Altair-Duino 3.0 Assembly & Operations

Up-to-date instructions are always available at www.adwaterandstir.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.)

Bag #1

- 5 x 1kΩ Resistor Array
- 1 x 47uF Capacitor
- 1 x 470Ω Resistor
- 1 x 1kΩ Resistor

Bag #2

- 1 x 2x3 Female Header
- 2 x 40-pin Single Male Header
- 2 x 40-pin Double Male Header
- 5 x 18-pin DIP Socket
- 1 x 28-pin DIP Socket
- 1 x 16-pin DIP Socket

Bag #3

- 17 x MTS-102 Toggle Switch
- 8 x MTS-123 Toggle Switch

Bag #4

- 37 x 5mm Red LEDs
- 36 x 12mm LED Spacers

Bag #5

- 5 x ULN2803APG
- 1 x PIC32
- 1 x SP3232

Bag #6

- 8 x 8mm M-F Standoffs
- 8 x M3 Nylon Nuts
- 10 x 6mm M3 Nylon Bolts
- 8 x 8mm M3 Stainless Bolts
- 8 x M3 Stainless Nuts

Bag #7

- 1 x DC-022 Power Jack
- 1 x DC-005 Power Jack
- 1 x 3.5mm Audio Jack
- 1 x USB-A Connector
- 1 x VGA Cable
- 1 x DE9 Cable
- 1 x USB-A Extension Cable
- 1 x Power Cable w/Barrel Connector
- 1 x Power Cable w/XH Conn.
- 1 x 14” Gray Wire
- 1 x 3-Pin Fan Power Connector
- 4 x Jumpers

Bag #8

- Micro SD Module
- Micro SD Card
- 1 x 10uF Capacitor
- 9 x 100nF (104) Capacitor
- 2 x 27pF Capacitor
- 1 x 8MHz Crystal
- 1 x 1kΩ Resistor
- 1 x 100kΩ Resistor
- 1 x 220Ω Resistor
- 1 x 150Ω Resistor
- 1 x 4.7kΩ Resistor

Bag #9

- 6 x 26 Pin Female Header
- 1 x 100nF (104) Capacitor
- 1 x 0.33uF (334) Capacitor
- 1 x L7805 Regulator
- 1 x TO-220 Heatsink Set

Unbagged Parts:

- 1 x Altair Reproduction Case
- 1 x Main Circuit Board
- 1 x Expansion Circuit Board
- 1 x Rear Port Panel
- 1 x Arduino Due
- 34-Pin IDC Cable
- 1 x Micro USB Extension
- 1 x Micro USB Cable
- 1 x 9v Power Supply

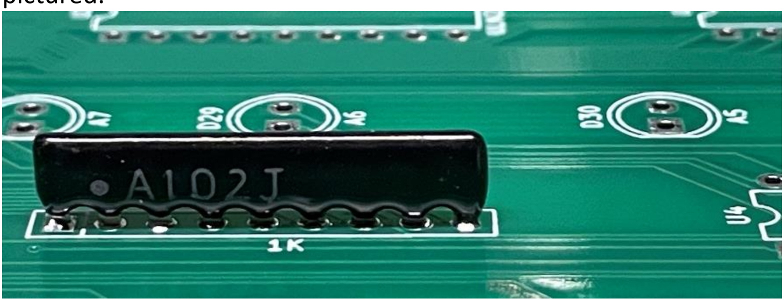
OTHER PARTS YOU MAY NEED

- 7mm Nut Driver (**strongly recommended**)
- 8mm Nut Driver (**strongly recommended**)
- Soldering Iron with a good tip
- Good Solder (I recommend Alpha Fry or Kester Rosin Core 0.032”)
- De-soldering Iron (optional)
- Phillips Screwdriver
- Needle-nose Pliers
- Side Cutters (Nippers)

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. 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 (750 Fahrenheit) and use the fine point tip.

Let’s start with bag number 1.

Add the five resistor arrays in RN1-RN5 on the back of the circuit board (look for screen print outlines), making sure the dot indicator faces to the left side (where the square is on the circuit board) as pictured.



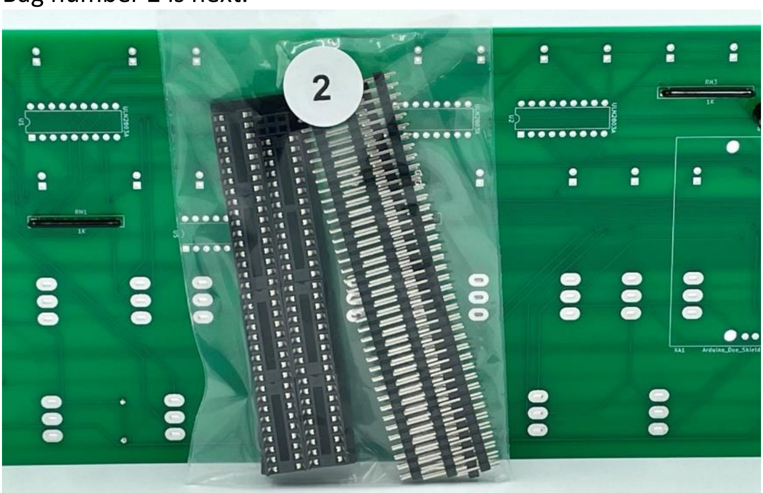
Resistor color codes for next step:

1k (Brown-Black-Black-Brown)

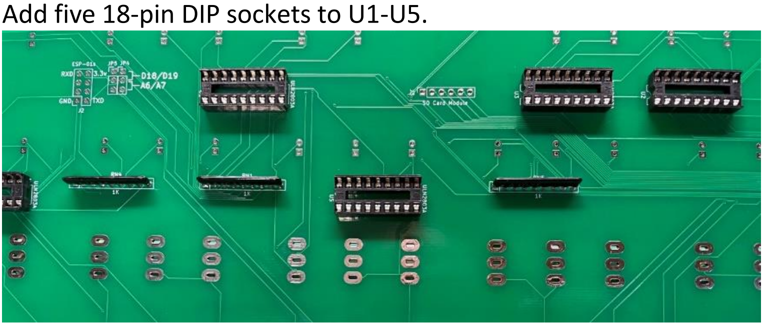
470 ohm (Yellow-Violet-Black-Black)

Add the 47uF Capacitor and the 470 ohm and 1k ohm resistors in C3, R1 and R2. Be sure to observe correct polarity for the 10uF capacitor.

Bag number 2 is next.



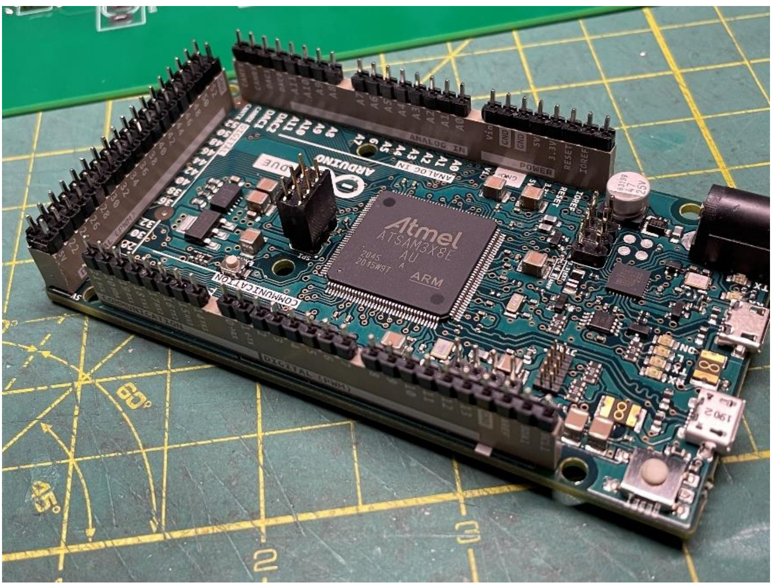
Add five 18-pin DIP sockets to U1-U5.



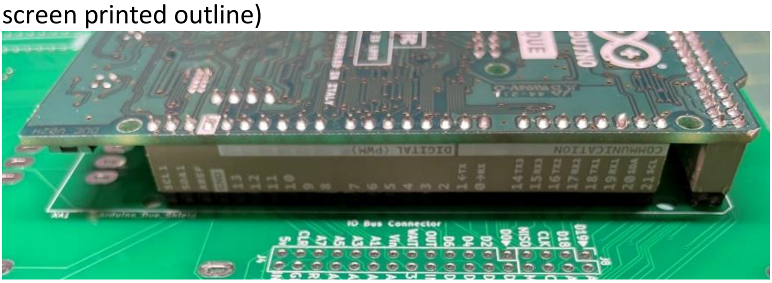
We’re going to use the Arduino Due to hold the pin headers temporarily while we solder them to the main circuit board. Cut (or locate) the following segments:

5 x 8-pin single-row male header
1 x 10-pin single-row male header
1 x 36-pin double-row male header
1 x 6-pin double-row female header

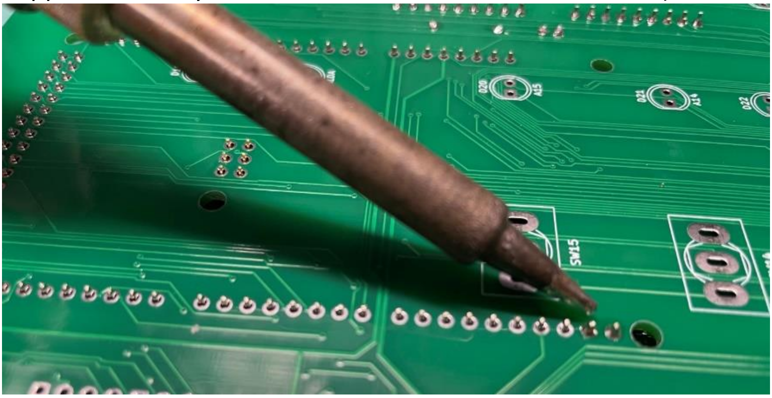
Place them on the Arduino Due like this:



Insert the Arduino into the **back** of the main circuit board (look for screen printed outline)

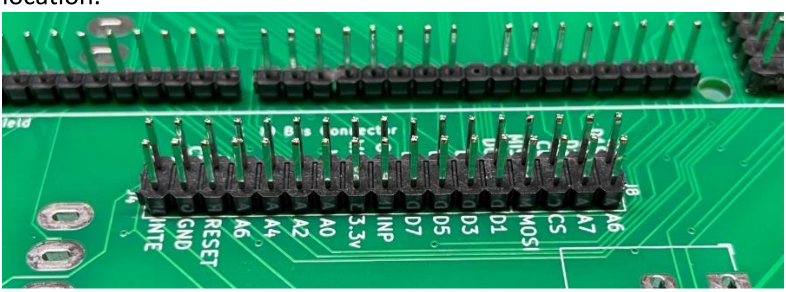


Solder all header pins in place (note: this is where most errors happen – it's easy to miss one or two header connections.)

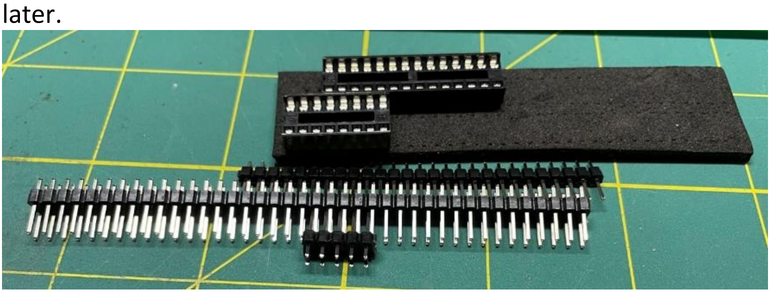


After all header pins have been soldered, remove the Arduino and place it aside for later.

Cut a 34-pin segment from a double-row male header and solder that to the **back** of the circuit board in the "IO Bus Connector" location.



Put the remainder from bag 2 aside, as we will use those parts later.



You’ll want to remove the front panel bracket from the case, and the front panel from the bracket using a 7mm nut driver (or pliers).

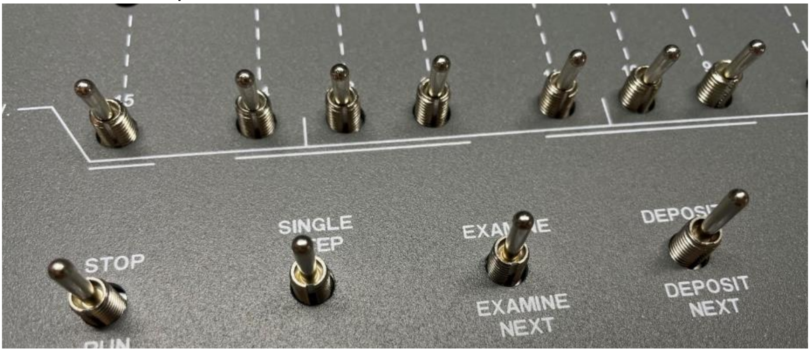
Next, we’ll add the toggle switches from bag number 3.

The first thing you need to do is to remove **all of the nuts and washers** from the switches. Put them aside as we will use some of them later.

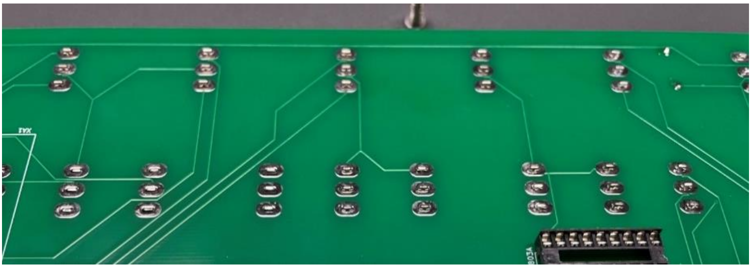
Add all of the switches in place without soldering. Add the eight momentary-off-momentary switches on the bottom row, and the 17 on-off switches to the top row (and power switch).

The MTS-123 (three-way momentary) switches will fit a bit tighter than the MTS-102 switches. You can get them in place by rocking them side-to-side, or you can gently squeeze the lugs a bit toward the center.

Place the front panel over the switches.

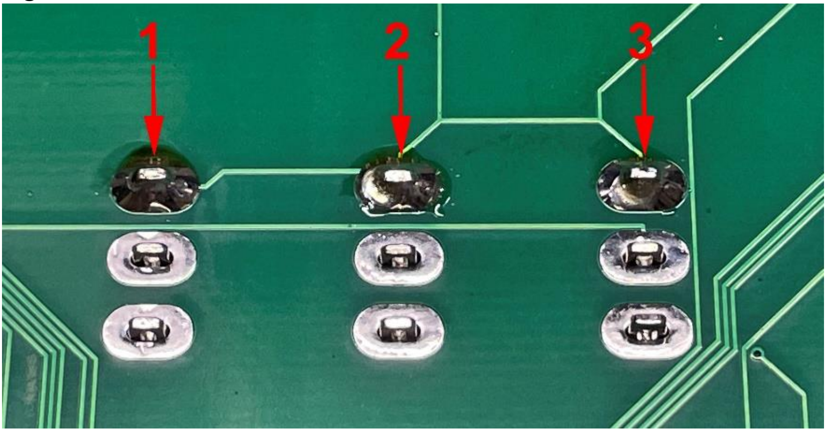


Hold the front panel and circuit board firmly and flip the board over.

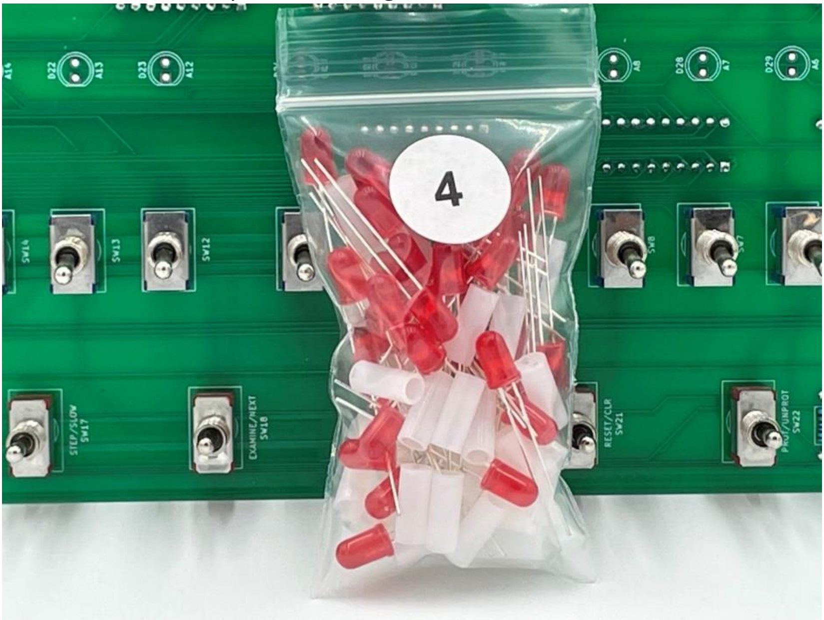


I like to support the front panel from the sides and the middle. Solder the switches in place. You may have to press up on each switch as you solder the first lug in place to make sure it is firmly in place.

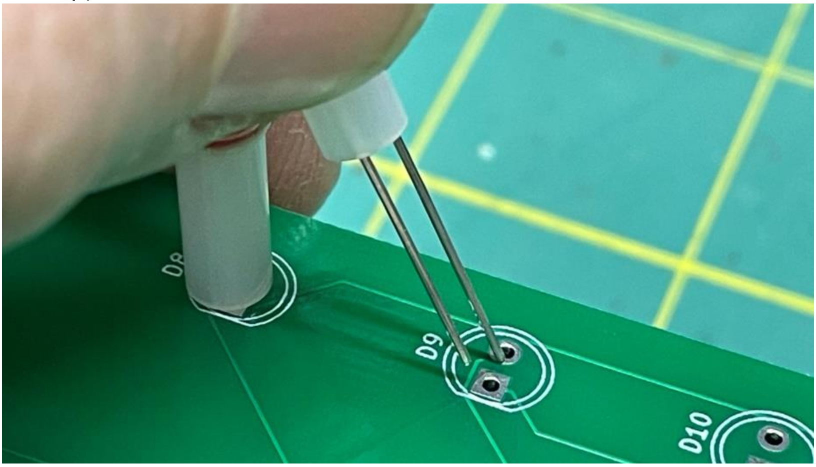
Be careful that you don’t over-heat the toggle switches while soldering. This can damage the switch mechanism. Instead of soldering all three lugs on the toggle one after the other, I solder the top lugs on all switches, then the center lugs, then the bottom lugs like this:



For the next few steps, we will bag number 4.

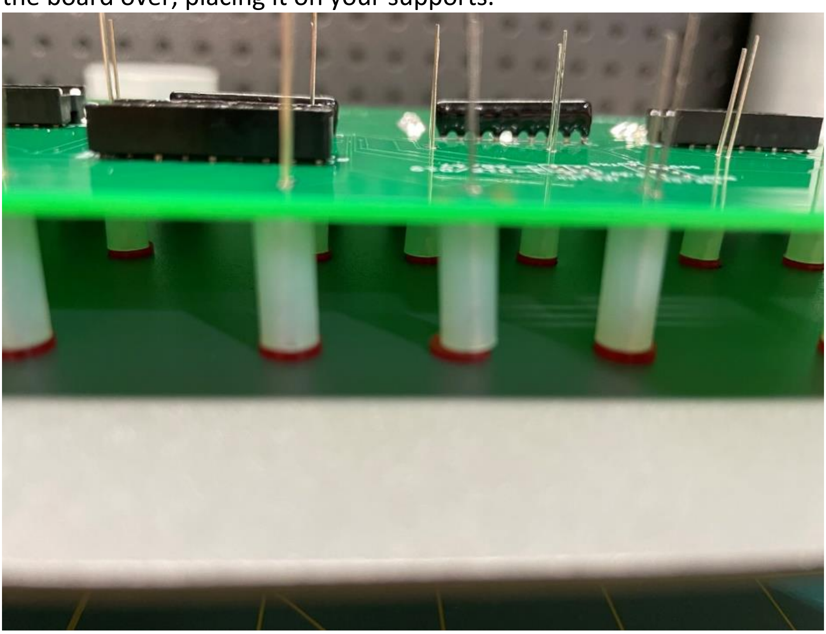


Place the main circuit board, top side up, on supports (like you did with the front panel earlier). Add 36 LEDs each with a 12mm standoff, paying attention to the correct polarity (long leg toward the top).

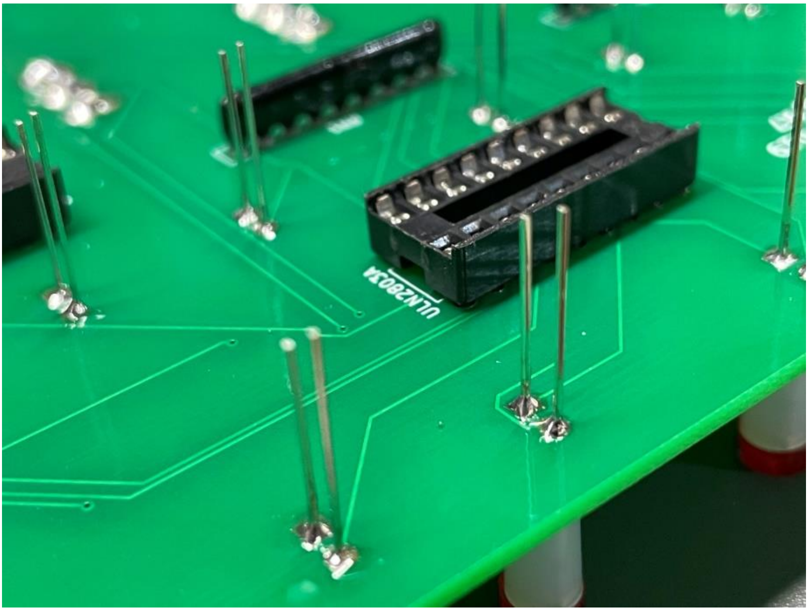


I like to support the circuit board at both ends and one support in the middle.

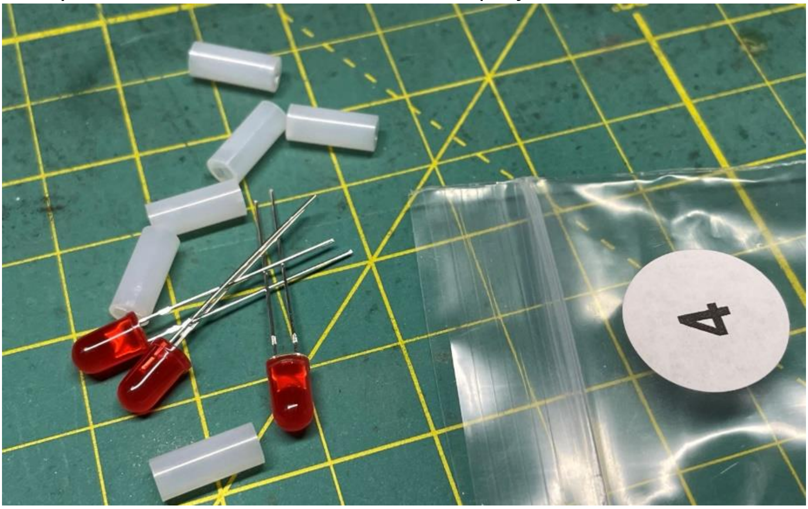
When all 36 LEDs and in place, put the front panel in place and flip the board over, placing it on your supports.



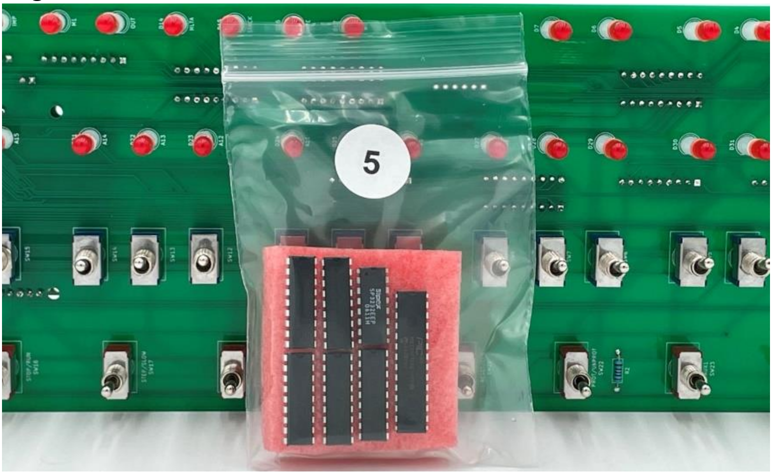
You may have to press down on the circuit board as you solder each leg of the LEDs. As you do this, make sure the long lead is in the correct location.



After all LEDs are soldered in place, you will find that you may have some LEDs and standoffs left over. You can discard them, but be sure you save one LED for use later in the project.

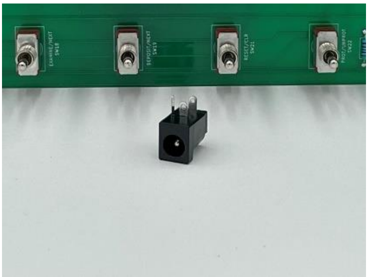
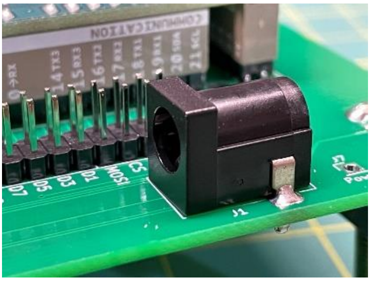


Bag number 5 is next.



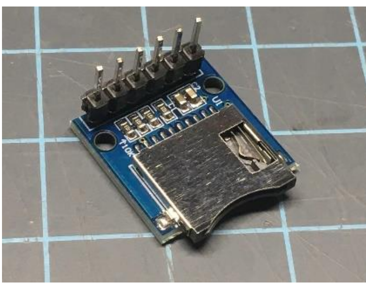
Insert five ULN2803 chips in the five 20-pin DIP sockets on the main circuit board. Be sure to pay attention to the orientation notch.

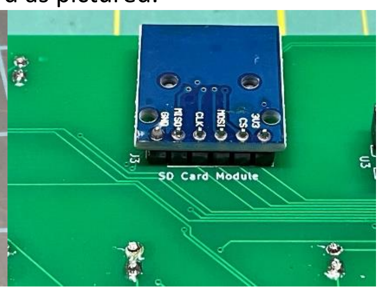
Take the DC-005 power jack from bag number 7 and solder it below where the Arduino sits.

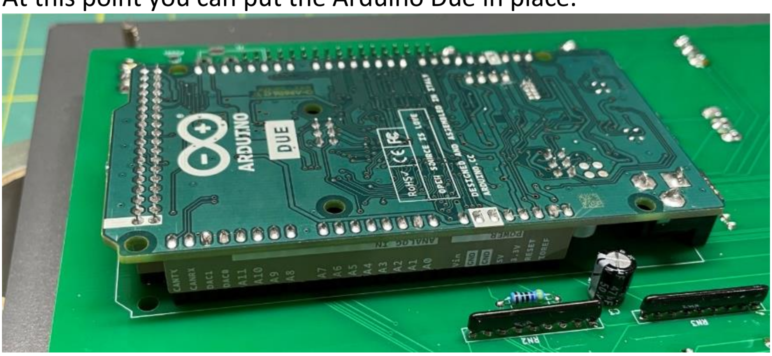
Take the SD Card module from bag number 8.

You will need to solder the male headers to the SD card module. It is very important you install the header as pictured, and solder it to the rear of the main circuit board as pictured:





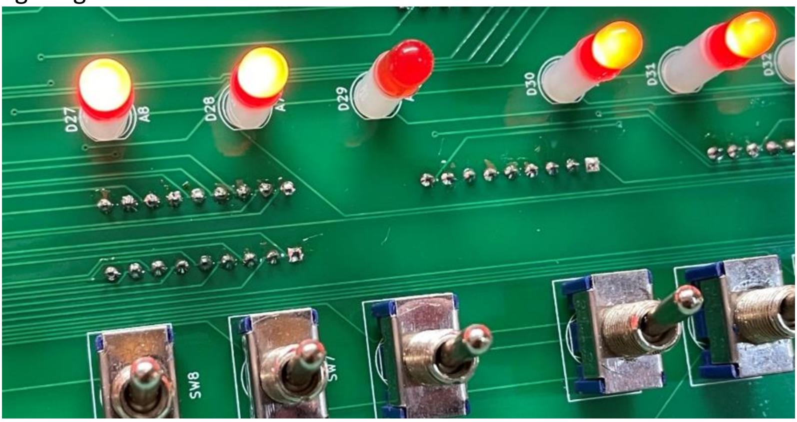
At this point you can put the Arduino Due in place.



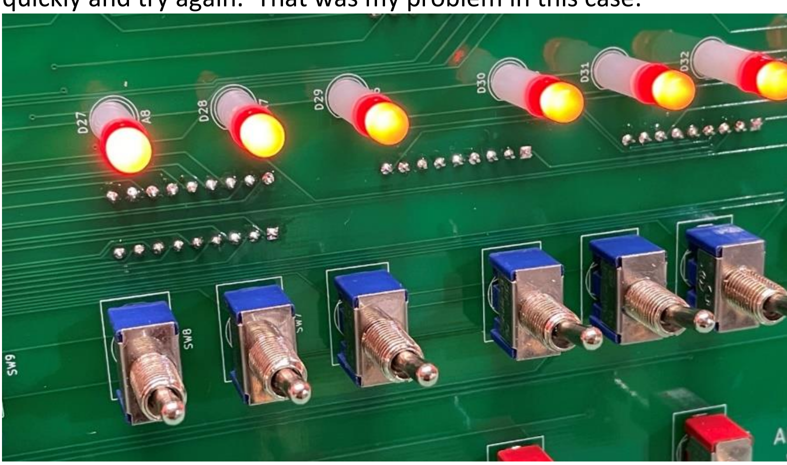
This is a good time to test your Altair-Duino. Plug a micro USB cable into your Arduino and connect it to a computer (or other USB power supply.) Try launching Kill-the-Bit by setting SW1 up and lower AUX1 as seen in this video: adwaterandstir.com/FirstTest.

Next, set SW0 through SW15 up and raise EXAMINE and see if all address LEDs illuminate. If not, check your solder connections.

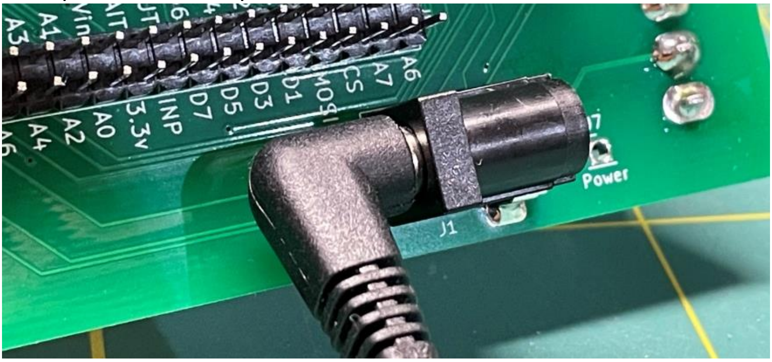
As you can see in this picture all data switches are up, but A6 is not lighting.



I checked the solder connections and all looked good. One thing I have seen in the past is that the toggle switches may develop some oxidation on the contacts when in storage. If you run into this situation, just toggle the switch back and forth several times quickly and try again. That was my problem in this case:

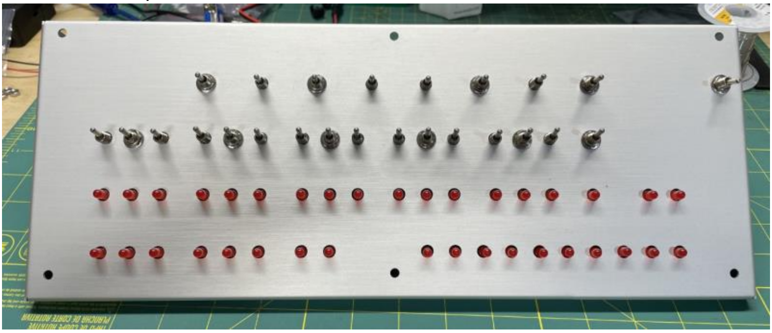


You can also plug the power adapter into the power jack and test the operation of the power switch.



Now we'll attach the main circuit board to the front panel. Take the front panel support bracket and insert the switches and LEDs through the holes.

Hold the front panel in place and secure it with several toggle switch lock washers and nuts (that you previously removed from the switches). You can use an 8mm socket driver for this.

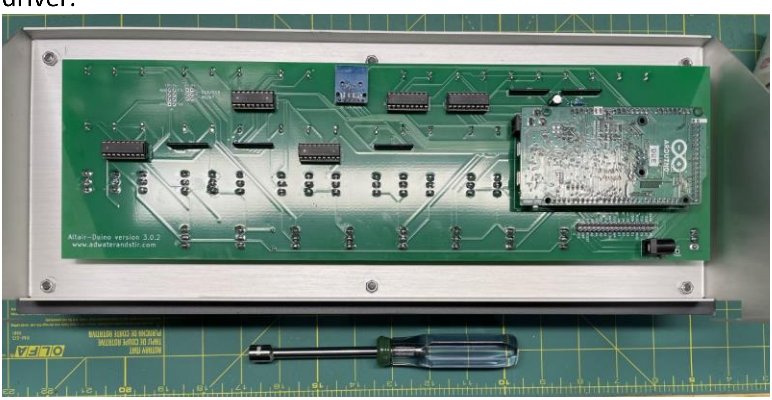


You don’t need to secure every switch, just enough to keep the board in place (you can see in the photo I secured 11).

It’s very important that you do not overtighten the nuts. As you can see it would be easy to break a switch without much force:

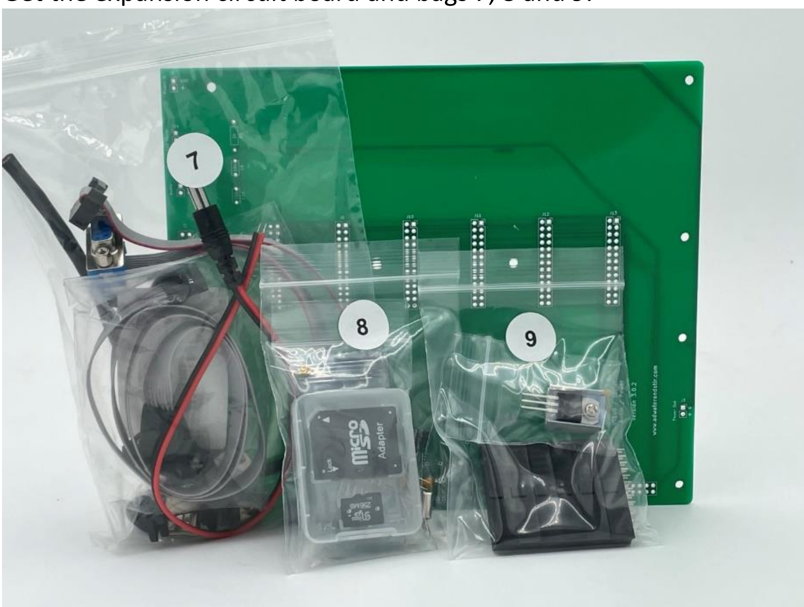
Only tighten the nuts until they are snug. About finger-tight.

Once the main circuit board is secured to the support bracket, reattach it to the front panel with six M4 nuts, using a 7mm socket driver.



The front panel is complete. You can set it to the side as we work on the expansion circuit board.

Get the expansion circuit board and bags 7, 8 and 9.



All component locations are clearly screen printed on the circuit board.

Resistor color codes:

1k (Brown-Black-Black-Brown)

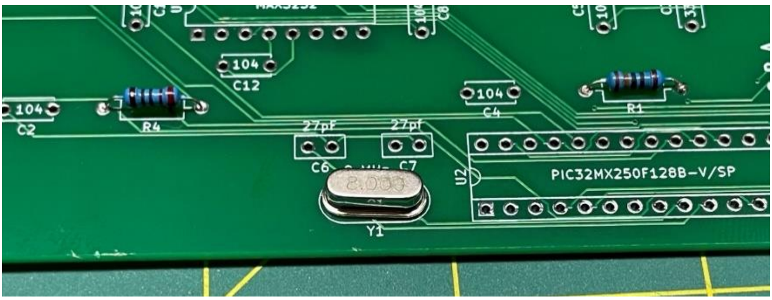
100k (Brown-Black-Black-Orange)

4.7k (Yellow-Violet-Black-Brown)

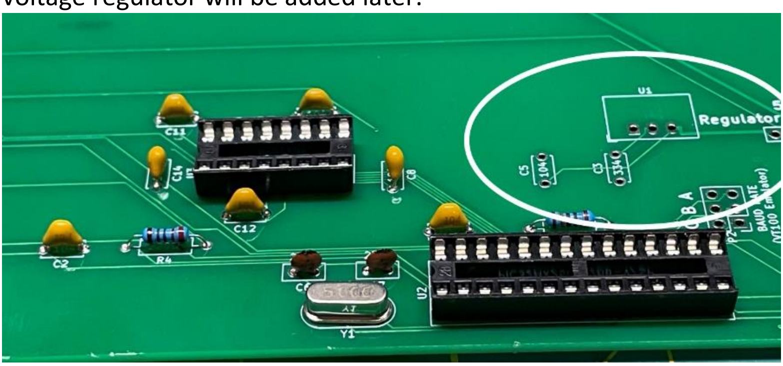
220 ohm (Red-Red-Black-Black)

150 ohm (Brown-Green-Brown)

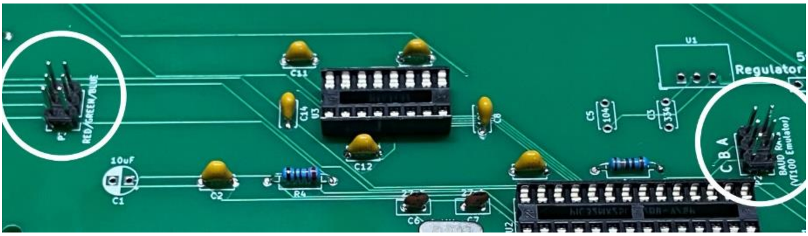
Start by installing the five resistors and crystal (from bag 8) in their locations as indicated on the circuit board.

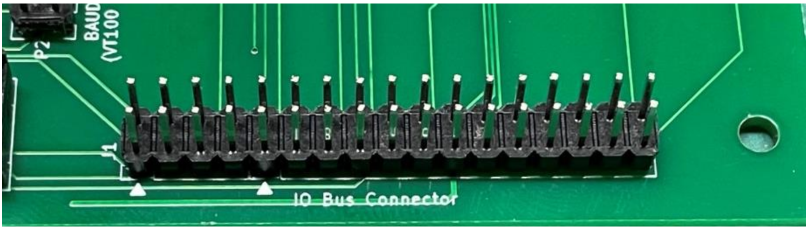


Add the DIP sockets (from bag 2) and two 27pF capacitors and nine 100nf (104) capacitors. You may notice there are locations for ten 104 capacitors. The 104 and 334 capacitors by the location of the voltage regulator will be added later.

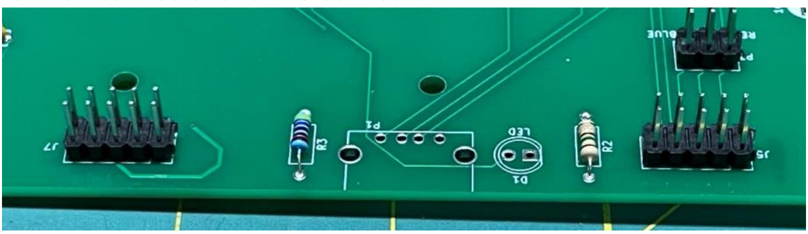


Cut two six-pin male headers and solder those to the circuit board for video color and VT100 baud rate. Also add the 34-pin double header to the left side.



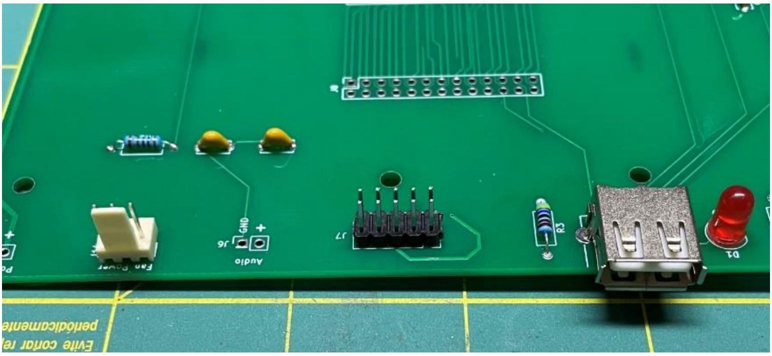


Add two ten pin double row headers to the top of the circuit board for VGA connector and DE9 connector.

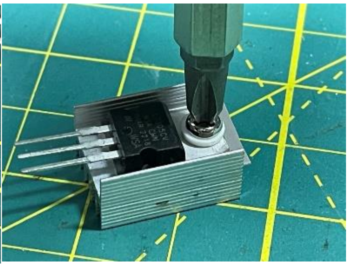


Add a 10uF capacitor, making sure to use correct polarity.

Add the USB-A jack and 3-pin fan connector to the circuit board as shown. Be sure to position the 3-pin connector with the correct orientation. Also add an LED next to the USB-A jack. Pay attention to the polarity (flat side indicated on silkscreen).

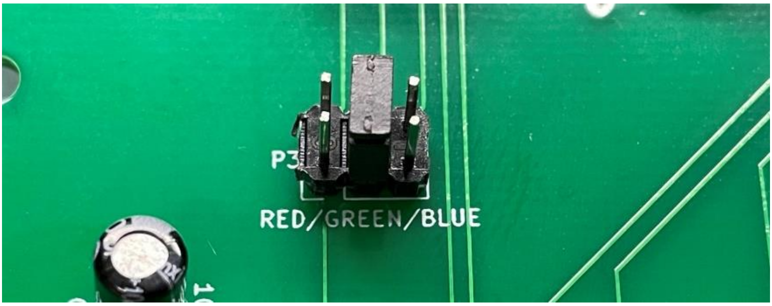


Take the small bag containing the power regulator from bag 9. Assemble the power regulator and heatsink (if necessary). First, put the thermal pad in place then attach the regulator with the included washer and bolt.



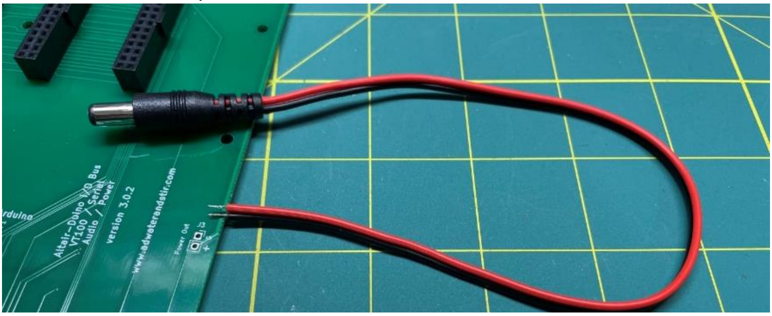
Solder the 104 and 334 capacitors to the circuit board, and then the voltage regulator. If you haven't already, add the 3-pin single header to the right of the voltage regulator.

There are four jumpers in bag 7. Add one jumper to select the VT100 text color.

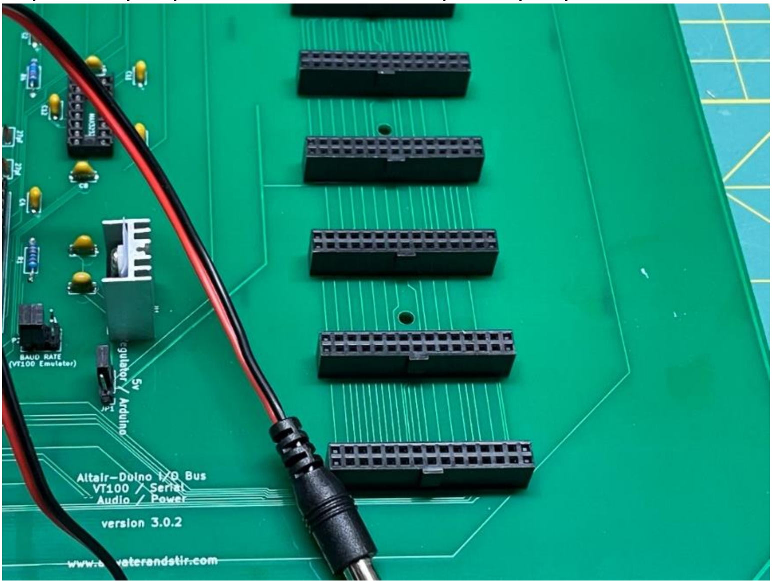


Add two jumpers to select the baud rate of the VT100 emulator – one at position C and the other at position B (this sets 9600 baud).

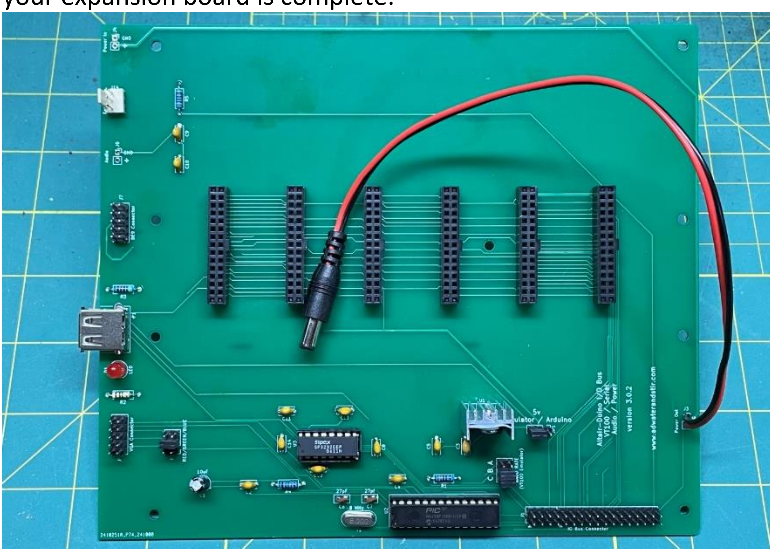
Get the pigtail power connector from bag 7. Solder this to the "power out" location on the circuit board (be mindful that the red wire is soldered to the + location and the black wire is soldered to the GND location).



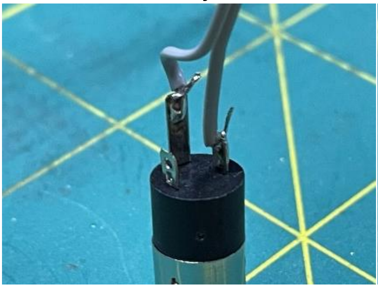
You can also add the six 26-pin expansion card sockets. It's very important you position these with the polarity key as shown:



Finally, add the PIC32 microprocessor and SP3232 from bag 5, and your expansion board is complete.



From bag 7 get the PJ392 audio connector and the 14 inch length of gray wire. The long leg is ground, the short leg is positive. You can also solder both short legs together if you wish. Solder the wire to the audio jack as shown:



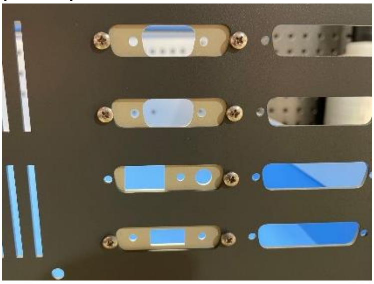
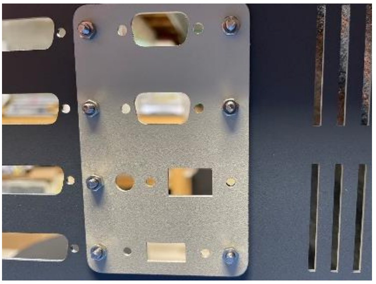
Get the DC-022 power connector and the length of power cable with an XH connector already attached and solder it to the power connector as shown:

Here’s another view:

For the next few steps we’ll need hardware from bag 6.

Take the rear ports panel from bag 9.

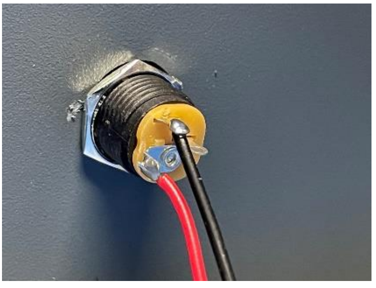
Take seven M3 bolts and seven M3 nuts from bag 6 and attach the ports panel as shown:

Notice the missing bolt on the second port from the bottom. Make sure you leave that open.

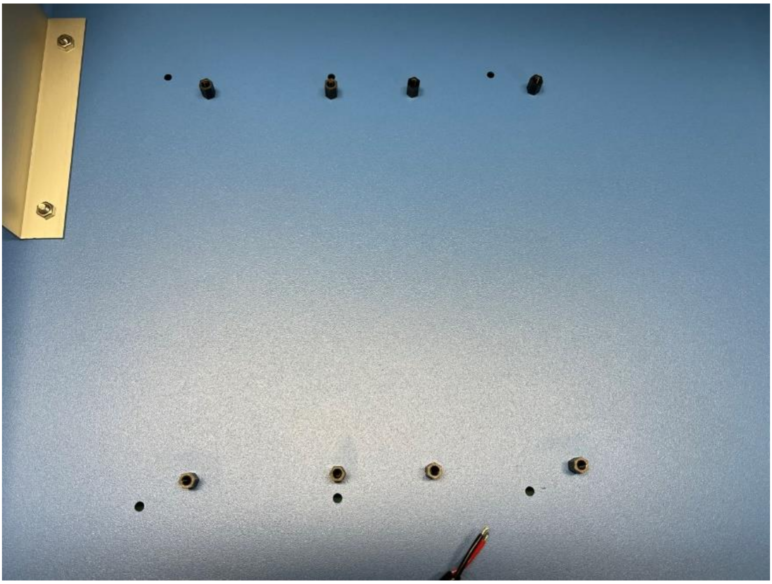
Add the audio jack you put aside earlier to the rear port panel.

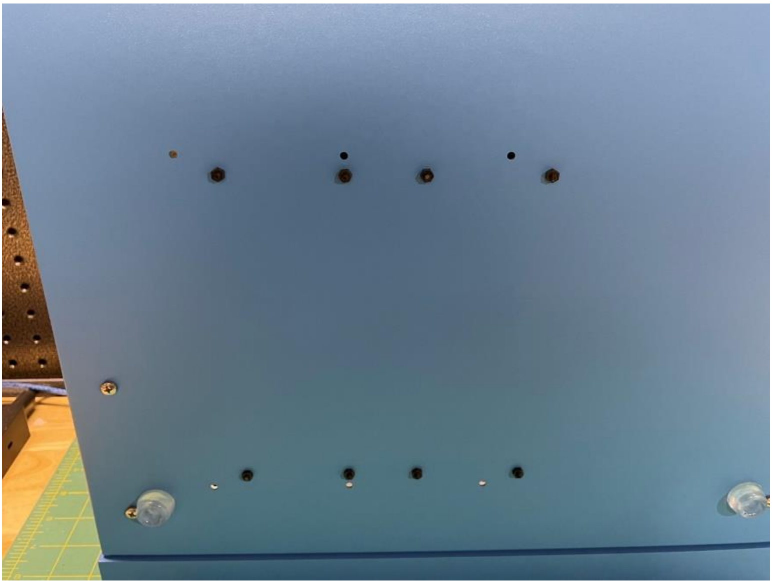

Add the power jack previously set aside to the rear of the case.

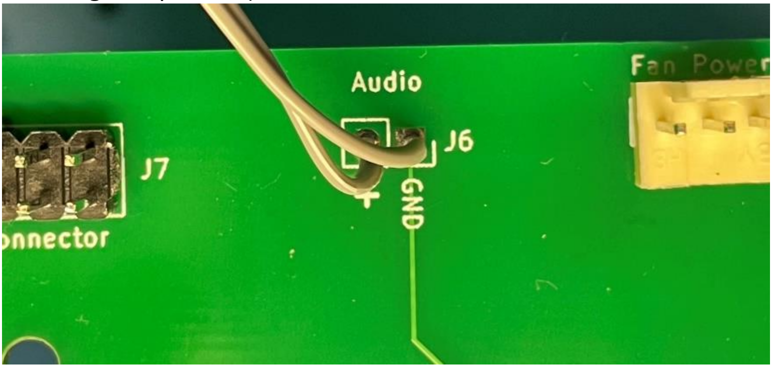
Would you rather power your kit with 110/220 volts? You can do this with the included strain relief bushing, a power cord, and a Mean Well SD-15-12 power supply (holes are cut in the rear of the case to match the mounting holes for this power supply). But this is optional and offers no enhanced performance or capabilities.

Add eight 8mm standoffs and eight nylon nuts to the bottom of the case as shown:

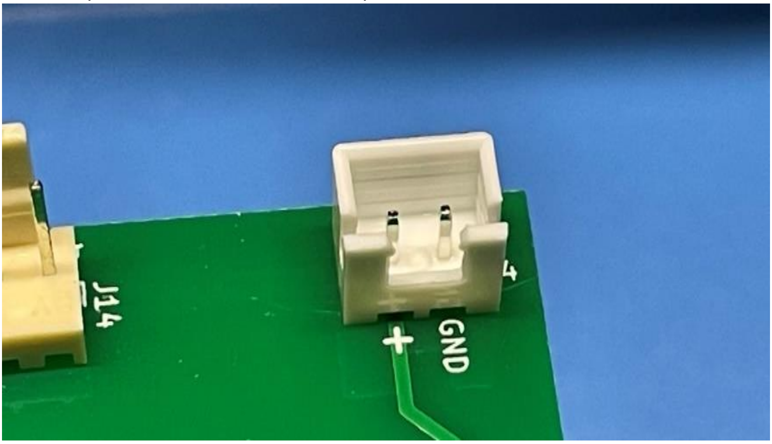




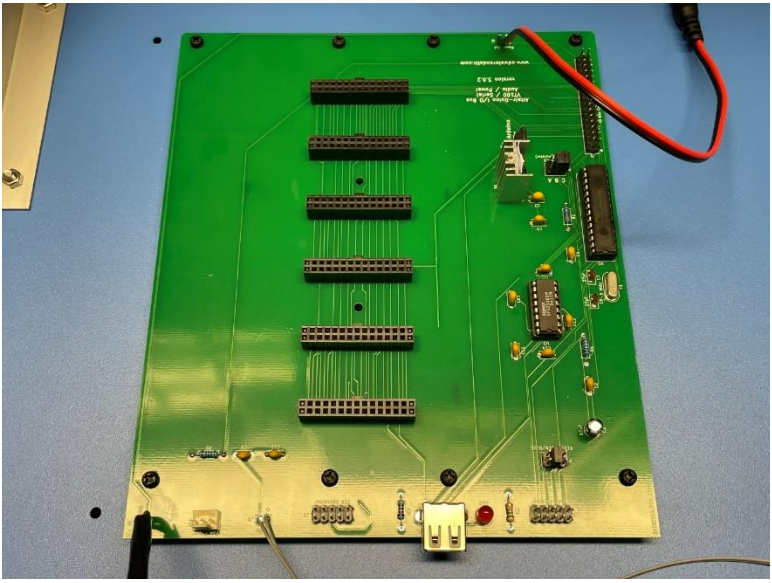
Solder the cable from the audio connector to the expansion circuit board. The wires are not color coded, so you will have to trace the wire back from the jack and solder the ground and positive to the appropriate locations (remember – the long leg was GND and the short leg was positive).



Solder the XH connector (should be plugged into the end of the incoming power cable) to the expansion circuit board exactly as shown (in this exact orientation):

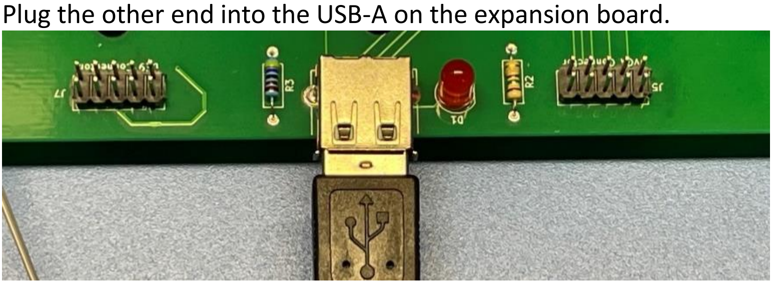


Attach the expansion circuit board to the standoffs you added to the case using eight 6mm M3 nylon bolts.

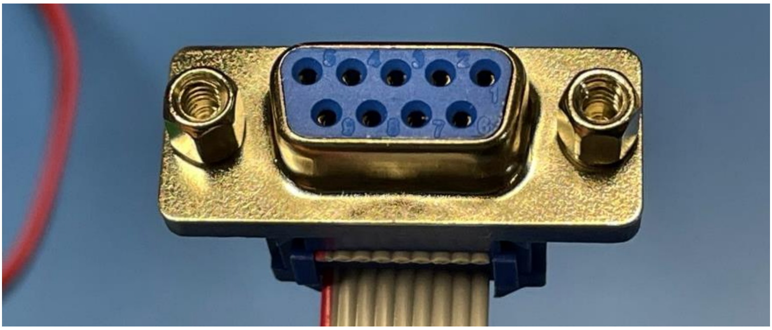


Attach the USB-A extension cable to the rear panel. The cable comes with two bolts, but I like to use one of the bolts that came with the cable, and the other bolt remaining in bag 6 (so it matches the others around the port panel).

Plug the other end into the USB-A on the expansion board.

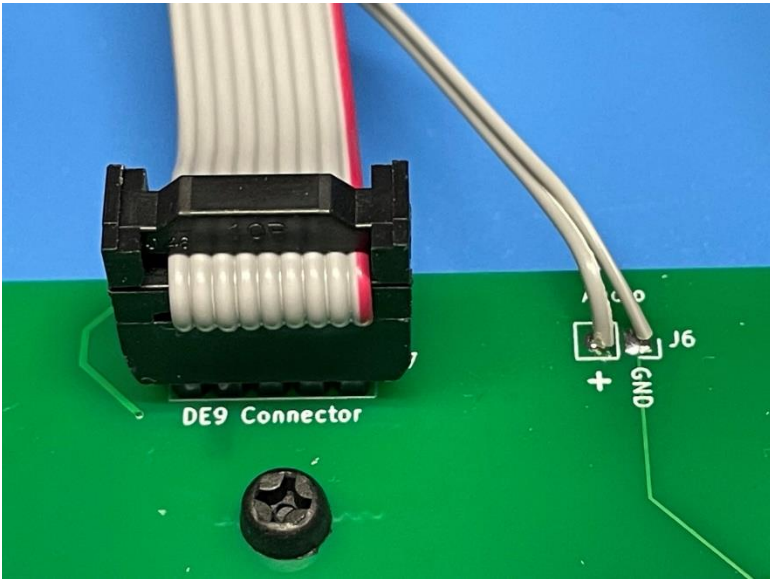


Remove the jack screws from the DE9 connector with needle-nose pliers or a 3/16” nut driver.



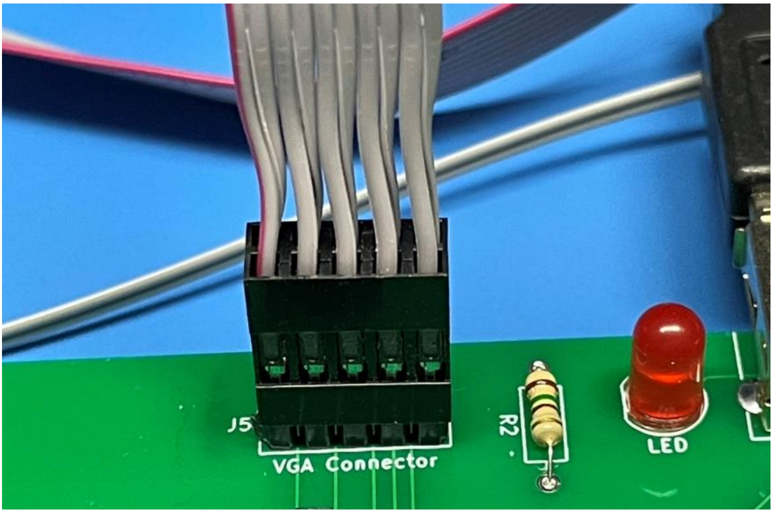
Mount the connector in the top port on the rear panel and replace the jack screws.

Plug the DE9 port into the expansion board with the red stripe toward the audio connection.



Similarly, remove the jack screws from the VGA connector and mount that in the rear panel.

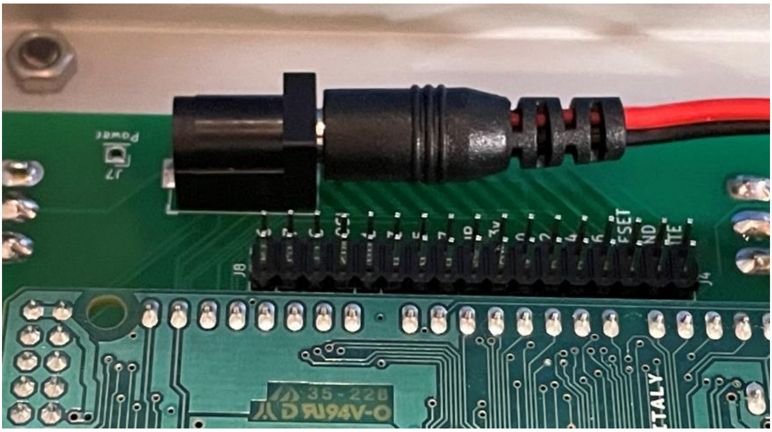
Plug that into the expansion board with the red wire facing **away from** the resistor and LED.



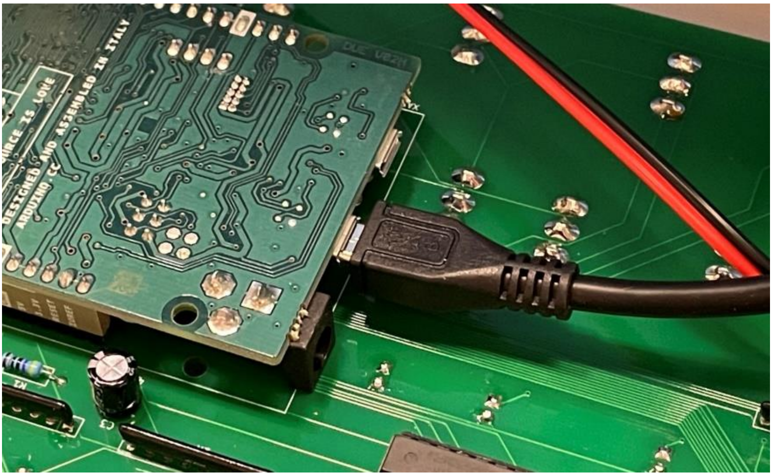
Mount the Micro USB extension to the final spot on the rear ports panel.

This would be a good time to add the front panel assembly and bracket back into the case. Secure it with four M4 bolts and four M4 nuts.

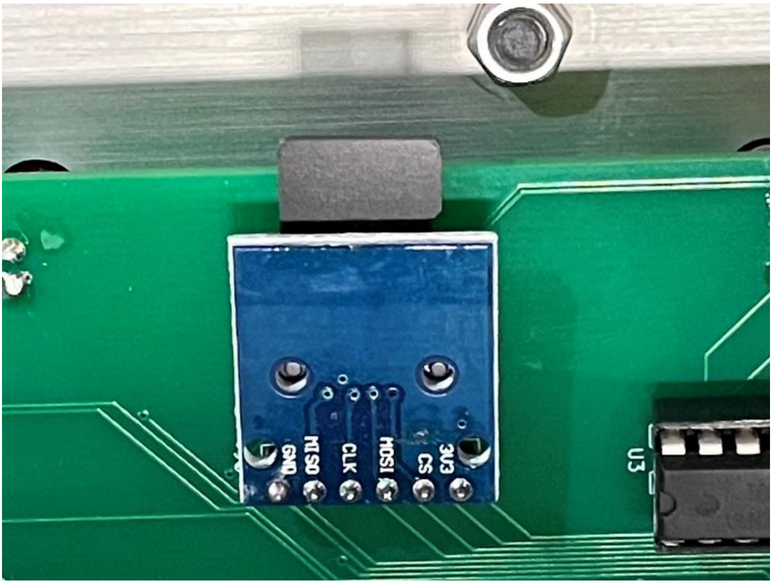
Plug the power connector from the expansion board into the main circuit board.



Plug the micro USB extension into the Programming port on the Arduino Due (the port closest to the Due’s power connector).

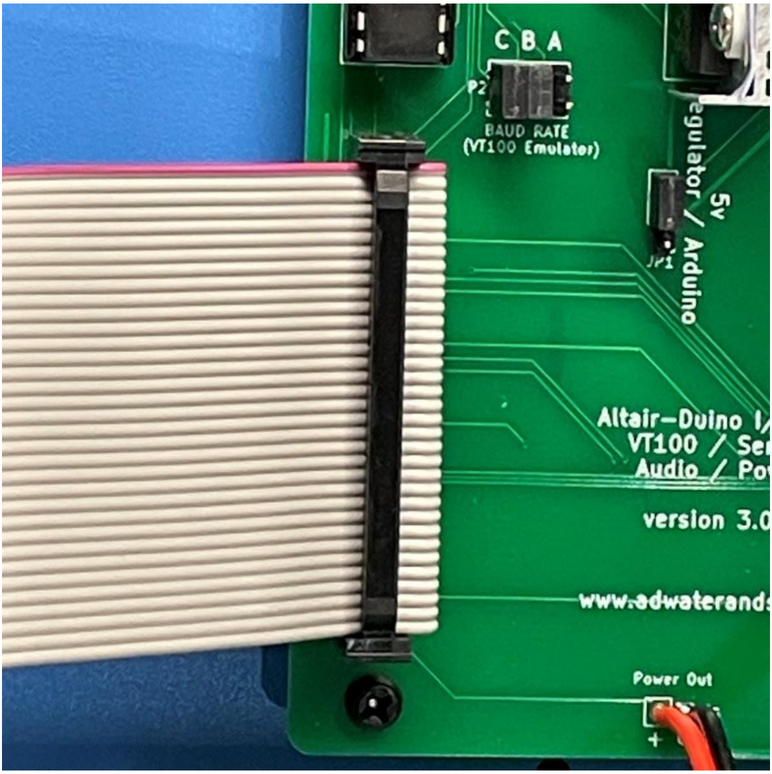


Insert the micro SD card into the card module with the printed side of the SD card facing the main circuit board.

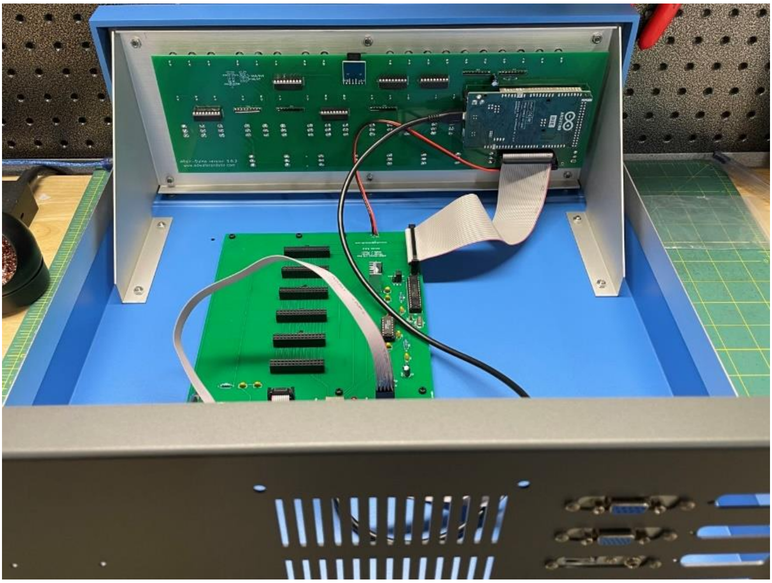


Plug the 34-pin ribbon cable into the main circuit board. Note the orientation and the location of the red wire.

Plug the other end of the cable into the expansion circuit board. Again, note the orientation.



You have assembled all components of the Altair-Duino Pro.



You can now replace the cover and secure with two M4 bolts.

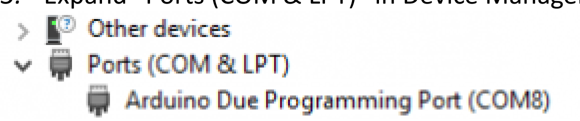
CONGRATULATIONS! YOUR ALTAIR 8800 IS COMPLETE!

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:

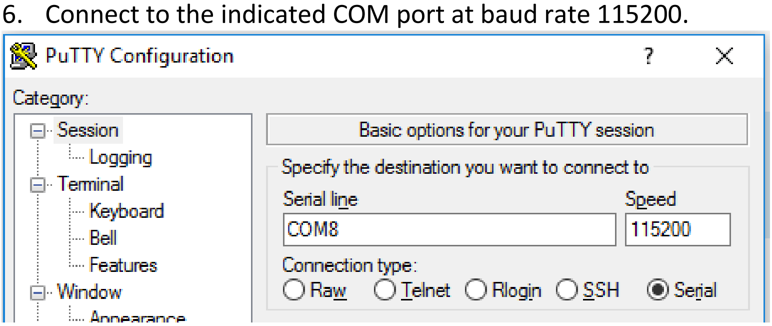
By default, your Altair-Duino is set up to communicate through the USB port.

1. Plug USB cable into computer and the other end to your Altair-Duino's micro USB port.
2. Windows 11 should automatically recognize a new serial port. To check, launch "Device Manager".
3. Expand "Ports (COM & LPT)" in Device Manager

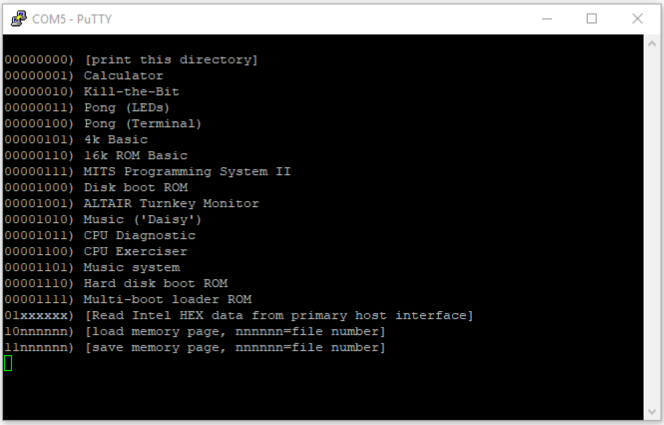


(COM8 is an example, your port may be different.)

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 DE9 connector to your serial device.
2. Connect a power supply to the Altair-Duino.
3. **Make sure the SD card is inserted.**
4. Set front panel data switches to “2” (switch 1 up, all other switches down).
5. Raise (and hold) DEPOSIT up.
6. Turn on Altair-Duino.

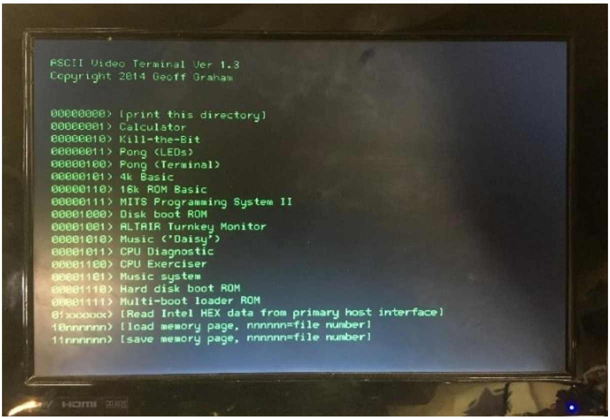
This will cause the Altair-Duino to load configuration 2 on power up. This configuration has been saved to communicate on serial port 2 at 9600 baud. If you want to communicate at different serial port settings, you will need to adjust the setting for configuration 2 (or create your own configuration). See David Hansel’s official project documentation for this information.

https://github.com/dhansel/Altair8800/raw/master/Documentation.pdf

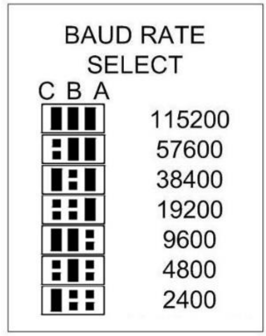
Using Geoff Graham's VT-100 emulator on serial port 1:

1. Plug a VGA monitor and USB 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.

This will cause the Altair-Duino to load configuration 1 from the SD card on power up. This configuration has been saved to communicate on serial port 1 at 9600 baud. You should see "ASCII Video Terminal Version 1.3 Copyright 2014 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.



Baud rates for the VT100 emulator (only):
The VT100 emulator and settings on the included SD card are set up for 9600 baud. Other baud rates are supported. Use the following jumper settings from this table:



The baud rate jumpers MUST match the baud rate set in the configuration menu for pin 18/19. I would encourage you to leave it set to the default 9600 baud. Other baud rates for the DE9 serial port (9600 default) and USB serial port (115200 default) are controlled in the configuration menu.

Getting a directory of disk images available on the SD card:

Raise STOP and RESET to stop the Altair from whatever it's doing. Raise SW12 and keep all other switches down. Toggle AUX2 down and you will see a directory of disk images available. To load a disk image, set the data switches to the binary number corresponding to the disk number. For example, Zork is disk 04, or 100 in binary. Set switch 12 up (indicating you are loading a disk image), and SW3 up. All other switches should be down. Then toggle AUX2 down. Your terminal should say "[mounted DISK04.DSK in drive 0]"

To run the disk book routine – SW3 up, all other switches down. Then toggle AUX1 down to run. You will see on the terminal that CPM is loaded and show the command prompt "A>".

Type ZORK1, ZORK2, or ZORK3 to run a game.

Please see the website (adwaterandstir.com/operation) 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).

You may have noticed you added a three-pin connector for a fan, yet there is no fan included with the kit. Unlike the original Altair, this kit does not generate much heat and therefore a fan would be used only for effect.

You can easily and inexpensively add one. Just look for a 120mm fan with 3-pin connector. They are available everywhere – Amazon, eBay, DigiKey, Mouser, Ali Express, etc. The fan will come with screws to attach it to the back panel, then just plug it into the expansion board connector.