

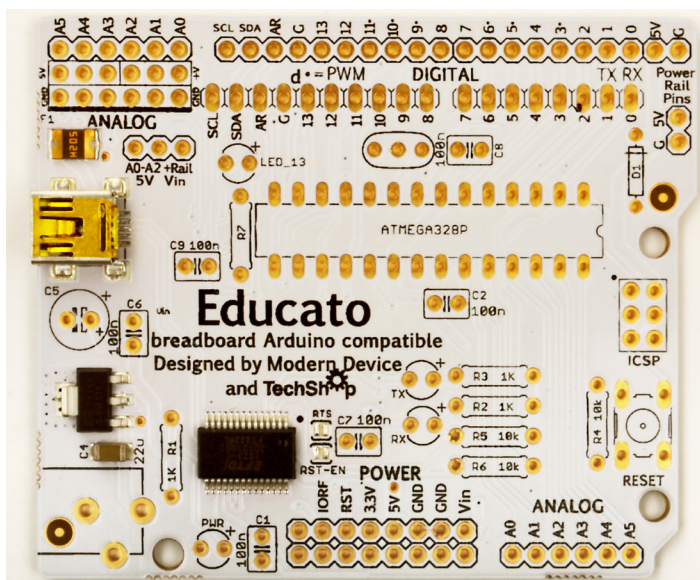
Product Description

The EducatO is an Arduino compatible board that has about the functionality of the Arduino Uno. It also has the ability, however, to plug into a solderless breadboard and to have all relevant Arduino pins available on the breadboard. The board has been specially designed for use in electronics classes where a breadboard-oriented development board is desirable. Most parts are through-hole for easy assembly by beginning electronics students.

Features & Specifications:

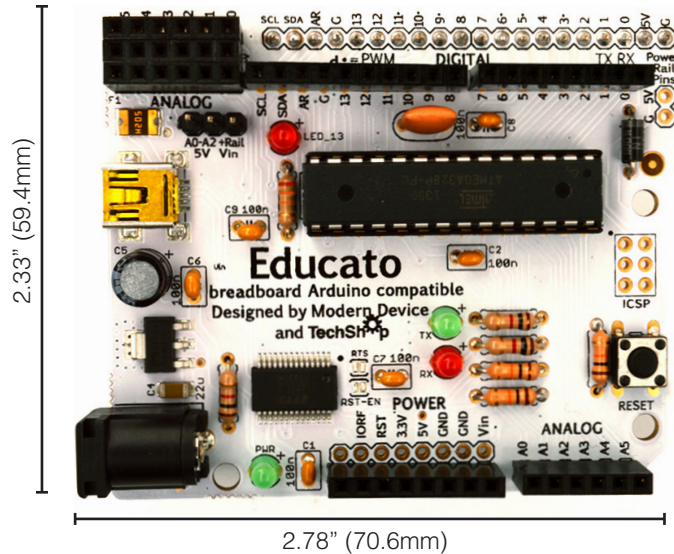
- ATMEGA328P
- FTDI communications chip, polyfuse, USB jack presoldered on the board
- Accepts all Arduino shields that will work with the Arduino Uno
- Special headers to power analog sensors.
- Selectable power rail voltage on three pins making servo motor interfacing convenient.
- On board 1 amp LDO voltage regulator with reverse polarity protection
- Voltage Regulator 5v, 1amp- ideally powered by 6 volts, facilitating servo motor interface
- External power adapter - 6 to 9 volts, 6 volts recommended
- Breadboard power pins compatible with power pins .28" and .38" from the first breadboard
- Weight: 32.0g

Assembly Instructions



Introduction

Pictured above is your bare EducatO board. The following items are pre-mounted at the factory: fuse, mini USB jack, voltage regulator, FTDI USB communications chip.



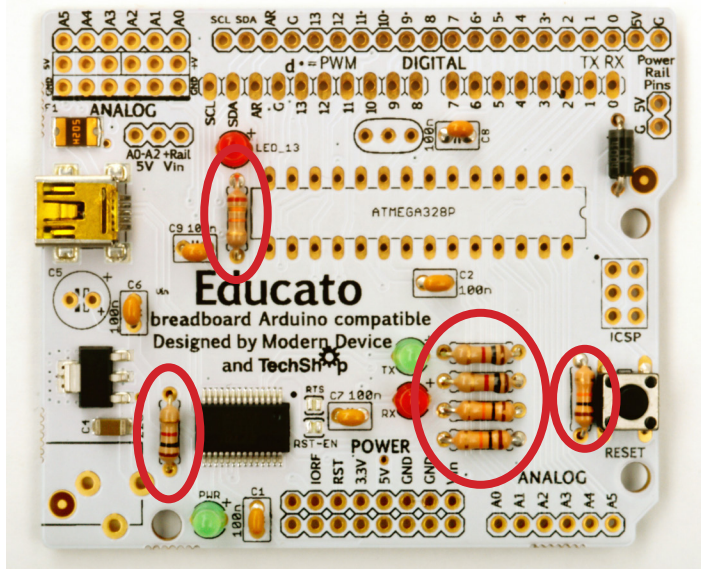
Bill of Materials

Surface-mounted

Qty.	Item
1	Polyfuse (partially assembled)
1	Mini USB jack
1	Voltage regulator
1	100nf capacitor C4
1	USB chip

Through-hole parts

Qty.	Item
3	1k ohm, 1/4 watt, std resistor
3	10k ohm, 1/4 watt, std resistor
1	3.3k ohm, 1/4 watt, std resistor
1	1n4004 diode
1	Push button switch
1	28 pin DIP socket
6	100nf ceramic capacitors
2	Red 3mm LEDs
2	Green 3mm LEDs
1	47uh, 25v electrolytic capacitor
1	16MHz crystal resonator
1	1x3 male header, standard length
1	Shorting jumper



Resistors

Solder in three 1K resistors marked R1, R2, R3. Resistors are not polarized so the orientation is not important.

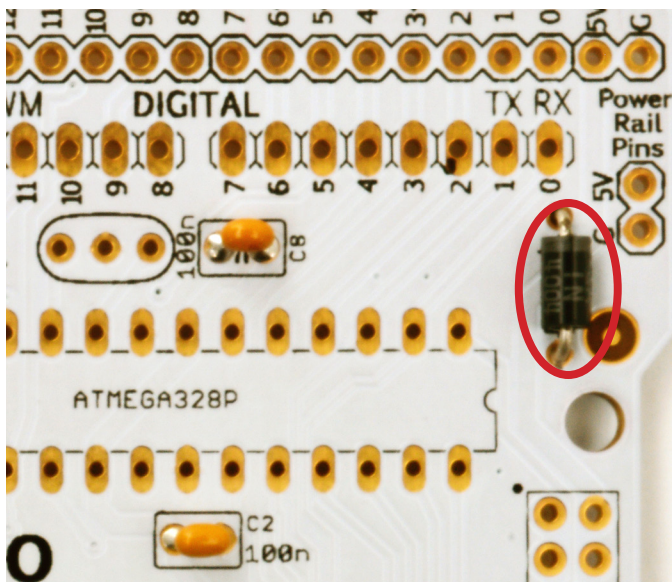
1K (1,000 ohms)
brown-black-red-gold

Solder in three 10K resistors marked R4, R5, R6. Again, orientation is not important.

10K (10,000 ohms)
brown-black-orange

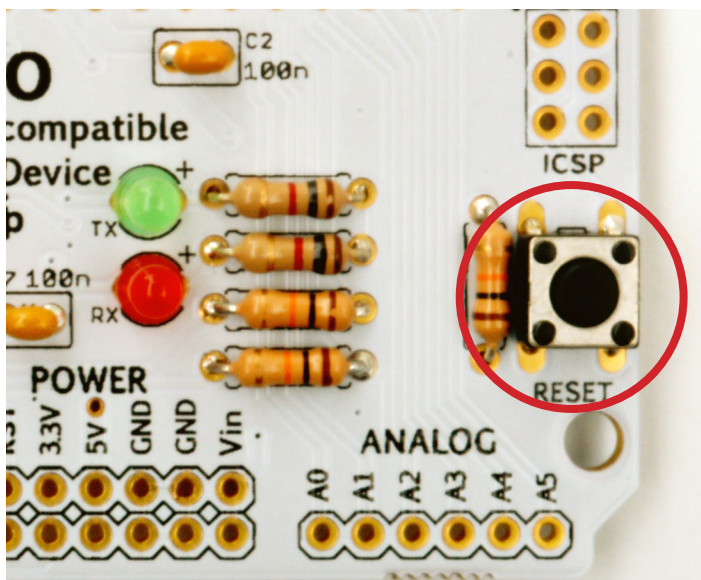
Lastly, solder in the only 3.3K resistor at R7.

3.3K (3,300 ohms)
orange-orange-red



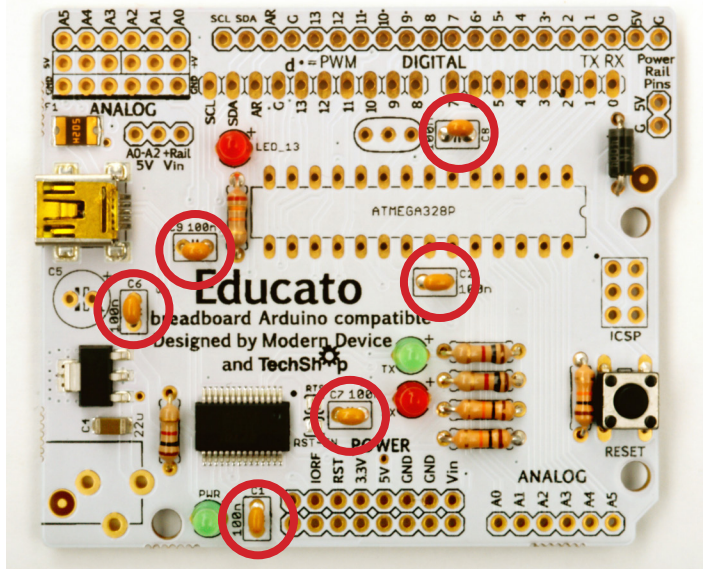
Diode

Solder in 1n400 Diode (polarized) to D1. Diodes are always polarized, so be sure to match the part stripe with the board. Note that the last digit in the part number may vary (ex: 1n400x).



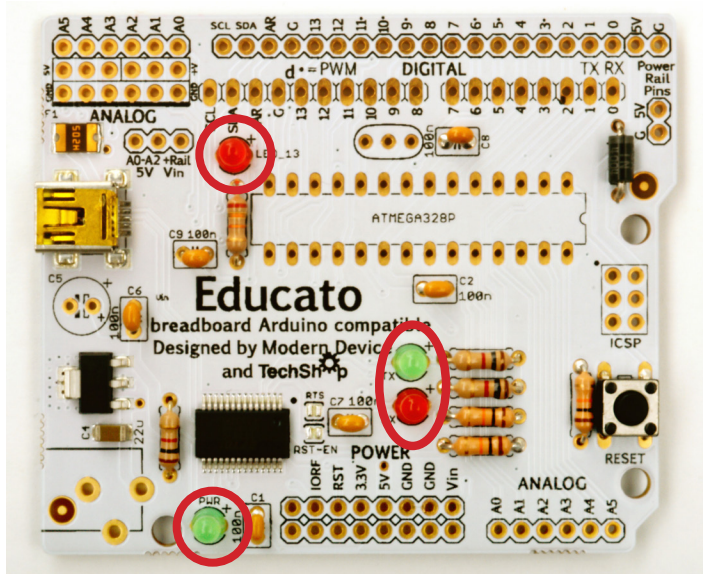
Reset Switch

Solder in the reset switch to RESET position. The switch will only fit easily into the board in the correct orientation, so don't worry that you're getting it in wrong.



Capacitors

Solder in six decoupling capacitors in C1, C2, C6, C7, C8, C9. They are not polarized, meaning they may be inserted facing any direction.

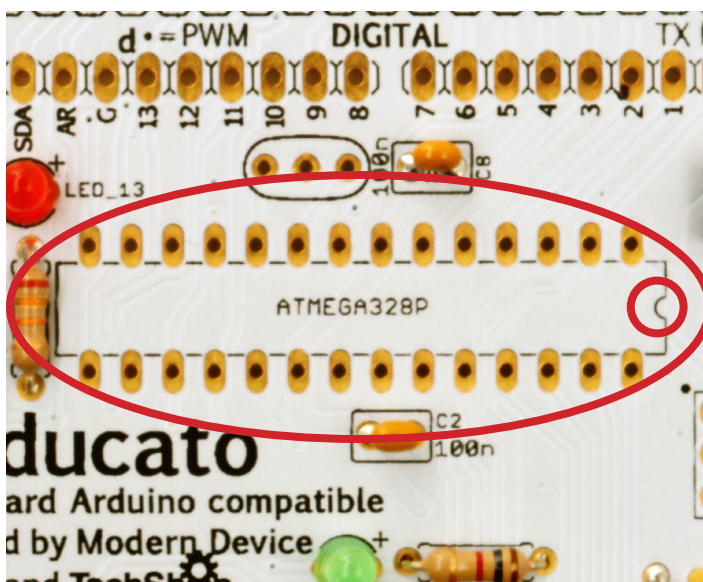
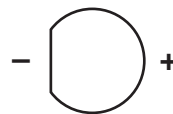


LED's

Solder in two red, two green LEDs

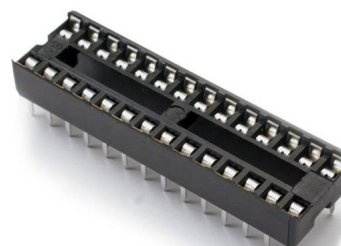
Red location: L_13, RX
Green location: TX, PWR

LEDs are polarized so you must insert them correctly, the longer lead (positive) should face the round edge of the mark on the board. See diagram below.

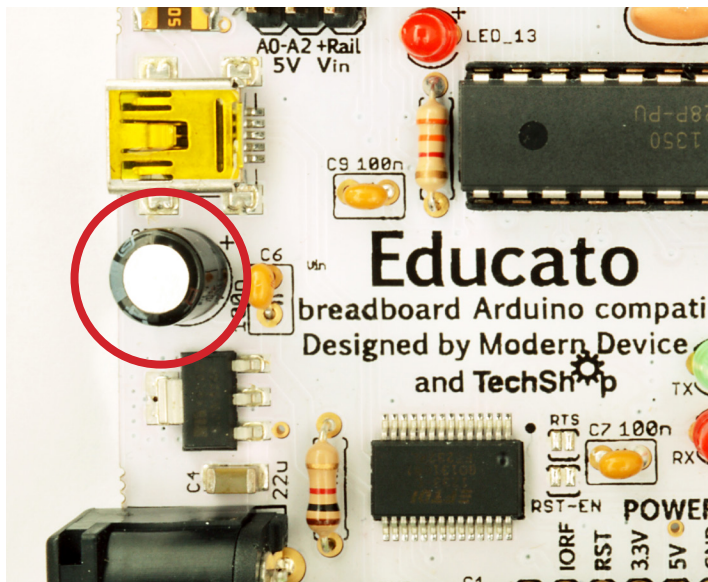


Microcontroller Socket

Solder in microcontroller socket (28 pin DIP package). Match the divet (notch) on the socket with the silkscreened notch symbol on the board. Also be sure that you are soldering in the socket and NOT the integrated circuit (chip), which could physically fit into the board. The socket makes it easy to change chips should you burn it out.

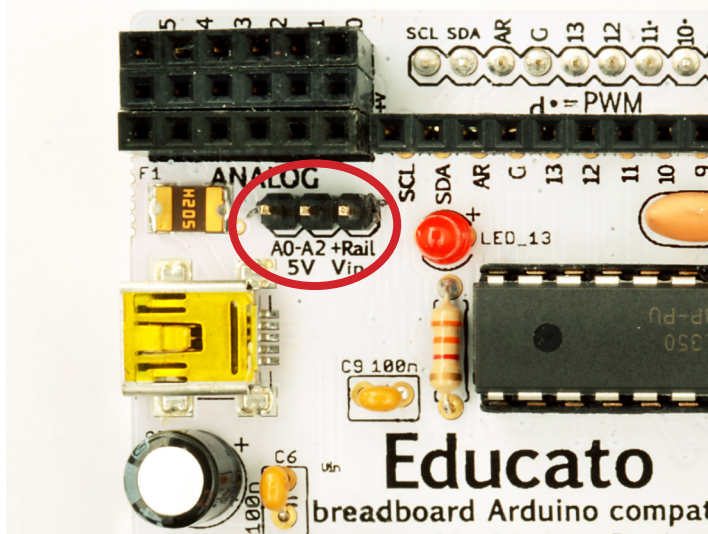


28-Pin Socket



Capacitor

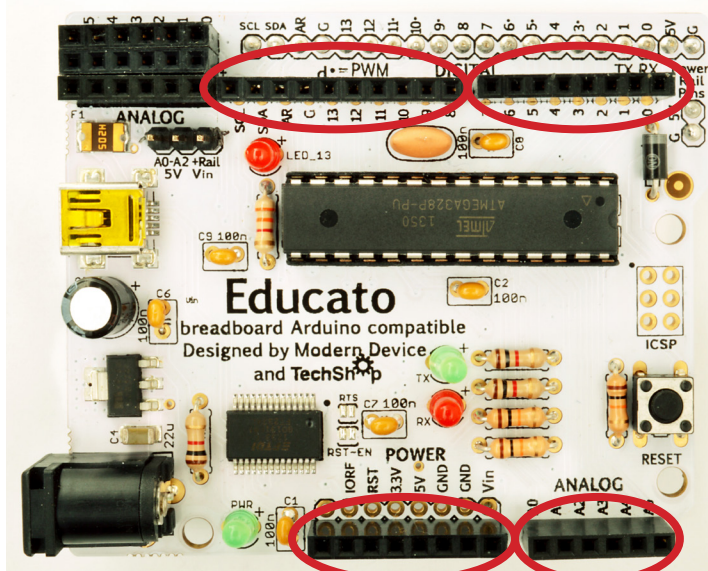
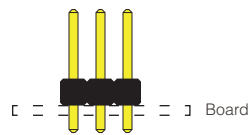
Solder in the electrolytic filter capacitor. Similar to the LEDs, the capacitor is polarized and the long lead is positive. If you examine the part though, the negative side is marked on the part label.



Male Header

Insert 1x3 male header in through the top of the board, and solder on the bottom side. Start by soldering just one pin and make sure the header is straight and flush with the board before soldering the other pins.

1x3 Male Header



Female Headers

Solder in the female headers one at a time, starting with one pin for each header. Inspect the header to make sure it is aligned flush and perpendicular to the board, and then solder in the remaining pins.

1 six-pin header

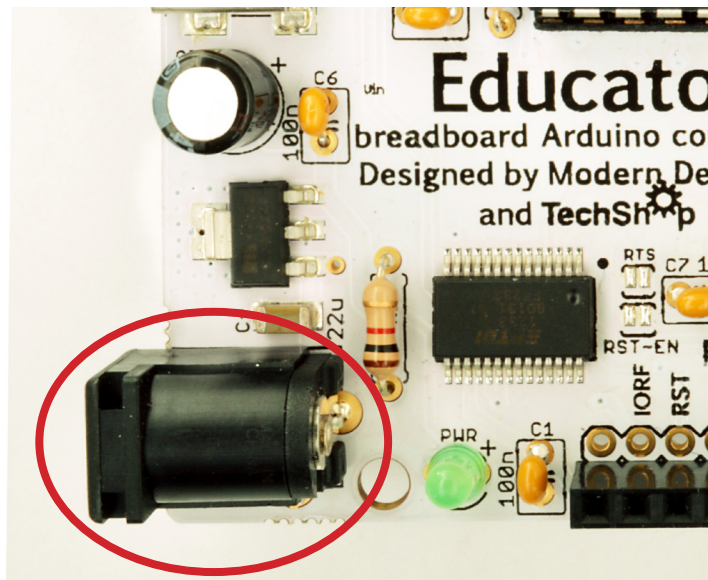


2 eight-pins headers



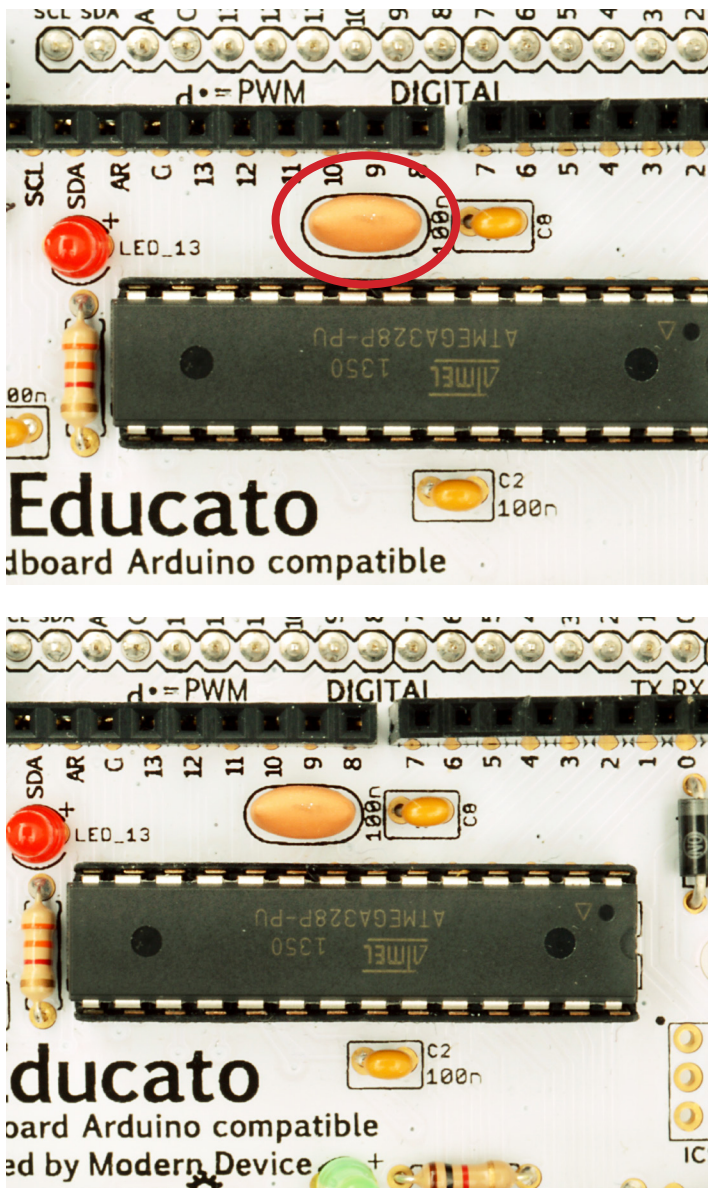
1 ten-pin header





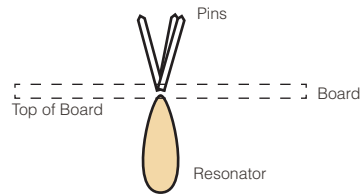
Power Jack

Solder in power jack, and be sure to use a little extra solder to fill the gaps between the pad and pin. You will also need to dwell on the pads longer with your soldering iron, to insure that the larger lugs are really hot enough for an effective solder joint.



Crystal Resonator

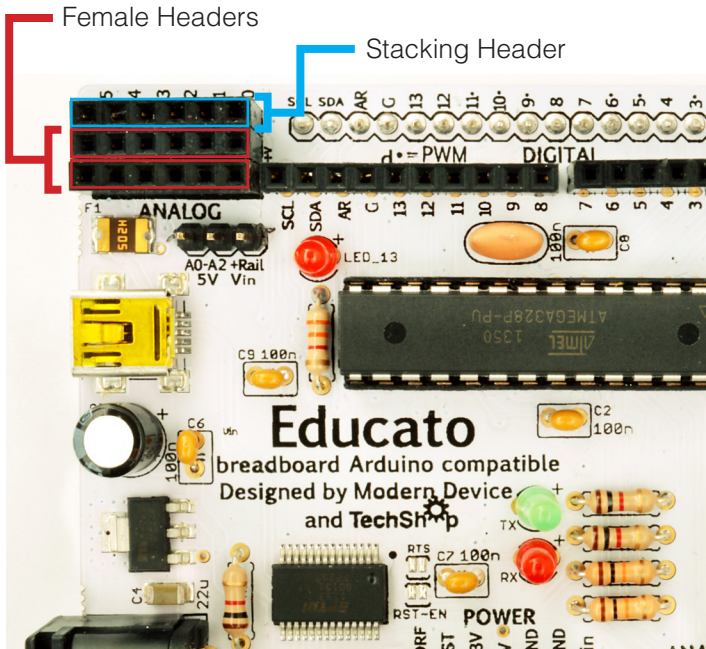
Solder in the resonator. Bend the pins in opposite directions to hold the resonator in while soldering.



Microprocessor Installation

Insert ATMEGA328P chip into microprocessor socket. You will first need to bend the pins of the chip into a parallel configuration. Do this by pressing the leads against a flat surface. This insures that the chip is easily inserted into the socket. See diagram below.

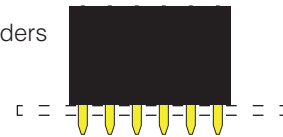




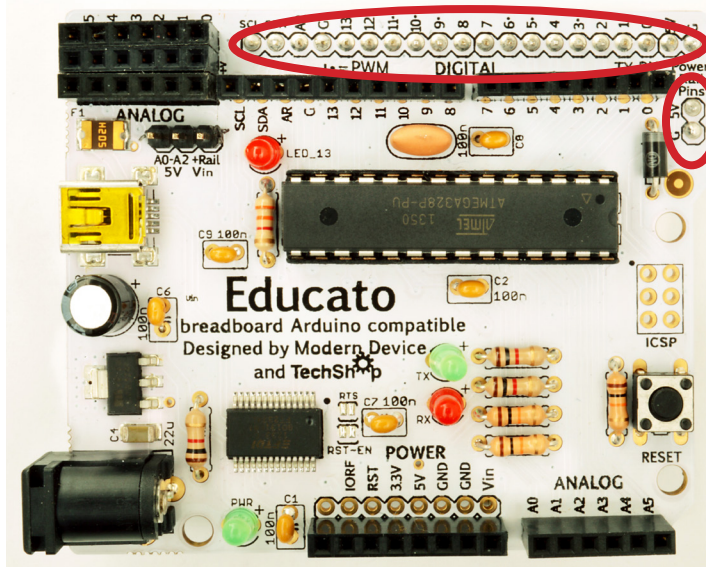
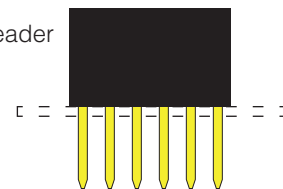
Analog Block

Solder six female headers one at Analog, starting with one pin for each header (and then inspect the header) to make sure it is aligned flush and perpendicular to the board. Be careful NOT to cut off the male parts of the stacking header that is inserted into the board.

2 six-pin female headers



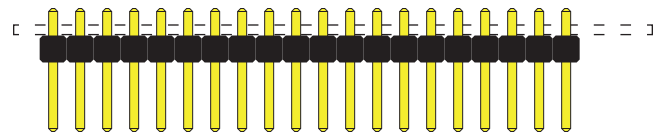
1 six-pin stacking header



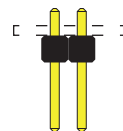
Male Headers

Insert 1x20 Male Header in through the bottom of the board, and solder the topside of the board. Start by soldering just one pin and make sure the rest are properly aligned before soldering the rest.

1x20 Male Header



1x2 Male Header (Power Rail Pins)



Educatro

Using the Educatro

The Educatro is very similar to an Arduino Uno and any shield that fits the Uno will fit the Educatro. If you have used the Uno before, too the Educatro is identical to use, with the difference that the Educatro as been specifically designed to work on a breadboard. Also it's a kit, so you get to have the fun of building it yourself. The USB communication is done with a FTDI chip similar to the Arduino Duemilanove.

Analog Block

The analog block consists of three rows of pins. On the top (looking from the board side) plugged into the breadboard, are the Arduino analog pins. The middle row is connected to either 5 volts OR in the cast of A0-A2 the power rail on the middle header can be switched. The lower row of pins are all connected to ground.

This analog block has been designed for a variety of reasons. Many sensors require power and ground so it's very convenient to have those pins adjacent to the analog input pin which will be connected to the output of whatever sensor is being used. Also the GND, PWR, SIGNAL format is the same as servo cables, so that a standard servo cable or just a servo may be plugged in directly to the analog header.

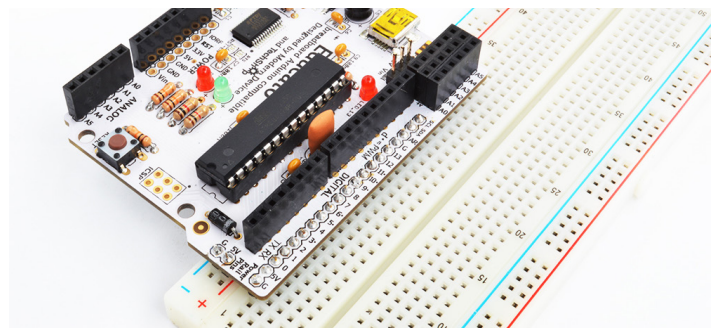
Using Hobby (RC) Servos

The Educatro has three pins just below the analog block (looking from the board side). There is a shunt that switches the positive power connection from +5volts - which is after the power regulator, to Vin, which is the power straight from the power adapter.

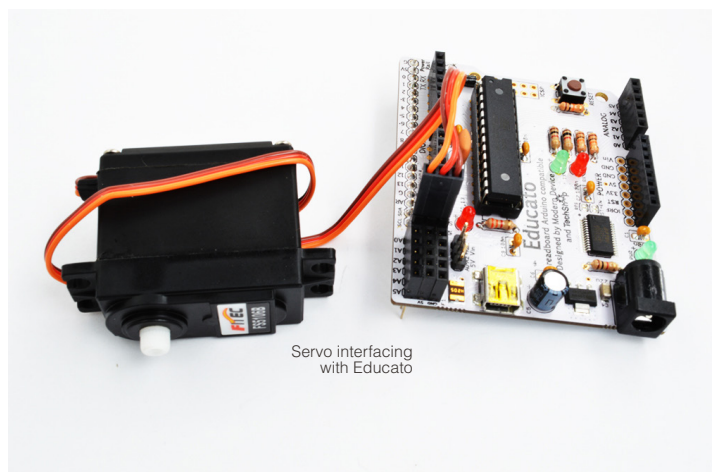
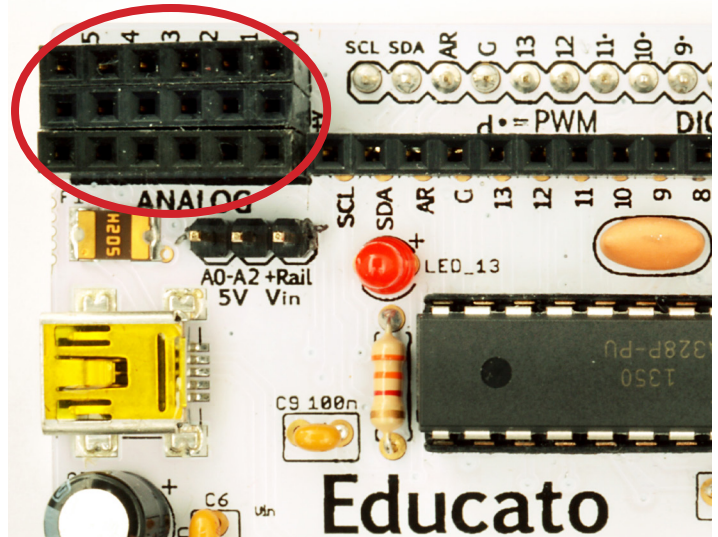
For use with hobby ("RC") servo motors, you can switch this shunt over to the Vin side. You should do this ONLY if you have a six volt power supply or wall adapter hooked up to the external power jack. You might also want to check the specifications on your servo motor to make sure that it's tolerant of six volts. The majority (but not all) hobby servos tolerate run well on six volts.

Switching the power to the External Power input (through the Vin shunt) has two positive effects. It allows your servos to run directly from your power supply, without being limited by the Educatro's voltage regulator. Also it removes some of the electrical noise that DC motors inevitably generate from the Educatro's internal power supply - after the voltage regulator. If DC motors, including hobby servos, are reversed, started or stopped quickly enough, they can often generate pulses on the power lines that end up resetting the microcontroller.

Having the servo motors (or DC motors) connected external to the power supply (on the other side of the voltage regulator), greatly mitigates this potential problem.



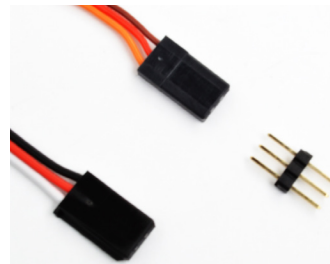
Above: Educatro interfaced with Breadboard
Below: Analog block



Servo interfacing with Educatro

Using Hobby (RC) Servos (cont.)

Note that servo motors do not have to be used with the analog pins. It just so happened that the pins were in the correct order and made hooking up servos very convenient. Any digital or analog pins on your Arduino may be used for servos and the Arduino servo library supports up to 12 servo motors. Note that this many servo motors might require more than a 1 amp power supply, so you might need to get a larger supply if you really want to run a large group of servo motors.



Some servo headers are colored differently



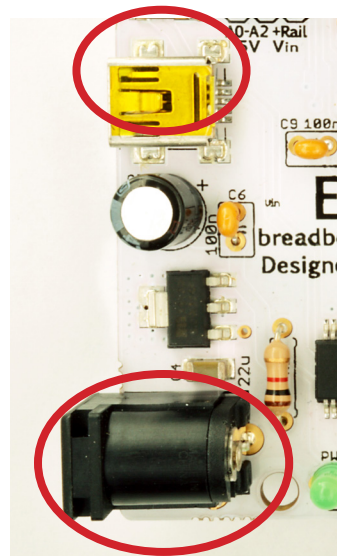
Changing header inserted into servo header

Power Supply

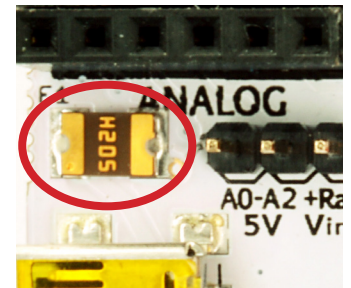
The power supply for the EducatO can come from two different places. The USB header and the external power jack. The USB jack is followed by a PTC (positive temperature coefficient) fuse. The fuse will help protect the USB line, if you accidentally short the wires. You should have an idea that the power line has been shorted because the power LED will go OFF.

This fuse necessarily has some resistance, which has a side effect. While powering only from USB, the voltage at the power jack will be read around 4.85 volts instead of about 5.00 volts. When you start power more loads, such as high brightness LEDs or very small motors, you will see this voltage drop slightly further.

Plugging in a wall adapter or battery pack into the external power jack will result in a voltage much closer to 5.00 volts. The voltage regulator used on the EducatO is immune to reverse polarity, so there is no need for a protection diode. The ideal wall adapter for the EducatO is a 6 volts 1 amp modern switching adapter (the smaller and lighter kind).



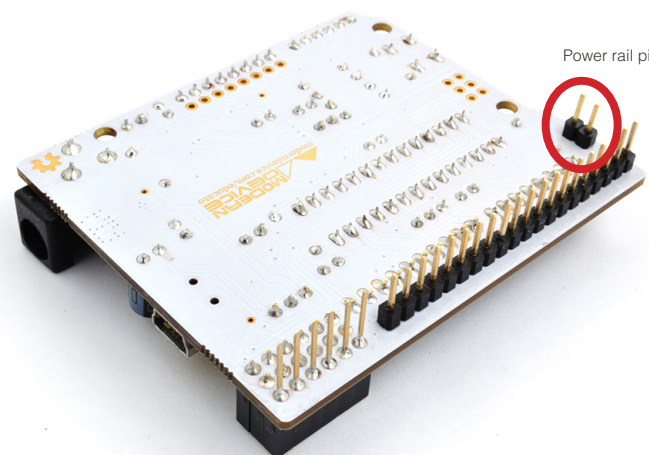
USB header and external power jack



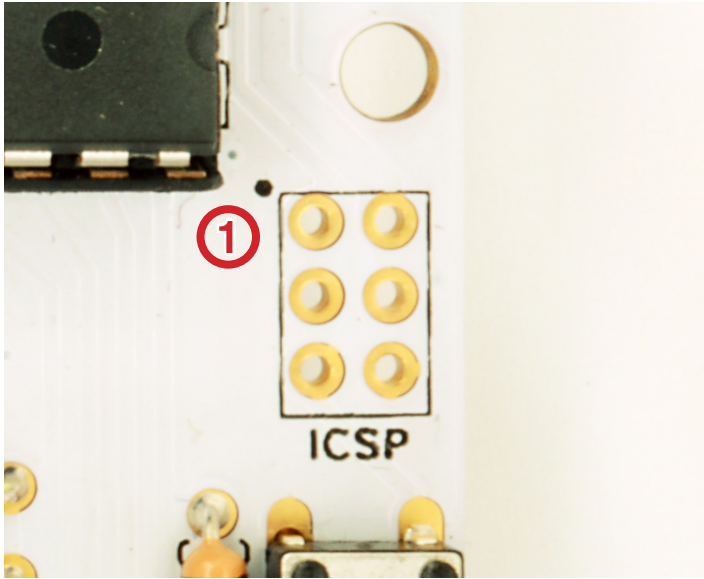
PTC fuse

Power Rail Pins

There are two pins that are made to power a breadboard, from the EducatO. These pins will not fit every breadboard, so perhaps line up the board with your breadboard before you solder on the pins. Also the pins only have one polarity, so the EducatO can only be properly used on one side of the breadboard. The pin marked with "5V" should go into the red breadboard rail and the pin marked with "G" should go into the blue breadboard rail.



Power rail pins



ICSP Header

There is a six hole ICSP header on the EducatO that can be used to reprogram the bootloader should it need it, or to replace the Atmega chip and reprogram a new bootloader. This is not a hard procedure but requires some form of serial programmer. We use the Atmel AVRISP mkII but Adafruit makes another model and another EducatO or any other Arduino can also be used as well. You can find instructions for burning bootloaders on the Arduino website.

Reset Line:

Some Arduino users have found it handy, NOT to have the have the Arduino (Atmega328P) chip reset when the serial monitor opens. This is handy when you want to be able to connect and disconnect a laptop monitor to a running EducatO (or Arduino) without having the program start over from the beginning.

To accomplish this you will need to cut the small shorting trace that runs in between the two RST-EN solder jumpers. Do this with an Exact-o or utility knife. To reverse the surgery if you wish, just solder up the pads.

Cutting the reset line does have a side effect on uploads however. You will need to push the reset button at just the right moment in the upload process, when uploading a sketch to the EducatO. To facilitate this, set the "Verbose - On Upload" checkbox in the Arduino preferences. Alternately you could short the contacts with a small screwdriver or knife when uploading.

RTS

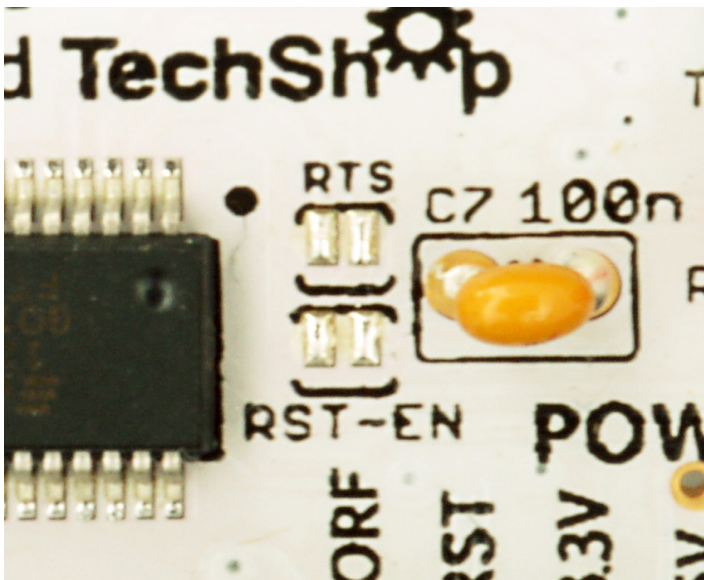
The DTR line of the FTDI UART chip is used for the microcontroller reset. If you wished to use the RTS line instead just jumper the solder pads with solder. In this case the DTR line and RTS will be paralleled. To use ONLY the RTS line, you will need to cut the default reset trace. Cutting this line just to the left of the RST-EN jumper would be handy in case you wanted to reconnect it in the future.

I2C Pins

The Arduino Uno initiated the idea of having the I2C pins available on the front digital row. These pins may appear to have different names but they are exactly the same pins as A4 and A5. While it is possible to use both functions (analog input and I2C output) at the same time, some deliberate coding would be required. Don't fool yourself that these are some kind of new pins, not previously found on the Atmega328P. The pins are wired in parallel with the A4 and A5 line.

Analog Pins vs. I2C

A4	SDA
A5	SCL



Troubleshooting

Procedure:

Power the EducatO from a USB cable for troubleshooting. If the power LED does not light unplug the cable immediately while you look for problems. You will need to periodically plug the cable back in to see if you have fixed the problem but don't leave it plugged in for long if the board is not working.

Symptom: No pilot light.

Possible Causes:

- If the fuse, F1 gets warm/hot OR you get a "USB device over current" message on your computer, you have a short somewhere, unplug the board and begin looking for the short circuit. Check all your solder joints and pins look for accidental solder connections between them.

Also check for:

- Atmega368P chip in backwards
- Diode in backwards
- Electrolytic capacitor in backwards
- Power rails of breadboard shorted

Symptom: No pilot light, but fuse does not get hot.

Possible Causes:

- Power LED in backwards - check for voltage at power block with a multimeter
- No power at external jack or USB - check power, cables and polarity with a multimeter

Symptom: Pilot light on but program won't upload to board.

Hardware Causes:

- Atmega368P in backwards or not seated properly (check for pins that have "escaped the socket", seat firmly, check all solder joints AND/OR reheat all solder joints)
- Atmega368P not programmed with bootloader (factory issue)
- RST-EN jumpers have been cut but not resoldered
- Bad USB cable

Symptom: Pilot light on but program won't upload

Software/PC Causes:

- Drivers not installed on PC - Check Arduino->Tools->Serial Port to see if BUB / cable shows up when you plug / unplug programming adapter
- Visit <http://www.ftdichip.com/Drivers/VCP.htm> for the latest drivers appropriate for your machine
- Windows users see the device manager under USB Com Port

Symptom: My board has stopped uploading.

Causes:

- Chip damaged by overvoltage or reverse voltage - replace Atmega chip
- A sketch was heavily using the serial port - not enough delay between serial port writes. This can prompt the reset signal from getting through. Check "verbose on upload in Arduino preferences. Then press the board's RESET switch as soon as you see red text scrolling on the screen. You may need to do this repeatedly to get the timing right.
- Wrong board chosen in Arduino->Tools->Boards menu - you want Arduino Uno

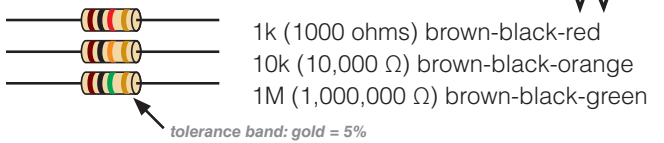
General Cure-Alls:

- Check values of all parts against BOM/instructions
- Reheat all solder pads on bottom of board, look for bridges (shorts) on chip pins
- Clean PCB with toothbrush and isopropyl alcohol, this removes the flux and can remove unseen solder balls that cause shorts
- Swap cables, power supplies, chips if possible

General Troubleshooting Ideas:

- Get your meter out - you can't see electricity without it!
- Try to isolate the problem in one system or subsystem
- Swap parts with working units
- Post questions to forum.moderndevice.com. You will need to register and wait for moderation of your first two posts

Resistors



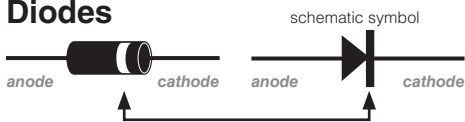
Resistors resist the flow of electricity, limiting the current. They are not polarized, meaning that they may be inserted in either direction. In the largest view, resistors have only two functions.

They act as:

- current limiters
- voltage dividers

In reality all resistors must do both jobs together, but the circuit in which they are installed may emphasize one use of the other. In the EducatO, most of the resistors act as current limiters. The 1K resistors are in series with LEDs and limit the current available to the LEDs. The 10K resistors act as current limiters on the datalines from the communication chip. One 10K resistor holds the reset line high (at 5 volts), in one sense it is acting as voltage divider in this role.

Diodes

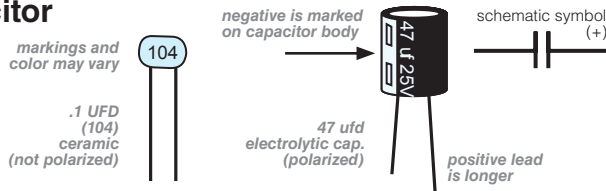


Diodes act as electrical “one-way” valves. Electricity flows in the direction of the arrow, but not the other way. They are polarized. The striped end is negative (cathode). Think of the stripe on the diode as the stripe in the schematic. Get the stripe oriented the correct way on the board, otherwise the project is guaranteed not to work.



Preprepare all the resistors and diodes for inserting into board by bending their leads at right angles.

Capacitor

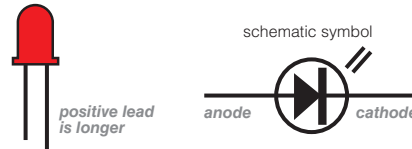


Capacitors are components that store electrical energy (charge). There are several different technologies that are used to construct capacitors. The BBB contains ceramic capacitors, that are not polarized, and electrolytic capacitors, that are polarized, and must be inserted with the correct orientation.

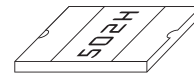
Electrolytic capacitors are marked in a slightly confusing manner. The negative side of the capacitor is marked. On circuit boards and schematics the positive side is always marked. The longer lead on the component is always positive however.

LED

LED's are diodes which emit light. They are polarized like diodes so insert them in the correct direction.



PTC Fuse



The positive temperature coefficient thermistor (PTC) acts as a type of fuse. It limits the current available from the USB line, in case a user accidentally creates a short circuit. A short circuit could come from either sloppy soldering or from connecting both lines of the power rails to each other.

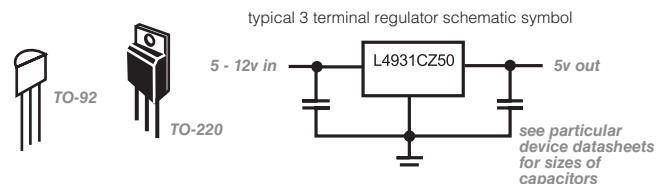
The PTC fuse gets hot, and increases its resistance to lower the current to safe levels. This usually has the effect of shutting off your board. The power LED should get very dim or go completely off.

Resonator



The 16 Mhz ceramic resonator acts as a calibrated oscillator for the EducatO. As you can see from the schematic, it contains a crystal element and two small capacitors. The resonator is symmetrical, so you can't put it in backwards, but it is a good idea to put it in so that you can read the label.

Voltage Regulator



The voltage regulator is an integrated circuit which limits higher input voltages to 5 volts output. It will also limit the current flow in case of short circuits. Regulators accomplish this by varying the resistance of a series element, to maintain the output at five volts.

Voltage regulators come in many ratings and sizes depending on how much power is required. The electronics industry calls the physical form in which an IC is packaged a “package” or “case”. The actual IC is always a small chip embedded somewhere in the plastic. A drawing of some through-hole voltage regulator cases is shown. The voltage regulator provided on your board is a surface mount variety that has been pre-soldered. It would have been possible to hand-solder the regulator but might have required a larger sized soldering iron than standard, to get the job down efficiently.