Altair-Duino Assembly & Operations

Up-to-date instructions are always available at www.altairduiuno.com/instructions. **Be sure to check this page before starting construction for addendums.**

I would strongly suggest comparing the parts you received with the list below. Let me know if you are missing anything and I will send a replacement. (It will not be unusual to have a few extra minor parts, like resistors/LEDs/transistors.)

PARTS LIST

- 1 x PC board
- 36 x 5mm red LED
- 36 x 12mm LED standoff
- 36 x NPN transistor
- 36 x 1kΩ resistor
- 36 x 10kΩ resistor
- 17 x Mini toggle on-off
- 8 x Mini toggle (on)-off-(on)
- 1 x 470Ω resistor
- 1 x 47µF capacitor
- 2 x 1kΩ resistor
- 2 x 0.1µF capacitor
- 1 x Dual pin header
- 2 x Single pin header
- 1 x 6 Pin female header
- 1 x USB cable
- 4 x 10mm nylon bolts
- 1 x USB panel jack/extension
- 2 x 8mm steel screws
- 1 x 9v power supply
- 1 x Pre-programmed Arduino Due
- 1 x Front panel
- 1 x "Altair 8800" metallic sticker
- 1 x 256mb micro SD card

If you have the "low profile" case Standard version:

- 1 x Bluetooth module
- 1 x Micro SD module

- 1 x Add-on circuit board
- 1 x MAX3232 IC
- 16-pin DIP socket
- 1 x DB9 connector
- 14-pin 90 degree male header
- 1 x DC Power jack
- 4 x 15mm M-F standoff
- 4 x 20mm F-F standoff
- 1 x 3.5mm Audio jack
- 5 x 100nF (104) capacitors
- 1 x Acrylic frame
- 1 x Clear acrylic back
- 1 x Laser-cut rear panel
- 4 x 8mm steel screws
- 4 x 14mm steel screws
- 4 x square steel nuts
- 3 x jumpers

If you have the full case Pro version with I/O expansion kit:

- 1 x PC Board
- 1 x 16 pin DIP socket
- 1 x 28 pin DIP socket
- 1 x VGA connector
- 1 x DB9 connector
- 1 x 3.5mm audio jack
- 1 x Micro SD module
- 1 x DC power jack
- 1 x USB-A connector
- 2 x 4.7kΩ resistors
- 1 x 220Ω resistor
- 1 x 150Ω resistor
- 1 x 100kΩ resistor
- 1 x 82Ω resistor
- 1 x 470Ω resistor
- 2 x 27pF capacitors
- 7 x 100nF capacitors
- 3 x 10uF capacitors
- 1 x 5mm red LED
- 1 x 8Mhz crystal
- 1 x MCP-1700 regulator
- 1 x MAX3232 IC
- 1 x PIC32 IC
- 1 x Dual pin header
- 1 x Single pin header
- 8 x Jumpers
- 4 x Rubber feet
- 4 x 15mm M-F standoffs
- 8 x 8mm M-F standoffs
- 8 x Nylon nuts
- 4 x 6mm nylon bolts
- 14 pin (2x7) ribbon cable
- 1 x Laser-cut rear panel
- 11 x 14mm steel screws
- 11 x square steel nuts
- 19 x 8mm steel screws
- 19 x Hex steel nuts
- 12 x acrylic pieces (blue & gray)

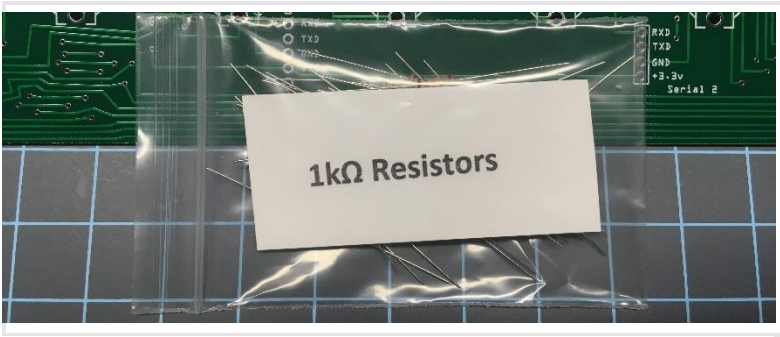
OTHER PARTS YOU MAY NEED

- Soldering Iron with a nice fine tip
- Good Solder (I recommend Alpha Fry Rosin Core 0.032")
- De-soldering Iron (optional)
- Phillips Screwdriver
- Needle-nose Pliers
- Side Cutters (Nippers)
- Computer

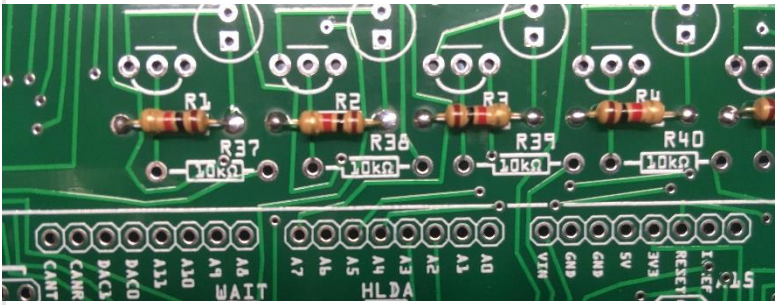
A word about soldering: Do not underestimate the need for good solder and a good soldering iron. Most problems I've seen people have with this kit are caused by cold joints or insufficient wetting. That does not necessarily mean you have to spend a lot of money. I have had good luck with $8 soldering kits from eBay (however, I do throw away the solder that comes with those...) Just make sure it has an adjustable temperature and comes with an assortment of tips. Right now, I'm using a $55 soldering station and it works great. I strongly advise you to get quality 60/40 Rosin core .032" diameter solder (I use Alpha Fry or Kester). The spools I buy are only $10 and well worth it. I set my iron to 400 degrees and use the fine point tip.

A note about assembling acrylic pieces: Some people may want to glue the case together. This is fine, and will add some strength to the project, but I'd suggest not using "super glue" or similar plastic cement. The fumes can adhere to the acrylic causing undesirable marks. I've had luck with "Loctite Plastics Bonding System" or other types of adhesives with activators. Assemble first to be sure everything fits, then disassemble and use adhesive.

Start off by finding the bag labeled "1kΩ Resistor".

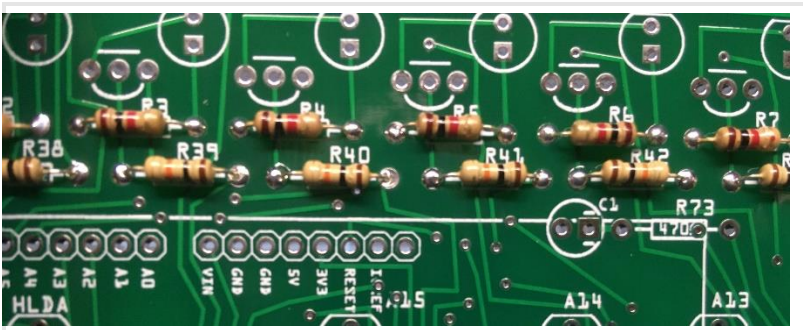


Add the 36-1kΩ resistors to the top rows under the LED/Transistor pairs in locations R1-R36. Resistors are non-polarized, meaning they can go in either direction; you do not need to worry about orientation.

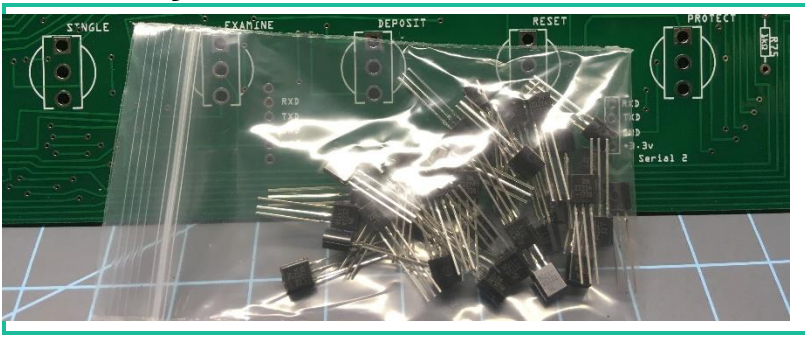


Next is the bag labeled "10kΩ Resistor".

Add the 36-10kΩ resistors to the second row in R37-R72.



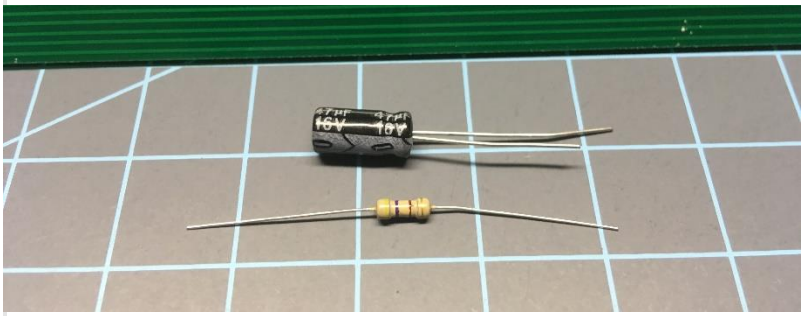
Next is the bag of 36 transistors.



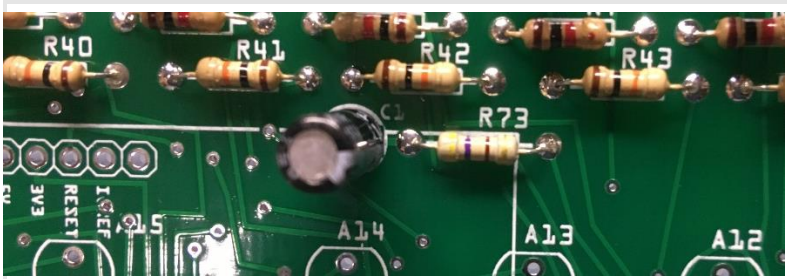
The orientation of the transistor is crucial, but relatively simple. Just make sure the flat end of the transistor is facing up, just like the image printed on the circuit board.

Grab the ziplock bag of assorted parts.

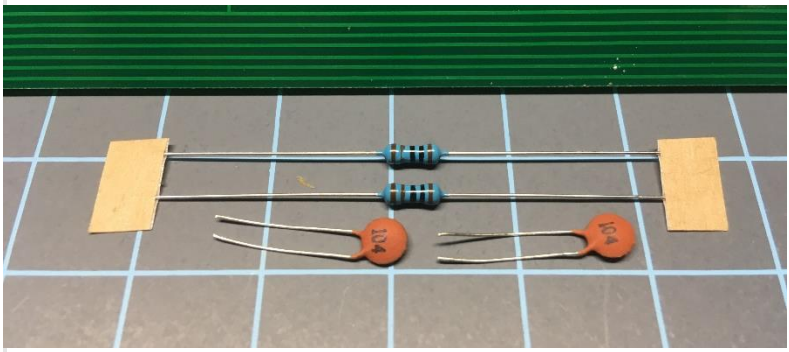
In that bag you will find one electrolytic capacitor and one 470Ω resistor (Yellow, Violet, Brown, Gold color code). If you don't want to decipher the color code, just know you will find three resistors in the bag, two that match, and one that does not. This is the one that does not match another.



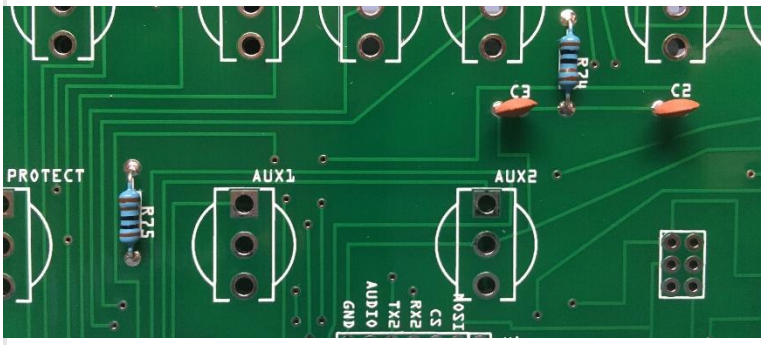
These two components mount on the PC board in R73 & C1. The orientation of the resistor does not matter, but make sure the short lead of the capacitor (marked with a "-" on the side) goes in the hole also marked with a "-".



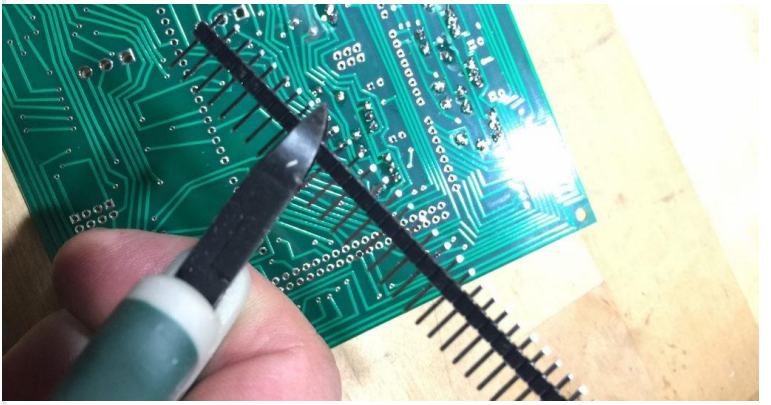
In the same bag, you will find two 0.1 µF capacitors (marked with "104") and two 1kΩ resistors (Brown, Black, Red, Gold).



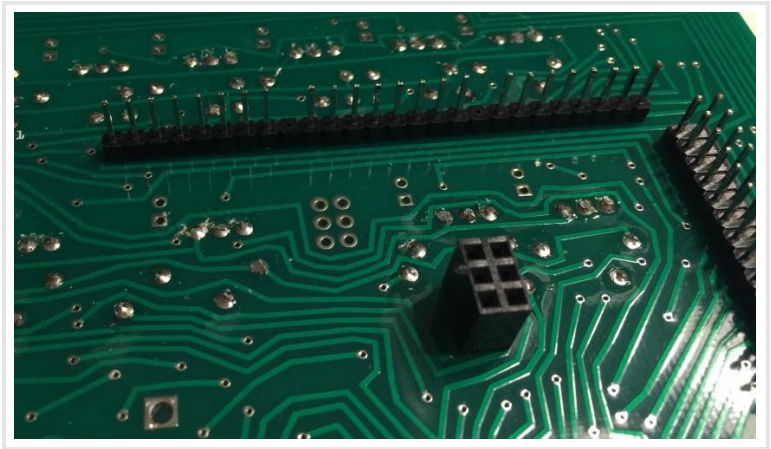
Those are mounted on the front of the PC board in R74, R75, C2, and C3 on the lower right side of the board. The orientation of the components does not matter.



Use your side cutters to clip the single pin headers into 5 segments of 8 pins, and 1 segment of 10 pins to mount the Arduino board. Also clip the double header to a 36-pin (2×18 pin) header.

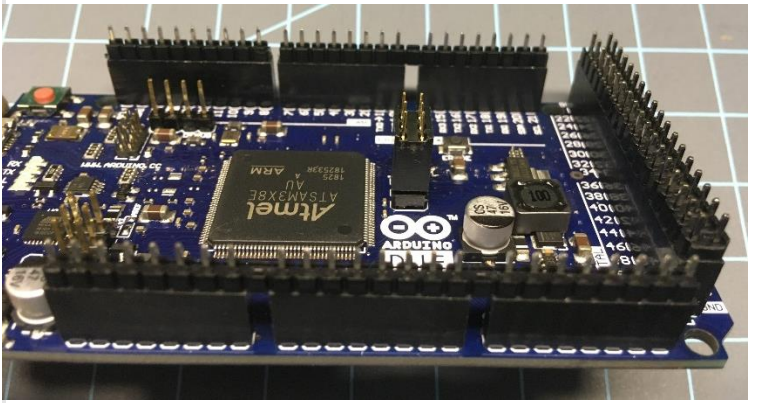


Add the male headers to the underside of the PC board. You can also add the six-pin female header for the SPI connector on the Arduino. Make sure you add these to the correct side of the board because desoldering 92 connections would not be fun!

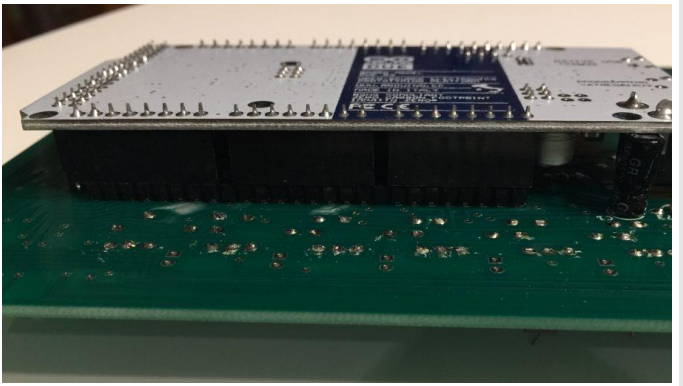


Solder the headers carefully. Make sure they are as close to vertical as possible, and make sure the solder flows completely over the connection. **Most problems happen here with cold solder joints, or solder bridges**.

It may be helpful to install the headers in your Arduino Due, then insert the headers in the circuit board to hold them in the correct position while soldering.

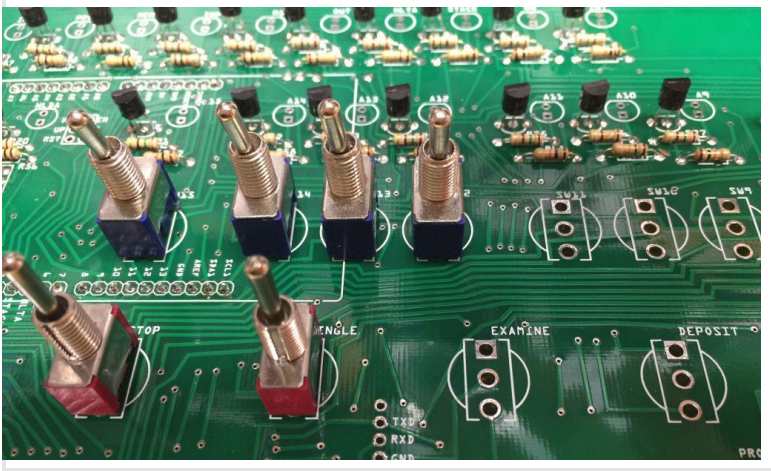


After you are done soldering the headers, try putting the Arduino in place and check for a secure fit. Remove it when you are done.



Get the bag containing 35 toggle switches. If your switches have nuts and washers, you may remove and discard them. Flip each switch back-and-forth a few times making sure it switches freely.

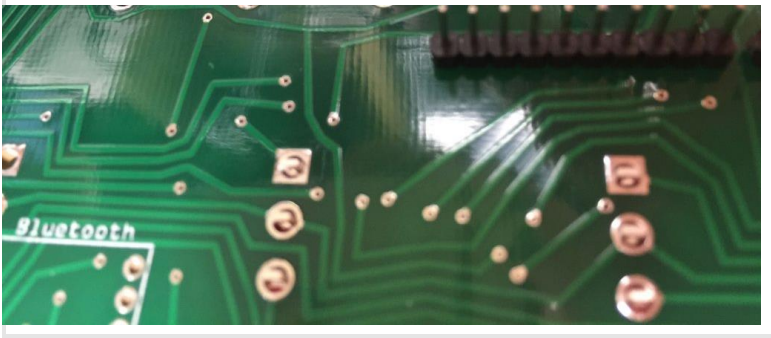
Put all the switches in place *without soldering them*. 17 two position toggles on the top row and the power switch location, 8 three position momentary toggles on the bottom row.



Put the front panel in place to hold the switches in the correct position (having all two-way switches in the down position makes this easier.)

Turn the board over and solder the switches.

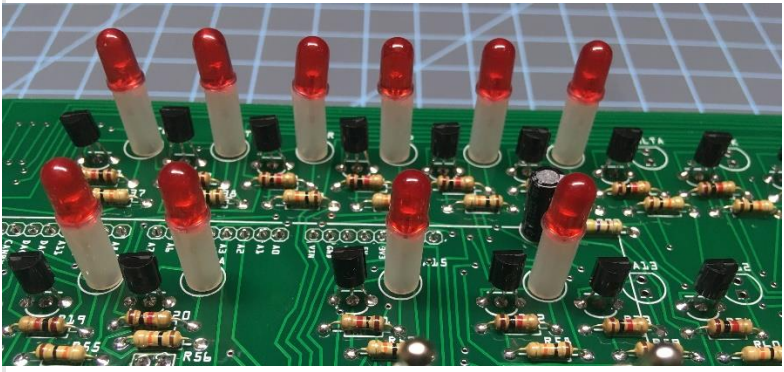
HINT: Before you solder, make sure all three legs are protruding through the holes. Two isolated incidents have been reported where the leg was pushed up into the switch, causing a short which was *very* difficult to diagnose!



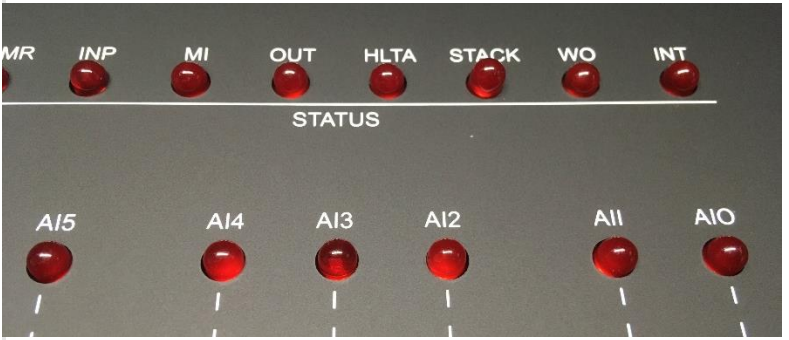
Next is the bag of LEDs and 12mm spacers.

Just like the switches, put the LEDs and spacers in place and do not solder them. You do not have to do them all at once, it may be easier to do them in two or three groups.

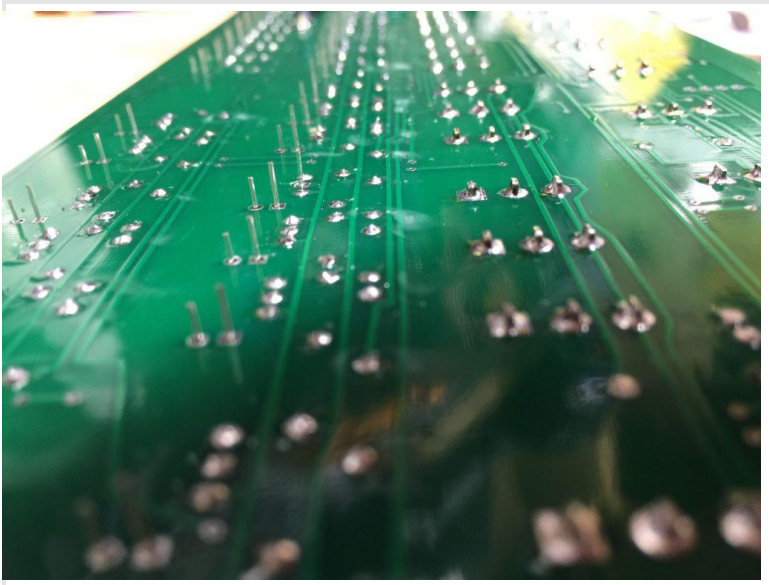
The orientation if the LEDs is crucial. Make sure the long lead of the LED is toward the bottom of the PC board and the flat side of the LED is toward the top.



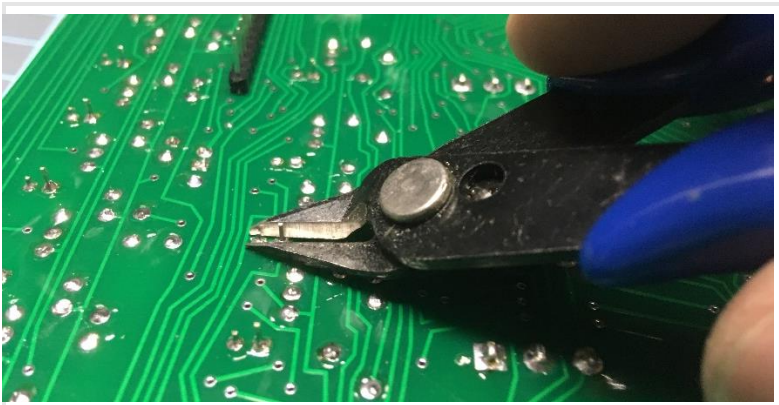
Again, like the switches, put the front panel in place to hold the LEDs while you solder them.



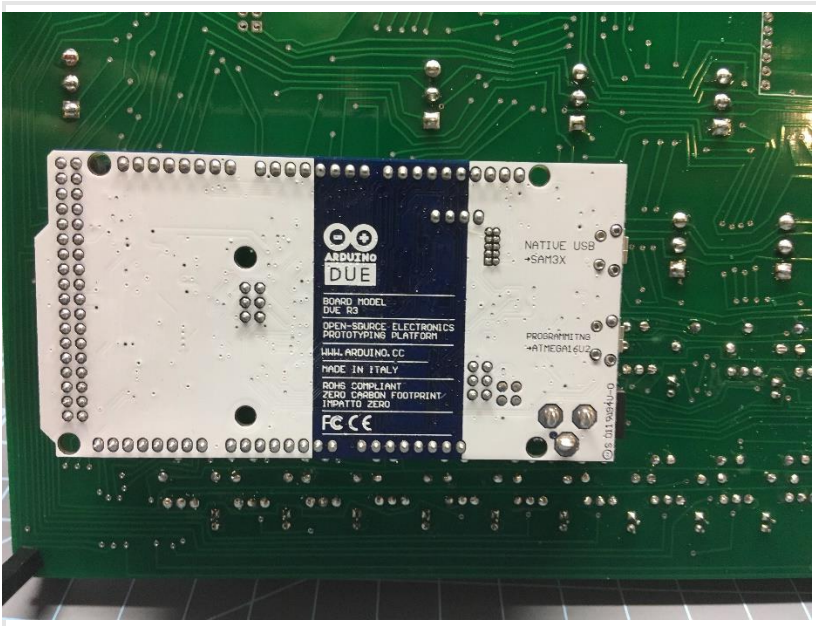
While you are soldering the LEDs, you can verify that the long lead is toward the bottom of the board.



Make sure you trim the leads near the Arduino position after you solder the components. The protruding leads can interfere with the mounting of the Arduino.



Put the Arduino in place.



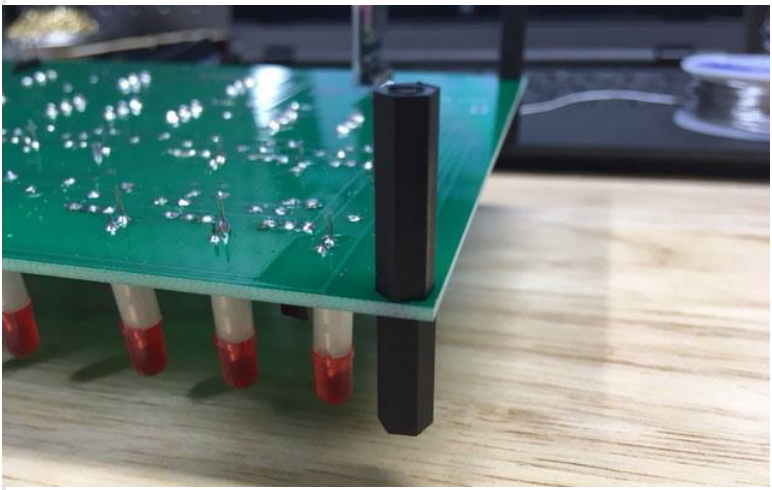
This is a good time to test your kit so far. Take the USB cable and plug it into the Programming port on the Arduino. Turn the board over (so you are looking at the face) and plug the other end of the USB cable into a computer or USB power supply. When the kit is powered, all LEDs will briefly flash, then go dark, and a second or

two later, a random pattern of LEDs will light. My favorite quick-and-easy test is to set SW1 on and lower the AUX1 switch. This will run "Kill The Bit" and you will see LED15 to LED8 light in sequence.

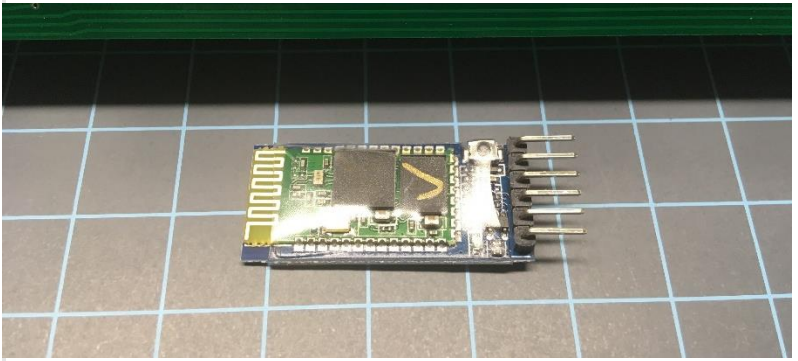
Here's a good second test: set all address switches (two-way toggles) to ON and raise the EXAMINE toggle. All address LEDs (0-15) should light. If not, there is either a problem with that addresses LED or toggle switch.

If you are building a kit with the "low profile" case, continue here (otherwise jump ahead 11 pages):

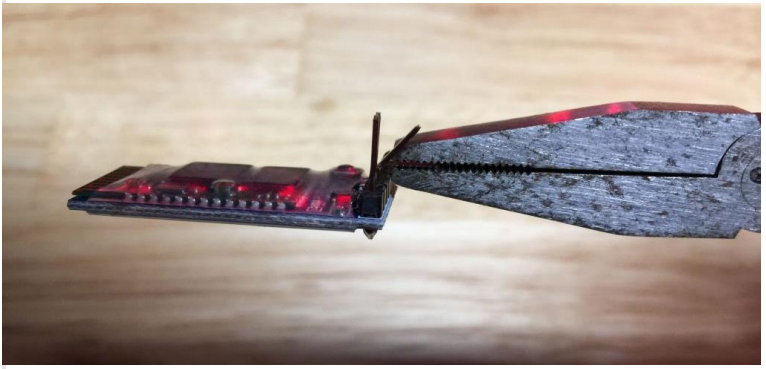
Add the 14mm male/female standoffs on the top, and 20mm female/female standoffs on the bottom (the side with the Arduino.)



Next, we're going to add the Bluetooth module. If your module has angled pins, that's not quite what we want.

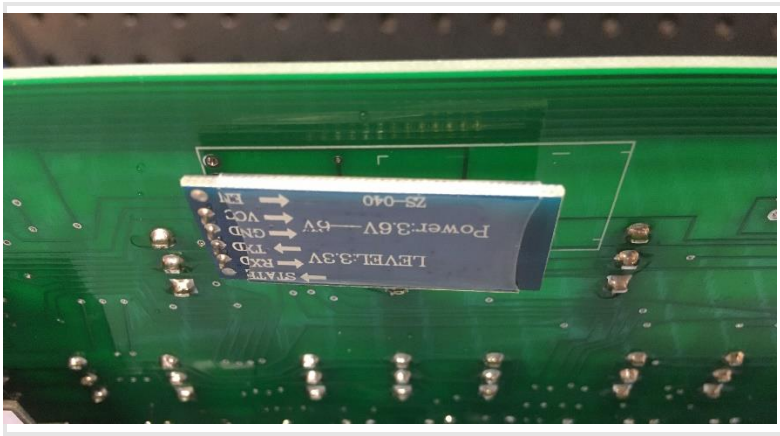


Grab a needle nose pliers and bend the pins straight slowly and gently.

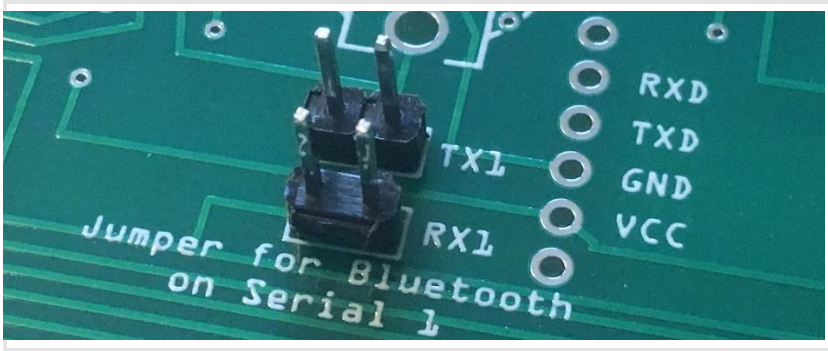


You can now solder the Bluetooth module to the *underside* of the PC board.

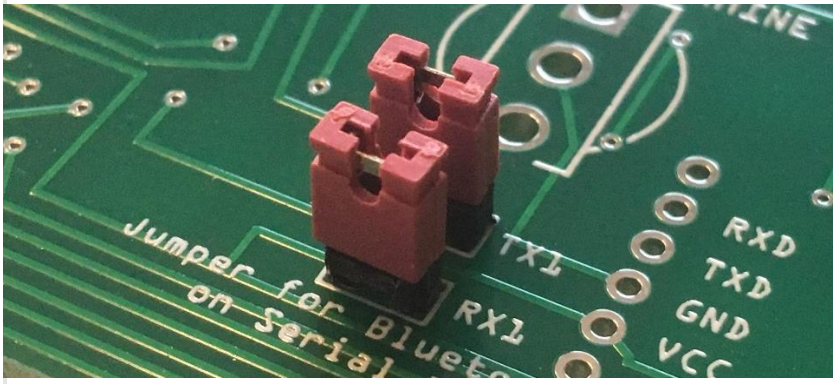
Your Bluetooth module may have six pins or four pins. If it only has four pins – solder them to the *center four pins* of the six-pin connection area.



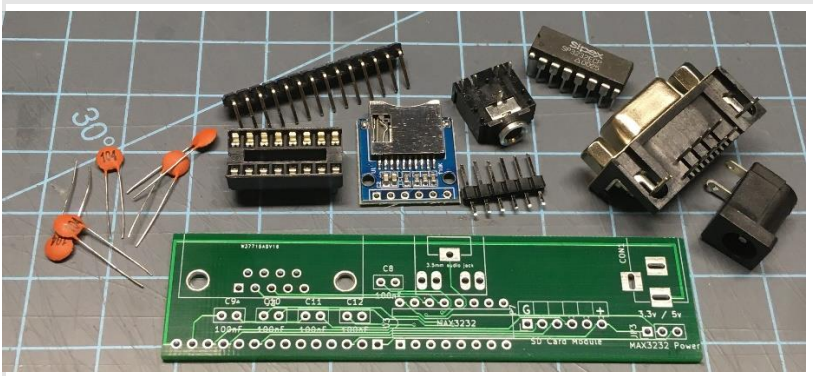
Add two 2-pin header pins to the left of the Bluetooth module.



Place jumpers on those header pins.

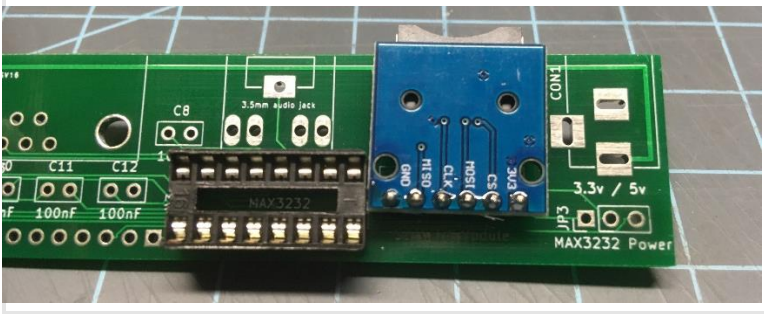


Next, you will assemble the expansion board.

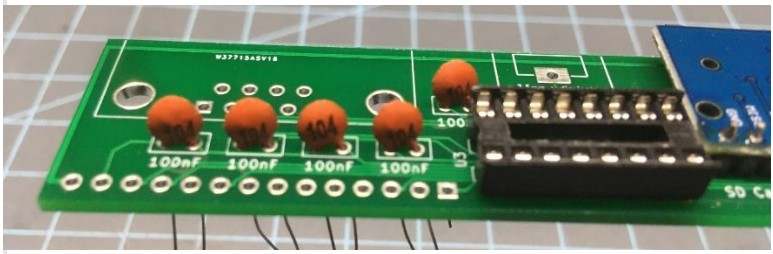


If the header pins are not attached to your SD card module, solder the header pins as pictured:

Add the 16-pin DIP socket and SD card module to the circuit board, making sure the SD module stays parallel to the board.

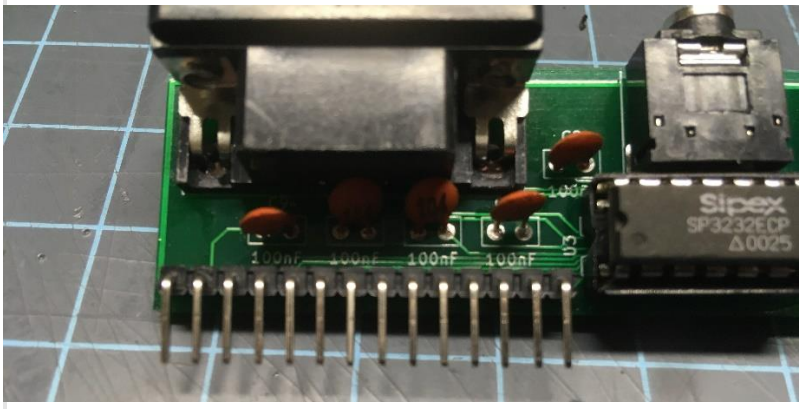


Solder in the five 104 (100nF) capacitors.



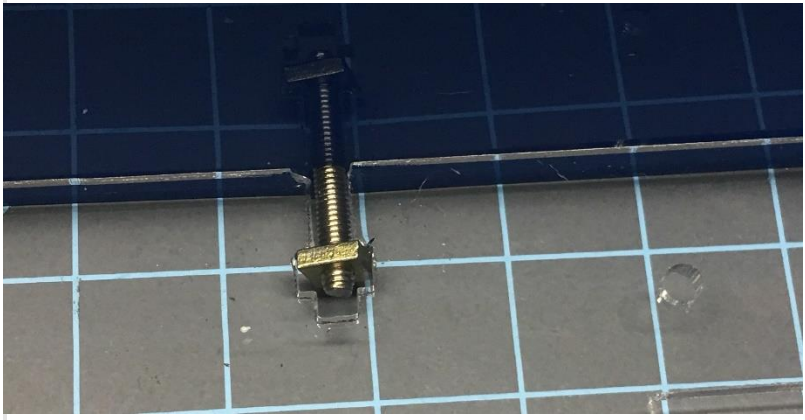
Add the DB9 serial port, audio jack, power jack, and 3-pin header to the circuit board.

Add the SP3232/MAX3232 IC to the DIP socket, and solder the 90 degree angle header to the FRONT of the circuit board, as shown.

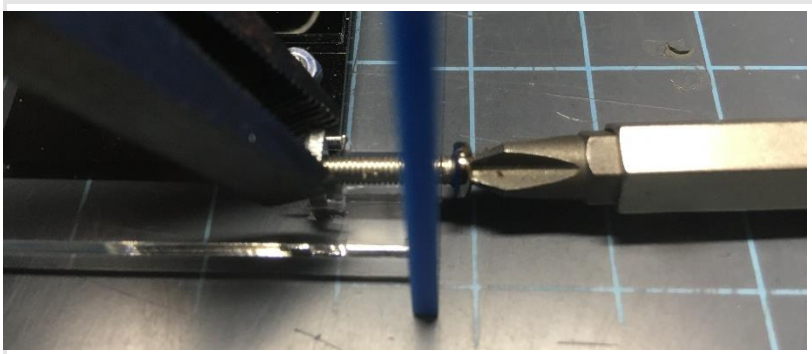


Add the real panel to the expansion module and attach the USB extension to the rear panel. Take the clear piece of acrylic and remove the protective paper. Attach the expansion module as shown (note the position of the t-slot on the left) using the top two 8mm bolts and nuts.

Attach the clear panel to the blue acrylic frame using the 14mm bolts and square nuts. The nuts/bolts attach as shown:

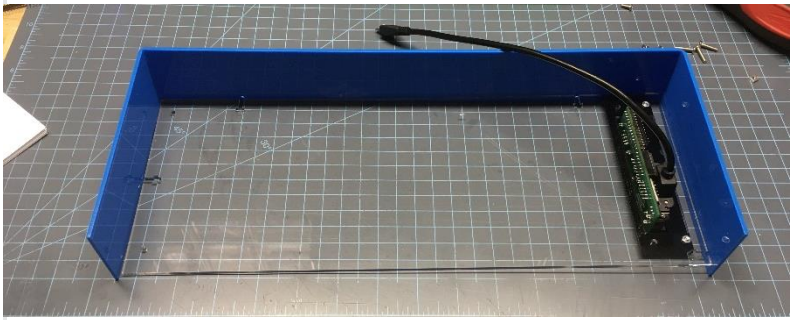


Getting the square nuts started can be tricky; I use a needle-nosed plier to hold the nut while I get the bolt started.

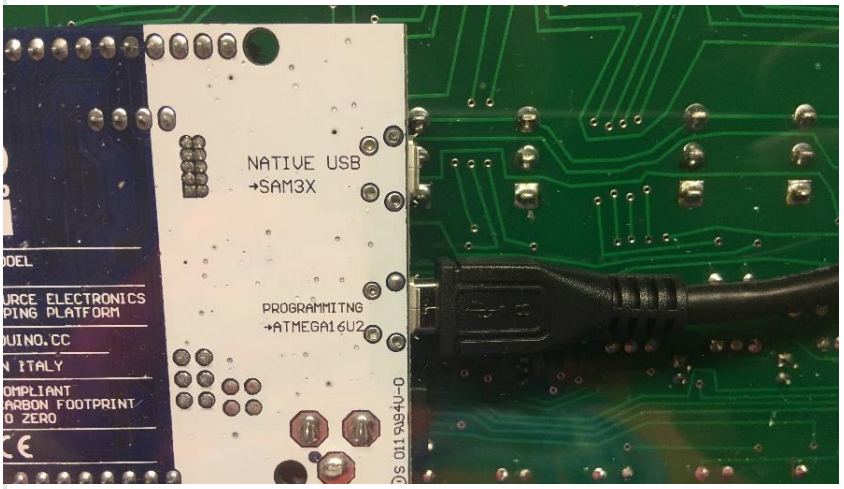


Make sure the screws are secure, but no not make them overly tight, they can break the acrylic.

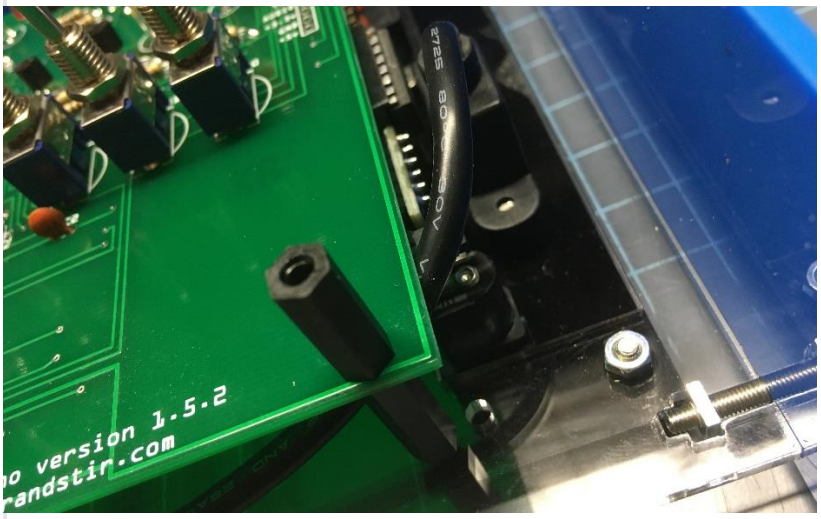
Once the back is attached to the frame, we are ready to put the main circuit board in place.



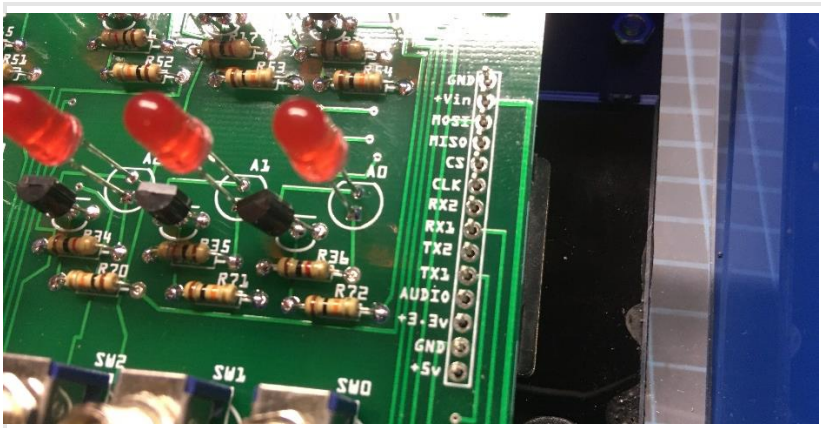
Plug the USB extension cable into the PROGRAMMING port on the Arduino Due.



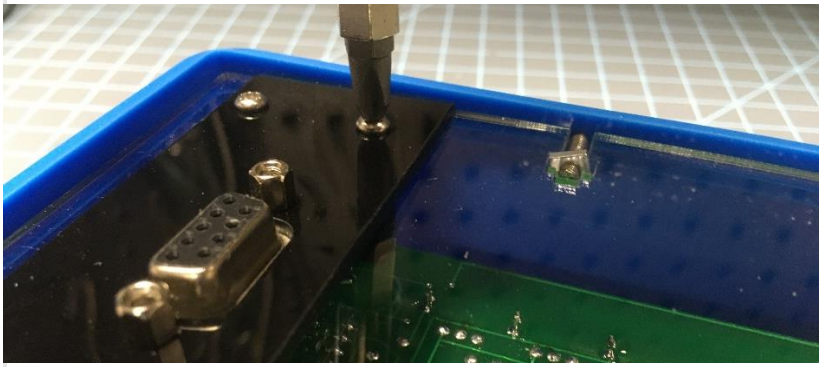
Put the main circuit board in place, taking care to guide the USB extension cable between the power jack and nylon standoff for the main circuit board.

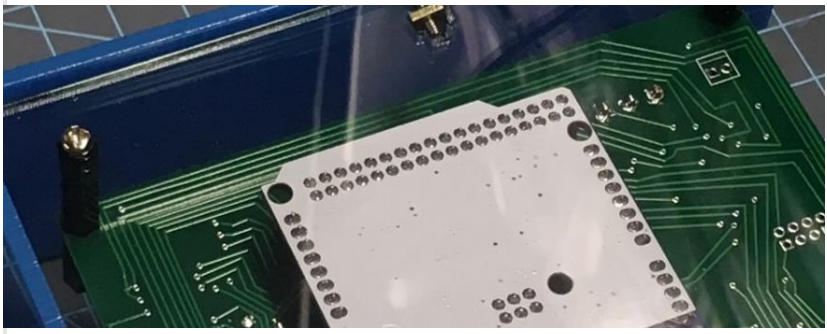


Guide the 14 pins from the expansion board into place.

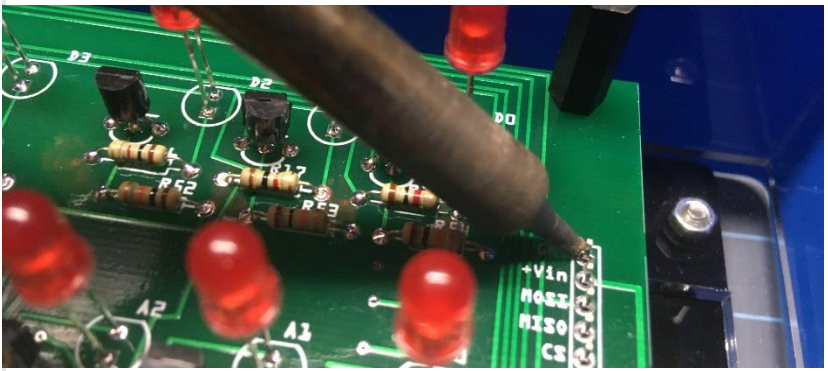


Attach the case to the main circuit board with four 8mm bolts.



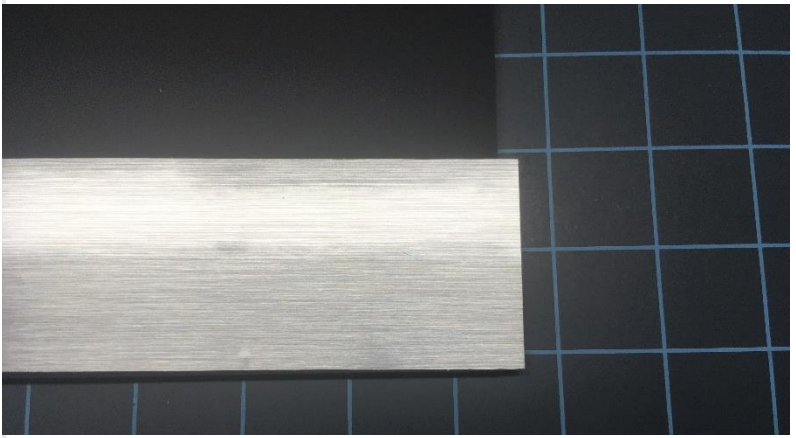


Solder the 14 pin connector from the expansion board to the main circuit board.



Apply the Altair 8800 sticker to the front panel. The adhesive is forgiving, so if you place it wrong, you can pull it up and put it in place again. Use a small Phillips screwdriver or awl to poke holes where the bolts will go.

Your label will be a little bit longer than the front panel.

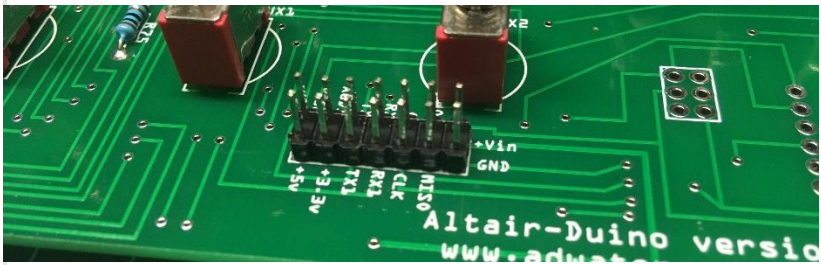


You may wrap the excess around the edge of the panel or trim it with a sharp razor.

Put the front panel in place, push down around the LEDs and switches to set it properly, and add the 10mm nylon bolts.

If you are building a kit with the full acrylic case and I/O expansion, continue here:

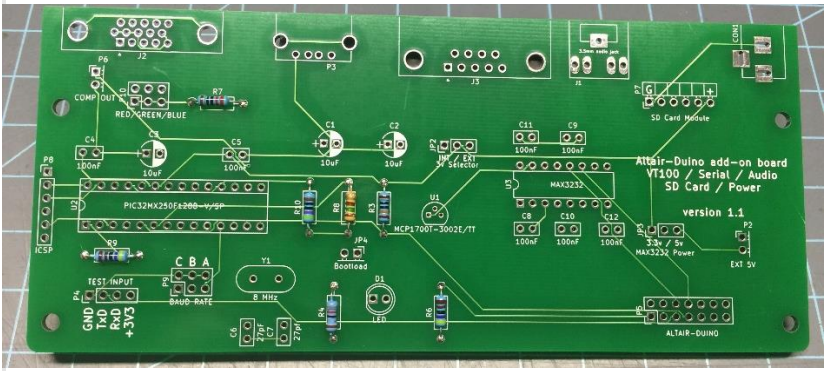
Get the main circuit board and solder a fourteen pin dual header on the lower right.



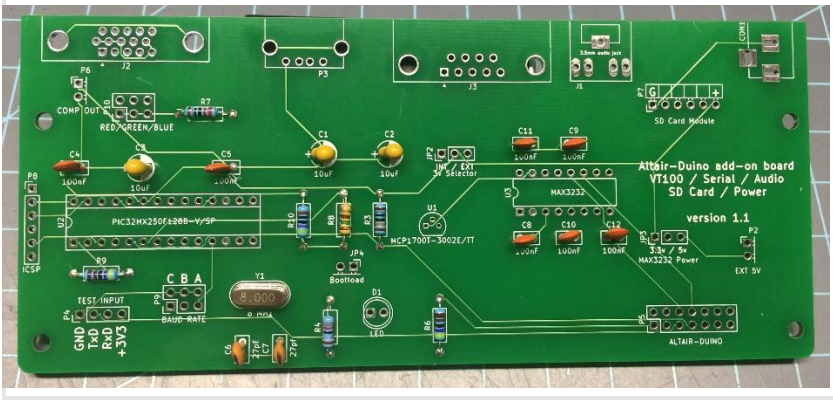
In your kit, you will find a bag with smaller circuit board and bags of miscellaneous parts.

There are seven resistors to install with six different values. You will need to identify your resistors with a multimeter, or with the color codes (see resistor-calculator.com for a handy tool.) The locations for the resistors are clearly marked on the circuit board.

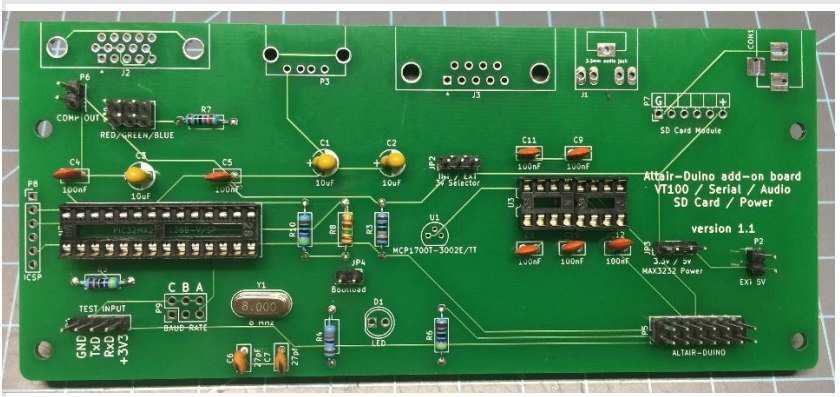
2 x 4.7kΩ (Yellow – Violet – Black – Brown)
1 x 470Ω (Yellow – Violet – Black – Black)
1 x 150Ω (Brown – Green – Black – Black)
1 x 82Ω (Black – Gray – Red – Black)
1 x 220Ω (Red – Red – Black – Black)
1 x 100kΩ (Brown – Black – Black – Orange)



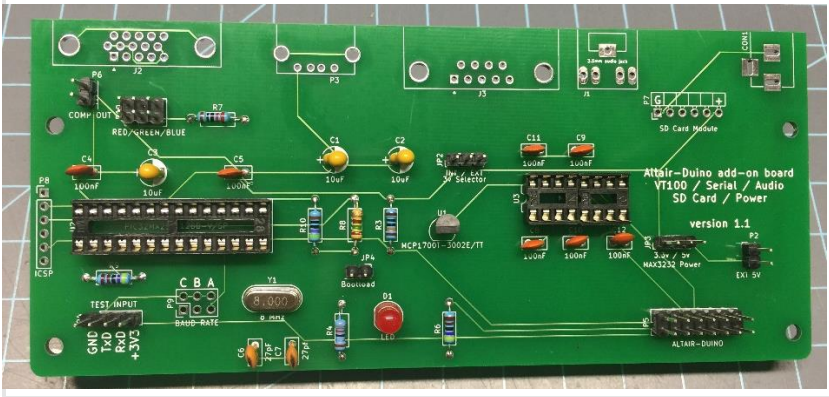
Add the capacitors and 8MHz crystal where marked.
7 x 100nF (marked "104")
2 x 27pF (marked "27")
3 x 10uF (Important: insert long lead in + hole)



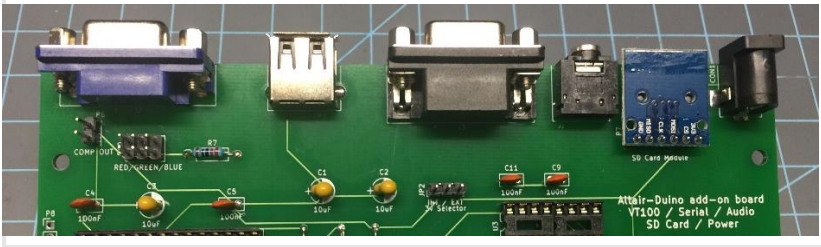
Next add the IC sockets (with the notch oriented to the left) and the single pin and double pin headers.



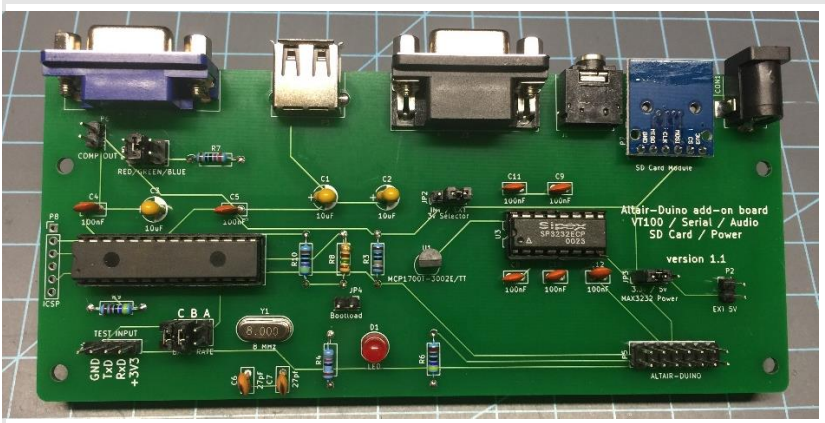
Add the LED *with long lead to the right and flat side to the left) and the MCP1700 voltage regulator with the flat side down.



Add the jacks and connectors.



Finally, insert the MAX3232 IC and PIC32 IC with the notch facing left.



Add the required jumpers to the I/O expansion. The following are the "default" jumpers. Later you can read more about the jumper options on the website.

From upper left to lower right:
Red/Green/Blue: Your choice of text color on VGA monitor, you must jumper at least one.

3v Selector: Set to EXT.

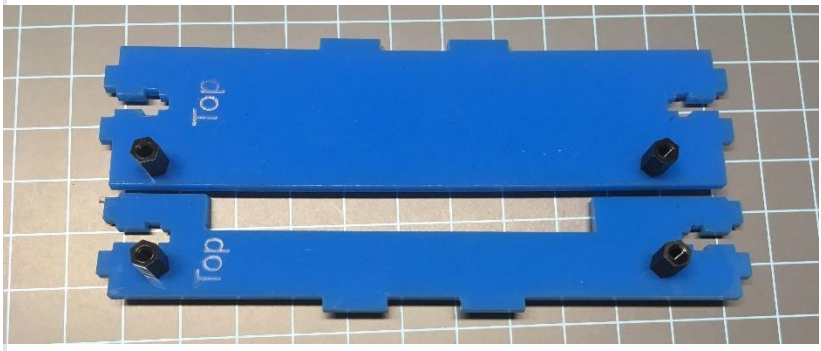
Baud Rate: Jumper C and B for 9600 baud.

Bootload: No jumper.

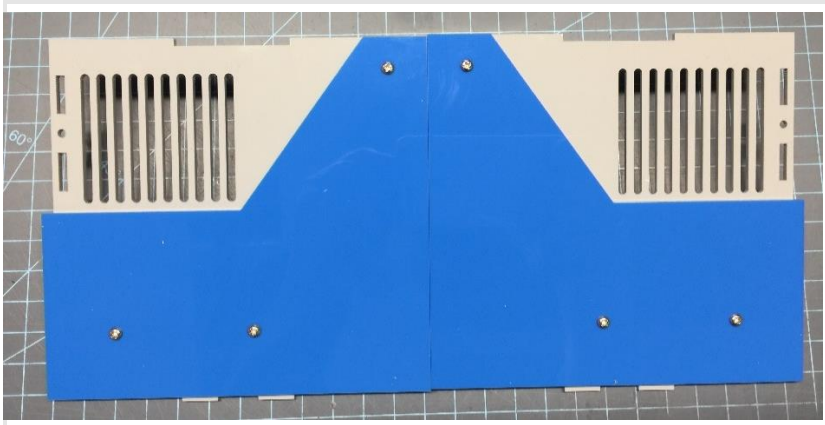
MAX3232 Power: Set to 3.3v.

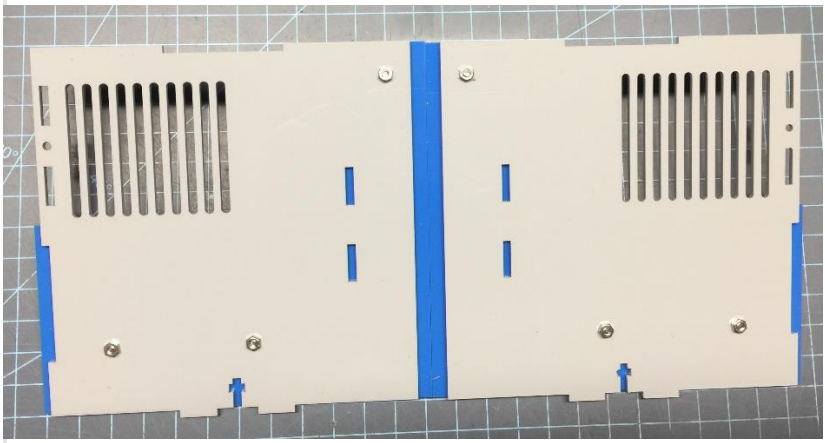
Get the acrylic pieces and start removing the masking paper.

Take the two smaller acrylic pieces with the word “Top” engraved. Add four 8mm nylon standoffs to the side that says “Top” and secure each with a nylon nut. (These pieces may be blue or gray.)



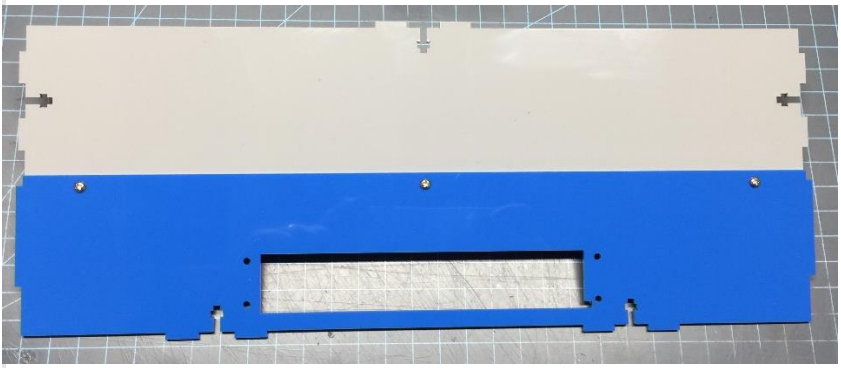
Next take the two gray side pieces (with “ventilation holes” and attach the blue side pieces with three 8mm bolts each.





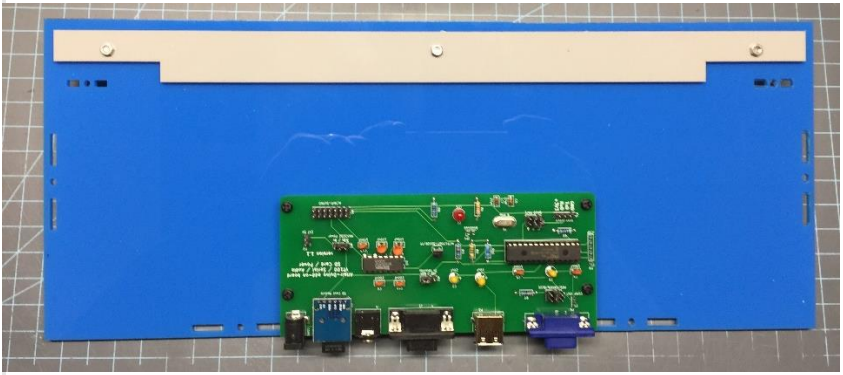
Attach the blue top piece to the gray top piece as shown with 8mm bolts. Make sure the blue piece extends 6mm over each side (turn it over if it doesn't.)

Attach the two back pieces together with 8mm bolts. Note the position of the notch in the lower right.



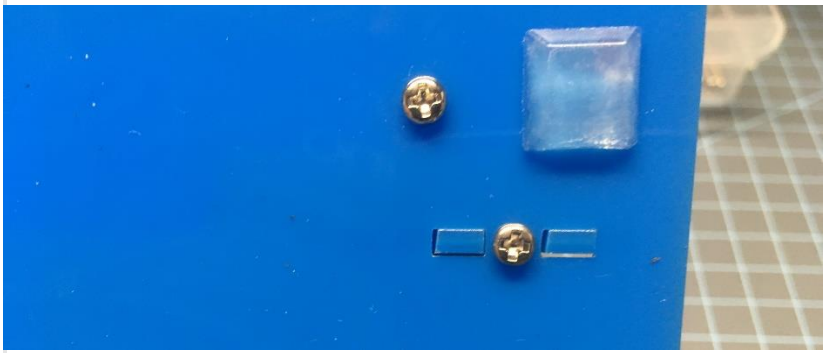
Attach the I/O circuit board to the blue bottom piece with four 8mm standoffs, nylon nuts and nylon bolts.

Attach the gray piece (as shown) to the bottom with 8mm bolts.

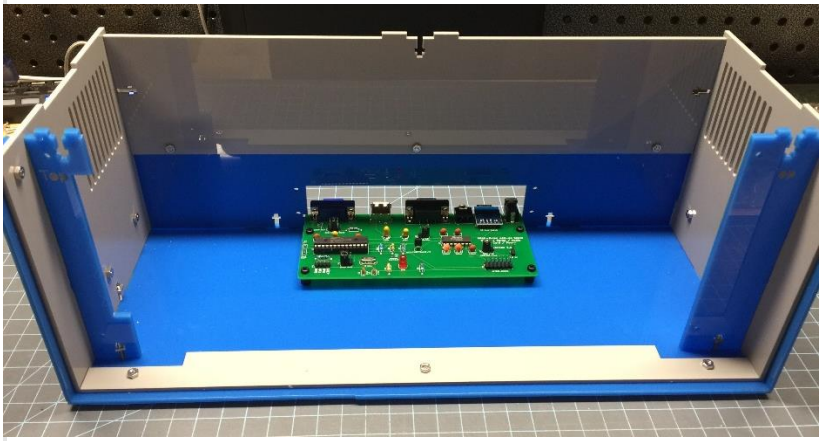


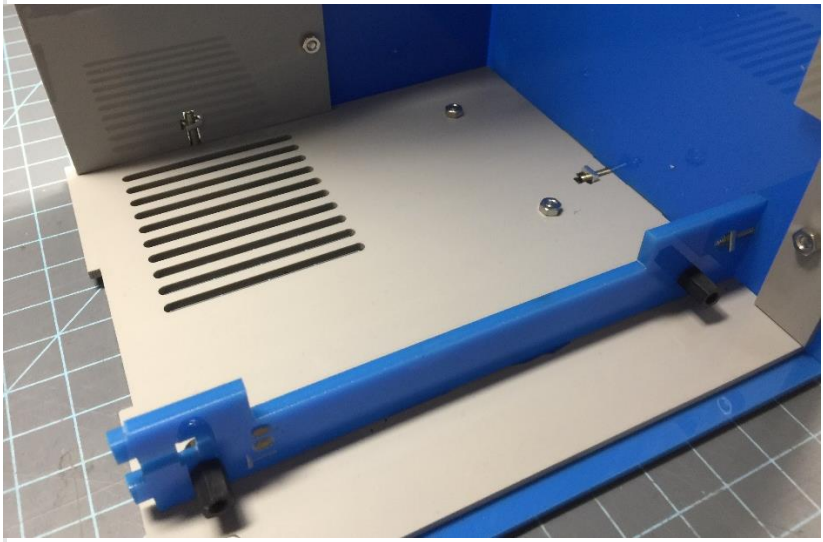
This would also be a good time to apply the rubber feet to the bottom piece.

Next we're going to start joining acrylic pieces with a t-slot joint. Start with the uprights where we will eventually mount the main circuit board. Attach them to the bottom piece with 14mm bolts and square nuts. Tighten firmly, but not too tight – acrylic can crack.

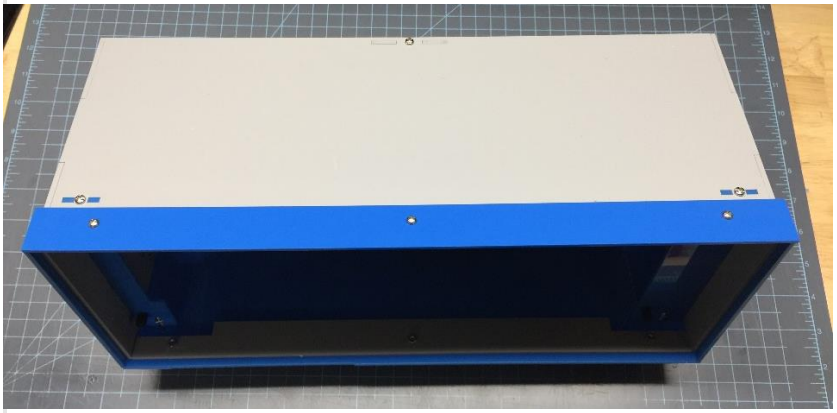


Add the back piece and side pieces and bolt in place with four 14mm bolts.



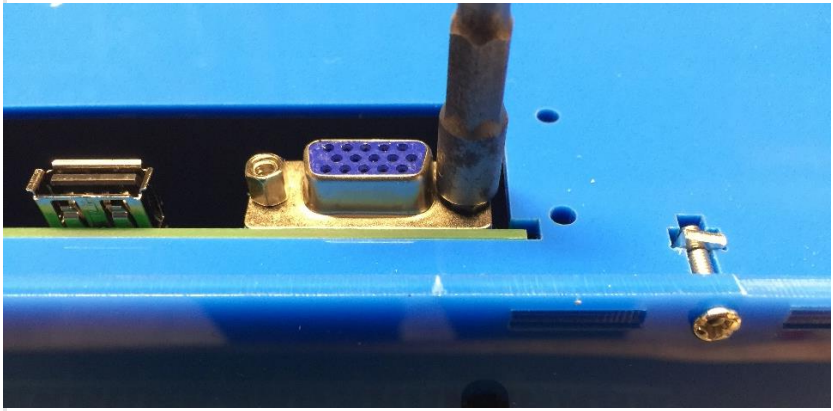


Add the top piece as shown and secure with three 14mm bolts.



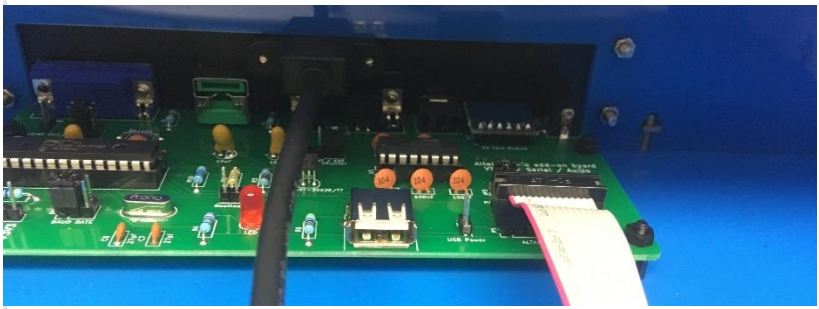
Get the small rear panel (for the ports) and add the USB extension with two 8mm bolts.

Remove the jack screws from the VGA and Serial connectors with a needle-nose pliers, or a 3/16" or 5mm socket.

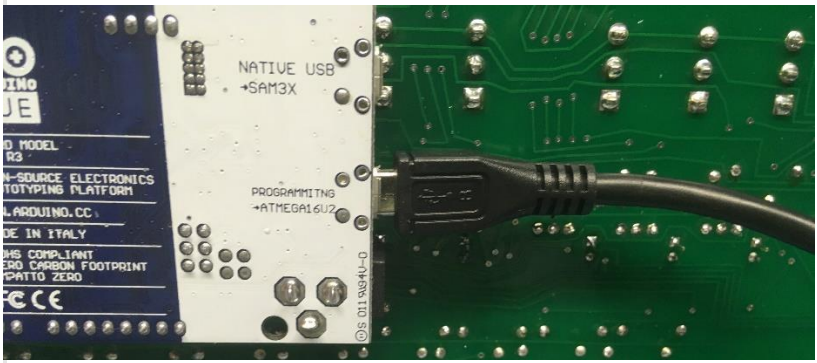


Place the rear panel in place and secure it with the jack screws and four 8mm bolts.

Connect the fourteen pin IDC cable to the I/O board, with the red stripe to the left.



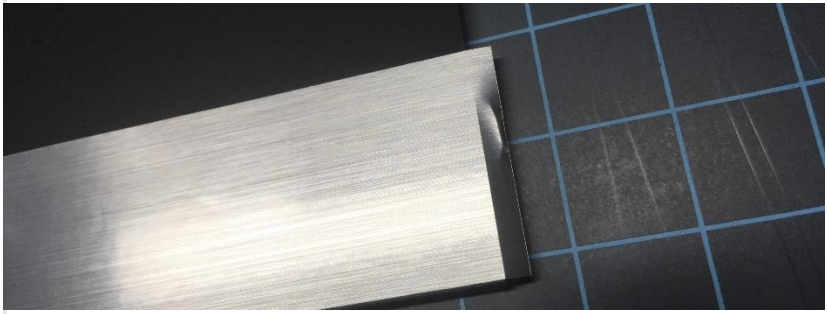
Connect the USB connection cable to the Programming port on the Arduino Due.



Attach the main circuit board to the case with 15mm M-F nylon standoffs.

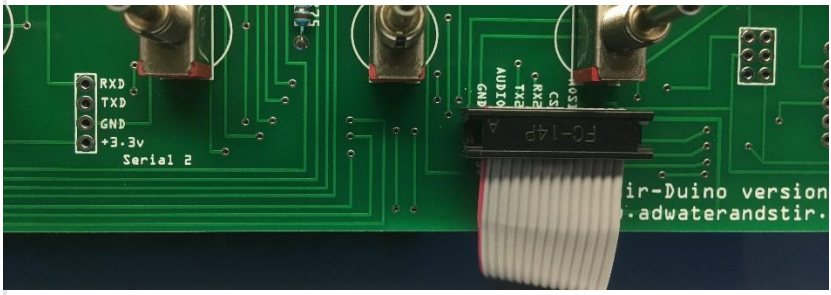
Apply the Altair 8800 sticker to the front panel. The adhesive is forgiving, so if you place it wrong, you can pull it up and put it in place again. Use a small Phillips screwdriver or awl to poke holes where the bolts will go.

Your label will be a little bit longer than the front panel.

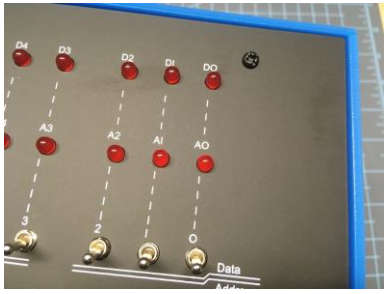


You may wrap the excess around the edge of the panel or trim it with a sharp razor.

Plug the fourteen pin IDC cable onto the front of the circuit board with the red stripe on the left.



Add the front panel to the main circuit board, push down around the toggle switches, and secure it with four nylon bolts.



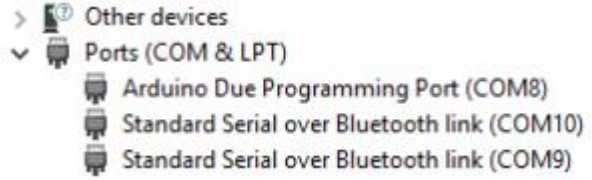
CONGRATULATIONS! YOUR ALTAIR 8800 IS COMPLETE!

See the web page www.adwaterandstir.com/operation for full documentation and easy step-by-step things to do.

Here are a few easy things to try:

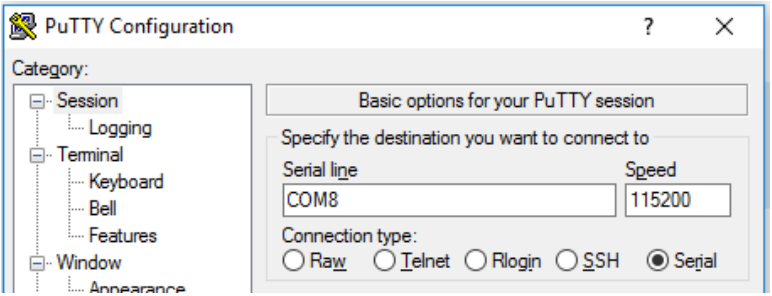
By default, your Altair-Duino is set up to communicate through the USB port.

1. Plug USB cable into computer and the other end to your Altair-Duino.
2. Windows 10 should automatically recognize a new serial port. To check, launch "Device Manager".
3. Expand "Ports (COM & LPT)" in Device Manager

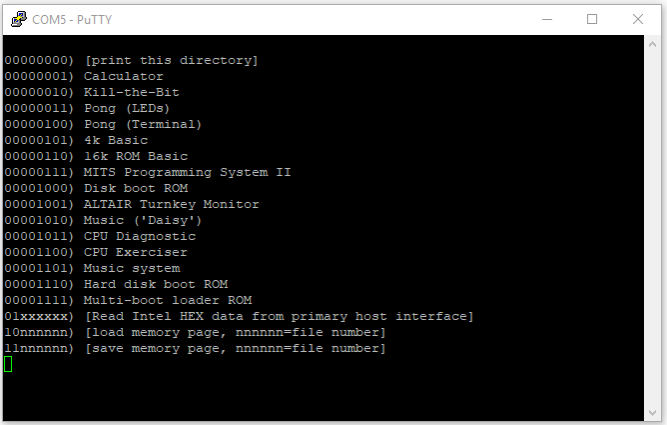


4. Your port should be identified as "Arduino Due Programming Port".
5. Launch PuTTY (or another terminal program if you choose.)

6. Connect to the indicated COM port at baud rate 115200.



7. The front panel lights will flash briefly while it connects.
8. With all switches down, press AUX1 down.
9. On the terminal, you should see a directory of options for front panel switches.



If you have a serial device (such as a dumb terminal):

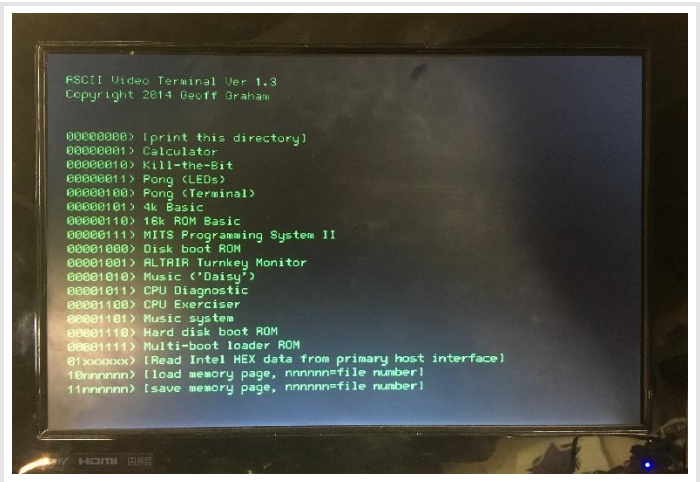
1. Plug a serial cable from the Altair-Duino to your serial device.
2. Connect a power supply to the Altair-Duino.
3. Set front panel data switches to "2" (switch 1 up, all other switches down).
4. Raise (and hold) DEPOSIT up.
5. Turn on Altair-Duino.

This will cause the Altair-Duino to load configuration 2 on power up. This configuration has been saved to communicate on serial port 2 at 9600 baud.

If you have Geoff Graham's VT-100 emulator on serial port 1 (using the I/O expansion board):

1. Plug a VGA monitor and PS2 keyboard into the Altair-Duino. Power on the monitor.
2. Connect a power supply to the Altair-Duino.
3. Make sure the SD card is inserted.
4. Set front panel data switches to "1" (switch 0 up, all other switches down).
5. Raise (and hold) DEPOSIT up.
6. Turn on Altair-Duino.

You should see "ASCII Video Terminal Version 1.3 Copyright 2013 Geoff Graham" on the VGA monitor. With all switches down, press AUX1 down. On the monitor, you should see a directory of options for front panel switches.



Please see the website (adwaterandstir.com) for many other examples and walk-throughs for common functions. Also visit the online forum to discuss the Altair-Duino with other enthusiasts, or to ask questions (adwaterandstir.com/forum).

Get out your reading glasses, because following is a reprint of David Hansel's documentation. David's manual is specifically written for the software and there may be minor differences with my implementation of his software in my kit.