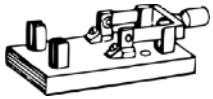
# 8-bit Workbench™ ED

# Assembly Instructions



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Make sure your kit is complete with all the loose parts, *see* the Bill of Materials.

The tiny parts are pre-soldered on the main printed circuit board (PCB), these are marked with an ‘A’ on the bill. **Do not touch** the microprocessor marked with ‘U1’ - the black rectangular box - as electrostatic discharges can damage it.

The smaller PCB is the front panel for the Binary Keyboard, it will hold the eight toggle switches firmly. Let’s proceed if all is there!

## Tools Needed

Assemble the kit at a solid desk and make sure there is enough lighting.

Prepare the following:

- Soldering **mat** (or a cutting mat) to protect the desk and your work.
- A temperature controlled soldering **iron** or station, at least 40W is recommended, 70W is even better. A bigger than standard tip (like Weller ET-D, 0.8 x 4.75 mm) is handy to solder the bigger pads of the toggle switches. Use a regular, small screwdriver shaped tip for the rest (e.g. Weller ET-A, 1.6 mm).
- **Solder**. For best results use a bigger diameter (like 1.5 mm) together with the big tip and a small diameter (like 0.7 mm) with the small tip. Use a temperature of about 335 °C when the ‘old’ leaded solder is being used. For lead-free solder, use a higher temperature setting of about 350 - 400 °C.
- Small **wire cutter** to cut the exceeding length of the soldered LED leads. Make sure to always reheat the solder once more after cutting. **Watch out:** hold the metal legs while cutting as they can jump away and cause damage.
- If *red* switches came with the kit, a **small flat screwdriver** (like a ‘watchmaker’) can be handy as well.

# Soldering Steps

This is not meant to be a soldering lesson for a starter. Solder tips are given, but please refer to online soldering tutorials to first learn the basics (*see* YouTube).

Follow these steps to assemble the kit:

1. Start with the *small* solder tip (smaller solder). Put in the **small sliding switch** (SW12) at the top: the *Power* switch. Solder one pin first, then melt the soldered pin again while pushing the switch all the way down in position. **Watch out:** the metal of the switch can get hot! Continue soldering all pins when it sits straight.
2. Now, the board's basic function can be tested before soldering further. Connect it to USB-C power, turn it on and see if the three green LEDs next to *Decimal*, *Hex* and *Octal* light up in sequence. Then test the *Mode* button and see if the active green LED changes. If this works, all is well and the processor is running. Disconnect power and proceed.

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3. Solder the other **small sliding switch** (SW9) at the bottom left corner: the *Flip the Bits* switch.
4. Put in the 3 **displays** (DS1, DS2, DS3), make sure their 'dot' is pointing to the bottom right corner. Solder two opposite pins only. Reheat the solder and press the displays all the way down. Make sure all three displays sit nice and straight, then (re-)solder all the pins.
5. Insert the 8 red **LEDs** (D2-D9). Notice the base of the LED is not a full circle, but has a flat edge. This edge (cathode side, short leg) should match the outline on the board.

   Solder *one leg* of all 8 LEDs first. Then melt the solder of the leg while pushing the LED all the way down. Repeat for all. Cut all the legs (unsoldered ones included) if the LEDs are sitting all straight. Then solder the remaining cut-short legs and re-solder the ones already done.

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6. Do not need battery power? Jump to step 7.

   The battery connector (J2, J3) has strain relief holes. The wires of the **9-volt battery clip** should be inserted through these holes from the back. At the front, their stripped tips should go in the pads with the + (red wire) and - (black wire) markings. Soldering is done at the back again, use plenty of solder. Then, the wires can be pulled from the back gently until they lay flat on the top of the board.

 

The two angled **pin headers** (J4, J5) act as a *cable reel* for the battery clip. Place them at the back side and solder them at both sides of the board. Use the provided **jumper** as a guide to align the header while soldering. Pin header J4 is 'adjustable', so solder it at one of the three positions that matches the cable length of the clip.

Important: before battery power can actually be used, a **solder jumper** (JP3) has to be shorted with a nice blob of solder (back side of the board). Just heat the two pads, add enough solder until one blob forms and both pads are connected.

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7. Mount the 4 *short* (8 mm) **standoffs** with 4 **nuts** at the corners of the board. The 2 *long* (12 mm) standoffs are fixed by the 2 **bolts**: hold the bolt with a finger on the back side while tightening the standoff.
8. Remove all metal nuts and rings from the 8 **toggle switches**. Put the switches in and make sure they are all oriented the same way (i.e. the notch in the threading points to the bottom edge of the board). Wiggle a bit to have them seated, when needed. In case of *blue* switches: leave 6 washers on (not for the middle two). For *red* switches: leave 1 nut on each and turn it all the way down. Do not solder them in yet.
9. Put on the **front panel** and tighten the remaining 2 black **nuts** securely on the *long* standoffs. For *red* switches: use the small flat screwdriver to tighten the metal nut of the switches upwards. Let them touch the front panel at the bottom side. Make sure the front panel stays horizontal, do not tighten them too much.
10. Solder the yellow **LED** (D1). Keep the legs long, they go through both the front panel and main board at the bottom. Solder them on the bottom board and on the front panel as well. The long leg is the anode (+) and the short leg the cathode (-, goes through the square pad).
11. Two **solder jumpers** (JP4, JP5) have to be bridged. Just heat the two adjacent pads, add enough solder until one blob forms and both pads are connected. Repeat for both jumpers.
12. Change to the *big* solder tip (bigger solder). When the 8 **toggle switches** are seated properly (washers or nuts are below the front panel), solder them all at the bottom. Then, screw on a final metal **nut** (1 per switch, without rings) at the top side of the front panel and tighten them by hand.

**HAPPY TOGGLING !**

 

# Theory of Operation

*See* the Schematics.

The board operates at 5V, directly from USB-C or powered from a battery source. A voltage range of 6.5V to 12V is supported. It uses max. 125 mA (or 50 mA on average). The ‘higher’ voltage is regulated down by the **voltage regulator** (U2). It is accompanied by a few condensators to smooth out the power supply (the tiny yellow boxes).

At the core of the workbench there is a **PIC microcontroller** (U1), the little black rectangle with 28 shiny legs. This little computer runs at 4 MHz and has a small memory of around 2 KB. It comes pre-programmed to let the board operate as it should.

The eight **toggle switches** (SW1-SW8) are direct input to the microcontroller. It calculates the output (value to be displayed) depending on the active *Mode* and based on the value (0 or 5V) of the switches. The red **LEDs** (D2-D9) show this value as well.

Three **digits** (DS1-DS3) are driven by the microcontroller in fast succession, each digit emits light for 5 milliseconds only. Three **transistors** (Q1-Q3) are used in this design to have more power available. It seems all digits are ‘on’ all the time as this oscillation happens too quick for the human eye. If you want to see it, take a few pictures with your phone.

**Also *see* the Operation Manual.**

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