Keyboard Keyer
Builder's Guide

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Here are a few instructions for building your own keyboard keyer. See the tutorial for a full description of this project.

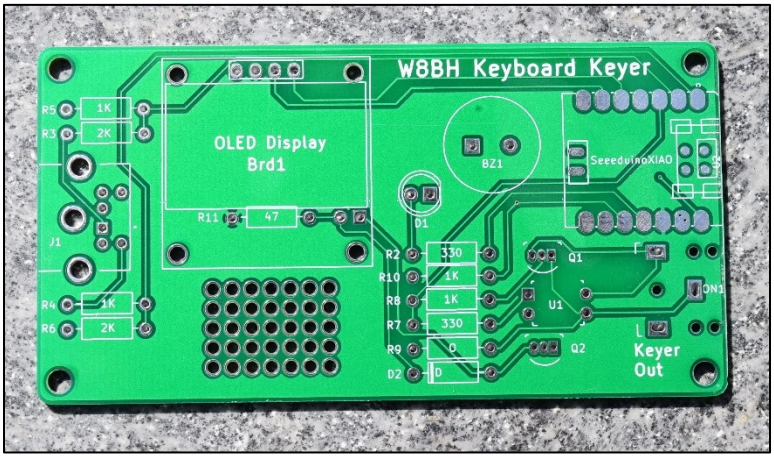
Not a Kit.

Forgive me for starting these notes with a disclaimer: this is not a kit, I am not selling anything, and there is no guarantee of success or suitability for any particular purpose. Still interested?

The PCB.

The first step is to order one or more of the printed circuit boards. To order a circuit board from a manufacturer you must provide a digital set of design files, called 'gerbers'. You can obtain the gerbers on my github account.

Almost all board fabricators' websites allow gerber-file uploads. Choose the manufacturer you like. I've used OSH Park (USA, excellent quality) in the past and have been very satisfied. For this project I used JLCPCB (China, hobby-quality). Choose the default 2-layer options, get your quote, and choose whatever shipping option you want. At JLCPCB I paid $2.00 + shipping for a set of 5 boards.

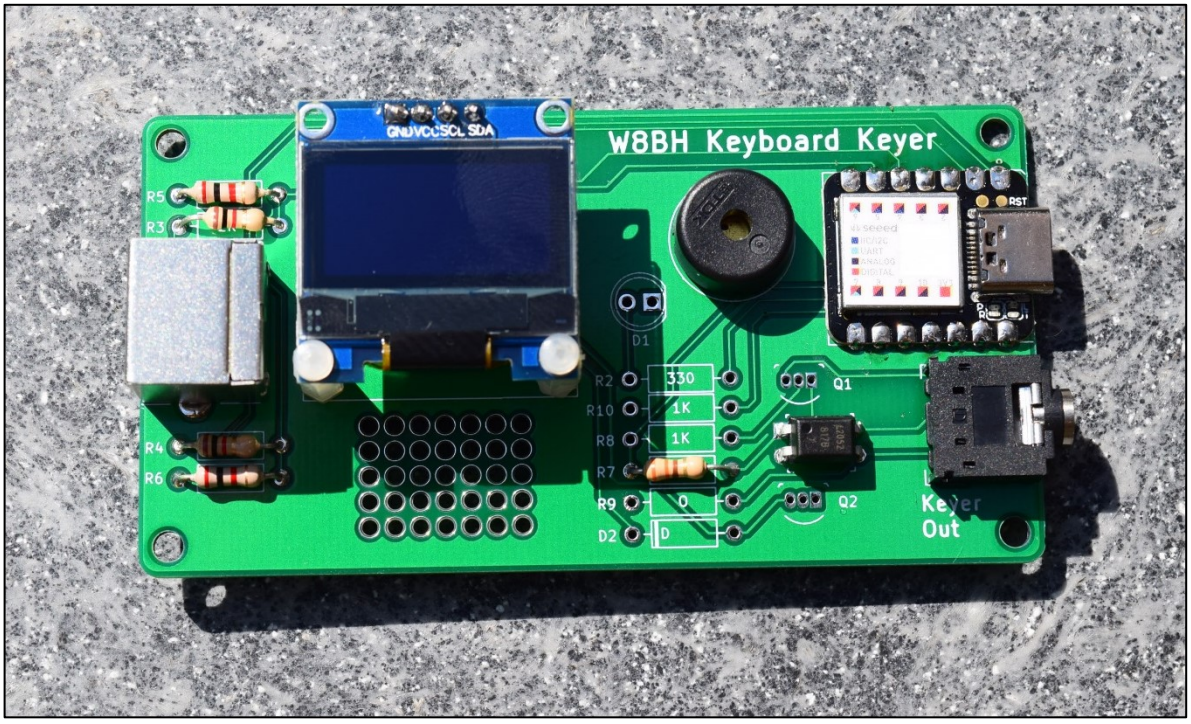


Bill of Materials.

Part	Qty	DigiKey	Amazon	Prices/Other
Seeeduino XIAO	1	1597-102010328-ND	Seeed Studio	$5.40
128x64 OLED Display	1	n/a	HiLetgo, Frienda	$6.40
Mini-DIN-6 PS/2 Jack	1	5749180-1	Leyal	$2.15
SJ1-3523N Audio Jack	1	CP1-3523N-ND	n/a	$0.75
Piezo Speaker	1	445-2525-1-ND	ELDDIY	$0.60
20mm Oval Speaker	1	n/a	uxcell, Fielect, TOTOT	$2.00
LTV-817 photocoupler	1	160-1366-5-ND	n/a	$0.40
2N3904 NPN Transistor	2			
1N4148 Diode	1			
1K Resistor	2			
10K Resistor	2			
20K Resistor	2			
330 ohm Resistor	2			
47 ohm Resistor	1			
Misc: 0.1” male/female headers, LED, USB-C cable, M2 standoff hardware				

The above table lists part numbers and/or links for my favorite sources. These parts should cost you about $20 + shipping. Please review the list of miscellaneous components. Do you have these already? If not, add them to your list. Several of the listed components are optional, so review the build instructions before purchasing.

Here is a completed board, showing component layout. Optional components are not installed.



Step 0: Preparation.

You will need a decent soldering iron, solder, and a voltmeter. You should be familiar with soldering and have successfully kitted other projects using ICs and other through-hole components. You should have sufficient lighting, magnification, and workspace area.

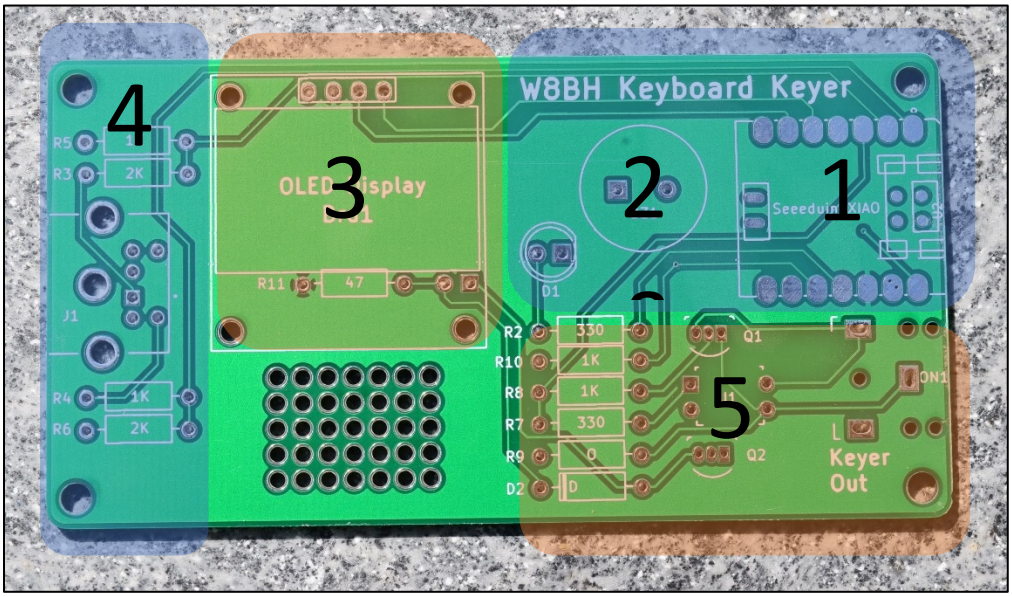
As I mentioned at the start of the series, I believe in starting small. Build the smallest something that you can and test it. Don't forge ahead until you are sure everything is working. In this build we will start with the microcontroller on the right-hand side of the board. We will gradually work our way, right to left, testing as we go.

The following instructions apply only to Rev 2 of the board. If your board does not say "BN41" and "Rev 2" on the back, these aren't the correct instructions for you.

- Review the Keyboard Keyer tutorial. Program your Seeeduino XIAO microcontroller with a current copy of the sketch. Satisfy yourself that the microcontroller is programmed correctly.

- Obtain the PCB and necessary parts.

- Familiarize yourself with the circuit board. The build will be done in 5 steps, starting with the microcontroller (step 1) at top/right. Step 2 is the piezo speaker. Steps 3-5 are the display, keyboard interface, and keyer output circuits, respectively.



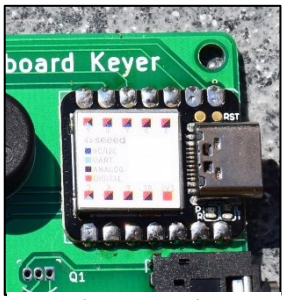
Consider if you are going to enclose the board. The mounting holes are large enough (3 mm) to accommodate M2.5 or 4-40 hardware. If you are facile with 3-D printing this might make a good enclosure project.

Step 1: Install the microcontroller

Decide whether you will solder the microcontroller directly to the board, or use headers. Direct mounting makes for a sturdy and compact installation, but is difficult to undo if your microcontroller goes bad. Header mounting is helpful is you want to breadboard the circuit first, or swap out the microcontroller at a later date.

If you want to try direct mounting, do the following:

- I recommend watching this Sparkfun video before soldering castellated pads. It is a good overview of the process.
- Align the XIAO over its board outline with the USB jack facing right, as shown. Ensure that the PCB pads extend beyond the XIAO pads on both sides.
- Tack one set of pads together with solder.
- Inspect the alignment. Reheat the soldered pad and realign if necessary.
- Solder the remaining pads.



Direct mounting

Alternatively, you may mount the microcontroller using headers:

- Solder male header pins to your microcontroller.
- Prepare two 7-pin lengths of female header.
- Temporarily mate the male and female headers
- Solder a single pin of both female headers to the PCB. Check header alignment.
- Remove the microcontroller and solder the remaining female header pins.

Test #1: Connect the USB-C cable to your microcontroller and briefly apply power. The green power LED should light. After a few seconds, the orange LED should flash dit-dah-dit. If not, refer to the troubleshooting guide. Remove power.

Step 2: Install the piezo element.

- Install the piezo element flush with the PCB. Theoretically, you should install the (+) lead of the piezo in the square pad. But either way works. Some piezo elements are not marked.

- **Test #2:** Connect the USB-C cable and apply power. After a brief pause, the piezo should softly beep dit-dah-dit ('R') in sync with the orange microcontroller LED. If not, refer to troubleshooting guide. Remove power.

Step 3: Install the OLED display.

- Cut a 4-pin length of female header. Solder the female header to the PCB for the OLED display. (Solder one pin, check to make sure header is firmly seated, perpendicular to the board, then solder the remaining pins)

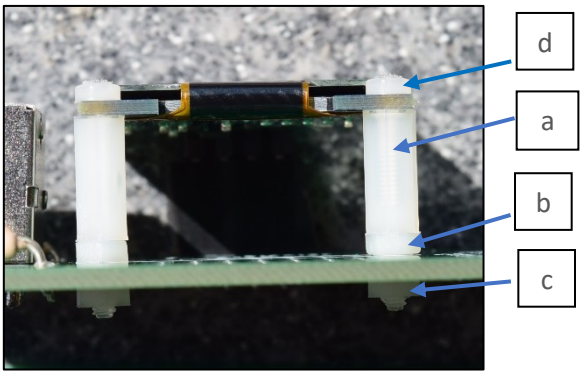
- Cut a 4-pin length of male header, and solder to the OLED display.

- Install the OLED display, mating the male & female headers.

- **Test #3:** Connect the USB-C cable and apply power. After a brief pause, the display should flash "READY", and you should see a horizontal line (status bar) along the top edge of the display. If not, refer to troubleshooting guide before continuing. Remove power.

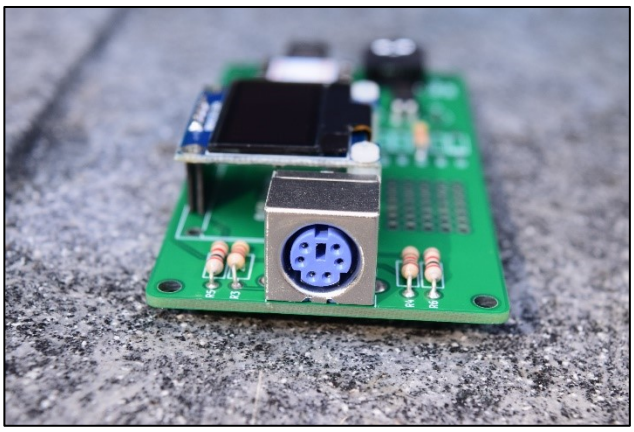
- Secure the display with M2 nylon standoffs using the bottom/left and bottom/right display mounting holes. The side-view photo below shows a suggested arrangement:

  a. Use a 10mm male-female standoff above the PCB. The male end faces the PCB and the female end faces the display.
  b. Place an M2 nut on the male end of standoff, just above PCB, to add 1mm of height to the standoff.
  c. Place an M2 nut below PCB to secure the standoff to the PCB
  d. Use a M2 screw to secure the OLED display to standoff.



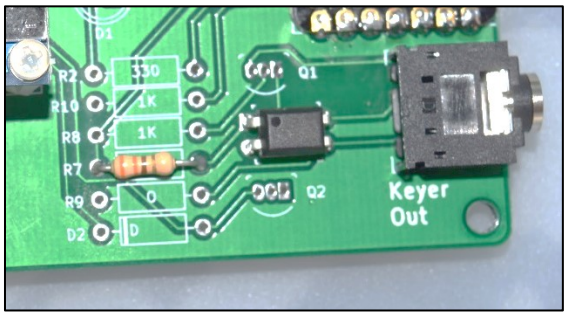
- Congratulate yourself and take a break.

Step 4: Install the keyboard circuit



- This circuit, on the left side of the board, includes a keyboard jack and 4 resistors. Install the keyboard jack first. Solder the large center pin first, confirm that the jack is seated correctly, then solder the remaining pins.
- Solder 10K resistors R3 and R4, which are immediately adjacent to keyboard jack. Note: on rev 2 boards, R3 and R4 are incorrectly labeled as 1K.
- Solder the two outer 20K resistors, R5 and R6. Note: on rev 2 boards, R5 and R6 are incorrectly labeled as 2K.
- **Test #4:** Plug a PS/2 keyboard into the jack. Connect the USB-C cable and apply power. You should again see the same startup sequence (Display flashes 'Ready', piezo softly beeps 'R'). Press 'S' on the keyboard. You should see 'S' appear on the screen and hear dit-dit-dit on the piezo. If not, refer to the troubleshooting guide. Remove power.

Step 5: Install the keyer circuit



- The basic keyer circuit is located in the bottom right portion of the PCB and contains 3 components: the 330-ohm resistor R7, the rectangular photocoupler IC, and the keyer output jack.
- Install the photocoupler, making sure that the round dot (pin 1 marker) on the IC is located in the top/left corner.
- Install R7 and the keyer jack. As before, soldering a single pin/lead first, confirm good part placement, and then soldering the remaining pins/lead.
- **Test #5:**
    - Configure your rig for straight key input such that the cable tip is (+) and the cable shield is ground.
    - Make sure the CW side-tone audio is enabled and transmitter output is disabled
    - Briefly short the cable tip and shield. Did you hear the side-tone? If not, recheck your rig configuration before proceeding.
    - Connect the cable from the rig to the keyer hack, and reconnect the PS/2 keyboard.

- Connect the USB-C cable and apply power.
- Tap ‘S’ on the PS/2 keyboard. Did your rig key? If not, refer to the troubleshooting guide.

Done. Your keyboard keyer is now complete! Refer to the User’s guide to explore its features.

There are 4 optional circuits which can be fitted on this board. They are not required for any keyer functionality.

Optional #1: LED OUTPUT

Components needed for this option: 5mm LED D1, 300-ohm resistor R2.

Install this option if you’d like to flash an LED in sync with your Morse Code output. It’s optional because the microcontroller already has a Morse LED onboard. However, if you want to add more flash, it’s there for you. Choose any 5mm LED you like, keeping in mind that a bright LED near the display could be distracting. You may remote the LED if you are putting this project in an enclosure. You can also use the anode side of the LED footprint for an extra digital output. The LED feature can be turned on/off in software.

On rev 1 boards, after installing D1 and R2, solder a clipped lead on the back of the PCB from the square hole (cathode) of D1 to the round hole (GND) of the piezo.

Option #2: SPEAKER OUTPUT

Components needed for this option: 20-30 mm oval speaker, 1n4148 diode D2, 47-ohm resistor R11, 1K resistor R10, 2N3904 transistor Q2. If you don’t have a 2N3904 handy, a 2N2222 or similar NPN transistor with an EBC pinout will do.

20mm oval speaker

The sound from the piezo speaker is quiet and tinny, and provides minimal audio feedback. I think most hams would prefer the pleasant-sounding side-tone of their own rig. But if you want better onboard audio – maybe you want to use this keyer for code practice – this option is for you. It does not provide room-filling audio. It will increase the keyer sound from “Did you hear anything?” to “OK, I can hear it now”.

Install D2 and R10 in the spaces provided. Make sure that the black band on the diode is facing to the left. Next, install Q2, with the flat side of the transistor facing away towards the top of the board. Now,

temporarily remove the display. Install R11. Position the speaker over the grid of holes, and solder the leads in the two holes to the left of R11 (on the rear face of the PCB these holes are marked "J2". Solder the red speaker lead in the round hole. Experiment with speaker position. Try placing the speaker on the front face of the PCB or the back, or off-center, to see what position gives the best sound. When you are satisfied with the position, carefully remove the thin rim of plastic on the speaker, exposing the adhesive, and gently press the speaker into position.

If you want more sound, consider routing the signal from the left side of R10 to an external amplifier. The signal is a raw 3.3V square wave, so some RC filtering might be helpful.

Option #3: ALTERNATE KEYER CIRCUIT

Components required for this option: 1K resistor R8, 2N3904 transistor Q1.

Personally, I like the photocoupler circuit and that's what I use. But if you want to save a few pennies and use a junk-box NPN transistor instead, this option is for you. **Important note: do <u>not</u> install this option AND the photocoupler circuit. It's one or the other, not both.**

Install 1K resistor R8 and save one of the leads. When you are installing R8, make sure that the slot for the photocoupler resistor R7, just below it, is empty. Install transistor Q1 with the flat side facing the top of the board. Finally, use the resistor lead as a 0-ohm jumper in the space for R9. The R9 jumper connects the ground lead of your rig to the ground plane of the PCB.

Option #4: 5V INPUT

Components required for this option: 1N4007 diode D3

Install the reverse-polarity protection diode D3, located under the OLED display. Apply 5V power to the adjacent pin marked "+5V pin" and "GND". Do NOT apply power via the USB connector when using this option.

Troubleshooting

If you followed the step-by-step approach above you will have an idea of WHERE the problem is. Here are a few follow-up suggestions to isolate the problem further.

Problem	Suggestions
Test 1: The microcontroller orange LED doesn't flash	a) Make sure that your USB-C cable is supplying power. The green LED on the micro should be lit – indicating power. If not, check your power source. b) With the unit powered on, carefully check the microcontroller 5V and 3V3 pins for proper voltage. c) Download and re-run the blink sketch.
Test 2: No piezo output	a) Listen again carefully: it's pretty quiet! b) Check your microcontroller soldering, especially the pad D9. c) With a voltmeter, check continuity between pad D9 and the square pin of the piezo. d) Download the diagnostic sketch"test_audio" from GitHub and run it. Prove D9 with a voltmeter or oscilloscope. If signal present, check for same at square pad of the piezo.
Test 3: No OLED display	a) Remove and reseat the display to see if it is a poor connection. b) Check all of the microcontroller and display solder joints with good light and magnification. c) Carefully check the voltage between the first and second display pins (marked "GND" and "VCC" on the display. You should see 3.3V d) With keyer unpowered, use voltmeter to check continuity between pin 3 of display (marked SCL") and microcontroller pad D5. Also, display pin 4 "SDA" and pad D4. e) Download the diagnostic sketch "test_display" from GitHub and run it.
Test 4: No Keyboard response.	a) Reseat the keyboard plug into the jack and try again. b) With the keyboard plugged in, remove and then re-apply power to the keyer. Most PS/2 keyboards will briefly flash their caps lock and num lock LEDs to indicate a power-on condition. c) Using a voltmeter, check for +5V between keyboard jack pins 3 & 4. These are the outside pins in the row of 4. d) With the keyer unpowered, check the keyboard clock line. There should be 10K resistance between keyboard jack pin 5 and microcontroller pin D0. Also, check the keyboard data line: 10K between jack pin 1 and microcontroller pin D1. e) Use an oscilloscope to probe the keyboard clock and data lines, as described in the tutorial.

Test 5: The keyer seems to be working but the rig does not key.	a) Recheck your rig settings: straight key input on cable tip. Plug the cable into rig and confirm that the rig keys when shorting cable tip and sleeve. b) With keyer unpowered, connect keyer to rig and briefly short across photocoupler pins 3 and 4. Rig should key, verifying the keyer jack. c) With keyer powered, briefly apply 3.3V from display pin 2 to left side of R7. Rig should key, verifying the photocoupler. d) Download diagnostic sketch “test_keyer” from GitHub and run it. It should send a string of dits to the keyer.