter to your computer and use the jumper wires to connect TXD, RXD, and Gnd from the adapter to the pins on CN3 of the 8031 computer. Open your terminal emulator software, choose the serial port of the USB to TTL adapter and set it to 9600 Baud, 8 Bits, No Parity bits, and one stop bit. Connect to the serial port then plug power to the computer you just built and press the space bar. The computer will respond with *MCS-51 (tm) BASIC V1.2a*

If that response is not seen, press the reset button, wait a second, then press the space bar.

At the > prompt, type 'print mtop' (without the quotes, case insensitive) and press <enter>. The computer will respond with 32767, which is the memory top. If you get a different number, please check the soldering work on the 74LS00, 74LS138, 74LS573, SRAM or the EPROM IC.

Next, type 'print xtal' and press <enter>. The computer will respond with 11059200 which is the frequency of the crystal used by the microcontroller.

Now you can enter a simple program.

```
10 FOR X=1 TO 100
20 PRINT "Hi! ",
30 NEXT X
```

RUN the program and it will print four lines of "Hi! Hi! Hi! Hi! Hi! Hi! Hi!
Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi! Hi!
Hi! Hi! Hi!" before returning to the > prompt.

If you wish to copy and paste commands to the 8031 computer, beware that the prompt isn't returned in the same time after each line of BASIC code is entered. Sometimes there

is a slight delay, which can be seen after entering line 10 of the program above. Set a Transmit Delay on the Serial Port Setup of Tera Term for 10msec/char and 1500 msec/line to slow down how fast Tera Term tries to send the data to the computer. Be sure to set that 1500 msec/line setting back down when finished or Tera Term will give you a 1.5 second delay after pressing enter when you are typing commands manually on the computer before you get the next > prompt.

Congratulations! You've successfully built and tested the computer!

Now take a close look at the back of the PCB and see if you can find the hidden [Easter Egg](#).

To learn more about the version of BASIC running on this system, please visit:

http://web.mit.edu/6.121/www/other/basic_man/CH1.html

http://web.mit.edu/6.121/www/other/basic_man/CH2.html

http://web.mit.edu/6.121/www/other/basic_man/CH3.html

http://web.mit.edu/6.121/www/other/basic_man/CH4.html

http://web.mit.edu/6.121/www/other/basic_man/CH5.html

http://web.mit.edu/6.121/www/other/basic_man/CH6.html

http://web.mit.edu/6.121/www/other/basic_man/CH7.html

http://web.mit.edu/6.121/www/other/basic_man/CH8.html