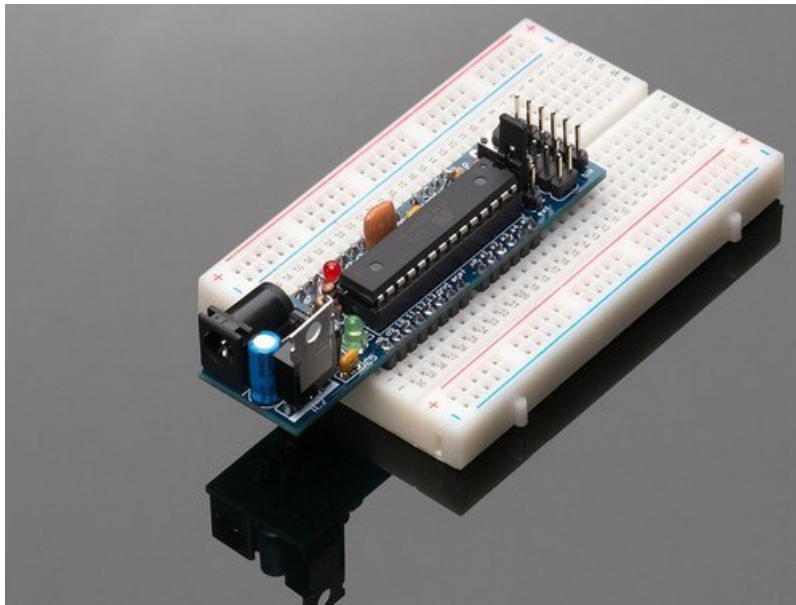
 adafruit learning system

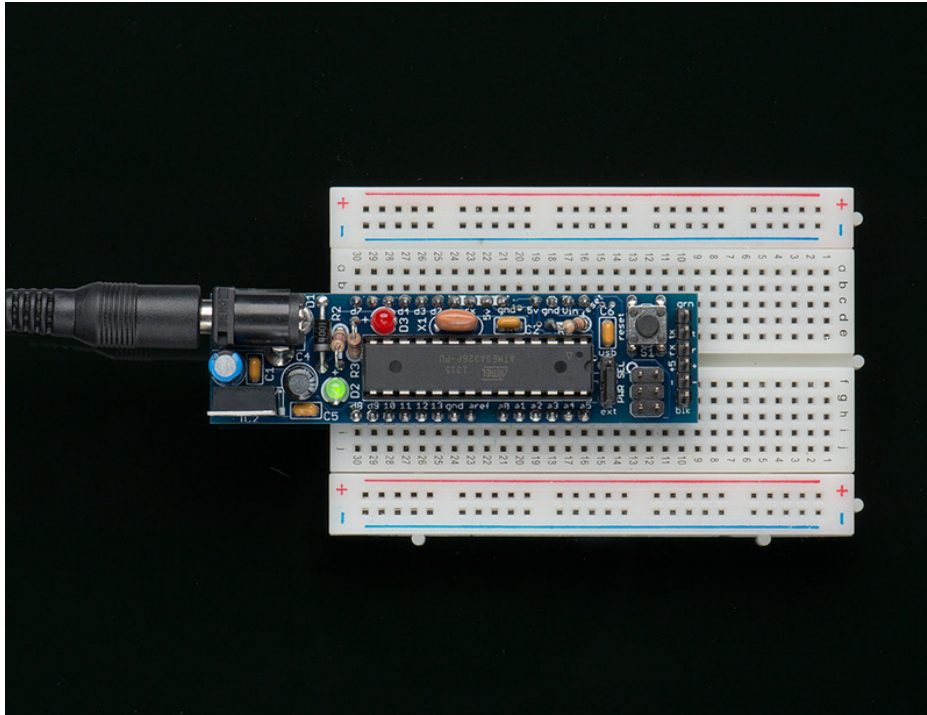
DC & USB Boarduino Kits

Created by lady ada

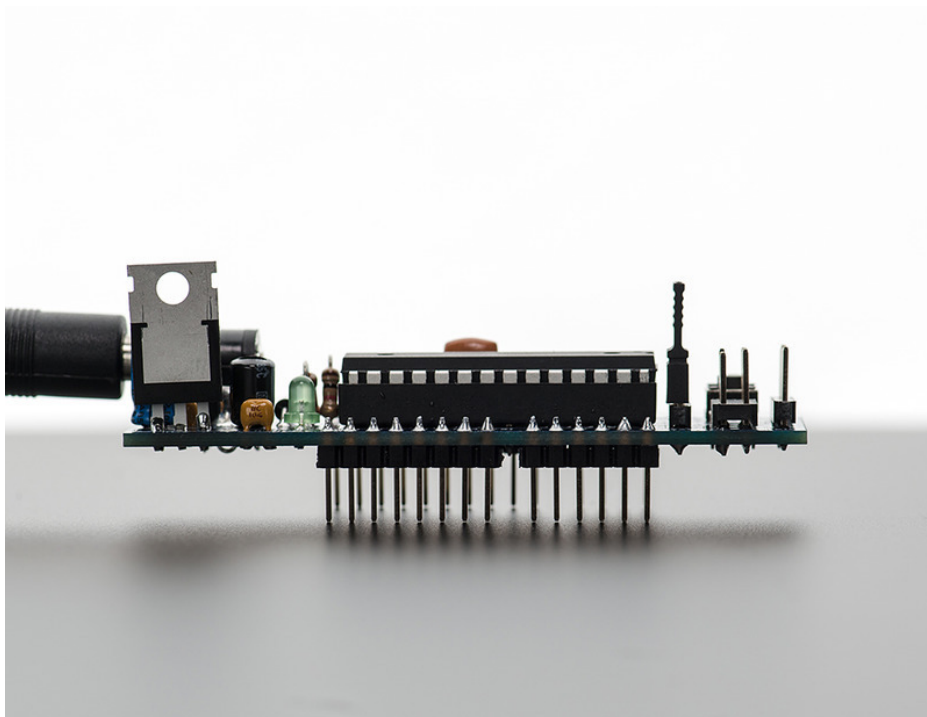


Last updated on 2019-12-28 06:11:21 AM UTC

Overview



If you've ever struggled to use a solderless breadboard with an Arduino, you understand how frustrating it can be! I designed this Arduino clone to solve this problem in an inexpensive DIY fashion.



The Boarduino is an Arduino clone: when programmed with the Arduino bootloader, it can talk to the Arduino software and run sketches just like the original.

There are noticeable differences between the Boarduino and the Arduino.

- Shields cannot be used as the form factor is so different
- There are two versions, a DC version and a USB version
For the DC version there isn't an on-board USB chip. This means you need to use a [USB-TTL \(https://adafru.it/c02\)](https://adafru.it/c02) cable or a [MiniUSB \(https://adafru.it/c03\)](https://adafru.it/c03) (or any other FTDI breakout board) which is not included. There are also no rx/tx LEDs and no rx/tx 1K series resistors.
For the USB version, there is an on-board USB chip but there isn't a DC jack or 5V regulator, you can power it through the USB jack. There is a rx 1K resistor so you can use this to talk to serial accessories.
- 16.00 MHz ceramic resonator is used instead of crystal, so cycle speed may be off by +/- 0.3nS (0.5%). This isn't relevant for UART timing, servo drivers, PWM, etc. but could be an issue if you need nanosecond-precision timing. Note that the Arduino software only provides millisecond-precision timing for general sketches (1 second = 1000ms. 1ms = 1,000,000 ns)

The specifications for the DC boarduino include:

- Designed to plug into a breadboard for easy prototyping
- Petite size, only 3" x 0.8" (75mm x 20mm)
- All 'standard' pins are brought out - Digital 0 thru 13, Analog 0 thru 5, ARef, 5V, Ground, Vin and Reset
- 2 LEDs, green power and red "pin 13" LED just like the Arduino Diecimila
- Standard Reset button
- ATmega328P, running at 16.00 MHz, just like the latest Arduino, the Duemilanove (note that the product photo above hasn't been updated)
- 6-pin standard ICSP header
- Standard 2.1mm DC jack (just like the original Arduino) with 5V regulator to run on 7V-17V power (DC)
- USB or External power, selectable with a jumper (just like original Arduino)
- 1N4001 diode protects against using incorrect wall adapter
- 6-pin header at the end for a [USB-TTL cable \(https://adafru.it/alH\)](https://adafru.it/alH)
- Auto-reset capability when used with a [USB-TTL cable \(https://adafru.it/alH\)](https://adafru.it/alH)
- Available as a low cost kit with standard parts, so its never out of stock
- All through-hole parts are easy to solder

The specifications for the USB boarduino include:

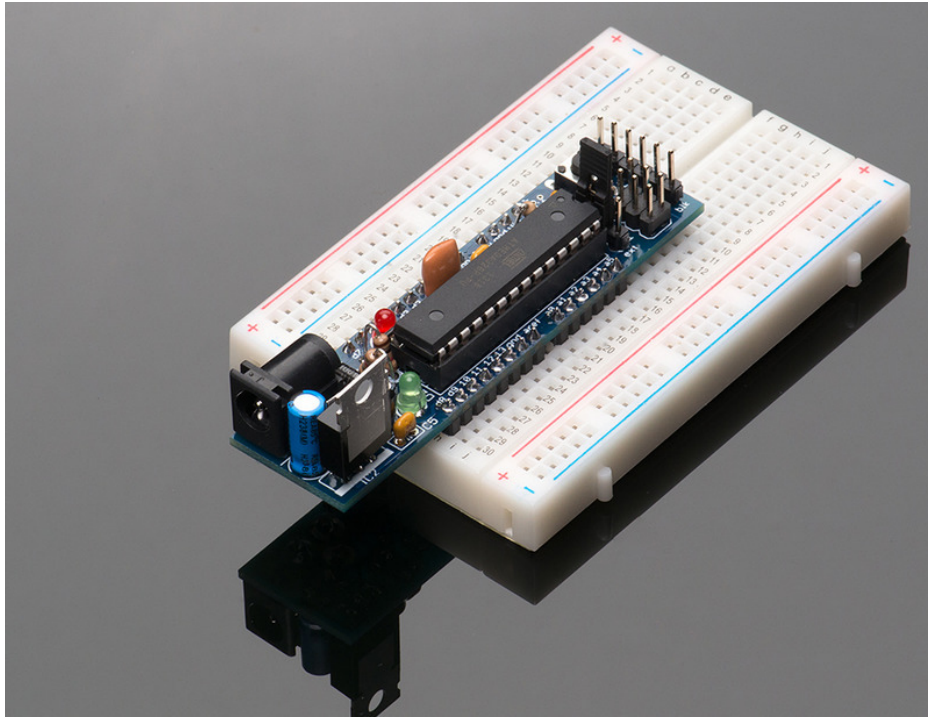
- Designed to plug into a breadboard for easy prototyping
- Petite size, only 2.75 " x 0.8" (75mm x 20mm)
- All 'standard' pins are brought out - Digital 0 thru 13, Analog 0 thru 5, ARef, 5V, Ground, 3.3V and Reset
- 2 LEDs, green power and red "pin 13" LED just like the Arduino Diecimila
- Standard Reset button
- ATmega328, running at 16.00 MHz, just like the Duemilanove
- 6-pin standard ICSP header
- Standard mini-USB jack
- USB or external power, selectable with a jumper
- 500mA fuse protects your computer from current overdraw
- Auto-reset capability
- Available as a low cost kit with standard parts, so its never out of stock
- All through-hole parts are easy to solder - SMT chip is presoldered & tested when purchased as a kit

If you have a USB boarduino check this page for instructions! (<https://adafru.it/cjT>)

Make It!

Steps

This is a very easy kit to make, just go through each of these steps to build the kit.



Preparation

Prep

Learn how to solder with tons of tutorials (<https://adafru.it/aTk>)!

Don't forget to learn how to use your multimeter too (<https://adafru.it/aOy>)!

(<https://adafru.it/c06>)Tools

There are a few tools that are required for assembly. None of these tools are included. If you don't have them, now would be a good time to borrow or purchase them. They are very very handy whenever assembling/fixing/modifying electronic devices! I provide links to buy them, but of course, you should get them where ever is most convenient/inexpensive. Many of these parts are available in a place like Radio Shack or other (higher quality) DIY electronics stores.

Soldering iron



Any entry level 'all-in-one' soldering iron that you might find at your local hardware store should work. As with most things in life, you get what you pay for.

Upgrading to a higher end soldering iron setup, like the [Hakko FX-888 that we stock in our store \(http://adafru.it/180\)](http://adafru.it/180), will make soldering fun and easy.

Do not use a "ColdHeat" soldering iron! They are not suitable for delicate electronics work and can damage the kit ([see here \(https://adafru.it/aOo\)](https://adafru.it/aOo)).

[Click here to buy our entry level adjustable 30W 110V soldering iron. \(http://adafru.it/180\)](http://adafru.it/180)

[Click here to upgrade to a Genuine Hakko FX-888 adjustable temperature soldering iron. \(http://adafru.it/303\)](http://adafru.it/303)





Solder

You will want rosin core, 60/40 solder. Good solder is a good thing. Bad solder leads to bridging and cold solder joints which can be tough to find.

[Click here to buy a spool of leaded solder \(recommended for beginners\).](http://adafru.it/145) (<http://adafru.it/145>)

[Click here to buy a spool of lead-free solder.](http://adafru.it/734) (<http://adafru.it/734>)



Multimeter

You will need a good quality basic multimeter that can measure voltage and continuity.

[Click here to buy a basic multimeter. \(http://adafru.it/71\)](http://adafru.it/71)

[Click here to buy a top of the line multimeter. \(http://adafru.it/308\)](http://adafru.it/308)

[Click here to buy a pocket multimeter. \(http://adafru.it/850\)](http://adafru.it/850)





Flush Diagonal Cutters

You will need flush diagonal cutters to trim the wires and leads off of components once you have soldered them in place.

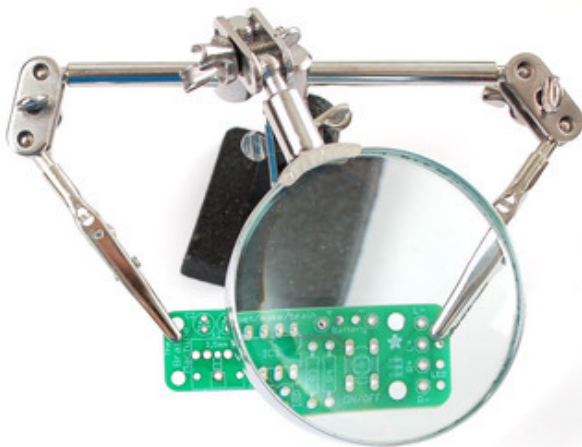
[Click here to buy our favorite cutters.](http://adafru.it/152) (<http://adafru.it/152>)



Solder Sucker

Strangely enough, that's the technical term for this desoldering vacuum tool. Useful in cleaning up mistakes, every electrical engineer has one of these on their desk.

[Click here to buy a one.](http://adafru.it/148) (<http://adafru.it/148>)




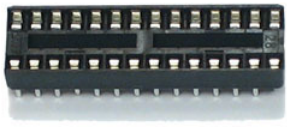





Helping Third Hand With Magnifier












Not *absolutely* necessary but will make things go much much faster, and it will make soldering much easier.

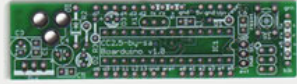
[Pick one up here.](http://adafru.it/291) (<http://adafru.it/291>)

DC Parts List

Check to make sure your kit comes with the following parts. Sometimes we make mistakes so double check everything and email support@adafruit.com if you need replacements!

Image	Name	Description	More Info	Qty
	IC1	Microcontroller (preprogrammed with Arduino bootloader when purchased in a kit).	ATmega328P-20PU (unprogrammed) Adafruit (Programmed)	1
	IC1'	28-pin socket	28 pin socket	1
	X1	16.00 MHz ceramic oscillator	16 mhz ceramic resonator	1
		2.1mm Power Jack	CUI PJ-202AH	1
	D1	1N4001 diode	Generic 1N4001	1
	IC2	5V regulator 7805 TO-220 package	7805	1
	C1 C2 C5 C6	Bypass capacitor	Ceramic Capacitor	3 or 4

	(opt)	0.1uF ceramic	Ceramic Capacitor	1
	C3	Electrolytic capacitor 47uF / 25V (or higher)	Electrolytic Capacitor	1
	C4	100uF/6.3V capacitor (or higher) (the image shows a 10V but 6.3V is fine)	Electrolytic Capacitor	1
	R1	10K ohm 1/4W 5% resistor (brown black orange gold)	Generic Resistor	1
	R2 R3	1.0K 1/4W 5% resistor (brown black red gold)	Generic Resistor	2
	D3	3mm red LED	3mm red diffused	1
	D2	3mm green LED	3mm green diffused	1
	SW1	6mm tact switch button	6mm tact switch	1
	ICSP	6 pin header, 0.1"x0.1" spacing	2x3 pin header	1
		40 pin male header, 0.1" spacing	0.1" male header strip	1
		Jumper		1



PCB

Circuit board

[Adafruit Industries](#)

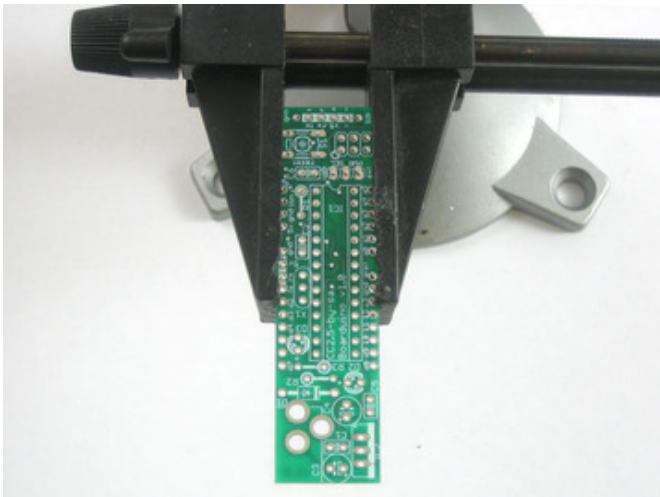
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DC Boarduino Assembly

The first step is to solder the kit together. If you've never soldered before, [check the Preparation page for tutorials and more](https://adafru.it/cjF) (<https://adafru.it/cjF>).

If you have a USB boarduino check this page for instructions! (<https://adafru.it/c04>)

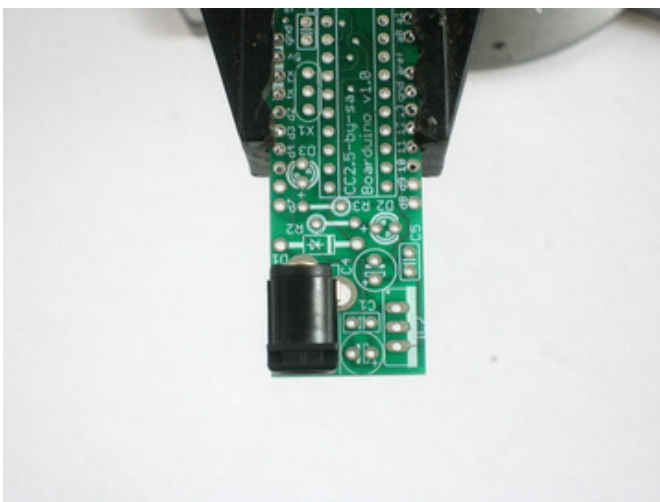
Check the kit to verify you have all the parts necessary, then get your tools ready! A board vise, soldering iron & solder, diagonal cutters, and a solder sucker (desoldering tool) if you have one.



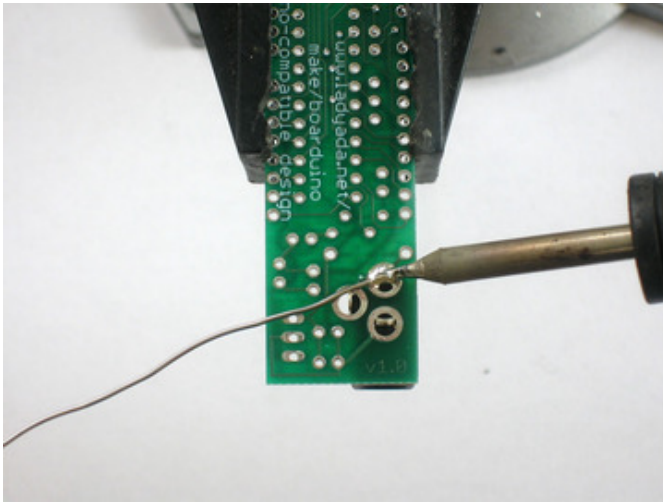
Place the PCB in a vise to make soldering easy!

Heat up the soldering iron to 700 degrees, tin it if necessary.

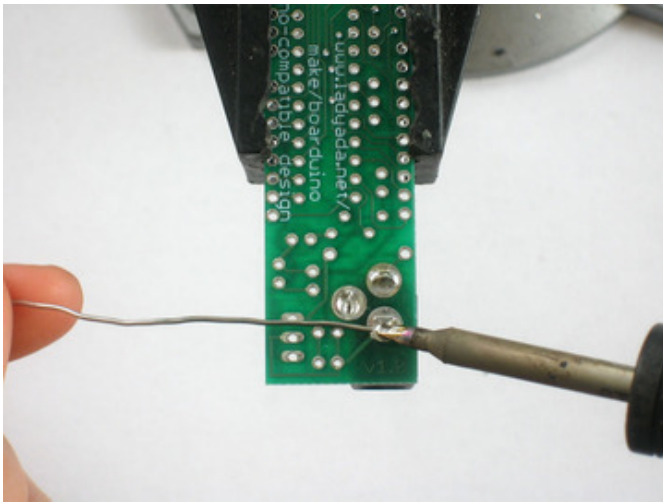
Make sure the sponge is wetted.

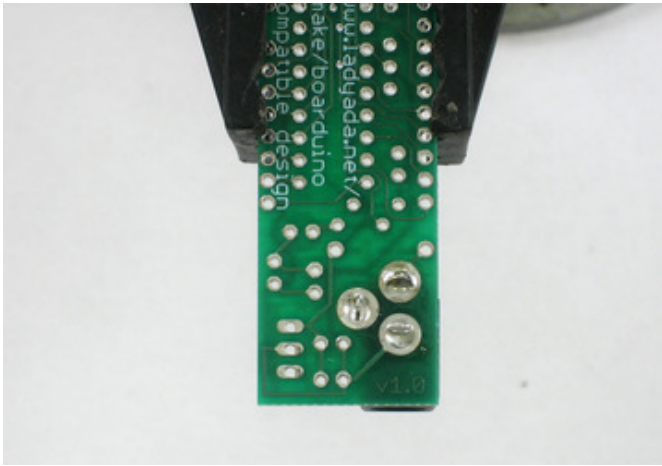


Place the 2.1mm DC jack as shown, it should fit in snugly. Make sure the part is on the top of the board, so that you can see the silkscreened images.

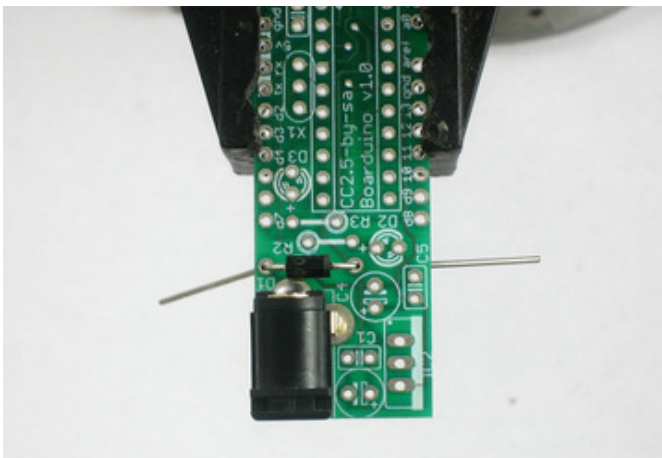


Use the soldering iron to heat up each of the 3 connections and poke the solder in so that it melts into the holes.



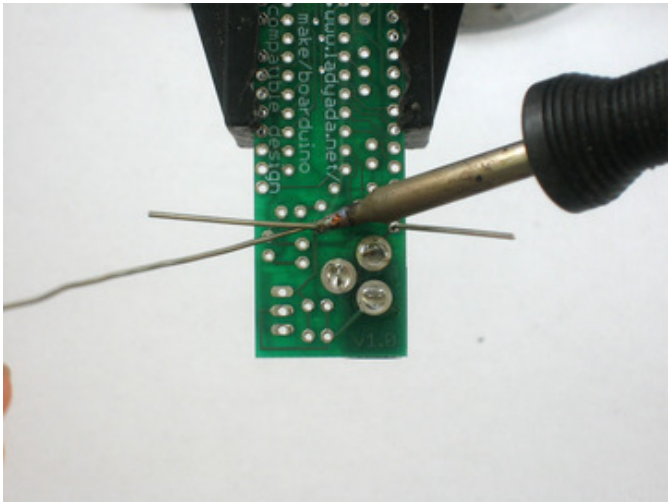


Make sure all three pads are soldered, with plenty of solder, the holes should be filled up. This gives the jack mechanical strength.

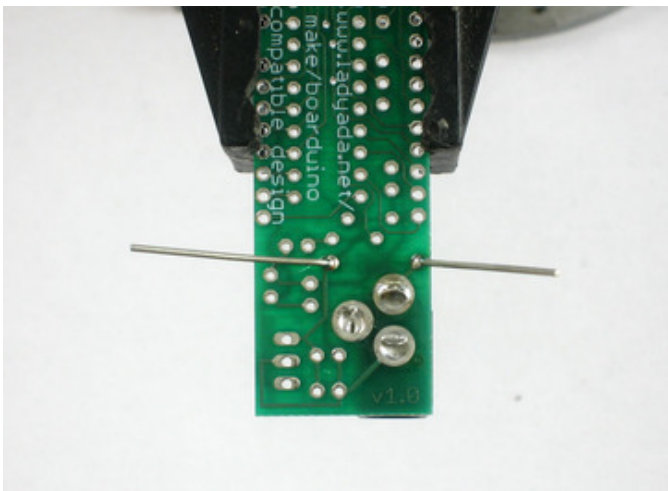
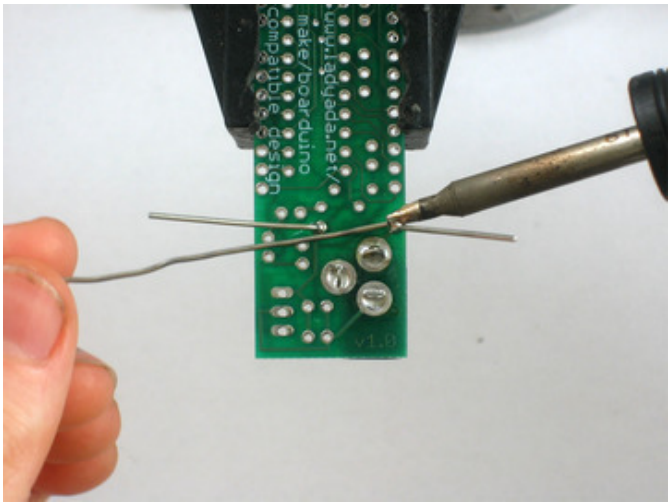


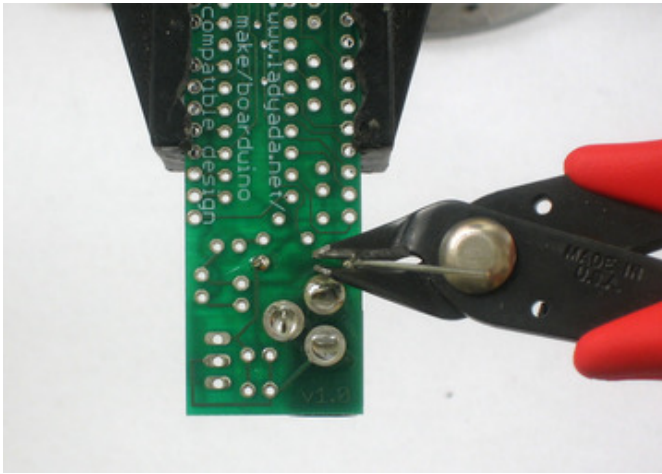
Next, place the 1N4001 diode **D1** . Diodes are directional, they only let current flow in one direction. This diode is used to protect the Boarduino from damage. Make sure the white stripe on the diode matches the white stripe in the silkscreened image below. In this picture, the stripe is on the right.

You can bend the leads a bit which will keep the part from falling out when you turn the board over.

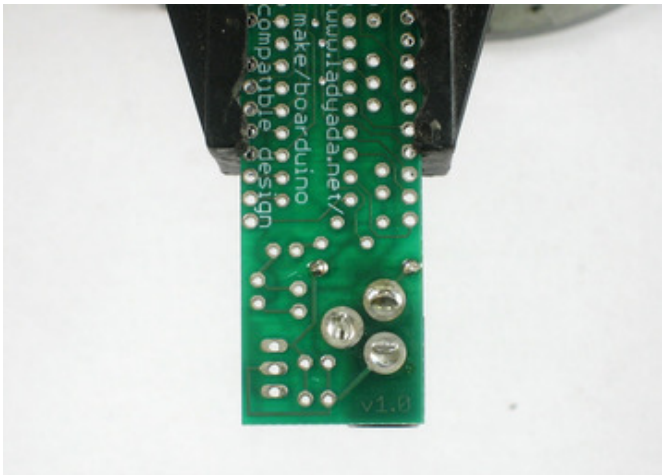


Turn the PCB over and solder both legs so that you get a nice shiny solder joint.

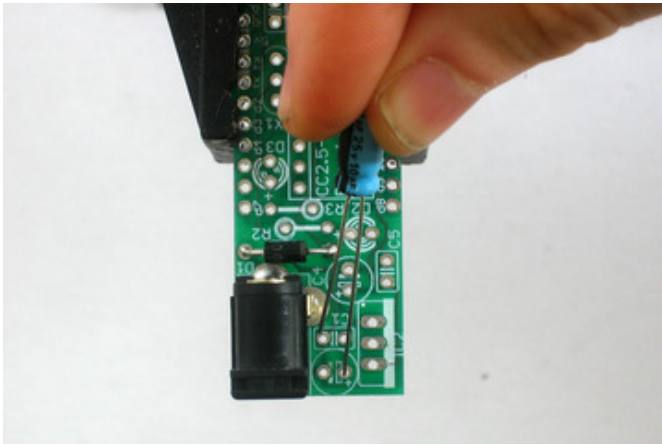




Use the diagonal cutters to clip off the long leads, leaving just a bump.

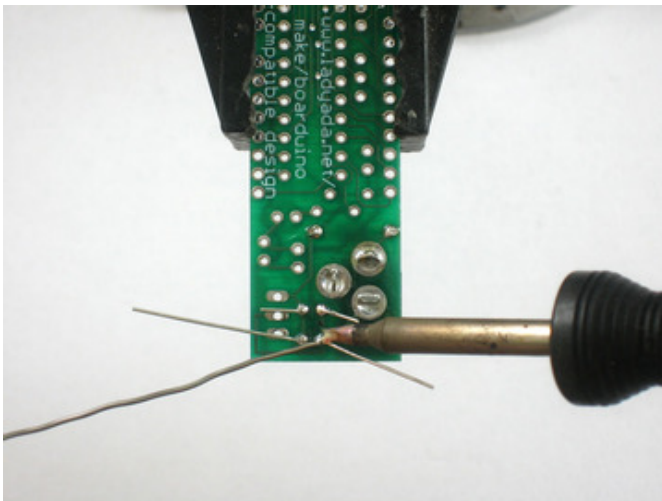
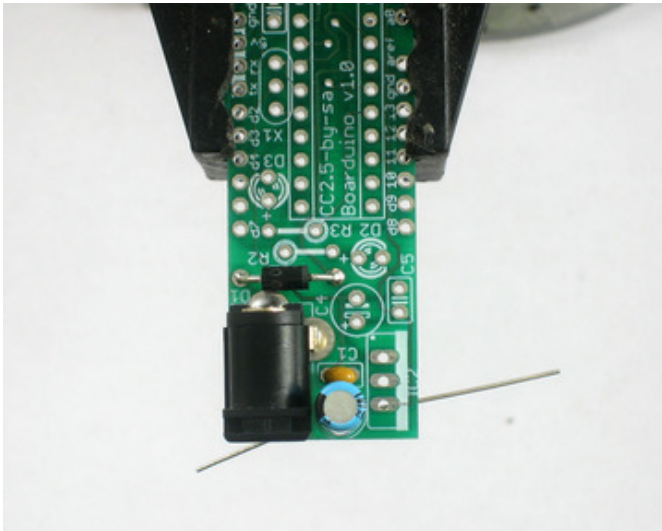


It should look like this.

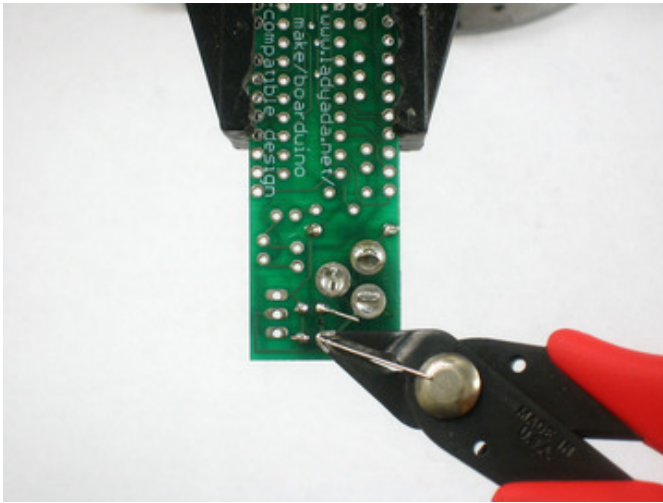


Next, its time to place the 25V electrolytic capacitor **C3**. Electrolytic capacitors are *polarized* which means they only work well in one direction. Put it in backwards and they can explode! You can tell how to place it because the silkscreened image has a plus near one hole and the capacitor has one long lead. That lead is the positive lead. In this image, its the one on the right.

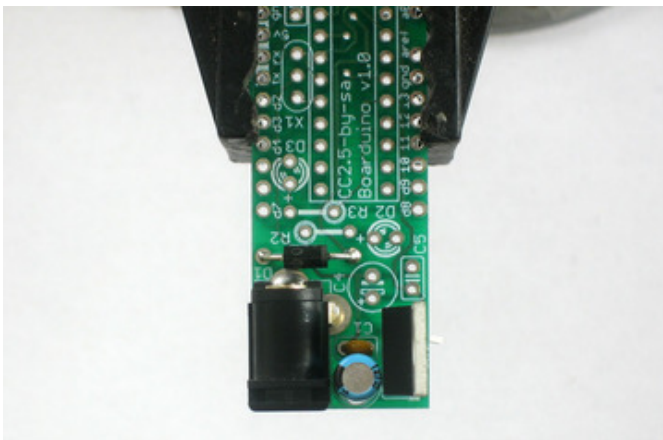
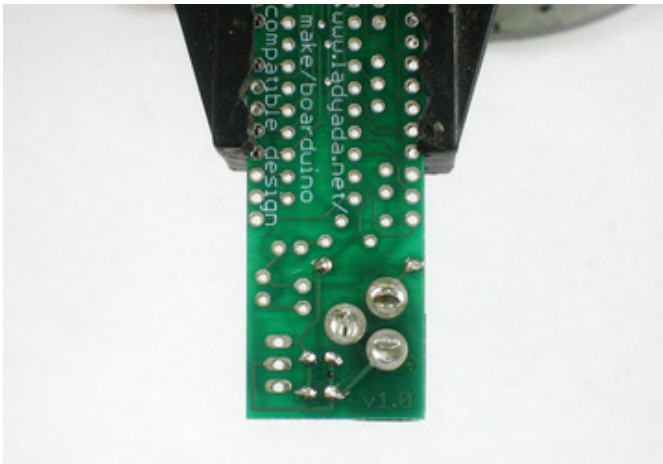
Also insert **C1** which is a ceramic capacitor. Ceramic capacitors are non-polarized so you don't have to worry about putting it backwards.



Solder all 4 leads.

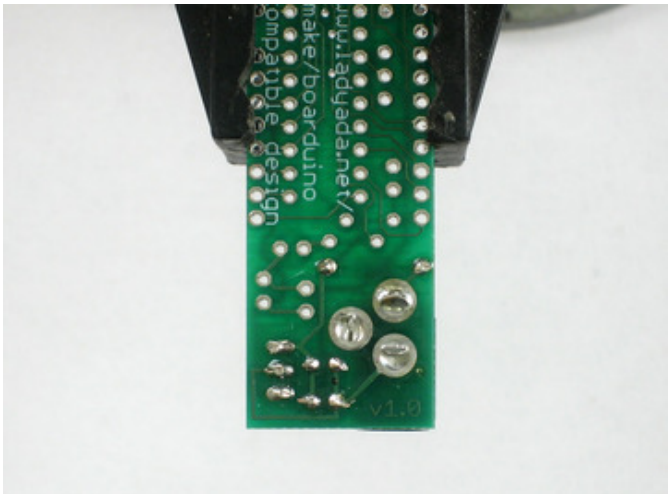
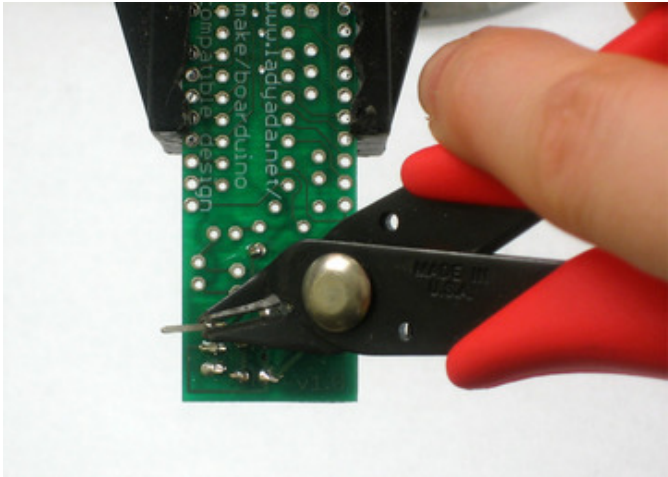
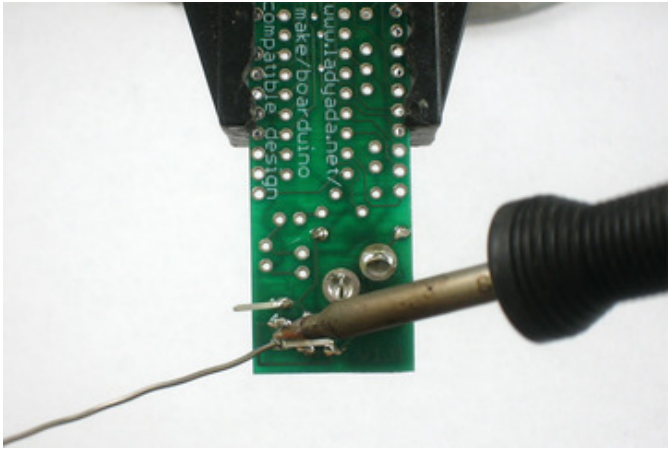


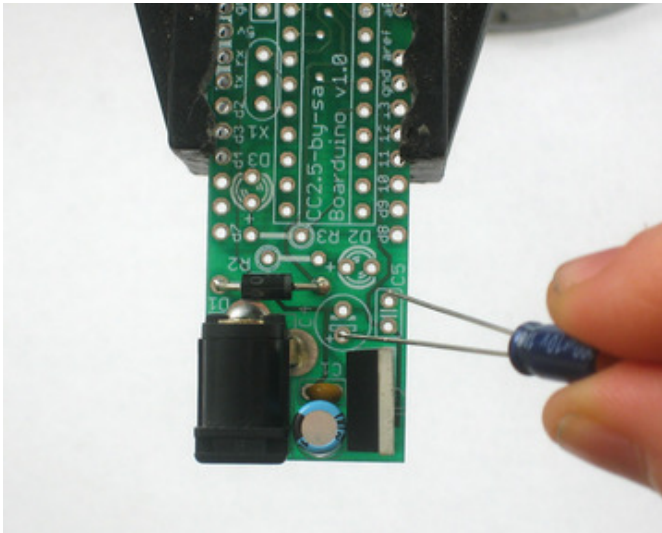
And clip them short with the cutters.



Next is the 5V regulator. This takes the power from the DC jack which may be something like a 9V battery, and brings it down to 5V, which is suitable for the microcontroller chip. This part must be placed as shown, with the metal heat sink tab on the right.

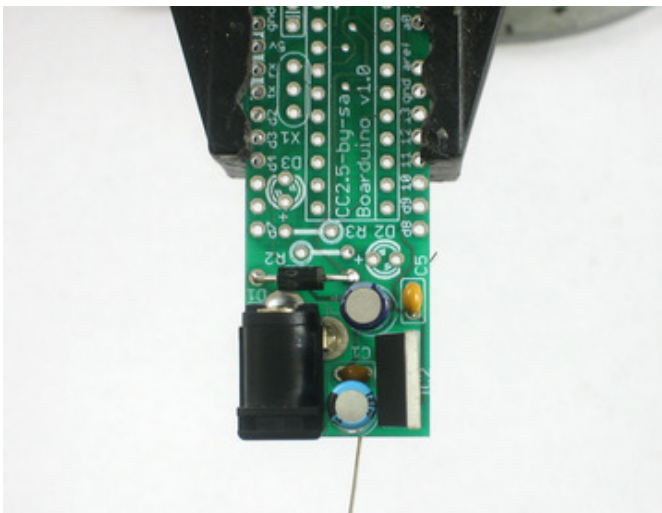
Turn over the board and solder all three pins, then clip them off.

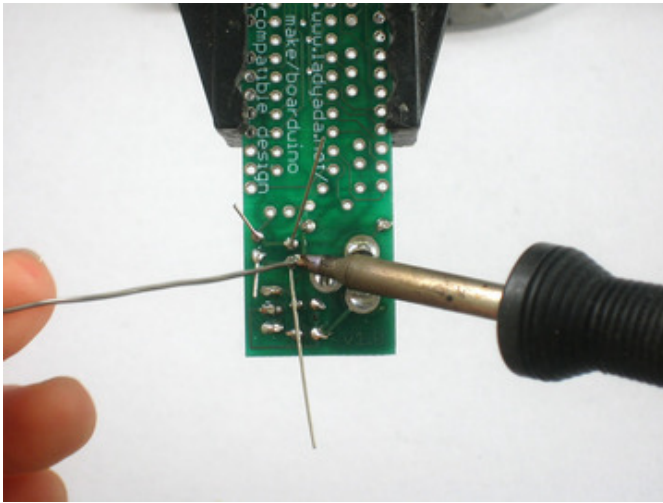




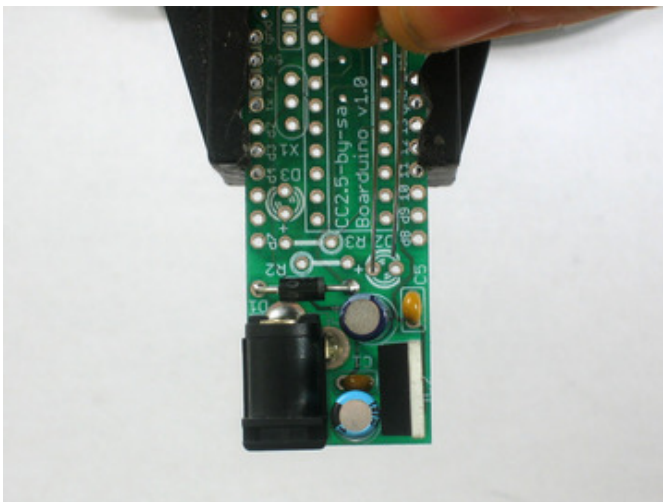
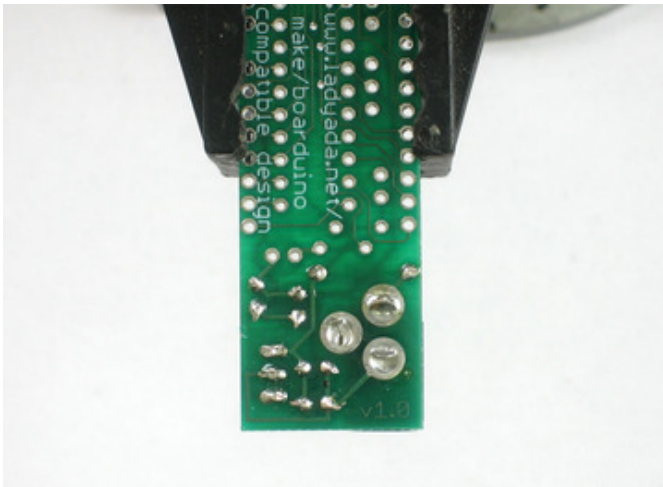
Now you should solder in the 6.3V electrolytic capacitor **C4** as shown. Remember its polarized so you must place the longer lead in the positive-marked hole.

Then place the ceramic capacitor **C5**.

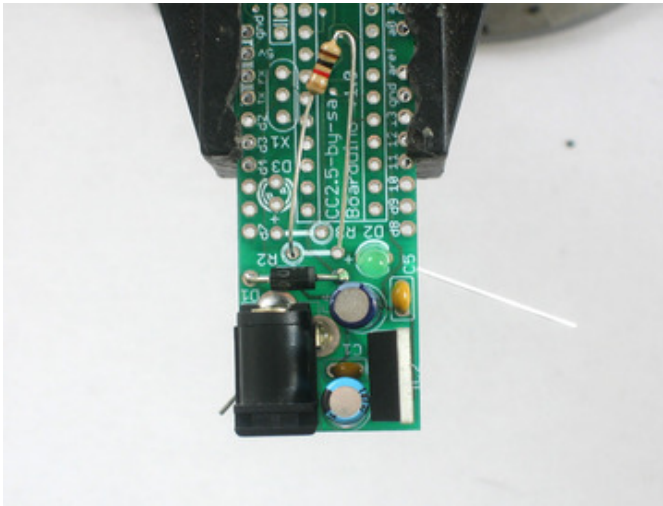




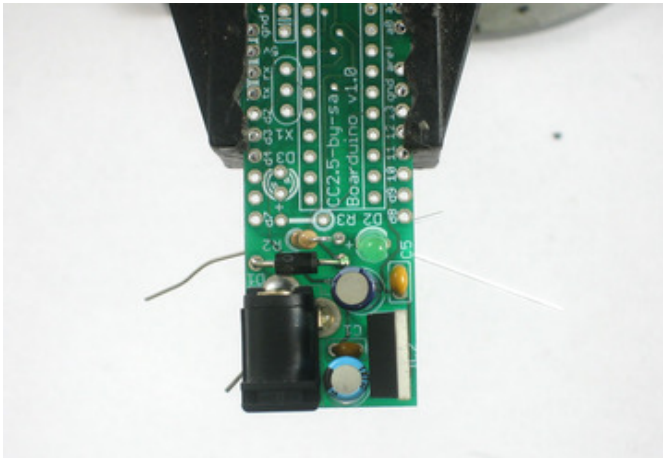
Solder in the capacitors and clip them.

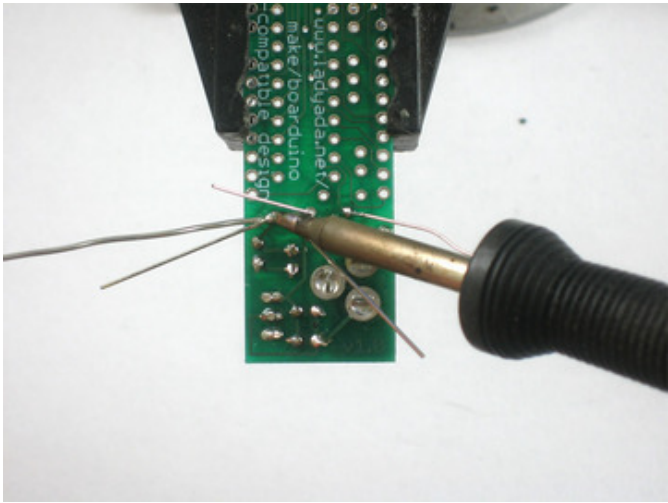


Next is the green 3mm LED **D2**. Like the electrolytic capacitors, LEDs have polarity and they won't work if soldered in backwards. The long lead is the positive lead, make sure it goes in the hole with a + next to it.

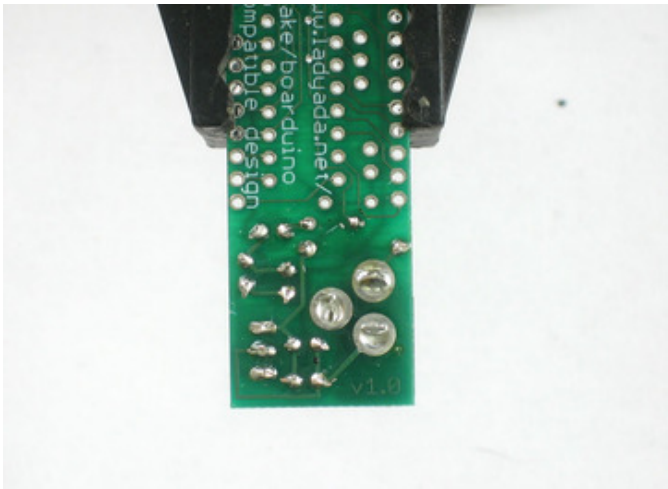


The 1K resistor R2 goes in, its the LED's matching resistor. Bend it over as shown to place it.





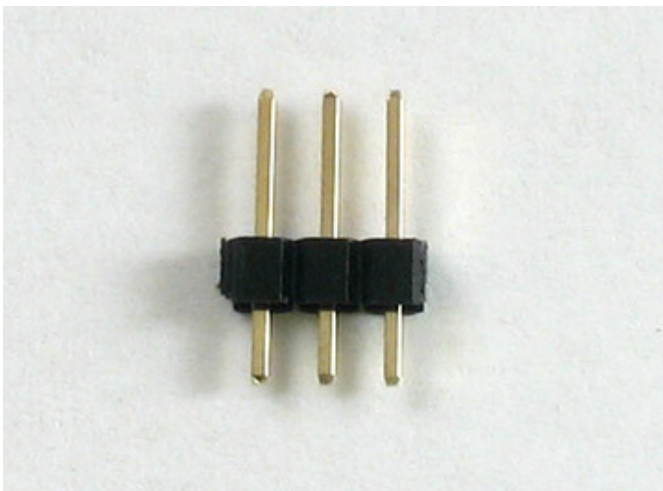
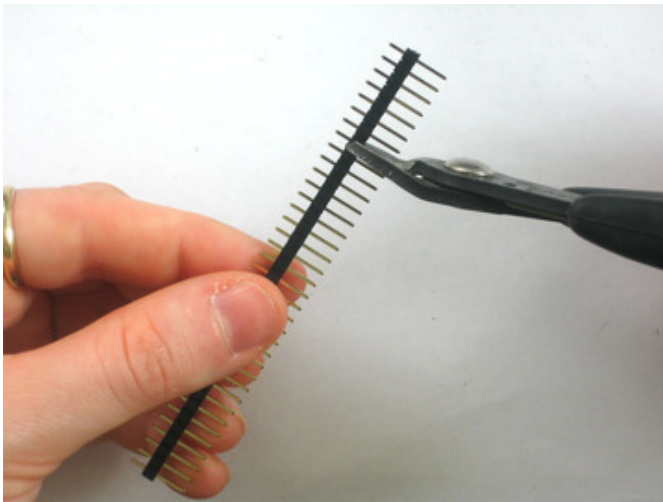
Solder in the resistor and LED and clip the leads.

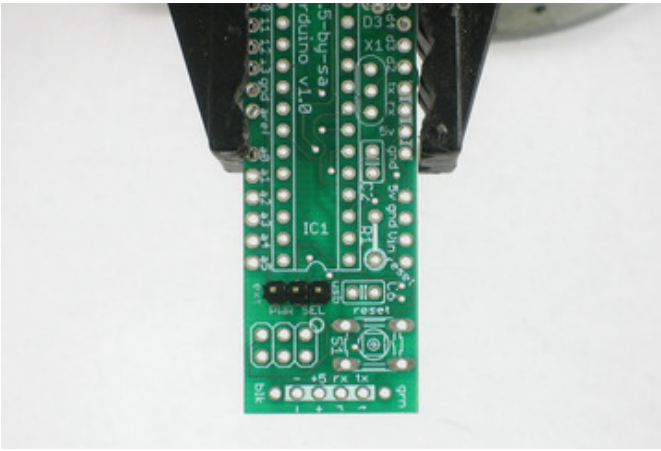




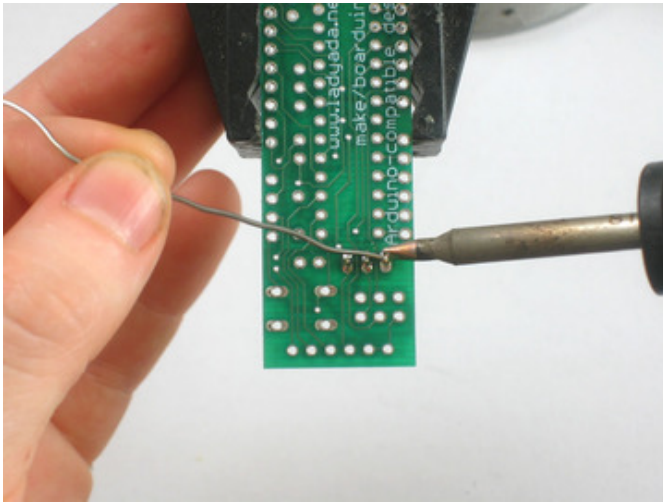
Next you have to make a 3-pin header.

Use the diagonal clippers or a pair of pliers to break apart the single row header.

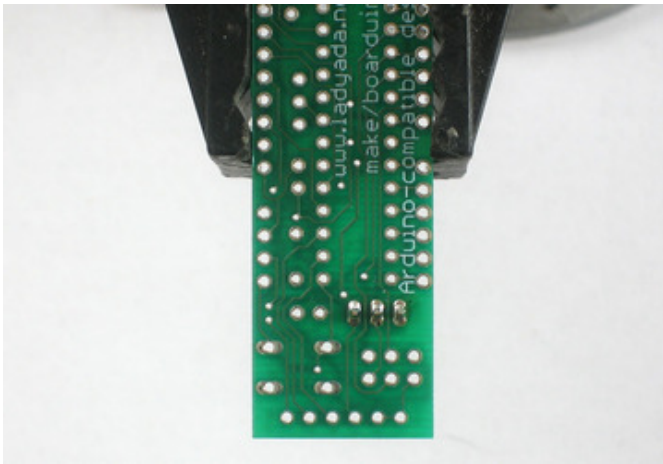


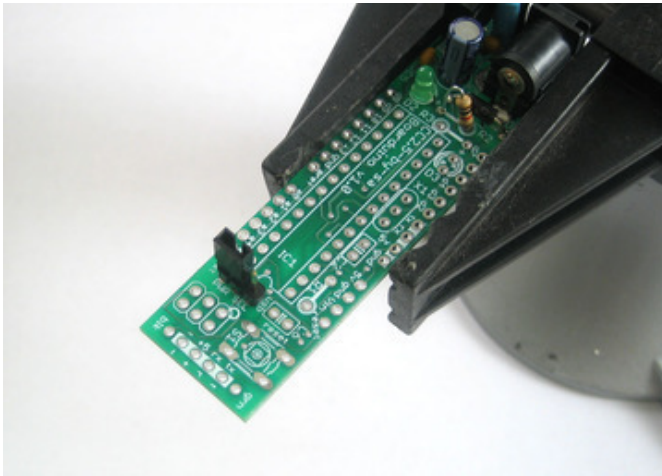


Place the 3 pin header at the other end of the board as shown. the short end goes into the PCB, and the long ends extend up.

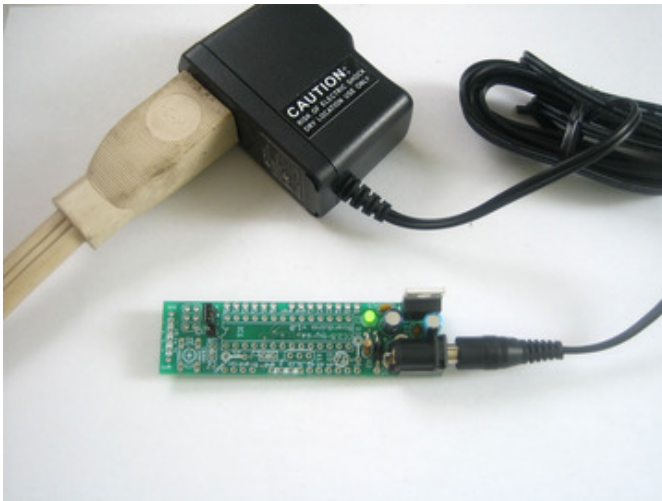


Solder the jumper header in place. You won't need to clip because the leads are short already!





Place the jumper/shunt as shown, so that its on the **EXT** pair of pins.



Take the board out of the vise and plug in a power source such as a 9V DC positive-tip wall adapter or a 9V battery with a 2.1mm barrel jack. You should see the green LED light up.

If no LED lights up check:

Is the battery or wall adapter good?

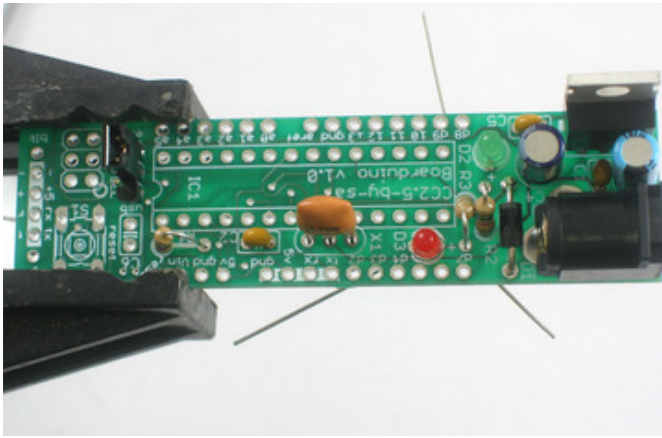
Is it positive tip?

Is the diode in correctly?

Is the LED in correctly?

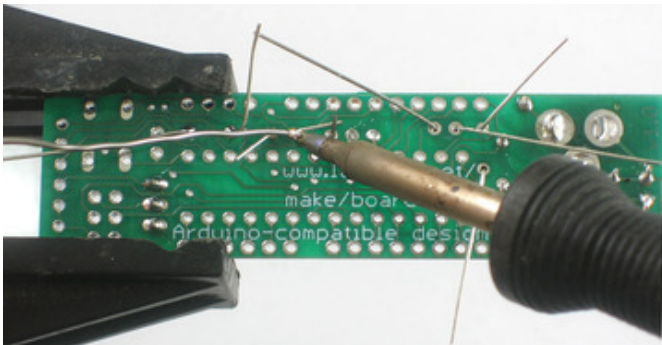
Are all the parts in place?

I don't suggest continuing if you can't get the green LED to light as it indicates a problem!

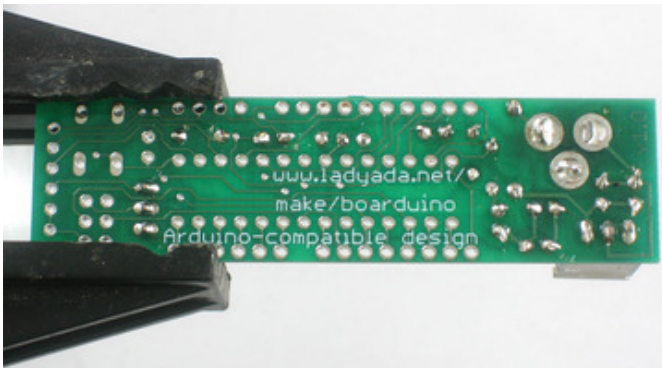
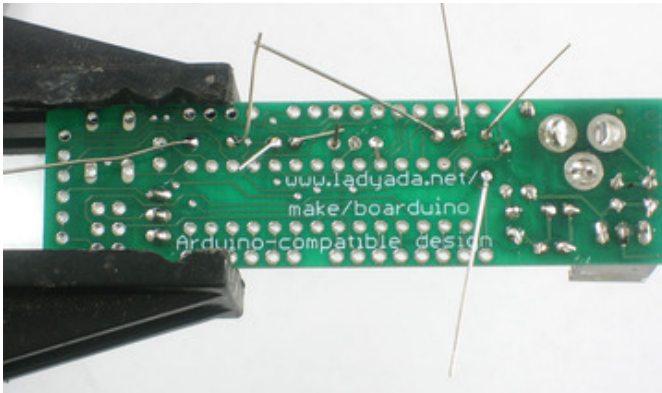


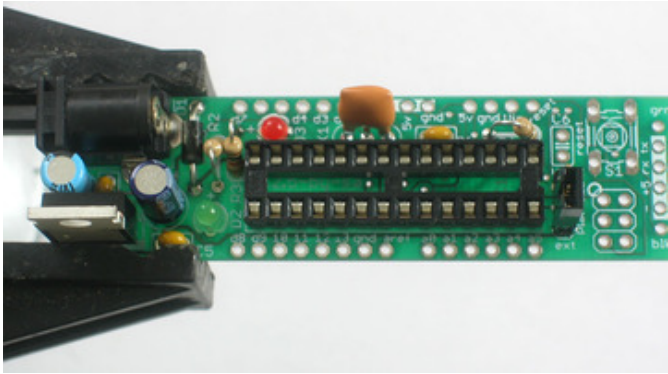
Place the red LED **D3**, taking care to make sure the long lead is in the positive-marked hole. Also place the matching 1K resistor **R3**

Also place the 16.00MHz ceramic oscillator **X1** (which is non-polarized) the third ceramic capacitor **C2** and the 10K resistor **R1**

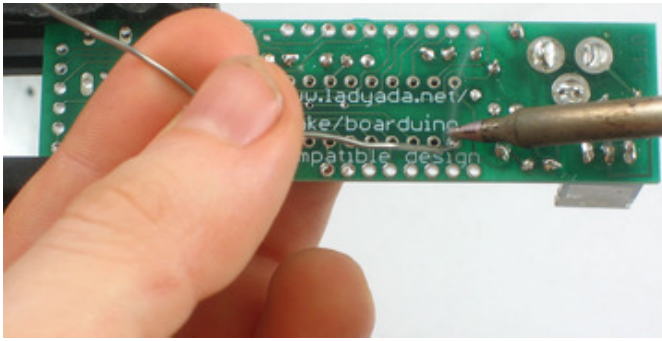


Solder and clip the leads.

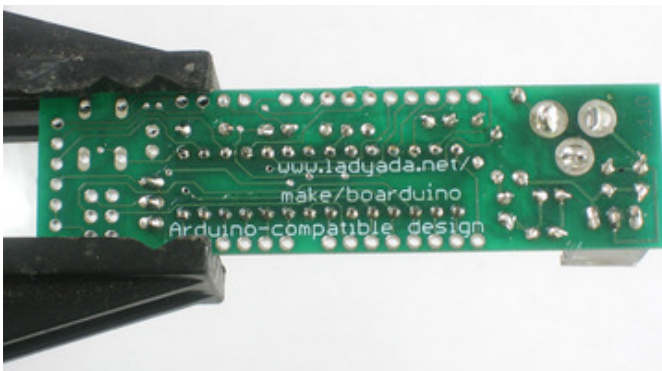
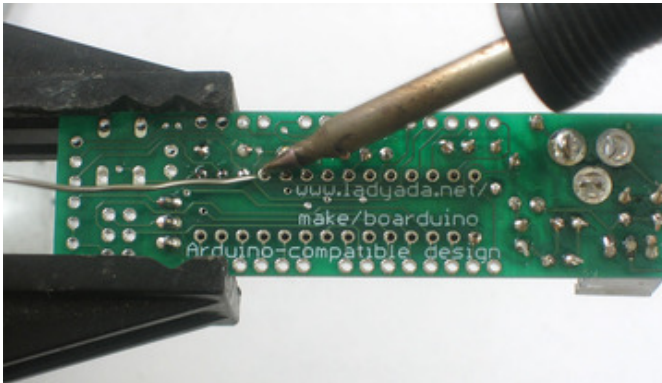


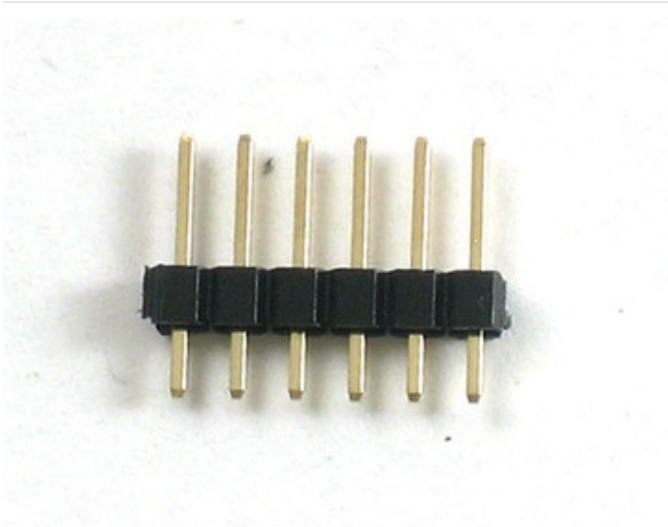


Place the 28 pin socket. This is to allow you to replace the microcontroller if necessary. Make sure the notch in the socket matches the notch in the silkscreened image. In this picture, its on the right.



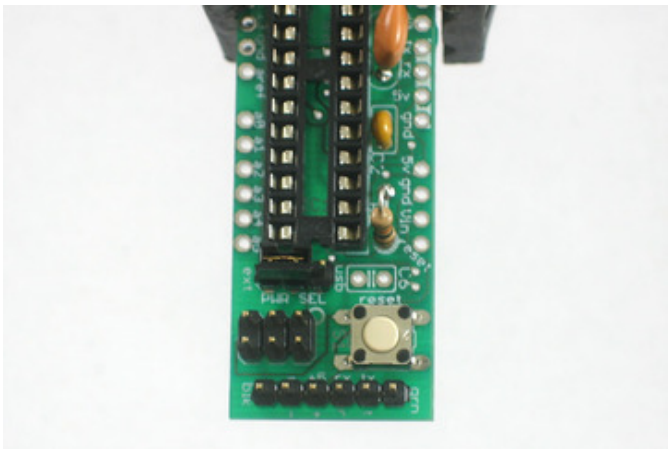
Solder in the socket by tacking two opposite corners and then soldering the rest of the pins. Press the socket into the board to make sure its flat up against it.

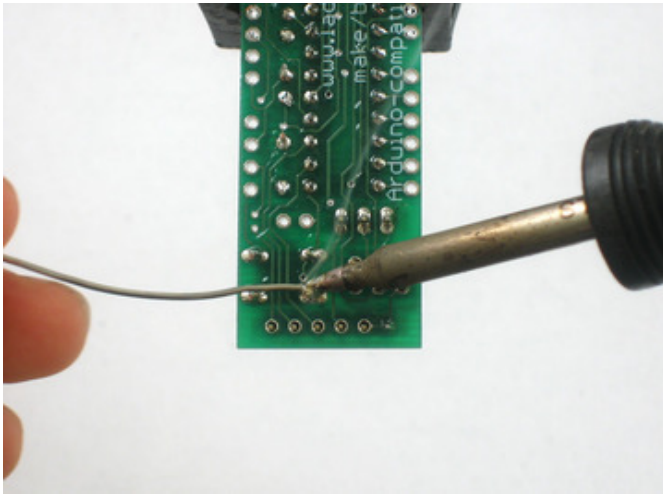




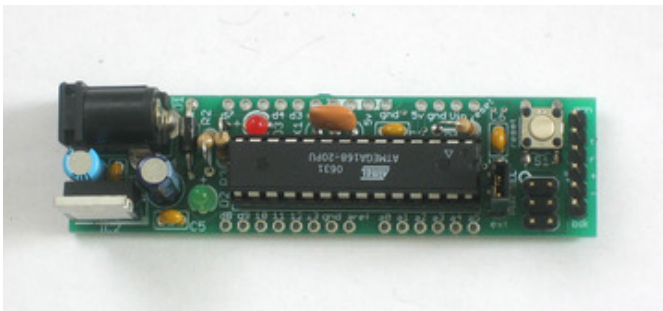
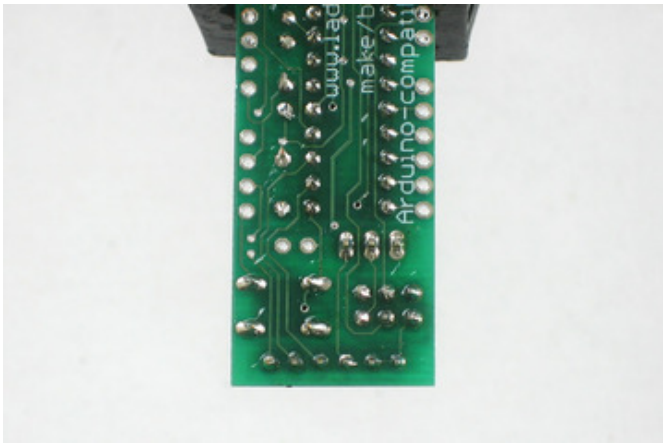
Cut another header off, this time a 6-pin piece.

Place the 6mm reset button, the 6-pin ICSP header and the 6-pin strip for using an FTDI USB cable.

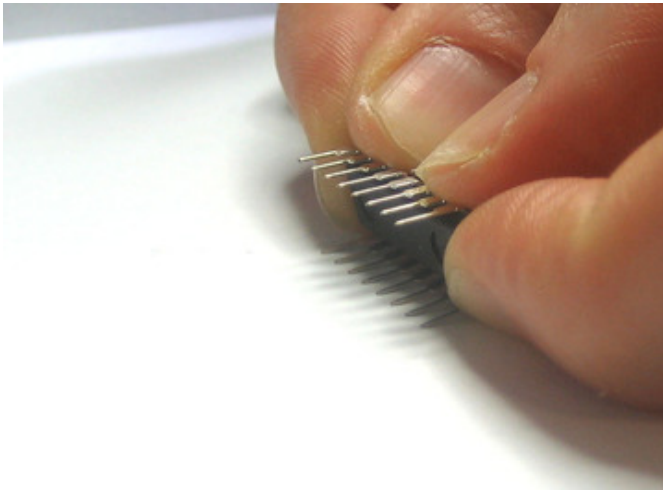




Solder the parts in.

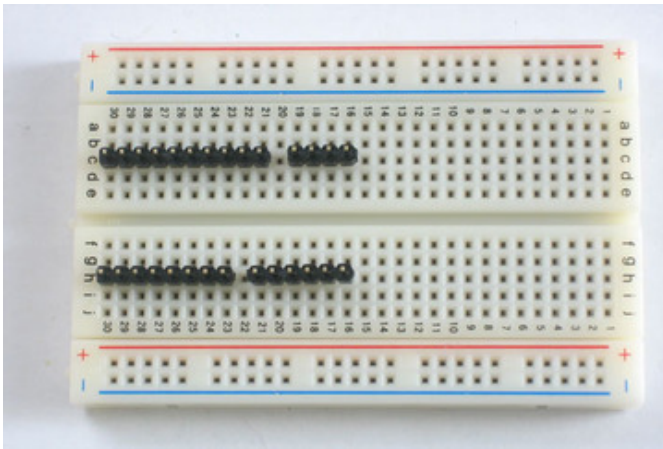


If you'd like to take advantage of the auto-reset capabilities added to the Arduino software, install ceramic capacitor **C6**.

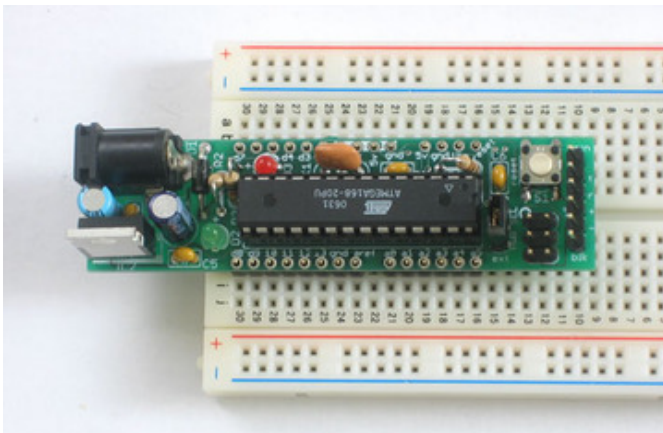


Now is a good time to insert the IC.

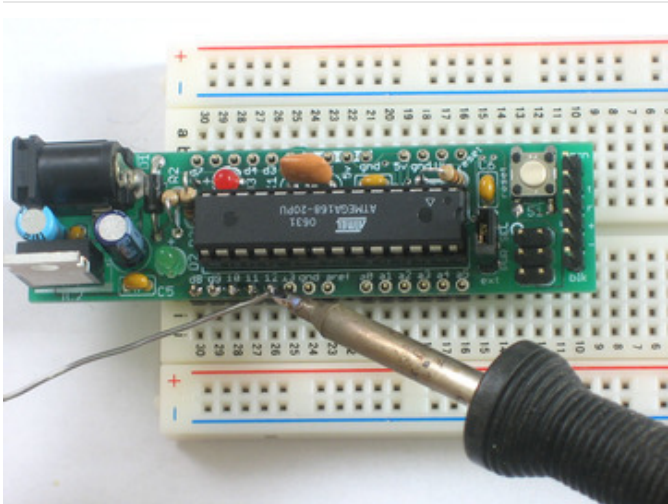
Bend the legs gently against a table and line up the notch in the chip with the notch in the socket. Carefully seat the chip, making sure all of the legs are lined up in the socket.



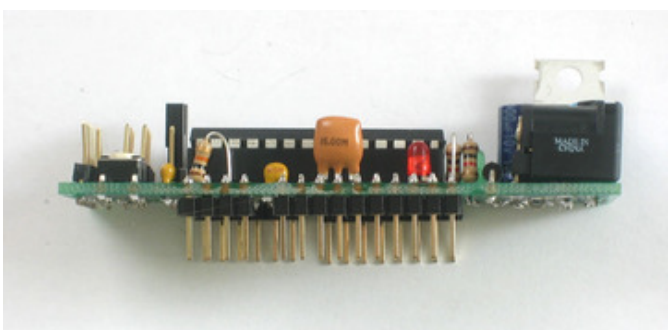
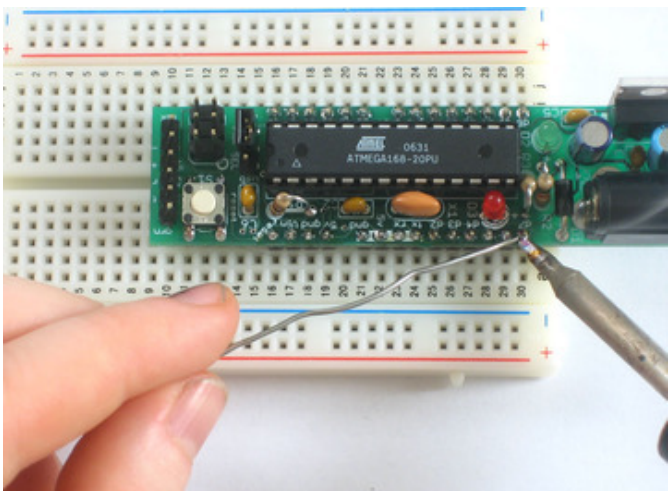
Cut 4 more pieces of header, a 10-pin, 8-pin, 6-pin and 4-pin. Insert them into a solderless breadboard as shown so that the long legs are in the solderless breadboard sockets.



Place the Boarduino on top, so that the header matches up with the solder holes in the PCB.



Solder all of the pins of the header, making sure that the board is sitting flat against the header.


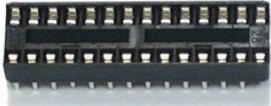






Carefully remove the boarduino by slowly rocking it back and forth to release it from the solderless breadboard.

You should now try to power it up again, and you will see the green LED light. Press the reset button, the red LED should blink a few times. If you don't see the red light blink make sure the chip is in the right way.

USB Parts List

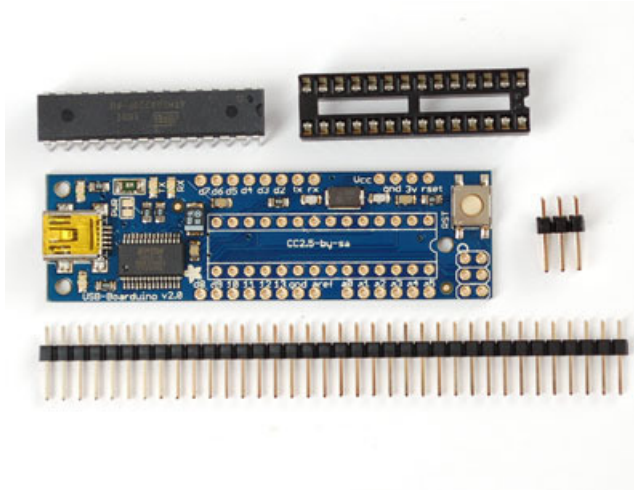
Check to make sure your kit comes with the following parts. Sometimes we make mistakes so double check everything and email support@adafruit.com if you need replacements!

Image	Name	Description	Part #	Distributor	Qty
	IC1	Microcontroller (preprogrammed with Arduino bootloader when purchased in a kit)	ATmega328P- 20PU	Digikey Mouser Adafruit(Programmed)	1
	IC1'	28-pin socket	Generic	Digikey Mouser	1
	ICSP	6 pin header, 0.1"x0.1" spacing	Generic	Digikey	1
		40 pin male header, 0.1" spacing	Generic	Digikey	1
		Jumper	Generic	Digikey Mouser	1
	PCB	Circuit board	Custom	Adafruit Industries	1

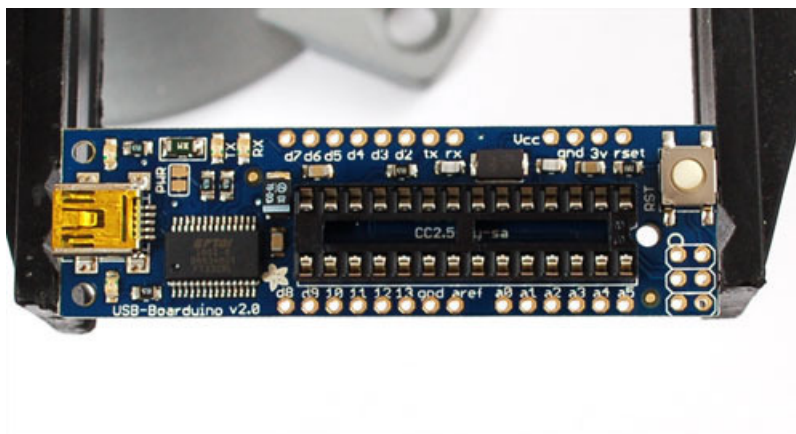
USB Boarduino Assembly

The USB Boarduino is almost completely assembled. Finishing it up should only take a few minutes.

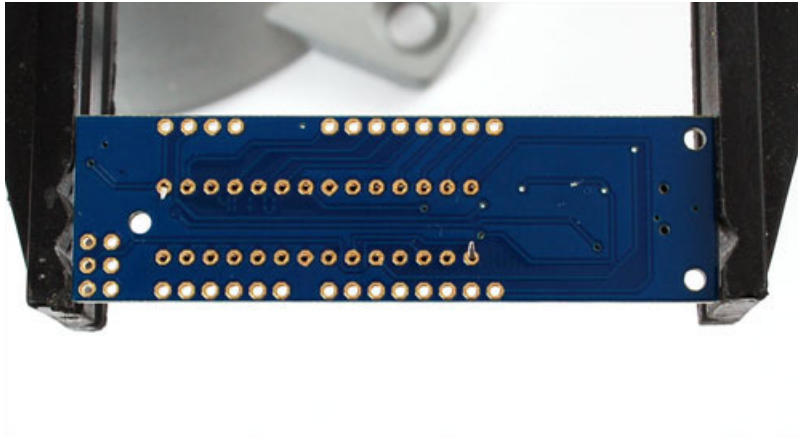
Check the parts in the bag, you should have the tested USB Boarduino board, a stick of 0.1" header, a 2x3 ISP header, a 28pin socket and a preprogrammed ATmega328p.



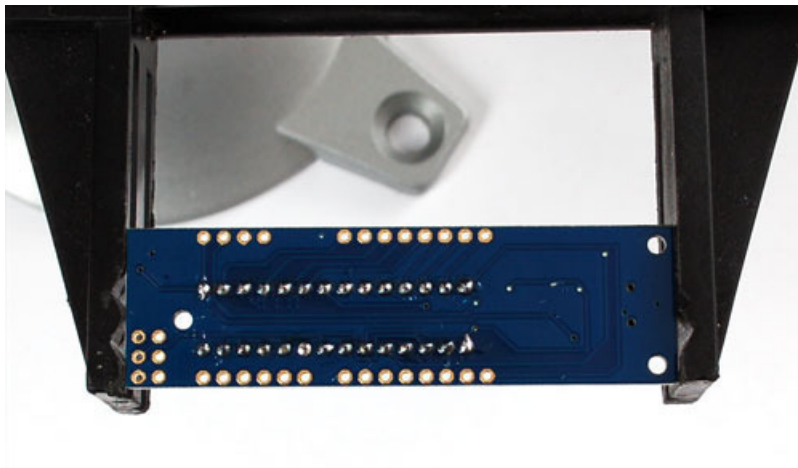
If you want to socket the microcontroller (we suggest it) Place the socket so that the **U** notch matches the **U** printed in the silkscreen. If you don't think you'll ever need to replace the microcontroller and you want a slimmer package, skip this step.



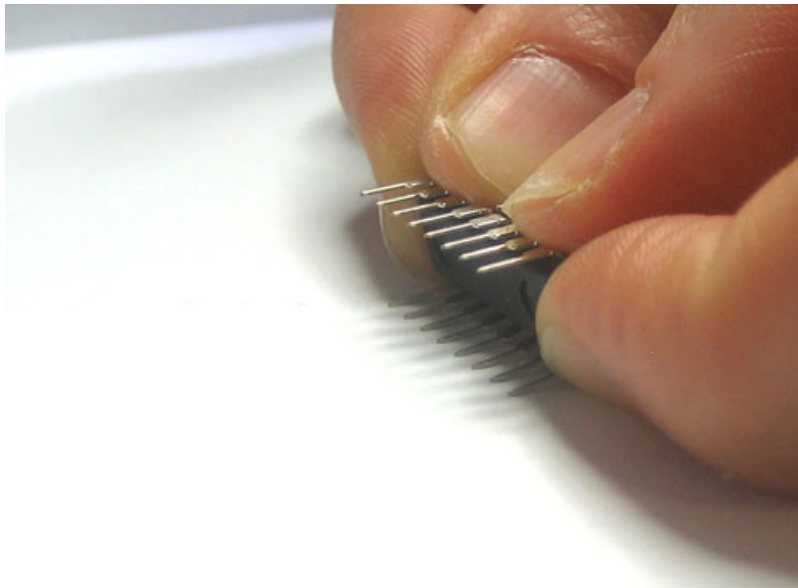
If you have sharp nails you can bend over two of the socket pins to keep them in place.



Solder all 28 pins well.



Take the microcontroller out of the foam and carefully bend all the pins so they are straight. We like to grip the chip by the edges and press it against a tabletop.



Once the pins are straight, insert the chip by matching the **U** notch in the chip with the **U** notch in the socket.

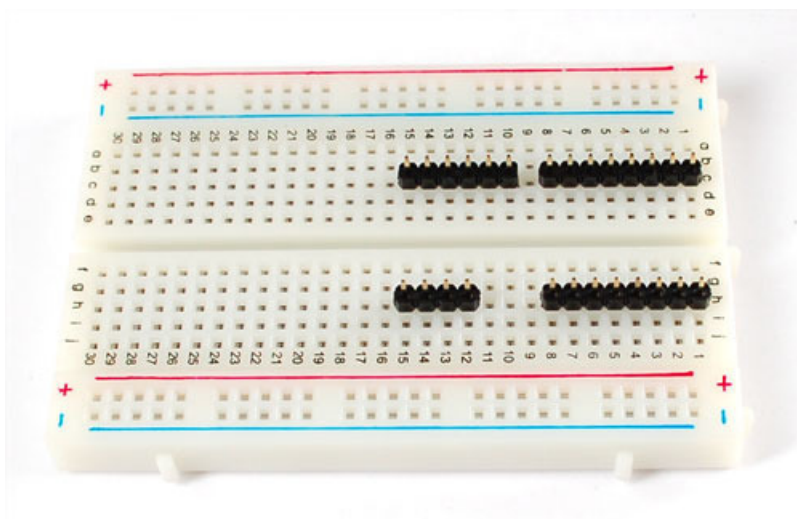


Next, you can attach header pins to make the USB Boarduino fit nicely into a breadboard. If you want to solder wires to the pins instead (free-wiring) you should skip this step.

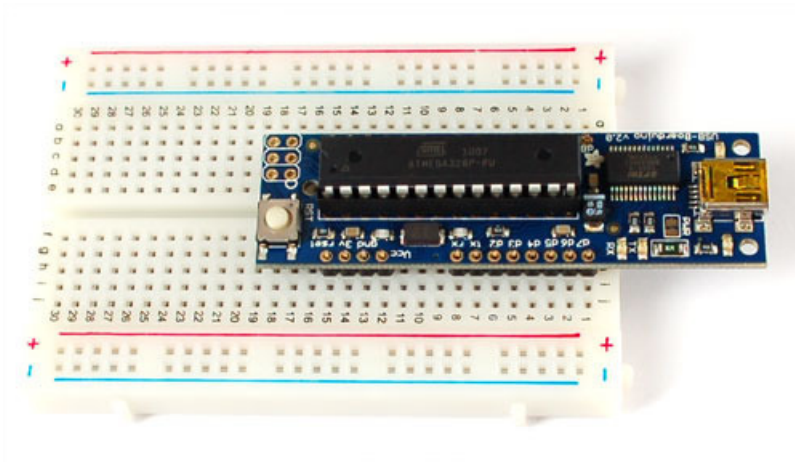
Break the break-away header into four pieces: 4 pin, 6 pin, and two 8 pin.



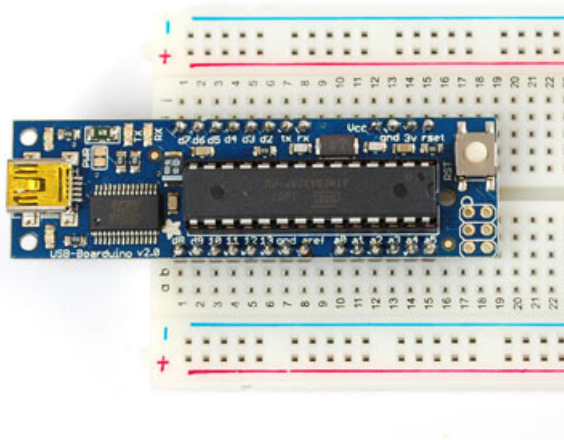
Stick them into any breadboard as shown, they should match up with the USB Boarduino so compare as you place the pieces.



Slip the USB Boarduino on top, it should easily fit.



Solder all the pins!



Using with the Arduino IDE

You can use any version of the IDE, when you plug in the USB boarduino it will show up as COM port (install the FTDI drivers that come with the IDE package if you're running Windows or Mac and have not done it yet).

Select **Diecimila/Duemilanove with 328P** in the **Boards** menu!

About the Design

Microcontroller

The chip is a ATmega328P which is a standard Arduino-core chip. It comes preprogrammed with a slight modification of the Arduino "Duemilanove" bootloader which takes up 2K. We did not use the bleeding-edge OPTIBOOT as we'd like to wait until its more stable.



The chip is clocked with a 16MHz crystal.

Serial Converter



The serial converter is soldered on board, it is a FT232RL. It works great as a USB/serial chip. There are two LEDs connected to it, labeled **RX** and **TX** which will blink when data is received or transmitted. A capacitor between the DTR pin and the AVR's Reset pin acts as the auto-reset for reprogramming, which is standard on all classic Arduinos.



Fuse



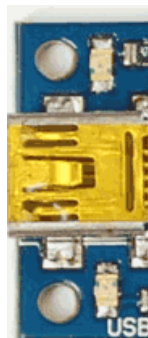
The USB boarduino has a 500mA fuse between the USB 5V pin and the rest of the board. If you draw over 500mA it will trip (it tends to trip at about 1 Amp).

RESET Button



There is a single button that you can press to reset the board, the board has the Arduino bootloader auto-reset capability so you don't need to press this before uploading.

LEDs



There are two LEDs on either side of the USB port. The green one indicates power (its lit if the board has power) and the red one is connected to pin **13** just like classic Arduinos. You can use the pin 13 LED for debugging. It will also blink during bootloading and right before the bootloader starts.

PWR Jumper



The PWR solder-jumper is a bonus for advanced users, it allows you to run the USB Boarduino at a different voltage. It is by default shipped with a trace connecting the two jumper sides, which means that the AVR is running at 5V from the USB port. If you would like to say, run the AVR at 3.3v, you can cut the jumper with a sharp xacto/craft blade (check with your multimeter that it is no longer shorted) and then on the breadboard, connect the *VCC* pin to the **3v** pin. This will run the board off of the FTDI chip's internal 3.3v regulator, which we should warn you can't supply more than maybe 50mA. Also, be aware that running a 16MHz AVR at 3.3v is considered 'overclocking'. We've never had a problem with it for hobbyist use but just be aware that this is outside the guaranteed performance of the microcontroller.

ISP Header



If you want to use the chip as a non-Arduino, rather you just want it as an AVR devboard, you can reprogram it via the ISP port. We provide a 2x3 pin standard ISP header. Pin 1 is indicated with a circle.

Downloads

All files are at the [GitHub repository \(https://adafru.it/cjU\)](https://adafru.it/cjU) Click **Download** to get the files!

Use It!

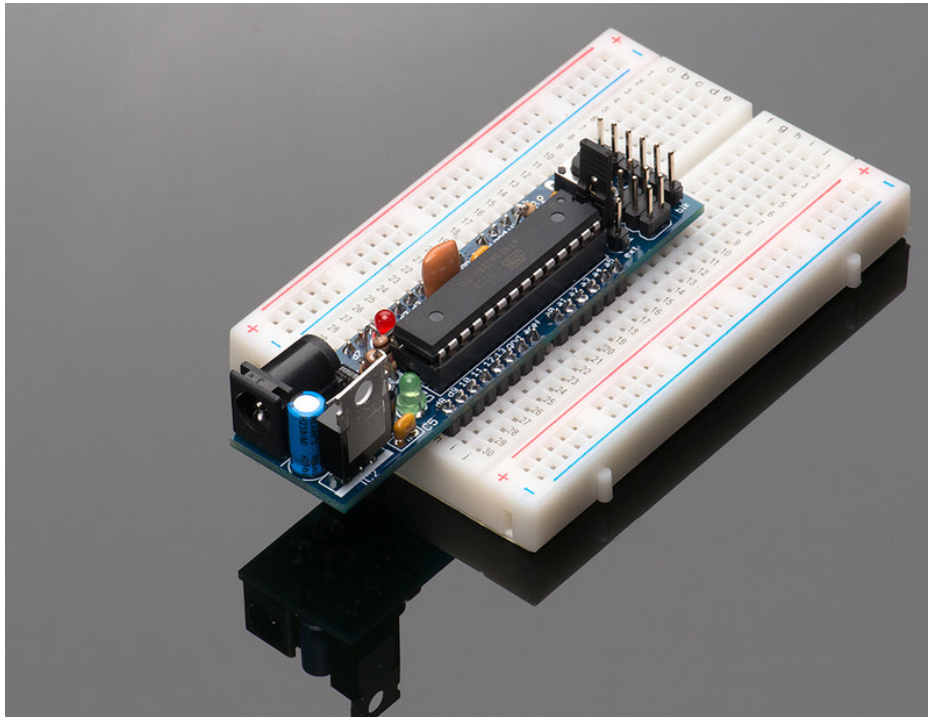
The Boarduino is basically like an Arduino. By default it comes with a chip preprogrammed with the Arduino bootloader (also known as an **STK500v1** bootloader) but you can use it as a general purpose AVR module.

Using with the Arduino IDE

You can use the board as a "Diecimila / Duemilanove" compatible. Dont forget to do the 'autoreset hack below or it wont auto-reset when its time to program.

Remember to check if you have a '168 chip or '328p chip (look at the chip!) ... If you have a '328p select "**Diecimila/Duemilanove with 328P**" or you will not be able to talk to it!

Using with a Breadboard



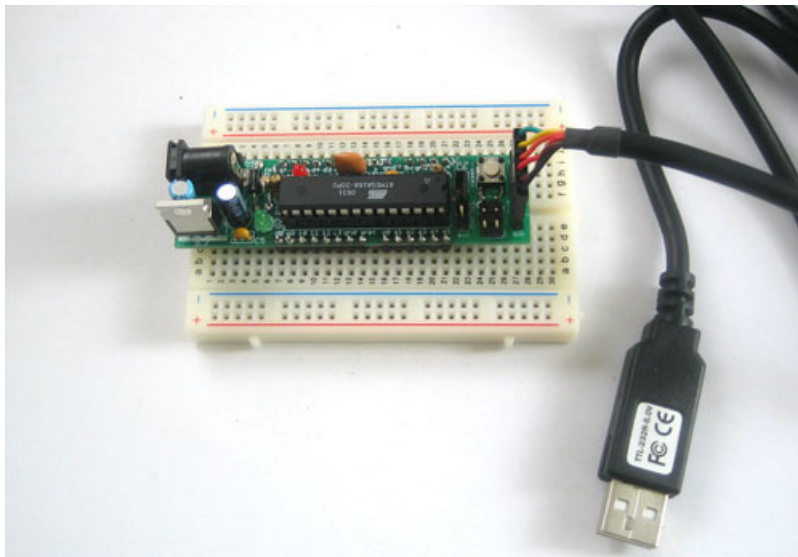
The Boarduino is designed to be inserted into a solderless breadboard, any standard breadboard will be suitable. Simply insert into the breadboard, making sure that the header pins are straight so that they can be easily inserted.

To remove, grab both ends of the board and gently rock back and forth. This will keep the header pins from bending.

Adding USB with an FTDI cable



The easiest way to start loading Arduino sketches into the DC Boarduino is to use a FTDI USB cable. These cables have the USB chip *inside the cable* and a 6-pin socket on the end.



This socket plugs into the Boarduino as shown, and then you can simply plug the USB A connector into your computer. Use the same drivers that you would use with a normal Arduino.

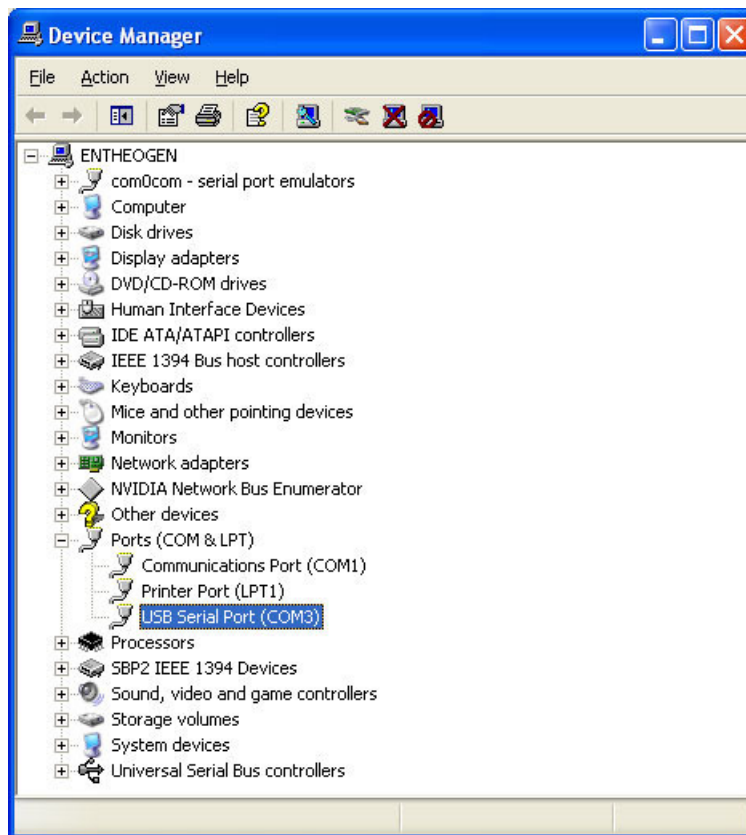
Don't forget to place the jumper into the USB position so you can power it from the FTDI friend or cable!

Arduino Compatibility

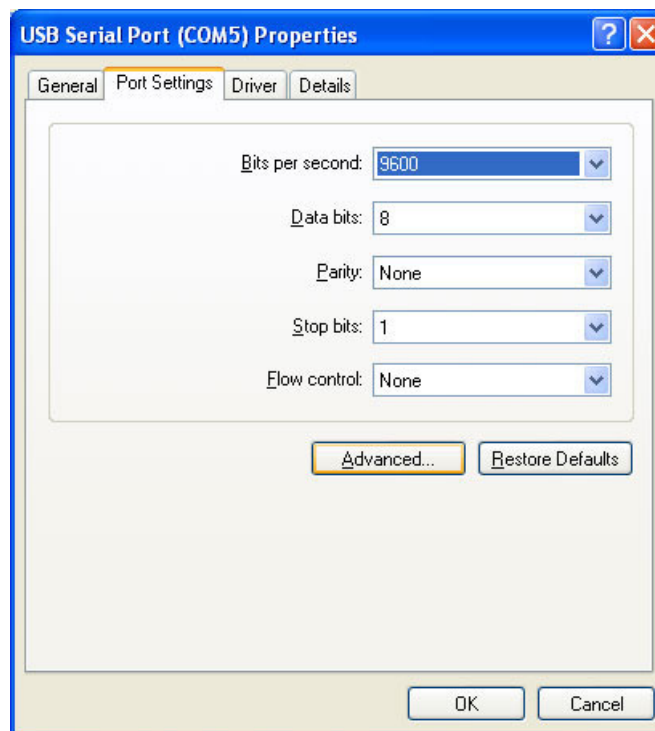
The bootloader installed is a cross between the NG and Diecimila. There is a 7-second timeout after pressing the reset button but once a sketch is uploaded it starts immediately.

If you'd like to have the auto-reset capability, make sure **C6** is soldered in. With Mac's and Linux it should just work fine.

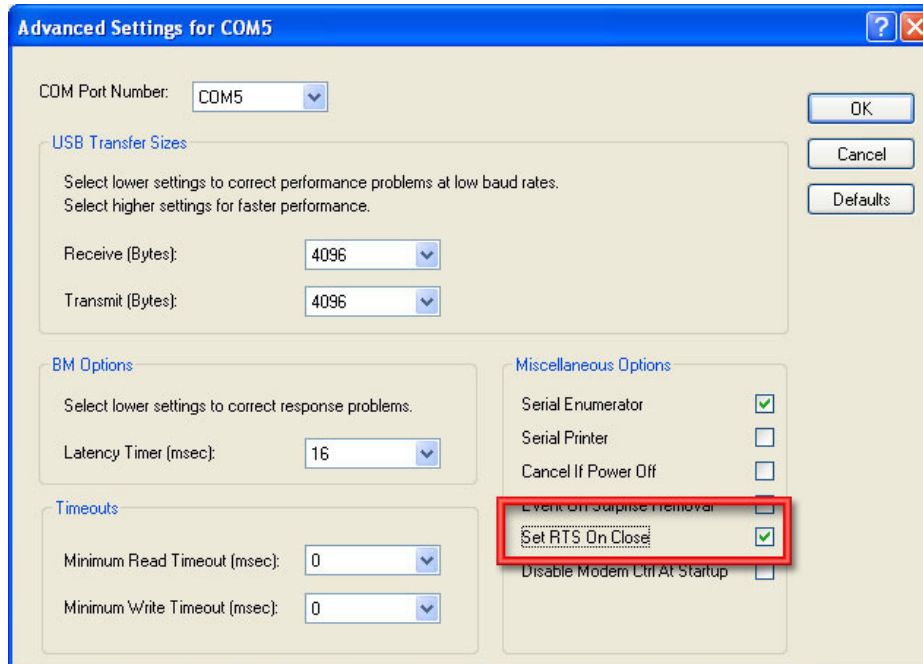
If you're using Windows you'll need to make a slight change to the driver preferences. In the **Device Manager**, select the USB COM port.



Then right click and select **Properties**.



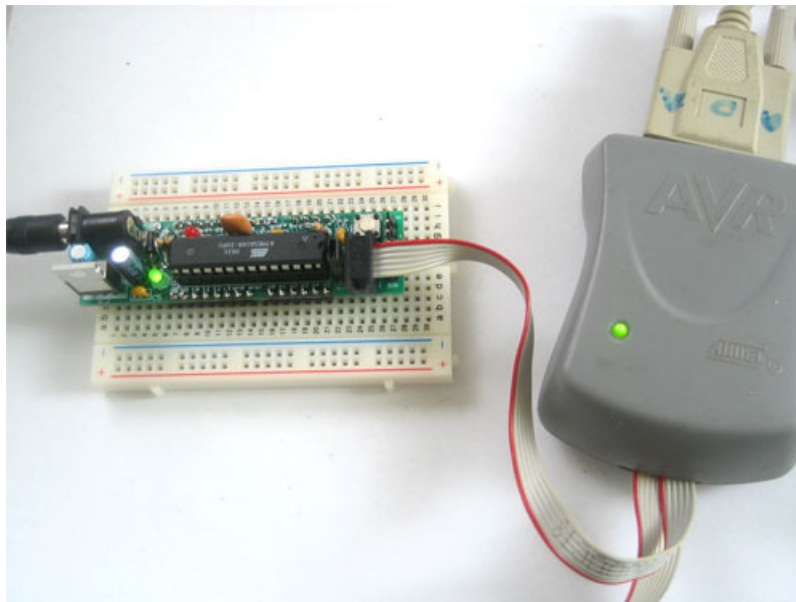
Click on the **Port Settings** tab, and click on **Advanced...**



Make sure **Set RTS On Close** is selected.

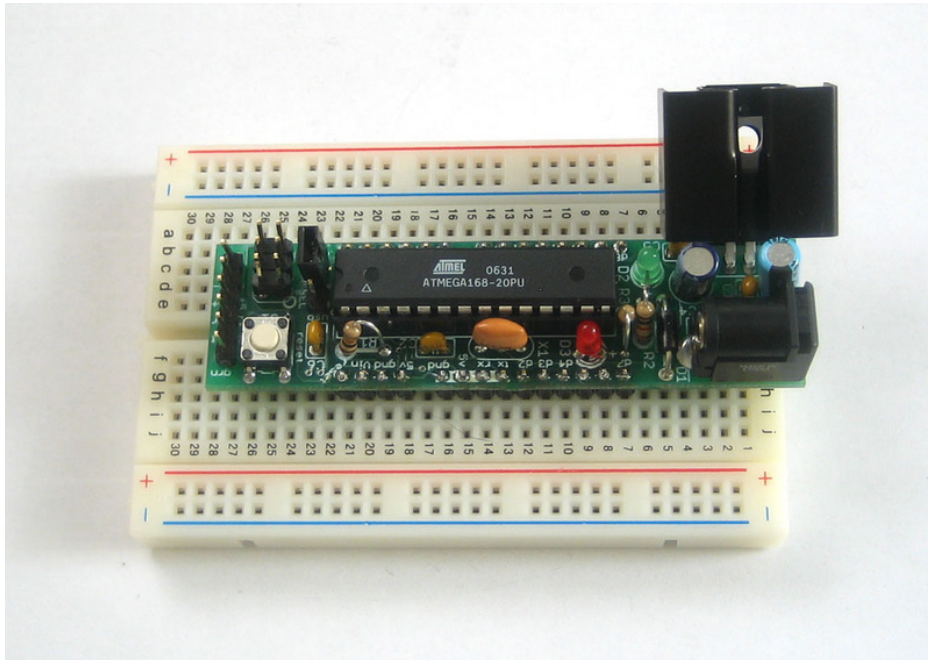
Note that, sadly, the Boarduino will not automatically start the sketch after upload if you do this. Its a bit of a tradeoff and you may find that pressing the reset button is faster and getting auto-start is better for you.

Programming



There is also a standard 6-pin ICSP (In-Circuit Serial Programming) cable that can be used to burn a new bootloader or just reprogram the chip.

High Power



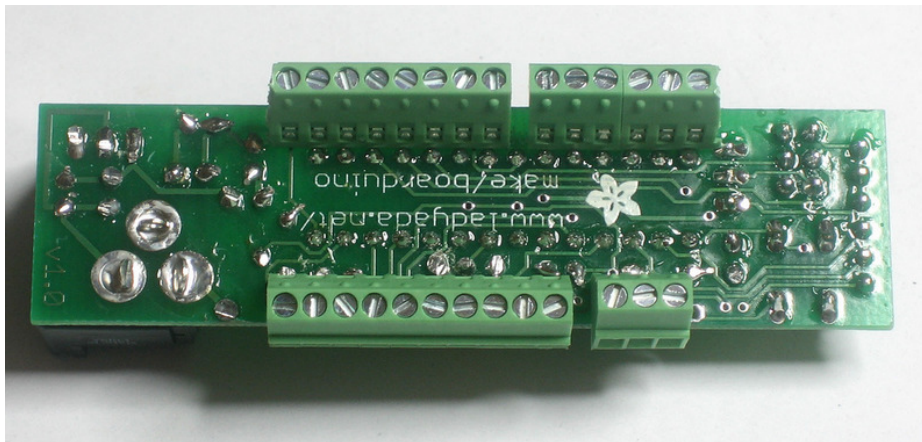
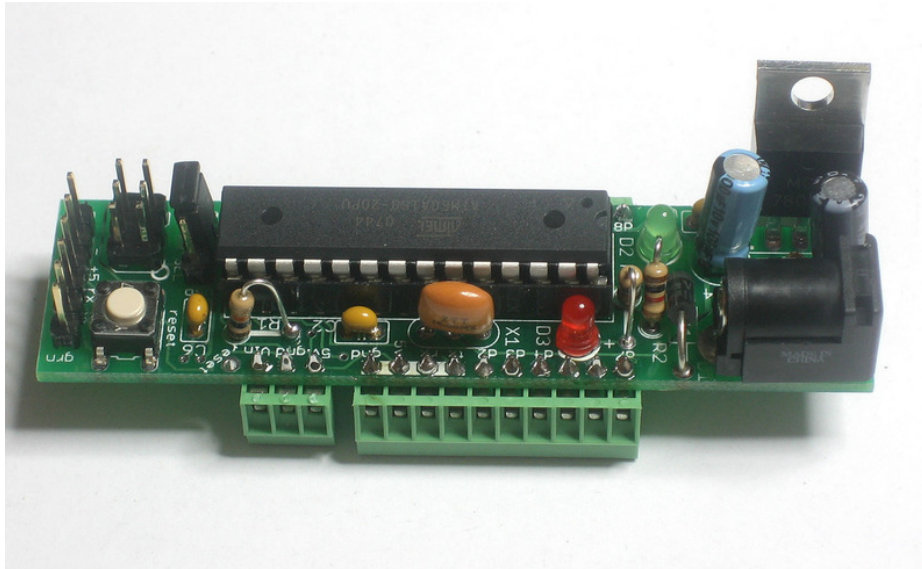
If you are planning to draw a lot of power from the 5V regulator, say for servos or many LEDs, you may want to add a heatsink to the 7805. Just bend the regulator back a bit and slip one on.

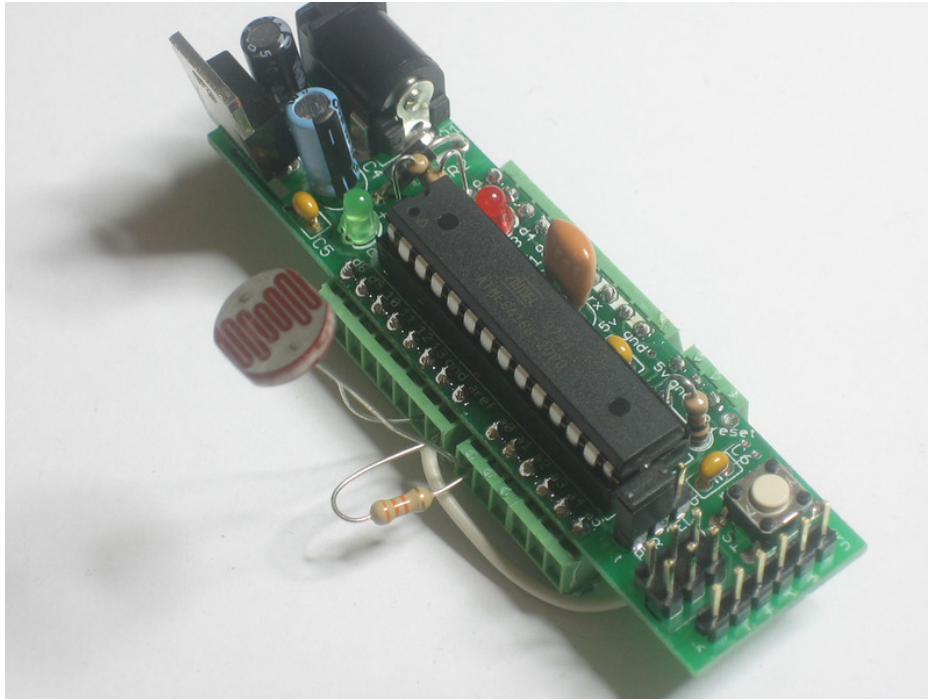
Ideas for Use

Here are some projects built with Boarduinos...just to give you an idea of what's possible!

Use Terminal Blocks

Terminal screw-blocks allow lightweight ultra-quick prototyping: just tighten the little screws to add or remove components! Use Phoenix brand 0.1" terminal blocks, part [1725672](https://adafru.it/cjG) (<https://adafru.it/cjG>) (4-position), [1725698](https://adafru.it/cjH) (<https://adafru.it/cjH>) (6-position), [1725711](https://adafru.it/cjI) (<https://adafru.it/cjI>) (8-position), [1725724](https://adafru.it/cjJ) (<https://adafru.it/cjJ>) (9-position).





Downloads

DC Boarduino

- [Schematic \(https://adafru.it/cnr\)](https://adafru.it/cnr) and [Board \(https://adafru.it/cns\)](https://adafru.it/cns) files in EAGLE CAD format
- [Schematic as PNG \(https://adafru.it/cnt\)](https://adafru.it/cnt)
- These are released as-is under Creative Commons 2.5 - Attribution - Share Alike

USB Boarduino

- [Schematic \(https://adafru.it/cnu\)](https://adafru.it/cnu) and [Board \(https://adafru.it/cnv\)](https://adafru.it/cnv) files in EAGLE CAD format
- [Schematic as PNG \(https://adafru.it/cnw\)](https://adafru.it/cnw)
- These are released as-is under Creative Commons 2.5 - Attribution - Share Alike
- [Fritzing object in the Adafruit Fritzing Library \(https://adafru.it/aP3\)](https://adafru.it/aP3)

Resources

- [Official Arduino site \(https://adafru.it/aL6\)](https://adafru.it/aL6)
- [Freeduino \(https://adafru.it/cjQ\)](https://adafru.it/cjQ) - True Open Source Arduino designs
- [Modern Device \(https://adafru.it/cjR\)](https://adafru.it/cjR) - Other Arduino Clones
- [FTDI TTL-232R cable \(https://adafru.it/c02\)](https://adafru.it/c02)
- [Arduino Tutorials \(https://adafru.it/aKU\)](https://adafru.it/aKU) - These are for traditional Arduinos but can easily be adapted for use with a Boarduino
- [Arduino hacks \(https://adafru.it/cjS\)](https://adafru.it/cjS)

