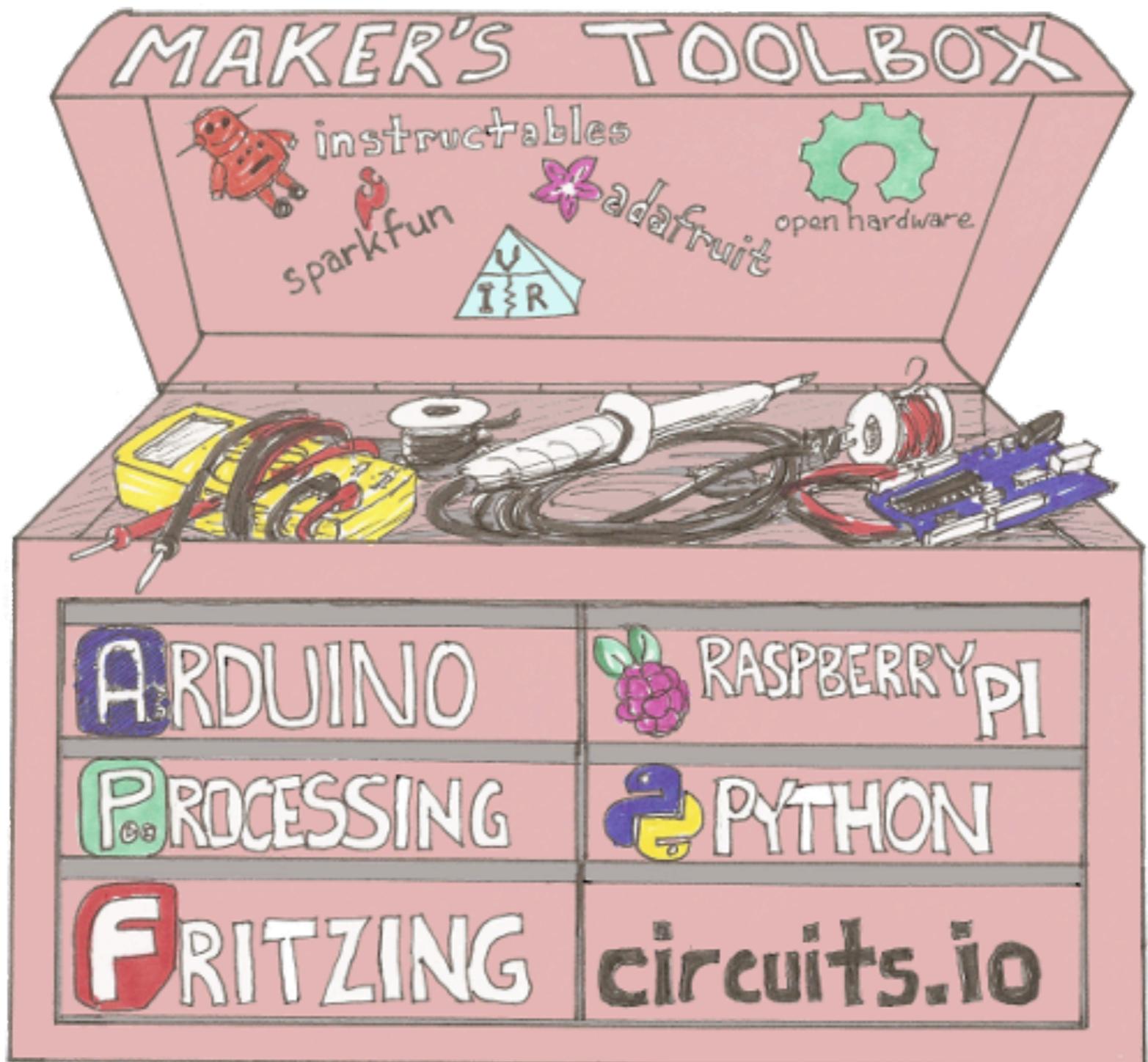




When  $a = -2$ ,

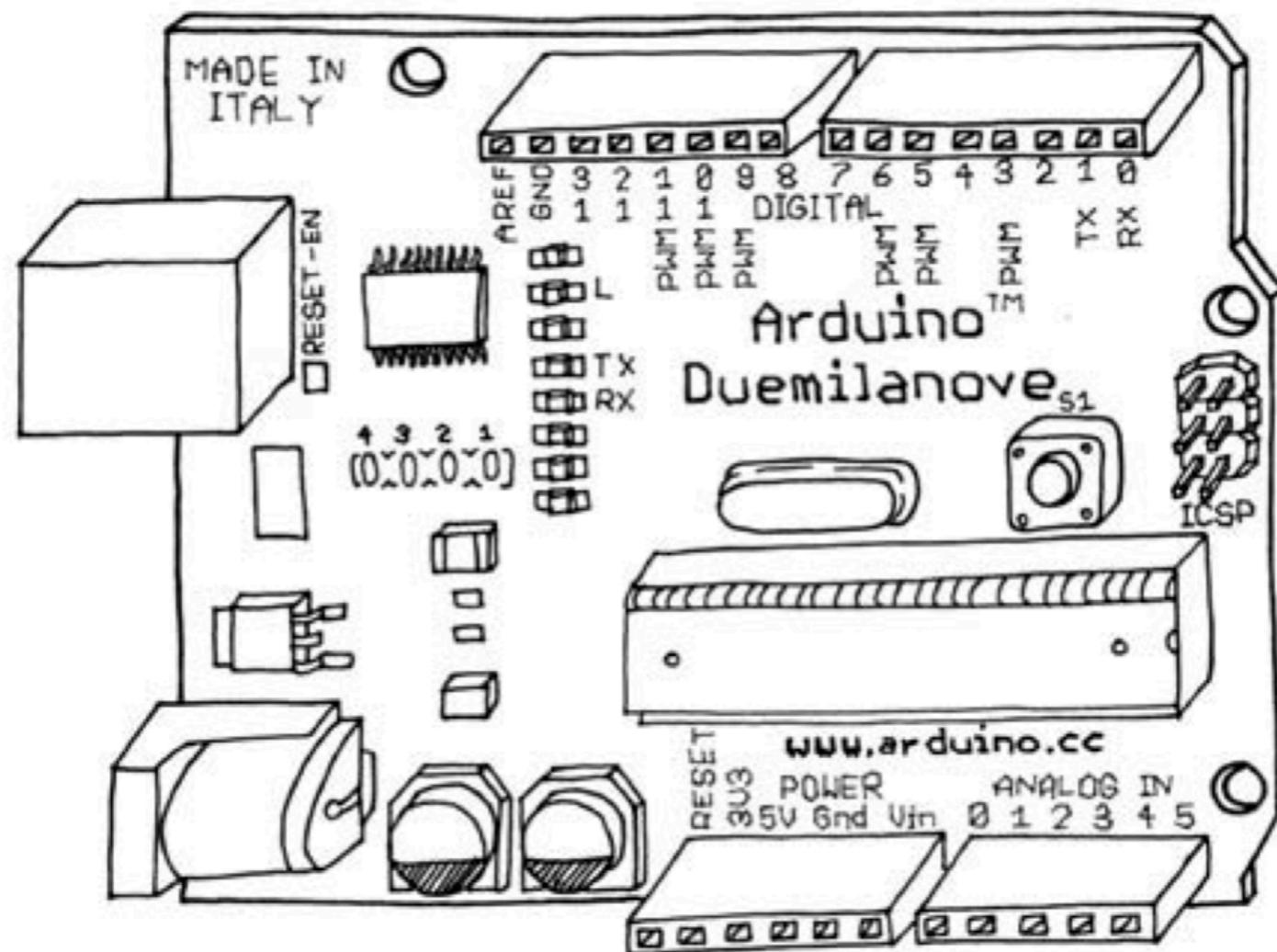
$$a^2 = ?$$





# Arduino

## An introduction

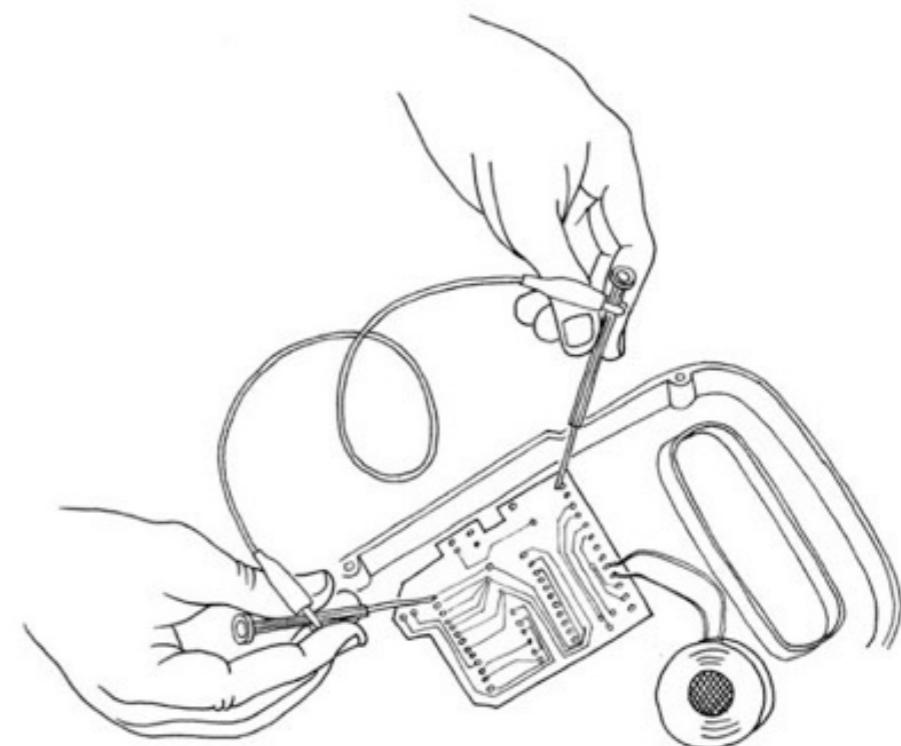
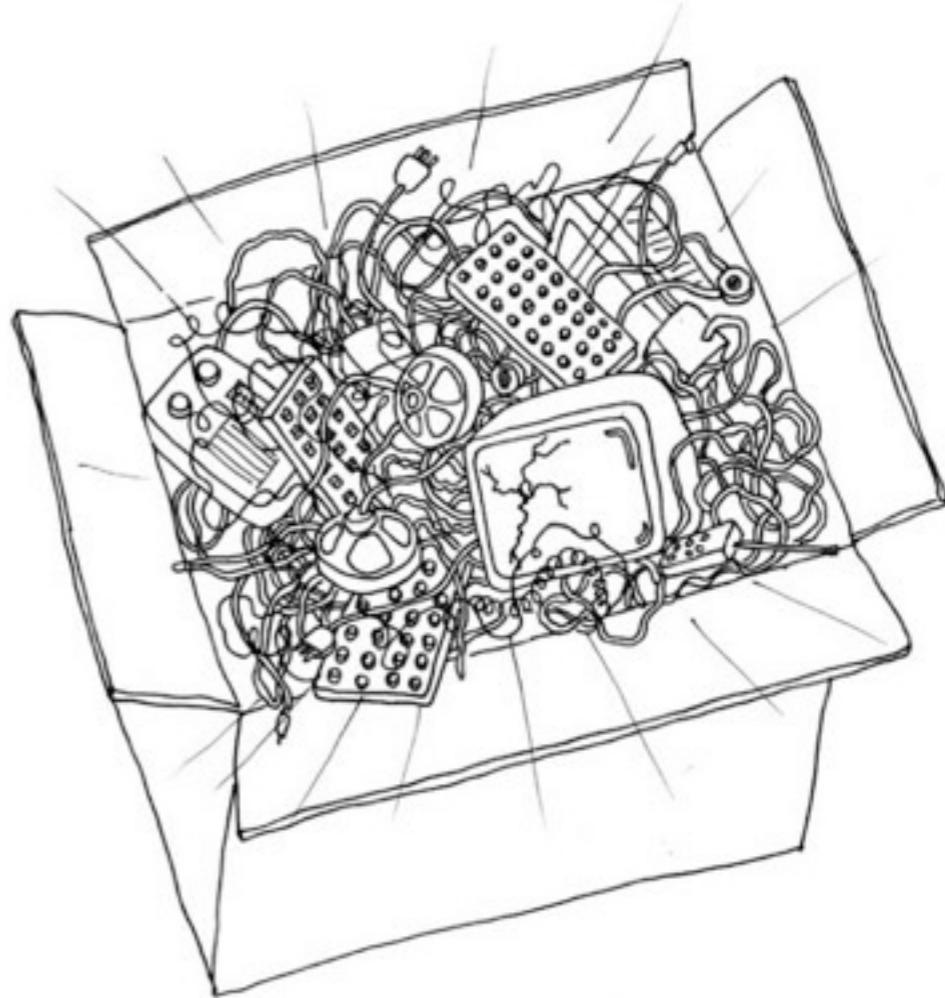


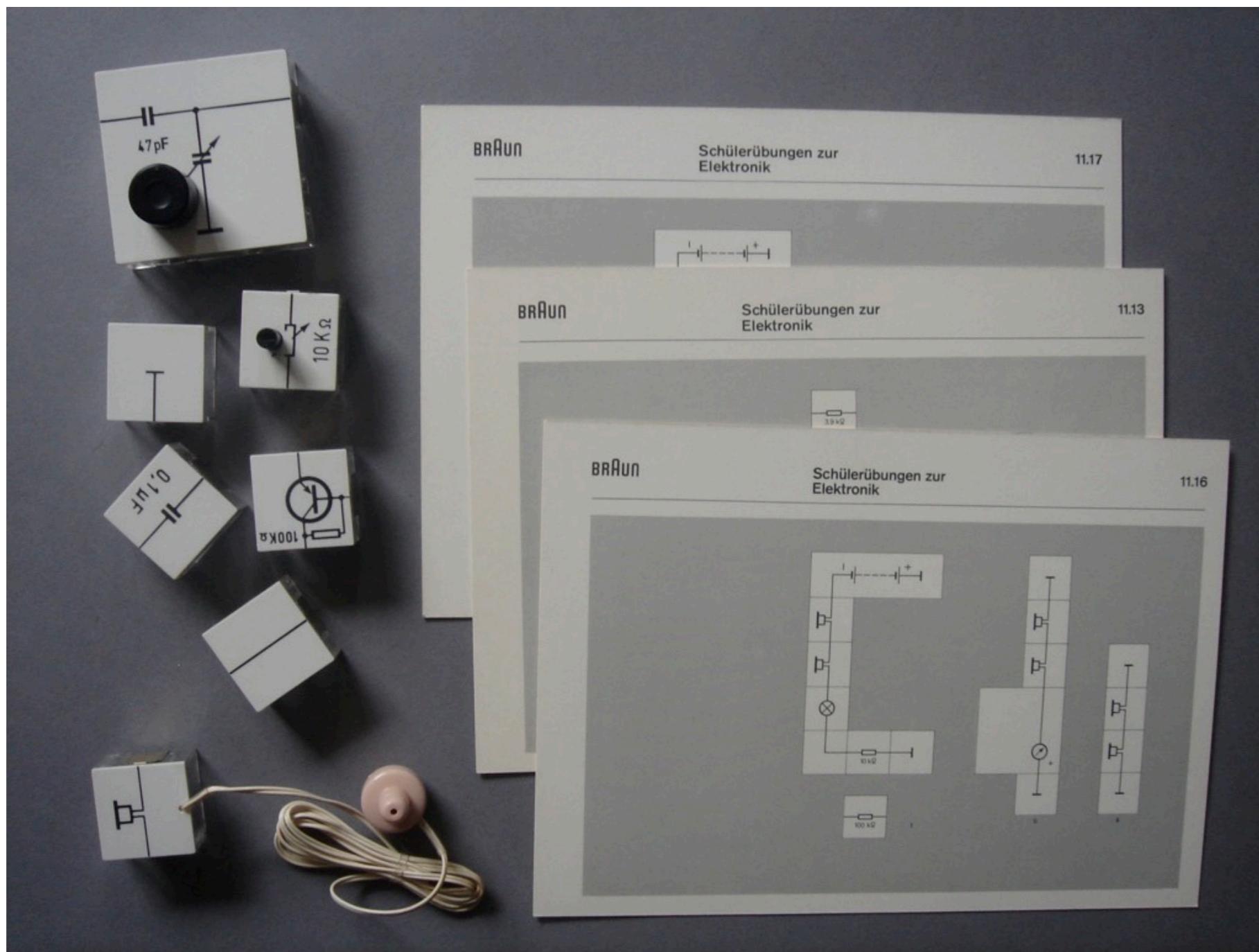
# THE MAKER'S BILL OF RIGHTS

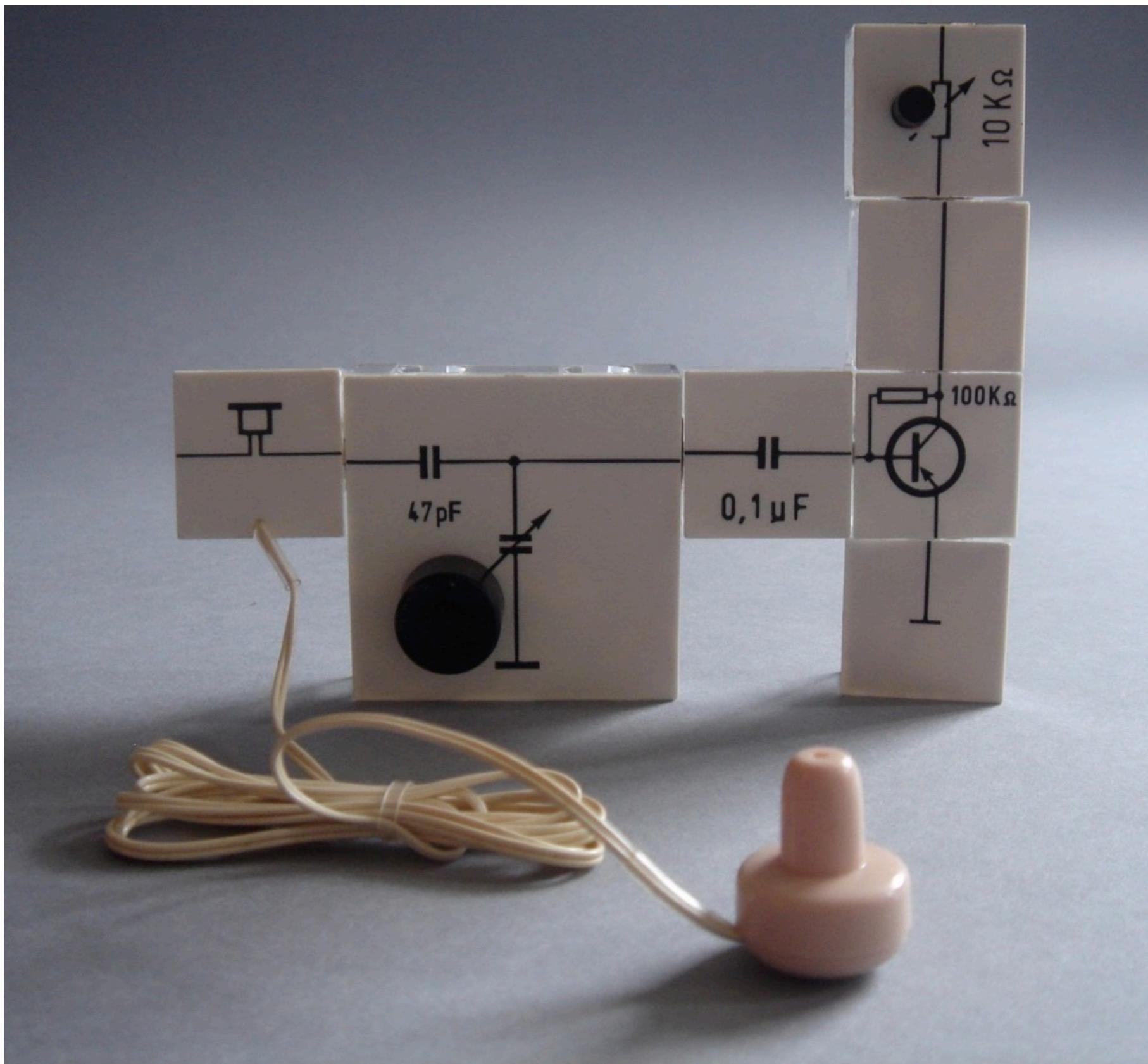
- Meaningful and specific parts lists shall be included.
- Cases shall be easy to open. ■ Batteries shall be replaceable. ■ Special tools are allowed only for darn good reasons. ■ Profiting by selling expensive special tools is wrong, and not making special tools available is even worse. ■ Torx is OK; tamperproof is rarely OK.
- Components, not entire subassemblies, shall be replaceable. ■ Consumables, like fuses and filters, shall be easy to access. ■ Circuit boards shall be commented.
- Power from USB is good; power from proprietary power adapters is bad. ■ Standard connectors shall have pinouts defined. ■ If it snaps shut, it shall snap open. ■ Screws better than glues. ■ Docs and drivers shall have permalinks and shall reside for all perpetuity at archive.org. ■ Ease of repair shall be a design ideal, not an afterthought. ■ Metric or standard, not both.
- Schematics shall be included.

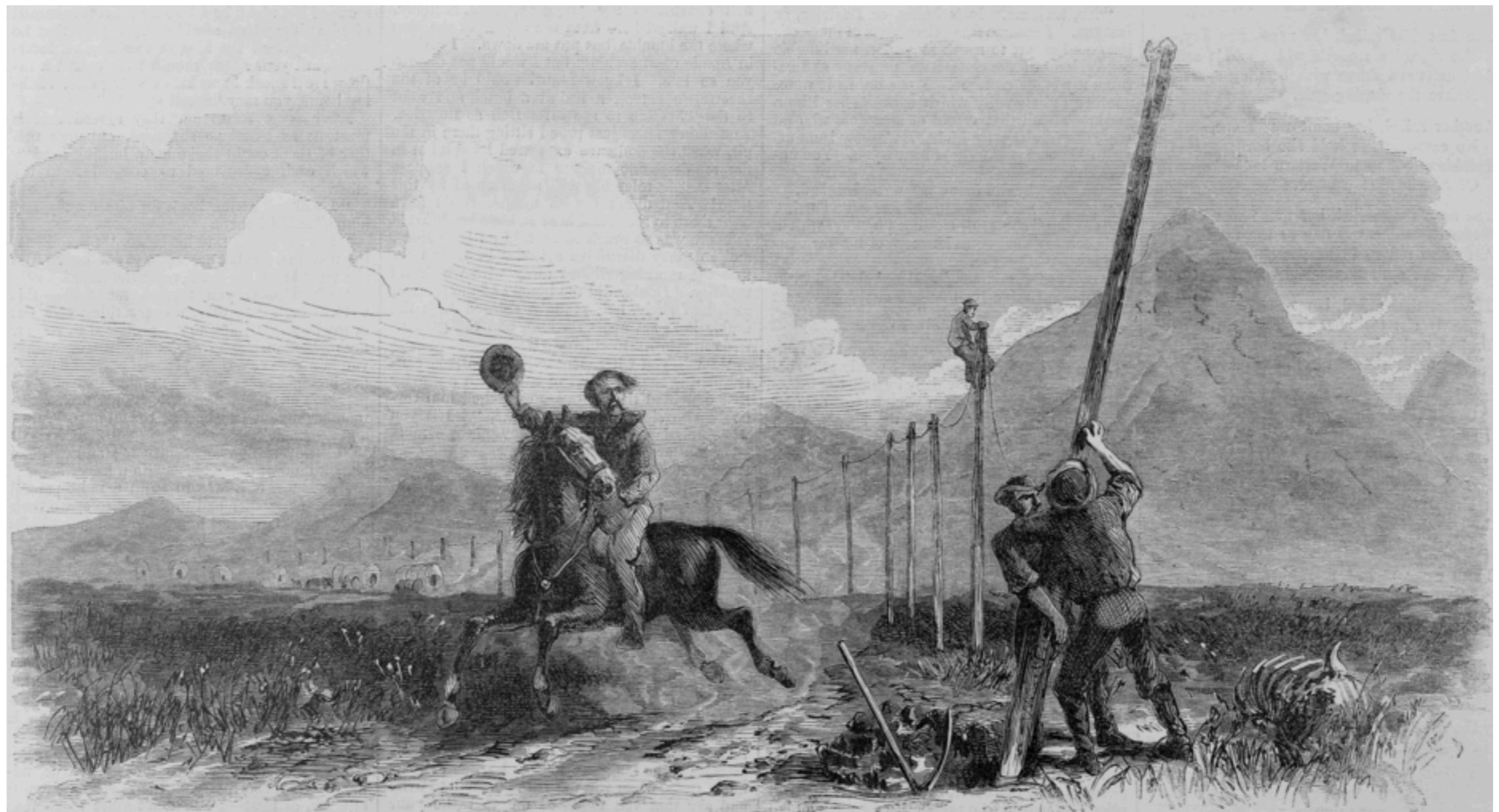
**Make:**  
technology on your time

Drafted by Mister Jalopy, with assistance from Phillip Torrone and Simon Hill.

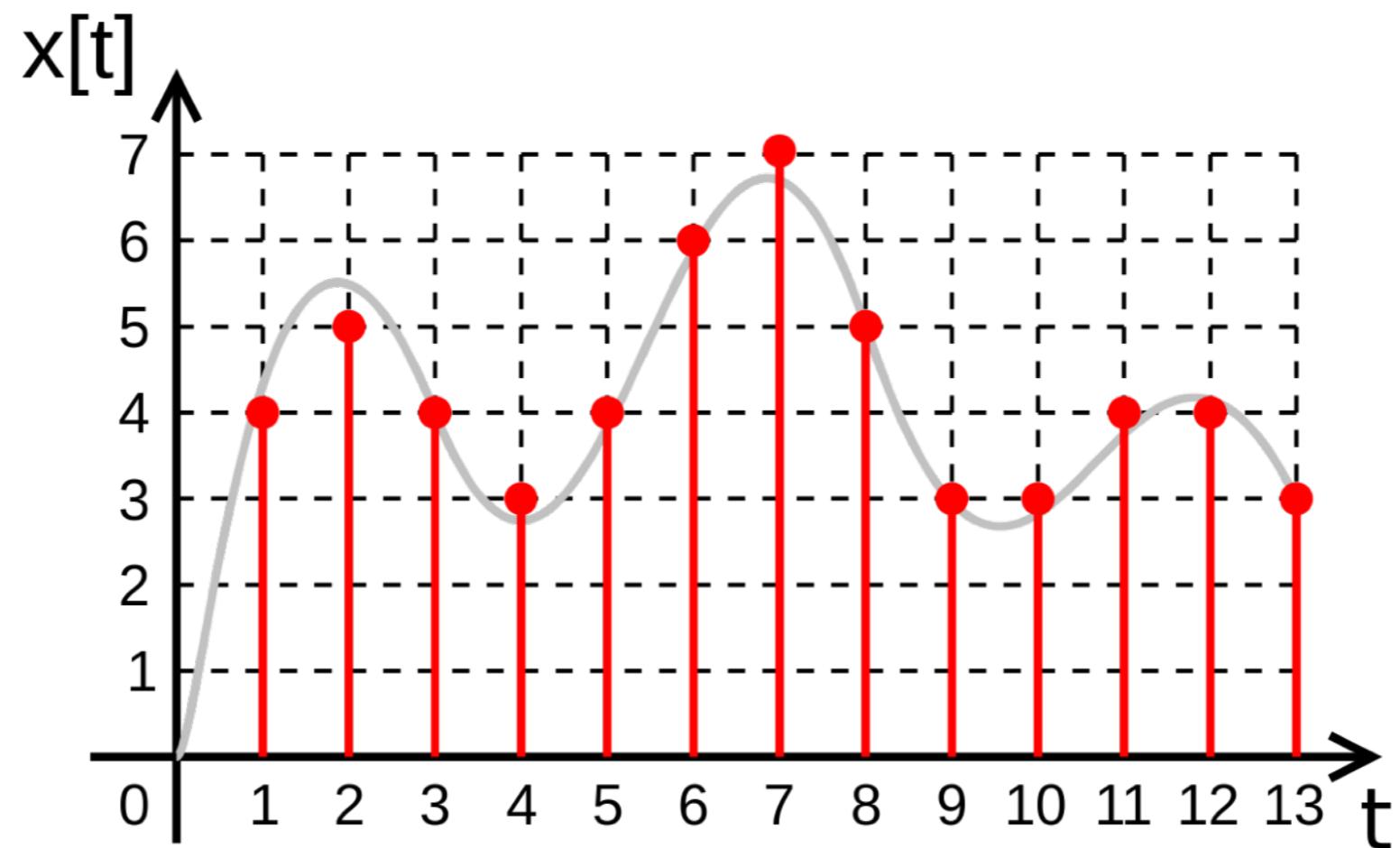


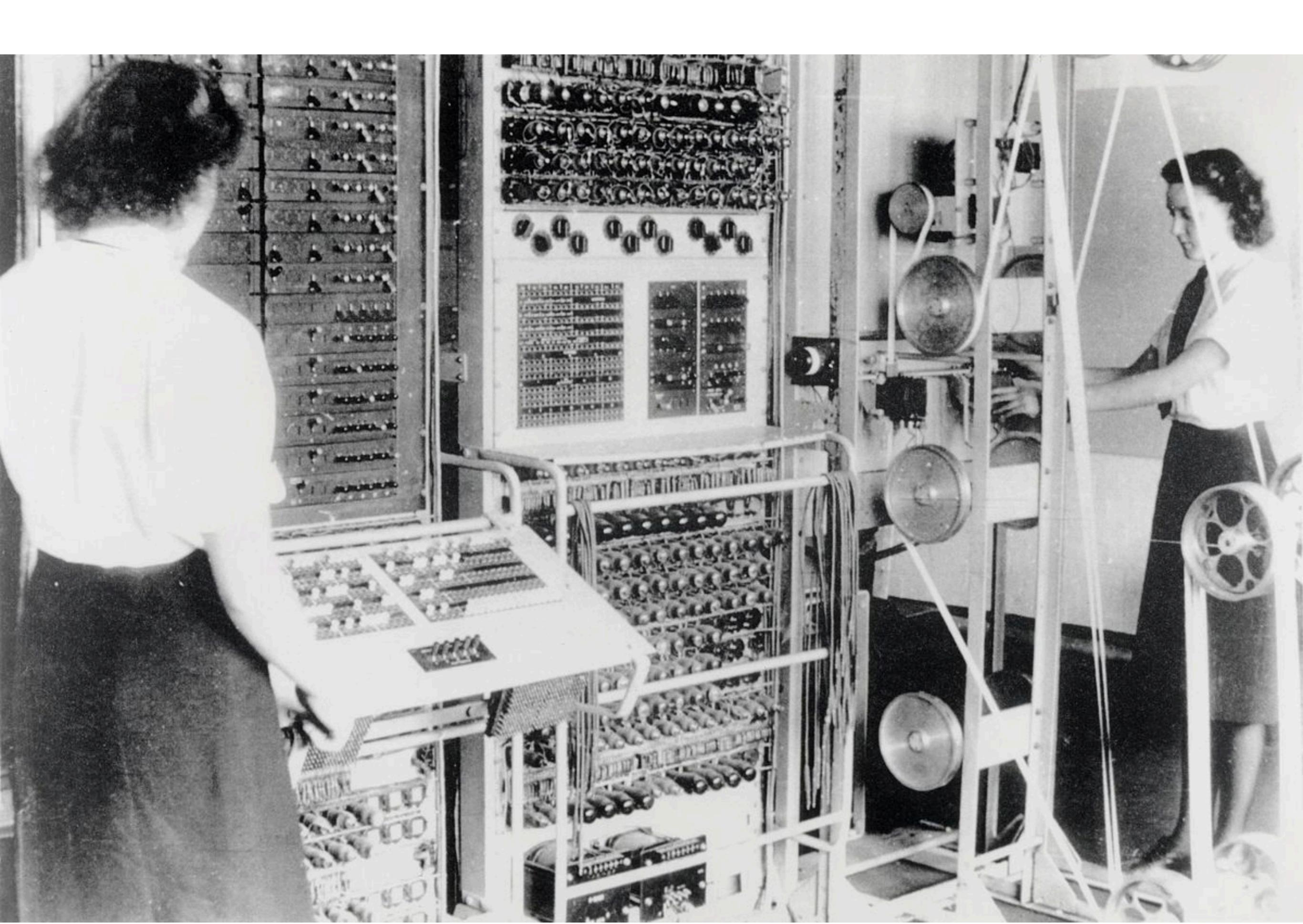


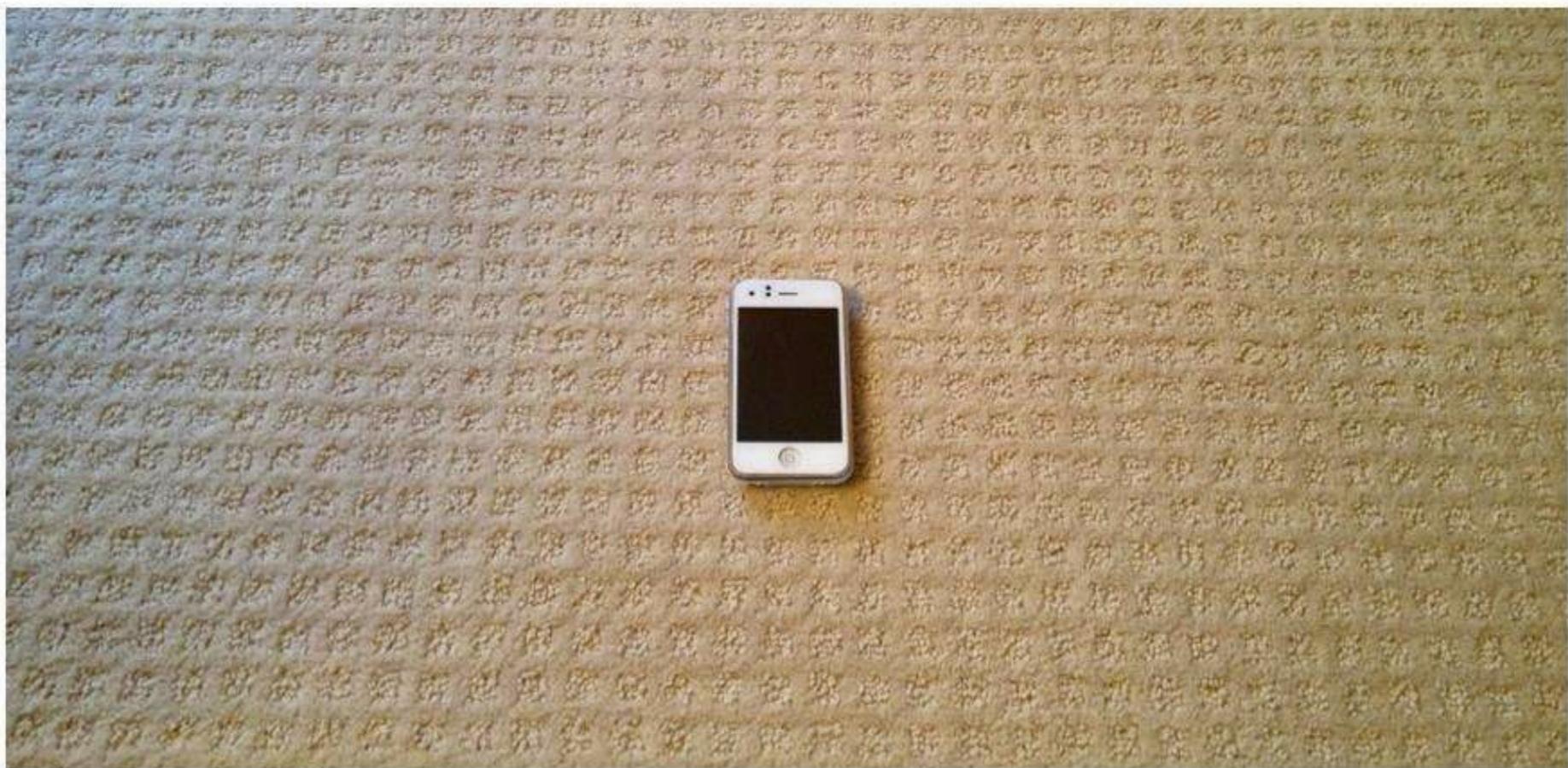


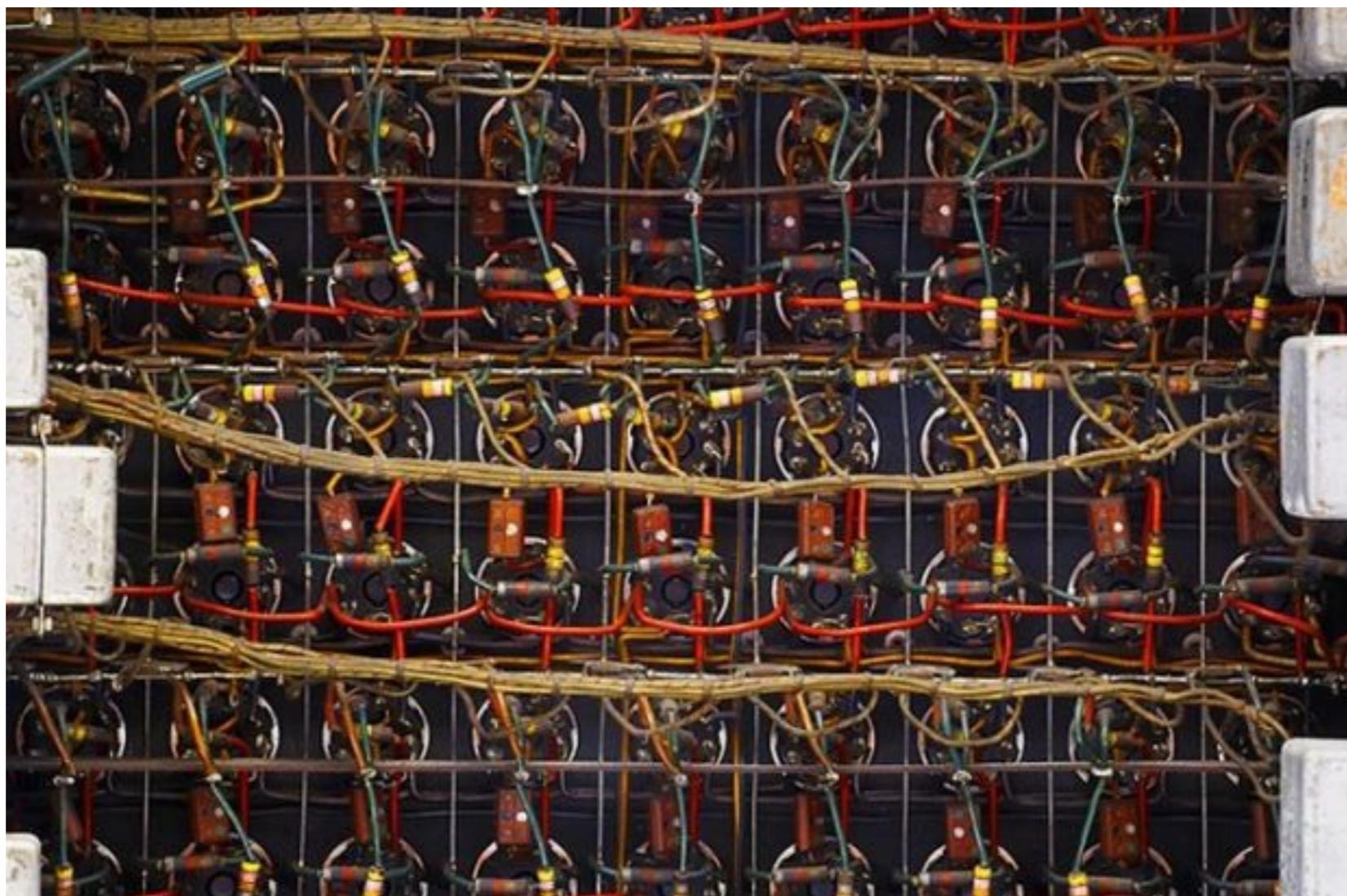


THE OVERLAND PONY EXPRESS.—[PHOTOGRAPHED BY SAVAGE, SALT LAKE CITY, FROM A PAINTING BY GEORGE M. OTTINGER.]

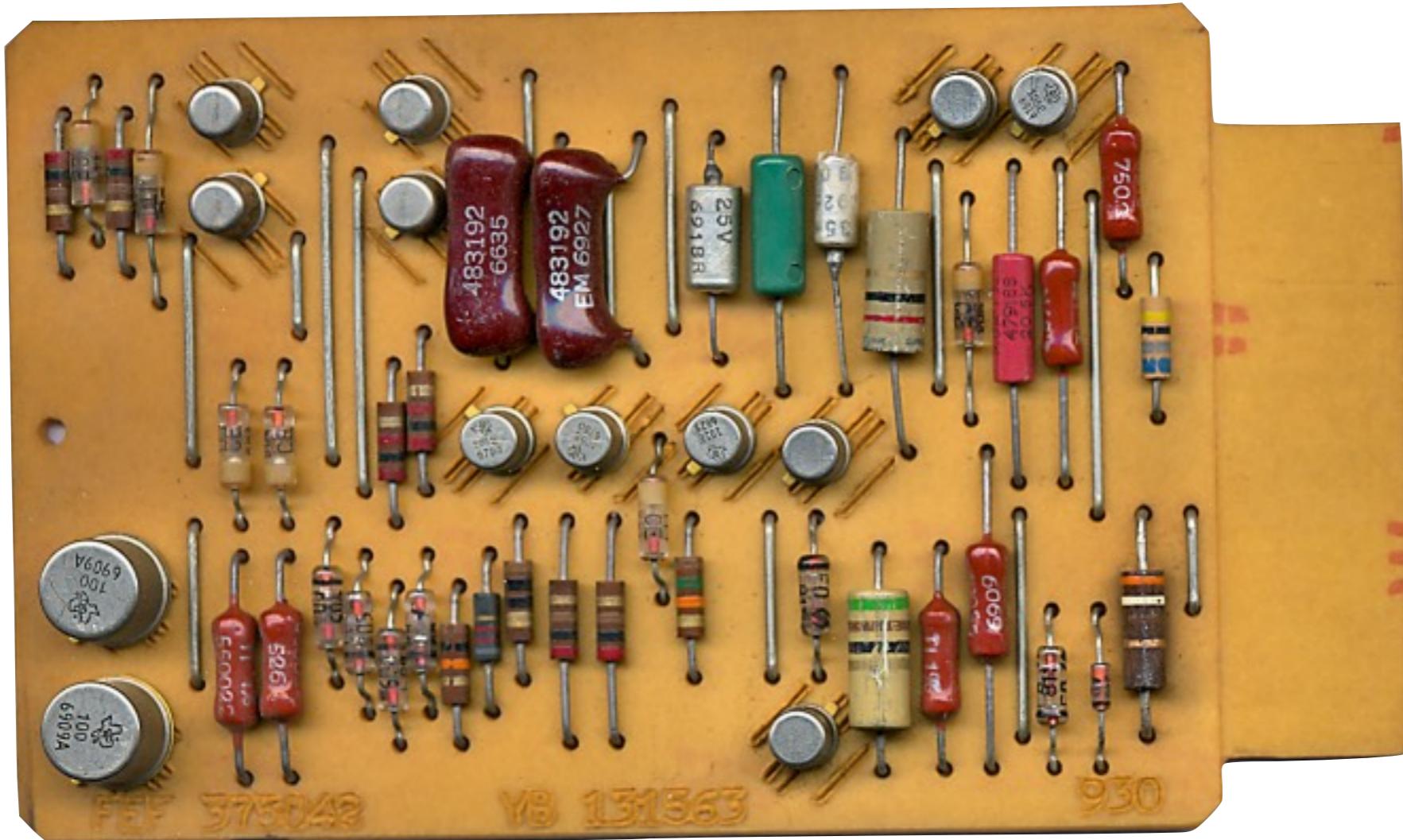




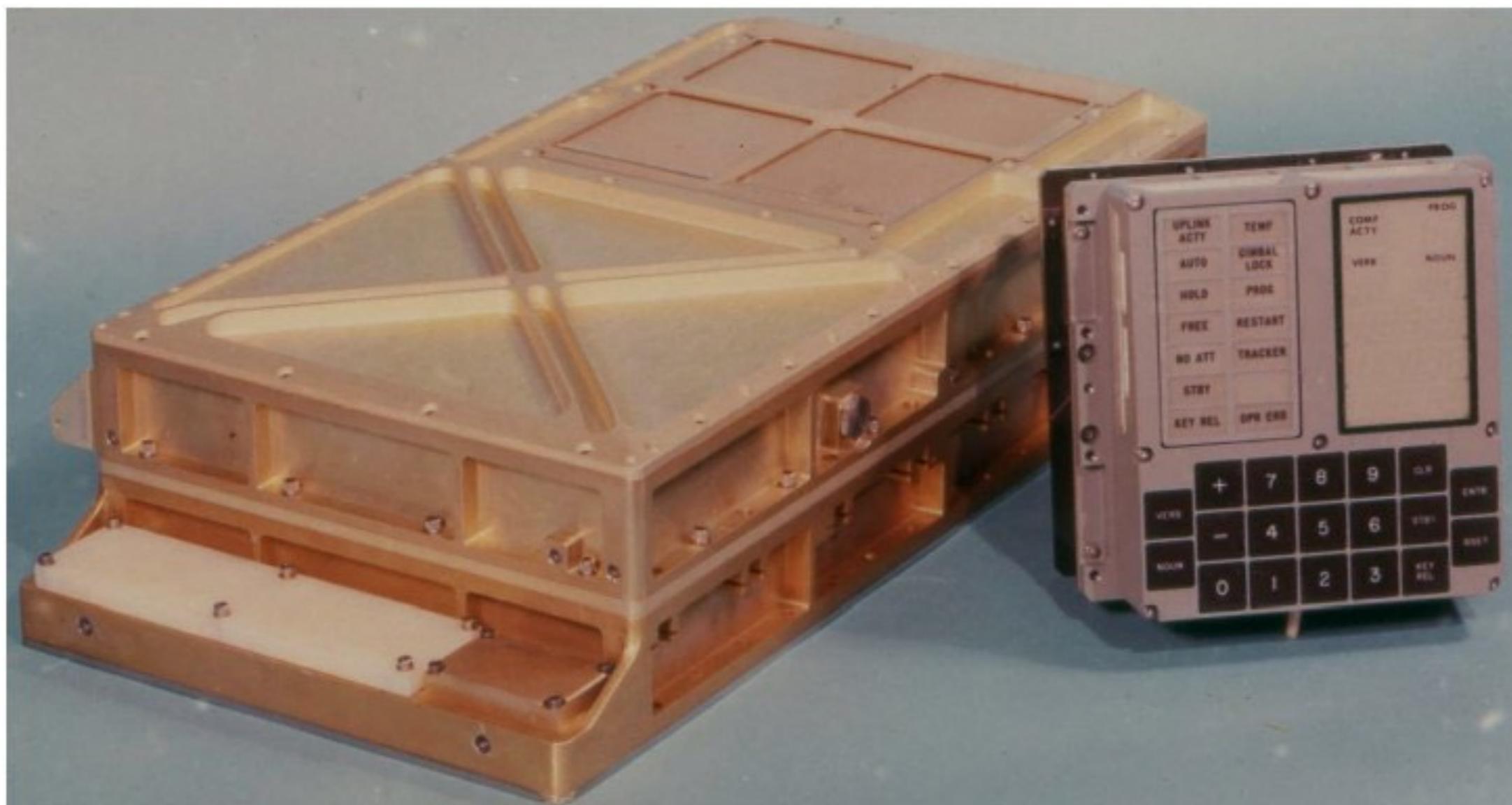




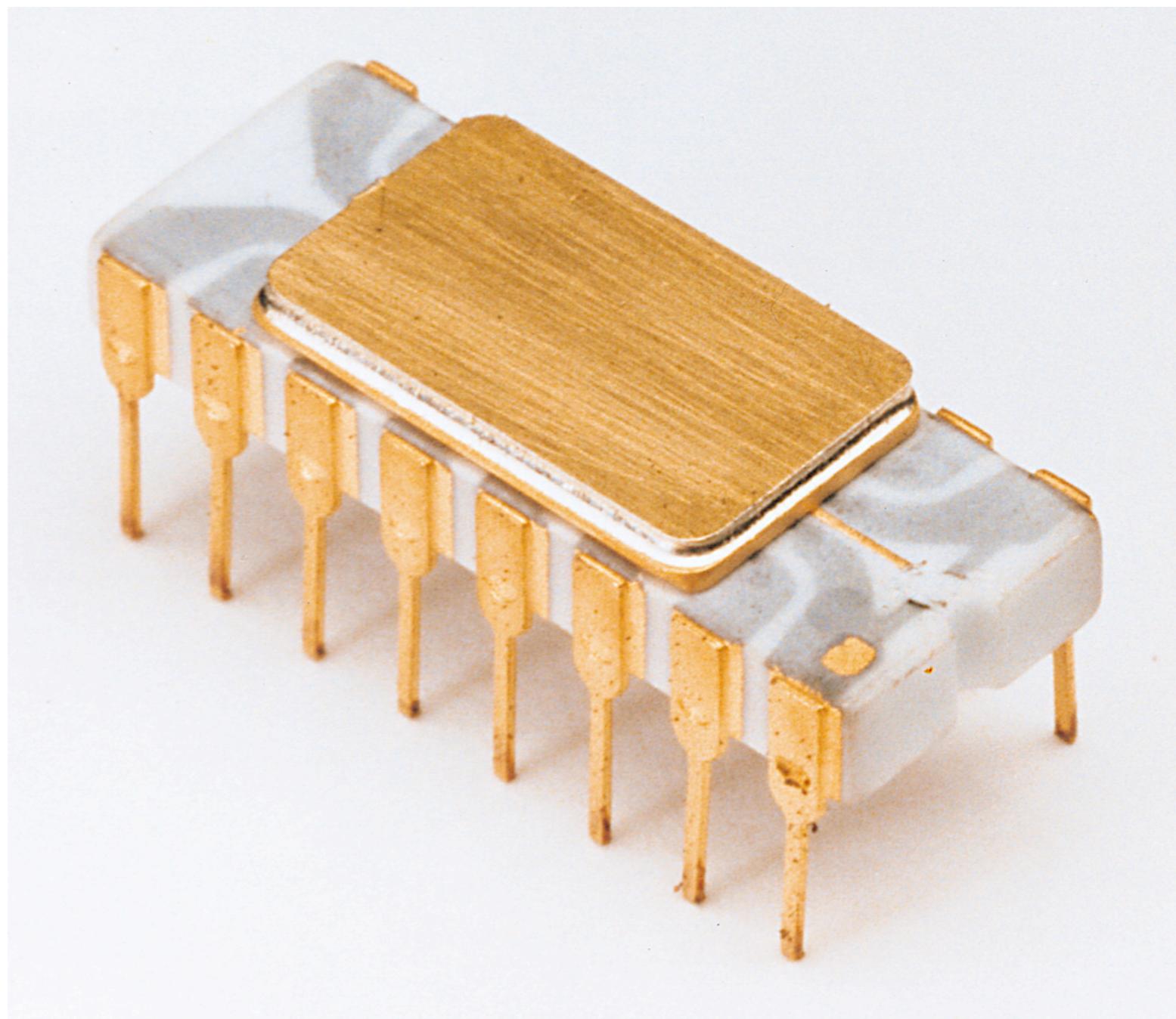
1946



1959



1968



1971



1976



1982



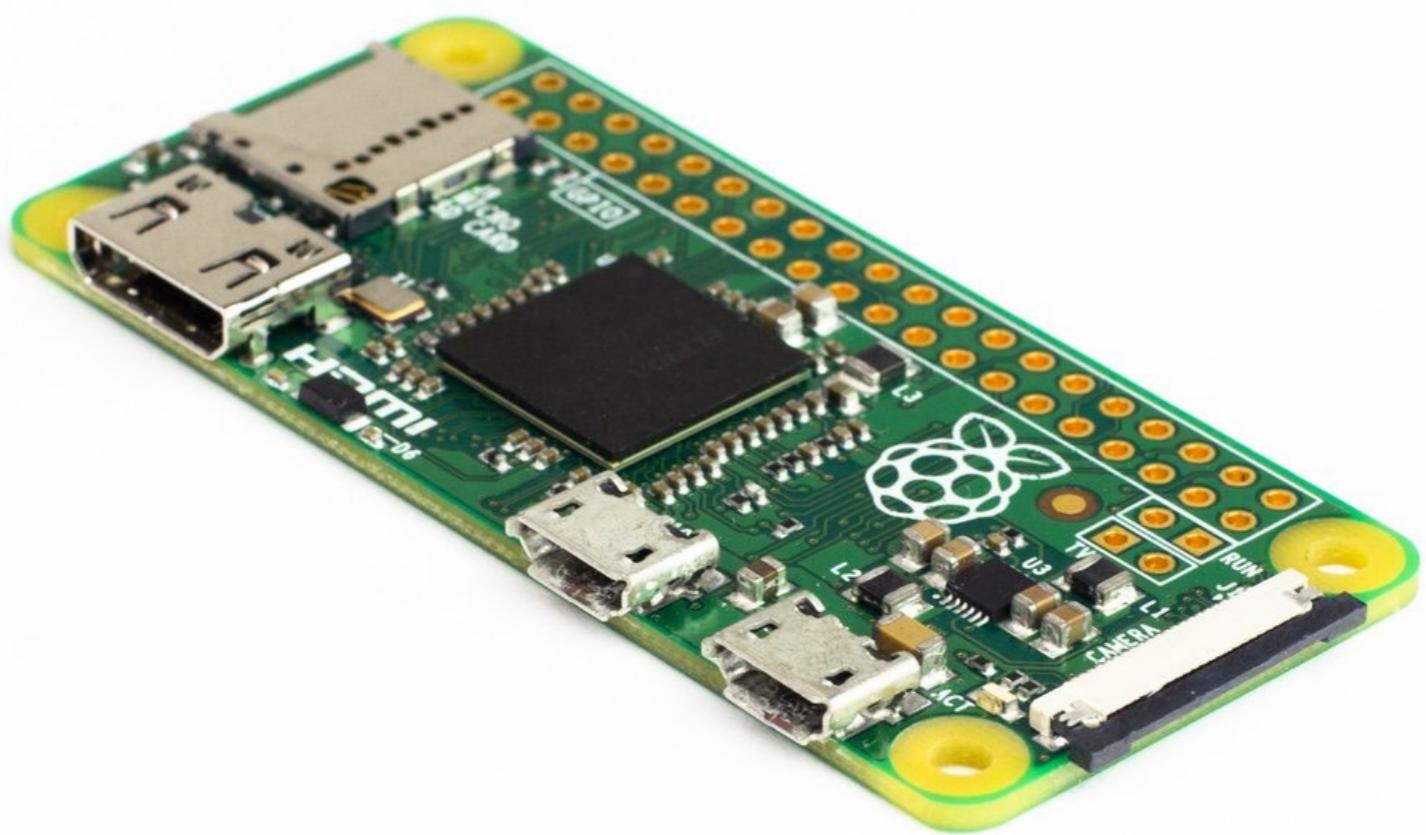
1996



1996

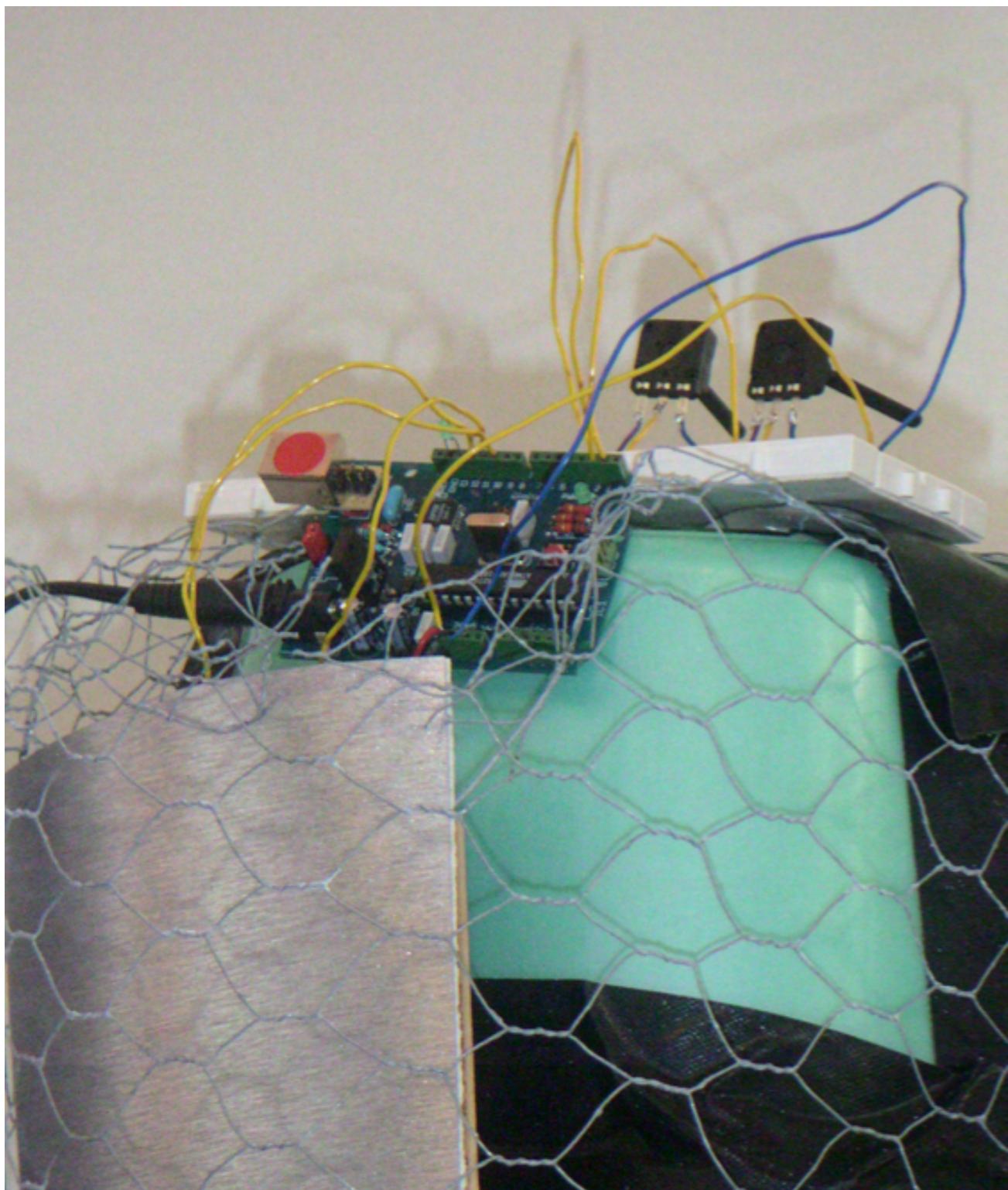


2010

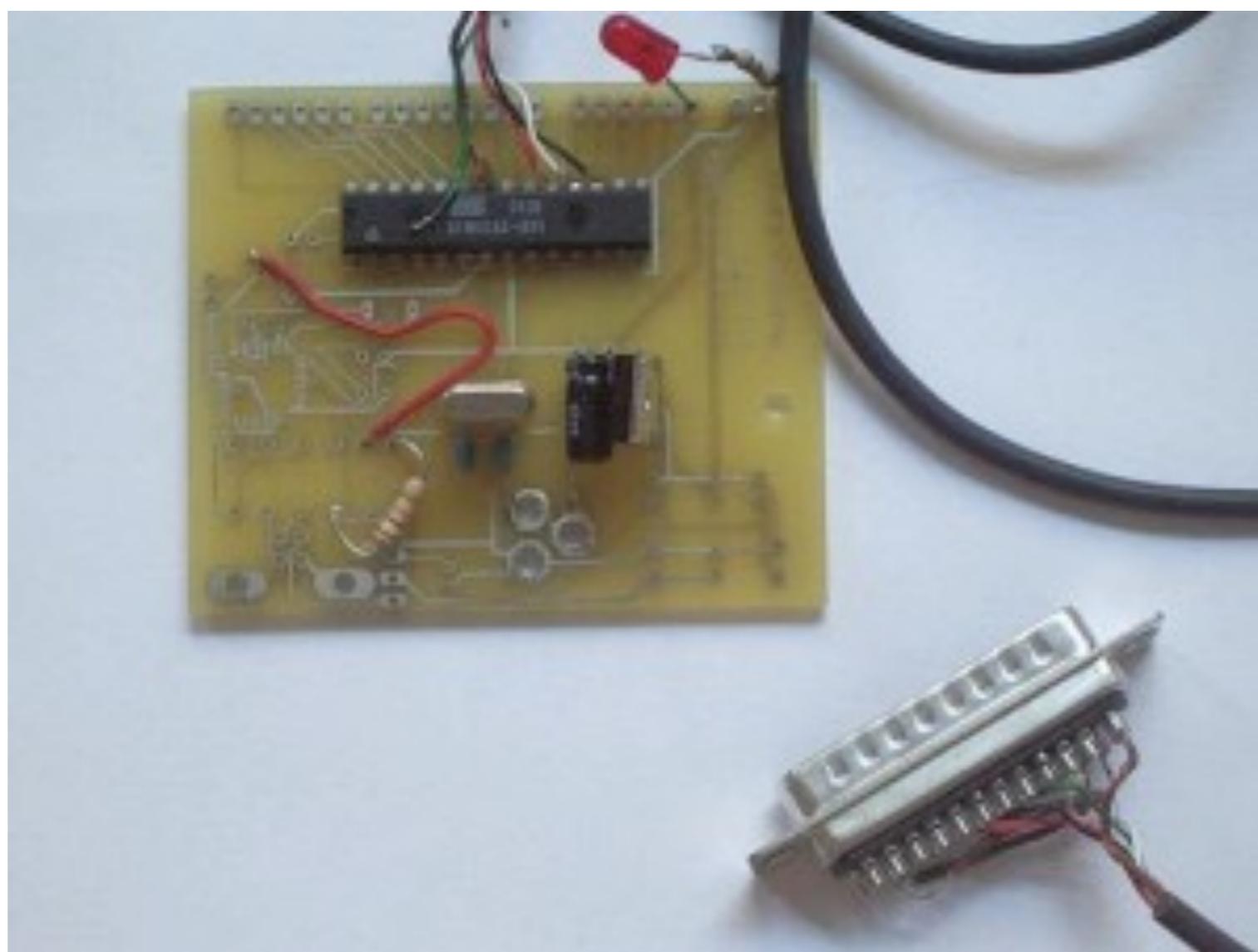


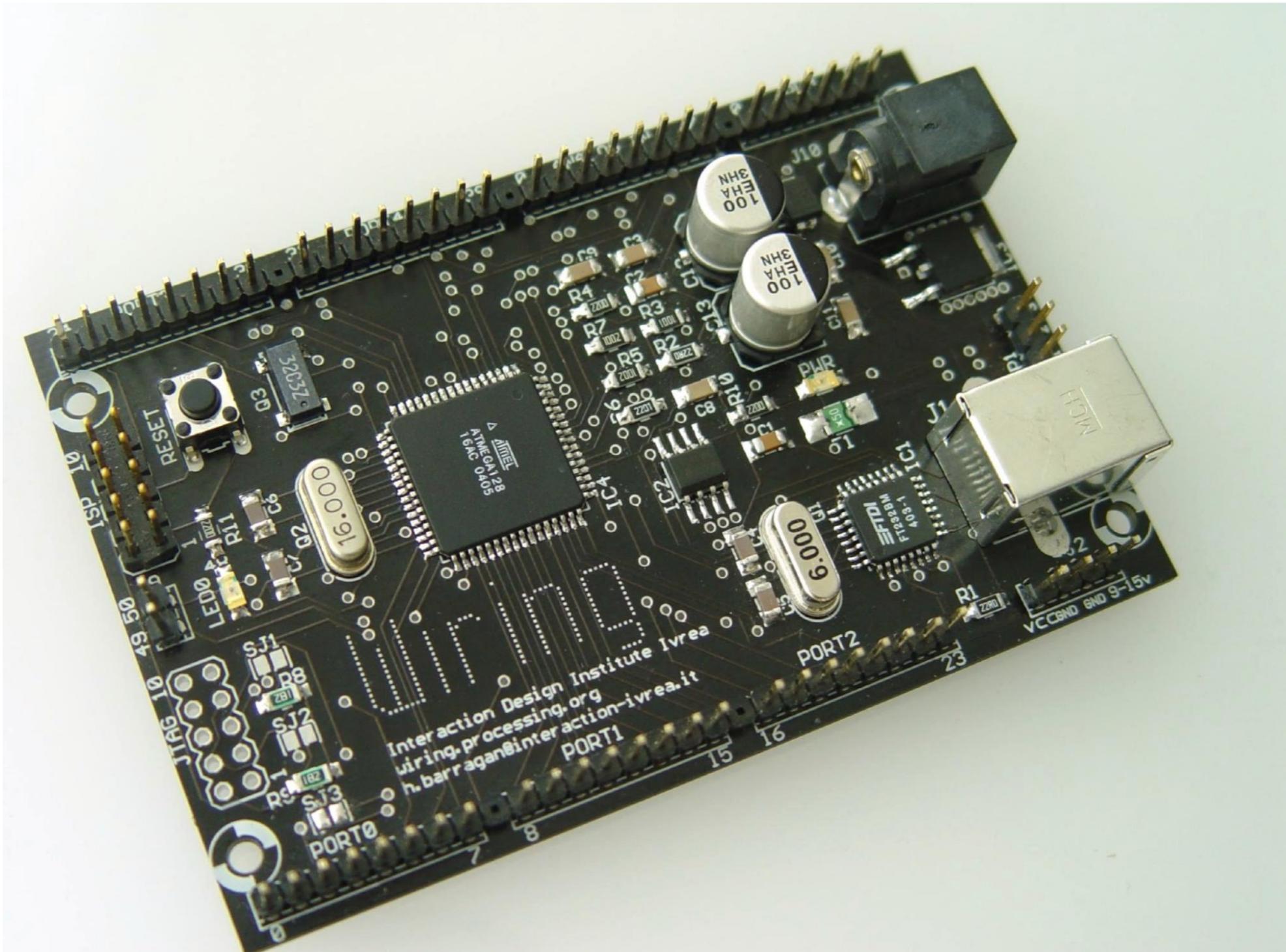
2017

Apollo	Arduino	Raspberry	iPhone 6
2 MHz	16 MHz	700 MHz x 2	1400 MHz x 2
4kB RAM	2kB RAM	512MB RAM	1GB RAM
72kB ROM	32kB FLASH	8GB FLASH	16GB FLASH

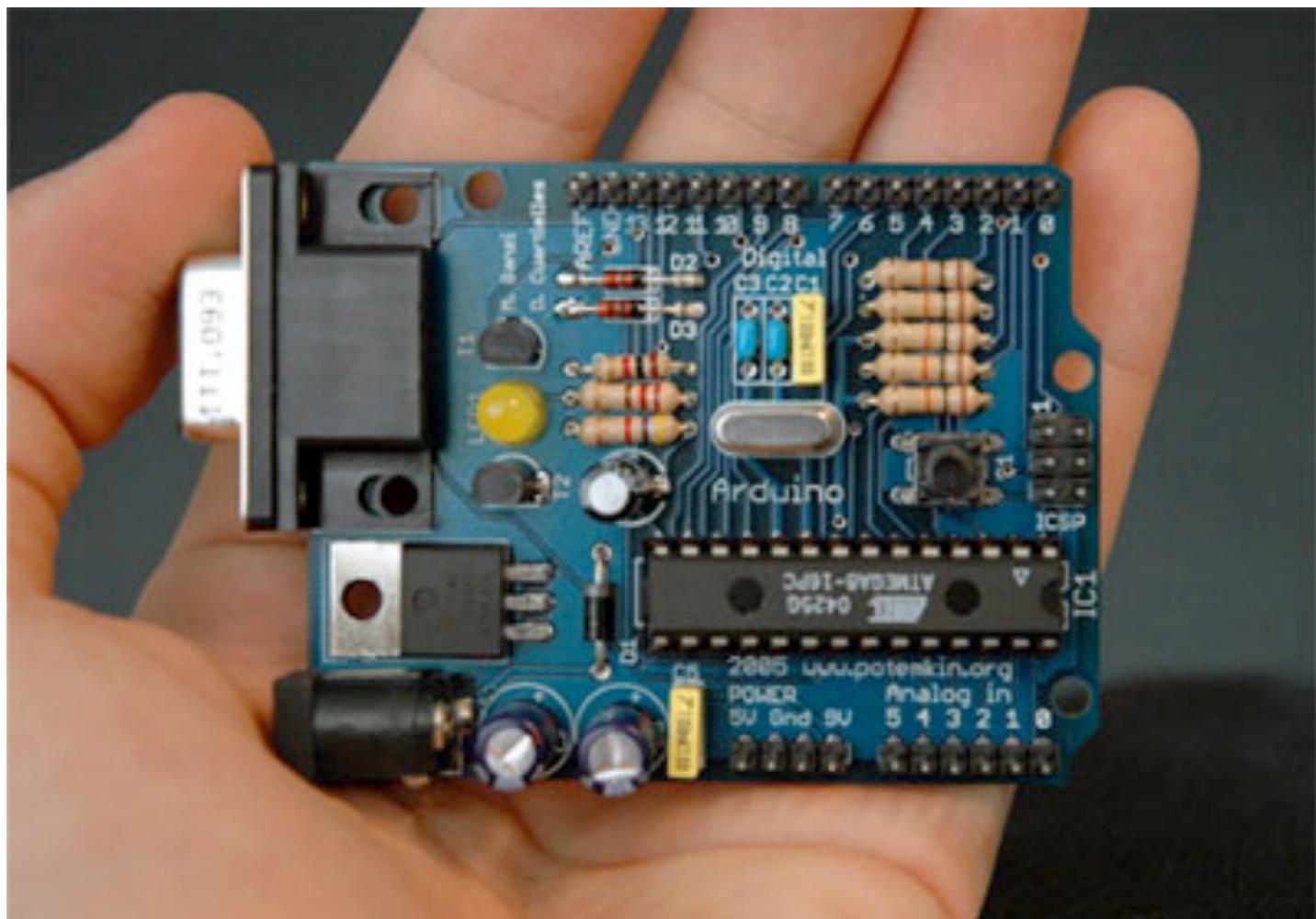


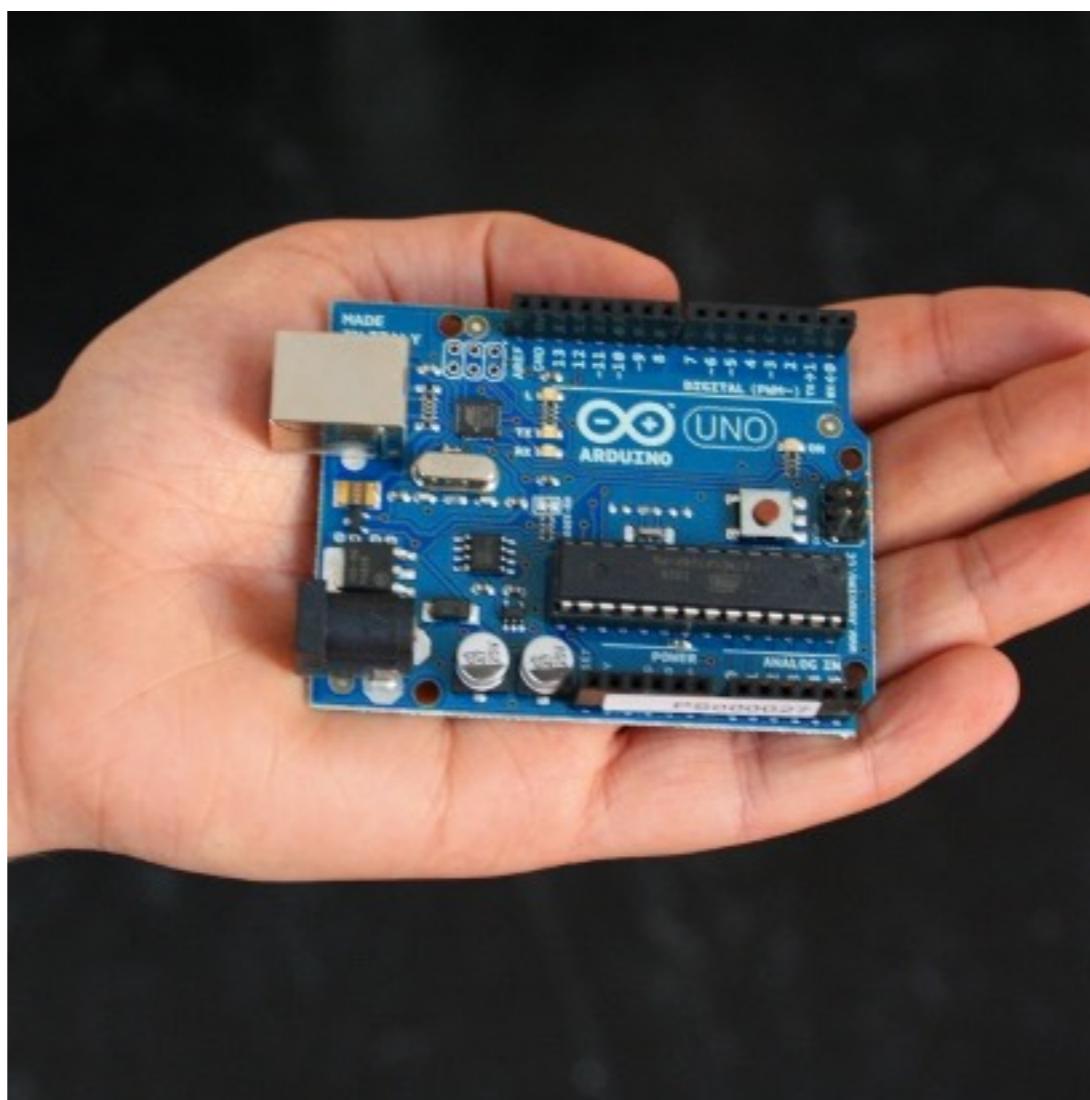






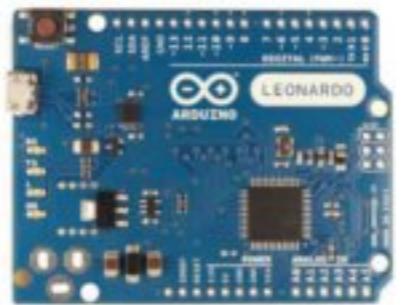
[http://people.interactionivrea.org/h.barragan/thesis/thesis\\_low\\_res.pdf](http://people.interactionivrea.org/h.barragan/thesis/thesis_low_res.pdf)







Arduino Uno



Arduino Leonardo



Arduino Tre



Arduino Micro



Arduino Due



Arduino Yún



Arduino Robot



Arduino Esplora



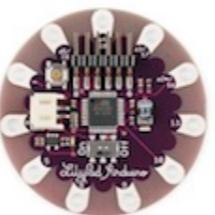
Arduino Mega ADK



Arduino Ethernet



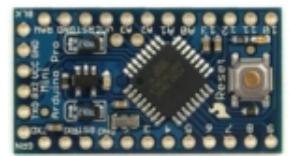
LilyPad Arduino USB



LilyPad Arduino  
Simple



Arduino Nano



Arduino Pro Mini



Arduino Mega 2560



Arduino Mini



LilyPad Arduino  
SimpleSnap



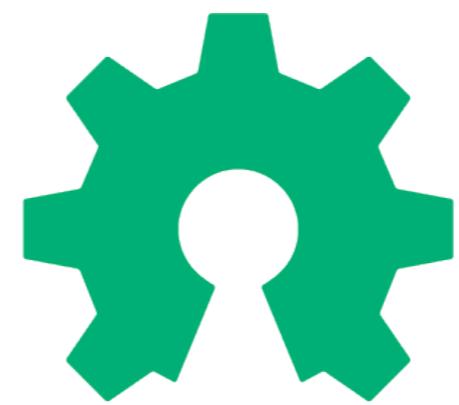
Arduino Pro



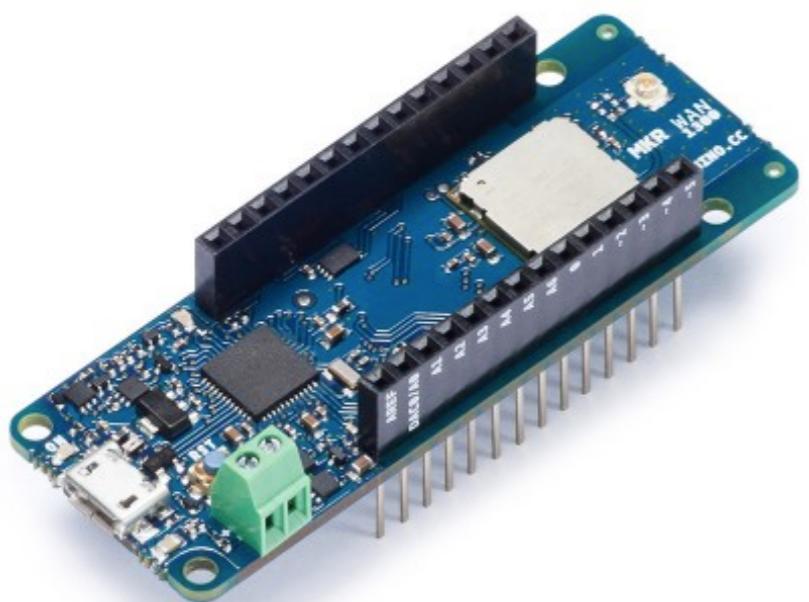
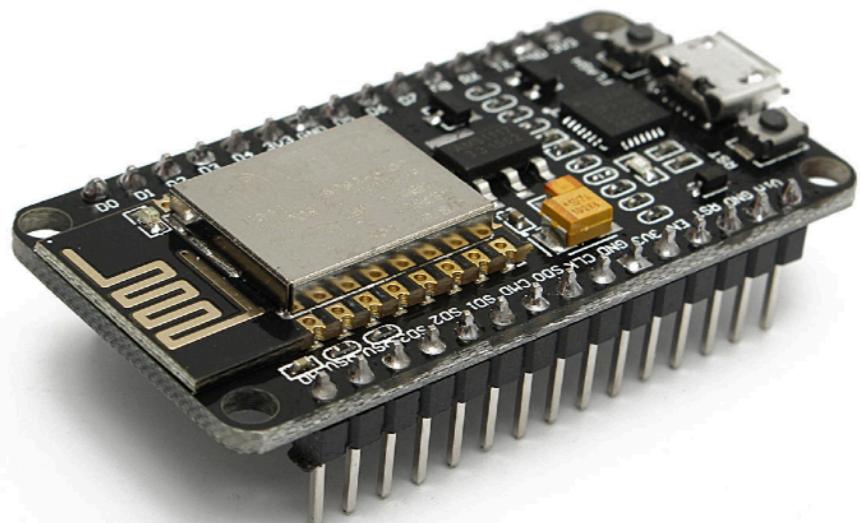
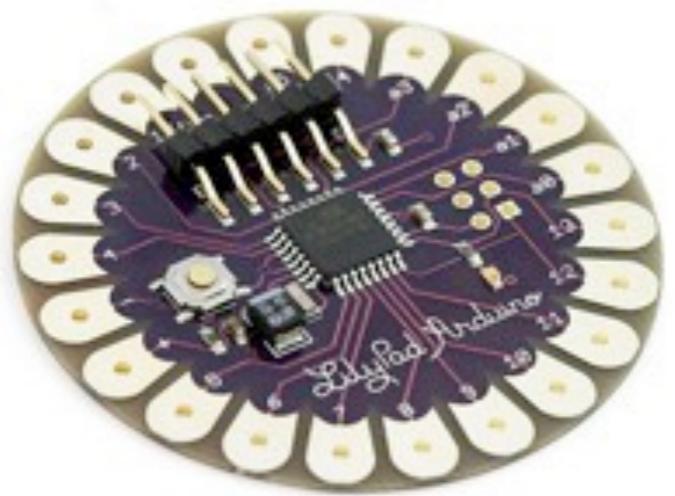
Arduino Fio



**open source**

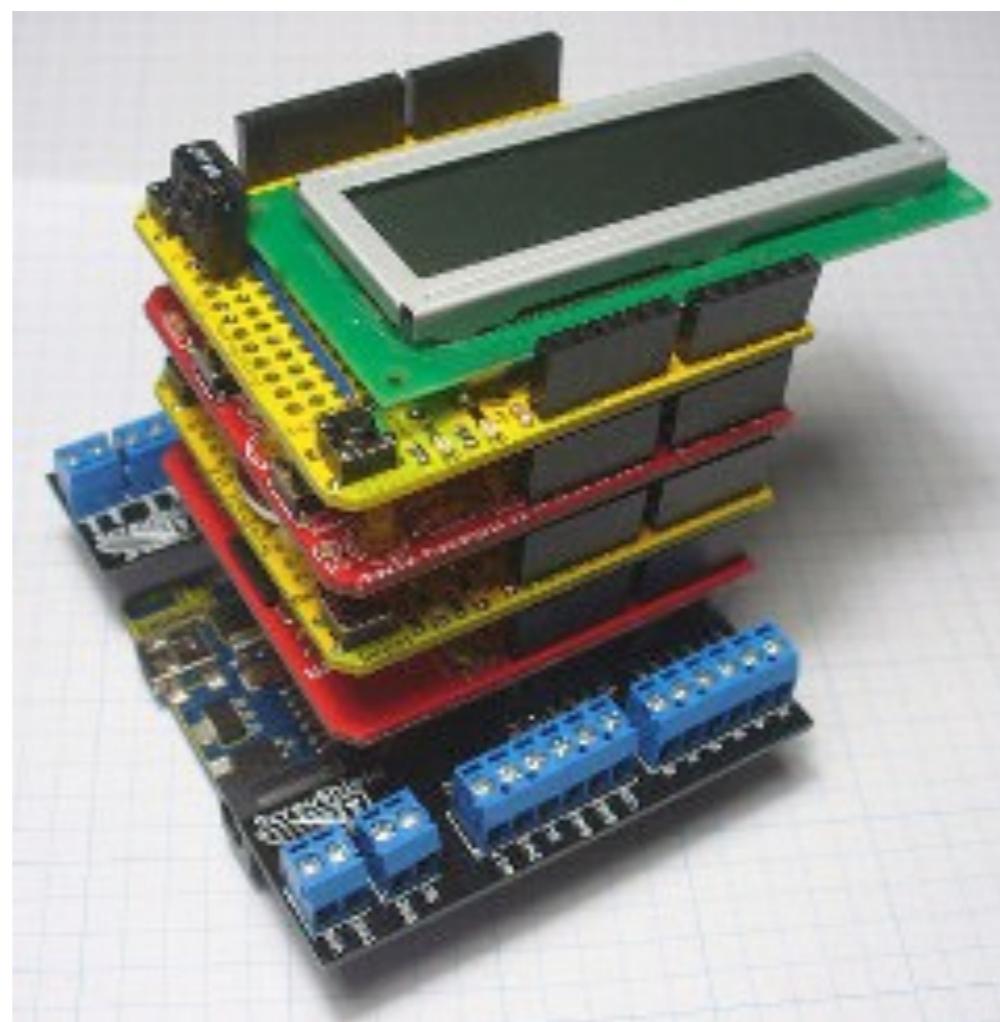


**open source  
hardware**

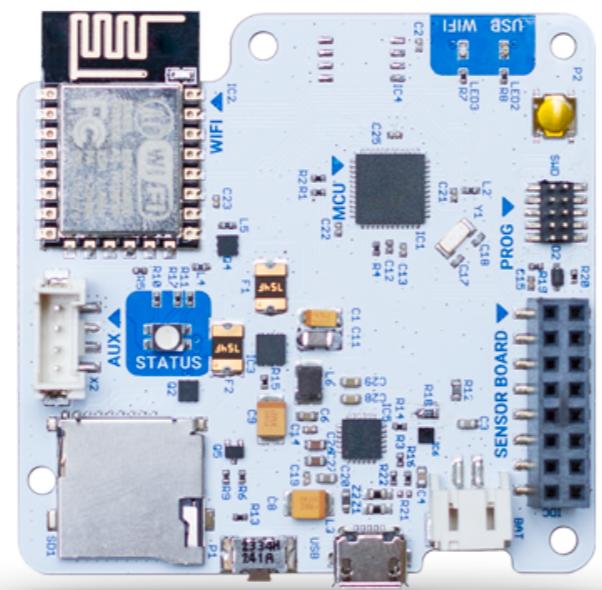
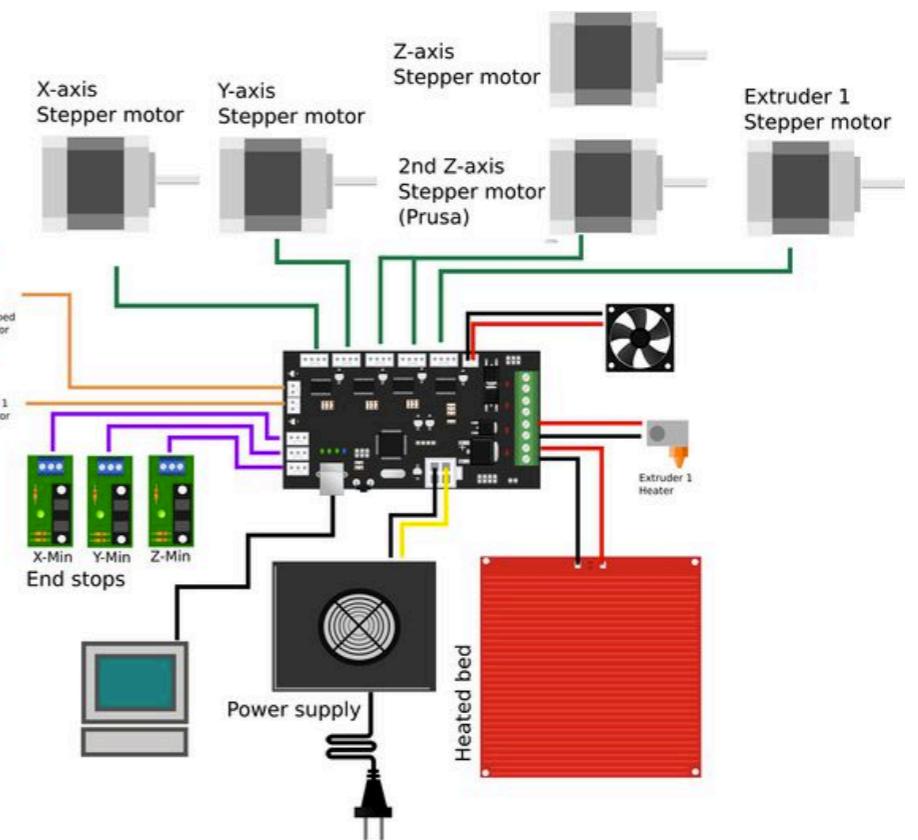
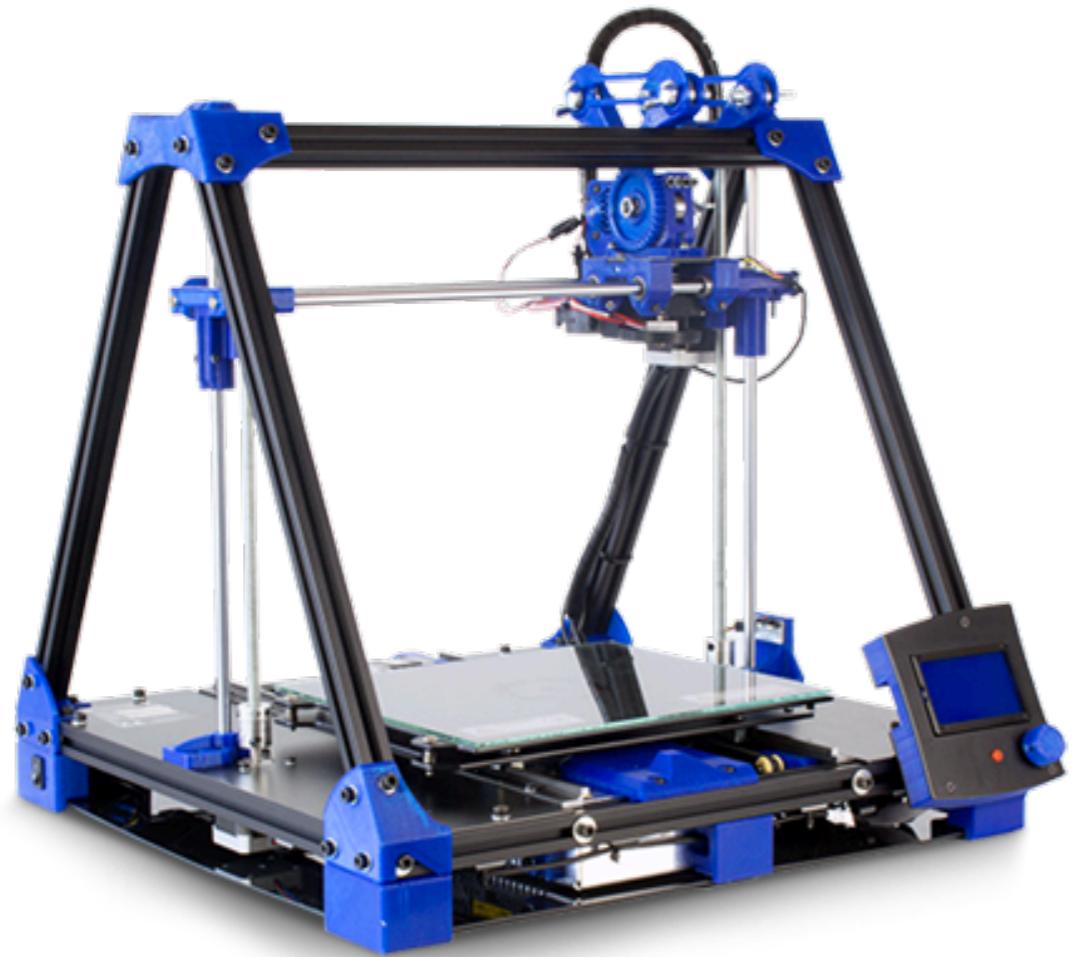


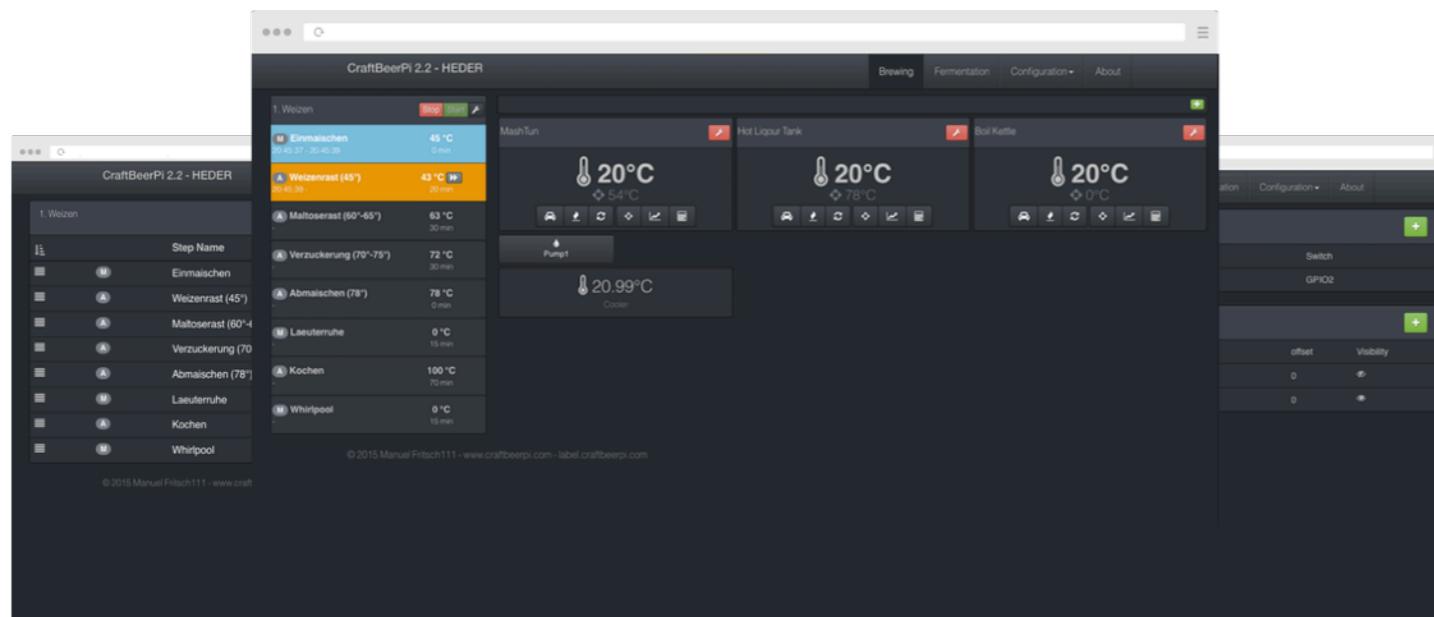
[https://www.sparkfun.com/arduino\\_guide](https://www.sparkfun.com/arduino_guide)

[http://www.bareconductive.com/wp-content/uploads/2015/03/  
BareConductive\\_MicrocontrollerGuideI.pdf](http://www.bareconductive.com/wp-content/uploads/2015/03/BareConductive_MicrocontrollerGuideI.pdf)



<http://shieldlist.org/>



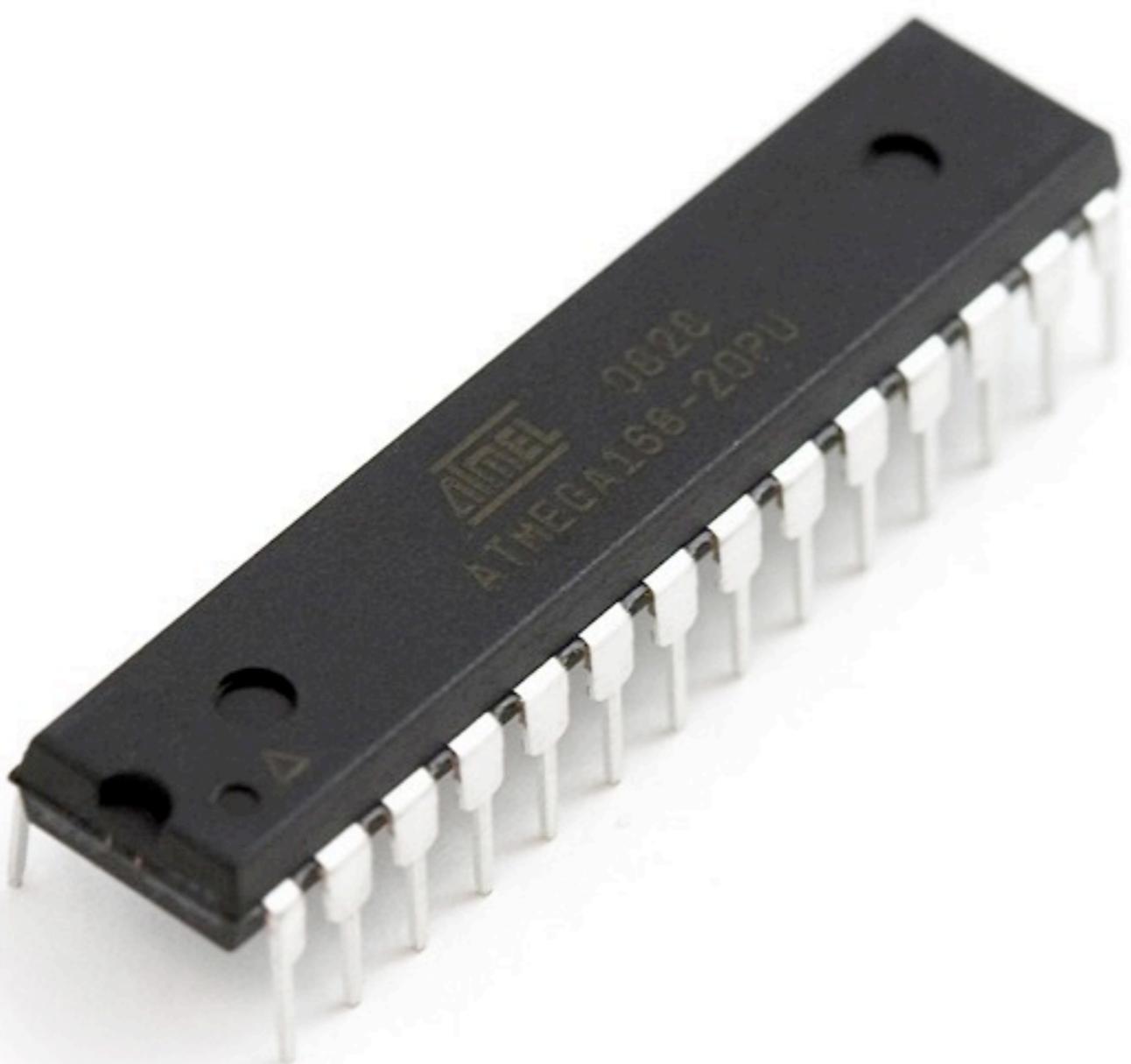


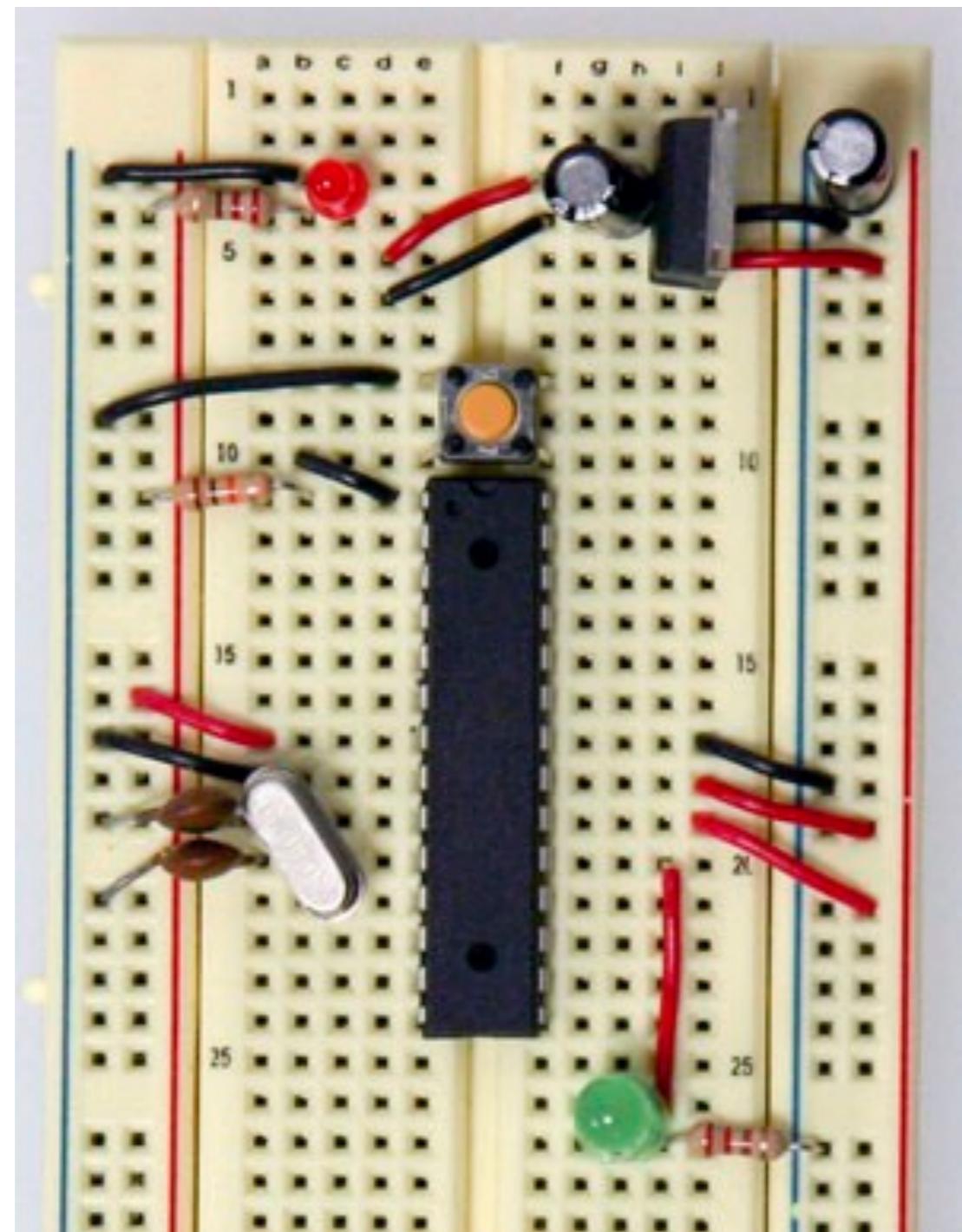
<http://web.craftbeerpi.com/>

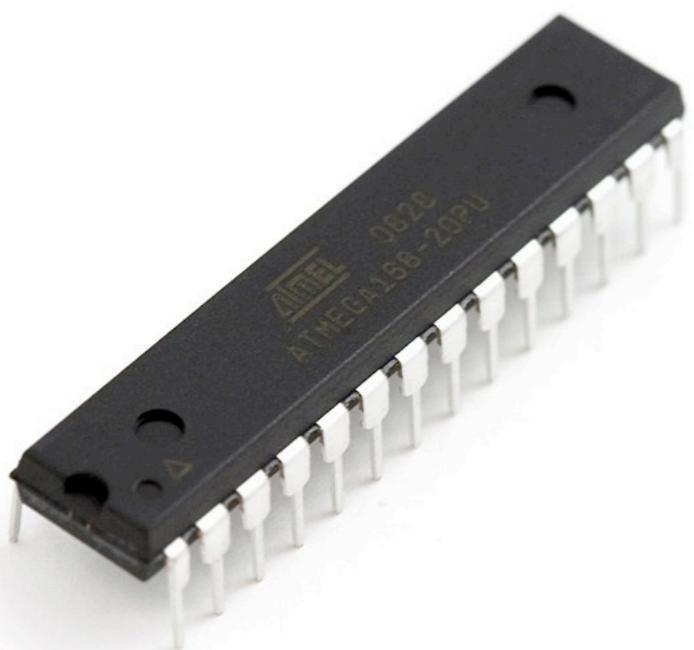
<https://brewpi.com/>











+

Arduino - 0003 Alpha

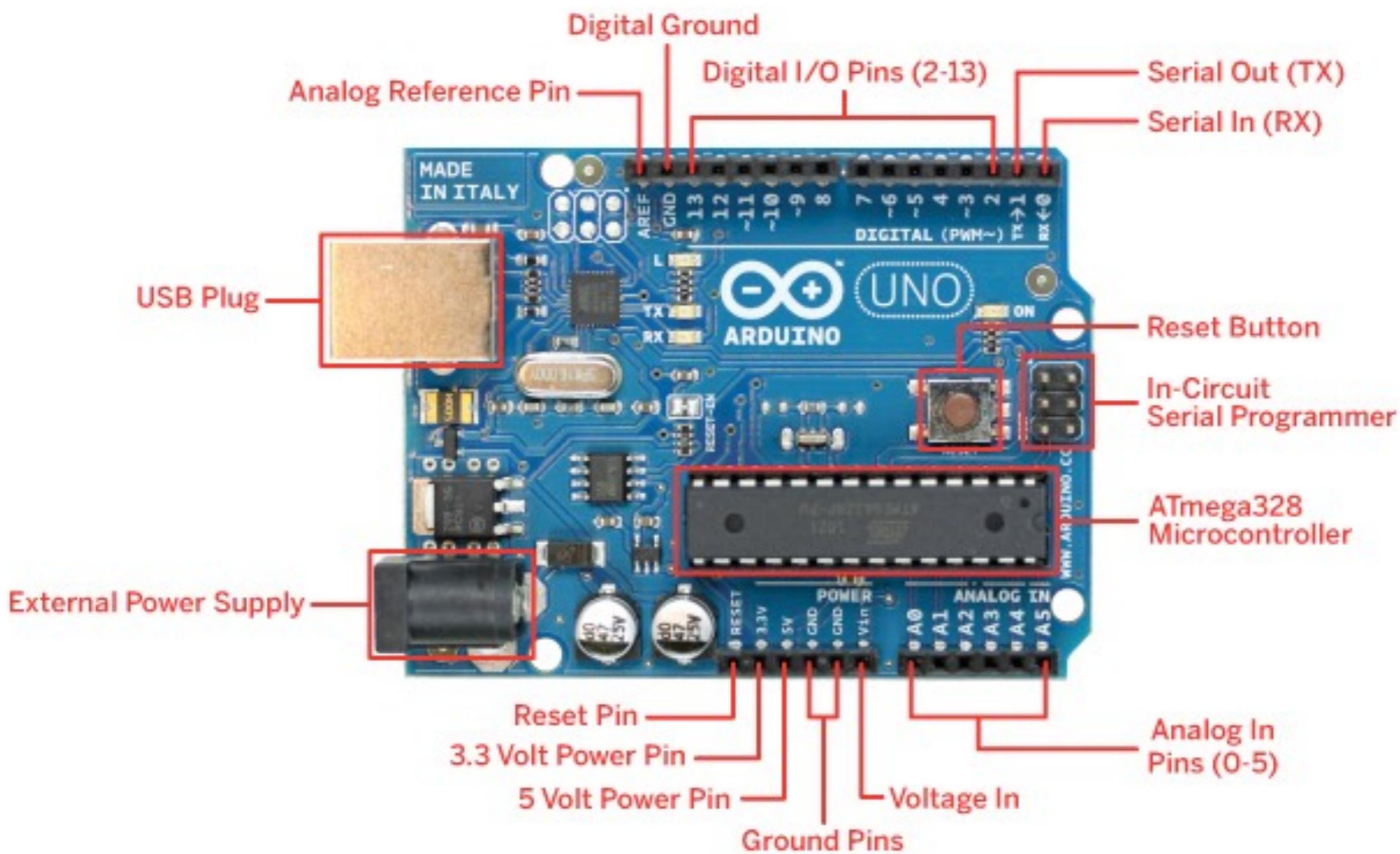
```
led_blink
/*
 * -----
 *
 * turns on and off a light emitting diode(LED) connected to a digital
 * pin, in intervals of 2 seconds. Ideally we use pin 13 on the Arduino
 * board because it has a resistor attached to it, needing only an LED
 *
 * Created 1 June 2005
 * copyleft 2005 DojoDave <http://www.0j0.org>
 * http://arduino.berlios.de
 *
 * based on an orginal by H. Barragon for the Wiring i/o board
 */
int ledPin = 13; // LED connected to digital pin 13

void setup()
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}

void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000); // waits for a second
  digitalWrite(ledPin, LOW); // sets the LED off
  delay(1000); // waits for a second
}
```

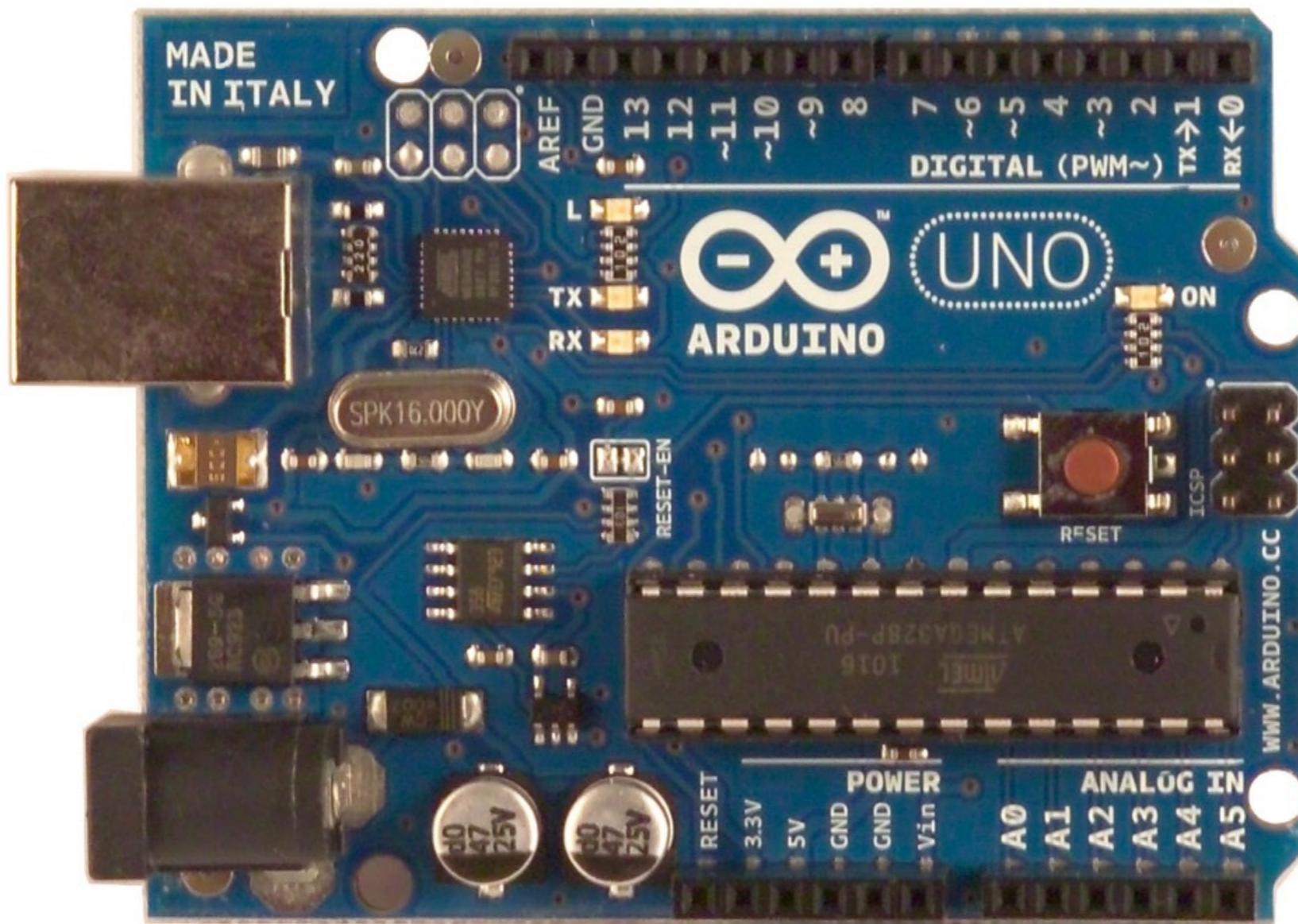
sum = num1 + num2

LDR R0, num1  
LDR R1, num2  
ADD R5, R0, R1  
STR R5, sum



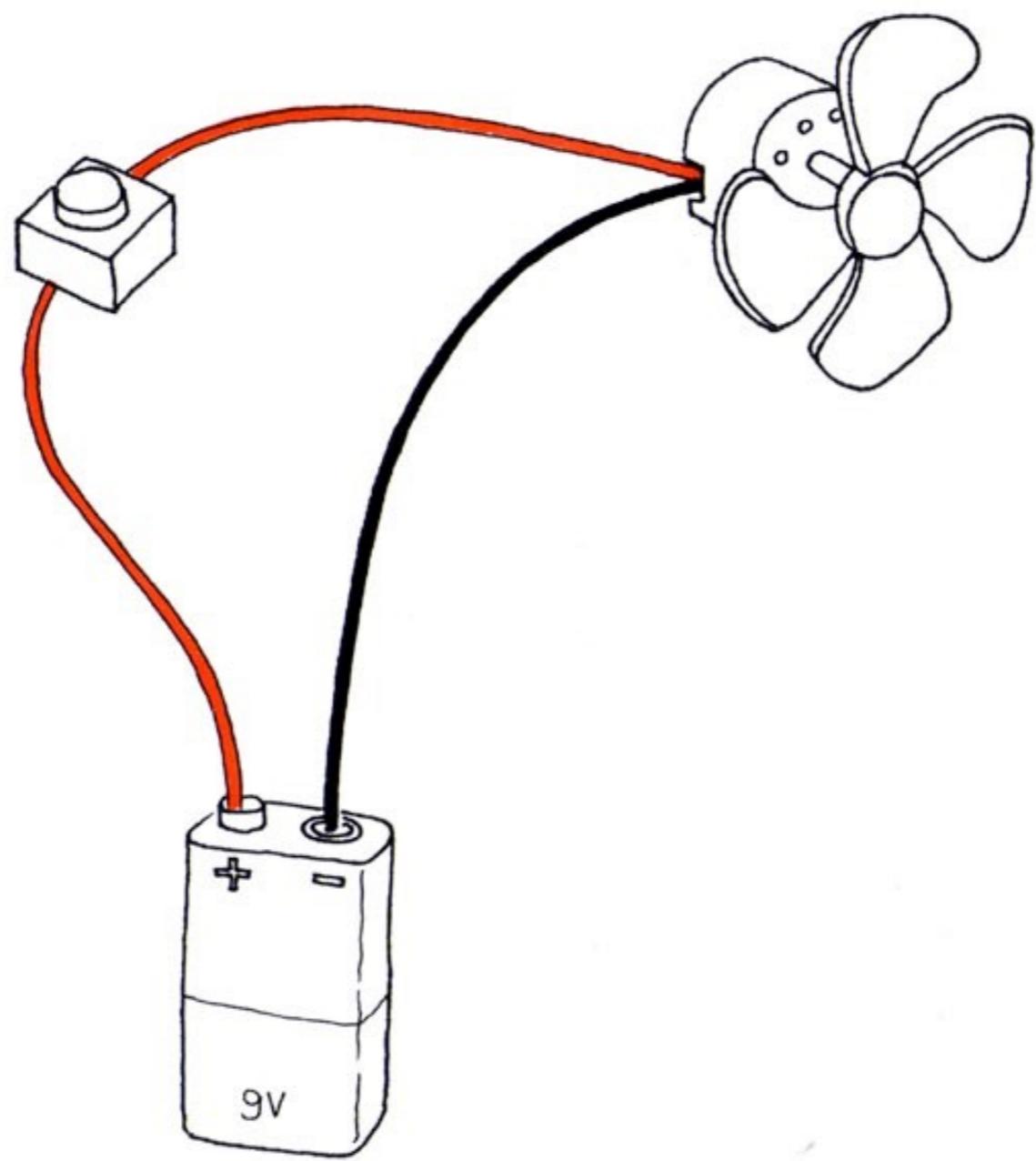
Digital IN / OUT  $\times 13$

~ Analog OUT (PWM)  $\times 6$

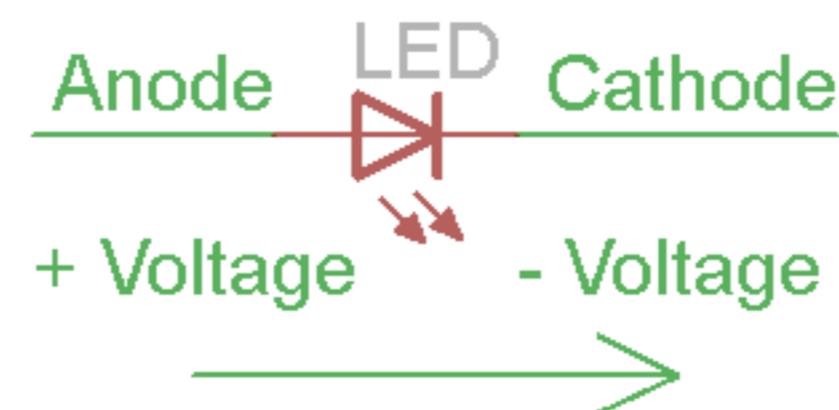
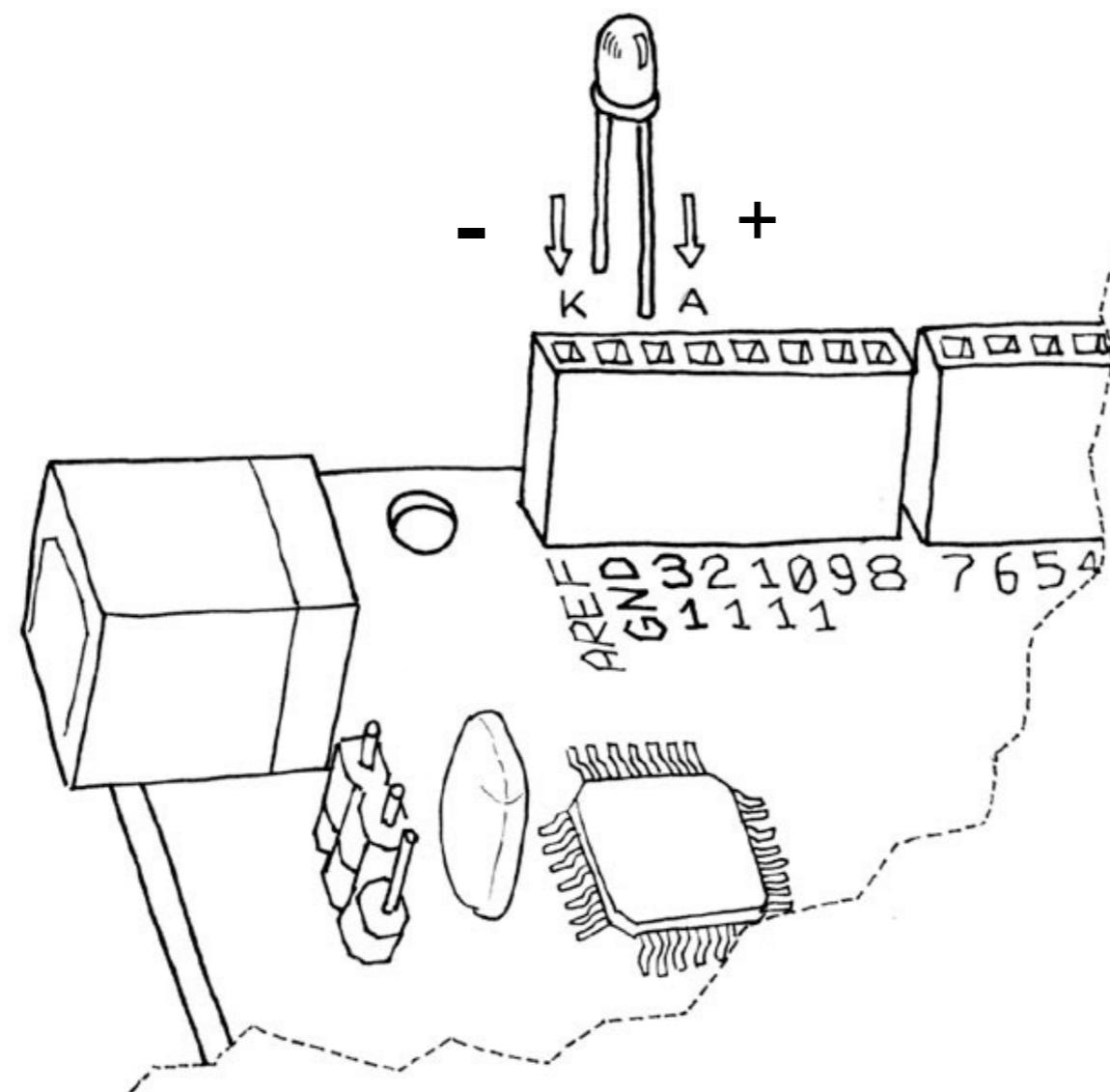


Analog IN  $\times 6$

	INPUTS	OUTPUTS
DIGITAL (on / off)	<code>digitalRead</code> HIGH / LOW 255 / 0	<code>digitalWrite</code> HIGH / LOW 255 / 0
ANALOG (less / more)	<code>analogRead</code> 0 - 1023	<code>analogWrite</code> PWM 0 - 255



# “hello, world!”



# “hello, world!”



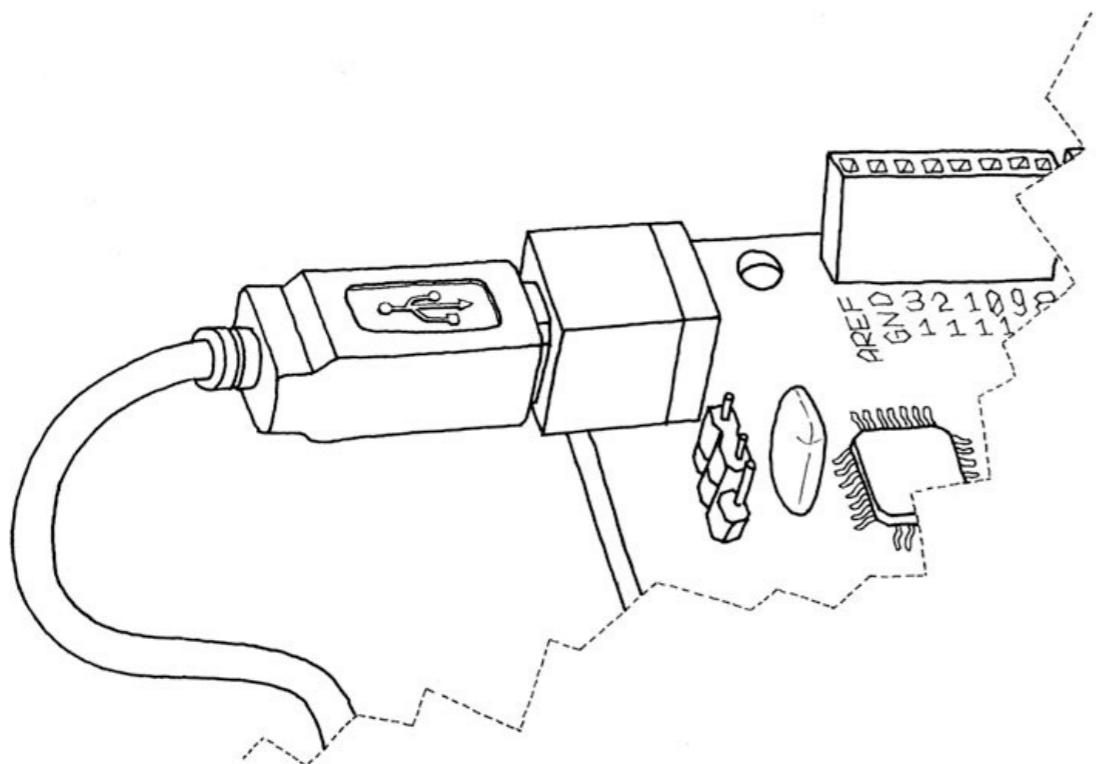
The screenshot shows the Arduino IDE interface with the title bar "Blink | Arduino 1.0". The toolbar includes icons for upload, refresh, and file operations, with "Upload" being the active button. The code editor displays the "Blink" example sketch. The code is as follows:

```
/*
 * Blink
 * Turns on an LED on for one second, then off for one second, repeatedly.
 *
 * This example code is in the public domain.
 */

void setup() {
    // initialize the digital pin as an output.
    // Pin 13 has an LED connected on most Arduino boards:
    pinMode(13, OUTPUT);
}

void loop() {
    digitalWrite(13, HIGH);      // set the LED on
    delay(1000);                // wait for a second
    digitalWrite(13, LOW);       // set the LED off
    delay(1000);                // wait for a second
}
```

The status bar at the bottom indicates "Arduino Uno on /dev/tty.usbmodem1d11".



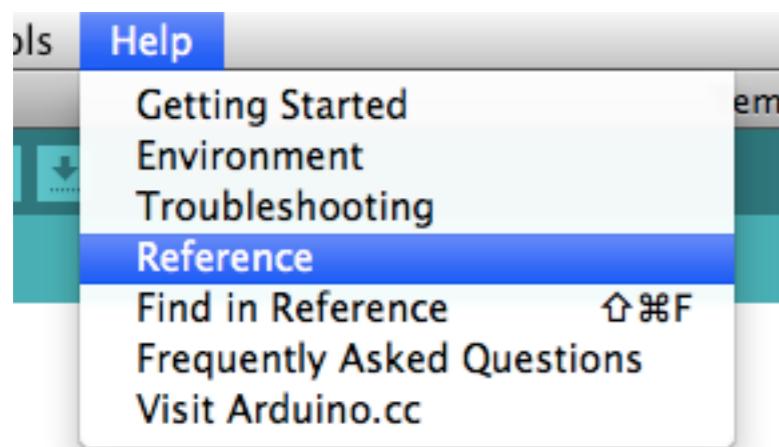
```
/*
Blink
Turns on an LED on for one second, then off for one second, repeatedly.

This example code is in the public domain.

*/
void setup() {
  // initialize the digital pin as an output.
  // Pin 13 has an LED connected on most Arduino boards:
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);    // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);     // set the LED off
  delay(1000);              // wait for a second
}
```

1      Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega328 on /dev/tty.usbmodem1d11



<http://arduino.cc/en/>  
**Reference/HomePage**

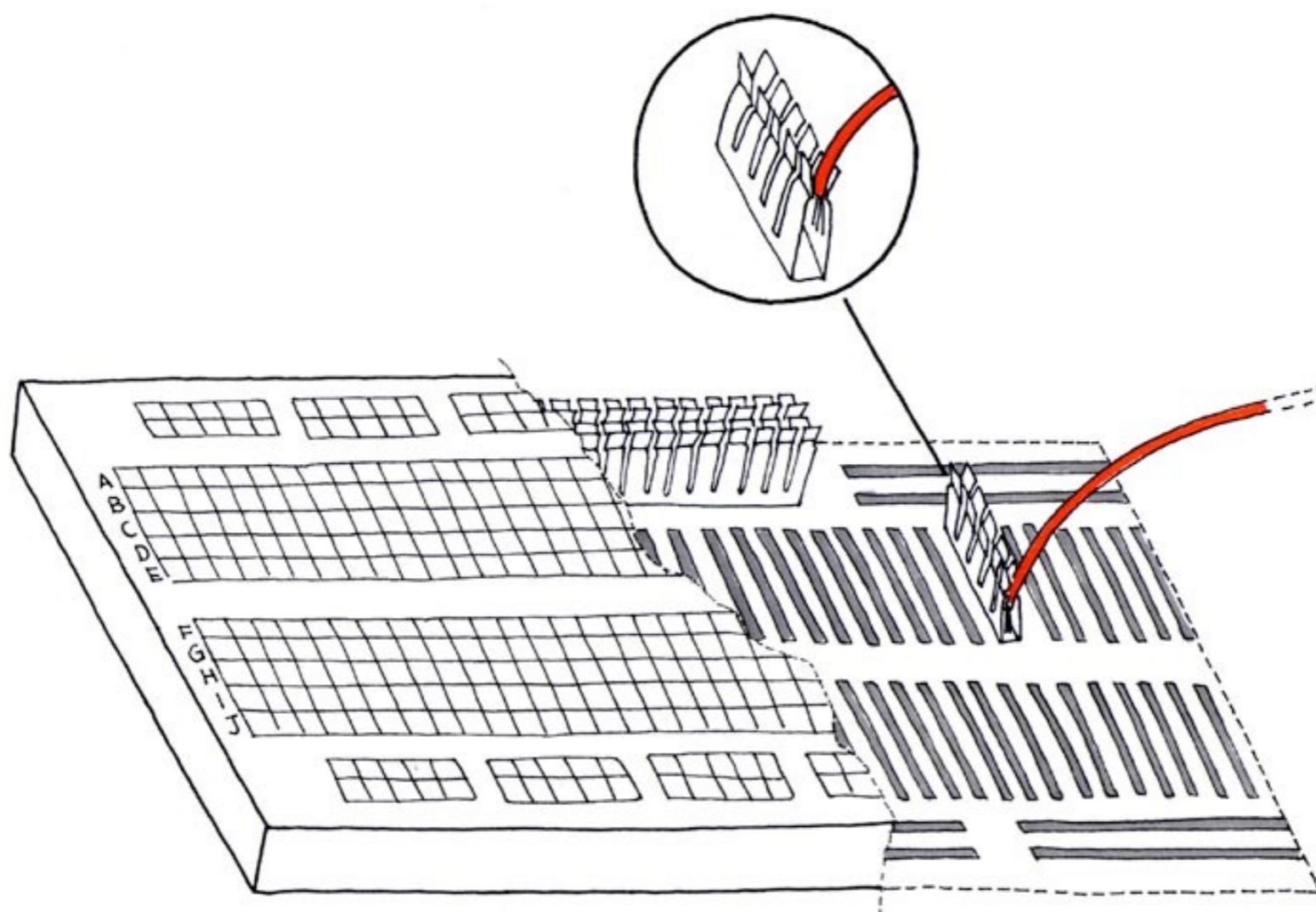
# Hands On



[http://www.seeedstudio.com/wiki/Arduino\\_Sidekick\\_Basic\\_Kit](http://www.seeedstudio.com/wiki/Arduino_Sidekick_Basic_Kit)

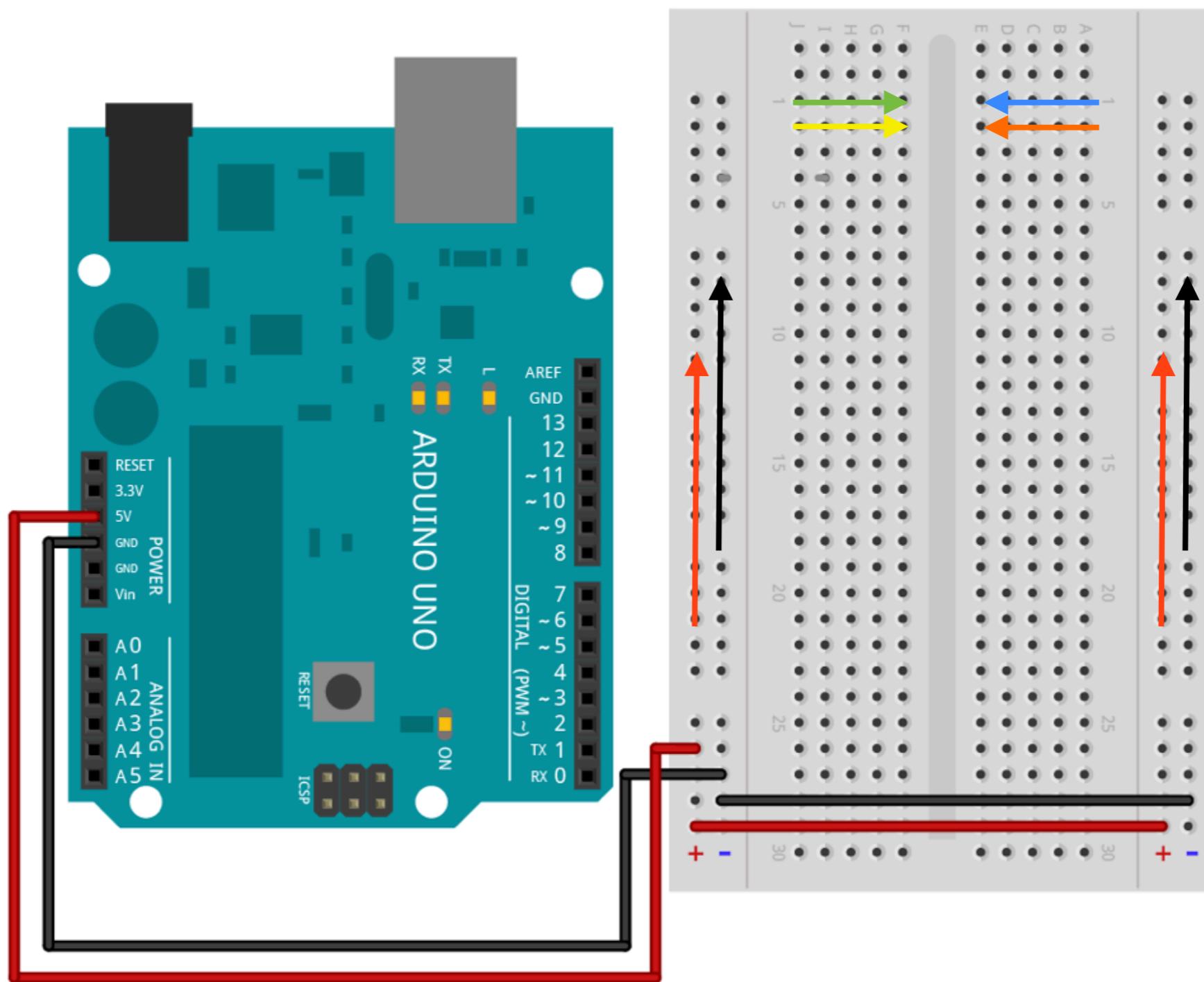
<http://www.cooking-hacks.com/arduino-starter-kit>

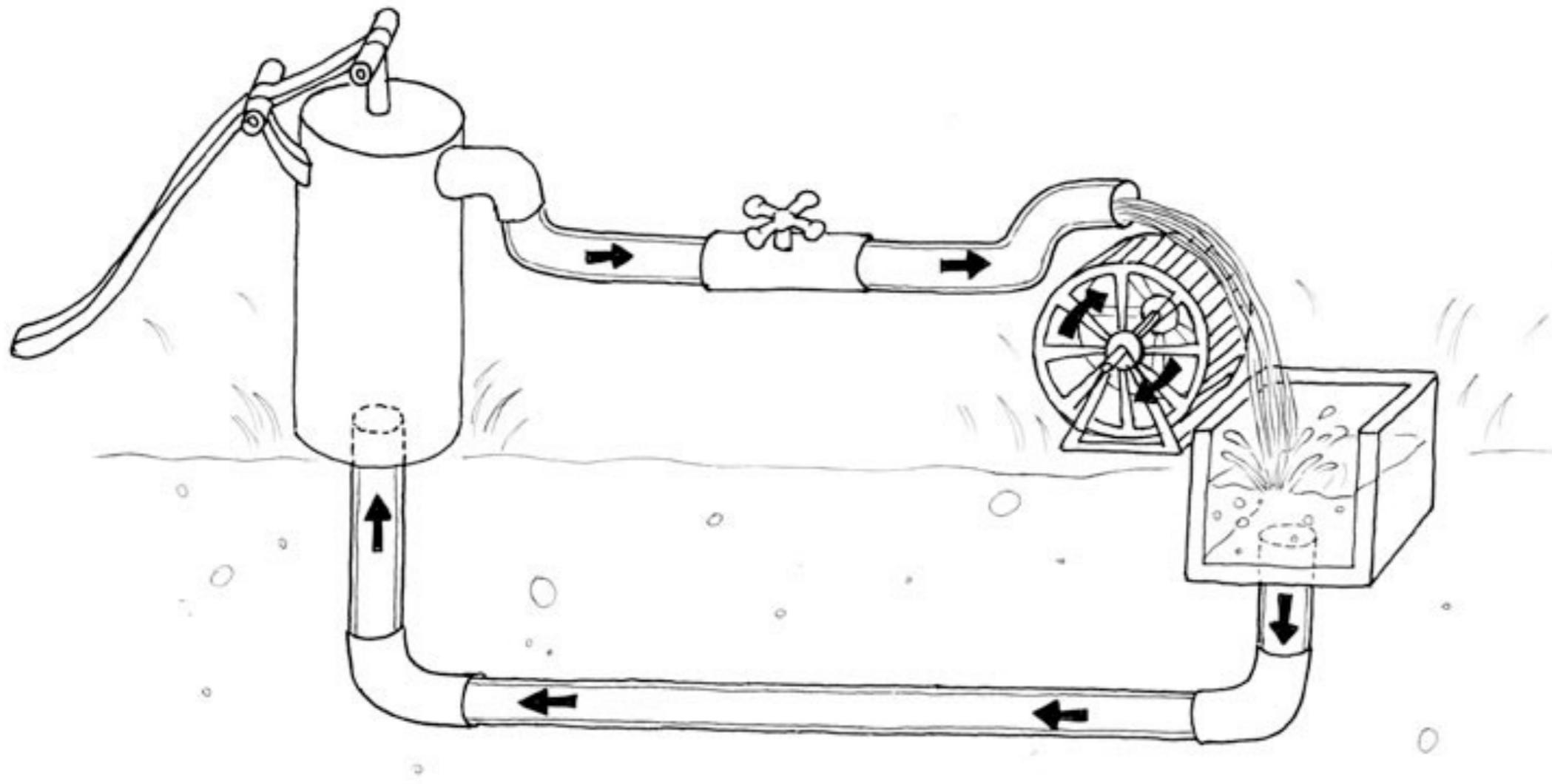
# The Breadboard (aka Protoboard)



<http://www.protostack.com/blog/2011/09/8-breadboard-hacks/>

# The Breadboard (aka Protoboard)





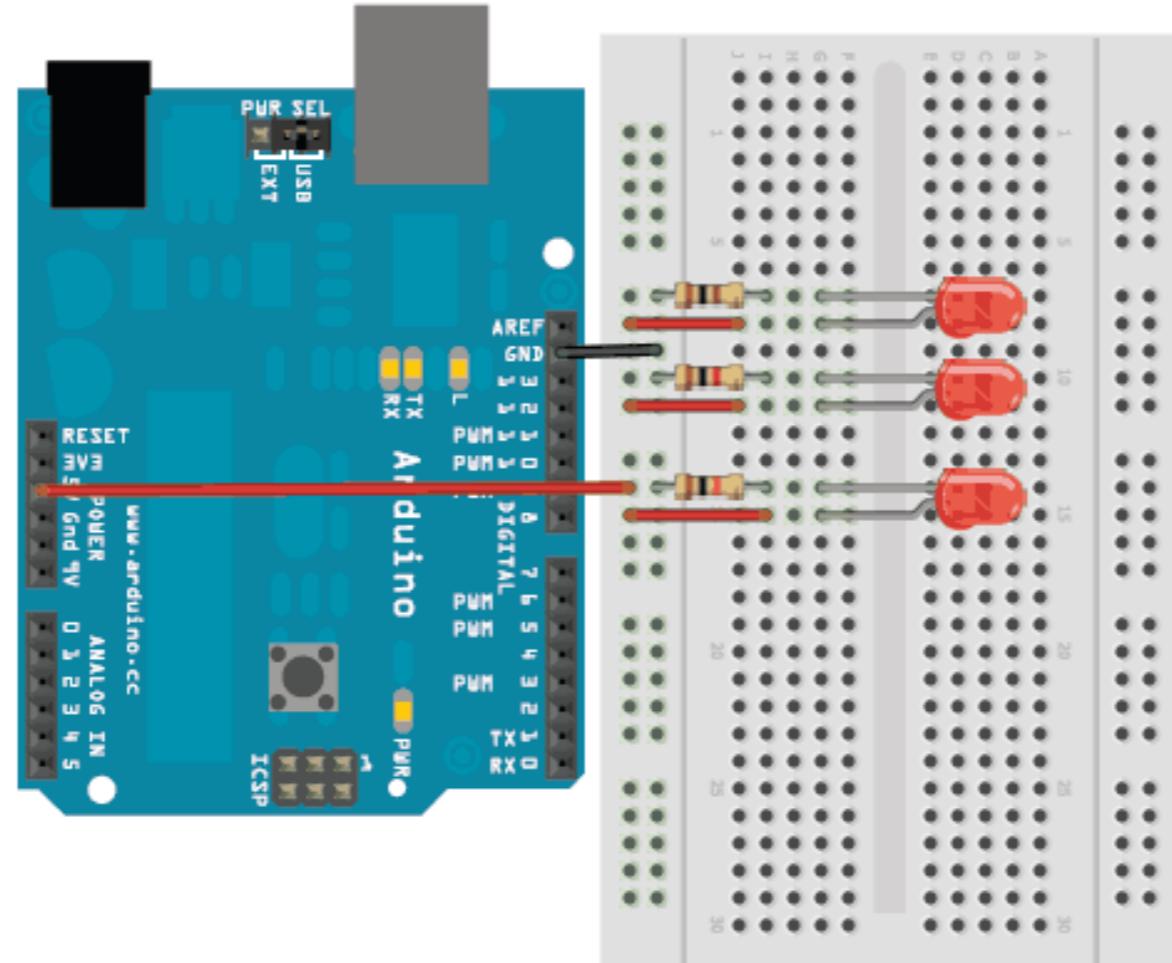
# Arduino Output

5V

max 40 mA

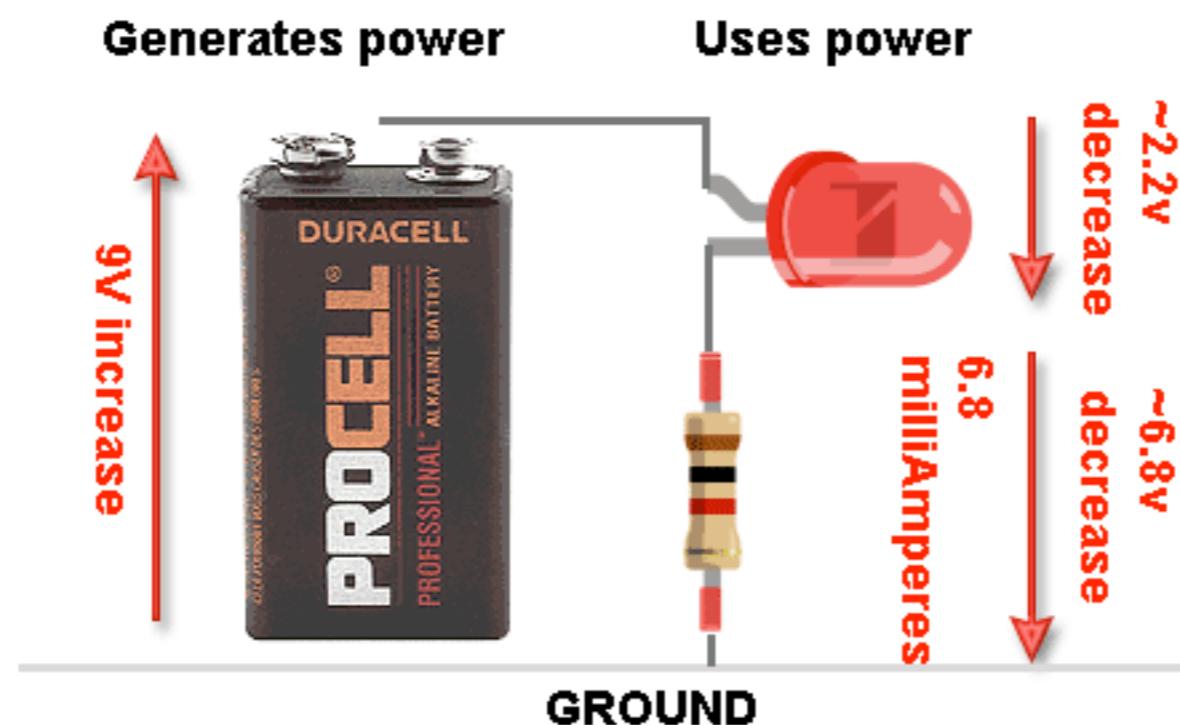
x PIN

# Why resistors?

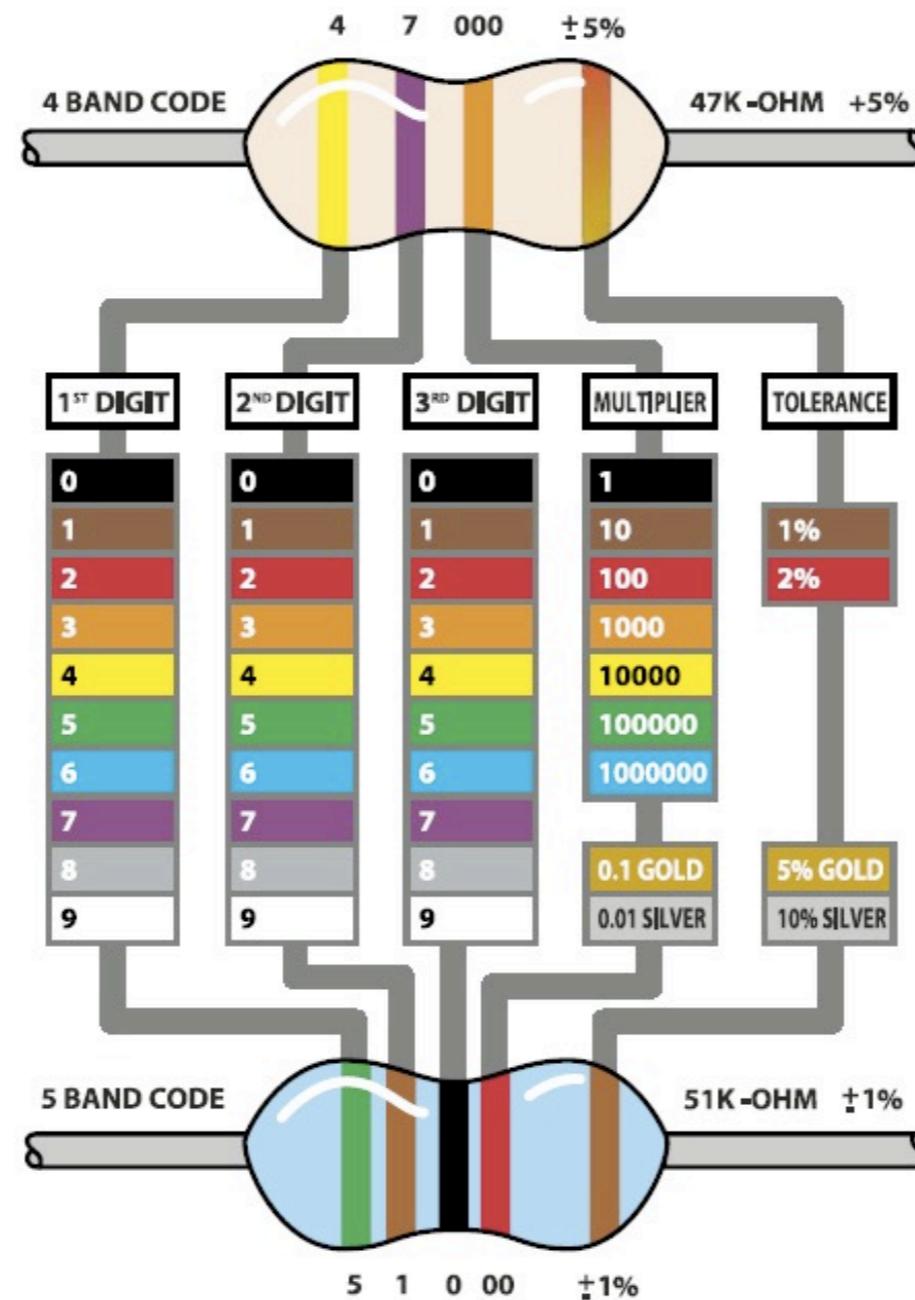


The resistor  
is your friend.

5V  
Max 40mA  
x PIN



# Resistors



<http://www.dannyg.com/examples/res2/resistor.htm>

<http://www.csgnetwork.com/resistcolcalc.html>

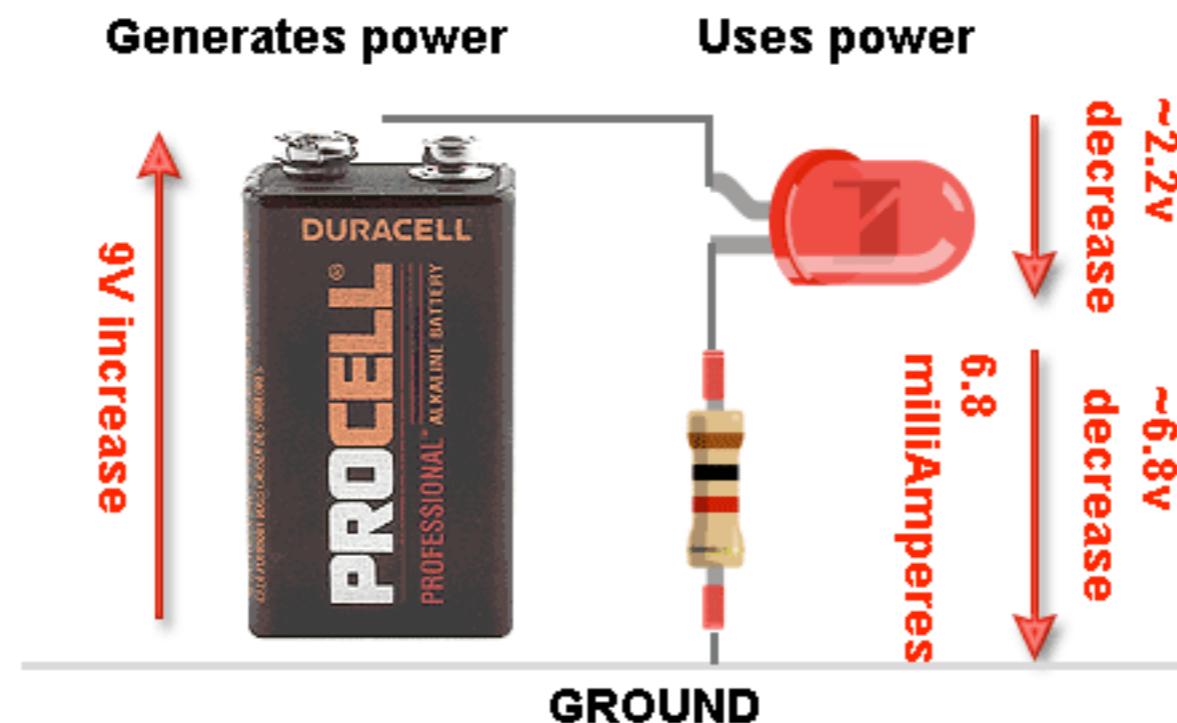
<http://www.hebeiltd.com.cn/?p=zz.led.resistor.calculatorext>

The resistor  
is your friend.

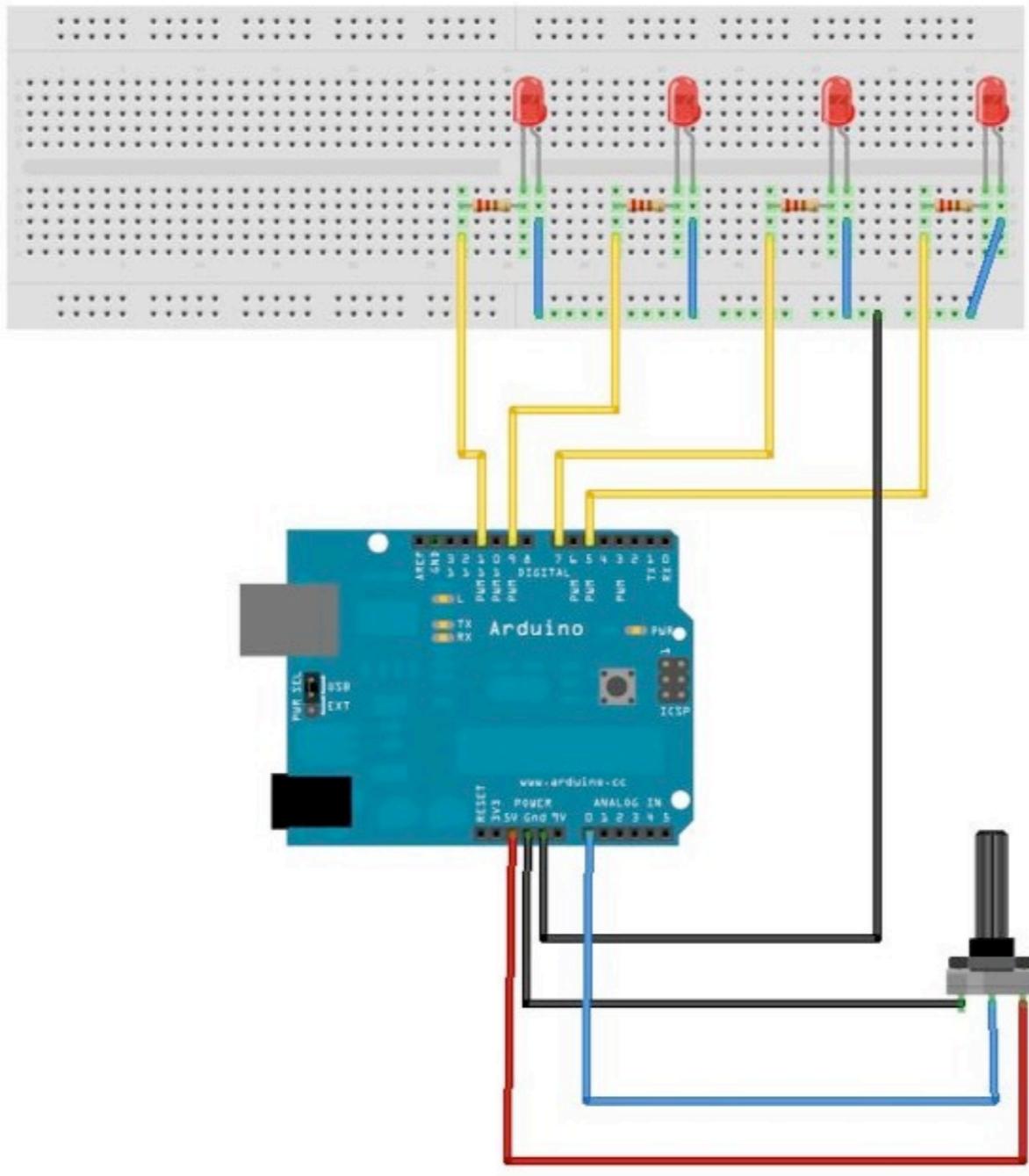
$$R = (5V - 2V) / 0.003A$$

$$1000\Omega = 4.6V / 0.003A$$

[http://  
www.raltron.c  
om/cust/  
tools/  
voltage\\_divid  
er.asp](http://www.raltron.com/cust/tools/voltage_divider.asp)

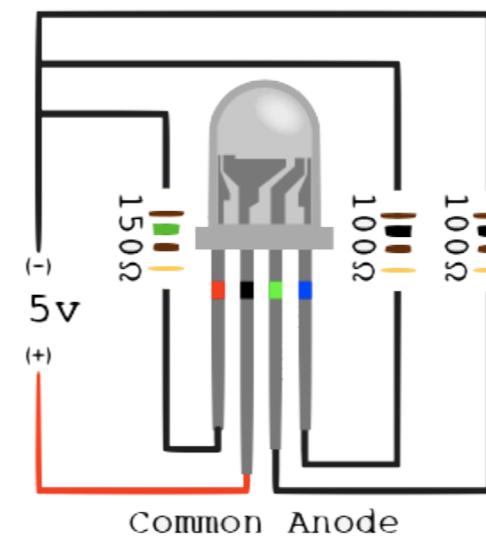
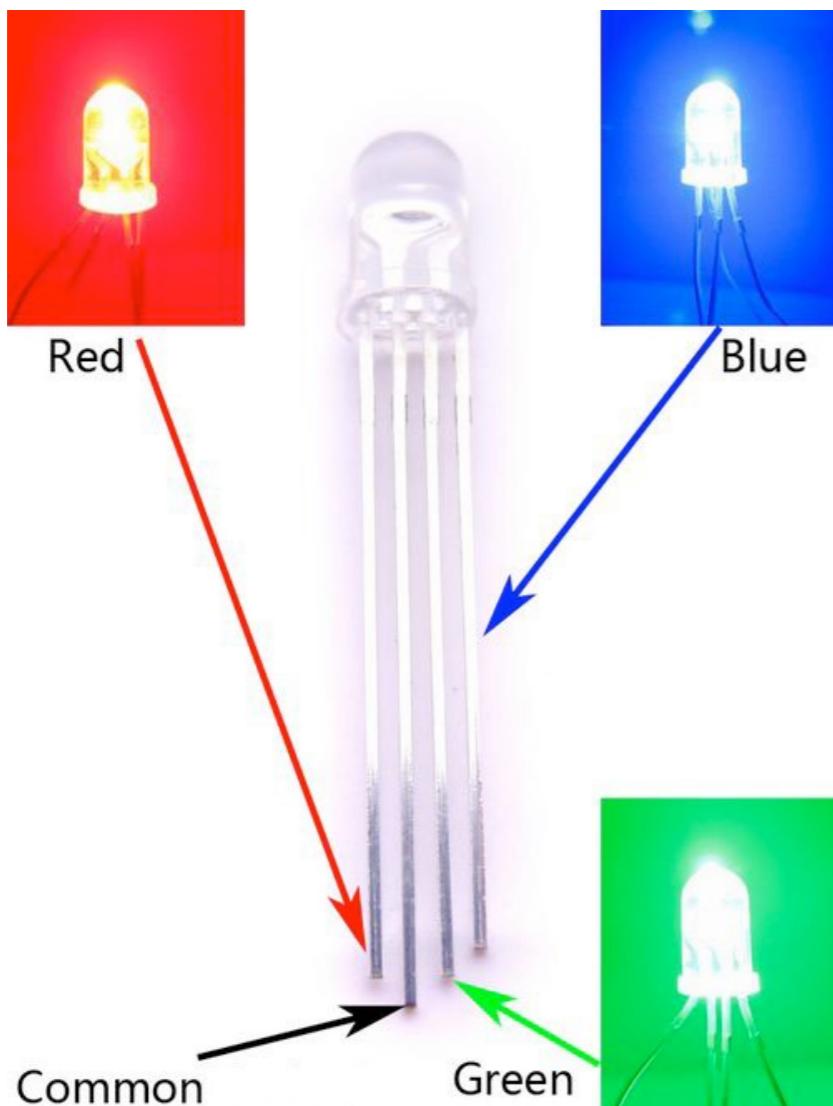


# LED's

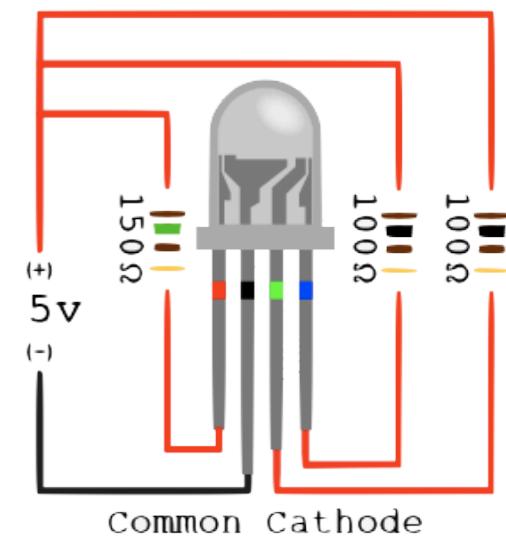


on/off or PWM  
(digitalWrite / analogWrite)

# RGB LED's



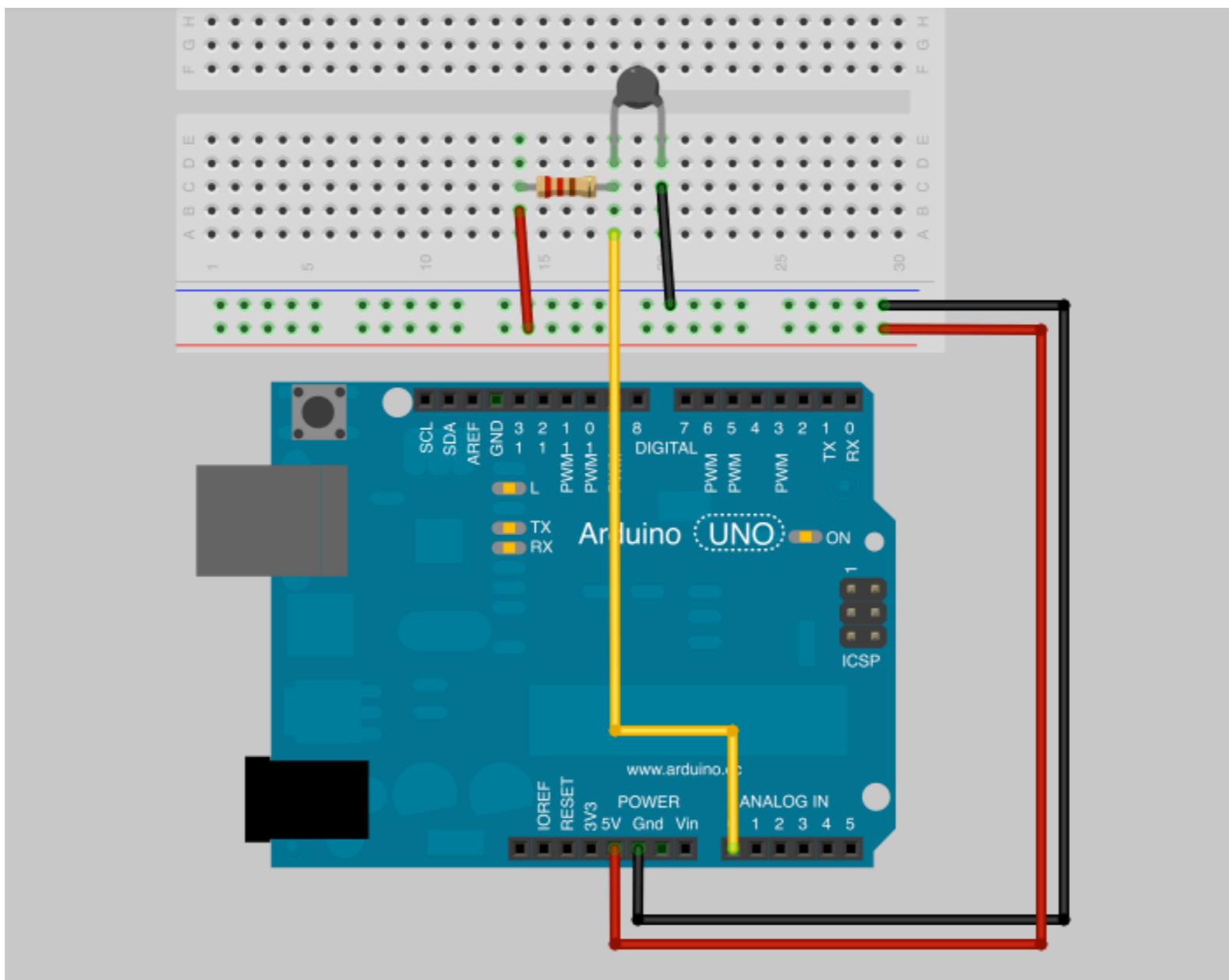
255-value



255

<http://learn.adafruit.com/adafruit-arduino-lesson-3-rgb-leds>

# Thermistor

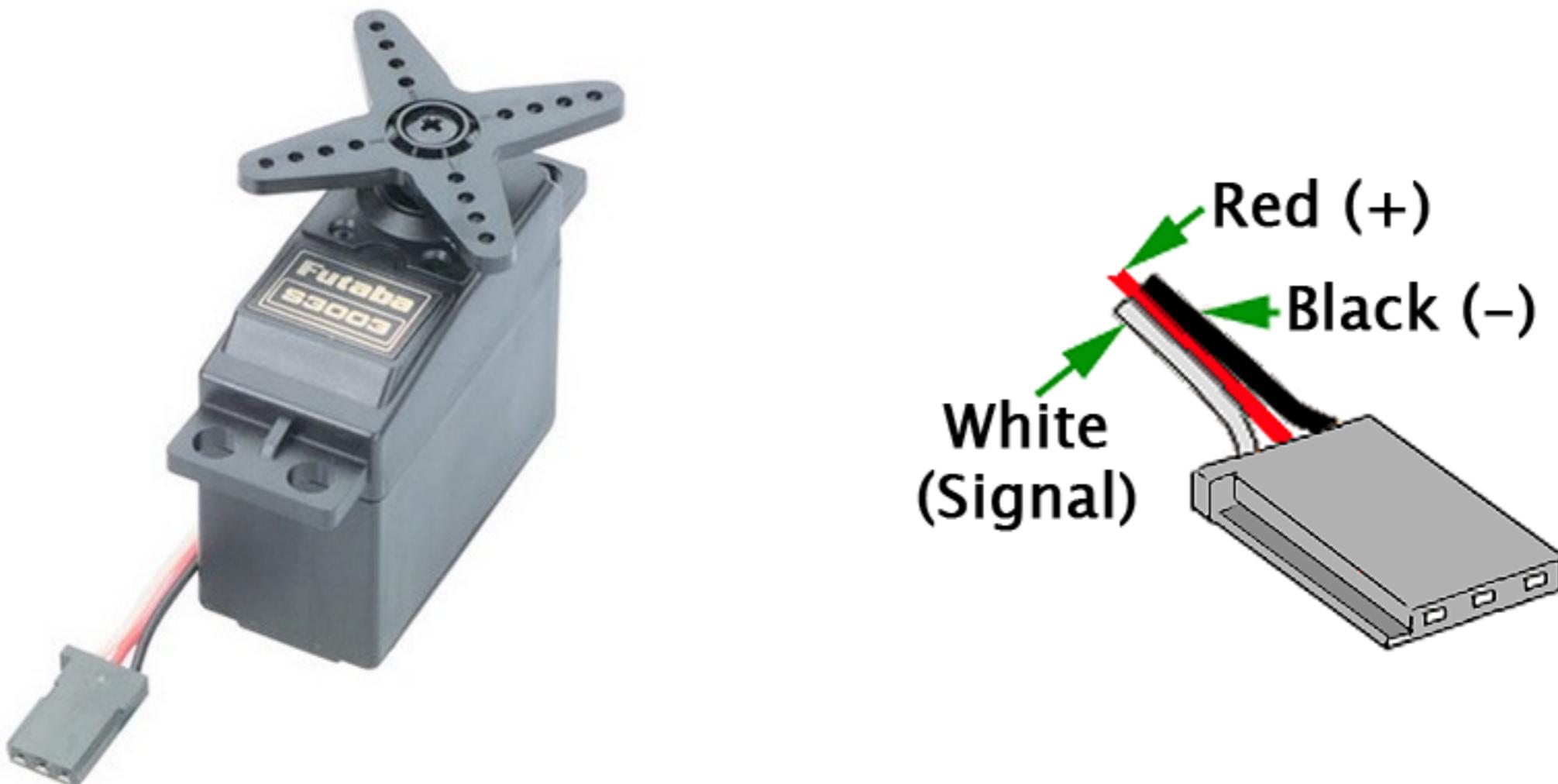


<http://learn.adafruit.com/thermistor>

<http://pastie.org/8467723>

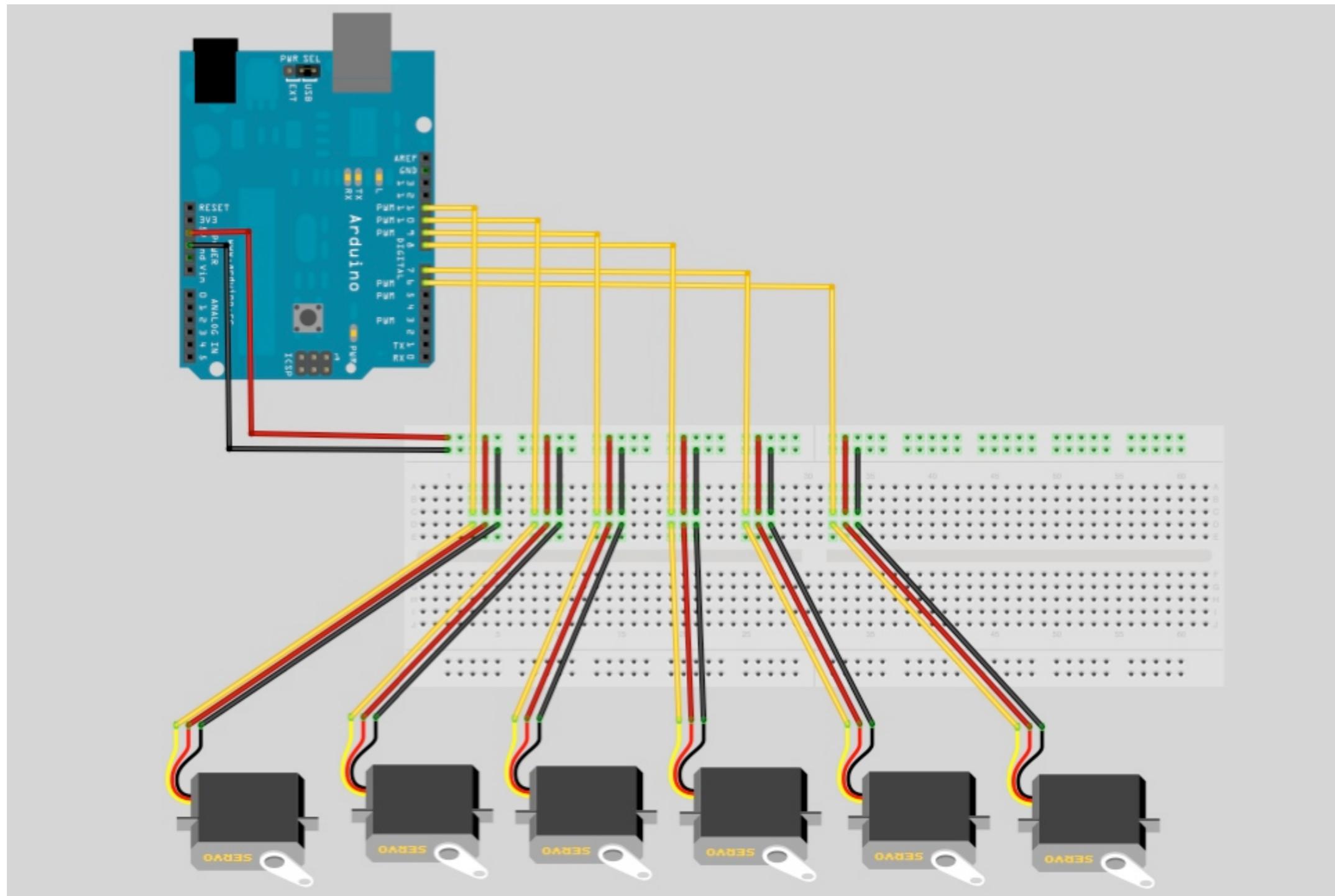
# Servos

```
#include <Servo.h>
```



<http://arduino.cc/en/Reference/Servo>

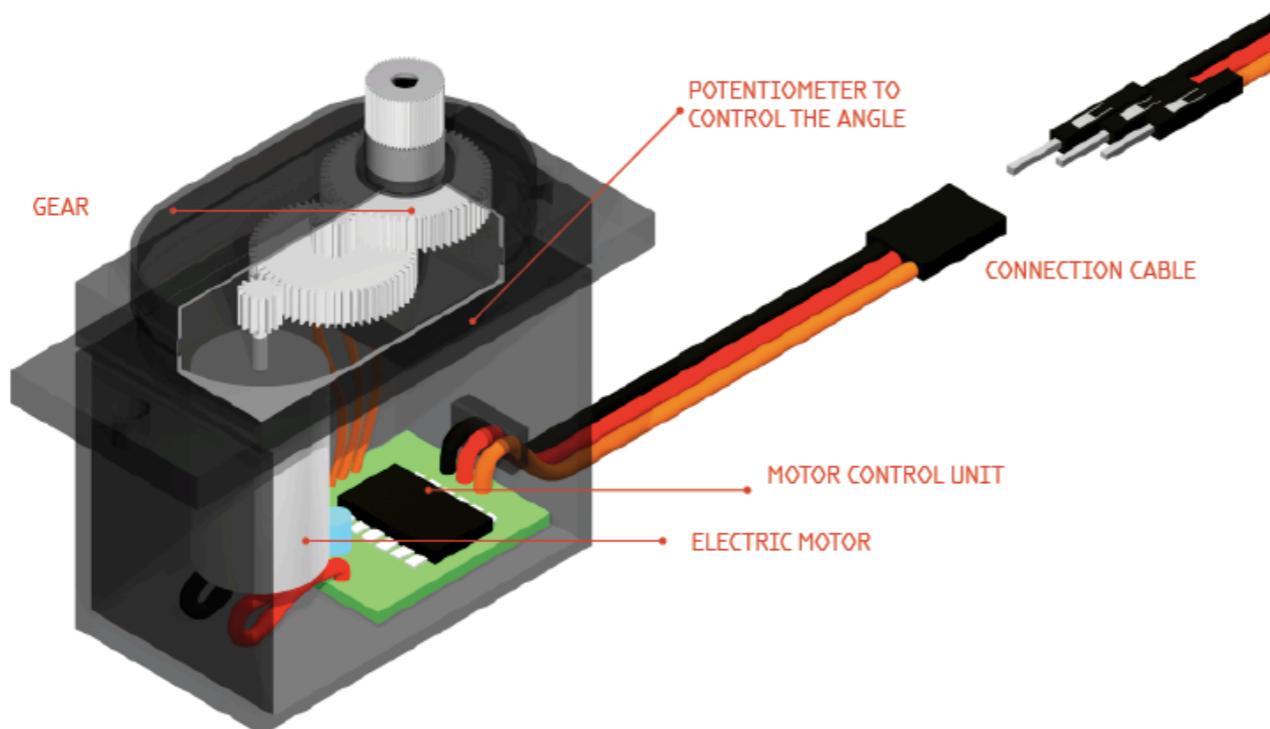
# Servos



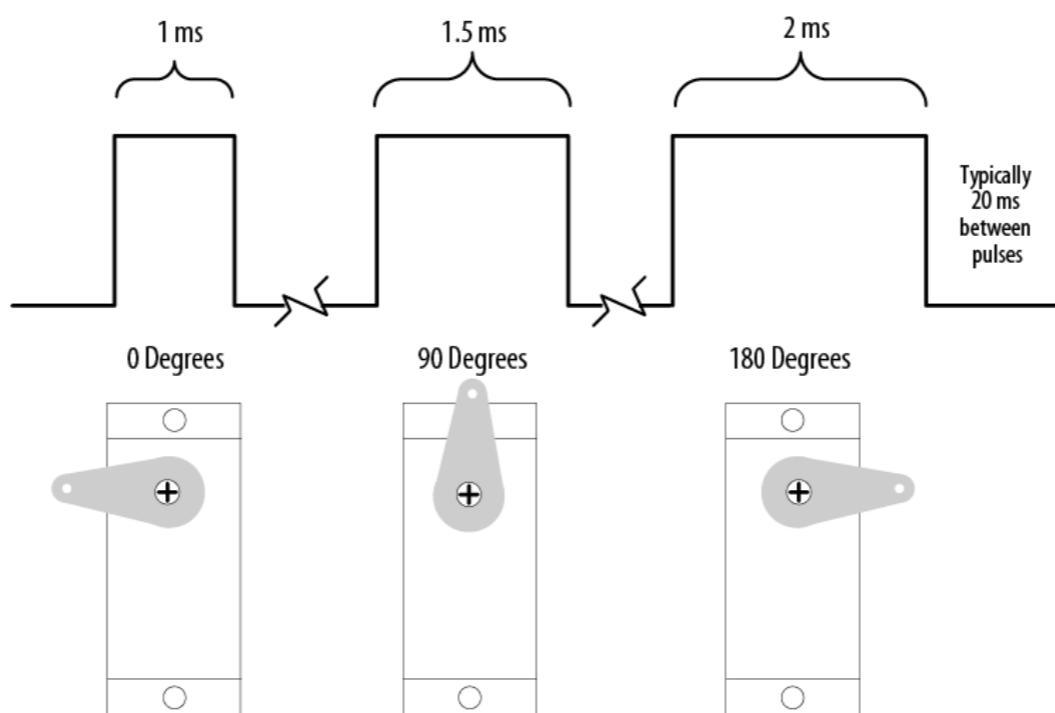
**Any Digital Pins** (disables PWM on 9 and 10)

a servo could take more power than the one the usb can provide, use an external power supply

# Servos

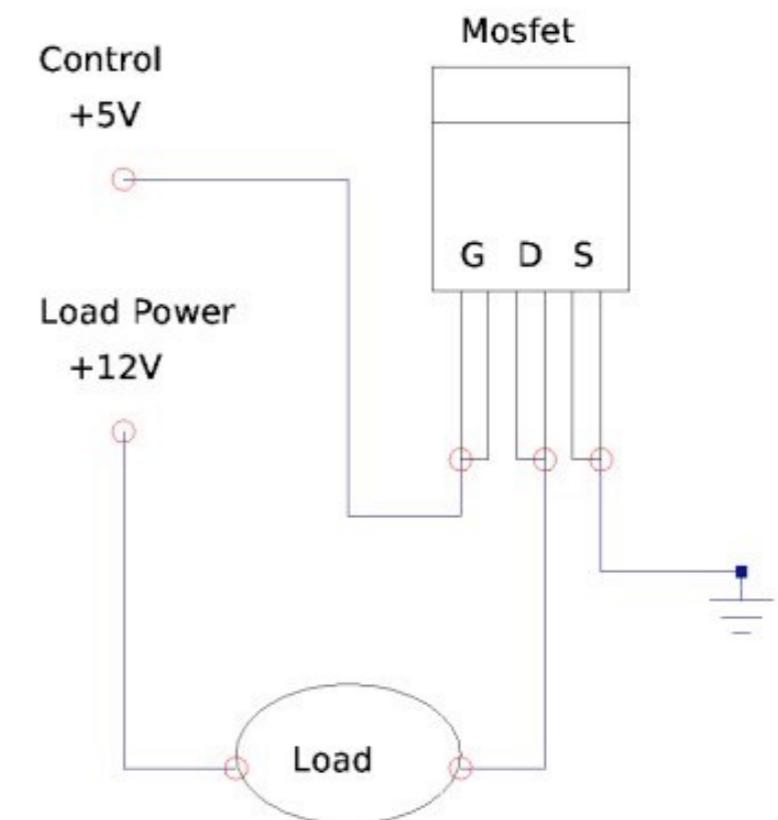
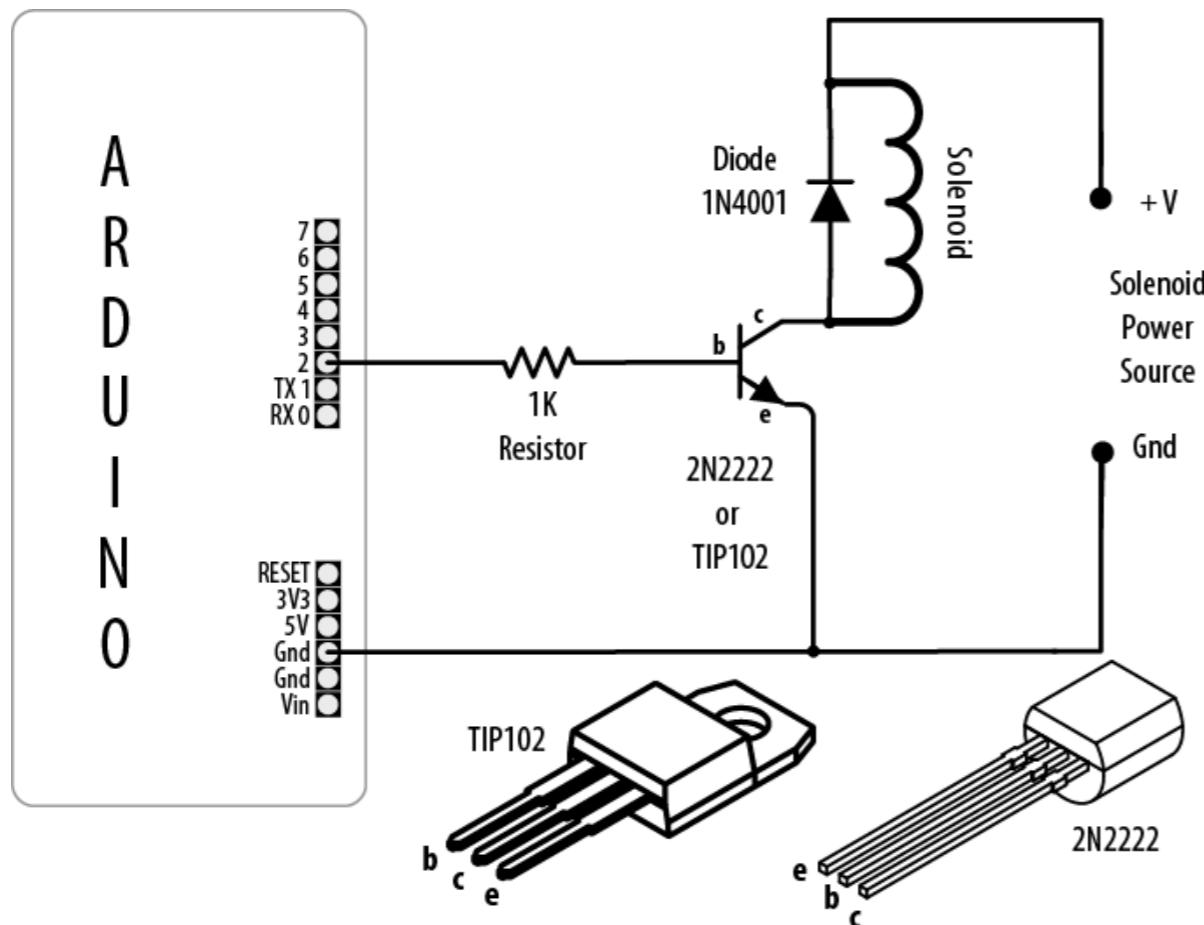


## Close loop control

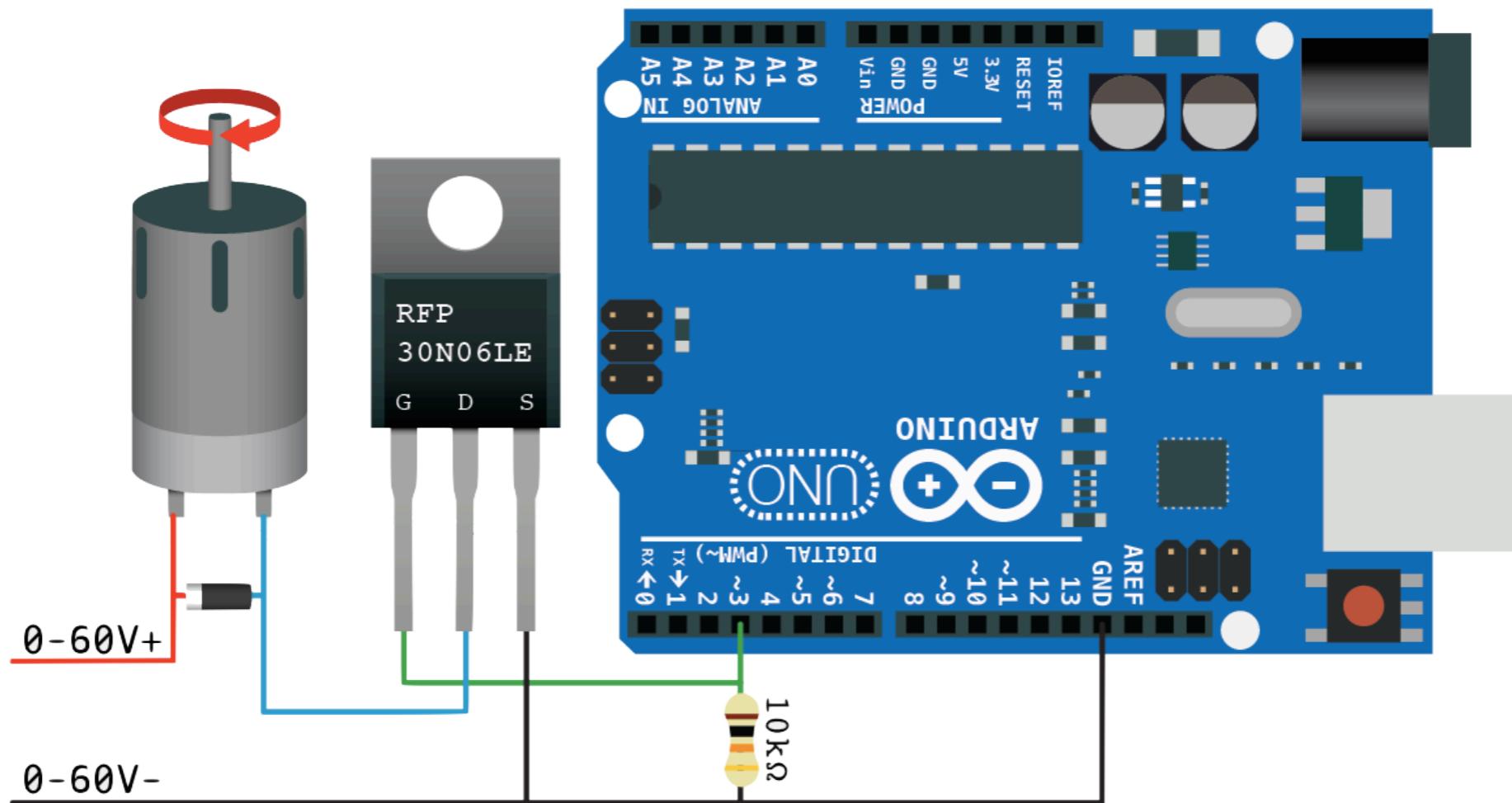


# Mosfet

> 40mA or > 5V



# Mosfet

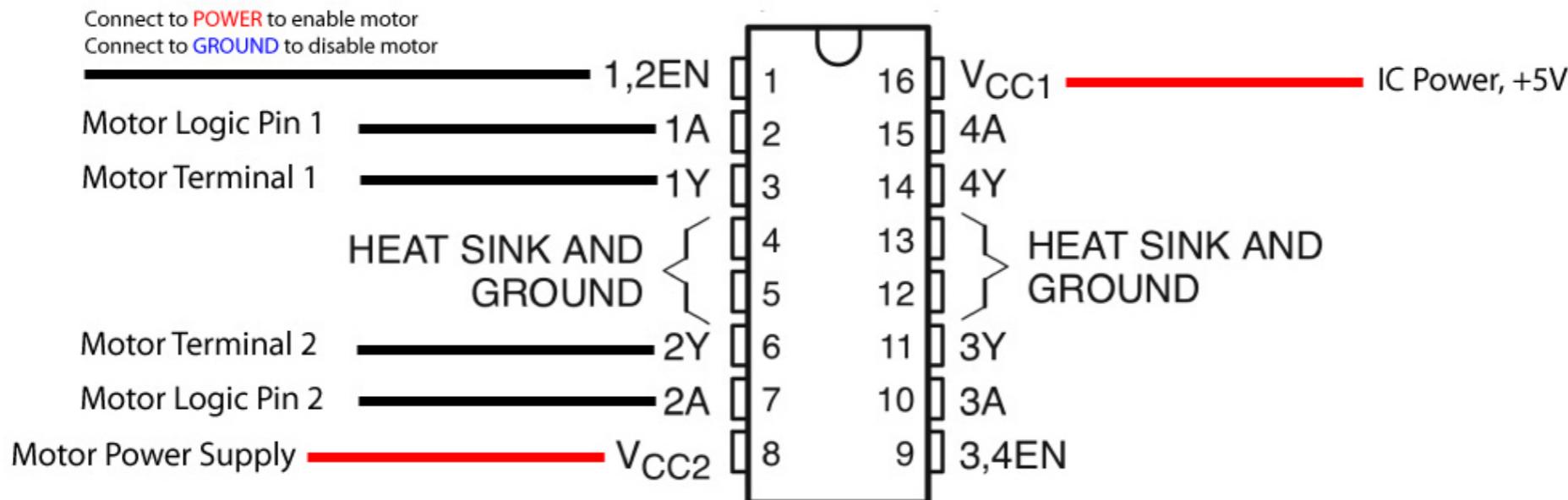


on/off or PWM  
(digitalWrite / analogWrite)

# H-Bridge

> 40mA or > 5V + DC motor control (+/-/-+)

L293NE or SN754410

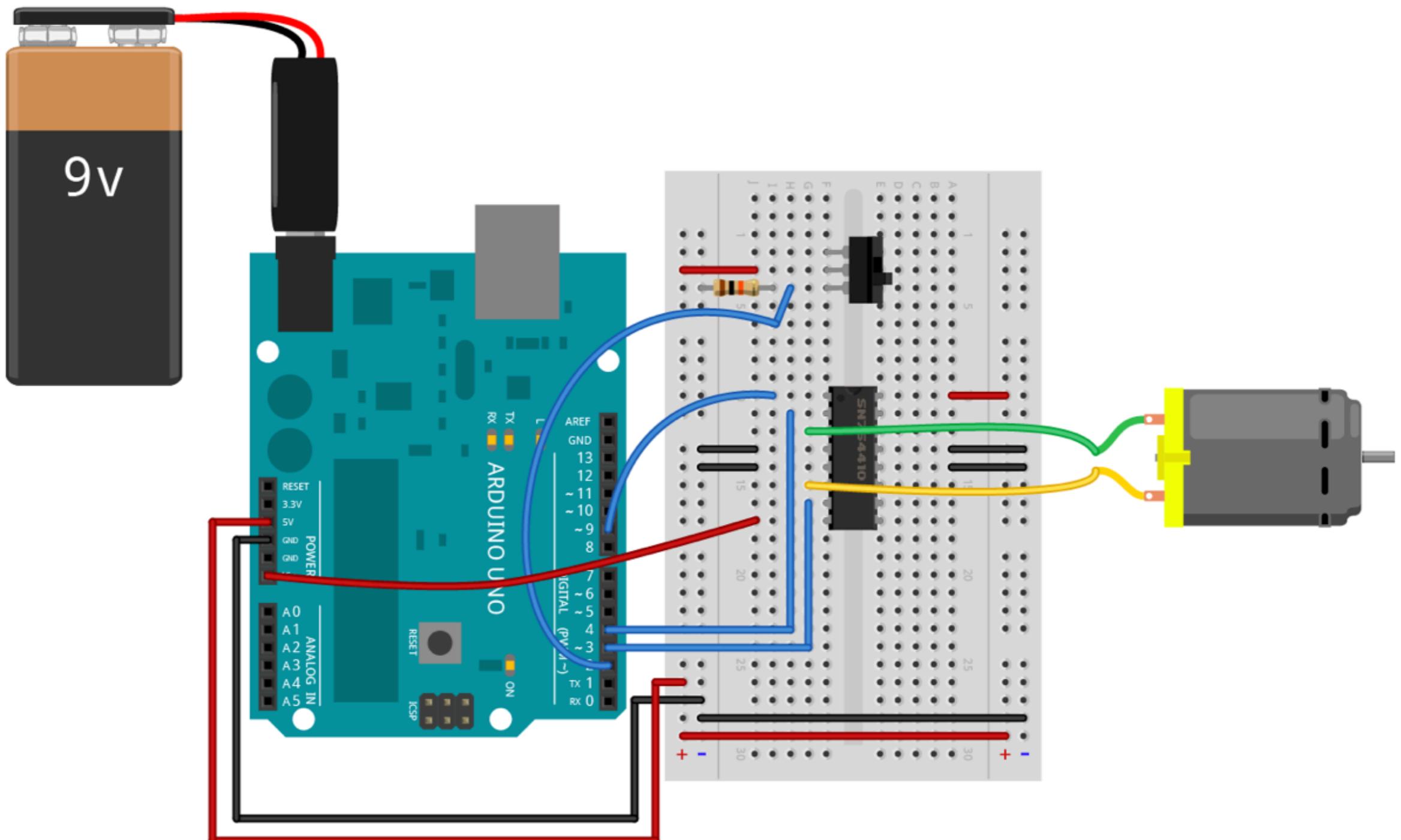


EN	1A	2A	FUNCTION
H	L	H	Turn right
H	H	L	Turn left
H	L	L	Fast motor stop
H	H	H	Fast motor stop
L	X	X	Fast motor stop

L = low, H = high, X = don't care

[http://learn.adafruit.com/adafruit-arduino-lesson-15-dc-motor-reversing/  
lm293d](http://learn.adafruit.com/adafruit-arduino-lesson-15-dc-motor-reversing/lm293d)

# H-Bridge



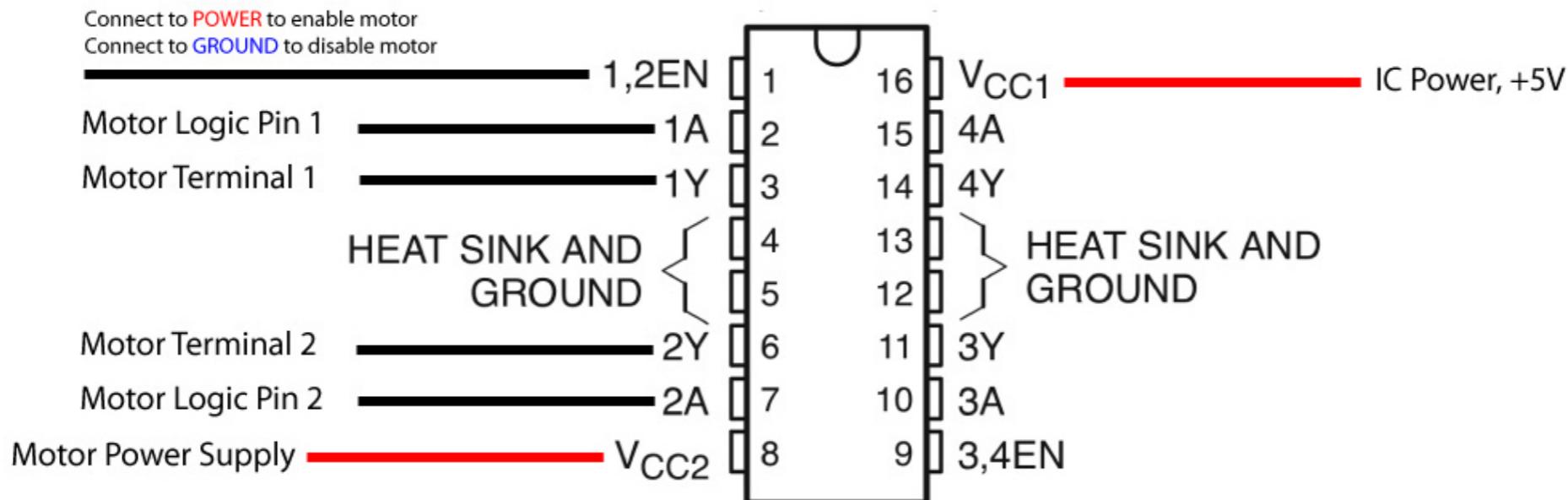
on/off or PWM

(digitalWrite /analogWrite)

# Stepper

> 40mA or > 5V + DC motor control (+/-/-+)

L293NE or SN754410

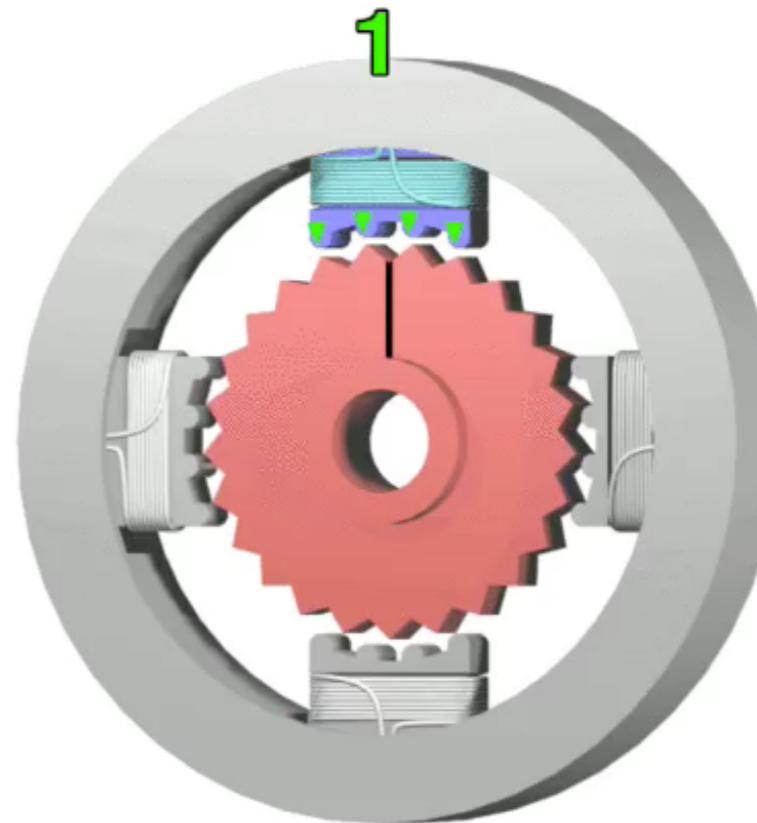
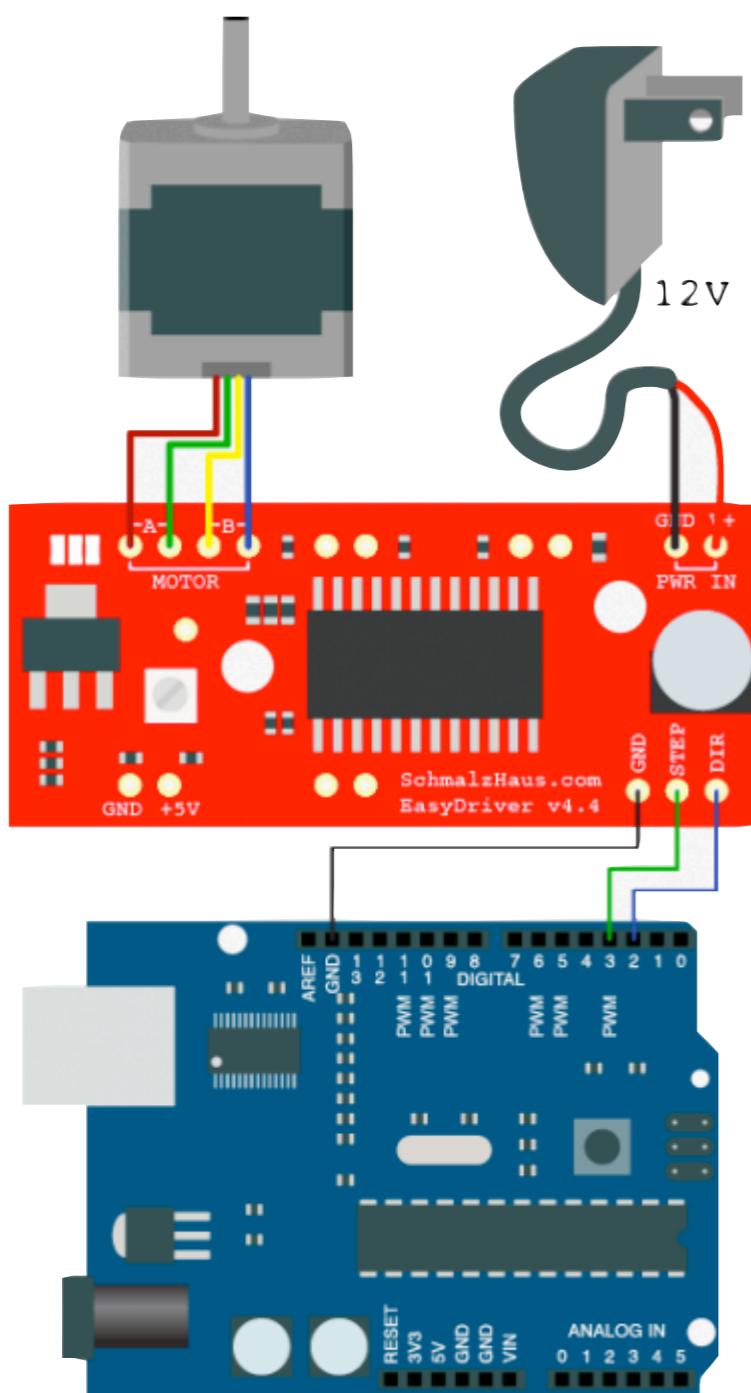


EN	1A	2A	FUNCTION
H	L	H	Turn right
H	H	L	Turn left
H	L	L	Fast motor stop
H	H	H	Fast motor stop
L	X	X	Fast motor stop

L = low, H = high, X = don't care

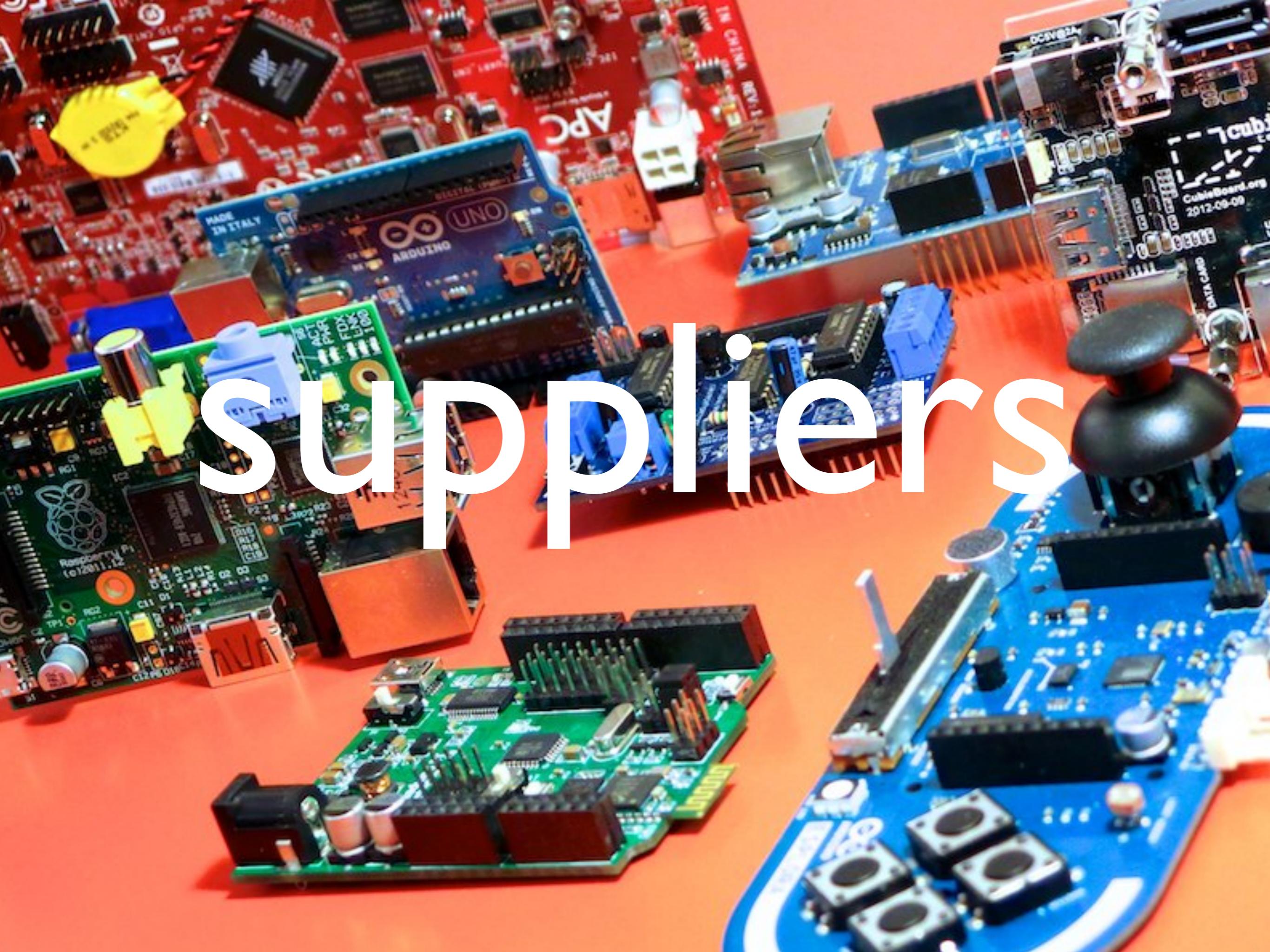
[http://learn.adafruit.com/adafruit-arduino-lesson-15-dc-motor-reversing/  
lm293d](http://learn.adafruit.com/adafruit-arduino-lesson-15-dc-motor-reversing/lm293d)

# Stepper



## Libraries

- <https://www.arduino.cc/en/Reference/Stepper>
- <http://www.airspayce.com/mikem/arduino/AccelStepper/>



# Suppliers

# Shops in Barcelona

Onda Radio <http://www.ondaradio.es/productos/buscar.aspx?v=A000066>

Location <https://plus.google.com/100101416647173159883/about?hl=en>

Diotronic [http://www.diotronic.com/raspberry-pi-arduino/arduino/placas\\_p\\_1080.aspx](http://www.diotronic.com/raspberry-pi-arduino/arduino/placas_p_1080.aspx)

Location <https://plus.google.com/117114665537047889067/about?hl=en>

Ro-Botica <http://ro-botica.com/>

Location <https://plus.google.com/110636064159550584786/about?hl=en>

## On-Line Shops near Barcelona (2-4 day shipping)

Cooking Hacks <http://www.cooking-hacks.com> (Zaragoza)

SnootLab <http://snootlab.com/> (Toulouse)

BricoGeek <http://www.bricogeek.com/shop/> (Carballo, Galicia)

Reflexiona <http://www.reflexiona.biz/> (Bilbao)

Electan <http://www.electan.com/> (Alicante)

## International

SparkFun <http://www.sparkfun.com/>

Adafruit <http://adafruit.com/>

Liquid Ware <http://www.liquidware.com/shop>

Itead Studio <http://iteadstudio.com/store/>

Seeed Studio <http://seeedstudio.com/>

Modern Device <http://shop.moderndevice.com/>

# tutorials





[learn.adafruit.com](https://learn.adafruit.com)



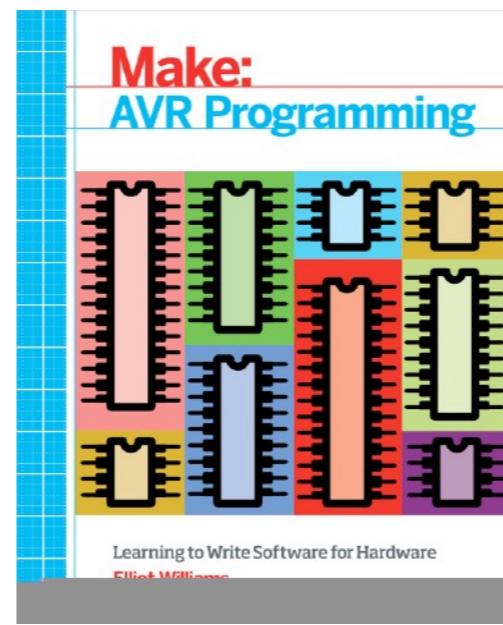
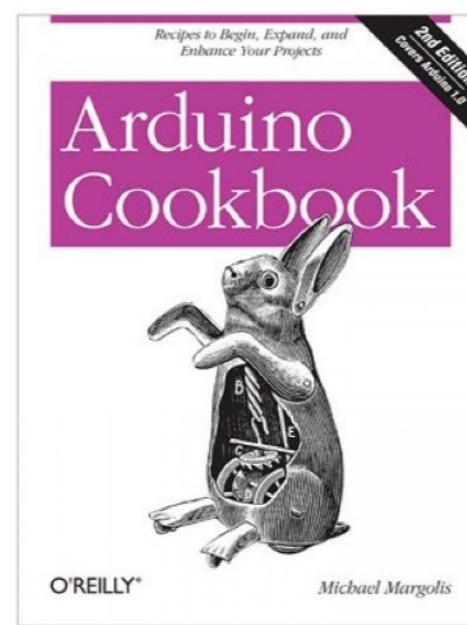
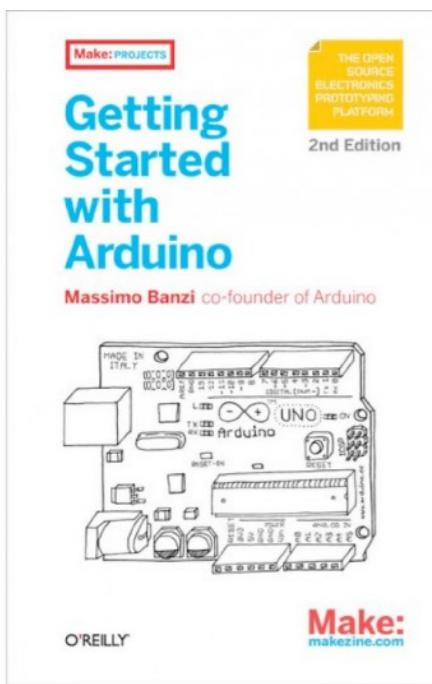
[learn.sparkfun.com](https://learn.sparkfun.com)



[arduino.cc/en/Tutorial/HomePage](https://arduino.cc/en/Tutorial/HomePage)



[bildr.org](https://bildr.org)



A large rocket is being assembled in a clean room. The rocket has a white cylindrical body with a blue and yellow nose cone. It is surrounded by various equipment, scaffolding, and workers in white lab coats and hard hats. The background shows more of the rocket's structure and some vertical panels.

[wiki.fablabbcn.org](http://wiki.fablabbcn.org)  
[/Arduino](http://wiki.fablabbcn.org/Arduino)