

Altair-Duino Assembly & Operations



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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, like resistors/LEDs/transistors.)

PARTS LIST (STANDARD VER.)

- 1 x PC board
- 36 x 5mm red LED
- 36 x 12mm LED
standoff
- 36 x NPN transistor
- 36 x 1k Ω resistor
- 36 x 10k Ω resistor
- 17 x Mini toggle on-off
- 8 x Mini toggle (on)-off-
(on)
- 1 x 470 Ω resistor
- 1 x 47 μ F capacitor
- 2 x 1k Ω resistor
- 2 x 0.1 μ F 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 Micro SD card
- 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
- 1 x 3.5mm Audio jack
- 5 x 100nF (104)
capacitors
- 1 x Clear acrylic back
- 1 x Laser-cut rear panel
- 6 x 8mm steel screws
- 2 x M3 steel nuts
- 1 x jumper
- 4 x 20mm F-F standoff,
or if you purchased
your kit September
2020 or later:
 - 1 x 14-pin header
 - 4 x 28mm Standoffs

OTHER PARTS YOU MAY NEED

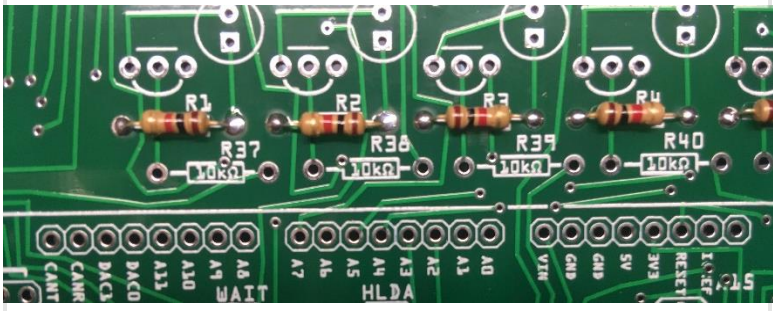
- Soldering Iron with a nice fine tip
- Good Solder (I recommend Alpha Fry Rosin Core 0.032")
- De-soldering Iron (optional)
- Phillips Screwdriver
- Needle-nose Pliers
- Side Cutters (Nippers)
- Computer

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.

Start by finding the bag labeled "1k Ω Resistor".



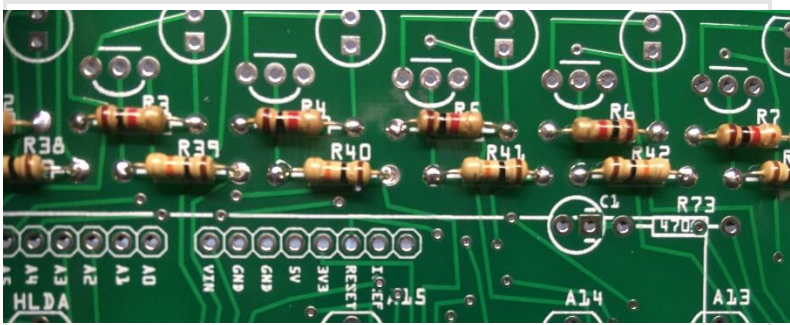
Add the 36-1k Ω resistors to the top rows under the LED/Transistor pairs in locations R1-R36. Resistors are non-polarized, meaning they can go in either direction; you do not need to worry about orientation.



Next is the bag labeled “10k Ω Resistor”.



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



Next is the bag of 36 transistors.



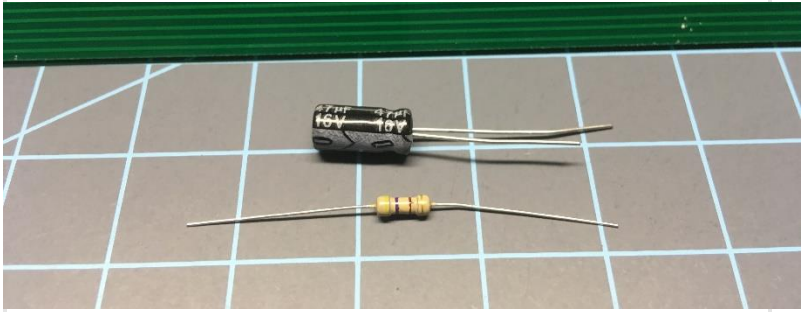
The orientation of the transistor is crucial, but relatively simple. Just make sure the flat end of the transistor is facing up, just like the image printed on the circuit board.



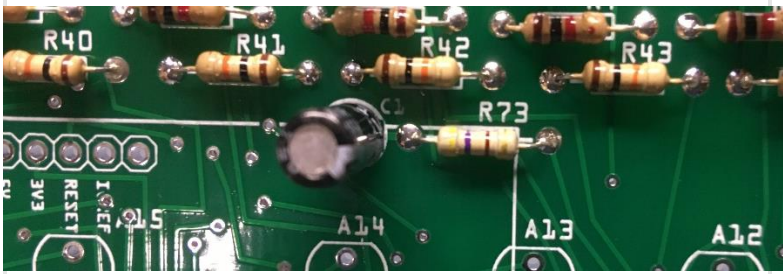
Grab the ziplock bag of assorted parts.



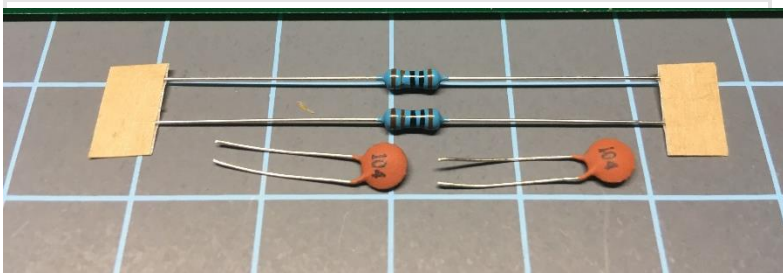
In that bag you will find one electrolytic capacitor and one 470Ω resistor (Yellow, Violet, Brown, Gold color code). If you don't want to decipher the color code, just know you will find three resistors in the bag, two that match, and one that does not. This is the one that does not match another.



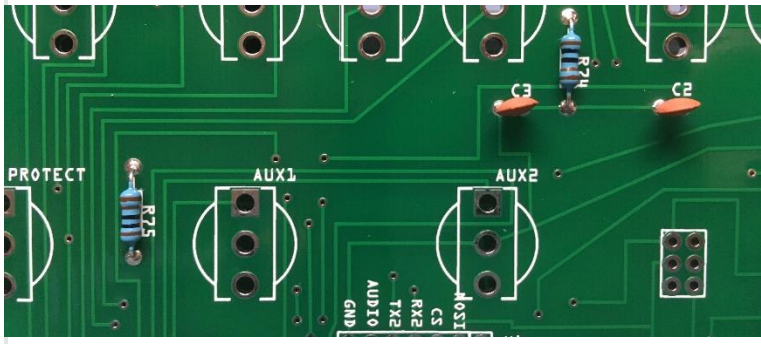
These two components mount on the PC board in R73 & C1. The orientation of the resistor does not matter, but make sure the short lead of the capacitor (marked with a "-" on the side) goes in the hole also marked with a "-".



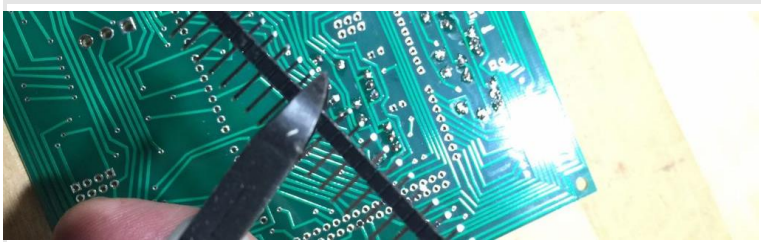
In the same bag, you will find two $0.1\ \mu\text{F}$ capacitors (marked with "104") and two $1\text{k}\Omega$ resistors (Brown, Black, Red, Gold).



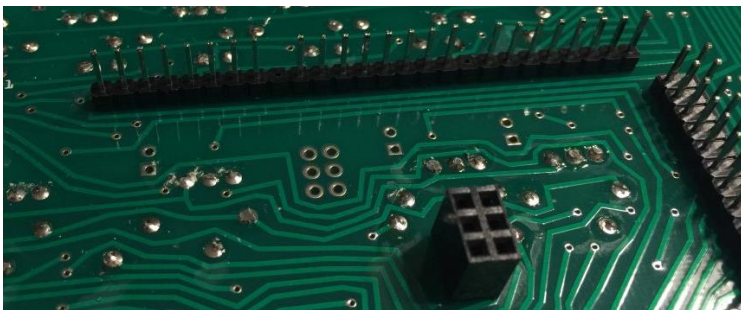
Those are mounted on the front of the PC board in R74, R75, C2, and C3 on the lower right side of the board. The orientation of the components does not matter.



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 (2x18 pin) header.

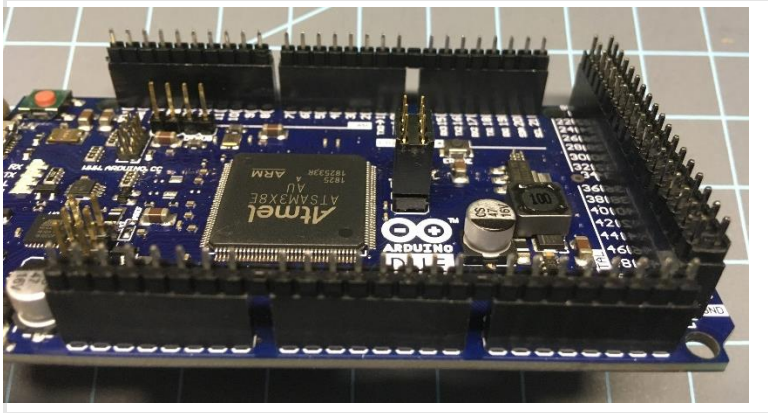


Add the male headers to the underside of the PC board. You can also add the six-pin female header for the SPI connector on the Arduino. Make sure you add these to the correct side of the board because desoldering 92 connections would not be fun!

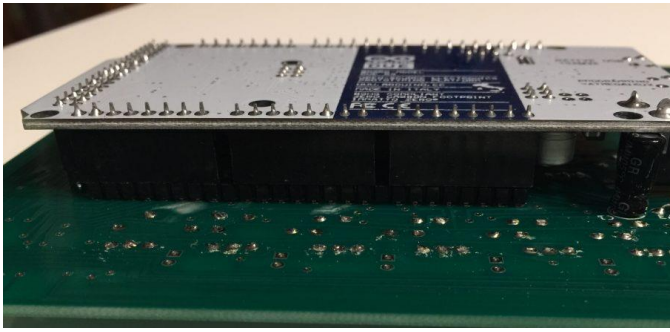


Solder the headers carefully. Make sure they are as close to vertical as possible, and make sure the solder flows completely over the connection. **Most problems happen here with cold solder joints, or solder bridges.**

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.



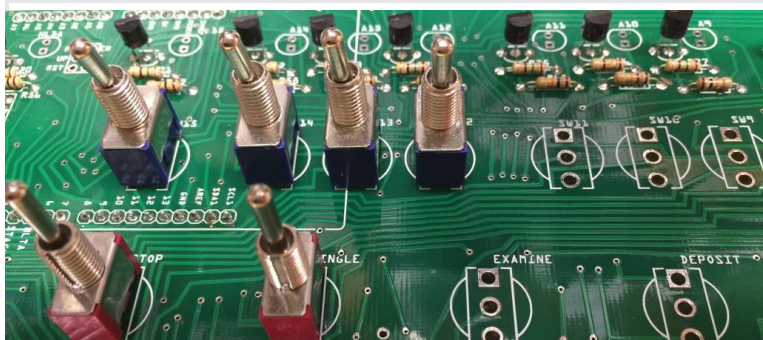
After you are done soldering the headers, try putting the Arduino in place and check for a secure fit. Remove it when you are done.



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.

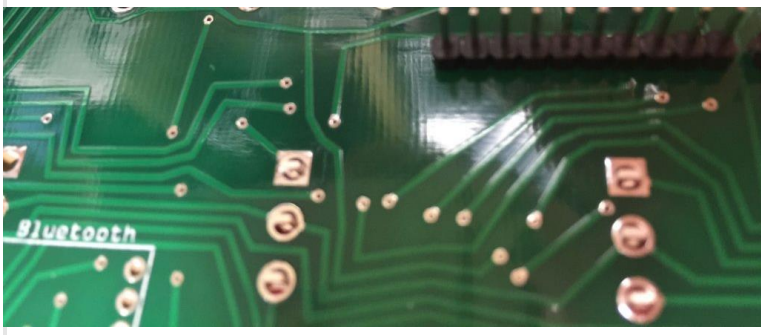


Put the front panel in place to hold the switches in the correct position (having all two-way switches in the down position makes this easier.)



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!

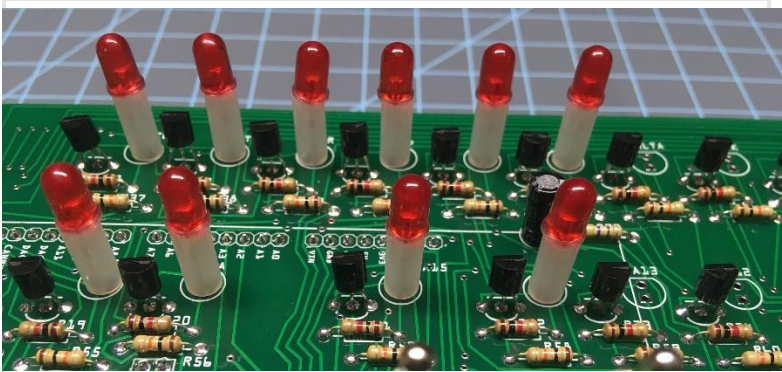


Next is the bag of LEDs and 12mm spacers.



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.

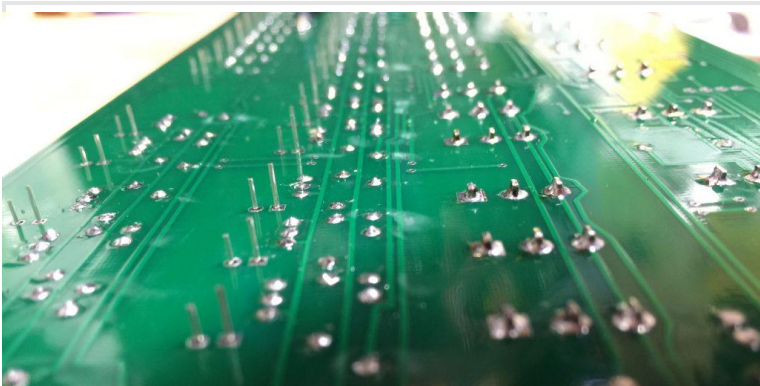
The orientation of the LEDs is crucial. Make sure the long lead of the LED is toward the bottom of the PC board and the flat side of the LED is toward the top.



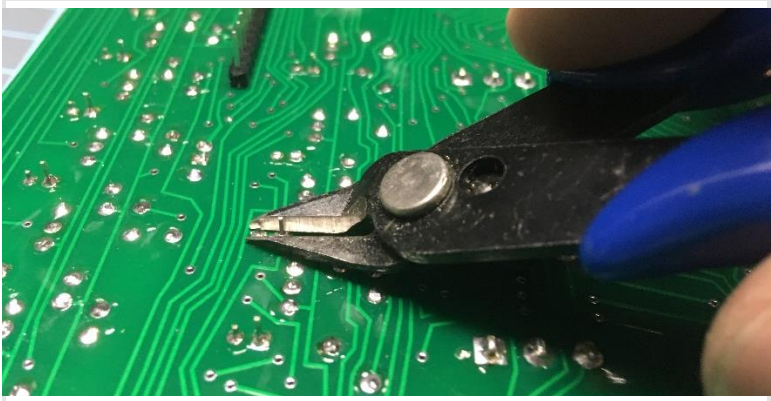
Again, like the switches, put the front panel in place to hold the LEDs while you solder them.



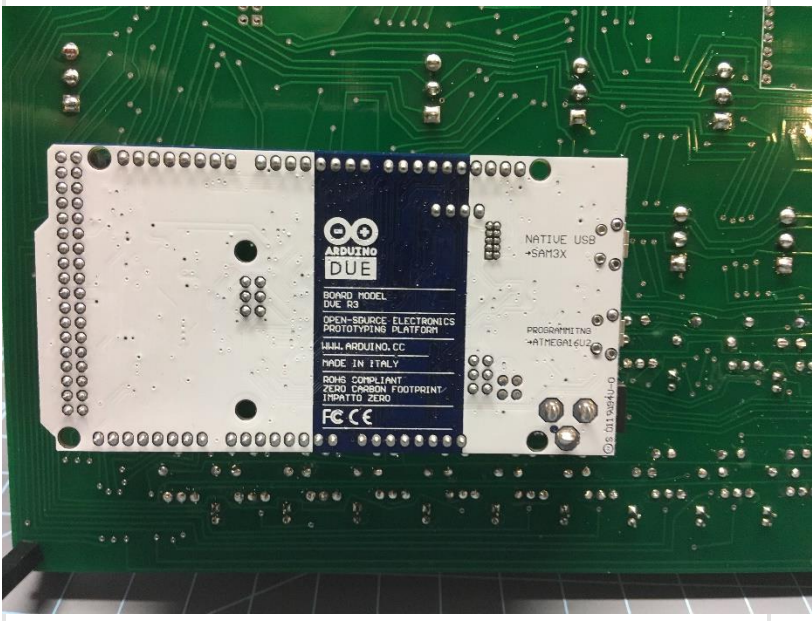
While you are soldering the LEDs, you can verify that the long lead is toward the bottom of the board.



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.

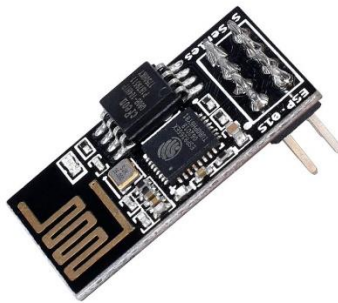


This is a good time to test your kit so far. Take the USB cable and plug it into the Programming port on the Arduino. Turn the board over (so you are looking at the face) and plug the other end of the USB cable into a computer or USB power supply. When the kit is powered, all LEDs will briefly flash,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

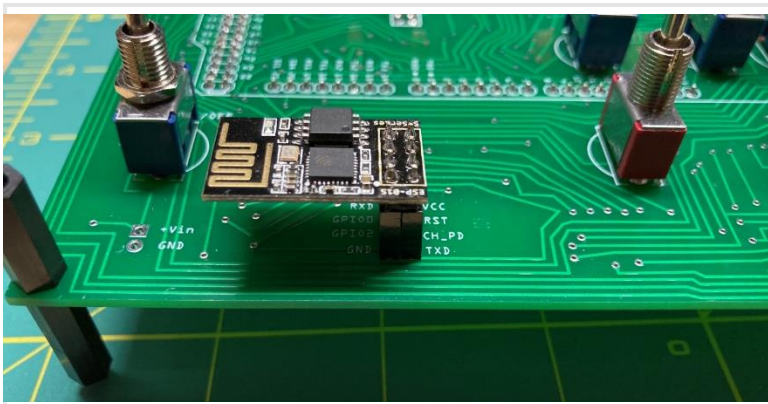
to set SW1 on and lower the AUX1 switch. This will run “Kill The Bit” and you will see LED15 to LED8 light in sequence.

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 purchased the pre-programmed ESP-01s for WiFi, this would be a good time to install that.

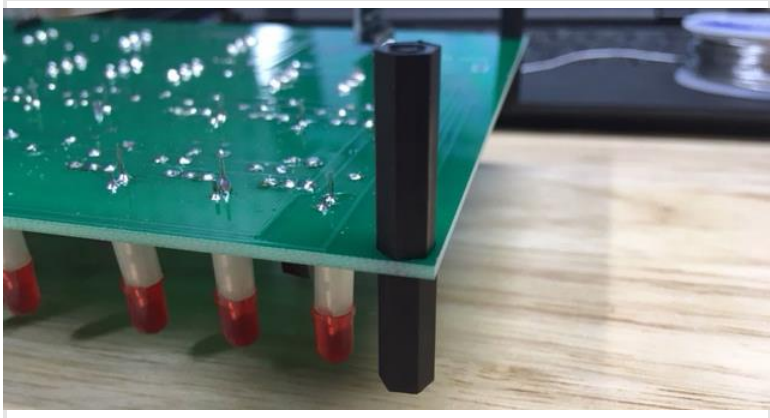


Locate the footprint for the ESP-01s on the front, lower left side of the Altair-Duino circuit board. Solder the included eight-pin header into this location (on the front of the PCB.)

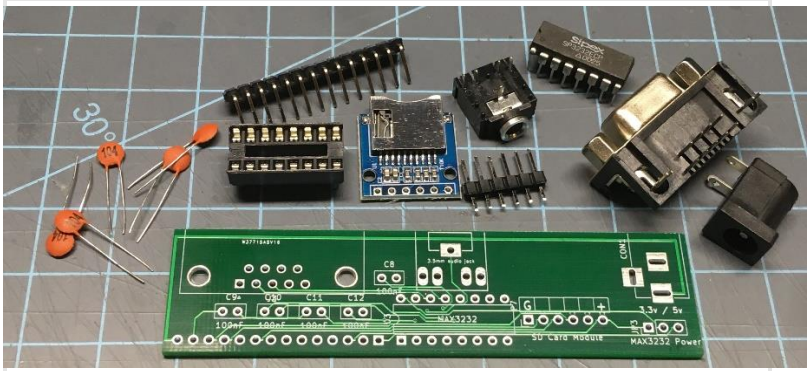


Place the ESP-01s into the header as shown. Operation instructions continue after the build is complete.

Add the 14mm male/female standoffs on the top. If you received the 20mm female/female standoffs, use them on the bottom if you want to solder the daughter board directly to the main PCB, otherwise use the 28mm female/female standoffs on the bottom (the side with the Arduino) and use the 14-pin female header.



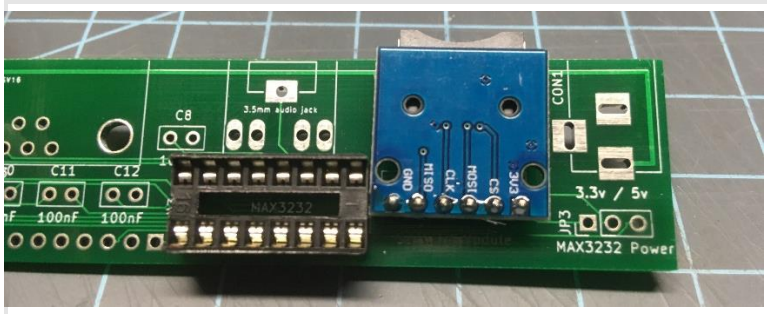
Next, you will assemble the expansion board.



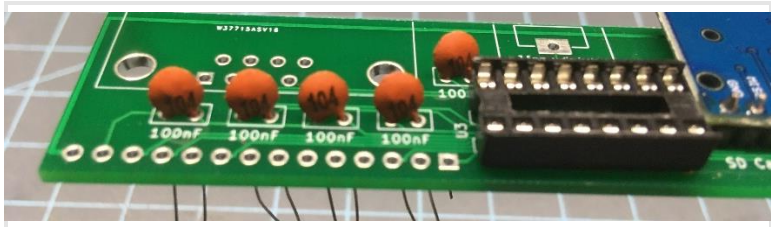
If the header pins are not attached to your SD card module, solder the header pins as pictured (this is important and often overlooked):



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.

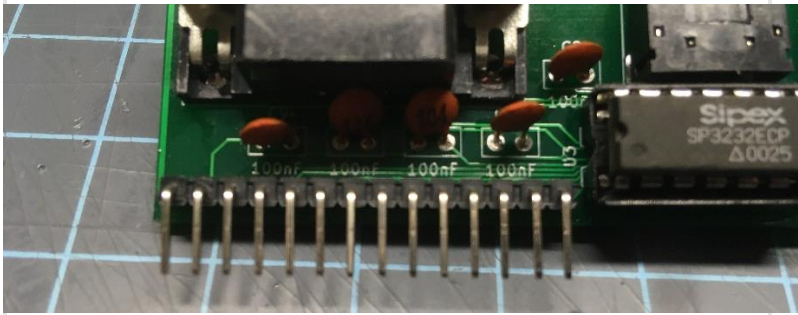


Add the DB9 serial port, audio jack, power jack, and 3-pin header to the circuit board.

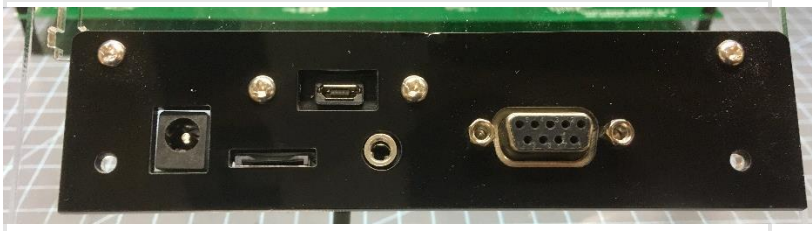


Add a jumper to the “MAX3232 Power” header. You will want to start with the jumper on the 3.3v position. I have found there are some older MAX3232 chips that require 5v, but that’s fairly rare.

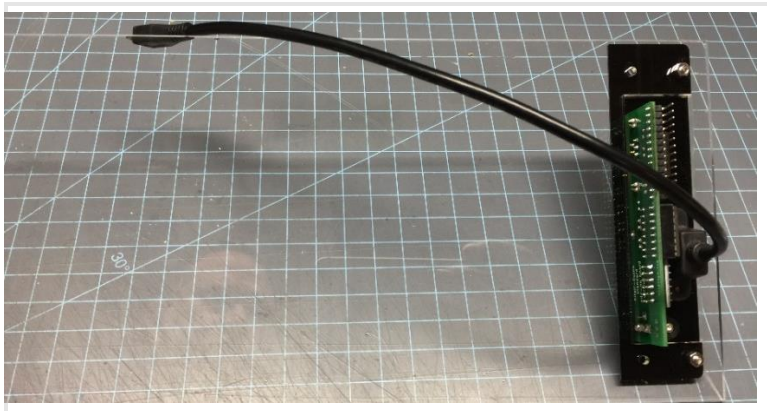
Add the SP3232/MAX3232 IC to the DIP socket, and solder the 90 degree angle header to the FRONT of the circuit board, as shown.



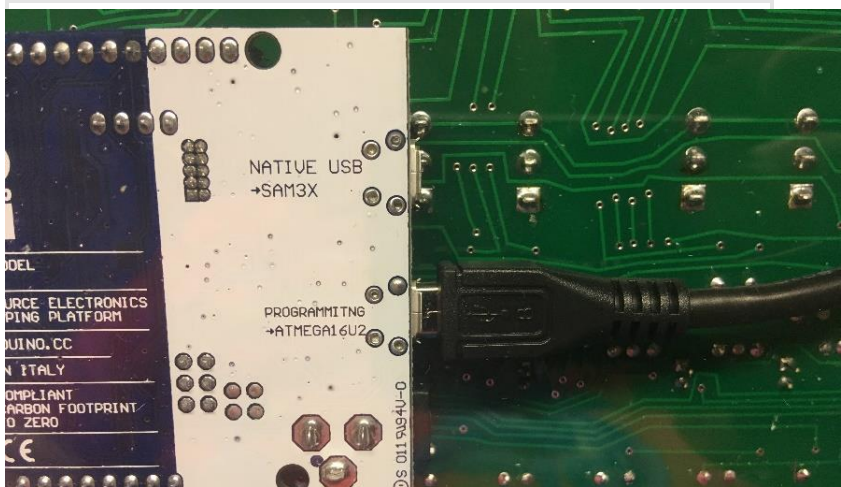
Add the rear panel to the expansion module and attach the USB extension to the rear panel. Take the clear piece of acrylic and remove the protective paper. Attach the expansion module as shown (note the position of curved corners on the top of the rear panel) using the top two 8mm bolts and nuts.



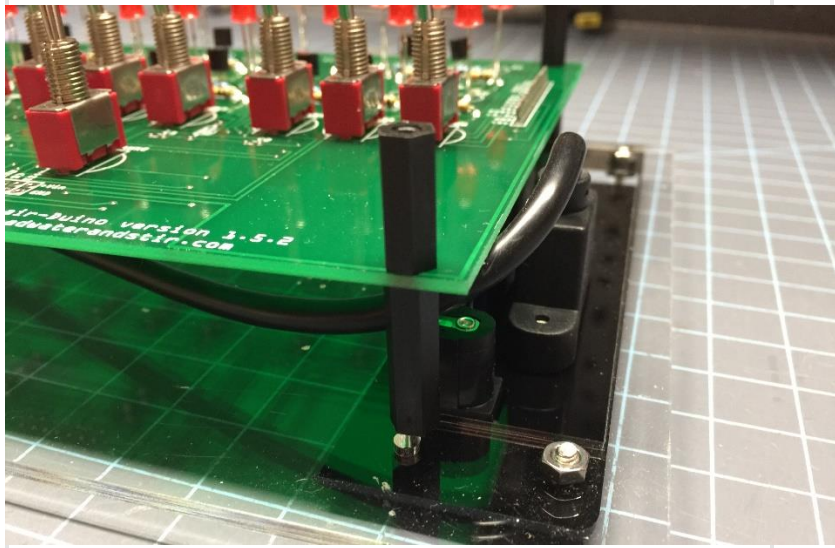
Your rear panel will look like this from the inside:



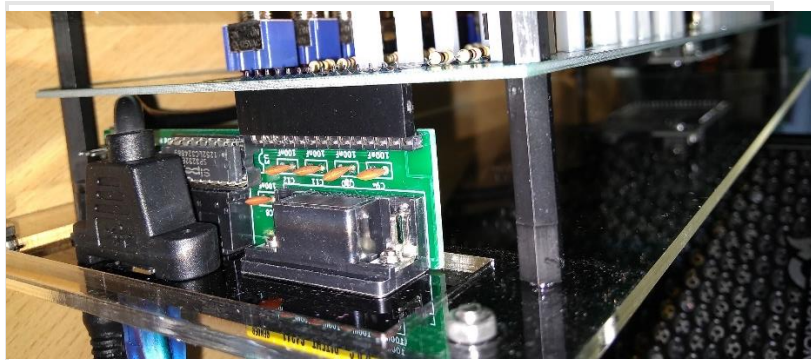
Plug the USB extension cable into the PROGRAMMING port on the Arduino Due.



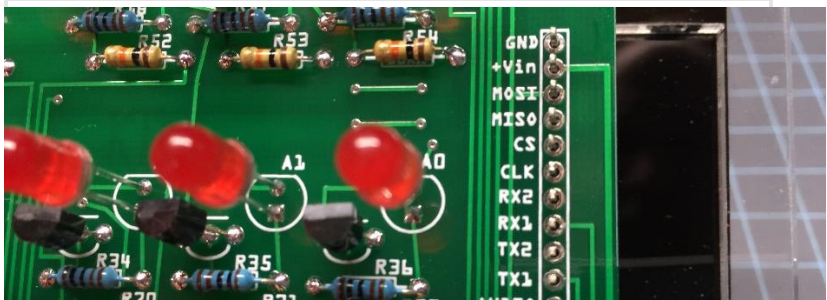
Put the main circuit board in place, taking care to guide the USB extension cable between the power jack and nylon standoff for the main circuit board.



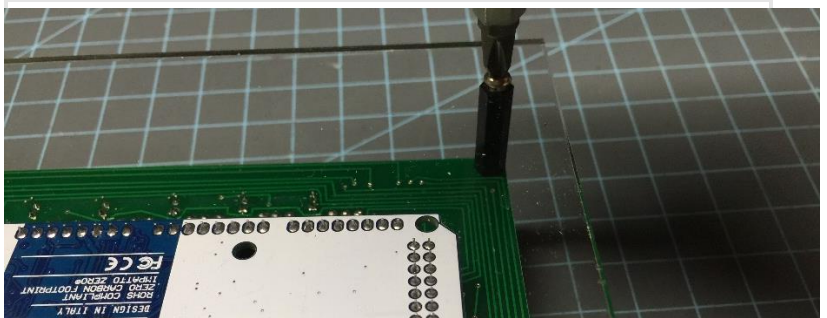
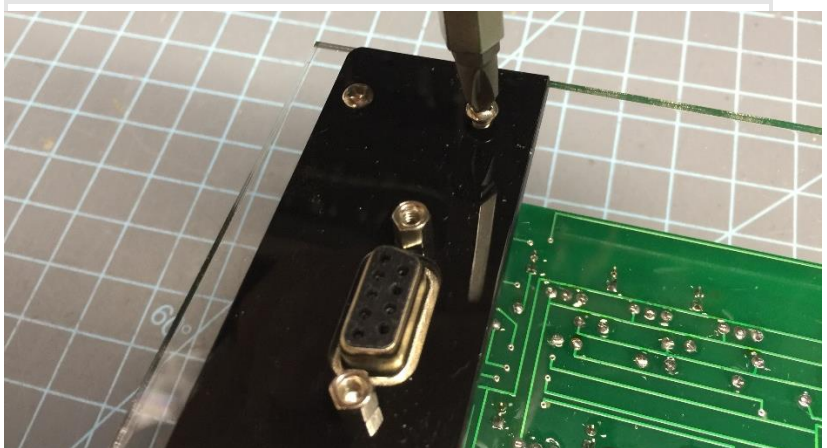
If you have the updated version of the kit purchased in September 2020 or later, you will have a 14-pin female header. This goes between the main circuit board and the daughter board.



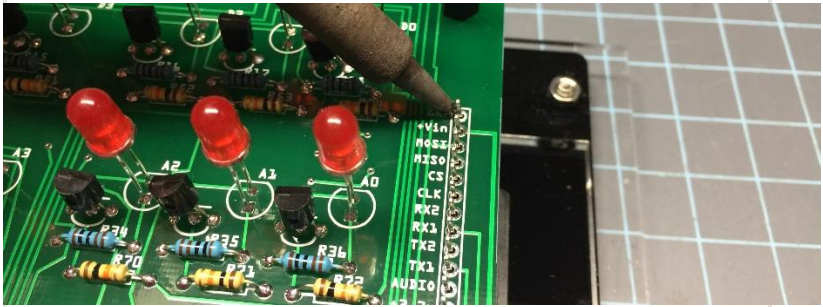
Guide the 14 pins from the expansion board (or female header) into place.



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.



CONGRATULATIONS! YOUR ALTAIR 8800 IS COMPLETE!

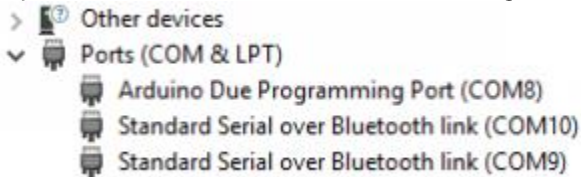
See the web page www.adwaterandstir.com/operation for full documentation and easy step-by-step things to do.

Here are a few easy things to try:

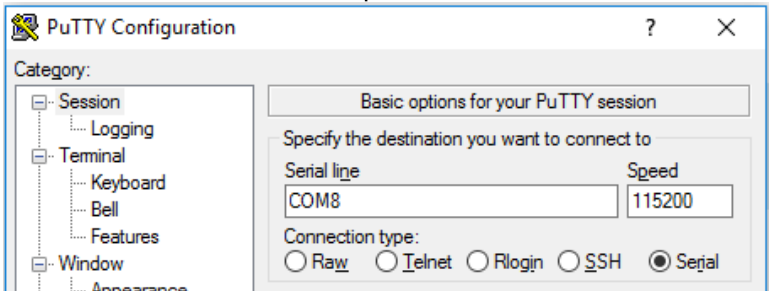
By default, your Altair-Duino is set up to communicate through the USB port.

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".

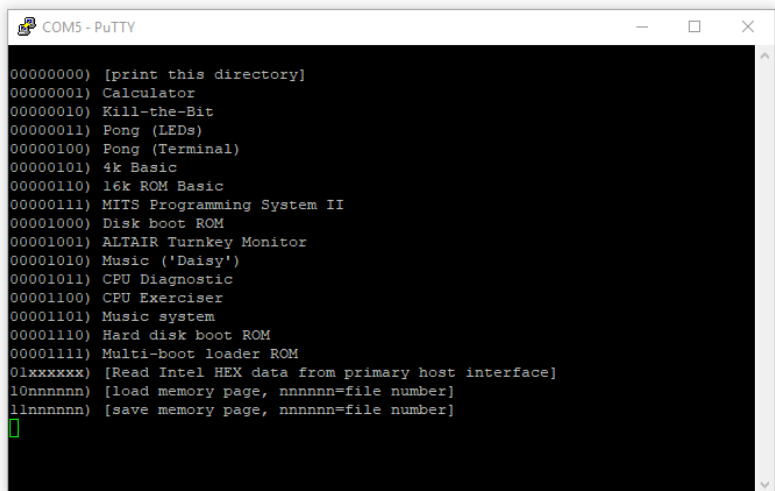
- Expand "Ports (COM & LPT)" in Device Manager



- Your port should be identified as "Arduino Due Programming Port".
- Launch PuTTY (or another terminal program if you choose.)
- Connect to the indicated COM port at baud rate 115200.



- The front panel lights will flash briefly while it connects.
- With all switches down, press AUX1 down.
- 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.

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).

If you would like to add a Bluetooth module:

NOTE: You cannot use both the Bluetooth module and the ESP-01s module.

A Bluetooth module can be used to emulate a serial port to connect a terminal emulator (PuTTY or TeraTerm) to your Altair-Duino. You'll need to purchase an "HC-05" or "SPP-C" Bluetooth module from Amazon, eBay, or other vendor.

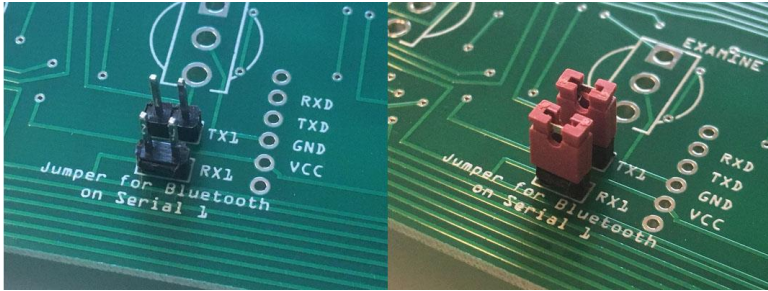


HC-05



SPP-C

Add two sets of jumpers next to the Bluetooth location on the circuit board.



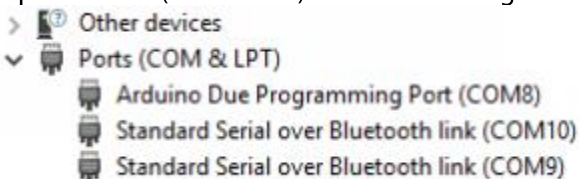
Solder the Bluetooth module to the *underside* of the circuit board (straighten the pins if necessary.)



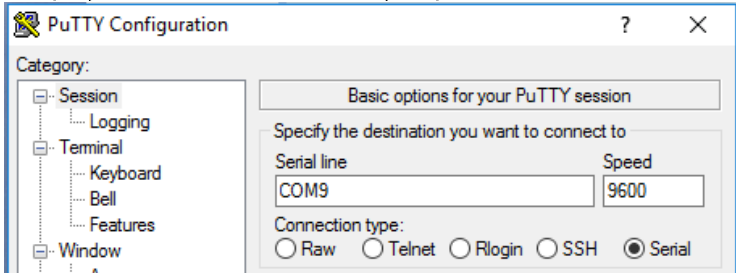
Your Bluetooth module will be connected to Pins 18/19 on the Arduino (Host Serial 1).

How to connect to Bluetooth:

1. Turn on Altair 8800.
2. Launch Bluetooth control panel on your computer.
3. Select HC-05 (or SPP-C) from list of Bluetooth devices and click "Pair".
4. When prompted for a passcode, enter "1234".
5. You will need to find the serial port assigned to the Bluetooth device. To check, launch "Device Manager".
6. Expand "Ports (COM & LPT)" in Device Manager



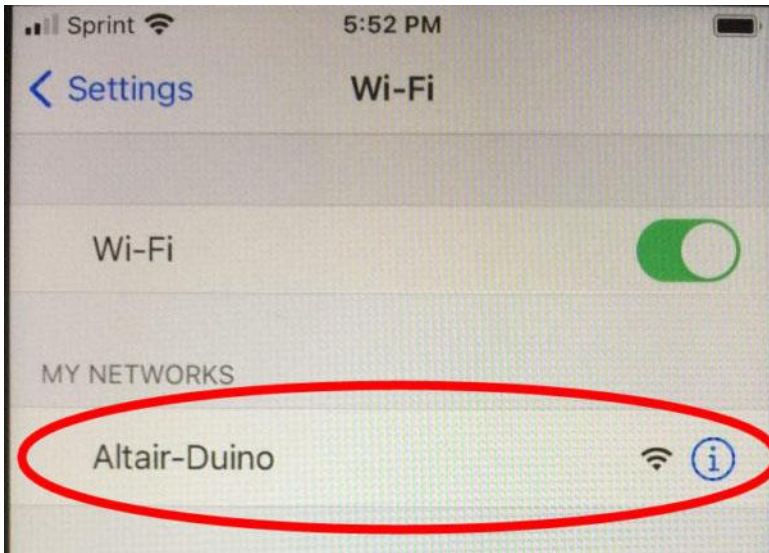
7. You will most likely see two ports identified as "Standard Serial over Bluetooth link". You may need to try both. Try the lowest serial port first.
8. Launch PuTTY (or another terminal program if you choose.)
9. Connect to the indicated COM port at baud rate 9600 (you can play with other baud rates if you prefer.)



How to use the ESP-01s WiFi Module:

We're going to want to direct the input/output of the Altair-Duino to pins 18/19 of the Arduino. The default is to use the USB connection for communication. Make sure the SD card received with your kit is inserted into the SD card reader. Raise SW0 and leave all other switches down. Hold DEPOSIT up, and turn the power on. You can release DEPOSIT. This instructs the Altair-Duino to load configuration #1 from the SD card.

Now that the Altair-Duino is powered up, grab your smart phone or computer and look at the available WiFi connections. You should see a new WiFi SSID called "Altair-Duino". Select that network.



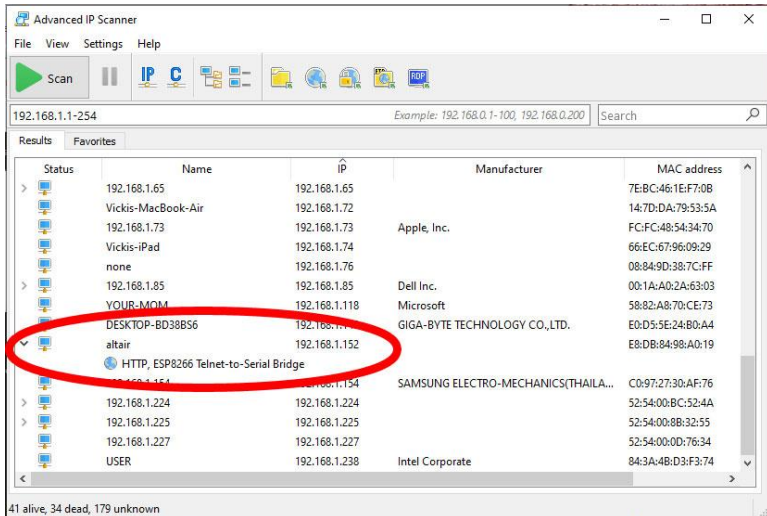
Once that connection is selected, you will be directed to a captive portal to select your WiFi network. Click "Configure WiFi". If you do not see this page, you can go to a browser and navigate to 192.168.4.1.

Altair-Duino	
WiFiManager	NETGEAR19
Configure WiFi	NETGEAR
Info	SSID
Exit	<input type="text"/>
	Password
	<input type="password" value="*****"/>
	Save

This is how you tell your Altair-Duino which WiFi to connect to. Select your WiFi network and enter your password. Click "Save". In less than 30 seconds, the captive portal should close. Your Altair-Duino is now connected to your WiFi network.

Open a browser and try to connect to "altair.local". Did it work? It should work if you have a Mac. If you have a Windows computer, it may or may not work.

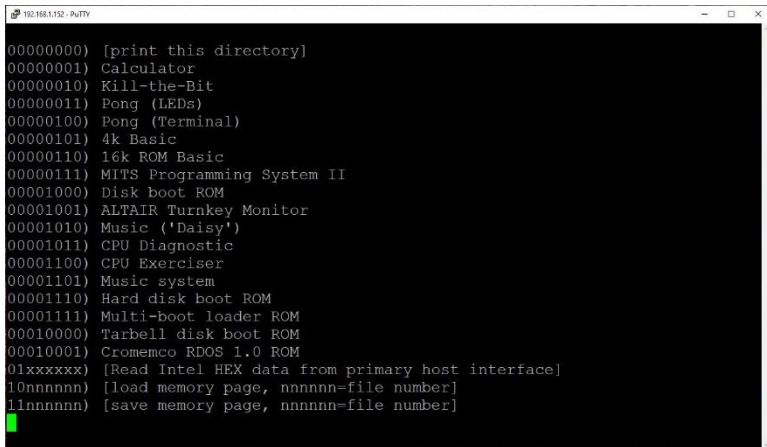
If it doesn't work for you, download a free utility called Advanced IP Scanner (www.advanced-ip-scanner.com). This will scan your network for connections.



What you're looking for may display a name of "altair" and a manufacturer of "Espressif Inc", but it may not. It should also show a ">" next to it indicating there is a service. When expanded, it should display "HTTP, ESP8266 Telnet-to-Serial Bridge". Remember this IP address.

Open Putty and select a connection type of Telnet. Enter the IP address (or "altair.local" if that works for you). You'll also want to change a couple settings. Under "Category", click "Terminal". On the right side, set Local echo to "Force Off". Under "Category" on the left, click Terminal > Telnet. On the right side uncheck "Return key sends Telnet New Line instead of ^M".

The next thing you see will be an empty black window. On your Altair-Duino, make sure all switches are down, then press AUX1 down. Do you see a list of built-in applications? No? Make sure your primary host serial is set to "Serial (pin 18/19)". (That should be what configuration #1 is set to.)



```
192.168.1.152 - PuTTY
00000000) [print this directory]
00000001) Calculator
00000010) Kill-the-Bit
00000011) Pong (LEDs)
00000100) Pong (Terminal)
00000101) 4k Basic
00000110) 16k ROM Basic
00000111) MITS Programming System II
00001000) Disk boot ROM
00001001) ALTAIR Turnkey Monitor
00001010) Music ('Daisy')
00001011) CPU Diagnostic
00001100) CPU Exerciser
00001101) Music system
00001110) Hard disk boot ROM
00001111) Multi-boot loader ROM
00010000) Tarbell disk boot ROM
00010001) Cromemco RDOS 1.0 ROM
01xxxxxx) [Read Intel HEX data from primary host interface]
10nnnnnn) [load memory page, nnnnnn=file number]
11nnnnnn) [save memory page, nnnnnn=file number]
```

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VT100 Terminal – Copyright (C) 2014 Geoff Graham **All rights reserved.**