1/Build a Mintronics: MintDuino

The MintDuino is perfect for anyone interested in learning (or teaching) the fundamentals of how micro controllers work. It will have you building your own micro controller from scratch on a breadboard, and then easily programming it from almost any computer via the Arduino programming environment.

Unlike pre-built micro controllers, the MintDuino demonstrates the specific relationship between the wires, resistors, capacitors, and integrated circuits that enables you to program the micro controller from your computer. After building the MintDuino, you'll have a much better understanding of how micro controllers work, and how electronics can interact with the physical world. This chapter explains how to assemble the MintDuino; in Chapter 2, you'll learn how to create a simple game with it.

Build the Power Supply

Start building your MintDuino by adding the 7805 power regulator. This converts the 9v power to 5v power that the ATMega can use. Insert the 7805 into column "i" on the breadboard and rows 1, 2, and 3. The metal heatsink should be facing the right (or column "J"). Now we are going to add two 10 µF capacitors to the power regulator:

1. I like to trim the leads down so they don't stick so far out of the bread-board. One lead is longer than the other. The long lead is the (+) lead and the short one is the (-) lead. If you trim it, make sure to keep the lengths different lengths so it's easy to identify the (+) and (-) leads.
2. Take the first capacitor and insert the (+) lead into "g1" and the negative lead into "g2". Easy!
3. Take the other 10 µF capacitor, and insert the (-) lead into row 1 of the (-) power rail of the breadboard. Insert the (+) lead into row 1 of the (+) rail of the breadboard.

Now lets get some regulated power over to the power rails of the breadboard. Start by stripping the ends of one piece of red wire cut to approximately 1/2"

long. Insert the wire from the (+) rail of the breadboard to “j3” of the breadboard. Next, strip the ends of one piece of black wire cut to approximately 1/2" long. Insert the wire from the (-) rail of the breadboard to “j2” of the breadboard. Your breadboard should look like Figure 1-1

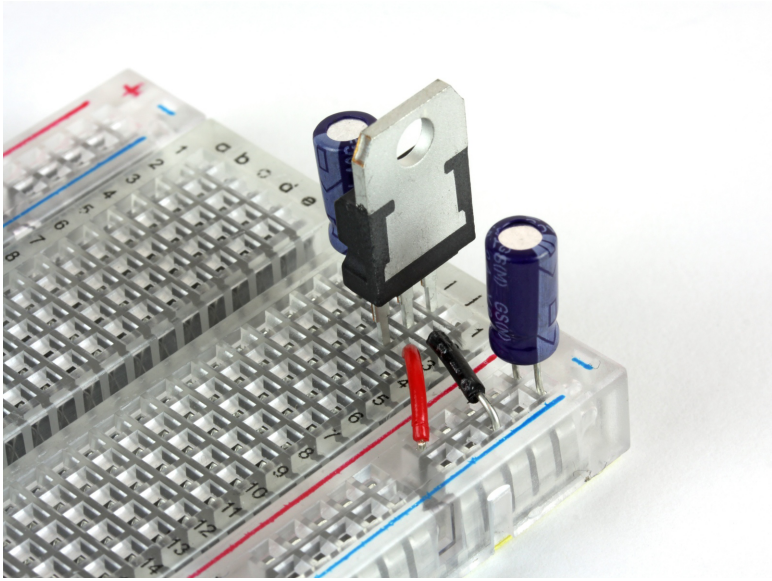

Figure 1-1. *Breadboard with voltage regulator, capacitors, and wire*

Now it’s time to add the power LED. Start by cutting down the leads, just as you did on the capacitor. Make sure to keep the long one (+) longer than the short one (-)! Now you can insert the red LED into the breadboard: the longer lead (+) goes into “d2” and the negative (-) goes into “d1”. Let’s get the power distributed around the board and to the LED:

1. Start by cutting one red wire, approximately 1/2" long and one black wire, approximately 1/2" long. Strip both ends of each wire.
2. Insert the red wire from “f1” to “e4”, and the black wire from “f2” to “e5”.
3. Cut another piece of black wire about 1/2" long (from here on out, I’m going to stop reminding you to strip each end, so make sure you do it) and insert it from the (-) rail of the breadboard and “b1”.

4. While we are here, lets add a 220 Ohm resistor (red, red, brown) from the (+) rail of the breadboard to "b2". This will limit the amount of current that goes into the LED, and keep it from burning out.
5. Lastly, cut (1) piece of red and black wire about 1 1/2" long and connect the right side rails together. Remember to connect (+) to (+) and (-) to (-). Your breadboard should look just like Figure 1-2

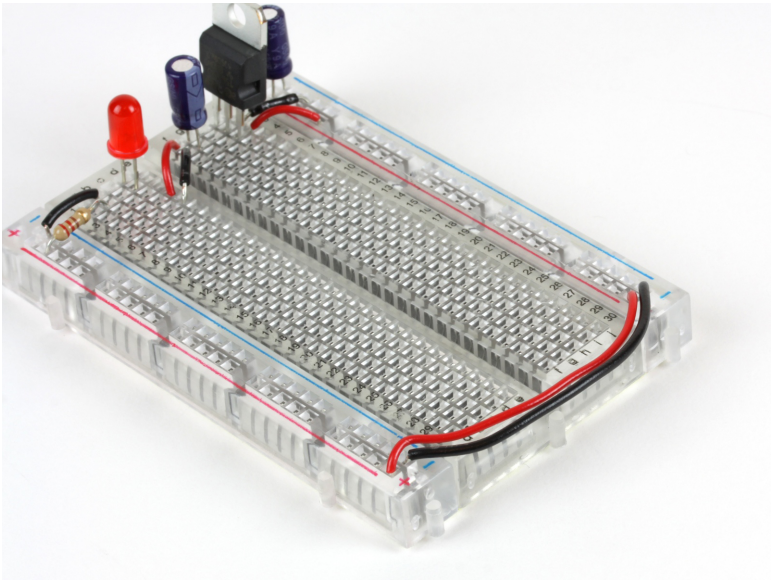

Figure 1-2. *Breadboard ready to be powered up*

Now we can power it up! Connect the battery clip's red wire (+) to "d4" and the black wire (-) to "d5". Connect a 9v battery and the red LED should light up. Your breadboard should look just like Figure 1-3.

WARNING: If the LED doesn't light up, disconnect the battery immediately and double check the wiring. Take the circuit apart if necessary and start from the beginning. If the LED doesn't work at this point, nothing else will.

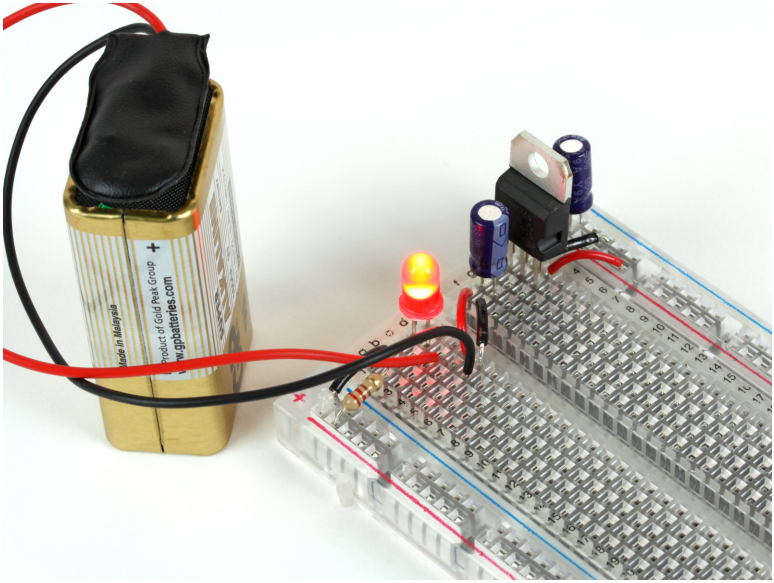

Figure 1-3. *Your breadboard is powered and ready for the next step*

Now you have a nice 5V regulated power supply from a 9V battery. Your ATMega will thank you for it! OK, enough fun. Unplug the battery and let's get started with the micro controller.

Power the Microcontroller

Now it's time to connect power to the ATMega 328 chip (also known as an integrated circuit or IC). This is the brains of your MintDuino. It combines a microprocessor, flash memory, RAM, and digital as well as analog inputs and outputs into a single chip known as a *microcontroller*. It's also the most fragile part, so make sure you've disconnected the battery before you do anything. The ATMega has a small "U" shaped notch on one end. This notch lets you know where pin 1 is on the chip. If you hold the chip vertically, with the notch on top, pin 1 is directly to the left of this notch. Insert the IC so the notch is pointing towards the power supply you just built, and so that pin 1 goes into "e9" on the breadboard.

NOTE: You may need to bend the pins in a little bit so they don't flare out too much. Don't use a lot of force to insert the IC or you may damage the pins.

With the ATMega inserted, you should insert the 16 MHz clock crystal, which controls the speed at which the microcontroller executes instructions:

1. Insert the crystal into the breadboard at “b17” and “b18”. It’s not polarized, so orientation isn’t important: you can insert it either way.
2. The crystal needs some capacitors to work properly. The two 22pF capacitors (marked “220”) are not polarized either, so their orientation does not matter.
3. Insert one 22 pF capacitor so one pin goes into the the ground rail of the breadboard and the other into “a17”.
4. Insert the other 22 pF capacitor with one pin into the the ground rail and the other into “a18”.
5. While we are working on this part of the breadboard, let’s connect a ground connection to the microcontroller: cut a 1/2" piece of black wire and connect the ground rail of the breadboard to “a16”.

At this point, the center of your breadboard should look like Figure 1-4.

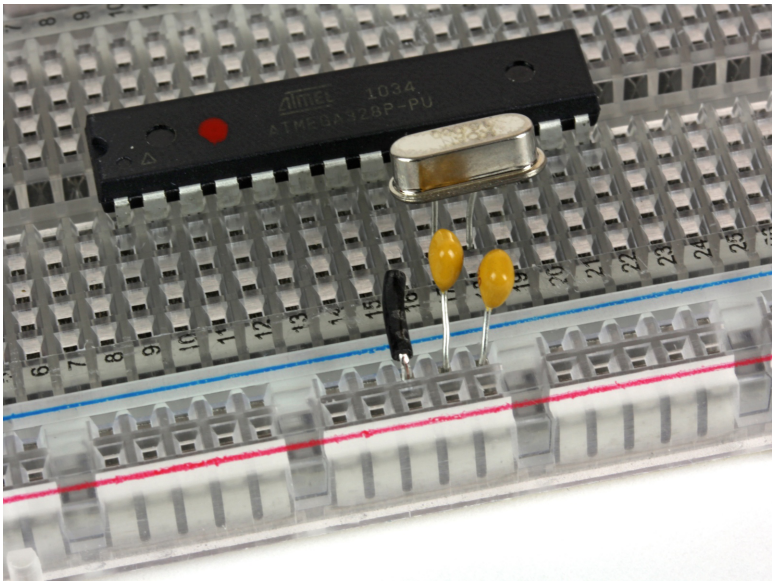

Figure 1-4. *ATMega with capacitors, crystal, and ground wire*