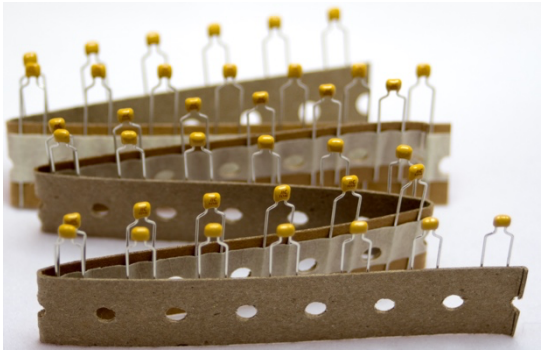
Assembly and testing

How to build your gigatron

Excerpted and adapted from the Gigatron Assembly Manual / User Manual
https://gigatron.io/media/Gigatron-manual.pdf

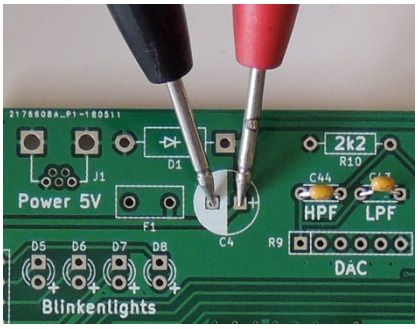
This chapter explains how to build the kit, part by part. Before building, make sure that you know how to solder (see chapter 4) and have checked that you have all the components (chapter 3). There's quite a lot of components, but don't be intimidated, we will be soldering them part by part. Building the gigatron will take about 3 to 4 hours. As an alternative to using this chapter as assembly guide, the video instructions at https://gigatron.io/build can be used.



1. To practice with soldering, we start by soldering **40 ceramic 100nF capacitors**, marked C5 through C44. There are at least 40 provided in the kit. Do not confuse them with the three 47pF capacitors. Only put in from C5 upwards, we will deal with C1 up to C4 later. C5 is located on the top, just below "Video Out", the rest is approximately clockwise on the board.

This is also a good time to remind you that the components are all placed on the printed side of the board (the front). The outline of the components is printed on the board to help you orient them correctly. The soldering is done on the backside!

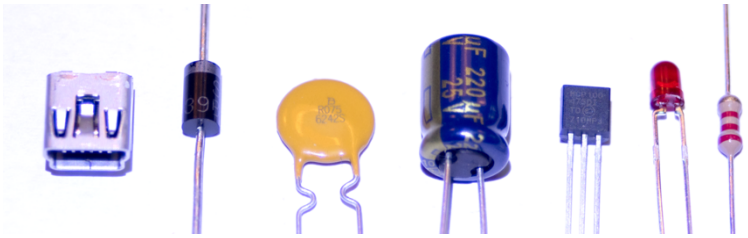
Another thing that is good to know, is that some pins will be easy to solder, whereas others seem to take more effort or time to heat up. This is due to the fact that sometimes, a pin has a single trace to another components and in other cases, the pin connects to the ground plane. This means there is a large metal surface connected to the pin, which causes the heat from your soldering iron to dissipate more quickly. So it is to be expected that the time it takes for the solder to melt differs for every solder joint.

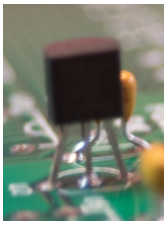


After the capacitors are soldered in, cut away all the excess wire. (This is necessary for the resistors, capacitors, LEDs, crystal, multi-fuse, diodes and supervisory circuit.)

Check that there is no short circuit, by measuring the resistance between the +5V and Ground. One place to find these is by connecting to the two pins of C4 (which is not yet soldered in) on the top left. There should be infinite resistance. Some multimeters will measure a value in the MΩ-range.

2. Now we are going to solder the power circuitry. Needed are the **USB connector** (J1), **zener diode** (D1), **multi-fuse** (F1), **220µF capacitor** (C4), the **supervisory circuit** (U2), **one LED** (D2) and **one 2k2 resistor** (R3, color code red-red-red).





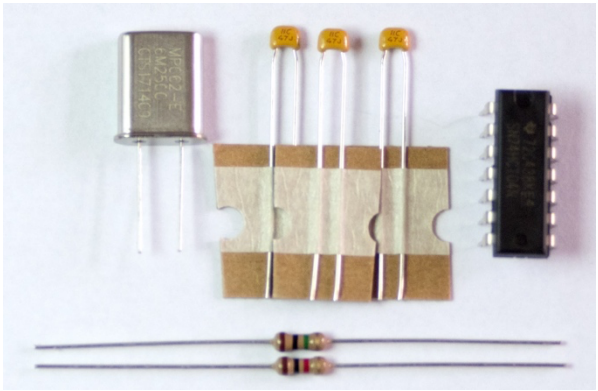
The USB connector has the smallest pins of all the components on the board, but there are only two to solder. Two large pins hold the connector firmly in place, the two small ones provide power. Three small pins are not soldered - they are for data connections we do not use. Make sure the zener diode, capacitor, supervisory circuit and LED are in the correct orientation. The zener diode has a stripe that is also printed on the board. The capacitor has a side that is marked with minus symbols, this should match the white side on the board. The supervisory circuit has its flat side to the right. Do not push it all the way down onto the board, let it sit 5-7mm (0.25") above the board. The LED has one round pad and one square pad. The long pin goes into the round pad marked '+', the short pin in the square pad.

You can now connect USB power to the gigatron. The LED should light up. If not, or if it is blinking, the most likely problem is that the power supply does not provide sufficient power. Please try another power supply. Also, check all the soldering.

It is good to know that the gigatron works on a voltage that is safe to humans, so nothing can go wrong if you accidentally touch (the components on) the board. Also, we have done our best to make the gigatron electrically safe: the zener diode and multi-fuse are included to prevent damage to the gigatron or the power supply in case of e.g. a short circuit or an excessive input voltage.

Always remove the USB power when commencing soldering again.

3. Next, we will be building the clock circuit that provides the timing signals for all the components (marked 'Clock Generator' on the board). Needed are the **crystal** (Y1), **three 47pF capacitors** (C1-C3), a **1MΩ resistor** (R1, color code brown-black-green), a **1kΩ resistor** (R2, color code brown-black-red) and a **74HCT04 chip**.

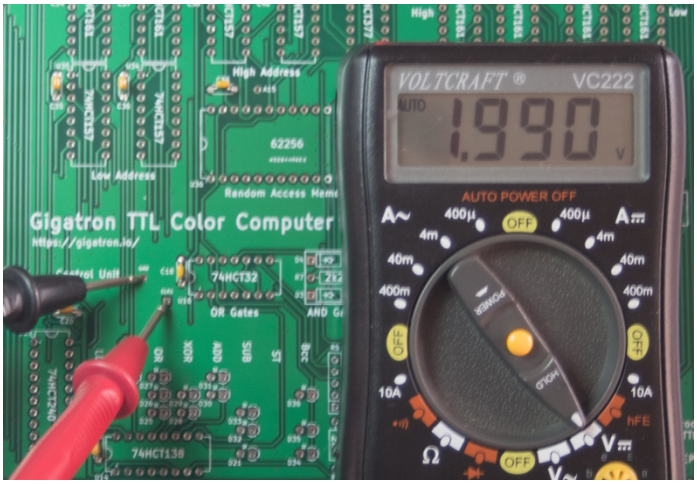


Apart from the chip, all components can be soldered in either orientation. See chapter 4 for more information about how to bend the pins of the IC to get it to fit into the board. If you solder it the wrong way around, cut the pins and remove them one by one, and request a new IC from us. In our experience, trying to get out the IC in one piece often results in damage to the board. This is true for all the IC's you are about to solder.

When done, the clock circuit should be working. The clock signal is a pulse. When using a volt meter, we can measure the average voltage of the pulse. When you are done soldering, turn on the board by plugging in the USB cable. If you look on the board below the large text "Gigatron TTL microcomputer", just to the right of the text "Control Unit", you will find two test pads. They are marked "GND" and "CLK1". Connect a Volt meter to these test pads. You should see a voltage of between 1.5 and 2.5 volts or -1.5 and -2.5 volts, if you swapped the two probes. This is because the

voltage is alternating between 0 and 5 volts. If you do see a voltage between 1.5 and 2.5 volts, your clock circuit is working!

If this is not the case, check all the soldering and check if the IC is in the correct orientation and repeat the test with the multimeter until it works.

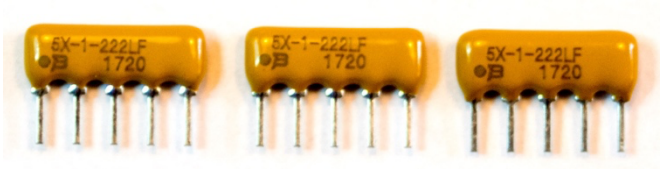


4. When you've gotten this far, you are ready to solder in all the ICs. First, solder the 28- pin socket on U36 (Random Access Memory) and the 40-pin socket on U7 (Program Memory), with the notch on the left. It could be that your kit has the RAM and/or EPROM already put into the socket. If this is the case, leave the ICs in their sockets and solder the combination into the PCB. Then, solder all the remaining ICs on the board, with the notch on the left or top as shown on the PCB. Mind the orientation, it is hard to desolder ICs without damaging the board. In the unfortunate case of a ending up with a wrongly soldered IC, it can be better to cut it loose and replace it with a new one. For reference, here is a list of what IC goes where:

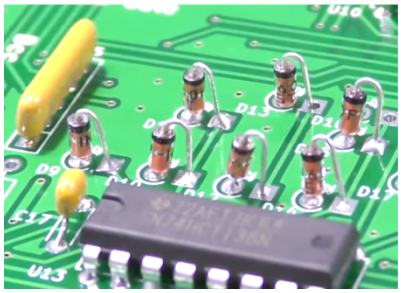
U1	74HCT04	Clock Generator	U21	74HCT153	ALU Bit 0
U2	MCP100	Supervisory Circuit	U22	74HCT153	ALU Bit 1
U3	74HCT161	Program Counter	U23	74HCT153	ALU Bit 2
U4	74HCT161	Program Counter	U24	74HCT153	ALU Bit 3
U5	74HCT161	Program Counter	U25	74HCT283	Adder
U6	74HCT161	Program Counter	U26	74HCT283	Adder
U7	40 pin socket	Program Memory	U27	74HCT377	Accumulator
U8	74HCT273	Instruction Register	U28	74HCT244	Bus Buffer
U9	74HCT273	Data Register	U29	74HCT161	X Register
U10	74HCT244	Bus Buffer	U30	74HCT161	X Register
U11	74HCT139	Bus Decoder	U31	74HCT377	Y Register
U12	74HCT153	Condition Decoder	U32	74HCT157	High Address
U13	74HCT138	Adress Mode Decoder	U33	74HCT157	High Address
U14	74HCT138	Instruction Decoder	U34	74HCT157	Low Address
U15	74HCT240	Inverters	U35	74HCT157	Low Address
U16	74HCT32	OR gates	U36	28 pin socket	Random Access Mem
U17	74HCT153	ALU Bit 4	U37	74HCT377	Output Register
U18	74HCT153	ALU Bit 5	U38	74HCT273	Extended Output
U19	74HCT153	ALU Bit 6	U39	74HC595	Input
U20	74HCT153	ALU Bit 7			

You have already soldered U1 and U2 on the board in the previous steps.

After every few ICs, do an inspection to see if adjacent pins are not soldered together and the ICs are in the right orientation. After you are done, you can power the board via USB. The "Power OK" LED should be on.



5. Next, solder on the **three resistor arrays** (R4, R5 and R8). Make sure pin 1 for each of these is in the correct spot. The PCB has a marking, the resistor array as well: a small dot near the pin. Solder in the remaining **four LEDs** (D5~D8). The long pin goes into the hole marked '+'. If you power up the board, some or all of these LEDs will light up, as will the power LED.

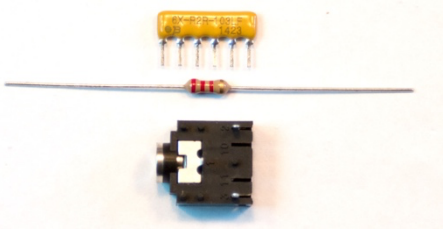


6. Now we are going to build the gigatron instruction decoder using the diodes. You will need **30 diodes** (D3, D4 and D9 up to D36) and **two 2k2 resistors** (R6 and R7, color code red-red-red). The diodes D3 and D4 lay flat. The stripe on the diode should match the marking on the board. Diodes D9~D36 are standing up. So for these, only bend the pin on the side that has the black ring. That pin goes into the square padded hole, the other in the round padded hole. In short: the diodes are on the left with the black ring on top, the wires are on the right.

7. Insert the **62256 RAM and 27C1024 EPROM ICs** (U36 and U7) into their sockets, if they are not already in there. Do this very carefully: if you push on the IC when the pin is not willing to slip into the hole, it will bend or break. But also, once you are absolutely sure all pins have slipped in and will move further down, press firmly so the ICs sit tight. Apply power. Now, the LEDs on the top left of the board should move in a test pattern, going back and forth. Congratulations! The gigatron is now running code!

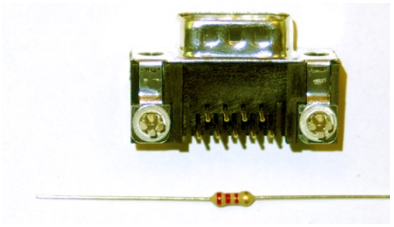
If the "Power OK" LED is off or blinking, the most likely problem is that the power supply does not provide sufficient power. Please try another power supply.

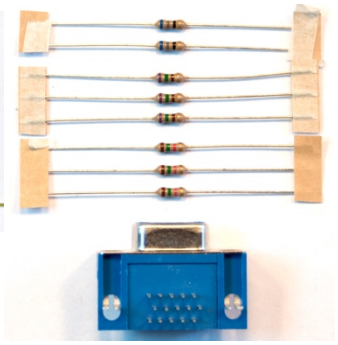
If you still do not get the LED pattern, the problem most probably lies with the soldering. Check all the solder joints. Make sure there is a good bond between the pin and the PCB. Check that there are no shorts caused by solder overflowing to another pin. You can use a magnifying glass or the camera in your smartphone to carefully check all the solder joints. Resolder where necessary and try again.



8. To do something more useful than flashing LEDs, all that is left is connecting inputs and outputs. For the audio output, solder in the 6-pin **resistor array** (R9) with the dot matching the square hole, **one 2k2 resistor** (R10, color code red-red-red) and the **3.5" jack plug connector** (J2). Depending on the kind of connector that is supplied in the kit, you might need to solder three or five pins. The large pins are not connected but are soldered to firmly connect the connector to the PCB. There is no difference in functionality between the two variants. The audio connector might not lay completely flat on the PCB. That is no problem.

9. For the game controller, only **one 2k2 resistor** (R19, color code red-red-red) and the **9-pin connector** (J4) are needed. For more sturdiness, solder the clips as well.





10. We conclude with the VGA output. Use **two 68Ω resistors** for sync (R17 and R18, color code blue-grey-black). Use **three 750Ω resistors** for each of the high bits of the six bit RGB output (R12, R14 and R16, color code purple-green-brown) and **three 1k5 resistors** for the low bits (R11, R13 and R15, color code brown-green-red). Solder in the **15-pin VGA connector** (J3) including the clips.

11. Connect a VGA-compatible monitor to the VGA connector, apply power and your gigatron should display the start screen! You could also use an HDMI monitor, if you have an (active) VGA-to-HDMI adapter. With some VGA-to-HDMI adapters, the edges of the screen will not be shown.

The gigatron comes with pre-programmed software contained in an EPROM memory module. Therefore, to get a working microcomputer, only the hardware assembly is necessary. There is no need to program it or load external software. Every time you turn on the gigatron, it will run the program that we pre-programmed into the EPROM.

If you do not get the start screen, the problem most probably lies with the soldering. Check all the solder joints. Make sure there is a good bond between the pin and the PCB. Check that there are no shorts because the solder is overflowing to another pin. You can use a loupe or the camera in your smartphone to carefully check all the solder joints. Resolder where necessary and try again.

If you cannot get the system to work, check https://gigatron.io/diagnostics for diagnostics or consult the forum at https://forum.gigatron.io/ If that does not help, contact support@gigatron.io.