

# Arduino For Total Newbies

## w/ TV-B-Gone as example project

### Mitch Altman

Chief Scientist, **Cornfield Electronics**, San Francisco, CA

Inventor of **TV-B-Gone** universal remote controls

Author of **The Brain Machine** in MAKE Magazine #10

Co-founder of **Noisebridge** (San Francisco hacker space)

email: [mitch@CornfieldElectronics.com](mailto:mitch@CornfieldElectronics.com)

site: [www.CornfieldElectronics.com](http://www.CornfieldElectronics.com)

twitter: [@maltman23](https://twitter.com/maltman23)

flickr: [maltman23](https://www.flickr.com/photos/maltman23/)

phone: +1 415-377-5993

+49 152 2723 0510

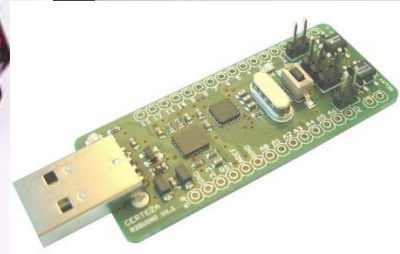
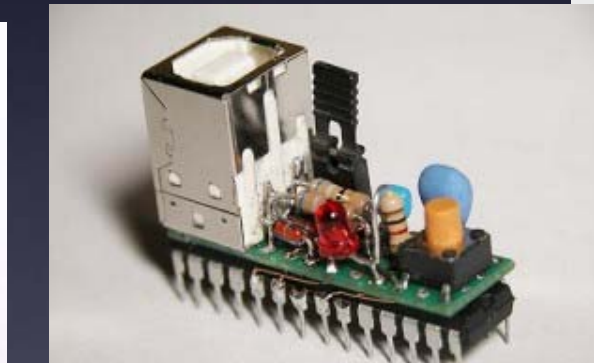
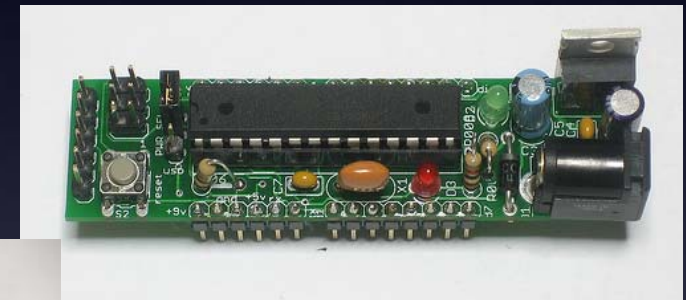
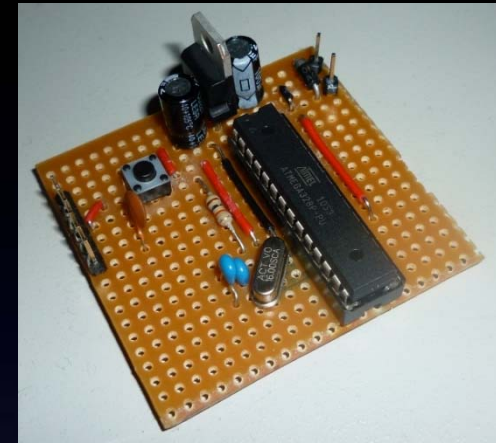
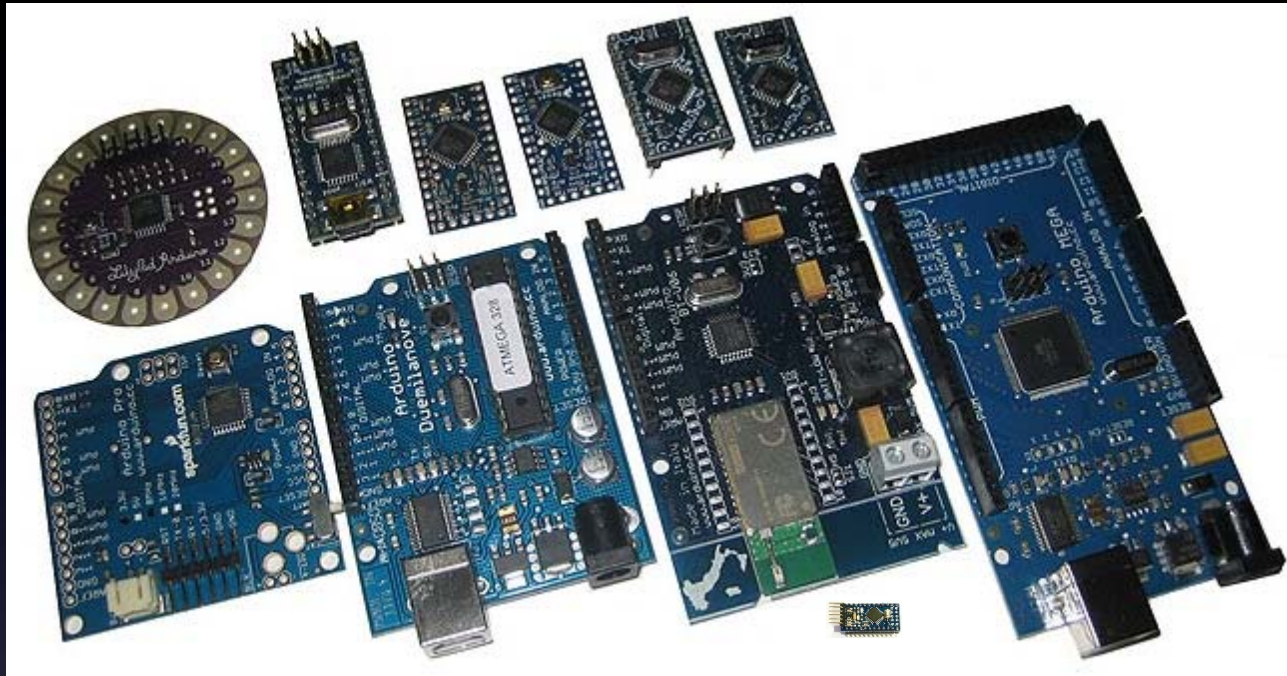
DECT: 2676 (CORN)



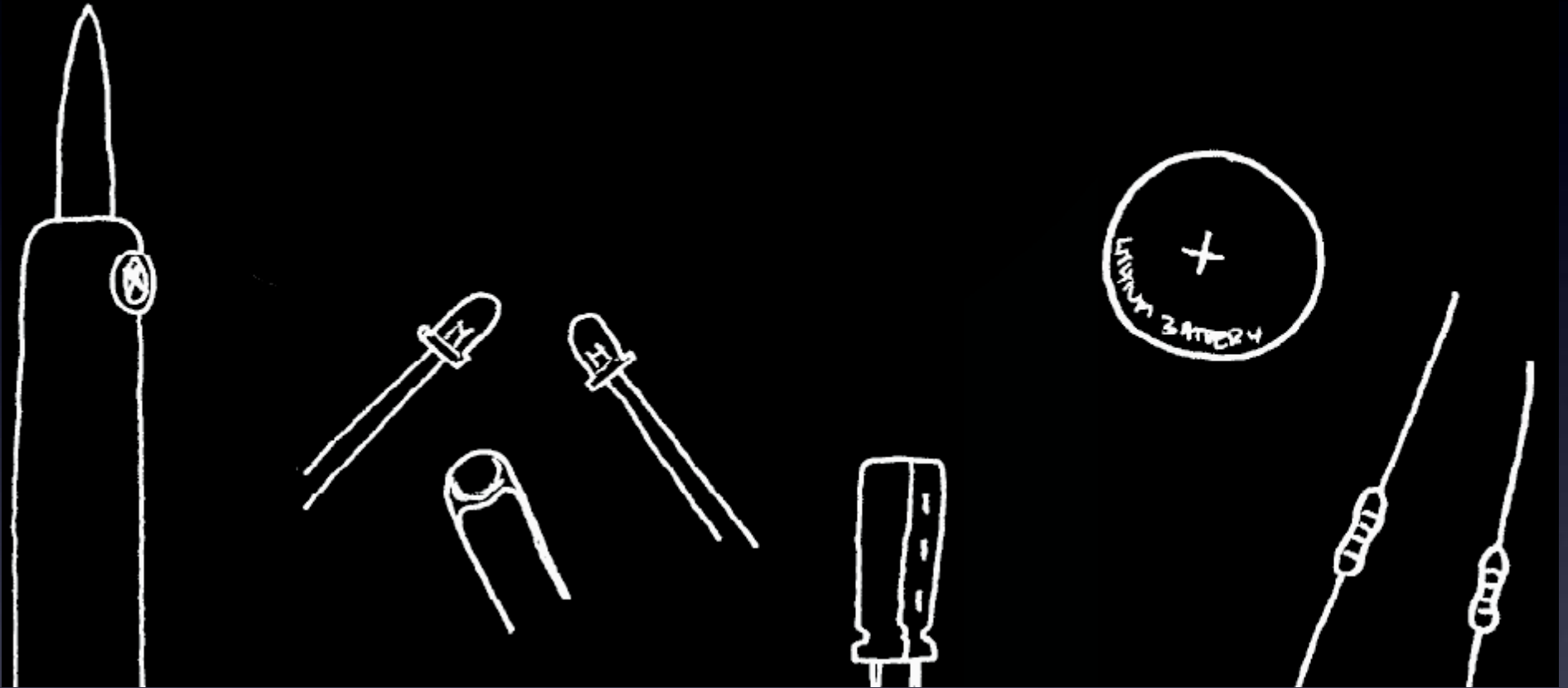
# Syllabus

- Intro
- Everything You Need to Know About Electronics
- How to solder / make your own Arduino
- How to Set Up and Use the Arduino Software
- How to Hack Arduino Programs (“Sketches”)
- How to Use Solderless Breadboards
- How to Read a Schematic
- Make a TV-B-Gone Remote Control with your Arduino Clone without soldering

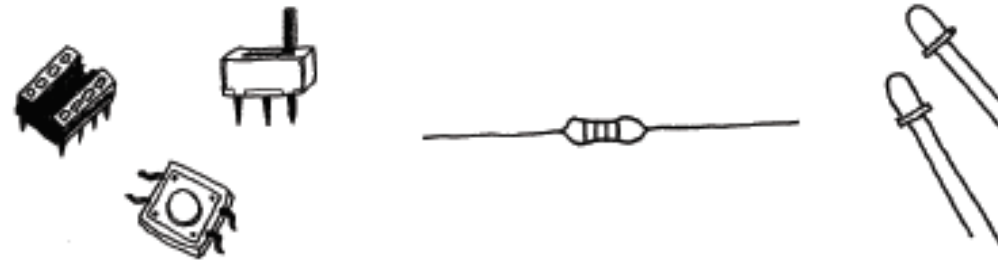
# Intro



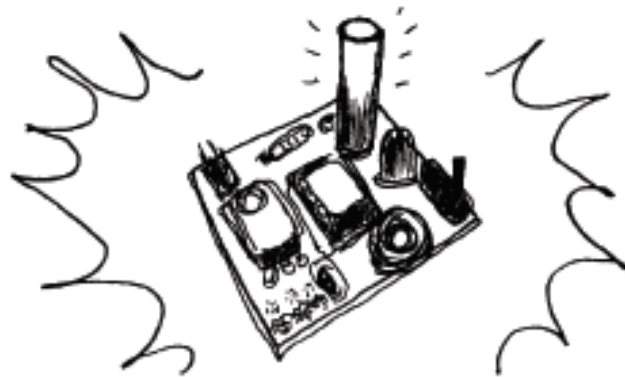
# Everything You Need to Know About Electronics



# Learn To Solder



## **SOLDERING IS EASY** *HERE'S HOW TO DO IT*



BY: **MITCH ALTMAN**  
(*SOLDERING WISDOM*)

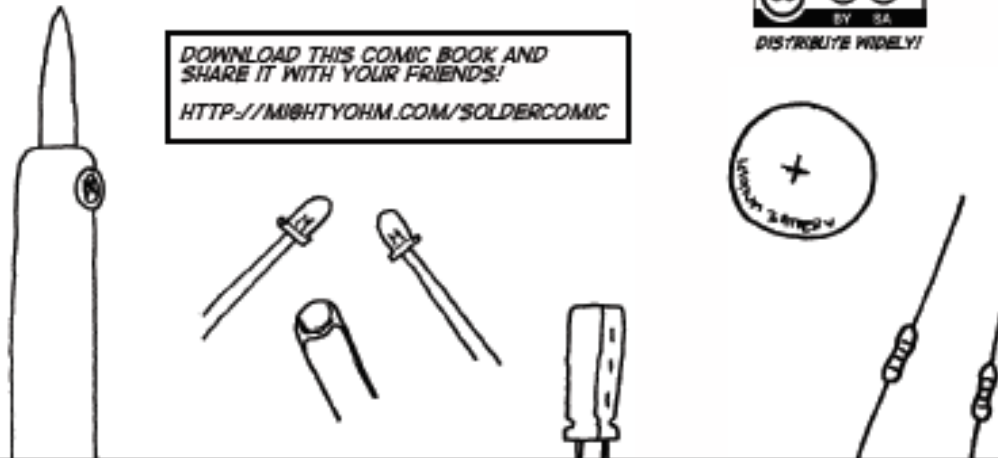
**ANDIE NORDGREN**  
(*COMICS ADAPTATION*)

**JEFF KEYZER**  
(*LAYOUT AND EDITING*)

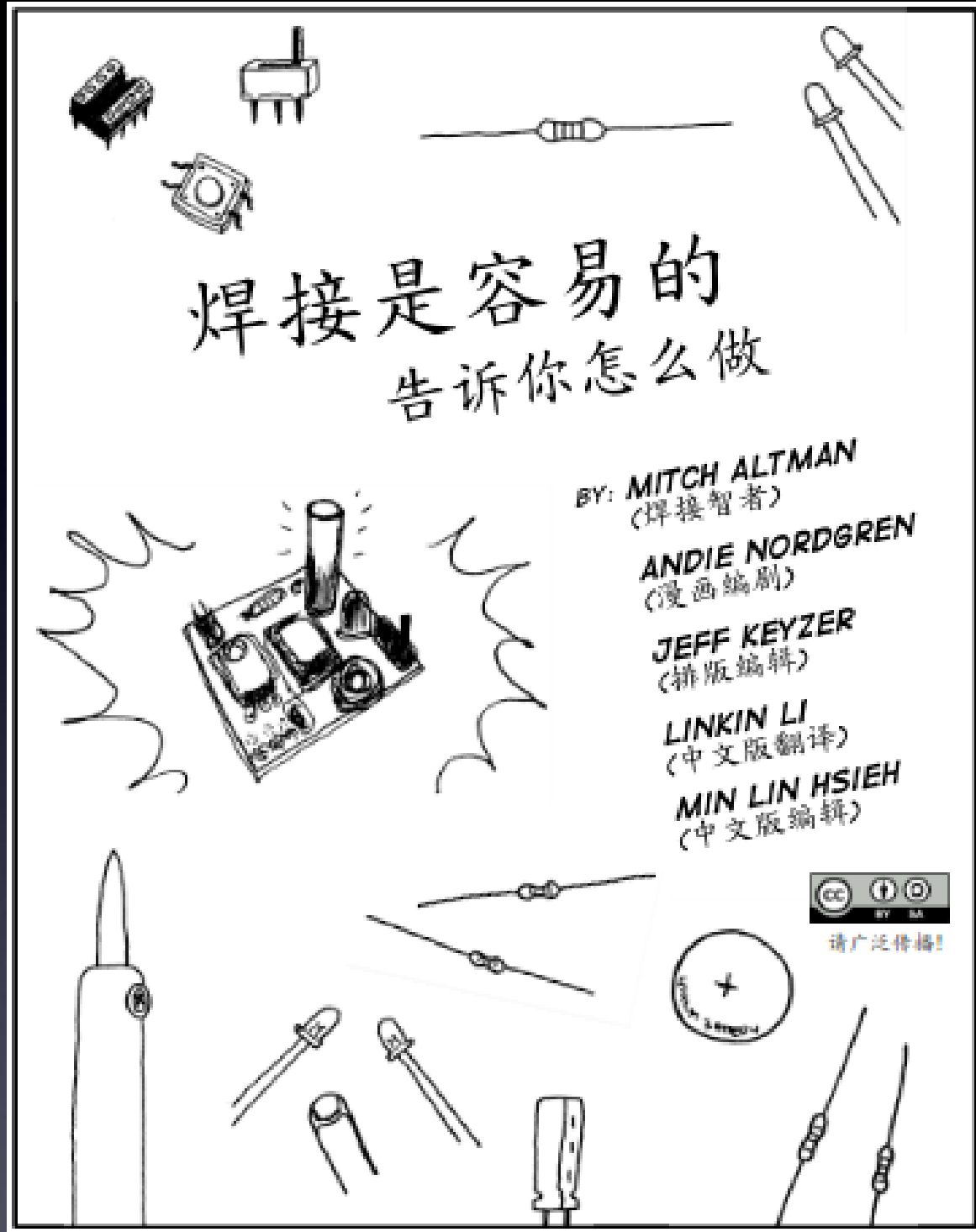
DOWNLOAD THIS COMIC BOOK AND  
SHARE IT WITH YOUR FRIENDS!  
[HTTP://MIGHTYOHM.COM/SOLDERCOMIC](http://mightyohm.com/soldercomic)



DISTRIBUTE WIDELY!



# Learn To Solder



# Learn To Solder



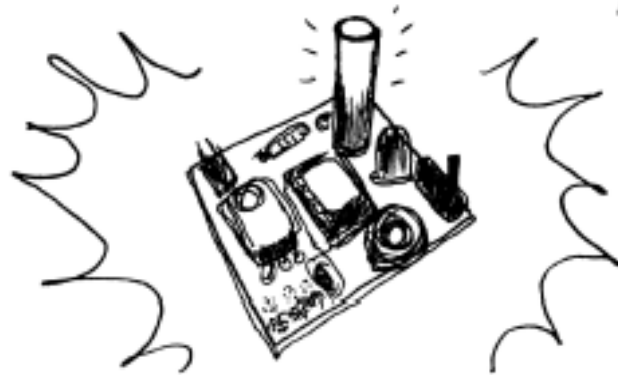
## ***SOLDER C'EST FACILE*** ***VOICI COMMENT FAIRE***

DE: **MITCH ALTMAN**  
(MAITRE SOUDEUR)

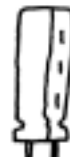
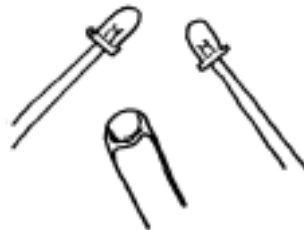
**ANDIE NORDGREN**  
(ADAPTATION BD)

**JEFF KEYZER**  
(EDITION, MISE EN PAGE)

**SNOOTLAB**  
(TRADUCTION FR.)



TELECHARGEZ CETTE BD  
ET PARTAGEZ LA AVEC VOS AMIS !  
[HTTP://MIGHTYOHM.COM/SOLDERCOMIC](http://mightyohm.com/soldercomic)



A DIFFUSER LARGEMENT !

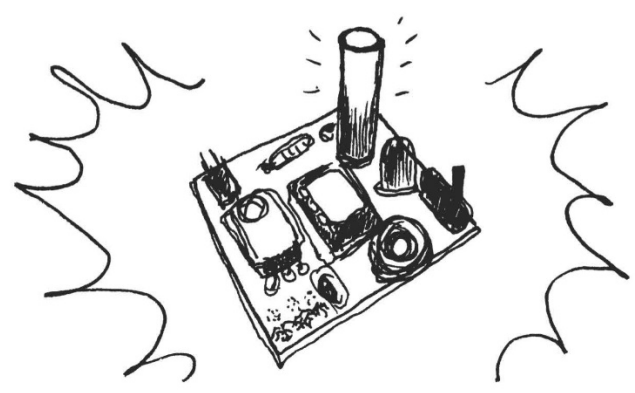


# Learn To Solder



# **SOLDAR ES FÁCIL!**

## **APRENDE CÓMO HACERLO**



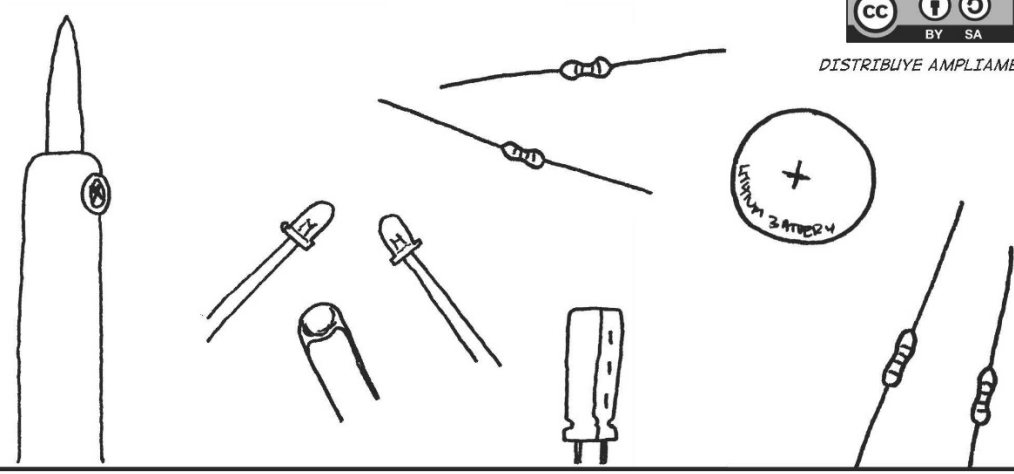
**POR: MITCH ALTMAN**  
(SABIDURÍA EN SOLDADO)

**ANDIE NORDGREN**  
(ADAPTACIÓN A COMIC)

**JEFF KEYZER**  
(DISEÑO Y EDICIÓN)



DISTRIBUYE AMPLIAMENTE!







# LÖTEN IST EINFACH SO WIRD ES GEMACHT

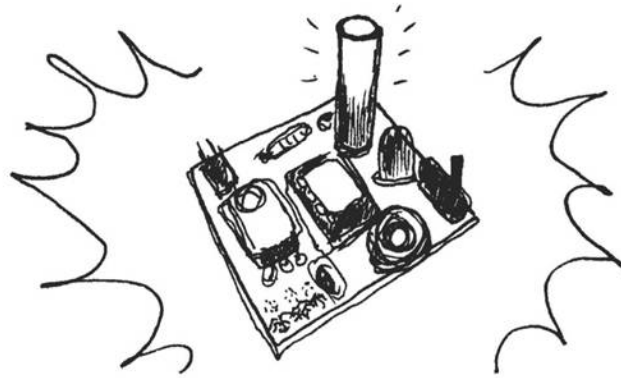
VON: MITCH ALTMAN  
(LÖTWEISHEITEN)

ANDIE NORDGREN  
(KOMIK-UMSETZUNG)

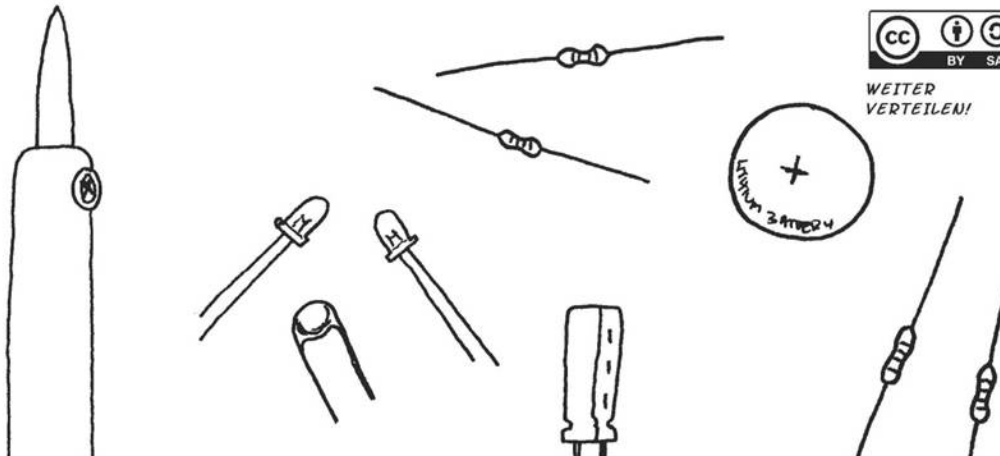
JEFF KEYZER  
(LAYOUT UND BEARBEITUNG)

ALEXANDER BODORA  
(ÜBERSETZUNG UND BEARBEITUNG)

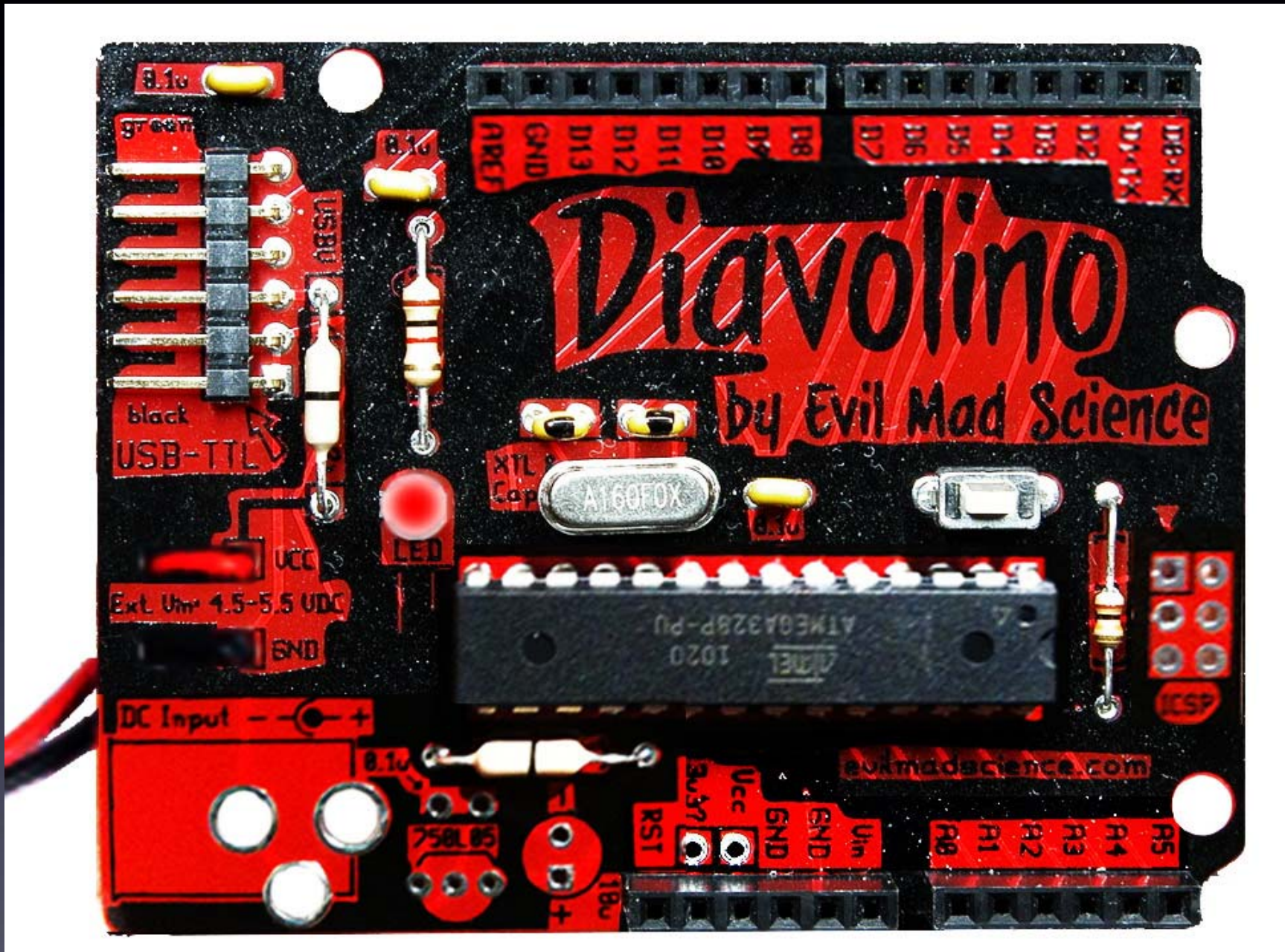
RICHARD MEINSEN  
(ÜBERARBEITUNG UND KORREKTUR)



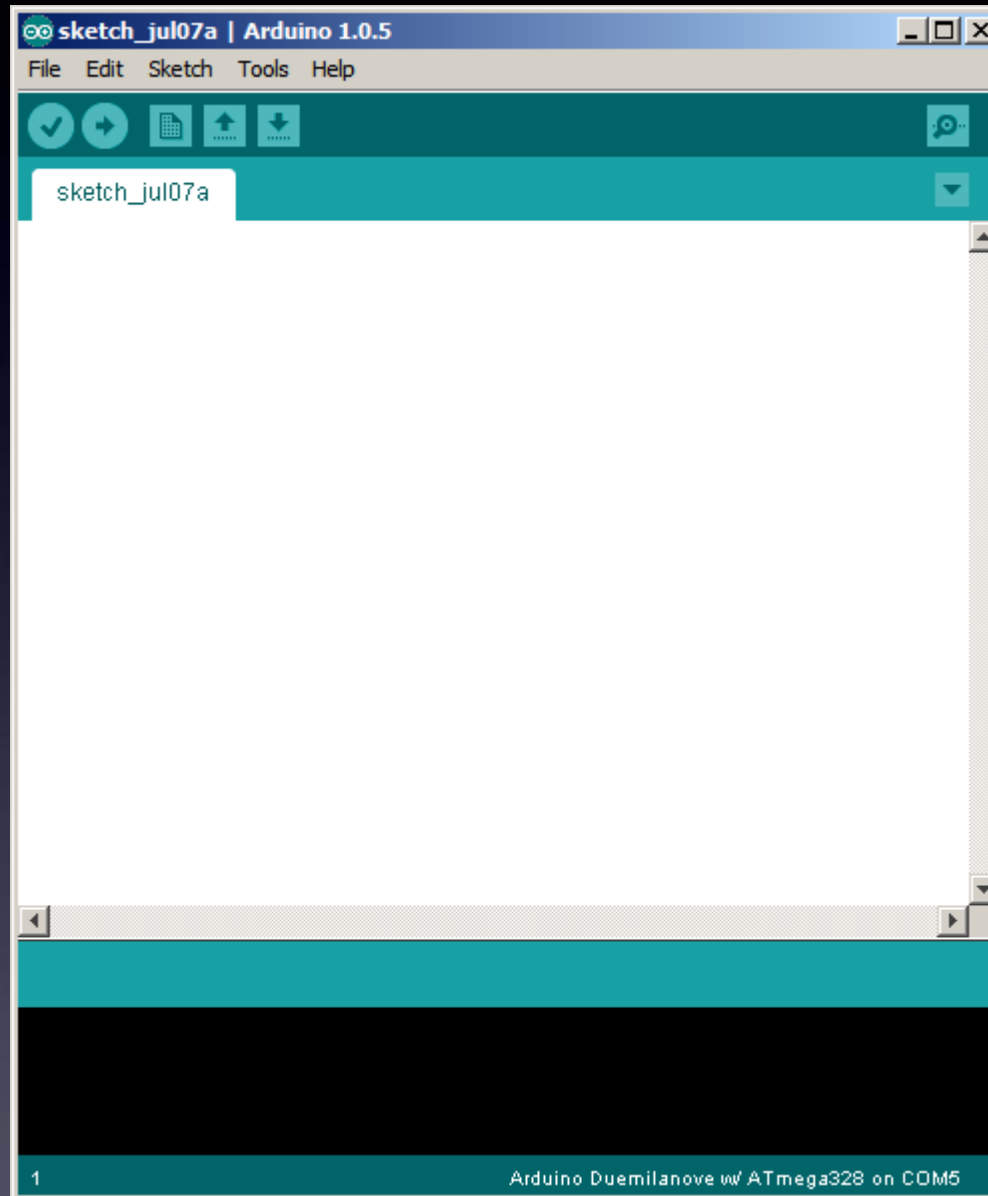
WEITER  
VERTEILEN!



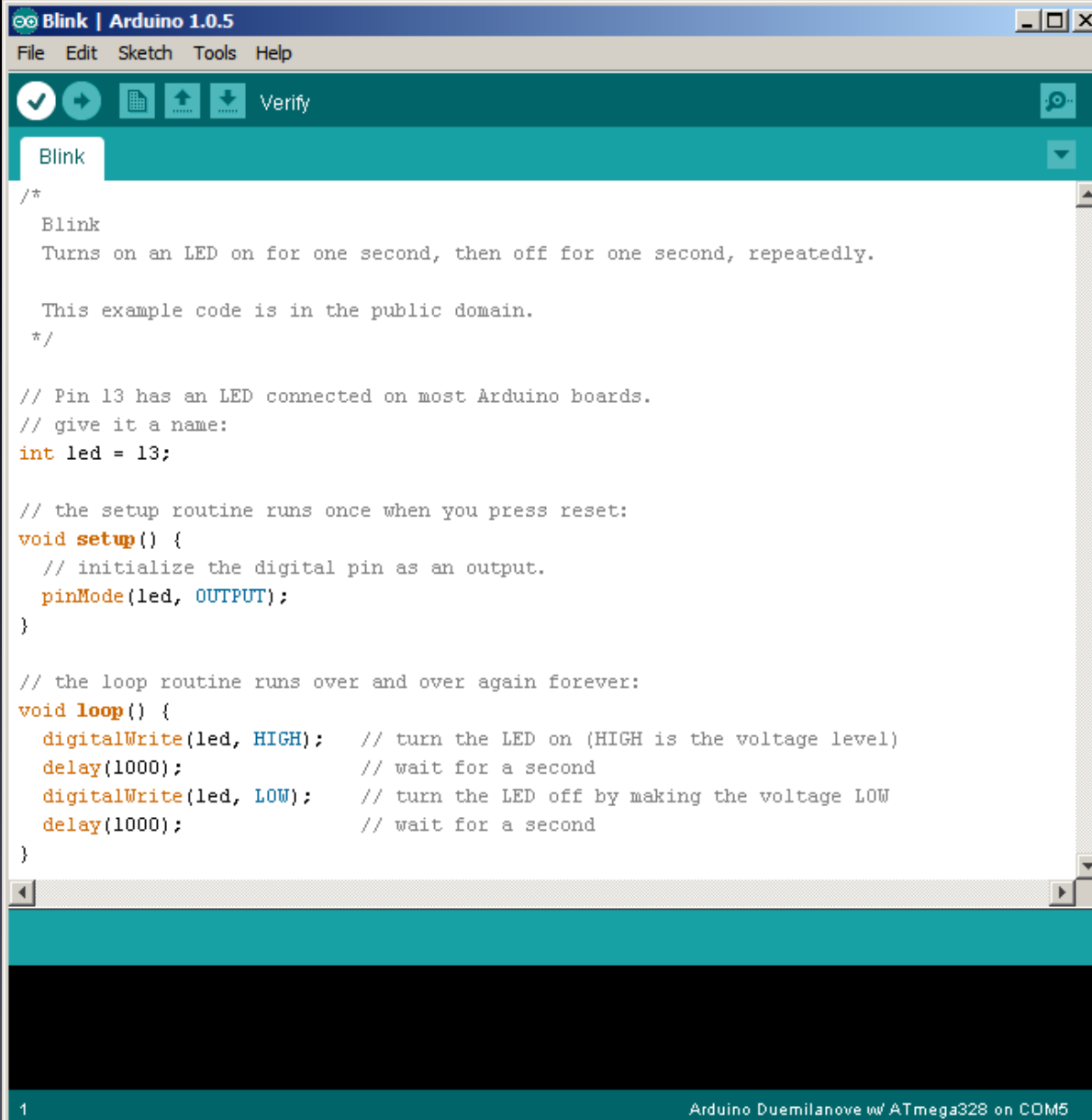
# Solder Your Arduino Clone



# How to Set Up and Use the Arduino Software



# How to Hack Arduino Programs (“Sketches”)

A screenshot of the Arduino IDE interface. The window title is "Blink | Arduino 1.0.5". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for a checkmark, a play button, a document with a plus sign, a document with a minus sign, and a "Verify" button. The main text area contains the following code:

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

  This example code is in the public domain.
  */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

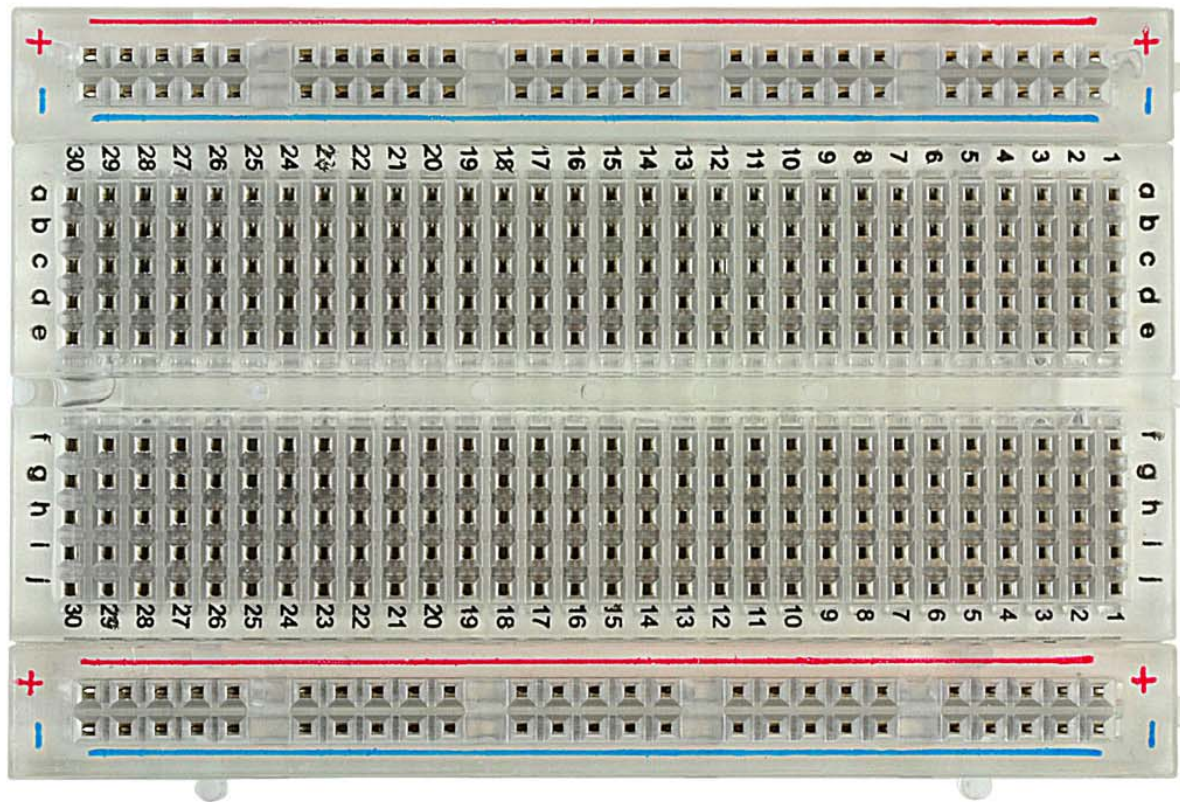
// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000);             // wait for a second
  digitalWrite(led, LOW);  // turn the LED off by making the voltage LOW
  delay(1000);             // wait for a second
}
```

The status bar at the bottom shows "1" on the left and "Arduino Duemilanove w/ ATmega328 on COM5" on the right.

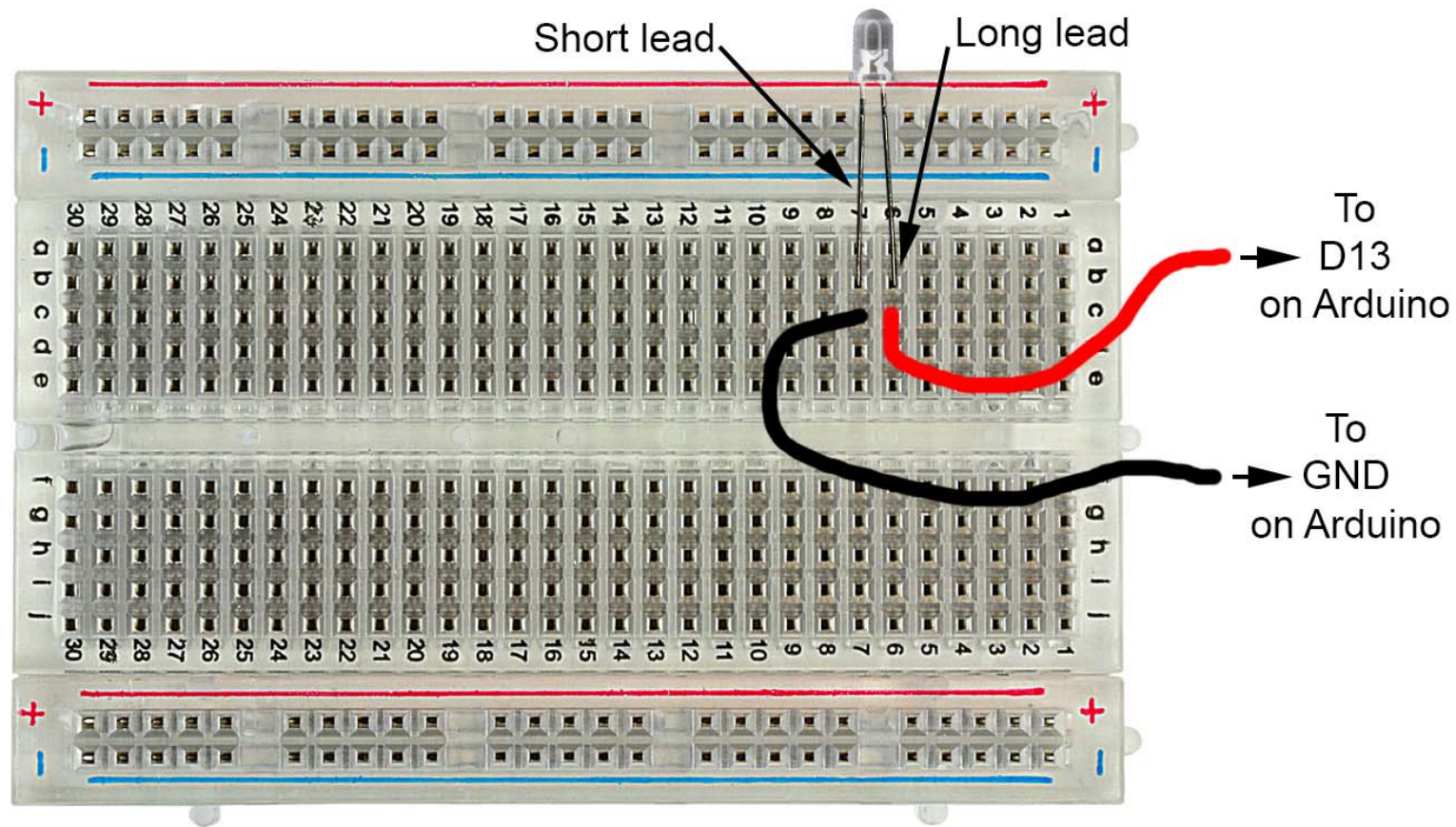
# How to Use Solderless Breadboards

## Solderless Breadboard



# How to Use Solderless Breadboards

## Solderless Breadboard with LED and wires

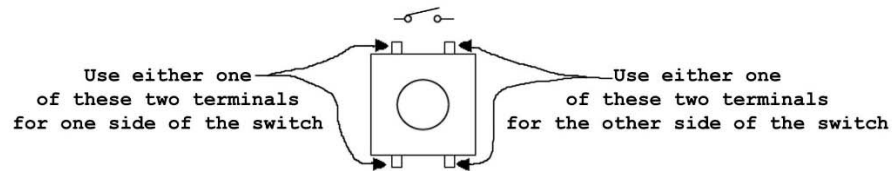
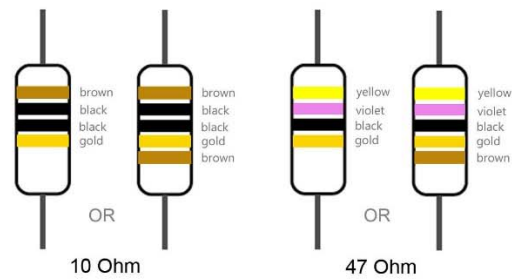
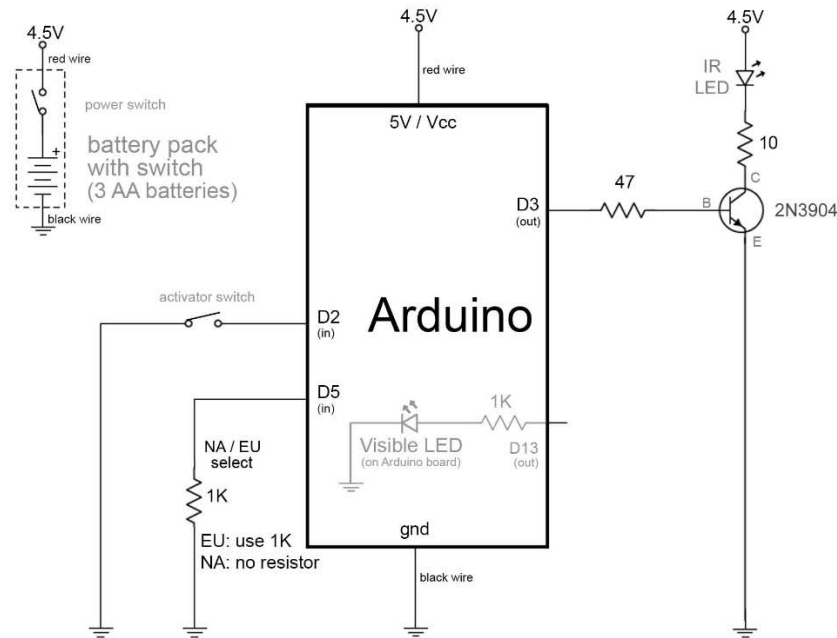


# How to Read a Schematic

## Arduino For Total Newbies

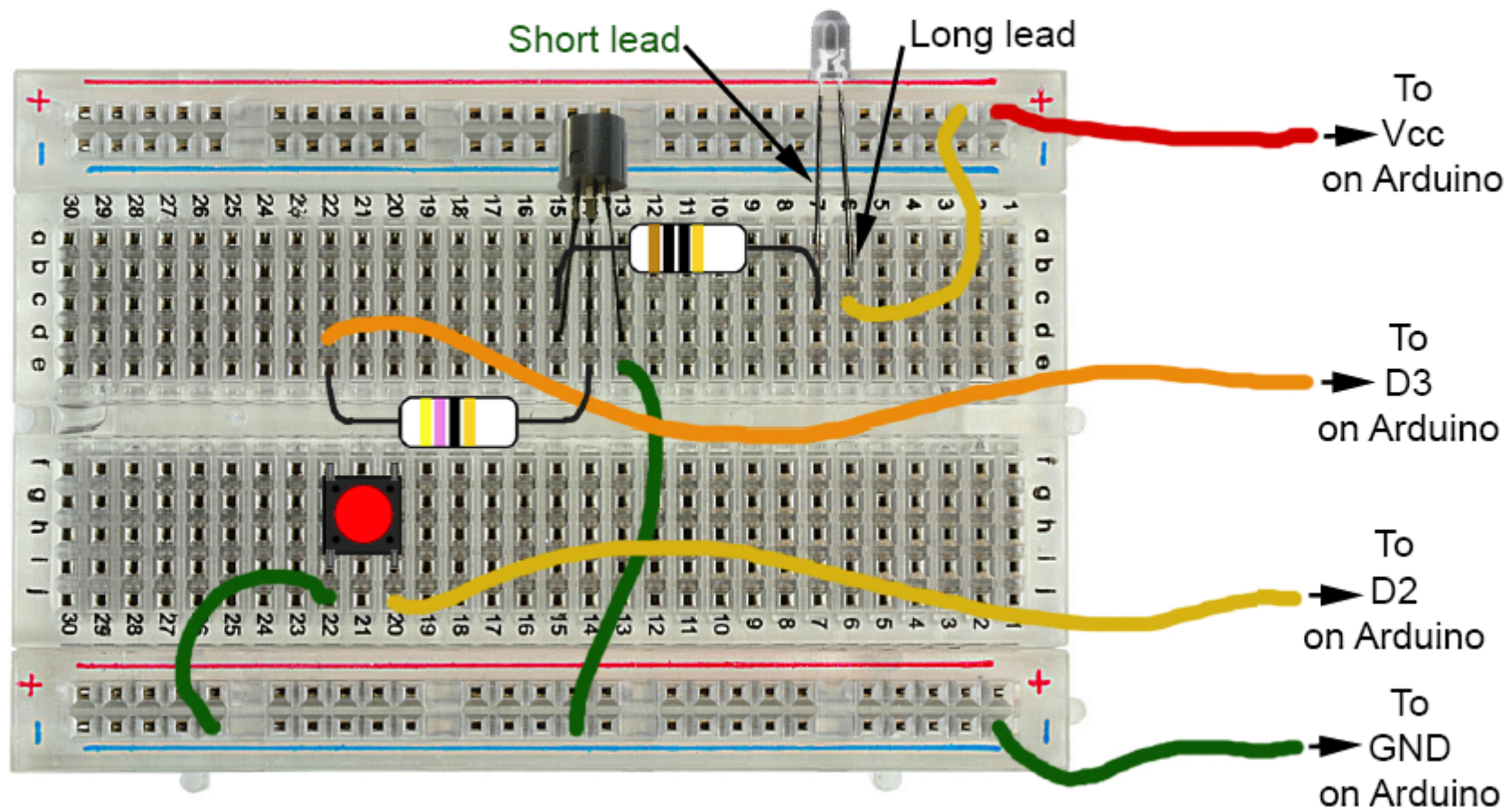
4-Sep-2015

Mitch Altman (original TV-B-Gone hardware and firmware, modified TV-B-Gone Arduino design)  
Limore Fried (firmware modifications, kit design)  
Ken Shirriff (original modifications for Arduino)  
Johannes Schneemann (documentation)

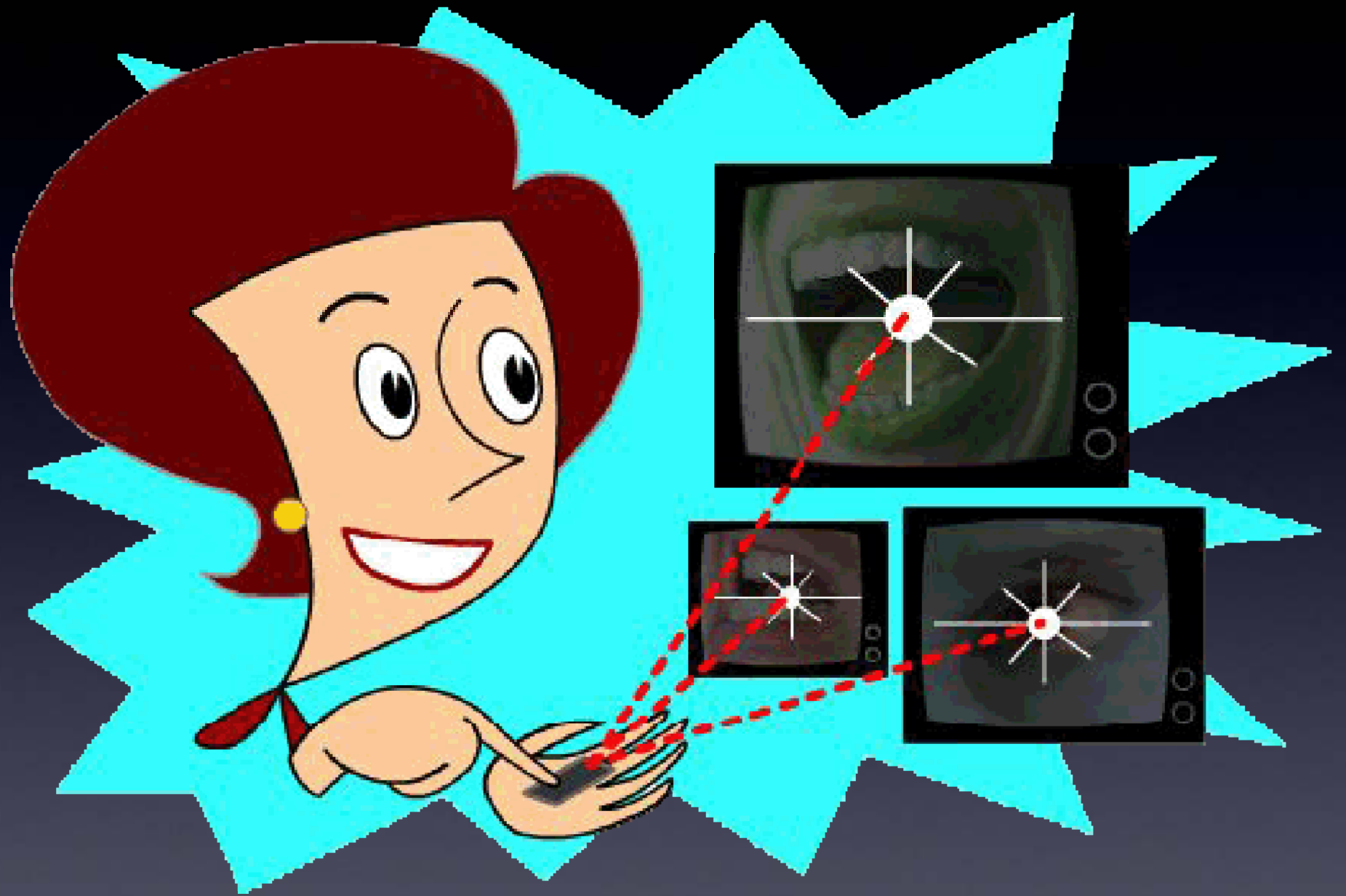


# Make a TV-B-Gone Remote Control with your Arduino Clone without soldering

## Solderless Breadboard with parts & wires for TV-B-Gone





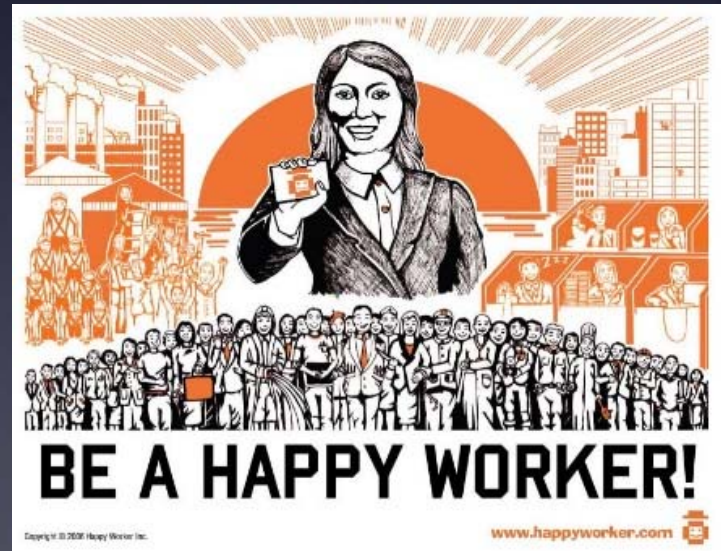


Questions?

# Intro



# Intro



# Intro

*Cornfield*  
 *Electronics, Inc.*

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**MITCH ALTMAN**

Chief Scientist / CEO

*“Useful Electronics for a Better World”*



**[www.CornfieldElectronics.com](http://www.CornfieldElectronics.com)**

572 Hill St. #Penthouse, San Francisco, CA 94114

phone: +1 415 / 377 - 5993

[mitch@CornfieldElectronics.com](mailto:mitch@CornfieldElectronics.com)

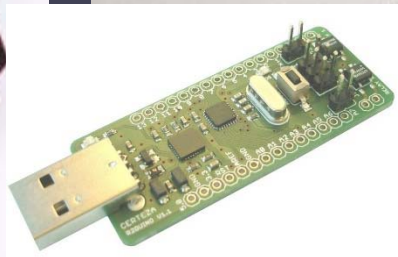
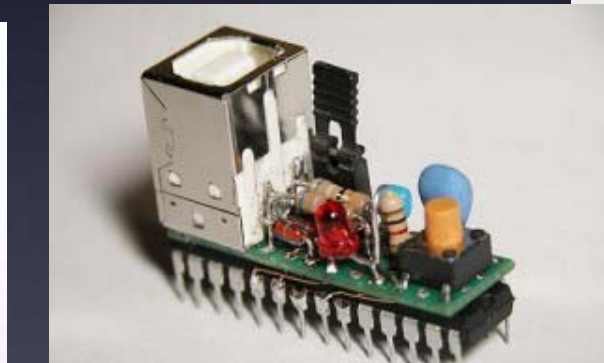
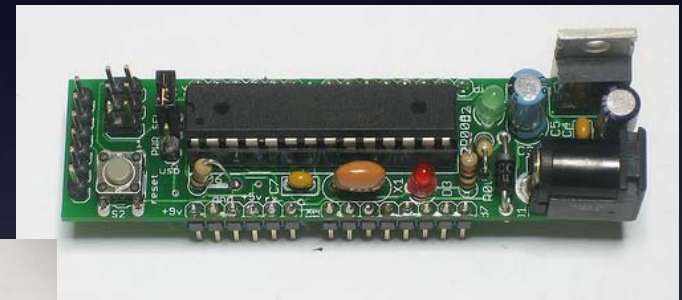
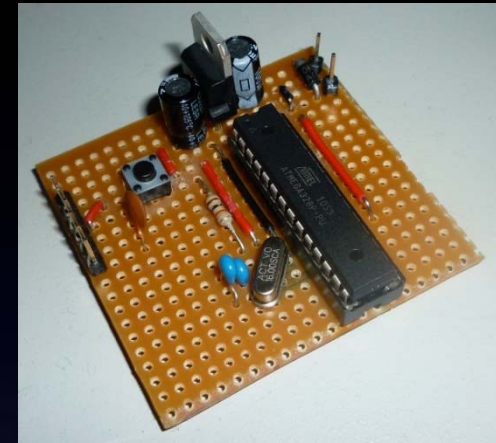
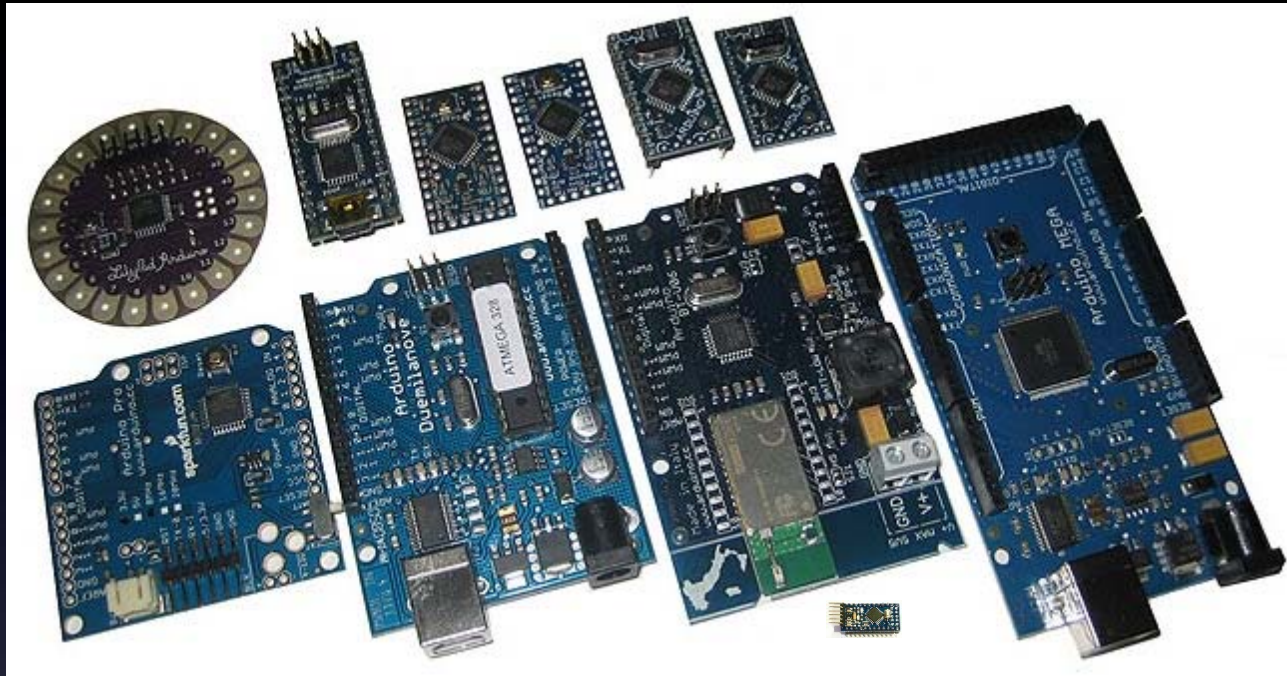
**@maltman23**

# Intro



Arduino For Total Newbies Workshop at 30C3, Hamburg Germany

# Intro



Open Source

# Intro

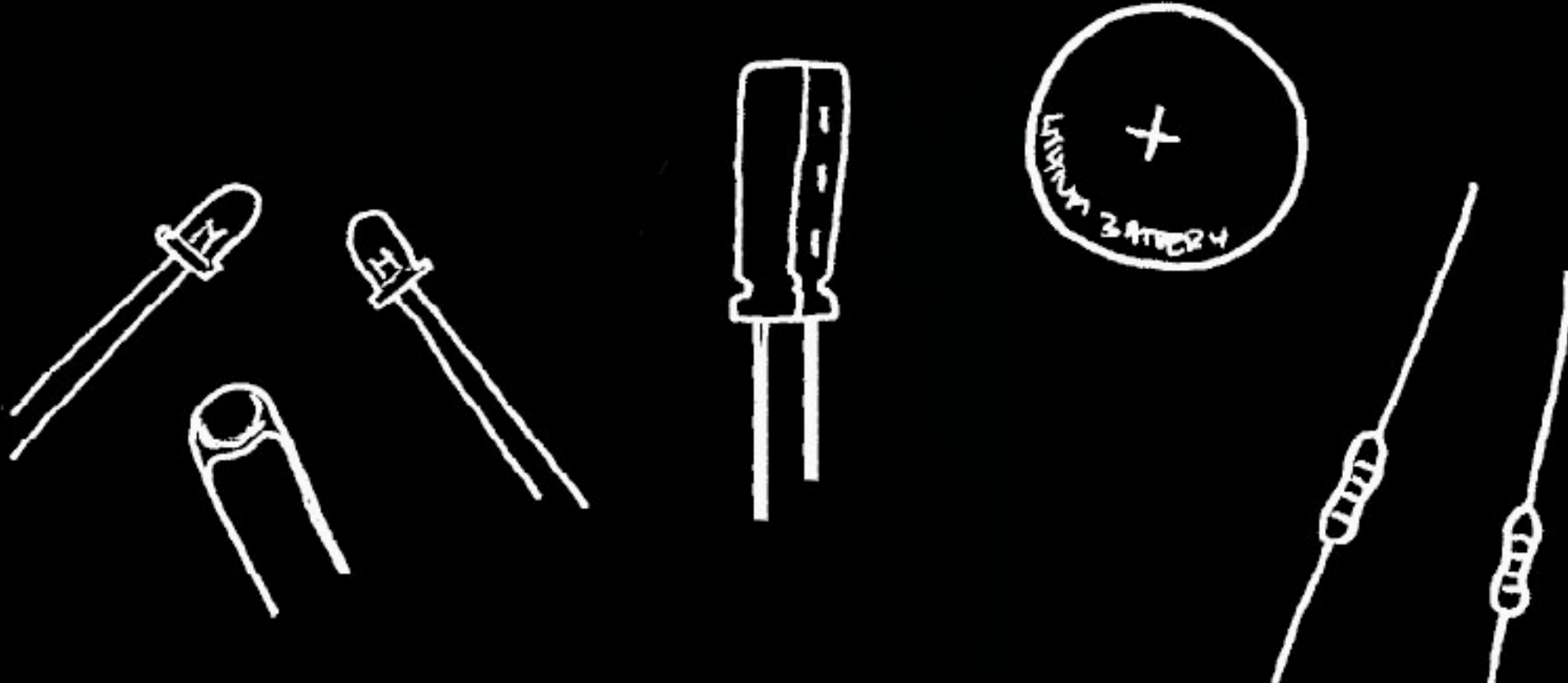




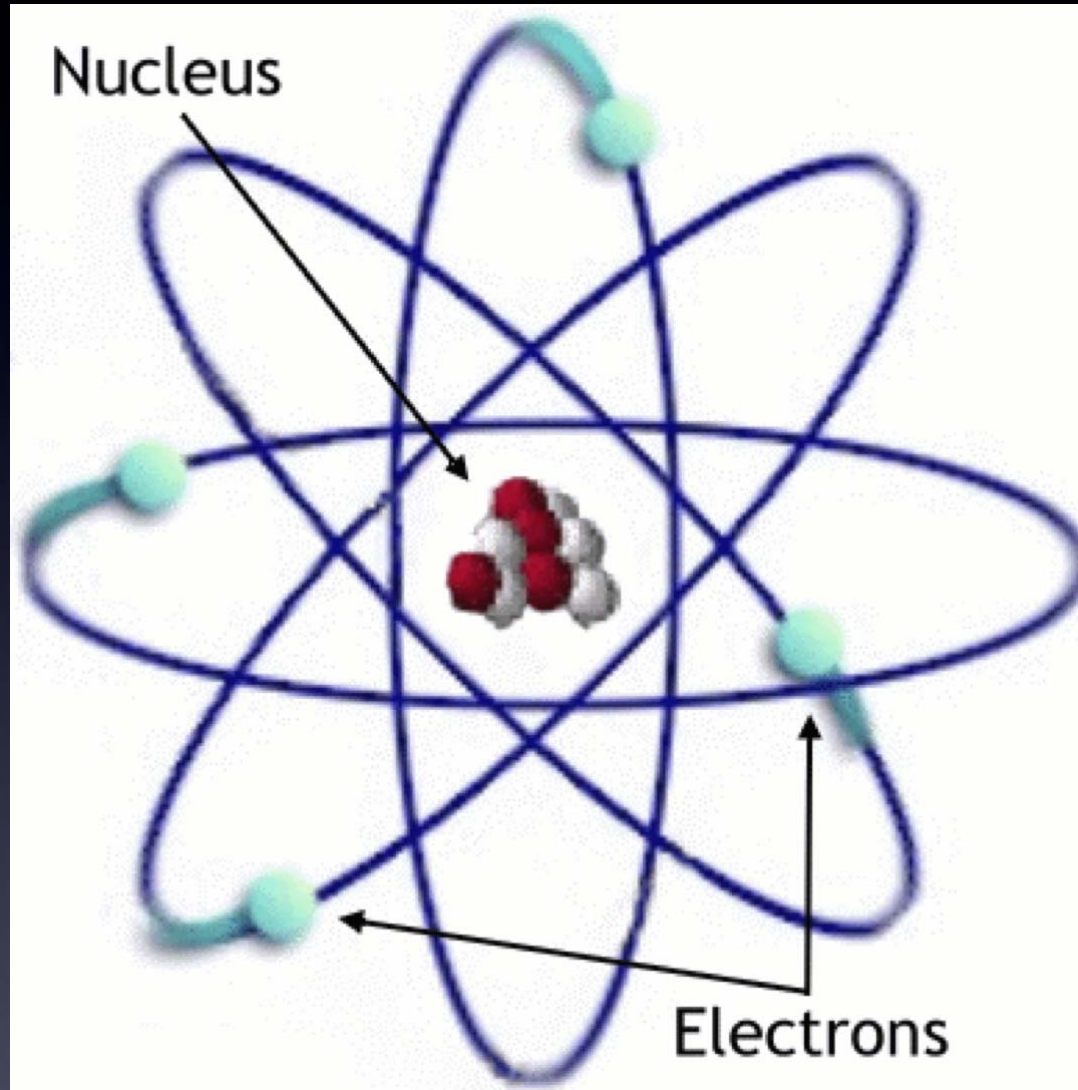
Intro

Questions?

# Everything You Need to Know About Electronics

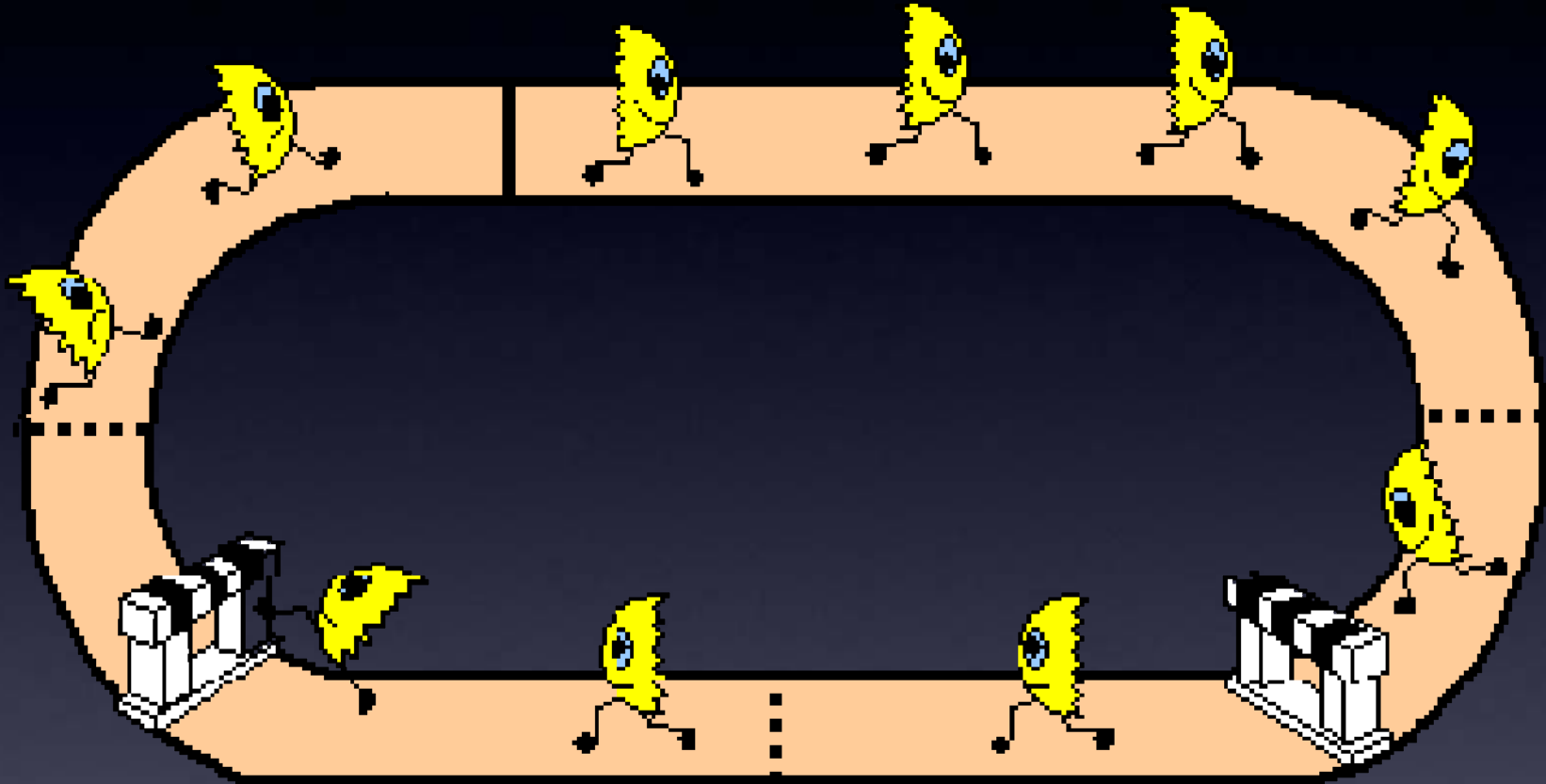


# Everything You Need to Know About Electronics



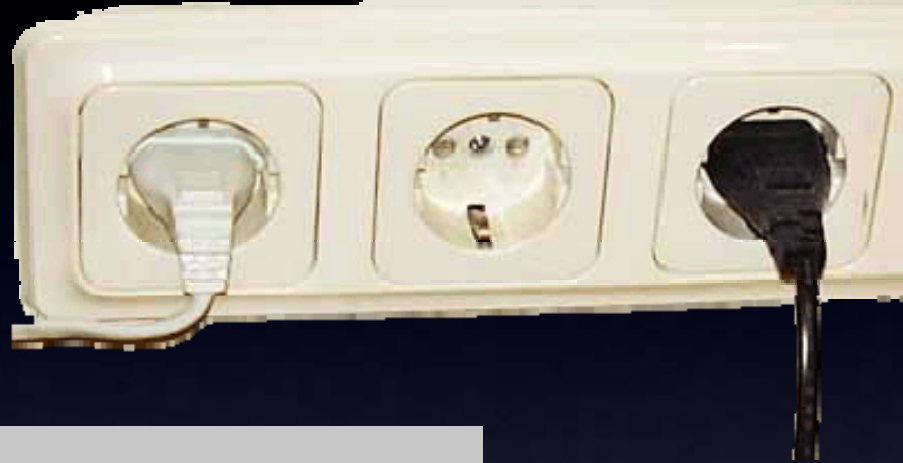
Electrons

# Everything You Need to Know About Electronics



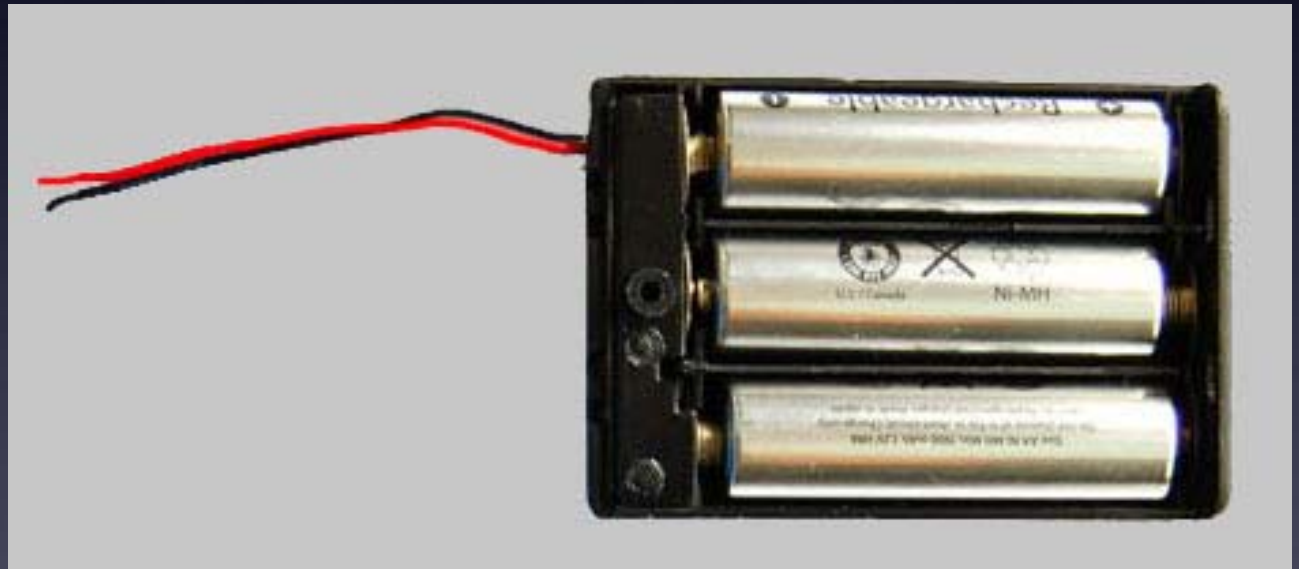
Circuits = Electrons going in circles = Magic!

# Everything You Need to Know About Electronics



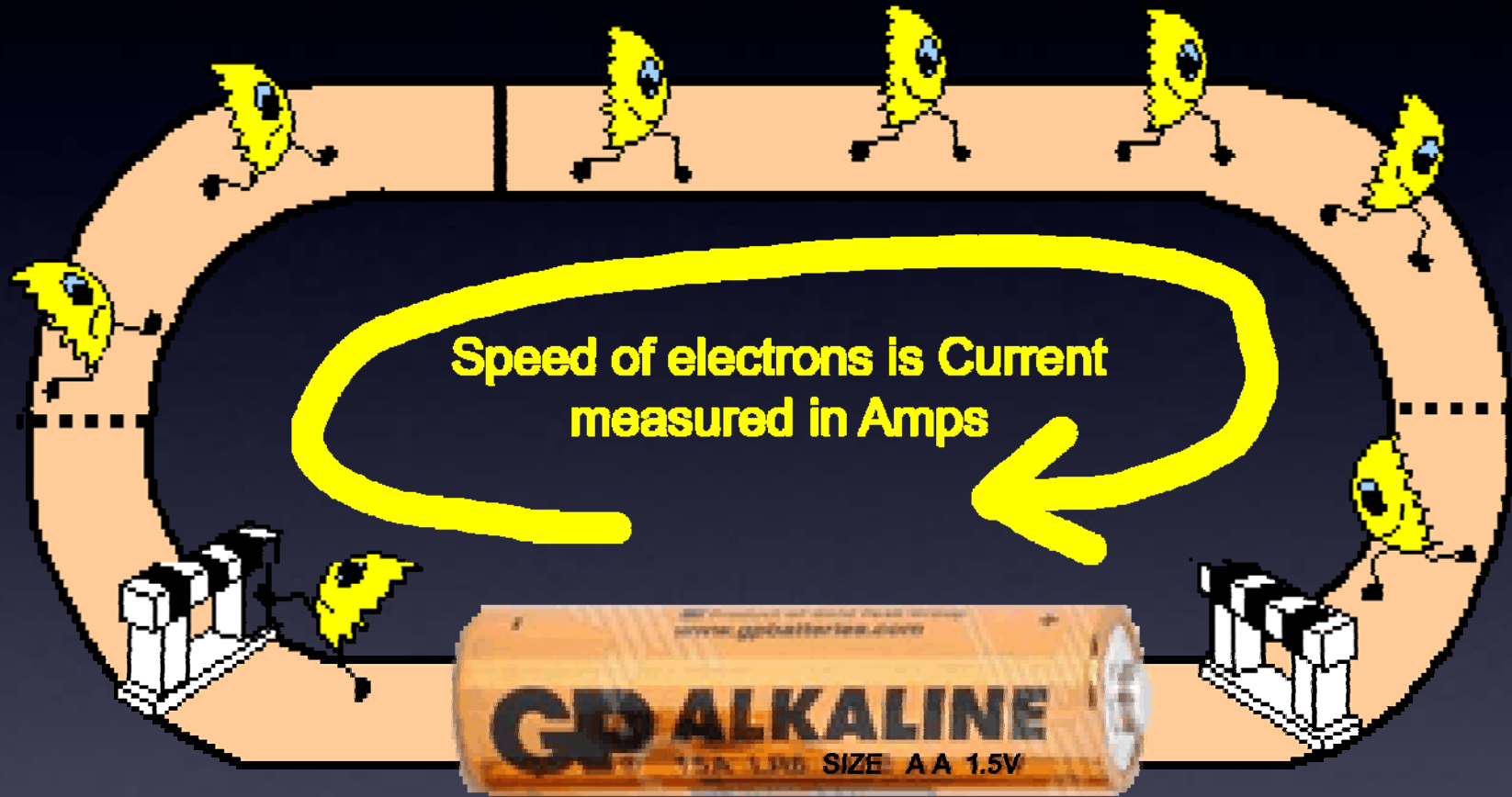
## Power Supplies

# Everything You Need to Know About Electronics



Volts / Voltage

# Everything You Need to Know About Electronics

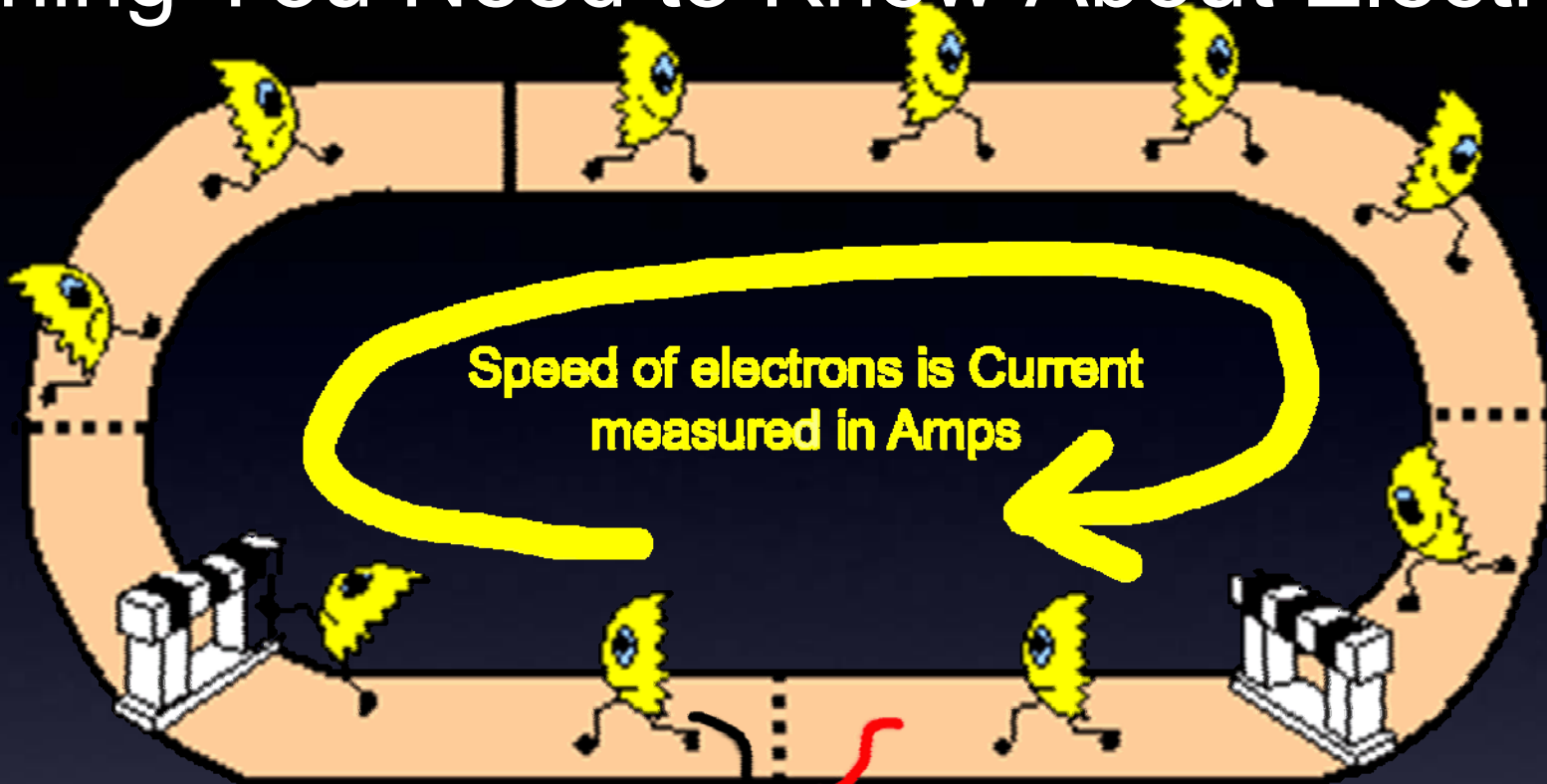


Speed of electrons is Current  
measured in Amps

Electrons pushed with 1.5V.  
So, they move!

Amps / Current

# Everything You Need to Know About Electronics



**3 times more Volts**  
**3 times more push**  
**3 times faster electrons**  
**3 times more current / Amps**

Amps / Current



# Everything You Need to Know About Electronics

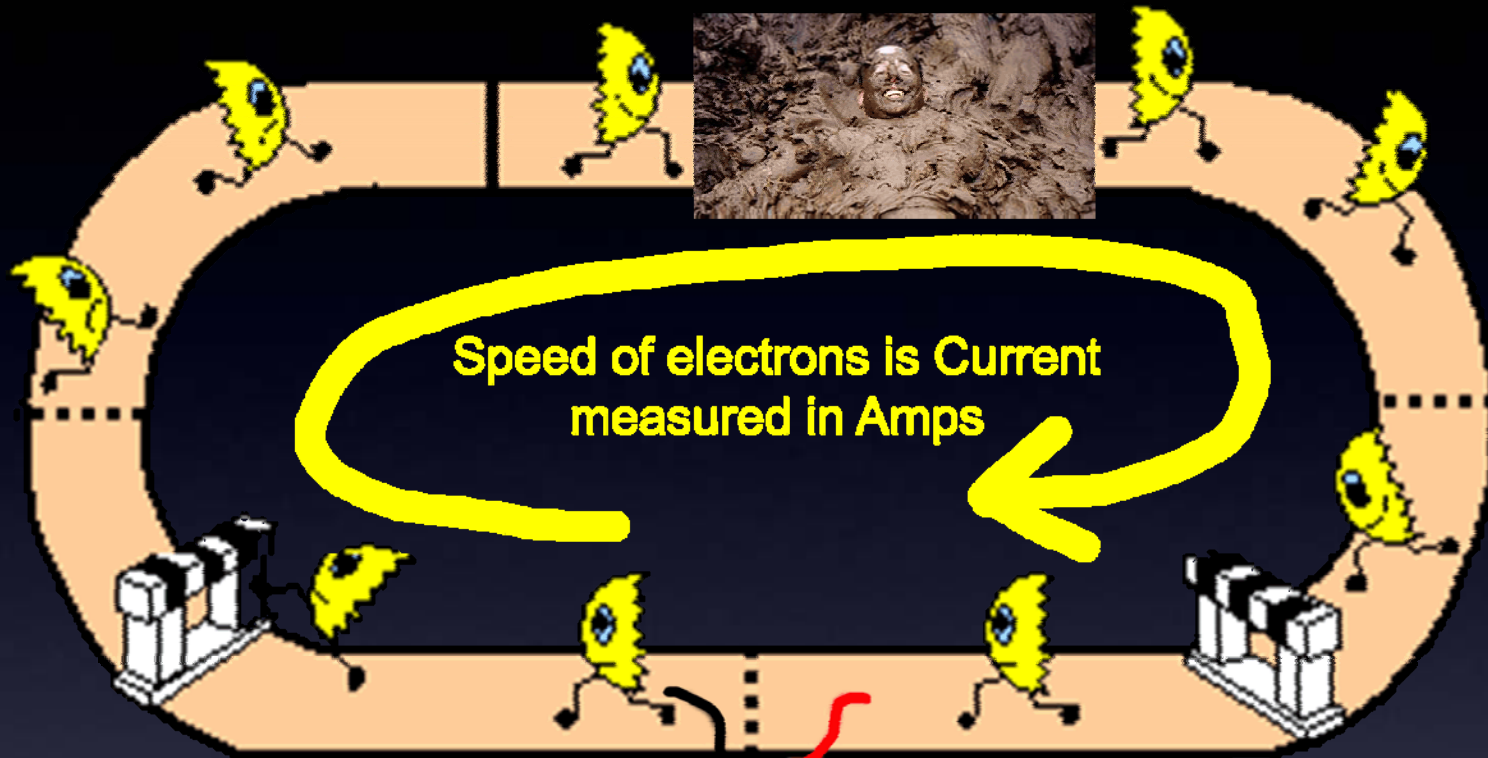
**Too much energy?**



**Lots of energy!**

Amps / Current

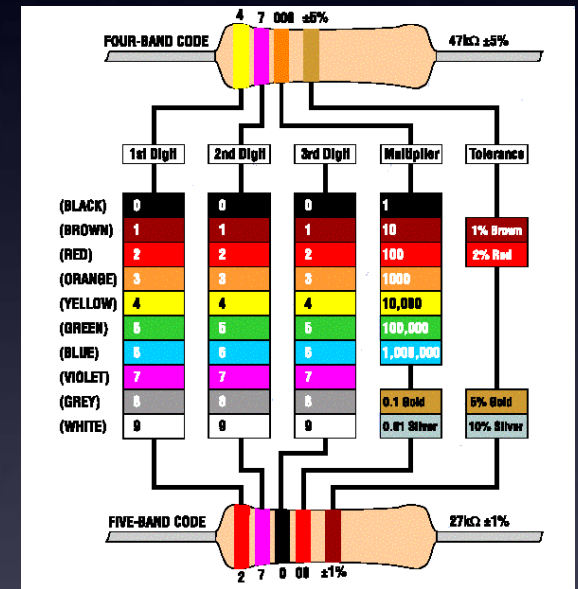
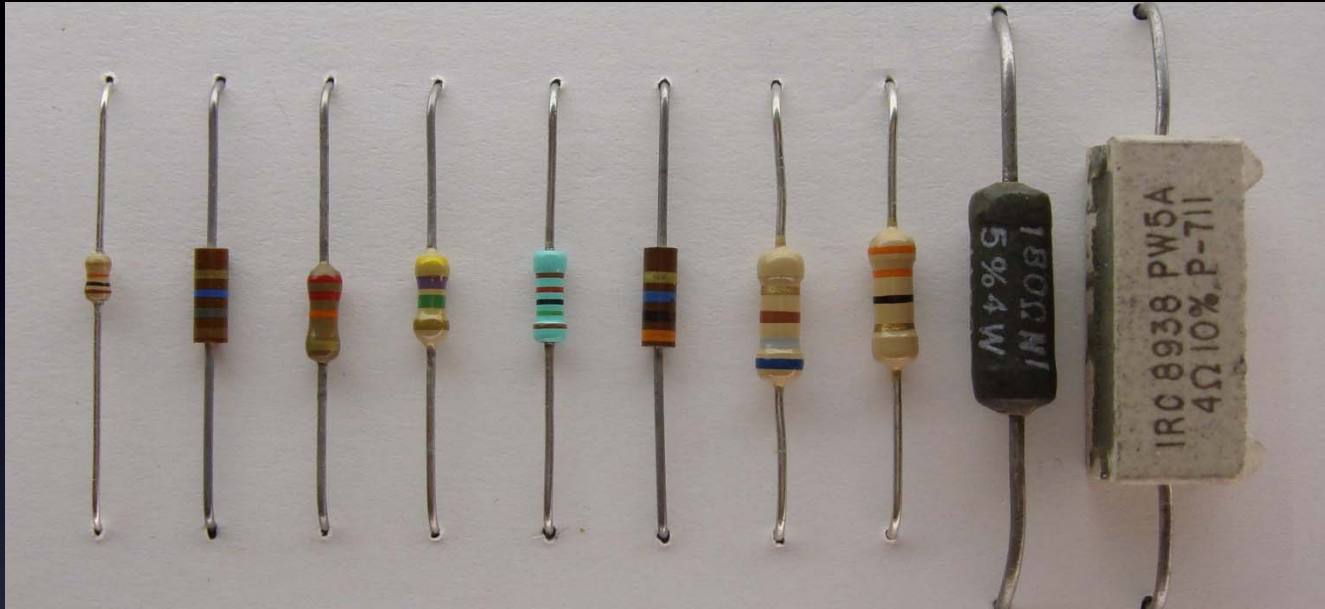
# Everything You Need to Know About Electronics



Resistance in the electrons' path slows them down, which means less current / Amps.

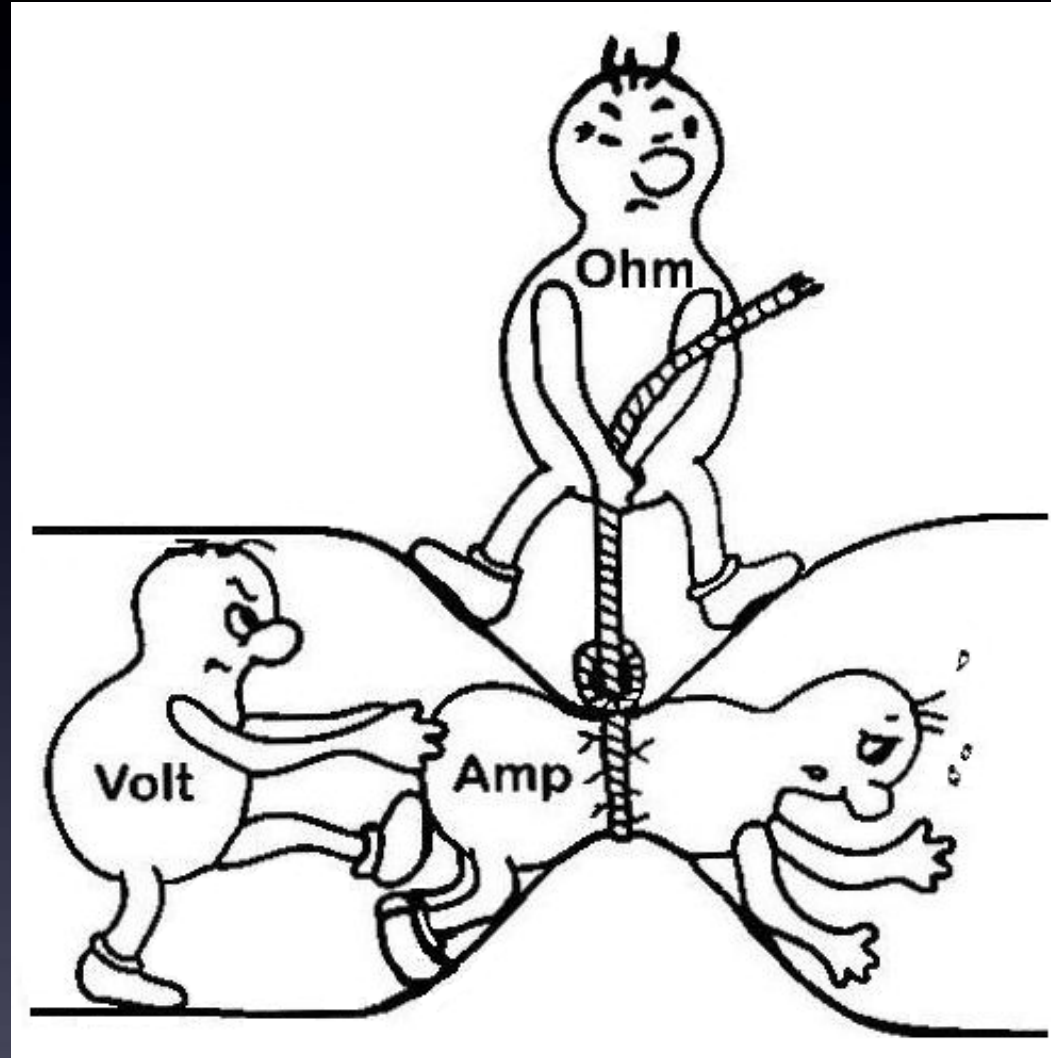
Resistance / Ohms

# Everything You Need to Know About Electronics



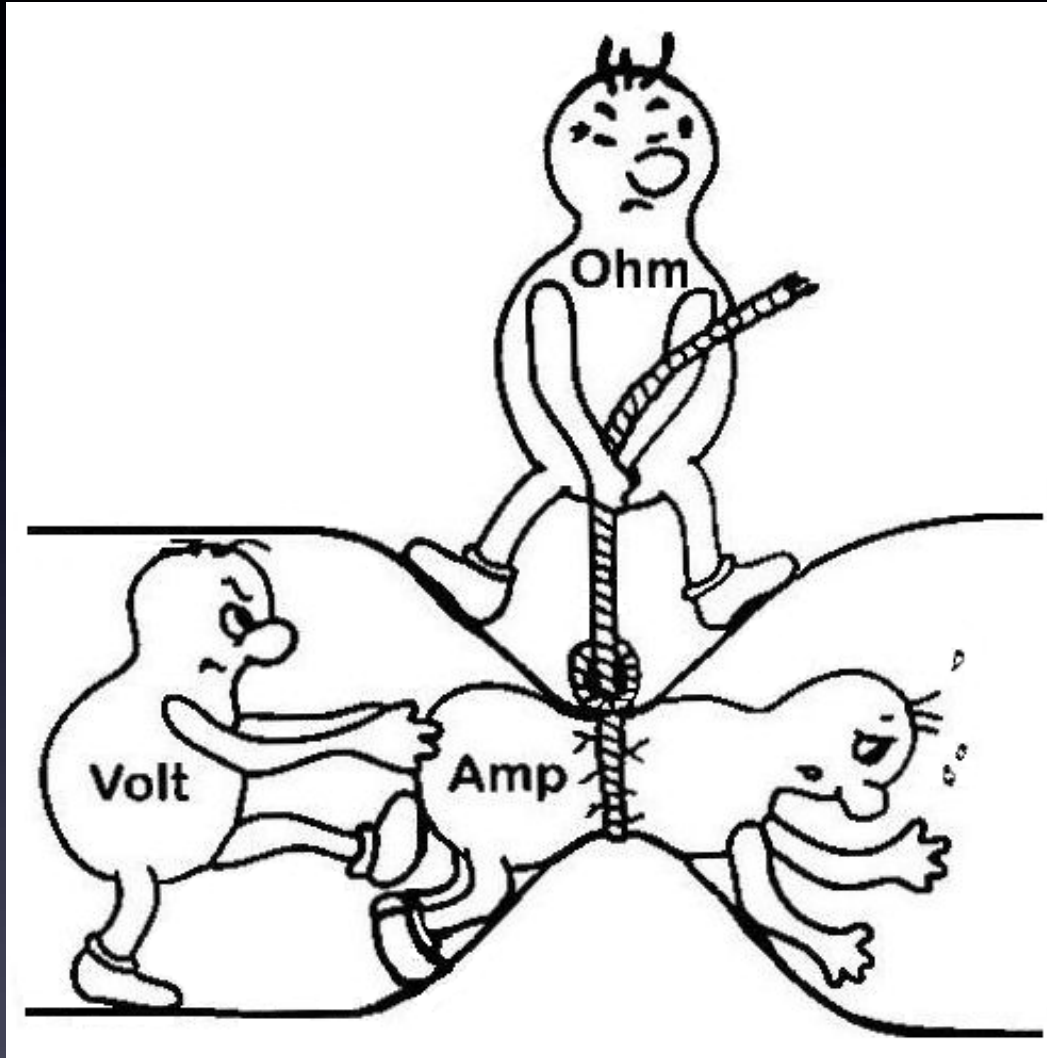
Resistors / Ohms

# Everything You Need to Know About Electronics



Ohm's Law

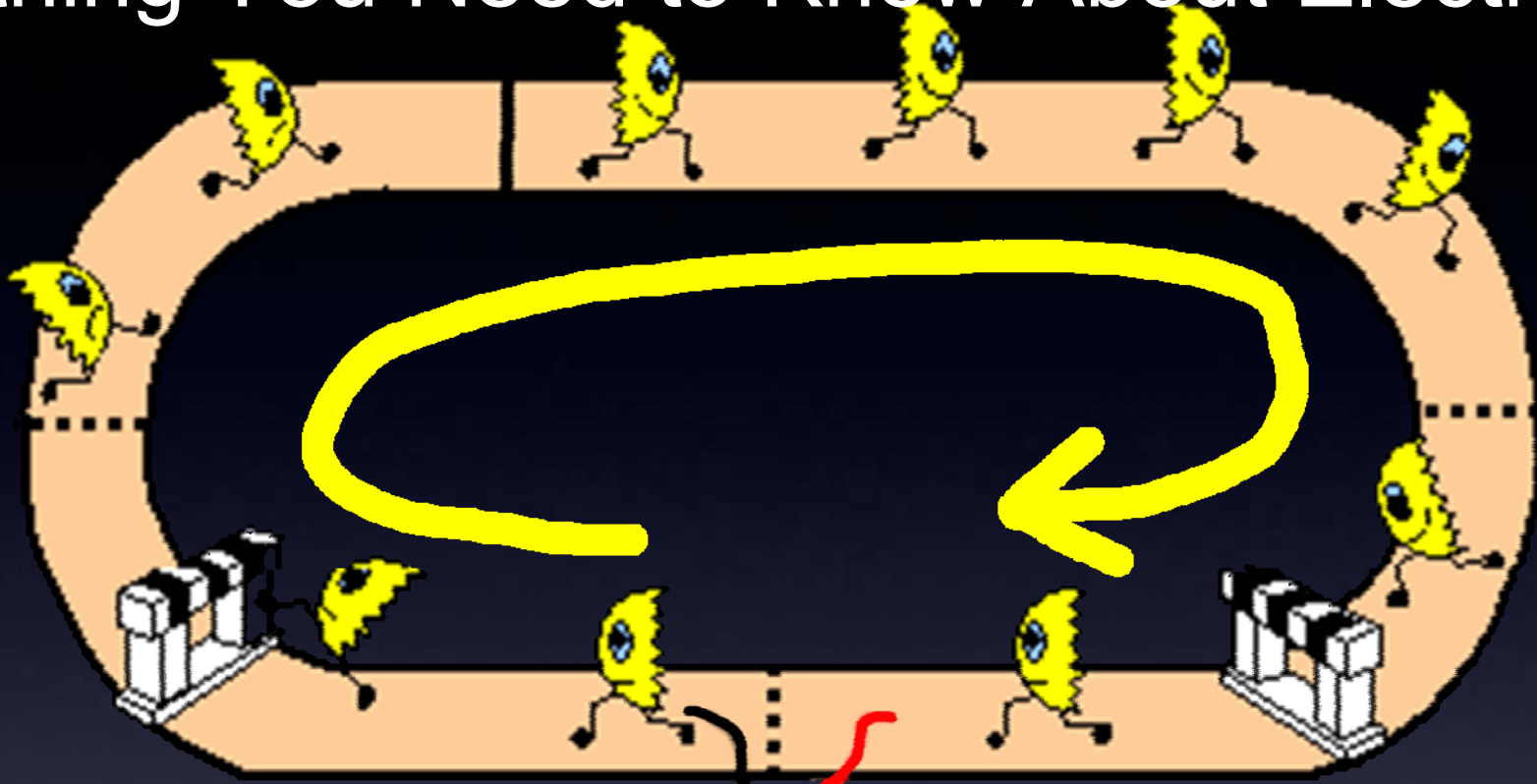
# Everything You Need to Know About Electronics



$$\text{Volts} = \text{Amps} \times \text{Ohms}$$

Ohm's Law

# Everything You Need to Know About Electronics



**Black Wire = “-”**

**Red Wire = “+”**



**Power Supply – it matters how you connect it!**

# Everything You Need to Know About Electronics

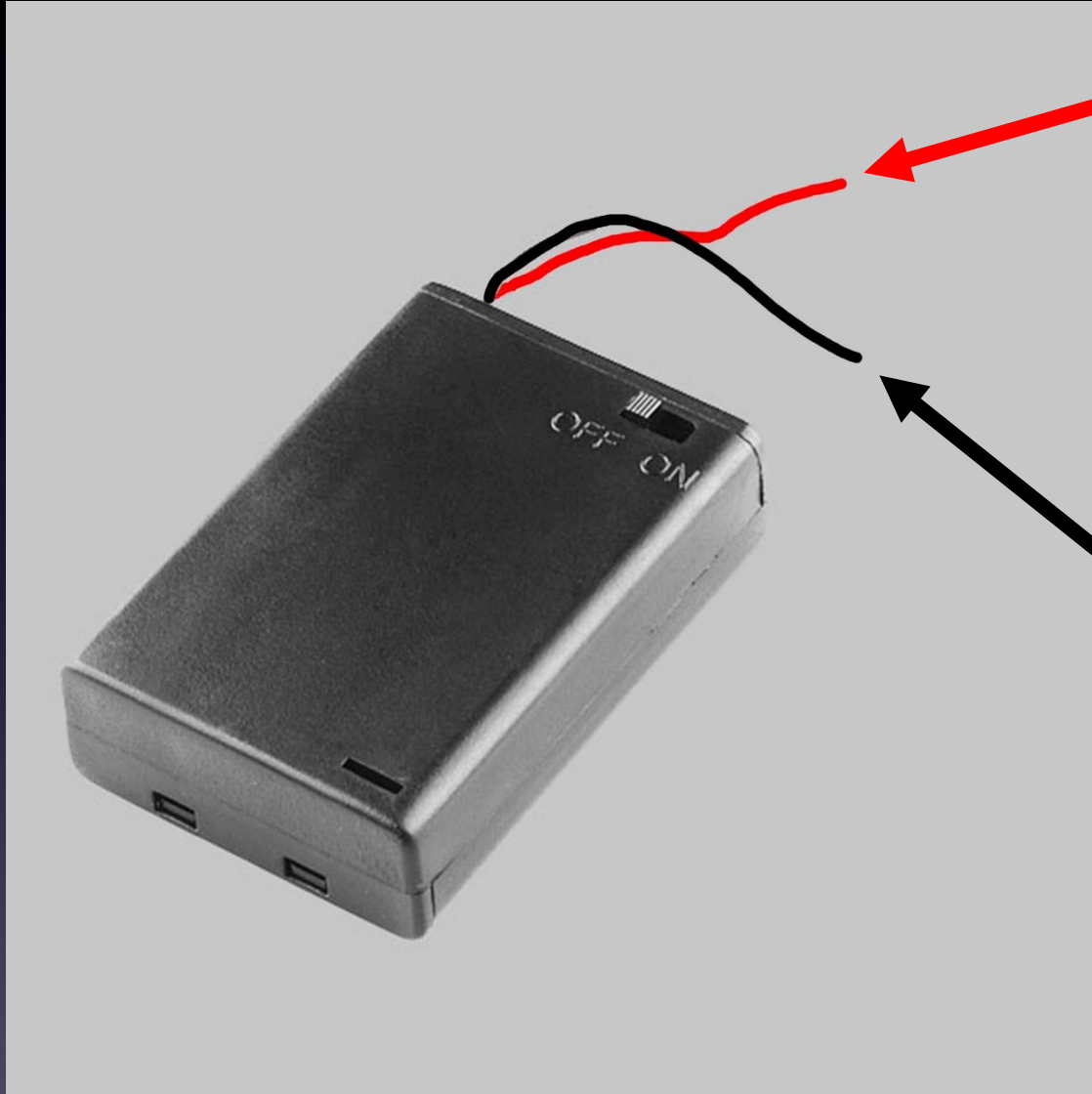


# What happens?

*Polarity*

Power Supply – it matters how you connect it!

# Everything You Need to Know About Electronics



**Red wire:**  
**Power,**  
**Plus, Positive,**  
**4.5V,**  
**Vcc**

**Black wire:**  
**Minus, Negative,**  
**0V,**  
**Ground**

Power Supply – it matters how you connect it!



# Everything You Need to Know About Electronics



or



or

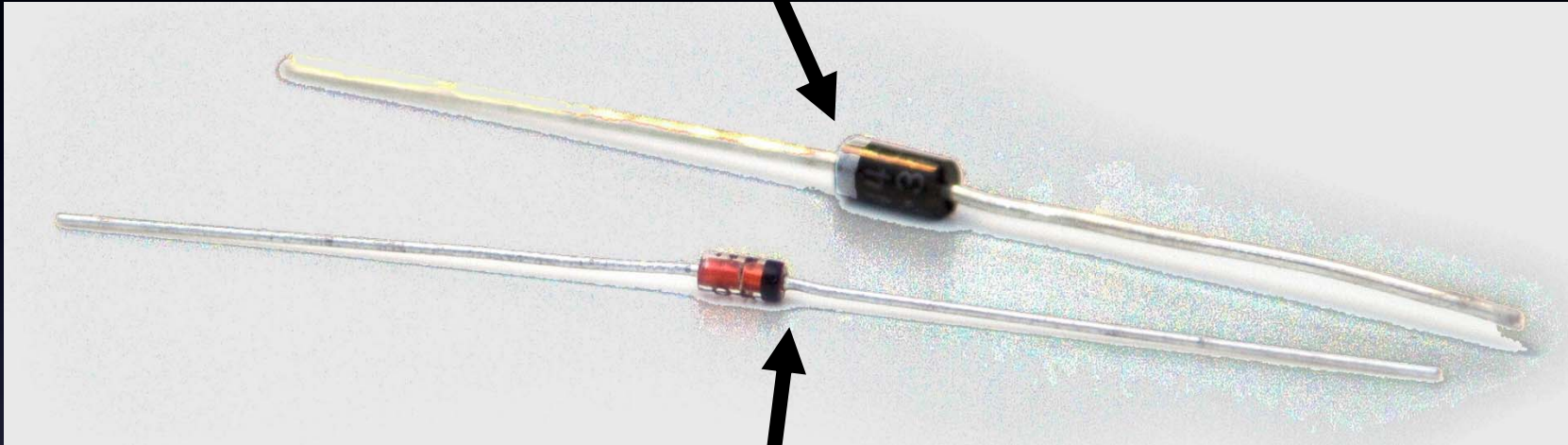


(electrons slowed down the same either way)

Resistors – it doesn't matter which way

# Everything You Need to Know About Electronics

**Minus / Negative side**



**Minus / Negative side**

**One-Way valve for electrons**

**Diodes – it matters which way!**

# Everything You Need to Know About Electronics



**Short wire is Minus / Negative**

Special kind of Diode – it Emits Light!

LED – it matters which way!

# Everything You Need to Know About Electronics



Lots of different colored LEDs! (including IR)

LED

# Everything You Need to Know About Electronics



More current → More brightness! (until...)

LED

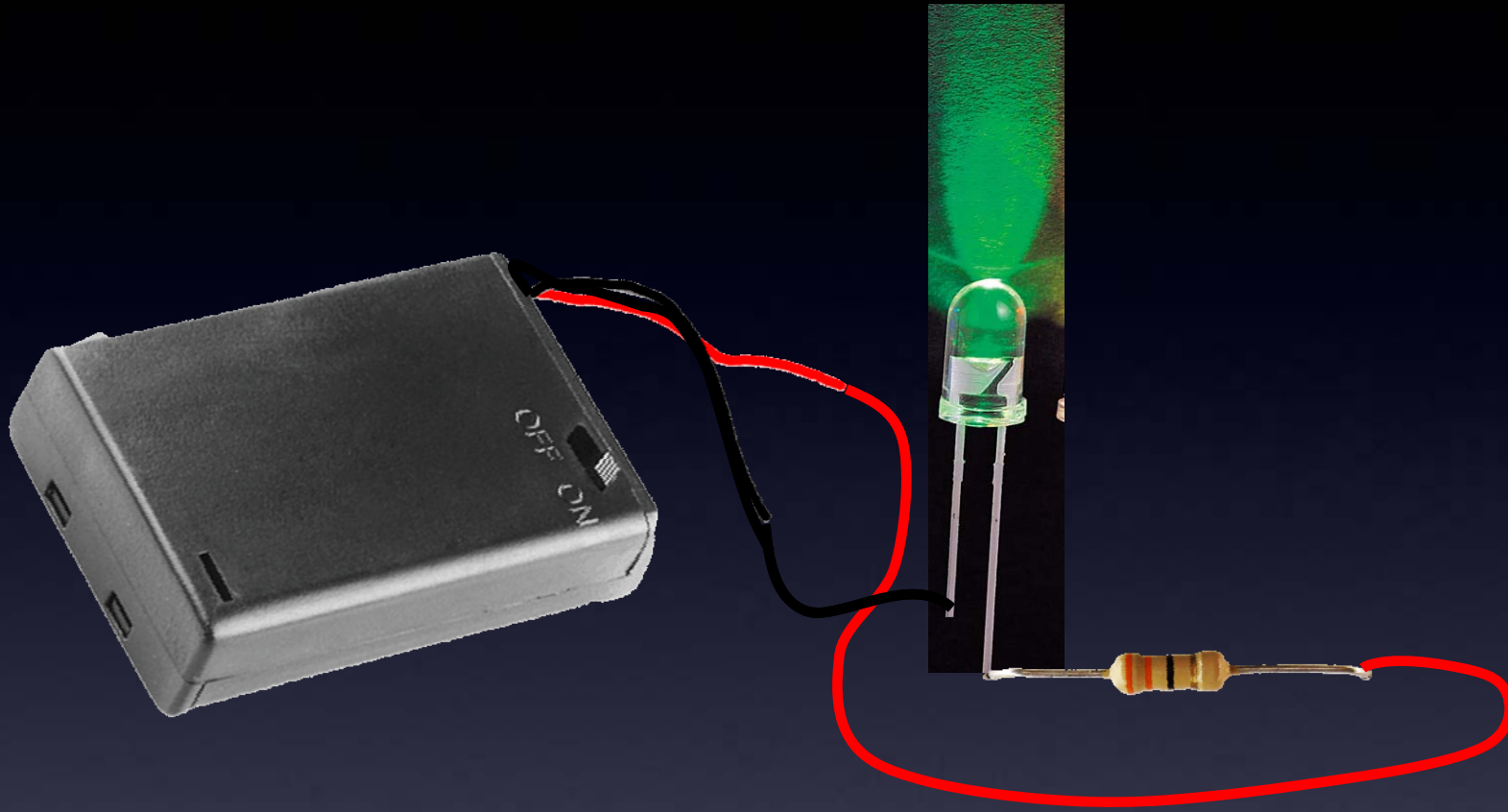
# Everything You Need to Know About Electronics



More current → More brightness! (until...)

LED

# Everything You Need to Know About Electronics



This is why we put a resistor in line

LED

# Everything You Need to Know About Electronics



Series = in line



Parallel = across



# Everything You Need to Know About Electronics



A “code” is IR light blinking on-off-on-off

IR Remote Control

# Everything You Need to Know About Electronics

Takes about 60 seconds



About 150 IR “OFF” codes (one per blink)

TV-B-Gone universal remote control

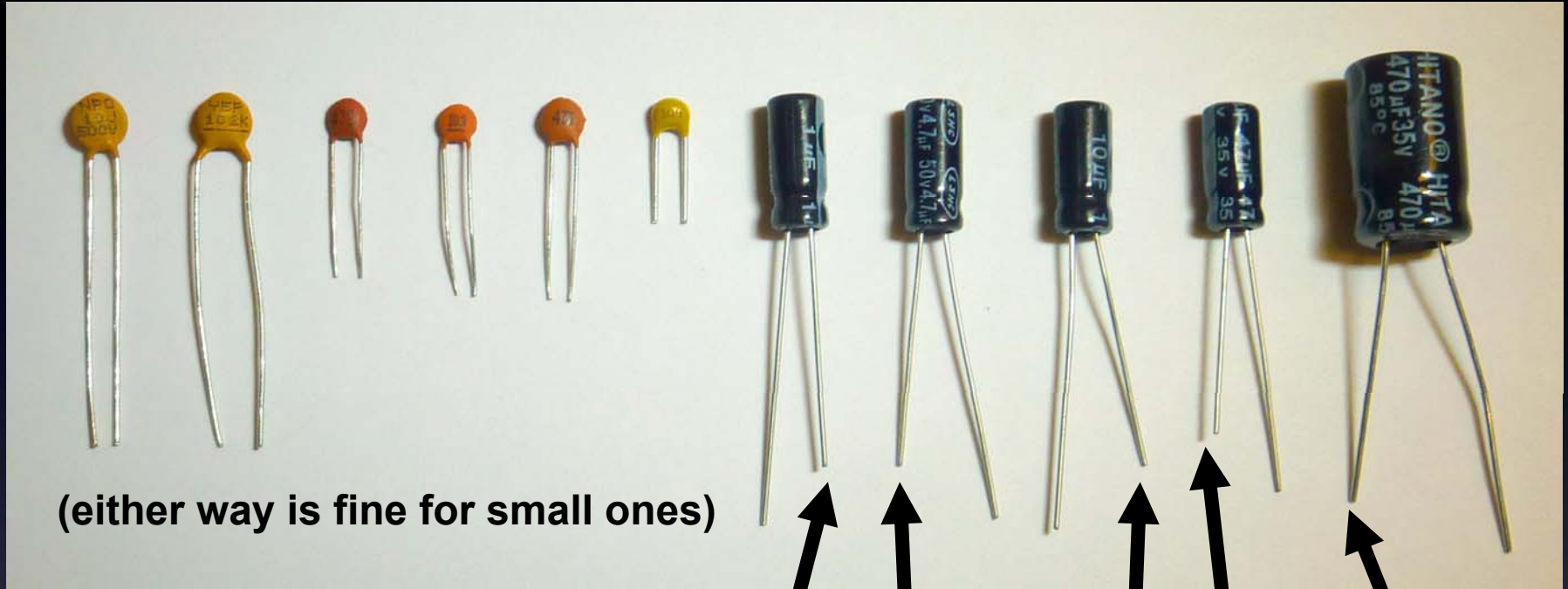
# Everything You Need to Know About Electronics



LED & battery

Our first circuit

# Everything You Need to Know About Electronics



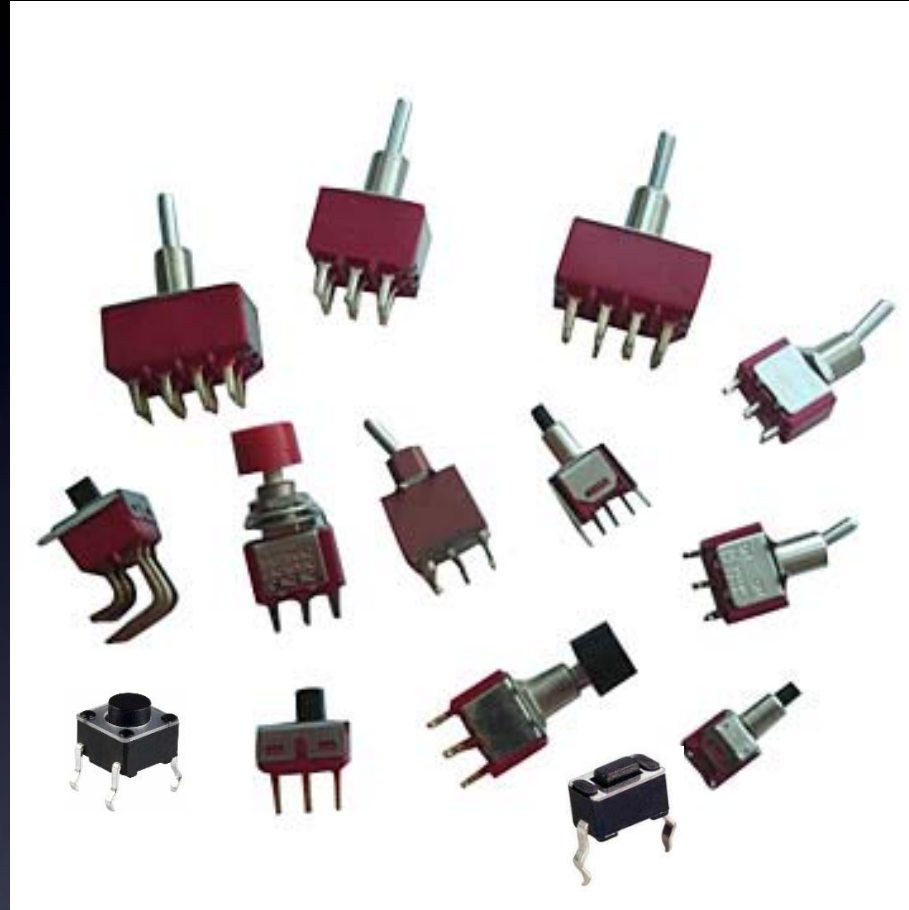
(either way is fine for small ones)

**Short wire is Minus / Negative**

Little buckets for electrons

Capacitor / Farads

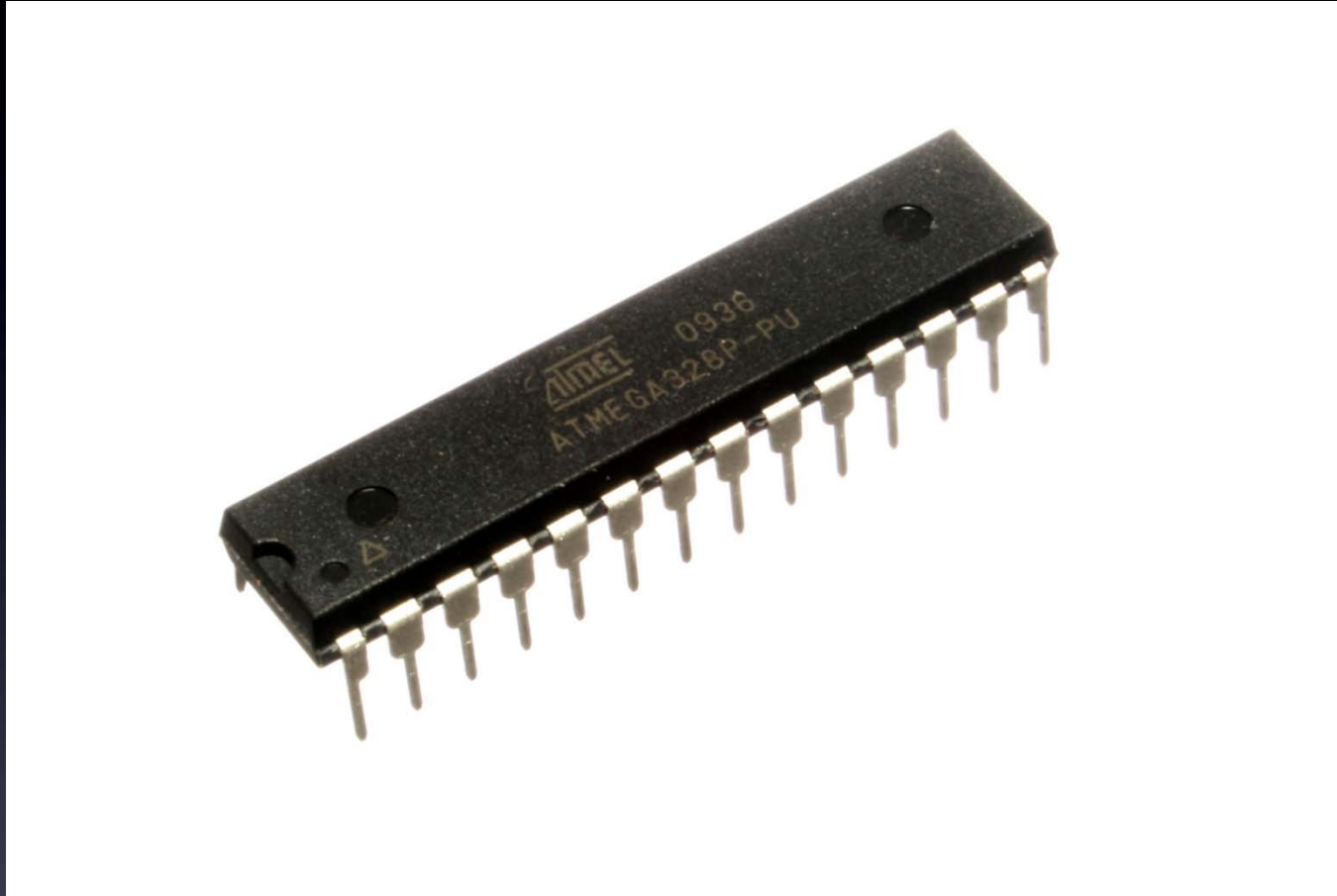
# Everything You Need to Know About Electronics



Strips of metal connected together – or not

Switch

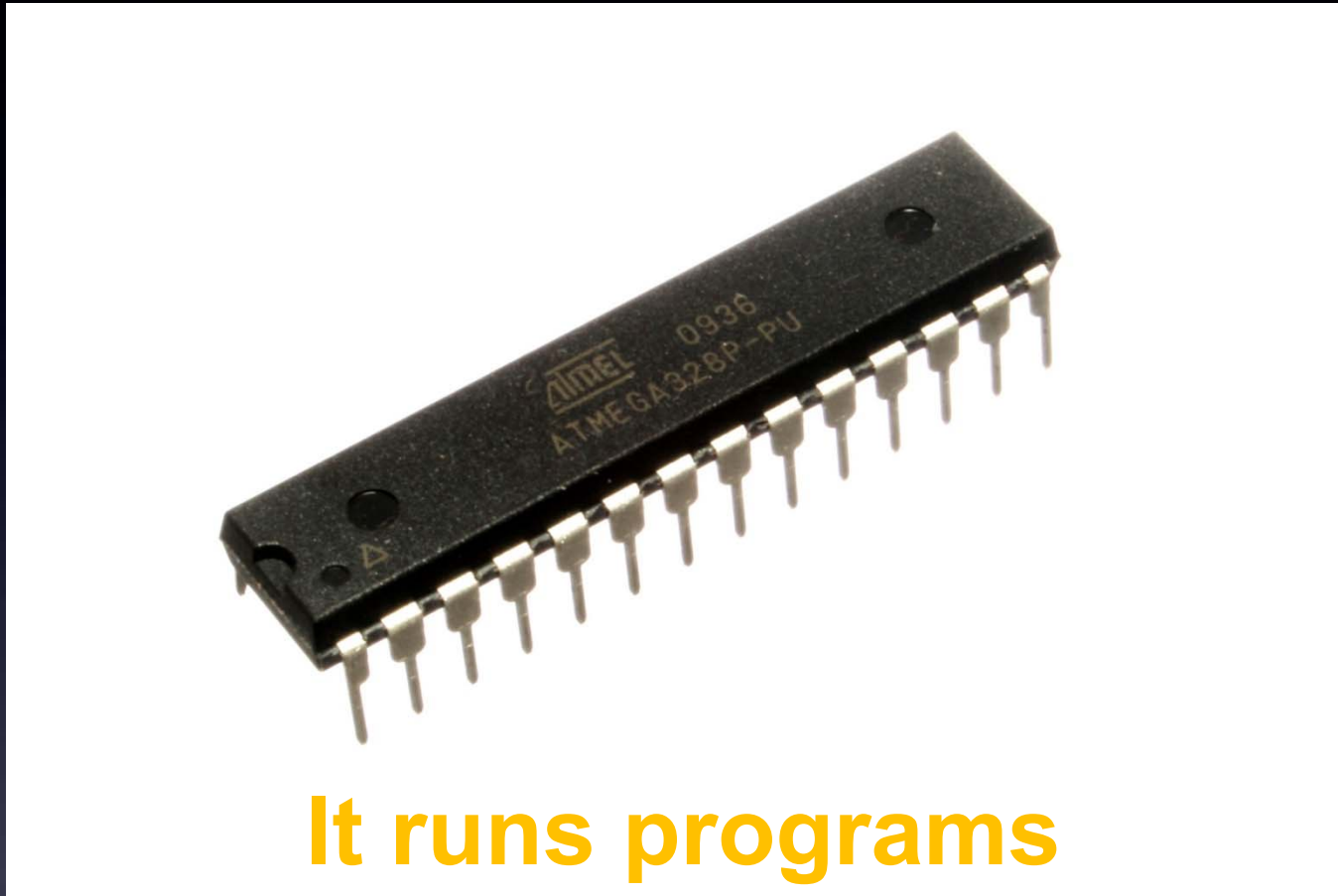
# Everything You Need to Know About Electronics



A complete computer on a chip

Microcontroller

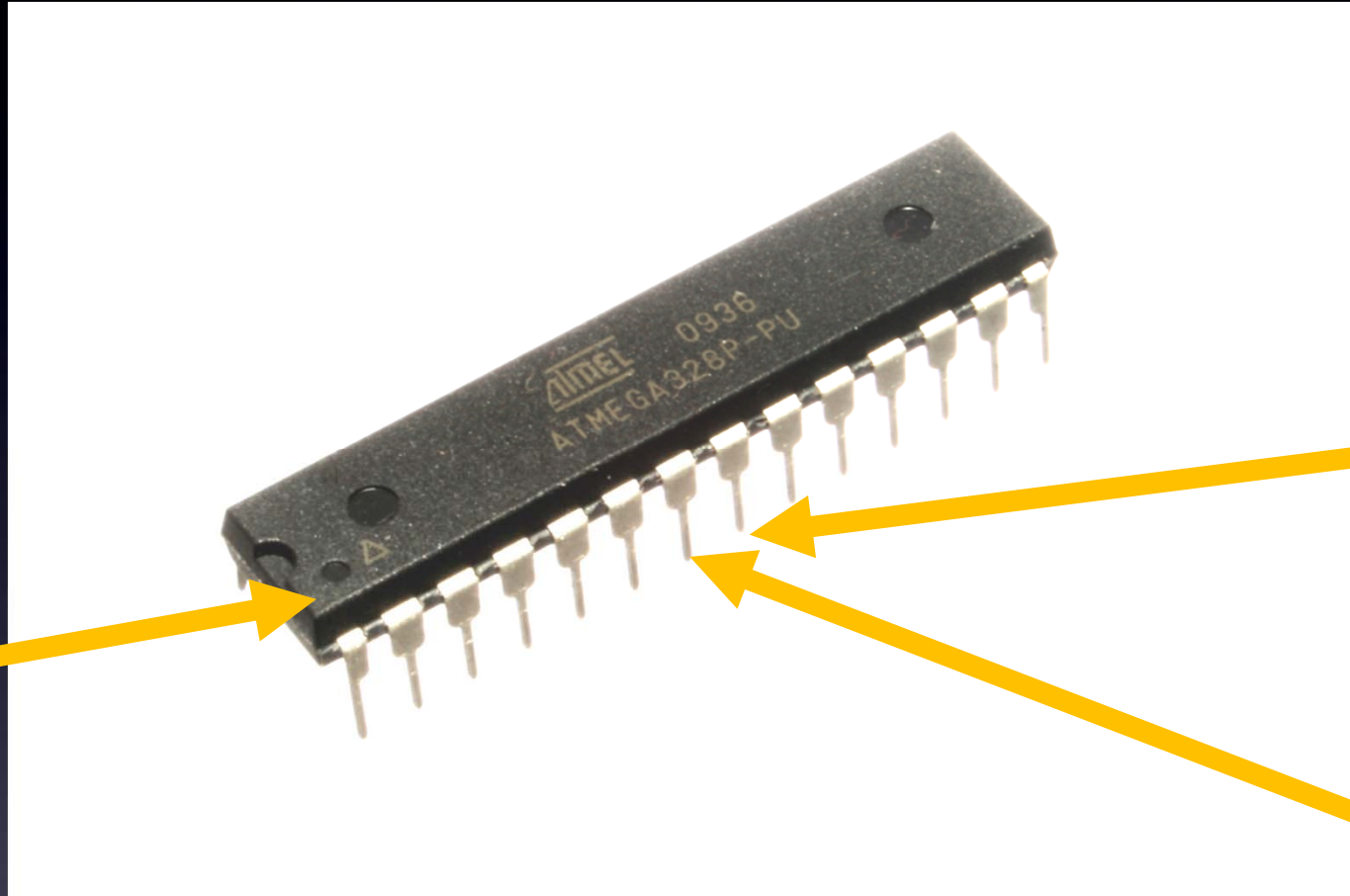
# Everything You Need to Know About Electronics



to control electronic parts connected to its pins.

Microcontroller

# Everything You Need to Know About Electronics



**2  
special  
pins:**

**Pin 1**

**Pin 8 =  
Ground**

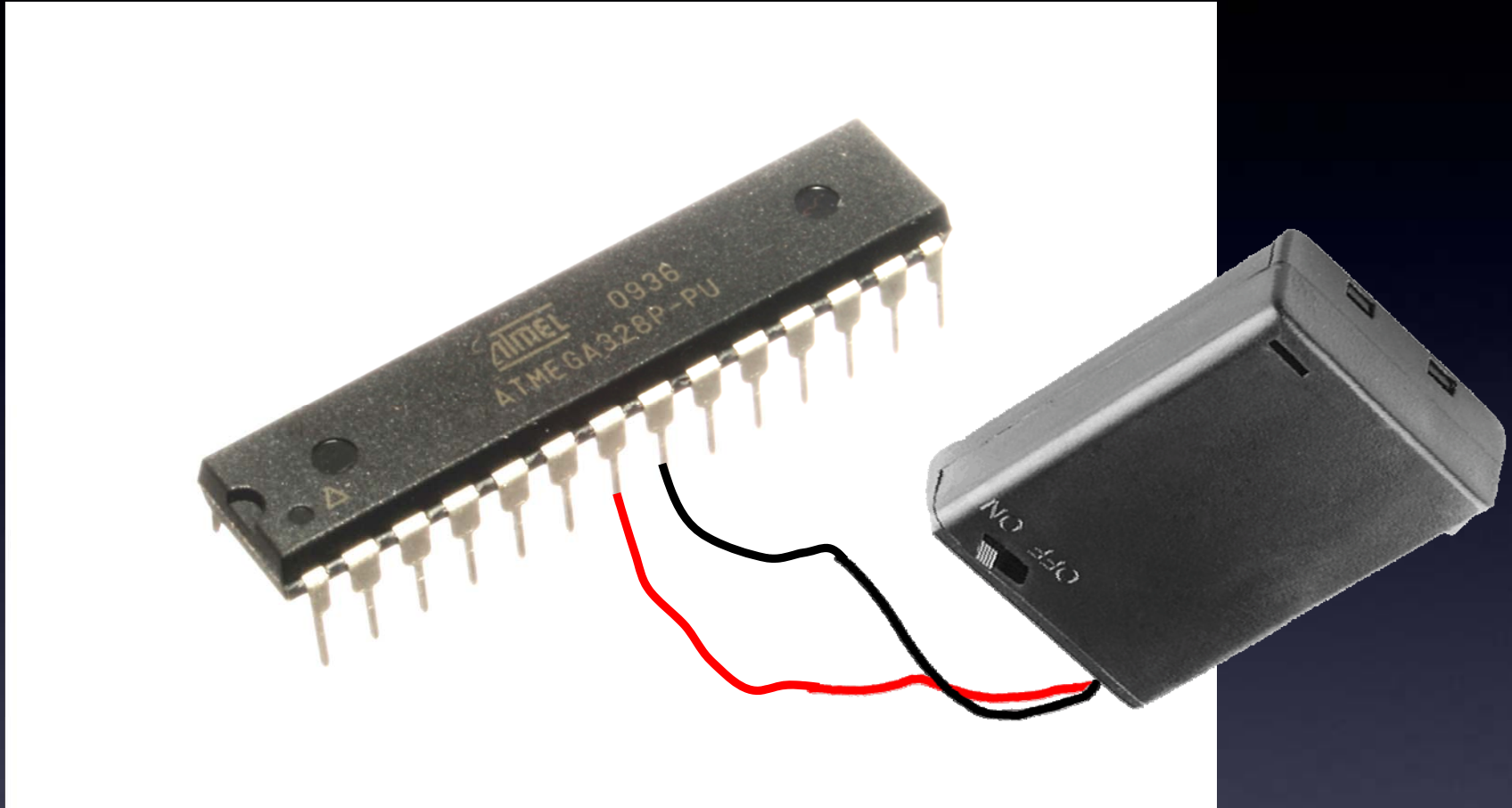
**Pin 7 =  
Vcc**

**A complete computer on a chip**

**Microcontroller – it matters how you hook it up!**



# Everything You Need to Know About Electronics

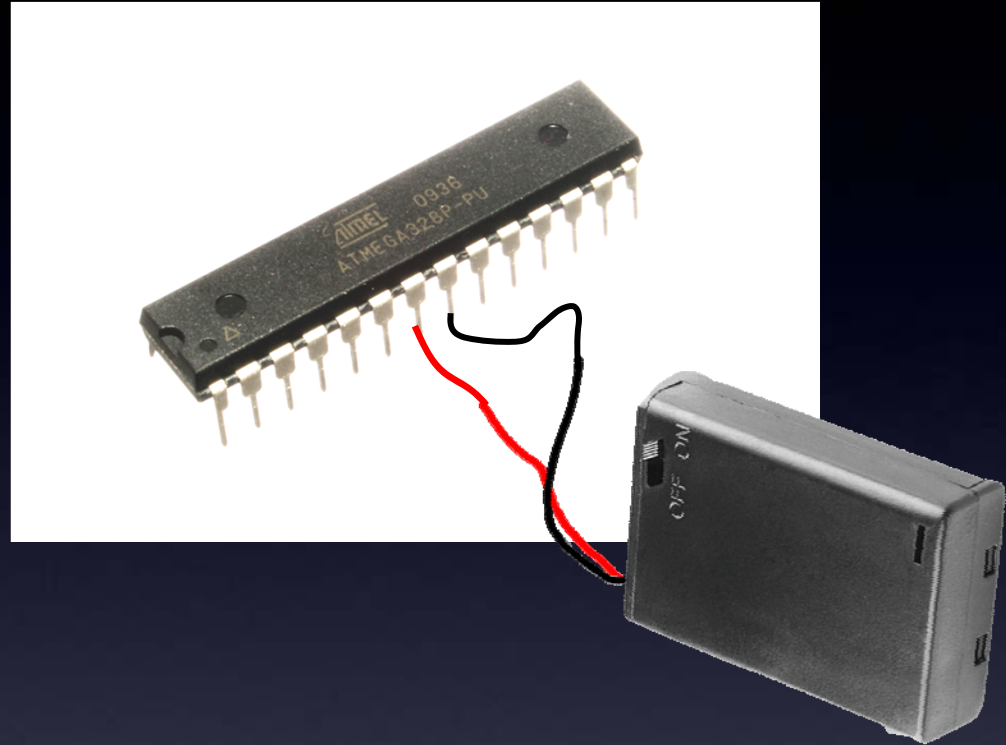


A complete computer – running a program!

Microcontroller – turned on!

# Everything You Need to Know About Electronics

**all other pins are  
input pins  
or  
output pins**



**Your program controls electronics parts  
on these other pins**

**Microcontroller**

# Everything You Need to Know About Electronics

**Analog Electronics:**

Any voltage between Ground (0V) and Vcc

**Digital Electronics:**

Only 2 choices: Ground (0V) or Vcc

2 types of electronics

# Everything You Need to Know About Electronics

**Ground (0V)**

**Low**

**Off**

**0**

**without Voltage  
without current**

**Power / Vcc**

**High**

**On**

**1**

**with Voltage  
with current**

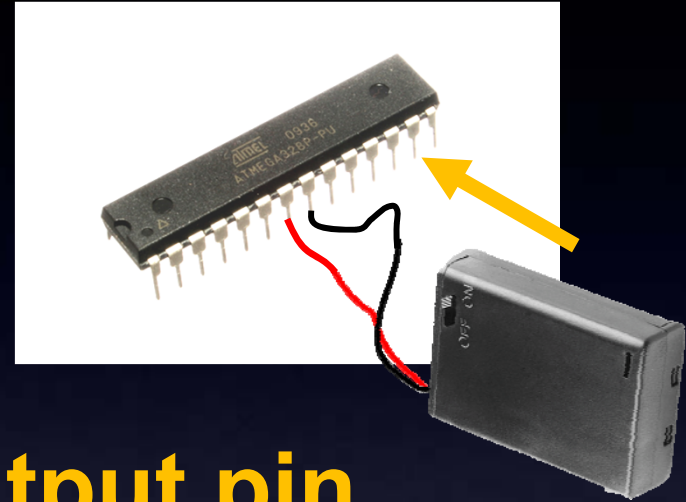
**Digital Electronics:**

**Only 2 choices: Ground (0V) or Vcc**

**Digital Electronics**

# Everything You Need to Know About Electronics

**To make a pin an  
output pin**



**you tell it to become an output pin  
with a statement in your program**

**Let's tell pin 13 to be an Output Pin**

Microcontroller – Output Pin

# Everything You Need to Know About Electronics

**Low**

**Off  
(0V)**

**High**

***almost the same*  
as the Red wire  
of the power supply**

**Only 2 choices: High or Low**

**Microcontroller – Output Pin**

Everything You Need to Know About Electronics

**A real world example**

**How to make an LED blink?**

**Hello World**

Microcontroller

# Everything You Need to Know About Electronics

## Software

Type:

Hello World  
on your screen

## Microcontrollers

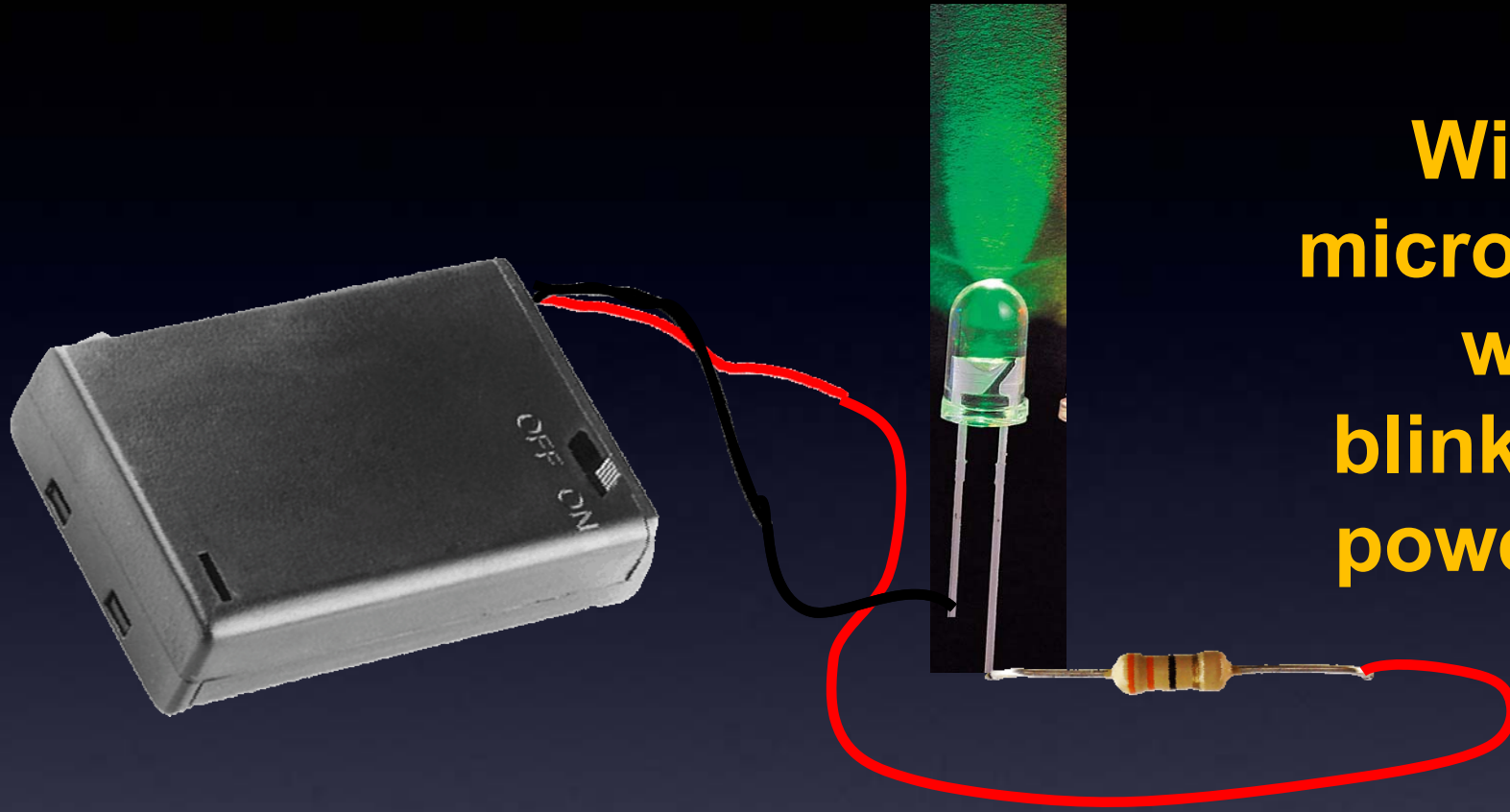
make an LED blink

**Hello World**

Microcontroller



# Everything You Need to Know About Electronics



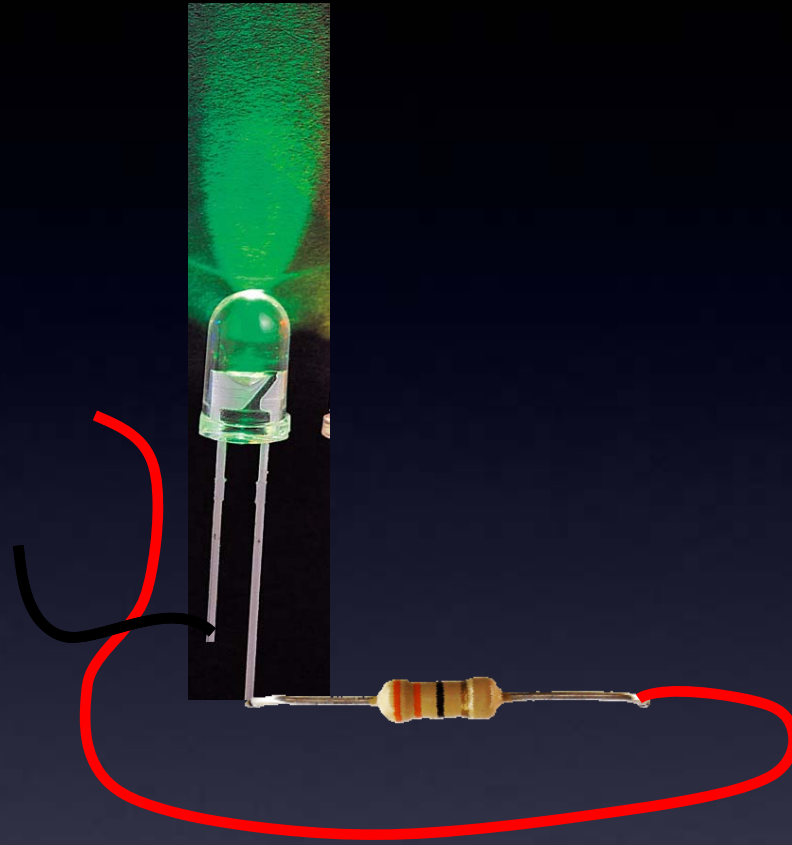
**Without a  
microcontroller  
we can  
blink with our  
power supply**

**Turning an LED on and off**

(Leading up to Hello World)

# Everything You Need to Know About Electronics

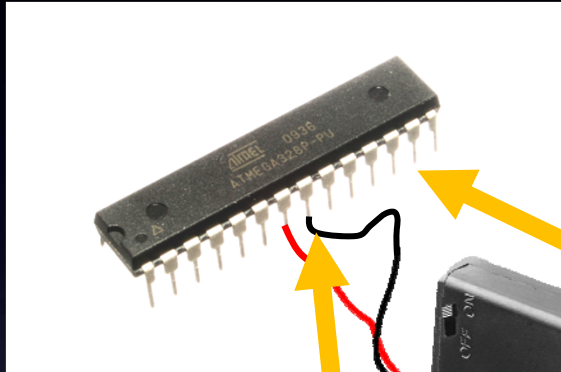
**Let's replace  
the power supply**



**Turning an LED on and off**

(Leading up to Hello World)

# Everything You Need to Know About Electronics



**With a microcontroller:  
we can use an Output pin  
for power (if it's On)**

**Let's use Pin 13**

**And we use the Ground pin for Ground**

**Turning an LED on and off**

**(Leading up to Hello World)**

# Everything You Need to Know About Electronics

**Since an Output pin  
is *almost* like the Red wire of our power supply  
when it is On**



**Let's connect this LED to an  
Output pin...  
...instead of our power supply**

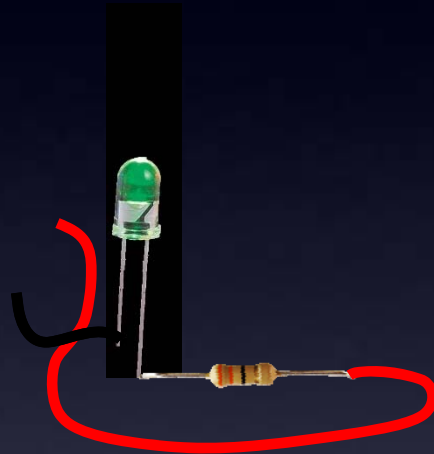
**And make it blink!**

**Turning an LED on and off**

**(Leading up to Hello World)**

# Everything You Need to Know About Electronics

**Since an Output pin  
is *almost* like the Red wire of our power supply  
when it is On**



**Let's connect this LED to an  
Output pin...  
...instead of our power supply**

**With a resistor  
(so no magic smoke goes away)**

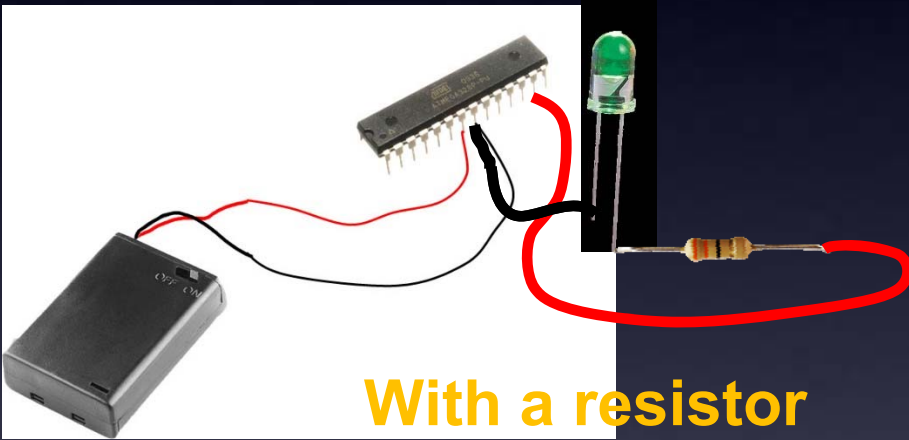
**And make it blink!**

**Turning an LED on and off**

**(Leading up to Hello World)**

# Everything You Need to Know About Electronics

**Since an Output pin  
is *almost* like the Red wire of our power supply  
when it is On**



**With a resistor  
(so no magic smoke goes away)**

**Let's connect this LED to an  
Output pin...  
...instead of our power supply**

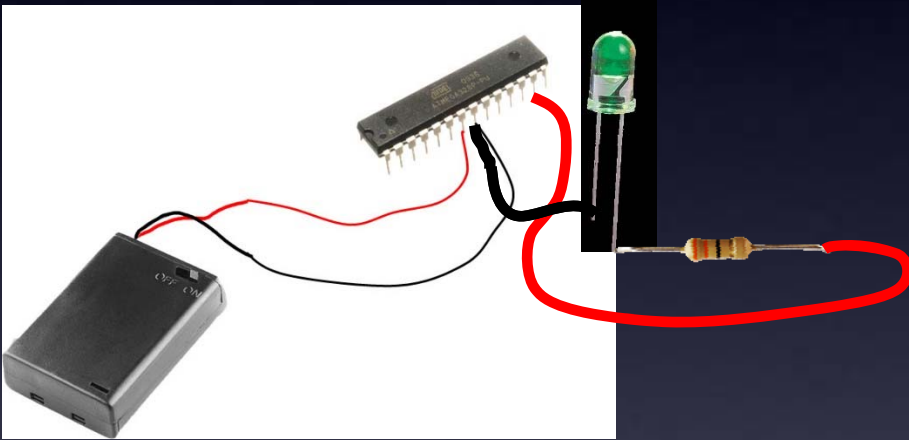
**And make it blink!**

**Turning an LED on and off**

**Hello World**

# Everything You Need to Know About Electronics

This is our **Hardware** for Hello World!

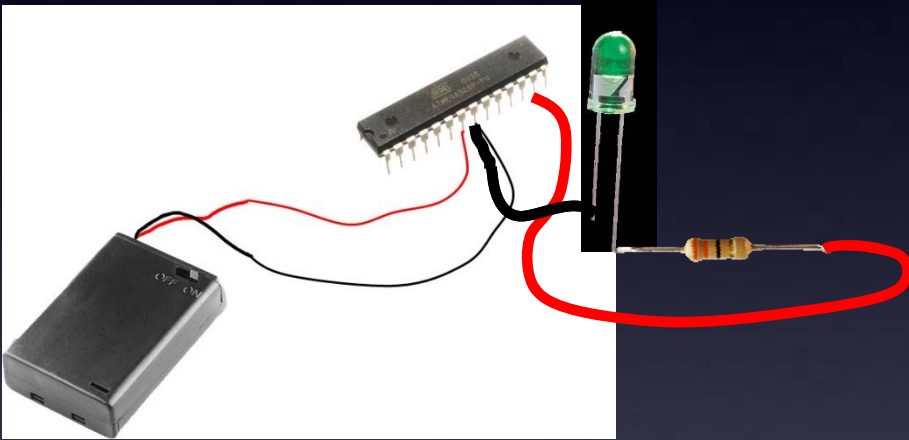


Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

How about our program?



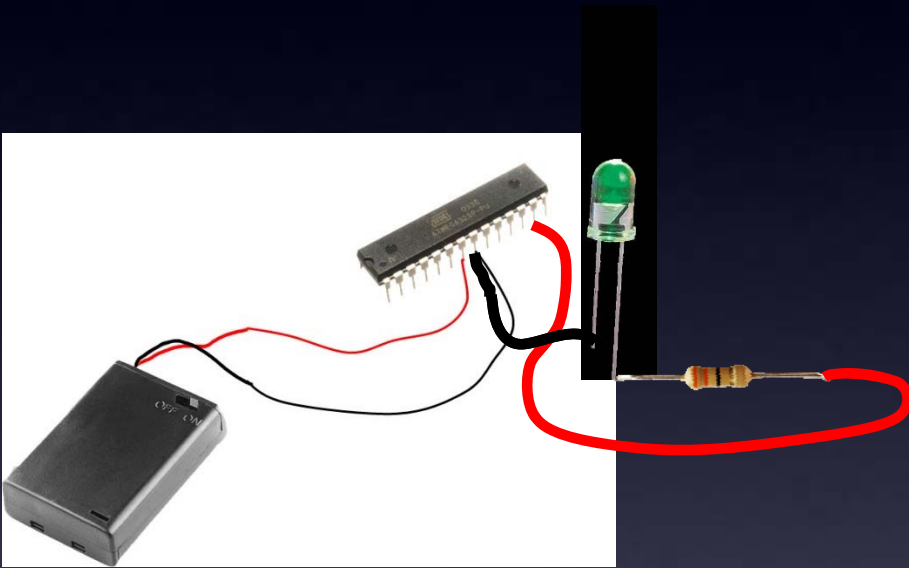
Turning an LED on and off

Hello World



# Everything You Need to Know About Electronics

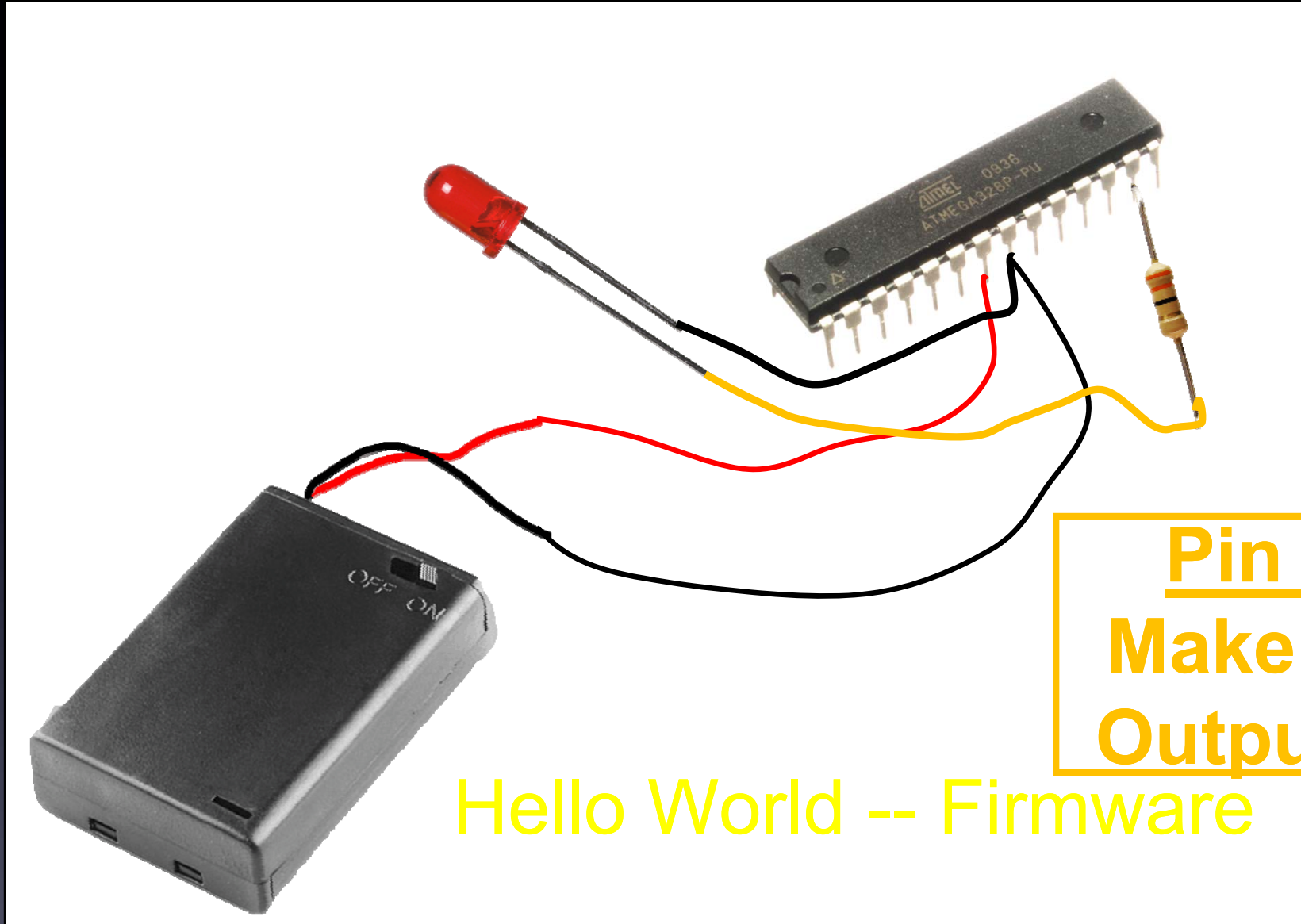
Programs on microcontrollers are called **“Firmware”**



Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

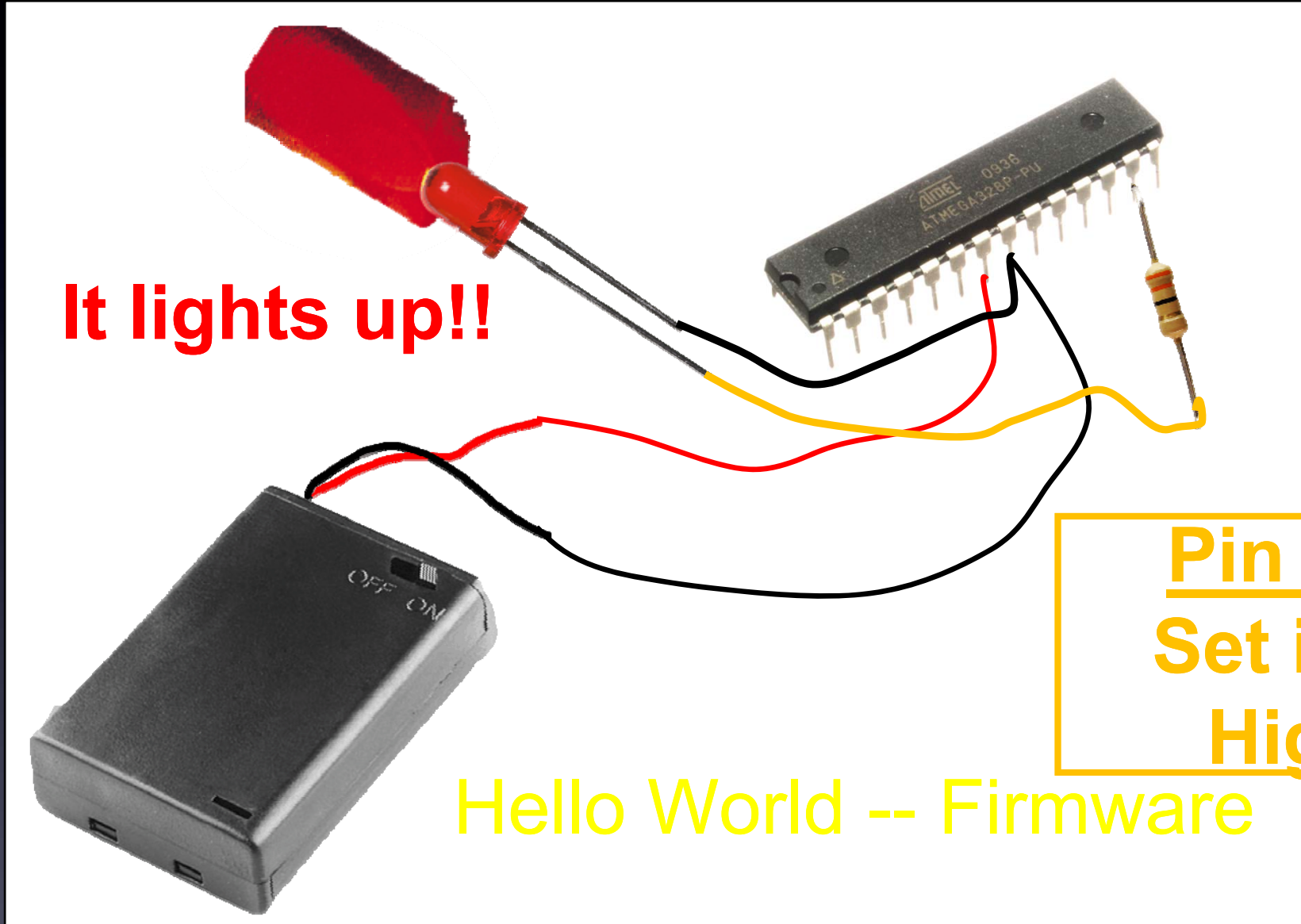


**Pin 13:**  
**Make it an**  
**Output Pin**

Hello World -- Firmware

Microcontroller

# Everything You Need to Know About Electronics



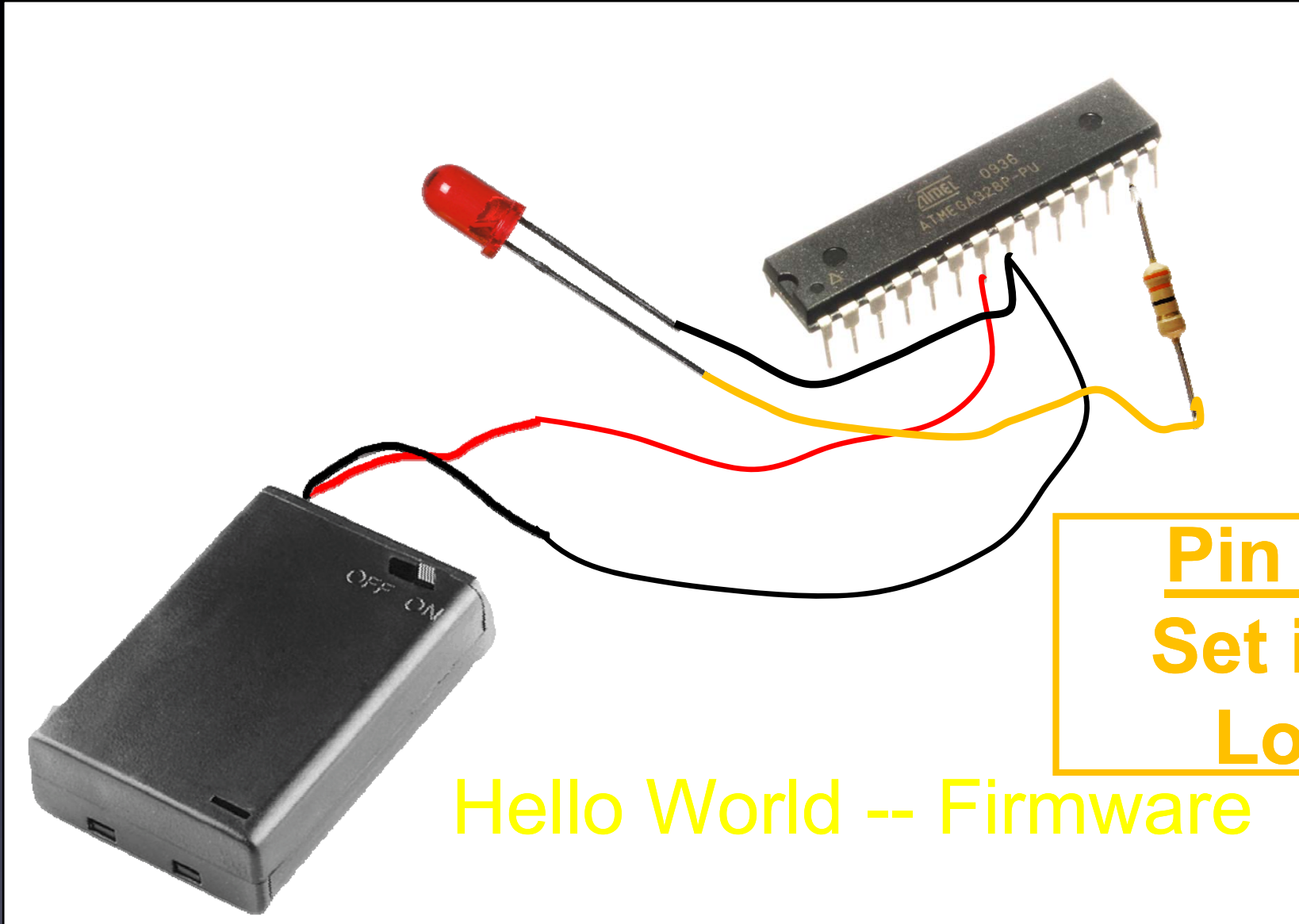
**It lights up!!**

**Pin 13:  
Set it to  
High**

**Hello World -- Firmware**

**Microcontroller**

# Everything You Need to Know About Electronics



**Pin 13:**  
**Set it to**  
**Low**

Hello World -- Firmware

Microcontroller

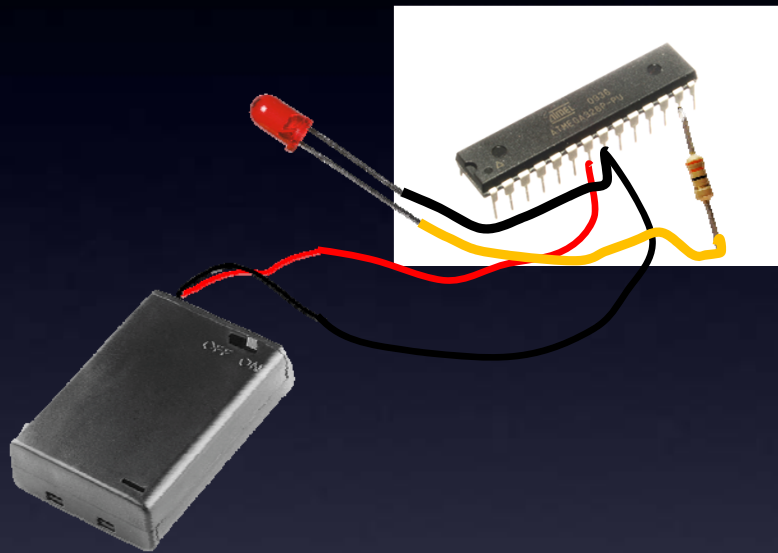
# Everything You Need to Know About Electronics



We now have  
Hello World!

Microcontroller

# Everything You Need to Know About Electronics



We now have  
Hello World!

**Except**

We won't see it 😞

Microcontroller

# Everything You Need to Know About Electronics



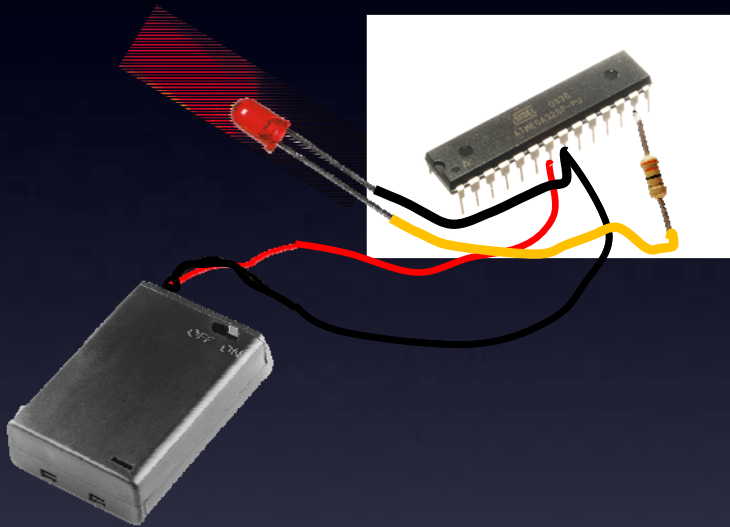
**We need a delay**

**Hello World – for real now!**

**Microcontrollers – they go really fast!**

# Everything You Need to Know About Electronics

## Hardware



## Firmware

- pin 13 is Output pin
- set pin 13 Low
- set pin 13 High
- delay
- set pin 13 Low

Programs on microcontrollers are called “Firmware”

Hello World

Microcontroller – Firmware



# Everything You Need to Know About Electronics



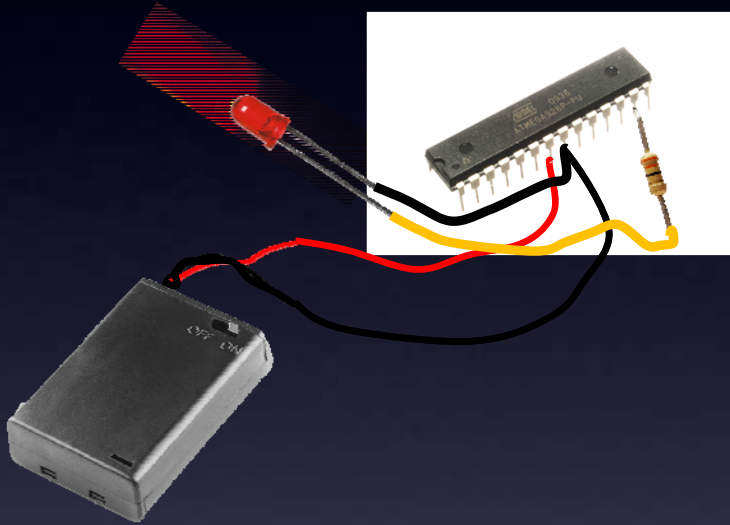
**A precision cut piece of quartz crystal**

**For precise timing**

Crystal

# Everything You Need to Know About Electronics

## Hardware



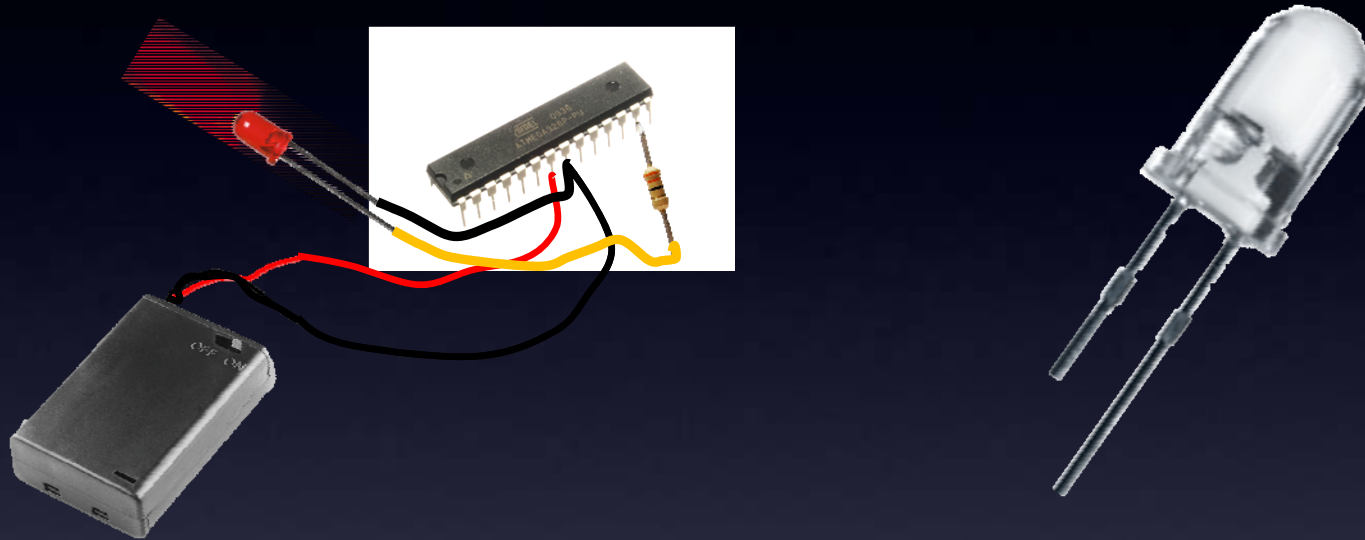
## Firmware

- pin 13 is Output pin
- set pin 13 High
- delay
- set pin 13 Low

# Let's hack Hello World!

Microcontroller

# Everything You Need to Know About Electronics

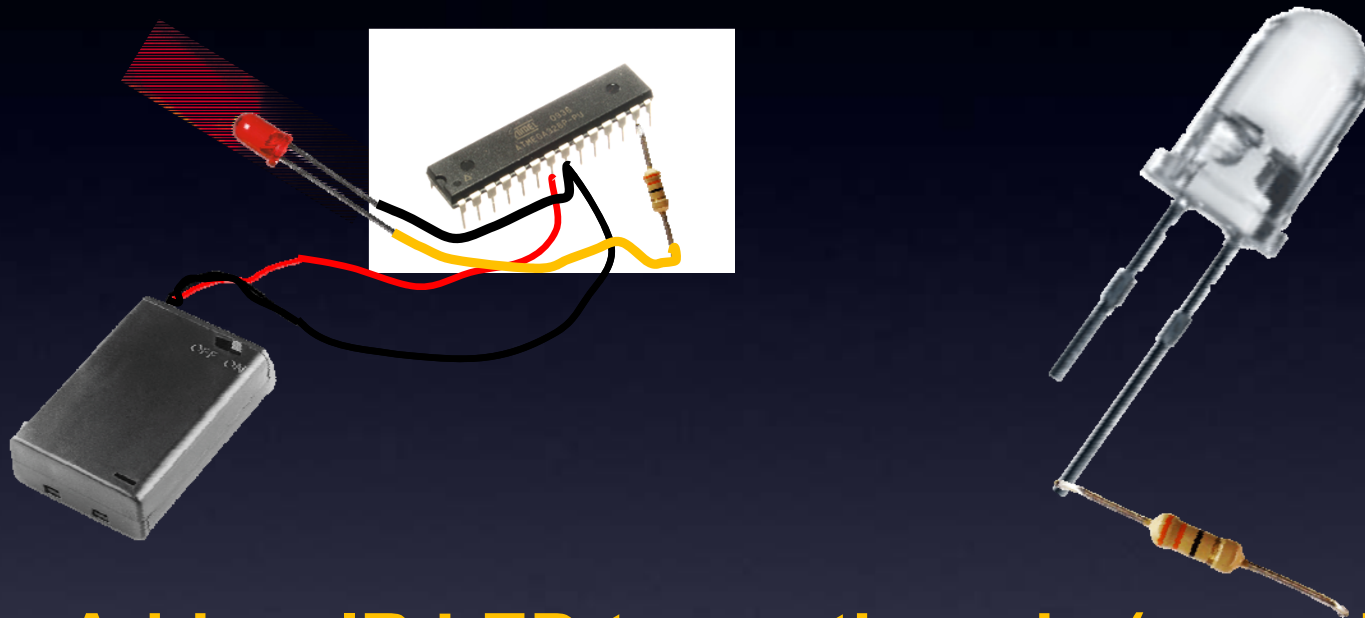


**Add an IR LED to another pin**

**IR "OFF" code**

Microcontroller

# Everything You Need to Know About Electronics

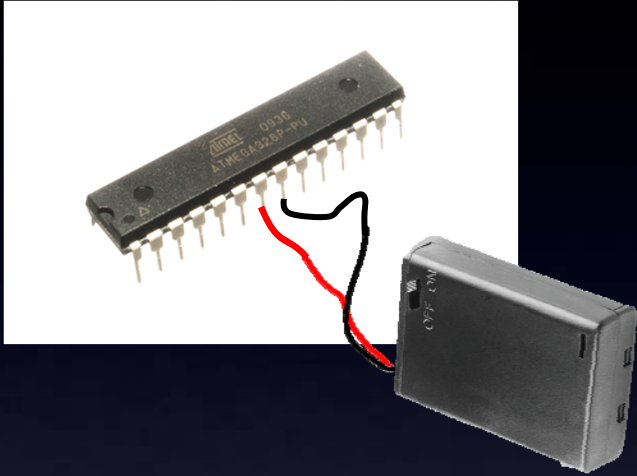


**Add an IR LED to another pin (say, pin3)  
and a resistor so no magic smoke goes away**

**IR "OFF" code**

Microcontroller

# Everything You Need to Know About Electronics

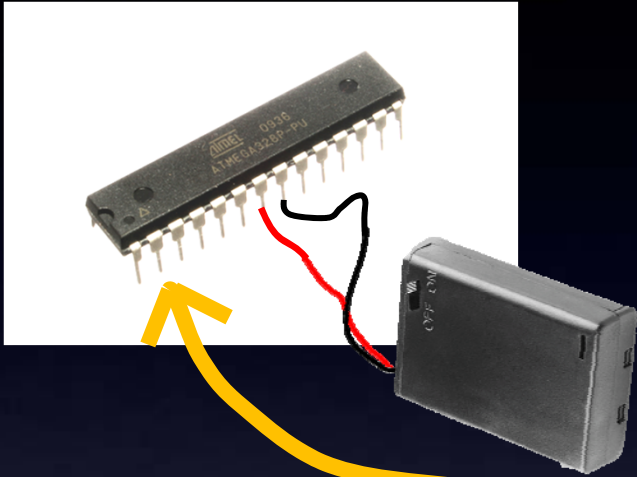


Let's add an Input pin!

We can add a Start button

Microcontroller

# Everything You Need to Know About Electronics



**How do we make a pin an Input pin?**

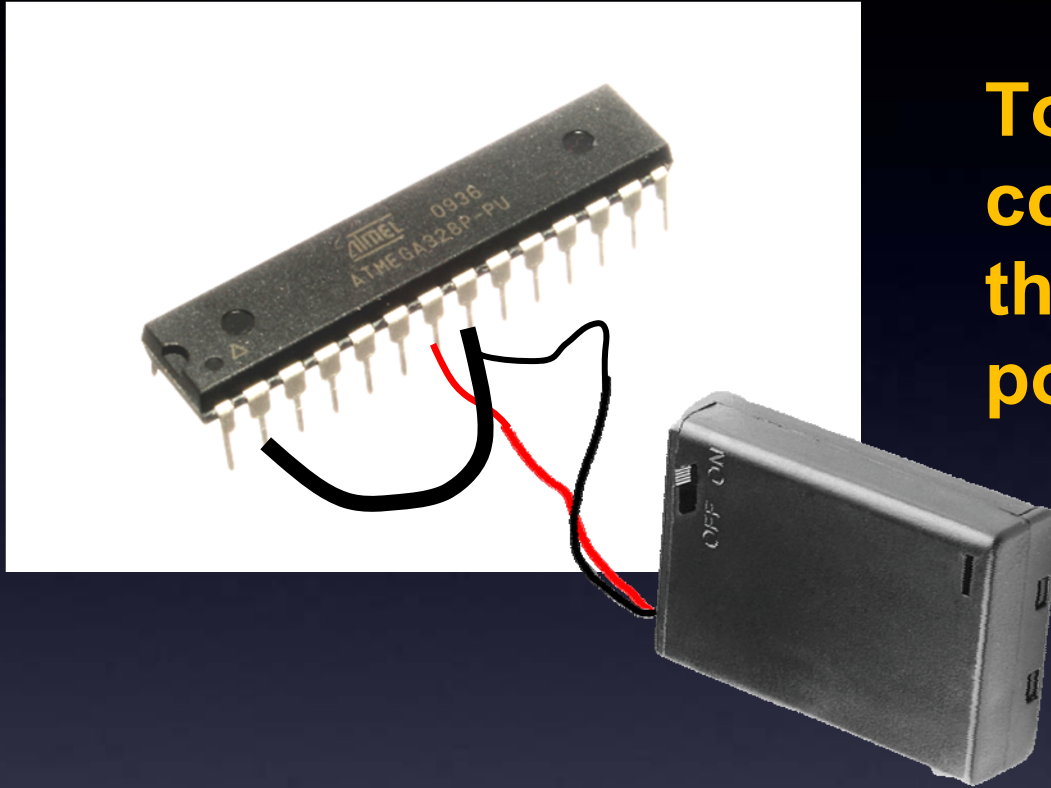
**We tell it to be one – with our program.**

***Any pin can be an Input pin (like, pin 2).***

**Only 2 choices: High or Low**

**Microcontroller – Input Pin**

# Everything You Need to Know About Electronics

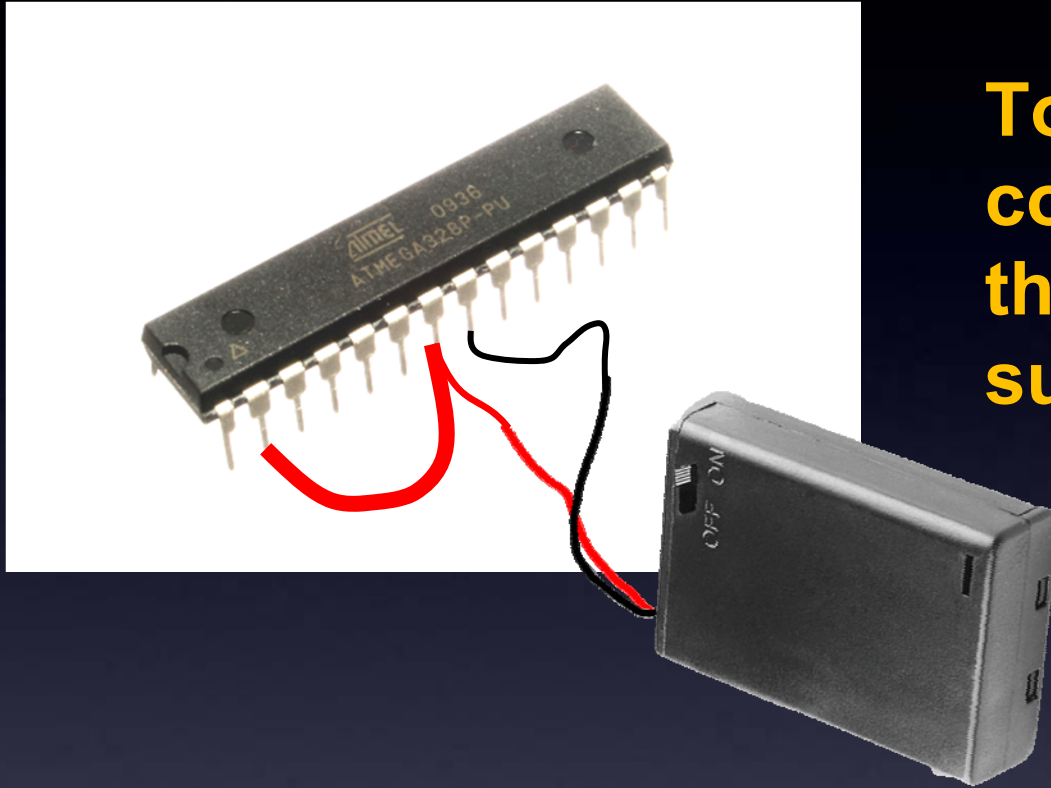


**To make the Input pin Low, connect it to the Black wire of our power supply (Ground).**

**Low**

Microcontroller – Input Pin

# Everything You Need to Know About Electronics



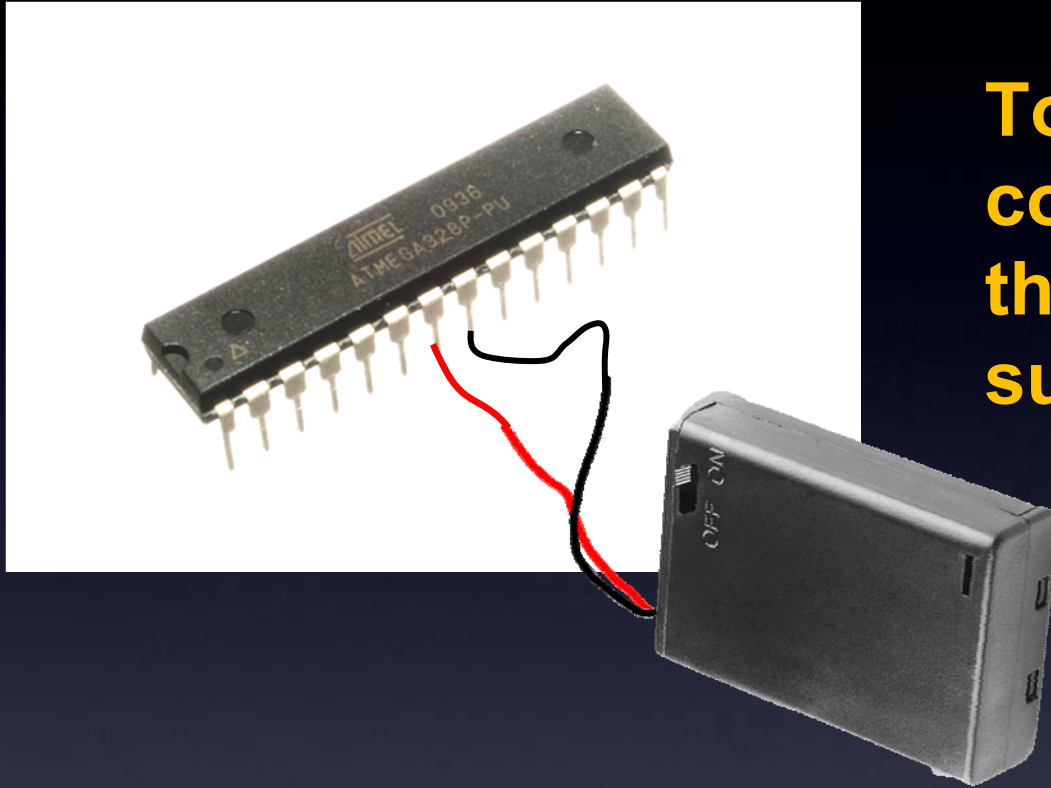
To make the Input pin High, connect it to the Red wire of our power supply (Vcc).

High

Microcontroller – Input Pin



# Everything You Need to Know About Electronics



To make the Input pin High, connect it to the Red wire of our power supply (Vcc).

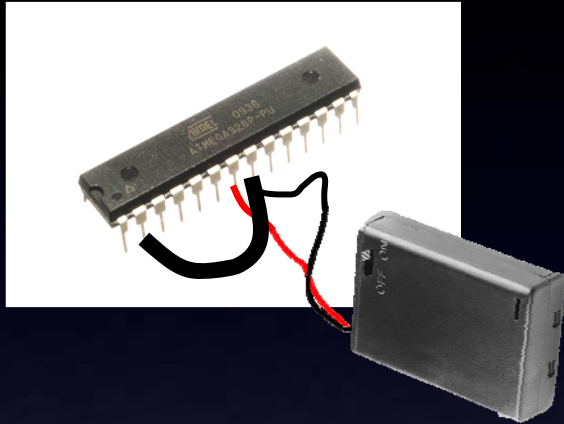
OR:

just leave it blank

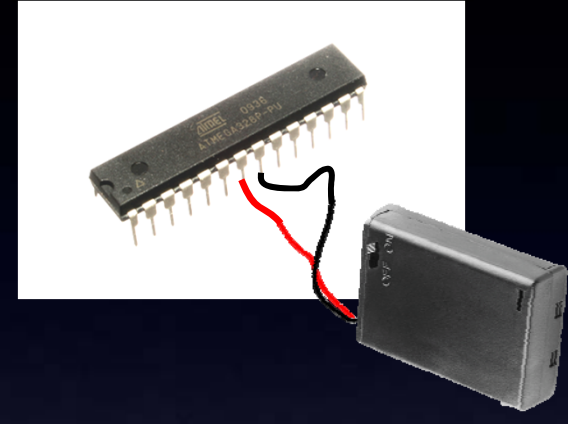
High

Microcontroller – Input Pin

# Everything You Need to Know About Electronics



If firmware looks at  
Pin 2 when it's like this,  
it reports back:  
**Low**

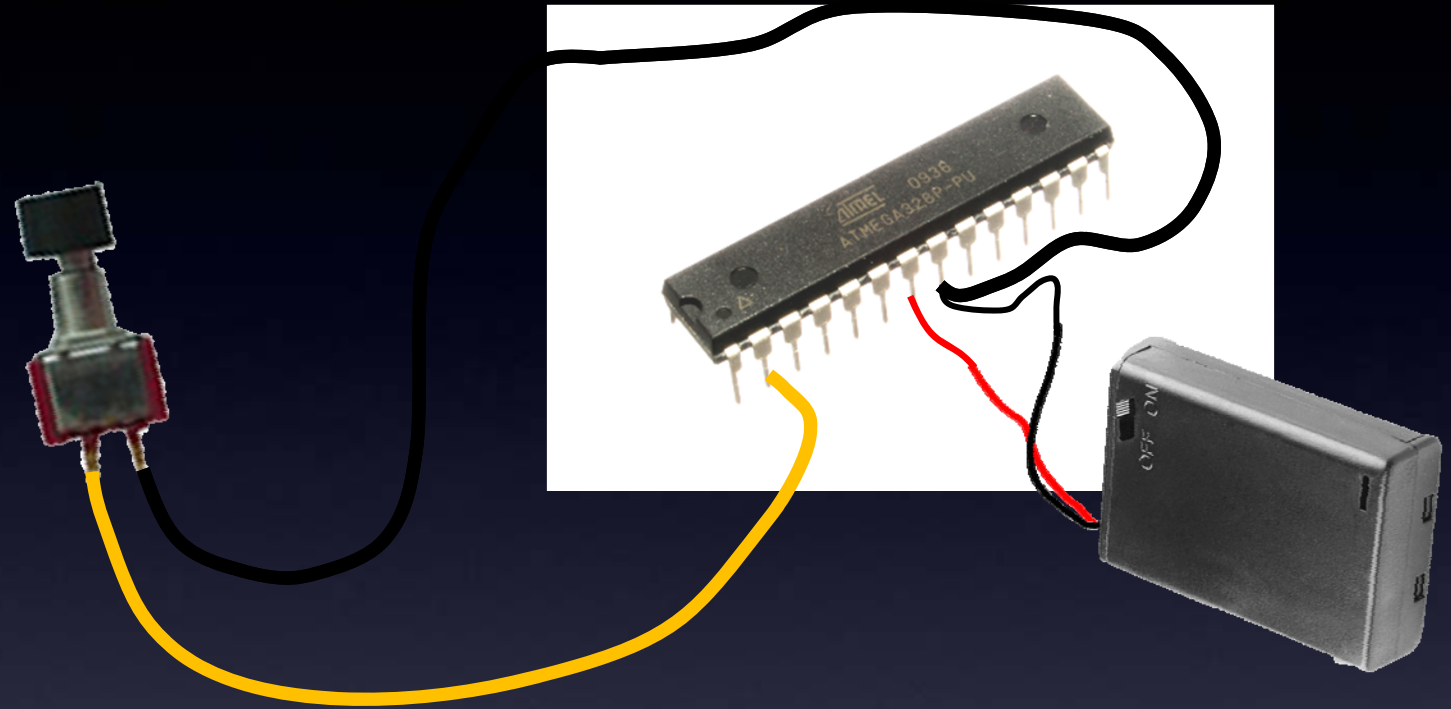


If firmware looks at  
Pin 2 when it's like this,  
it reports back:  
**High**

**Reading the Input pin**

Microcontroller – Input Pin

# Everything You Need to Know About Electronics

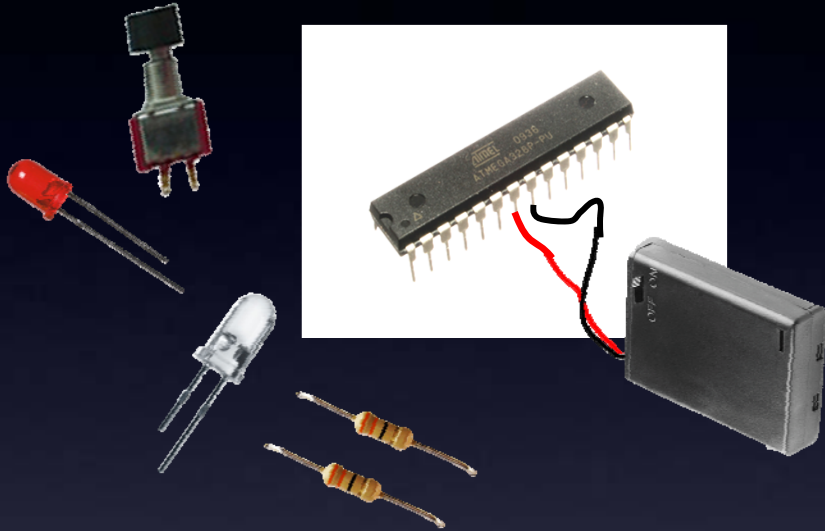


Reading the Input pin with a Switch

Microcontroller – Input Pin

# Everything You Need to Know About Electronics

## Hardware



## Firmware

Pin 13 Output – visible LED pin

Pin 3 Output – IR LED pin

Pin 2 Input – Push Button

Wait for Switch to be Low

Blink visible LED:

High, Delay, Low

Pulse IR LED for Sony “OFF” code:

High, Delay, Low, Delay...

Blink visible LED:

High, Delay, Low

Pulse IR LED for Panasonic “OFF” code:

High, Delay, Low, Delay...

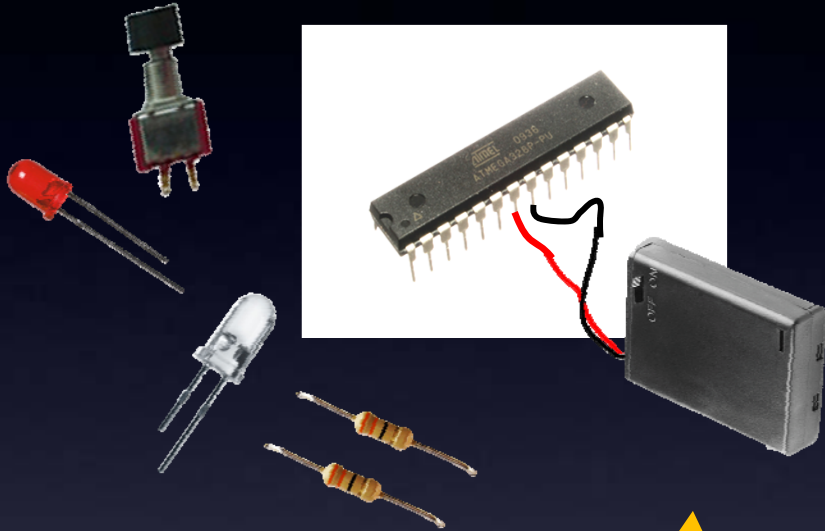
Etc for all “OFF” codes

## TV-B-Gone remote control

## Microcontroller

# Everything You Need to Know About Electronics

## Hardware



**Except**

**TV-B-Gone remote control**

**Microcontroller**

## Firmware

**Pin 13 Output – visible LED pin**

**Pin 3 Output – IR LED pin**

**Pin 2 Input – Push Button**

**Wait for Switch to be Low**

**Blink visible LED:**

**High, Delay, Low**

**Pulse IR LED for Sony “OFF” code:**

**High, Delay, Low, Delay...**

**Blink visible LED:**

**High, Delay, Low**

**Pulse IR LED for Panasonic “OFF” code:**

**High, Delay, Low, Delay...**

**Etc for all “OFF” codes**

# Everything You Need to Know About Electronics

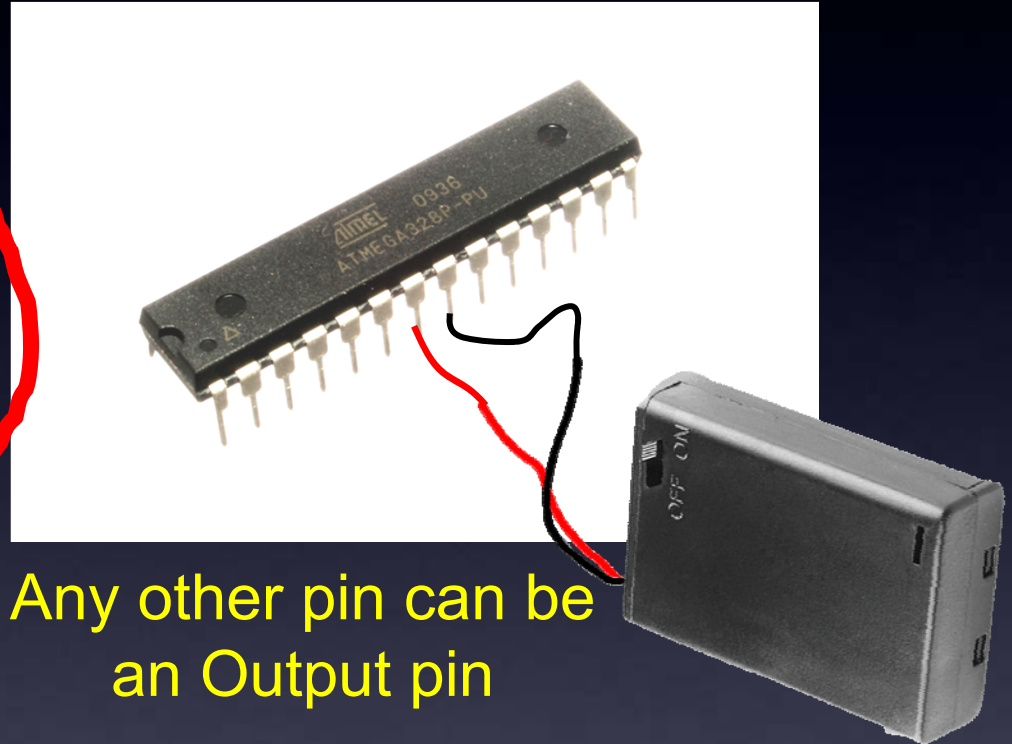
## Review:

Low

Off  
(0V)

High

almost the same  
as the Red wire  
of the power supply



Any other pin can be  
an Output pin

Output pin – only 2 choices: High or Low

Microcontroller – Output Pin

# Everything You Need to Know About Electronics

Low

Off  
(0V)

High

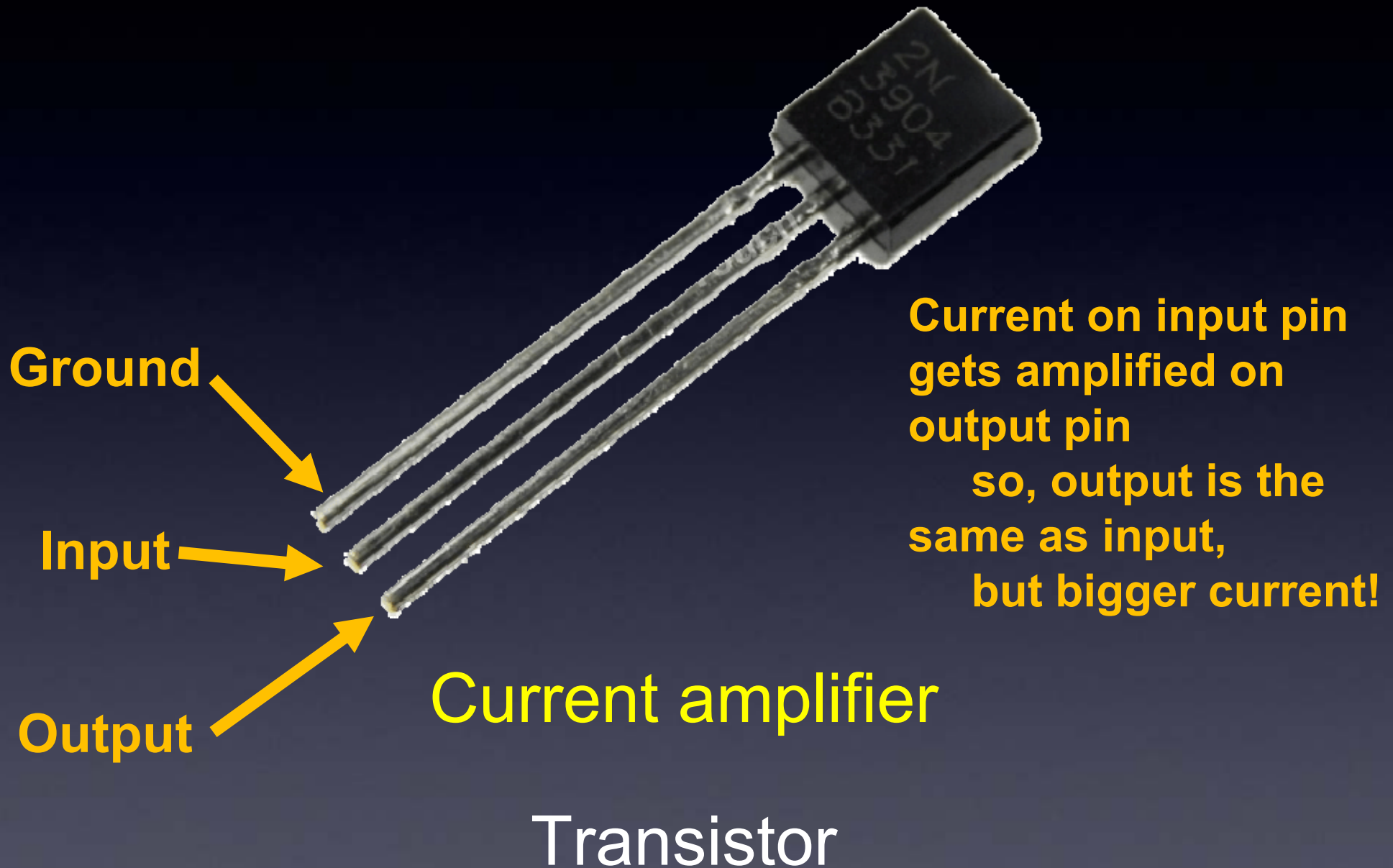
almost the same  
as the Red wire  
of the power supply

So,  
IR LED  
can only light up  
dimly  
from the output pin

Output pin – only limited current

Microcontroller – Output Pin

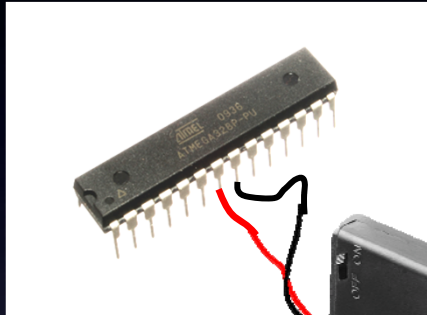
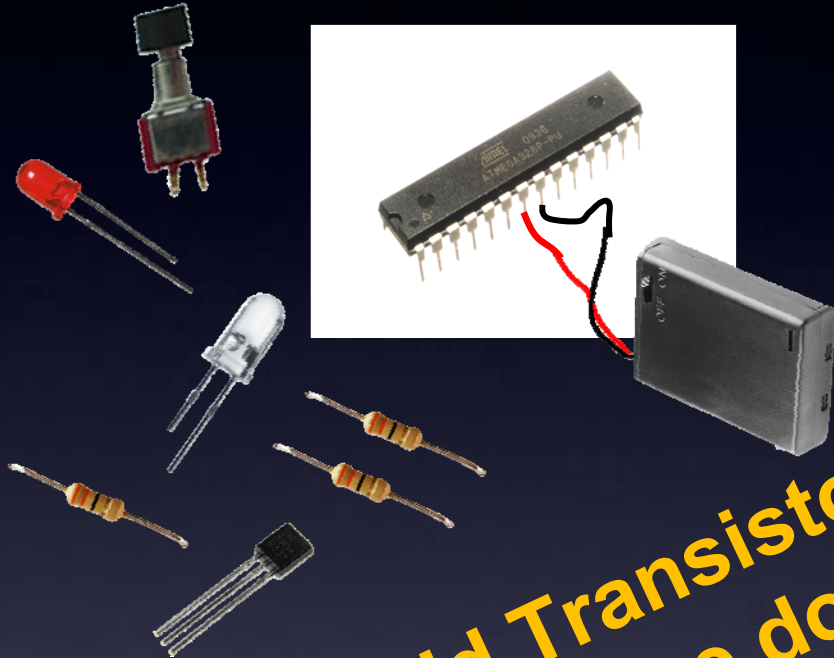
# Everything You Need to Know About Electronics





# Everything You Need to Know About Electronics

## Hardware



**Add Transistor  
and, we're done!**

## Firmware

Pin 13 Output – visible LED pin

Pin 3 Output – IR LED pin

Pin 2 Input – Push Button

Wait for Switch to be Low

Blink visible LED:

High, Delay, Low

Pulse IR LED for Sony “OFF” code:

High, Delay, Low, Delay...

Blink visible LED:

High, Delay, Low

Pulse IR LED for Panasonic “OFF” code:

High, Delay, Low, Delay...

Etc for all “OFF” codes

**TV-B-Gone remote control – we're done!**

Microcontroller

Everything You Need to Know About Electronics

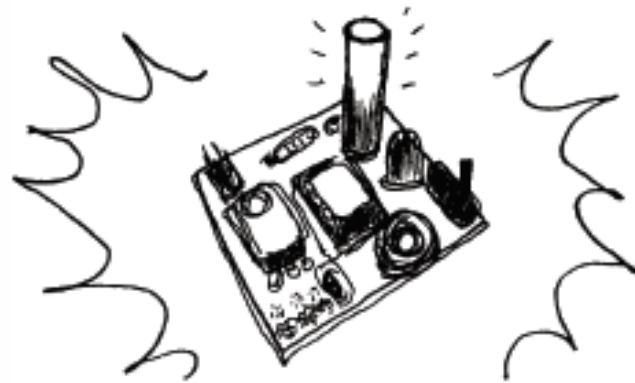
Questions?

# Learn To Solder



## **SOLDERING IS EASY**

HERE'S HOW TO DO IT



BY: **MITCH ALTMAN**  
(SOLDERING WISDOM)

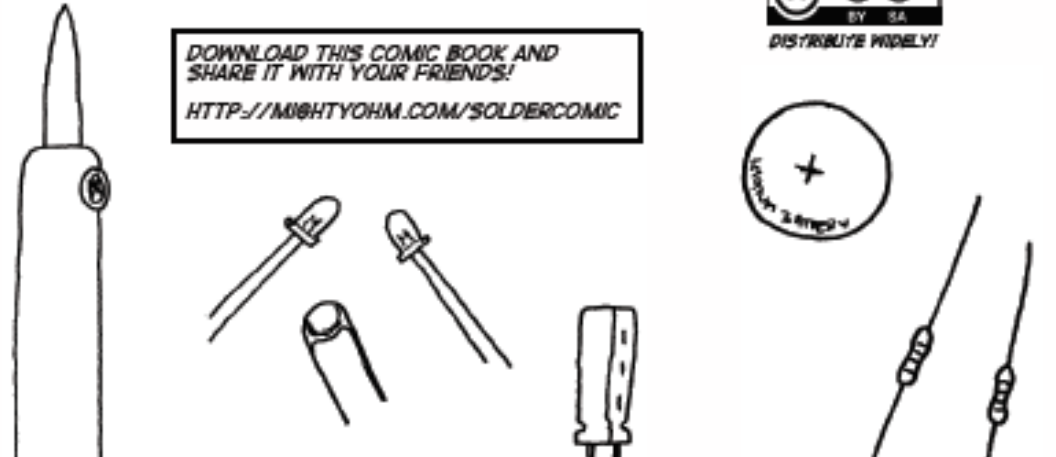
**ANDIE NORDGREN**  
(COMICS ADAPTATION)

**JEFF KEYZER**  
(LAYOUT AND EDITING)

DOWNLOAD THIS COMIC BOOK AND  
SHARE IT WITH YOUR FRIENDS!  
[HTTP://MIGHTYOEM.COM/SOLDERCOMIC](http://mightyoem.com/soldercomic)



DISTRIBUTE WIDELY!



# Diavolino

by Evil Mad Science

D6-RX D5 D4 D3 D2 D1-RX  
D8 D7 D6 D5 D4 D3 D2 D1  
D8 D7 D6 D5 D4 D3 D2 D1  
GND D13 D12 D11 D10  
AVCC

ATMEL 1020  
ATMEGA328P-PU

AT160FOX

evilmadscience.com

8.1k

8.1k

8.1k

green

black  
USB-TTL

USB

UCC

Ext. V<sub>in</sub> 4.5-5.5 VDC

GND

LED

XTAL  
Cap

GND

ICSP

DC Input - +

RST

Ucc

GND

GND

V<sub>in</sub>

R5 R4 R3 R2 R1 R0

75k 05

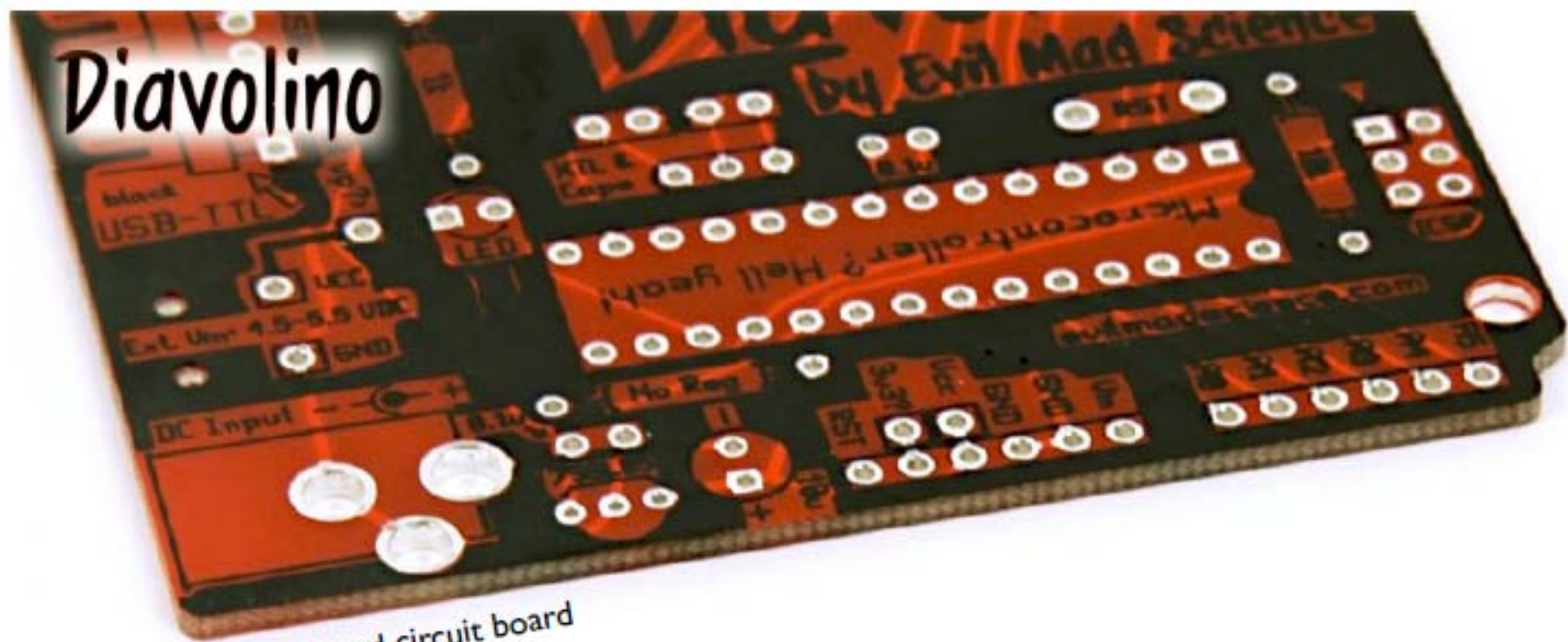
18u

D+

D-



# Diavolino



#1: Printed circuit board

#3: 1/4 W, 1 k resistor

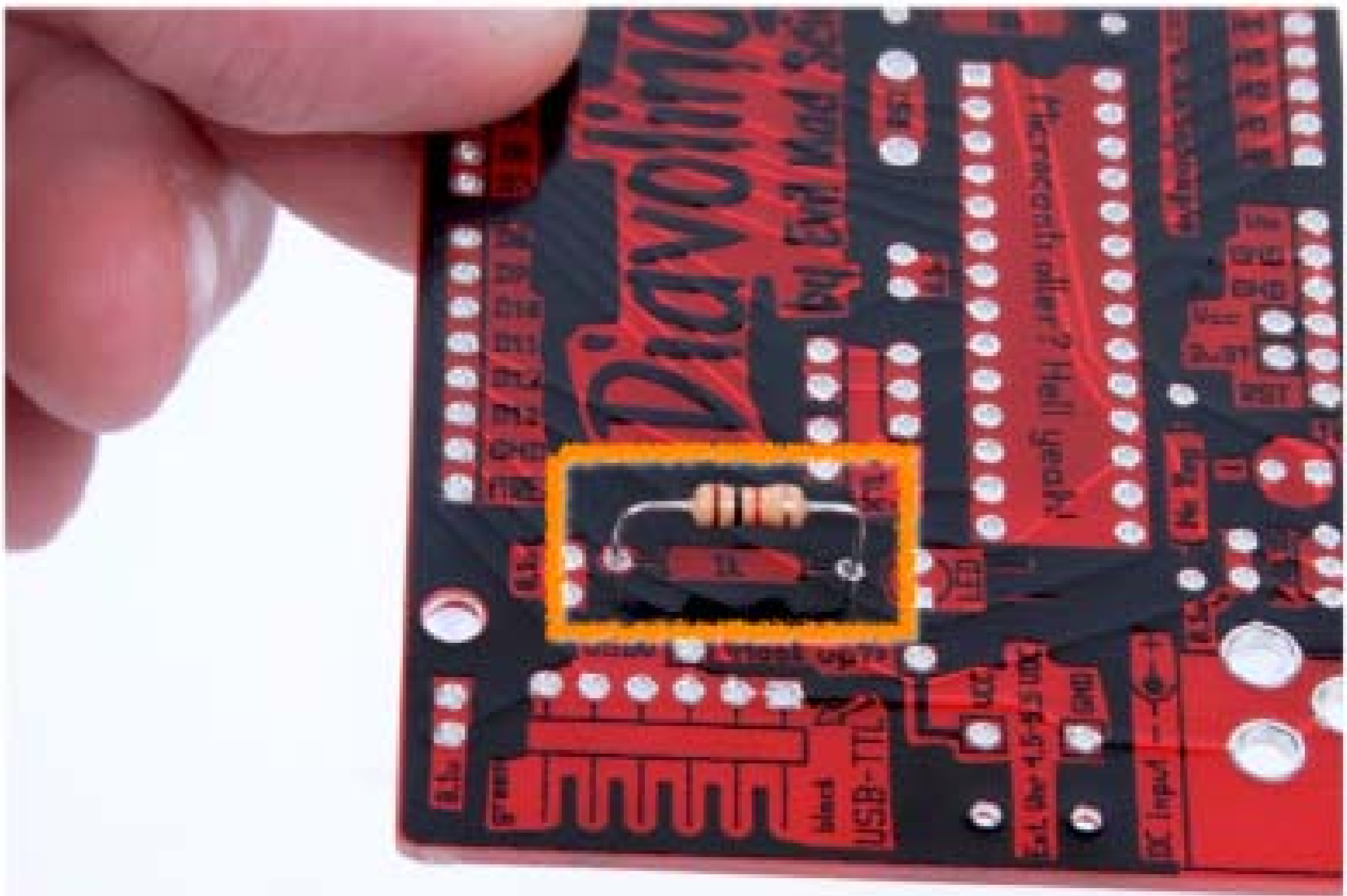
(AKA, the big one)



#4: 1/6 W, 10 k resistor

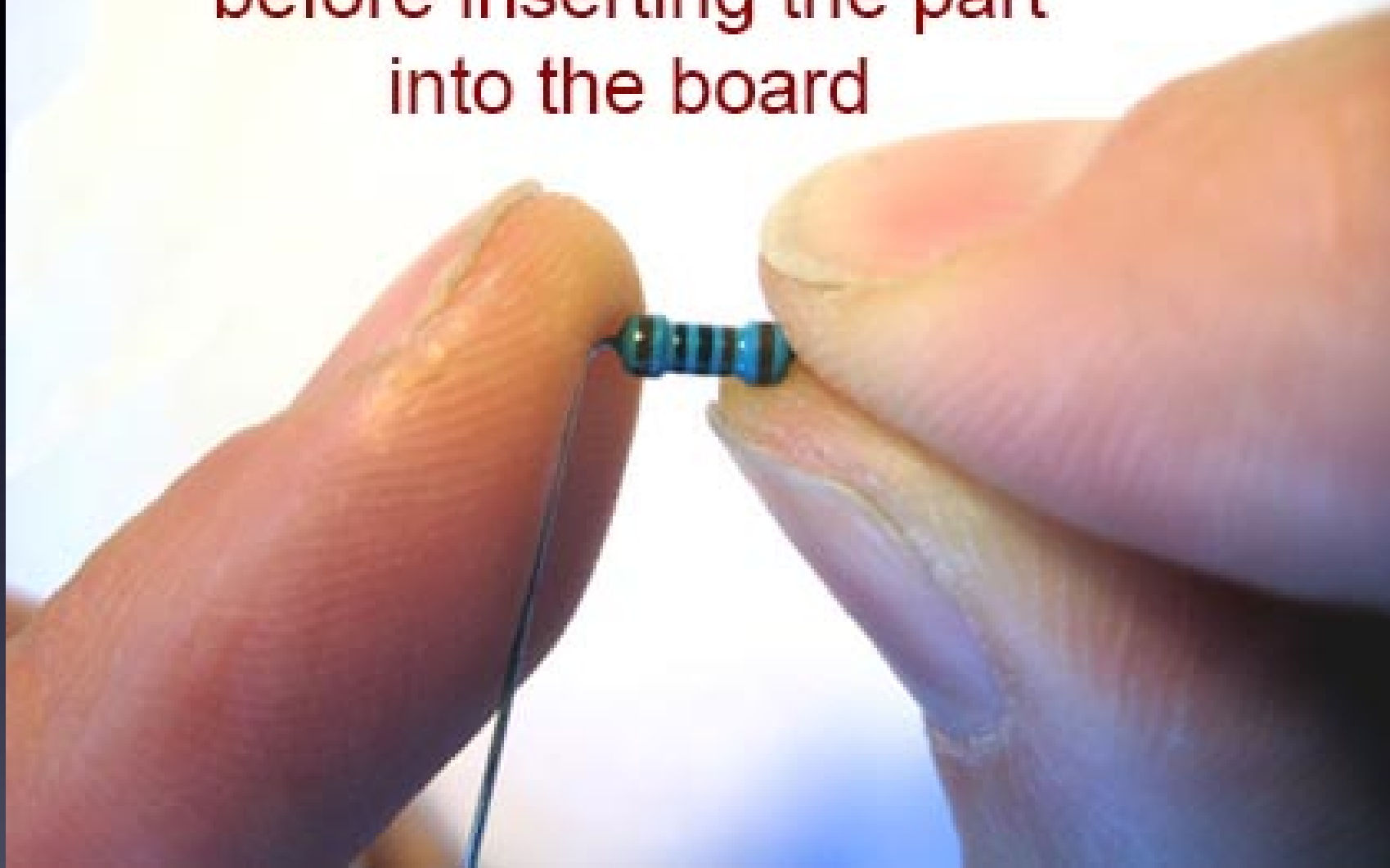
(AKA, the little one)



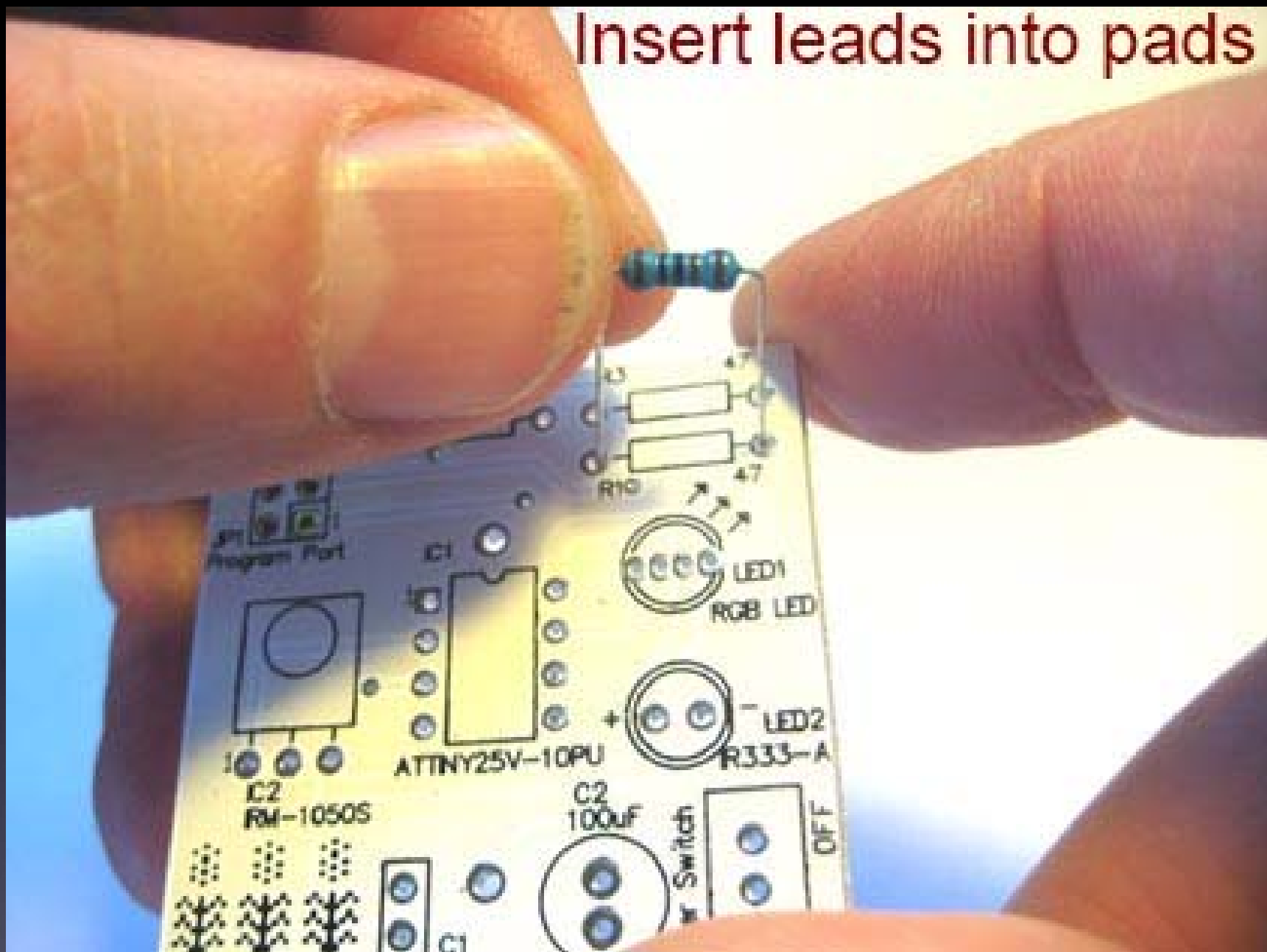


Insert the resistor in the "1k" location on the board.

Bend leads  
before inserting the part  
into the board

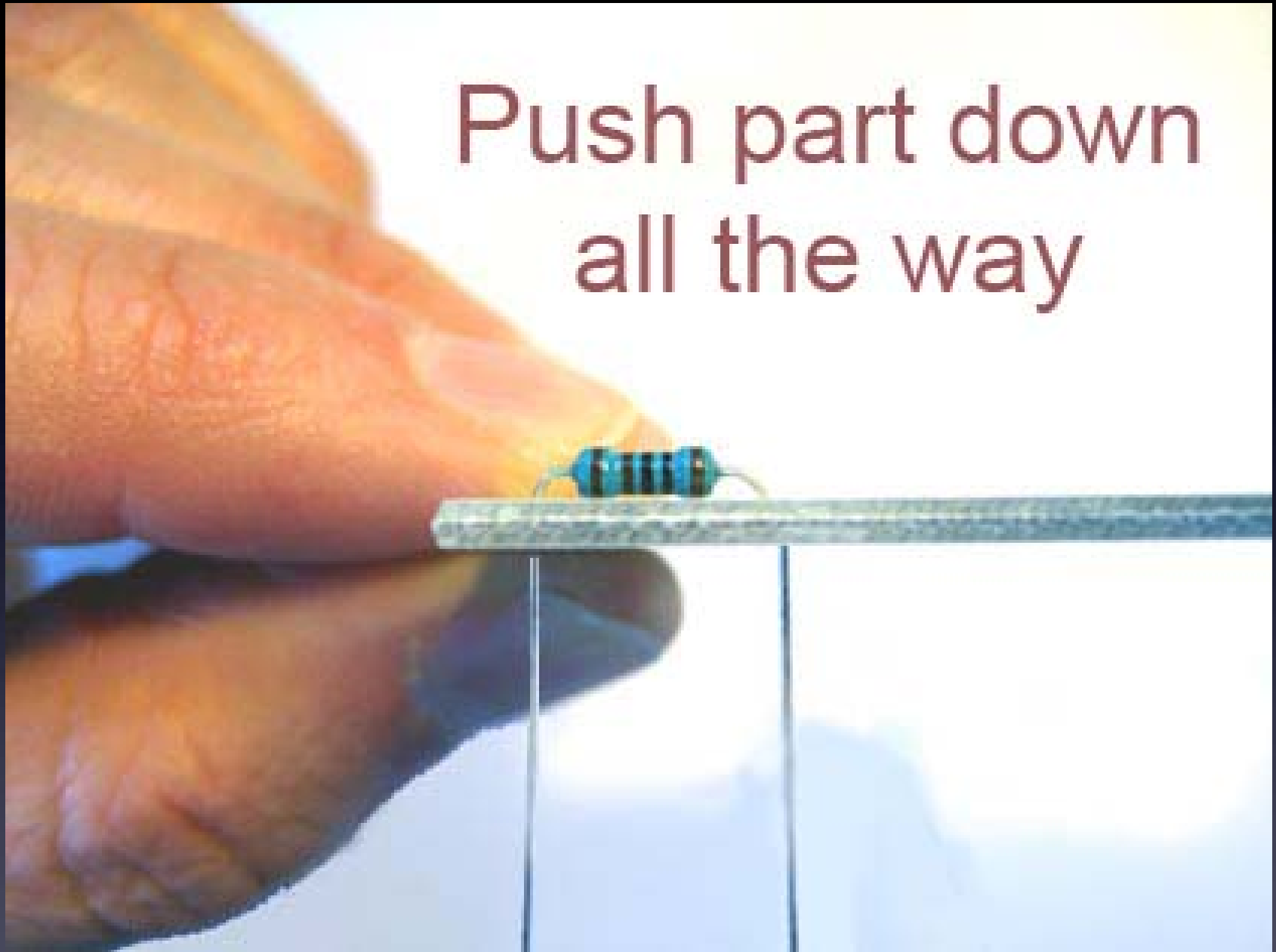


Insert leads into pads





Push part down  
all the way



A close-up photograph of a person's hand holding a thin metal wire. A small blue resistor with four black bands is attached to the wire. The wire is being bent downwards at a sharp angle. The background is a bright, slightly blurred sky. The text 'Upside down' is written in a dark red font at the top of the image. The text 'Wires bent half way out' is written in a dark red font on the left side of the image, with the word 'half' underlined.

Upside down

Wires bent  
half way  
out

# How to hold a soldering iron

The perfect kind of  
solder for electronics:

60/40 rosin core,  
0.031" diameter

# 3 Safety Tips...

Safety Tip #1:

Hot !!

Safety Tip #2:

Lead (Pb) is toxic

Safety Tip #3:

*(coming soon)*



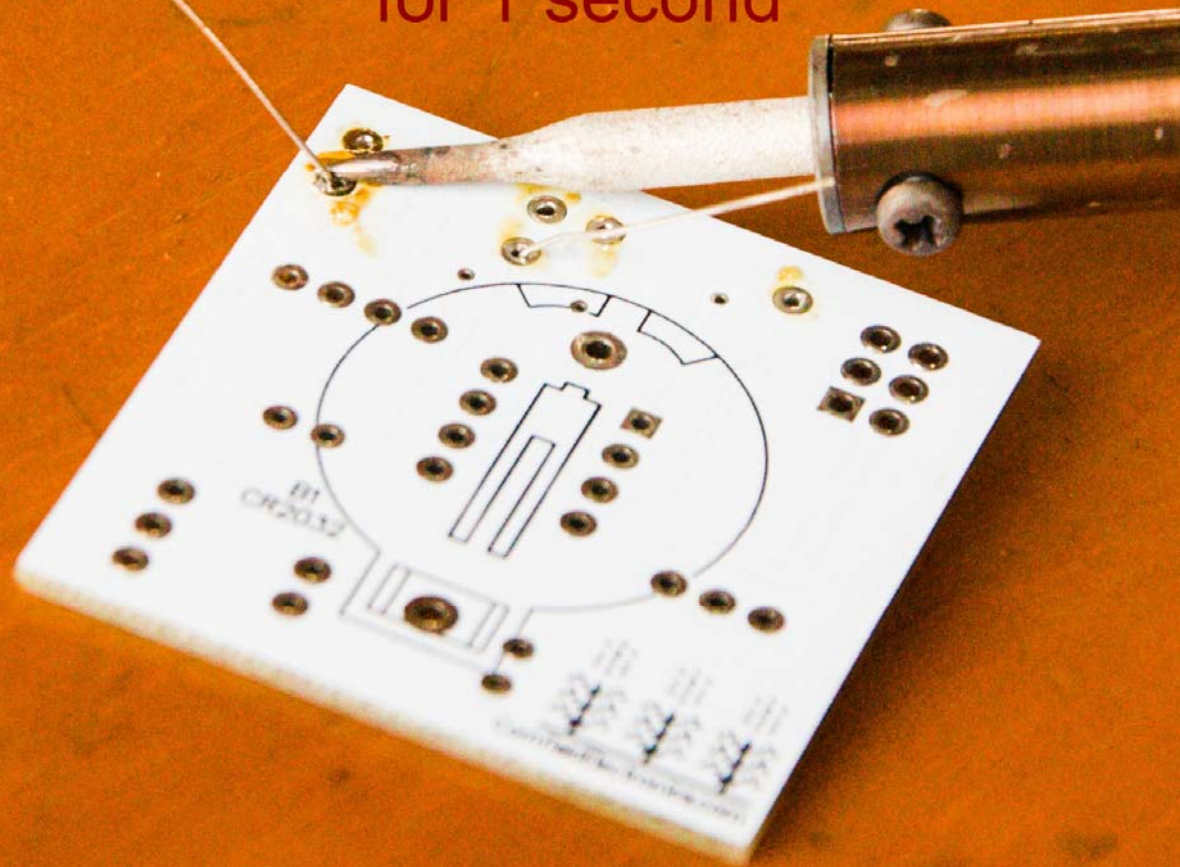
2 secrets  
to good soldering...

Secret #1:

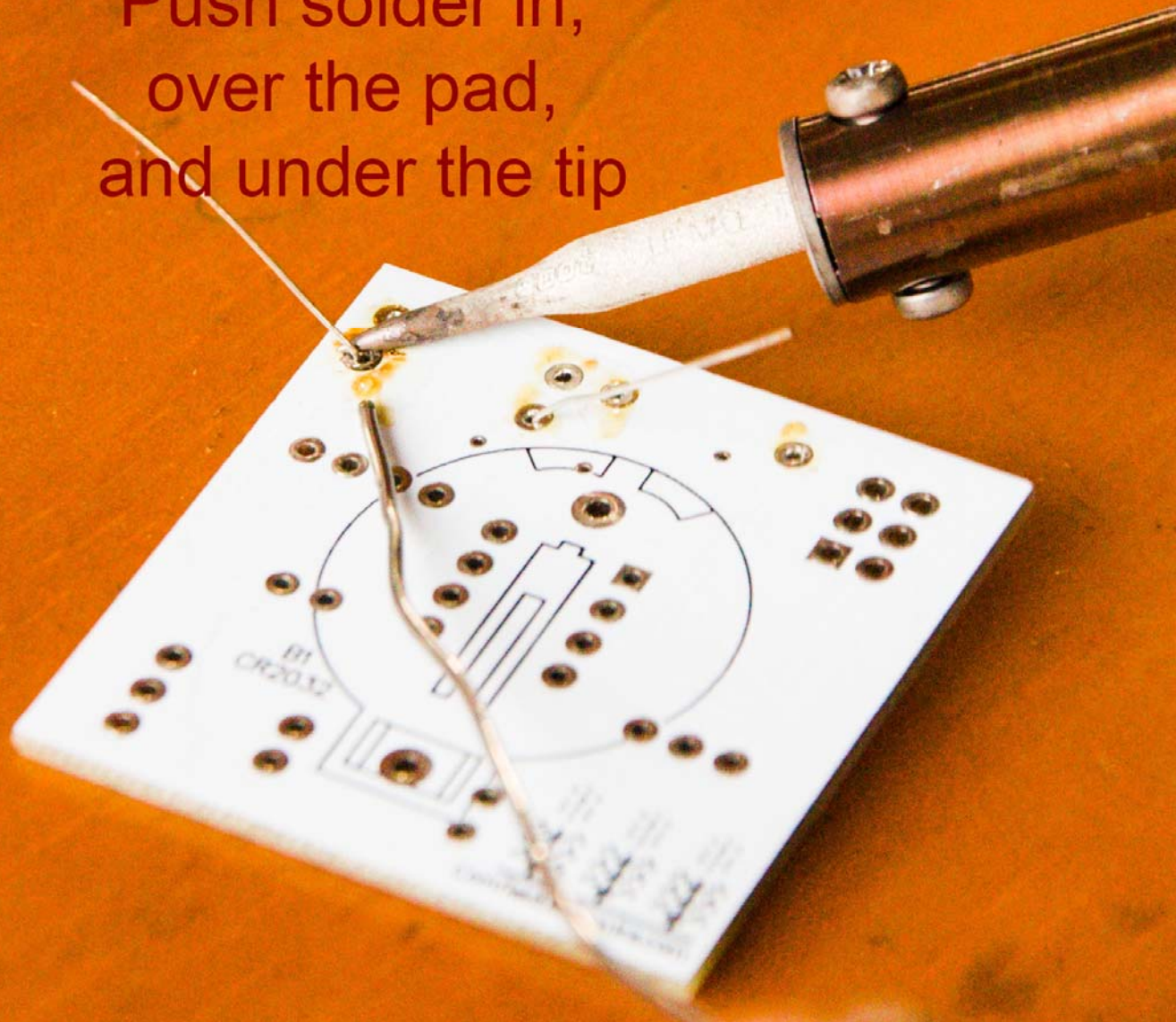
Clean the tip!

Bang 3 times,  
Swipe, Rotate, Swipe

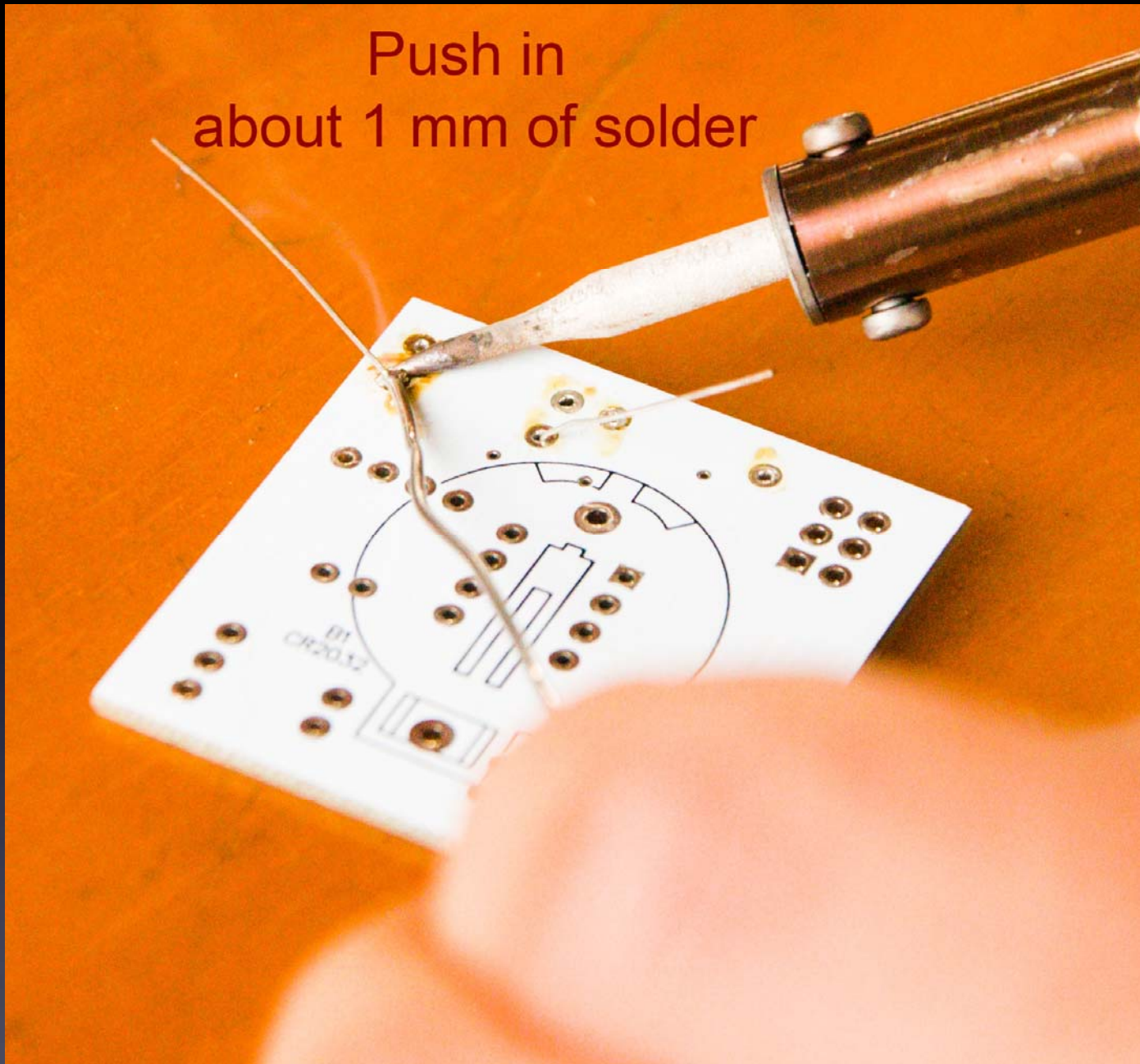
Lay clean tip across half of the pad,  
touching the pad and lead  
for 1 second

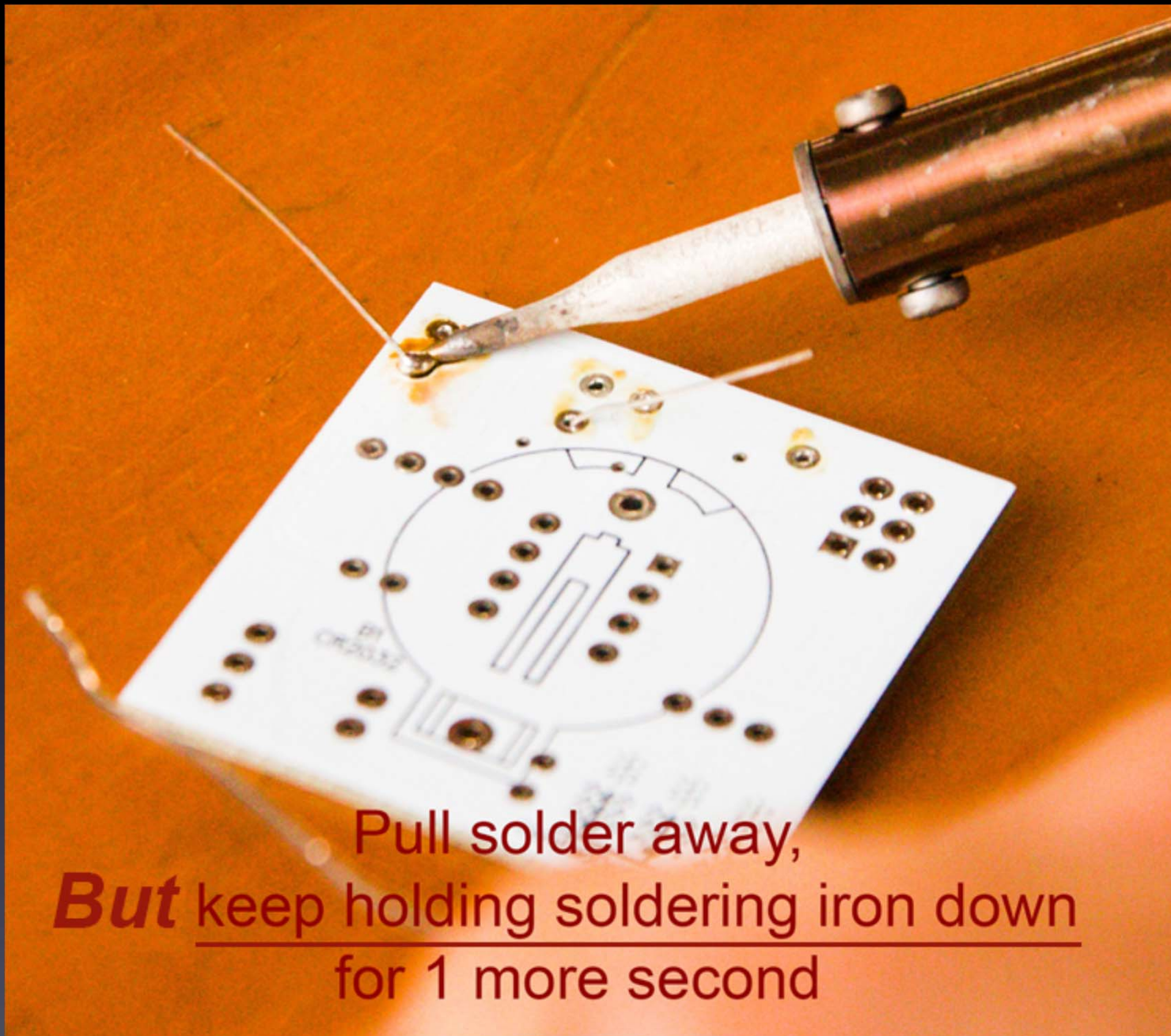


Push solder in,  
over the pad,  
and under the tip



Push in  
about 1 mm of solder

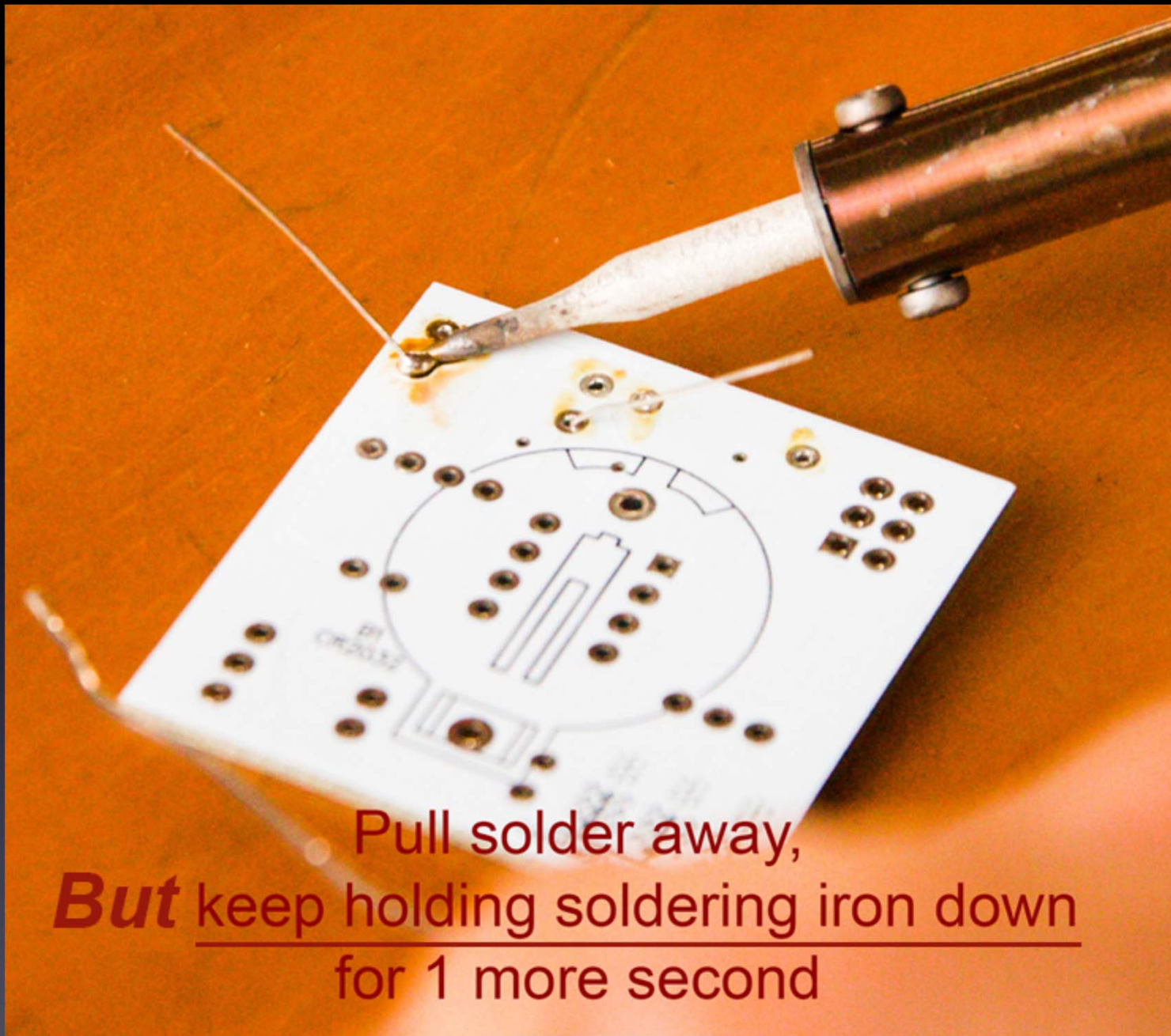




Pull solder away,  
***But*** keep holding soldering iron down  
for 1 more second

# Secret #2:

Keep hot tip down  
1 second  
for solder to flow !!

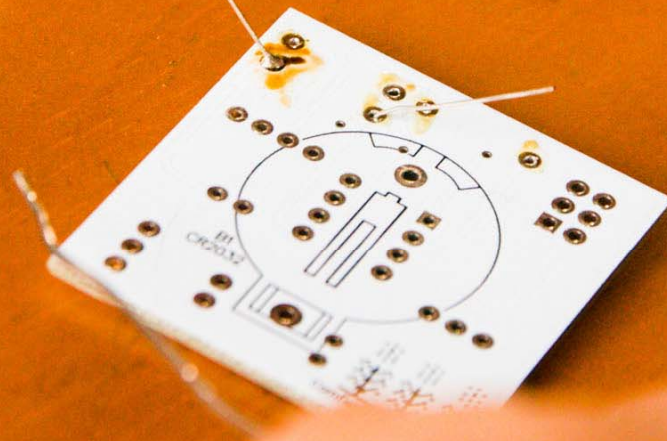


Pull solder away,  
***But*** keep holding soldering iron down  
for 1 more second

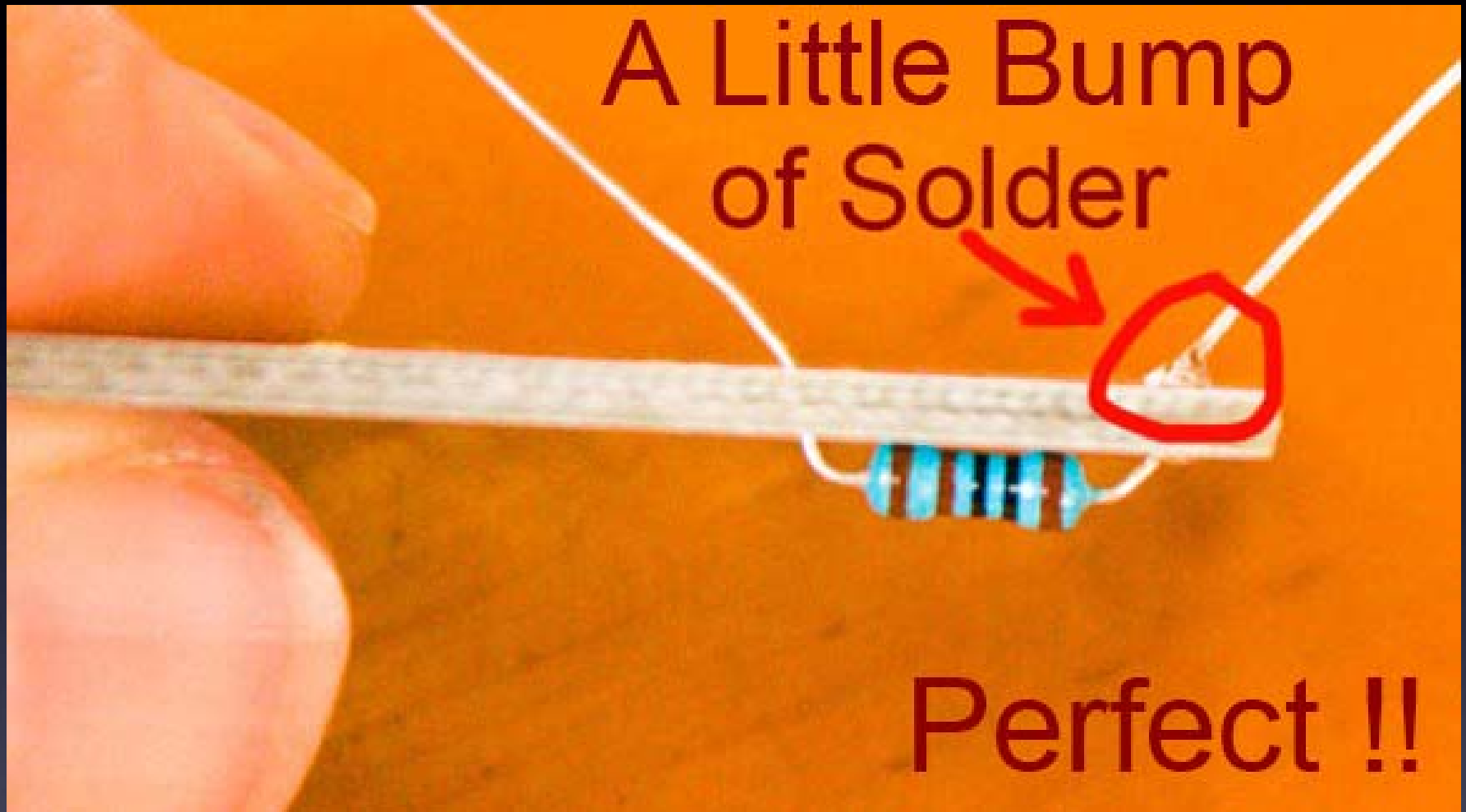


**Now**

**Lift soldering iron**

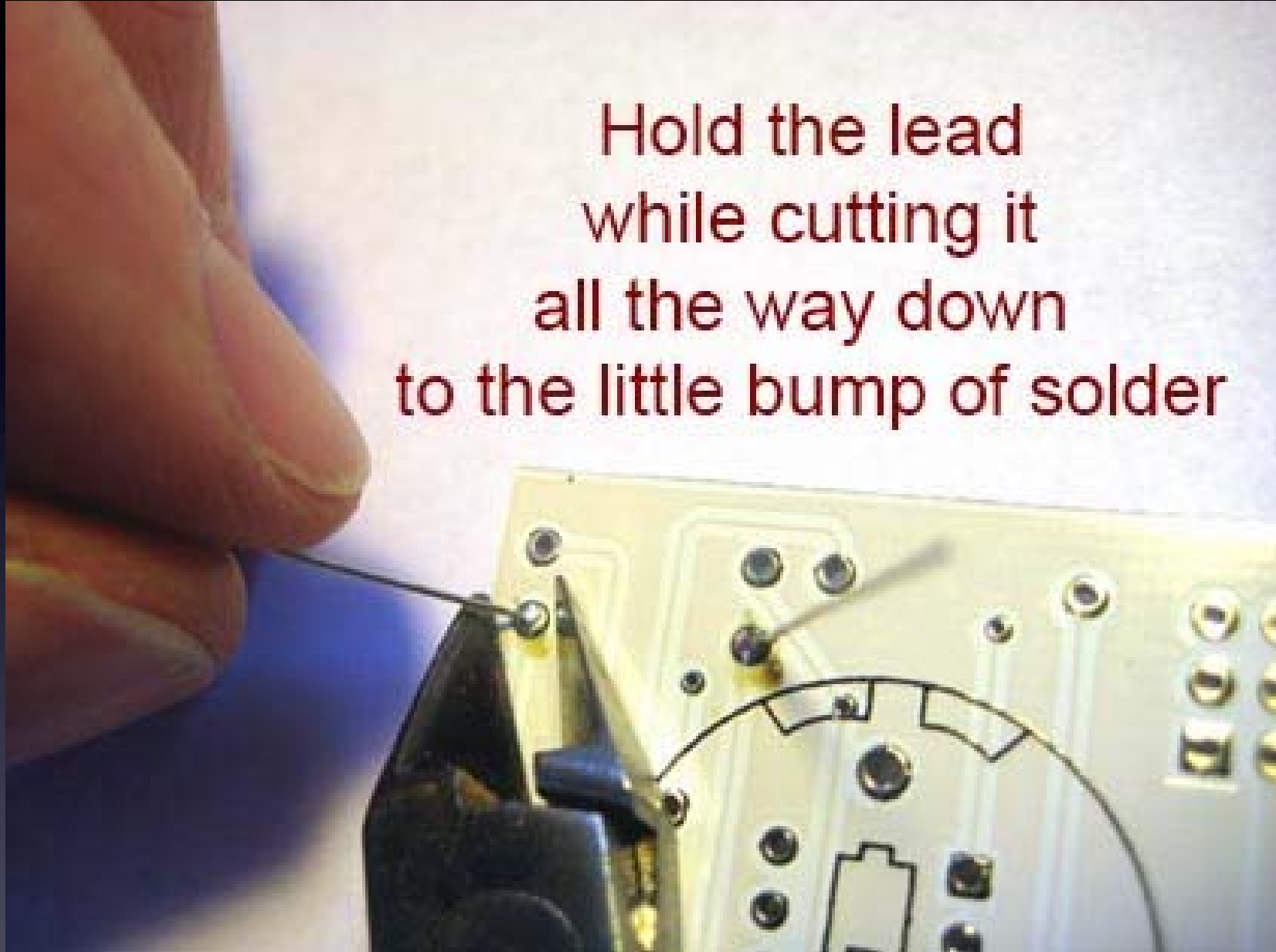


A Little Bump  
of Solder



Perfect !!

Hold the lead  
while cutting it  
all the way down  
to the little bump of solder



Safety Tip #3:

Hold or cover the lead !



All done !

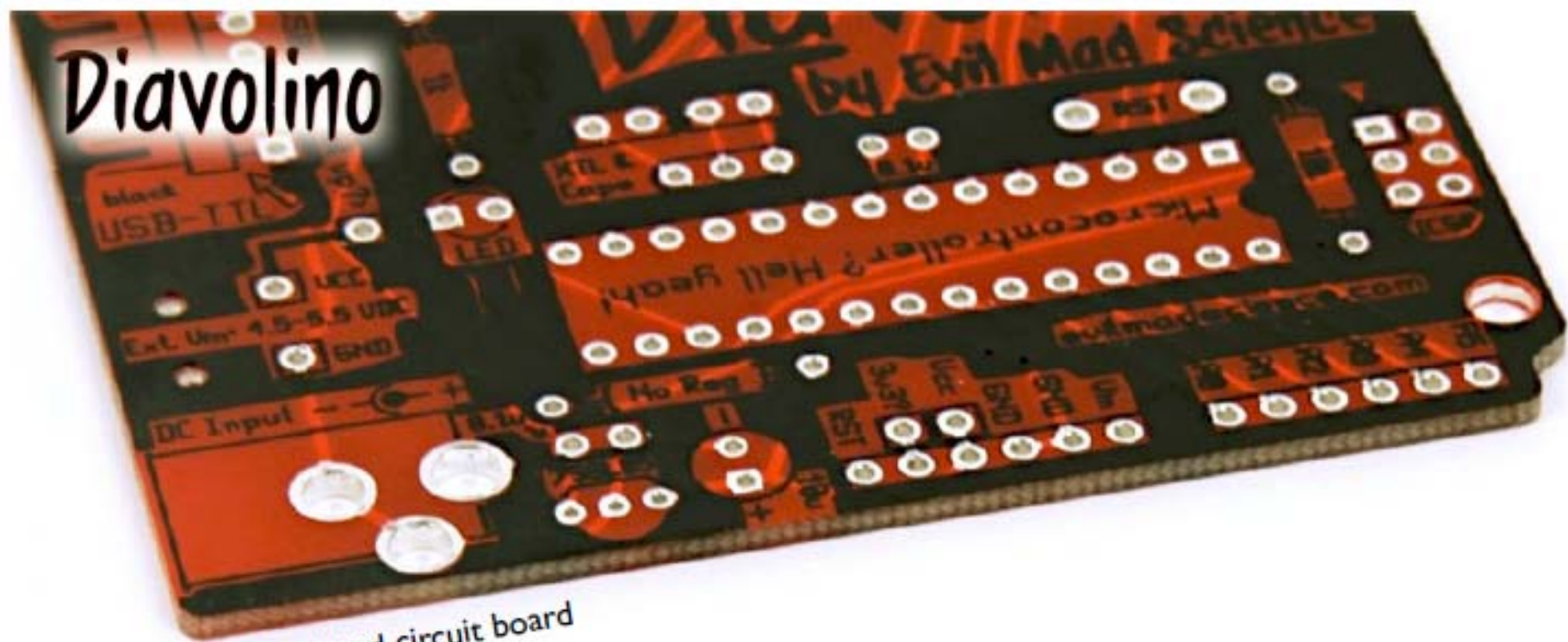
One part at a time

Till all the parts are soldered





# Diavolino



#1: Printed circuit board

#3: 1/4 W, 1 k resistor

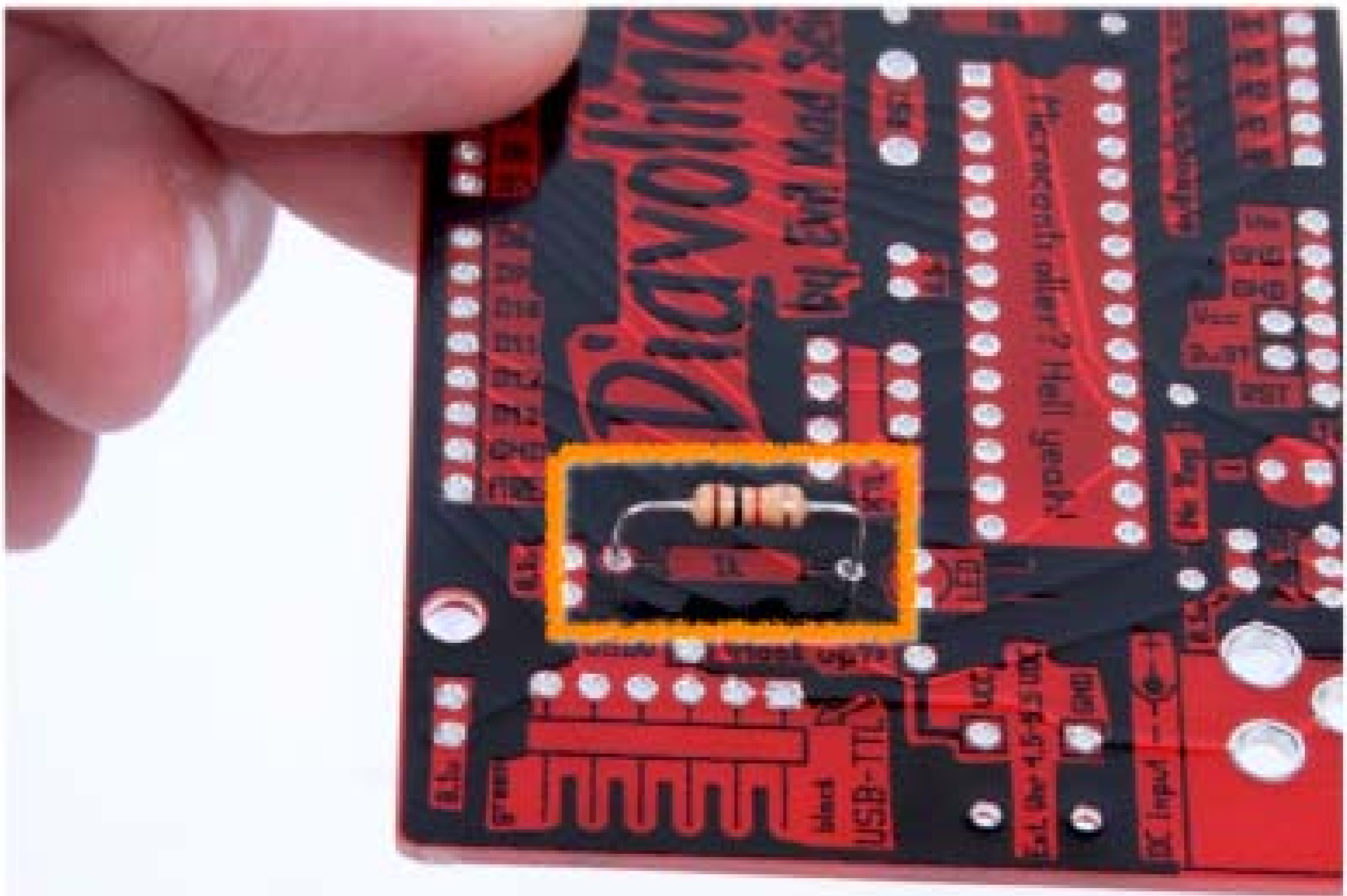
(AKA, the big one)



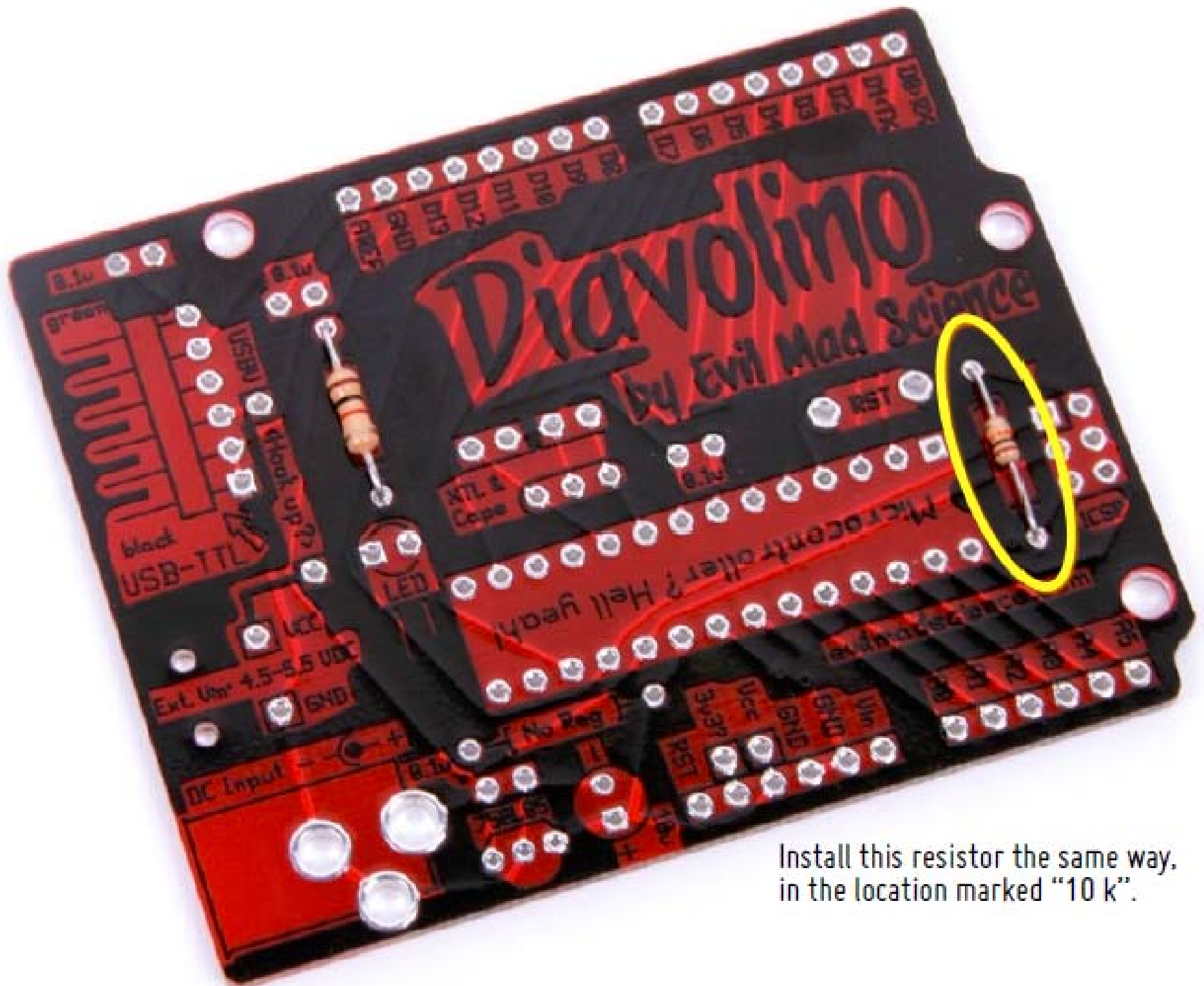
#4: 1/6 W, 10 k resistor

(AKA, the little one)





Insert the resistor in the "1k" location on the board.

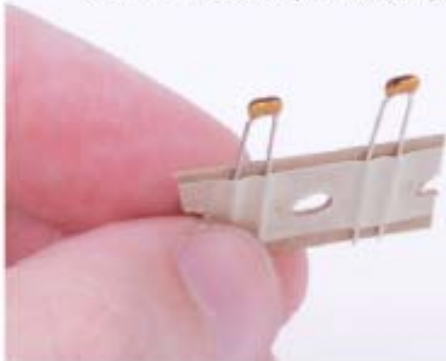


Install this resistor the same way, in the location marked "10 k".

# Diavolino

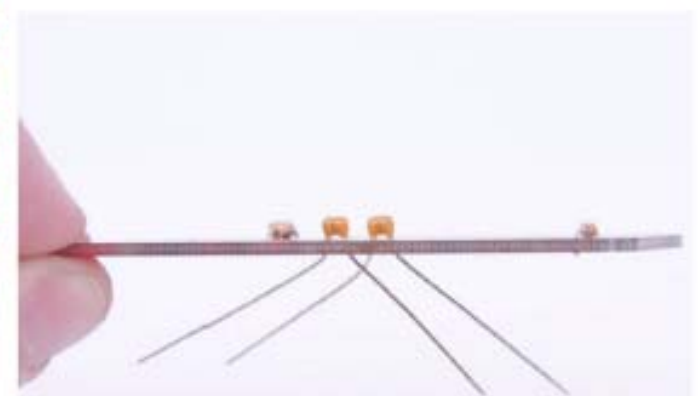
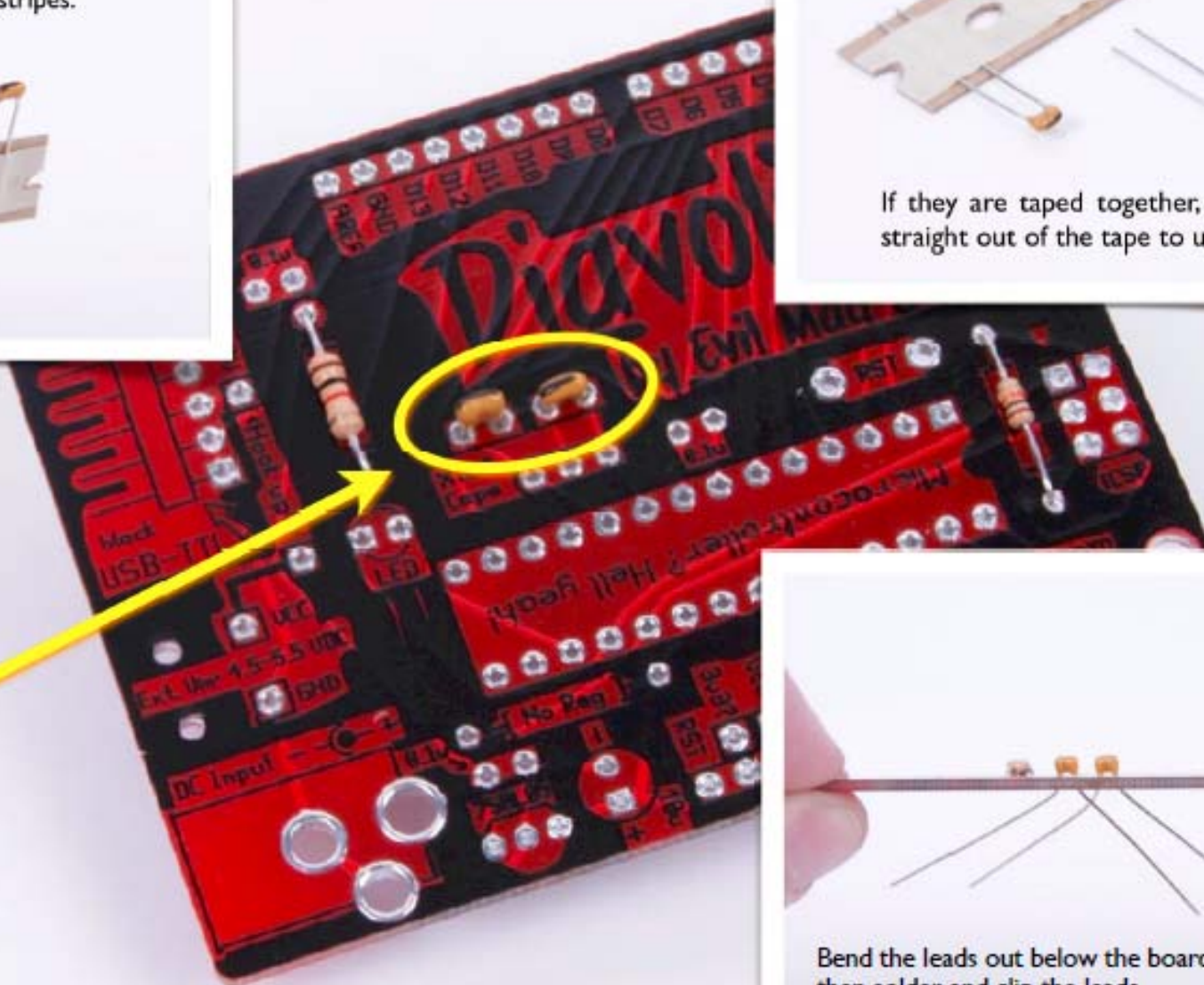
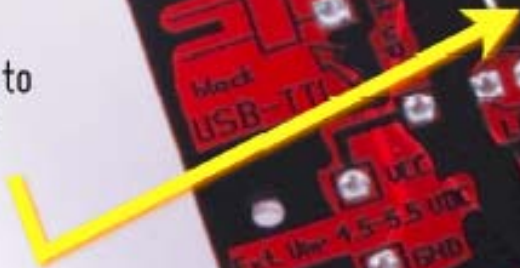
18 pF caps, #5

The two 18 pF capacitors in the kits are marked by black stripes.



If they are taped together, pull them straight out of the tape to use them.

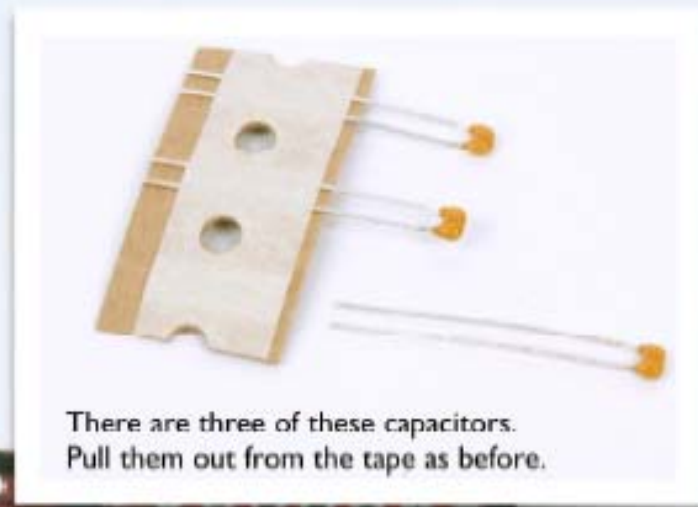
Add the two caps to the board here:



Bend the leads out below the board, then solder and clip the leads.

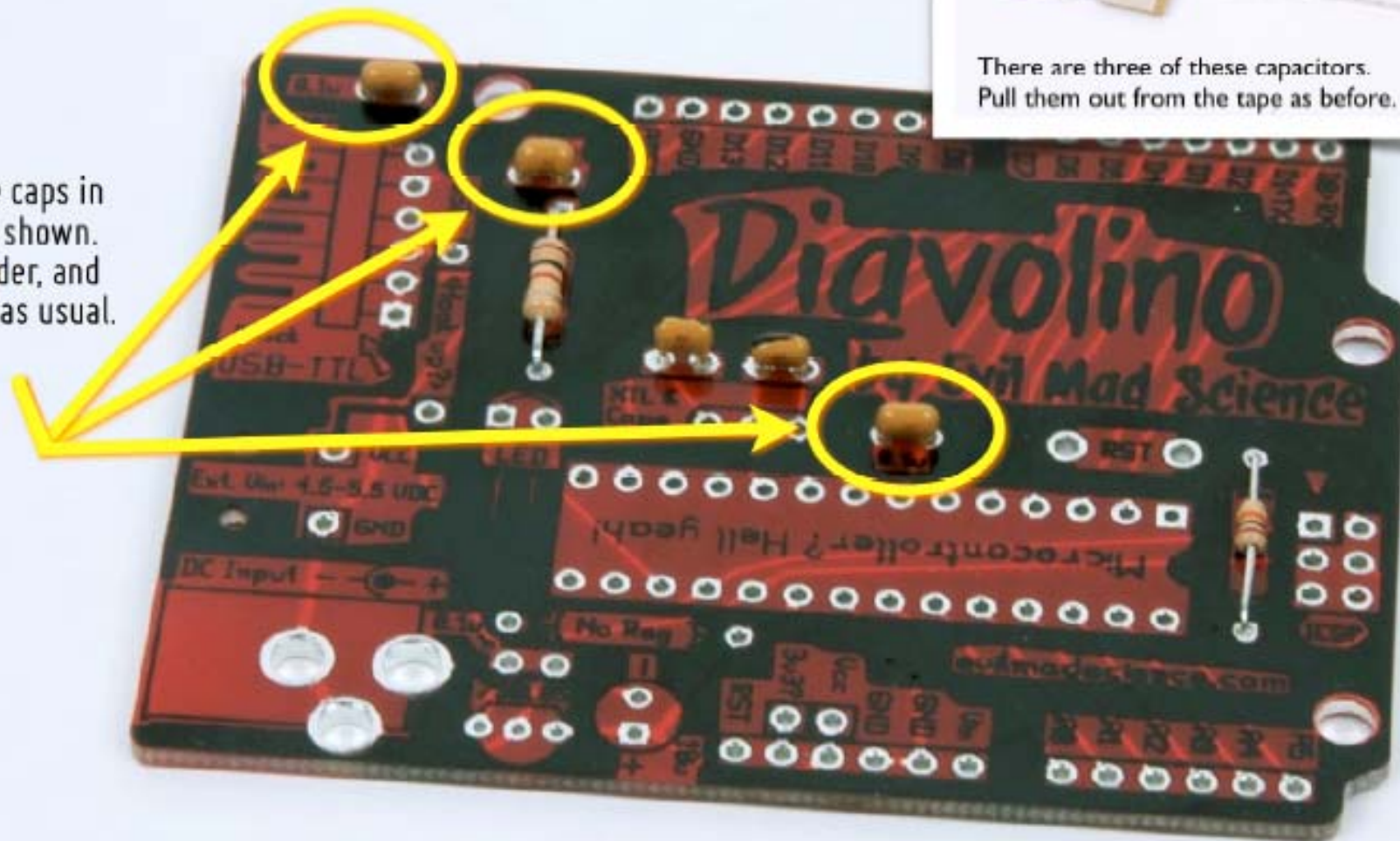
# Diavolino

0.1 uF caps, #6



There are three of these capacitors.  
Pull them out from the tape as before.

Add the three caps in the locations shown.  
Bend out, solder, and trim the leads as usual.

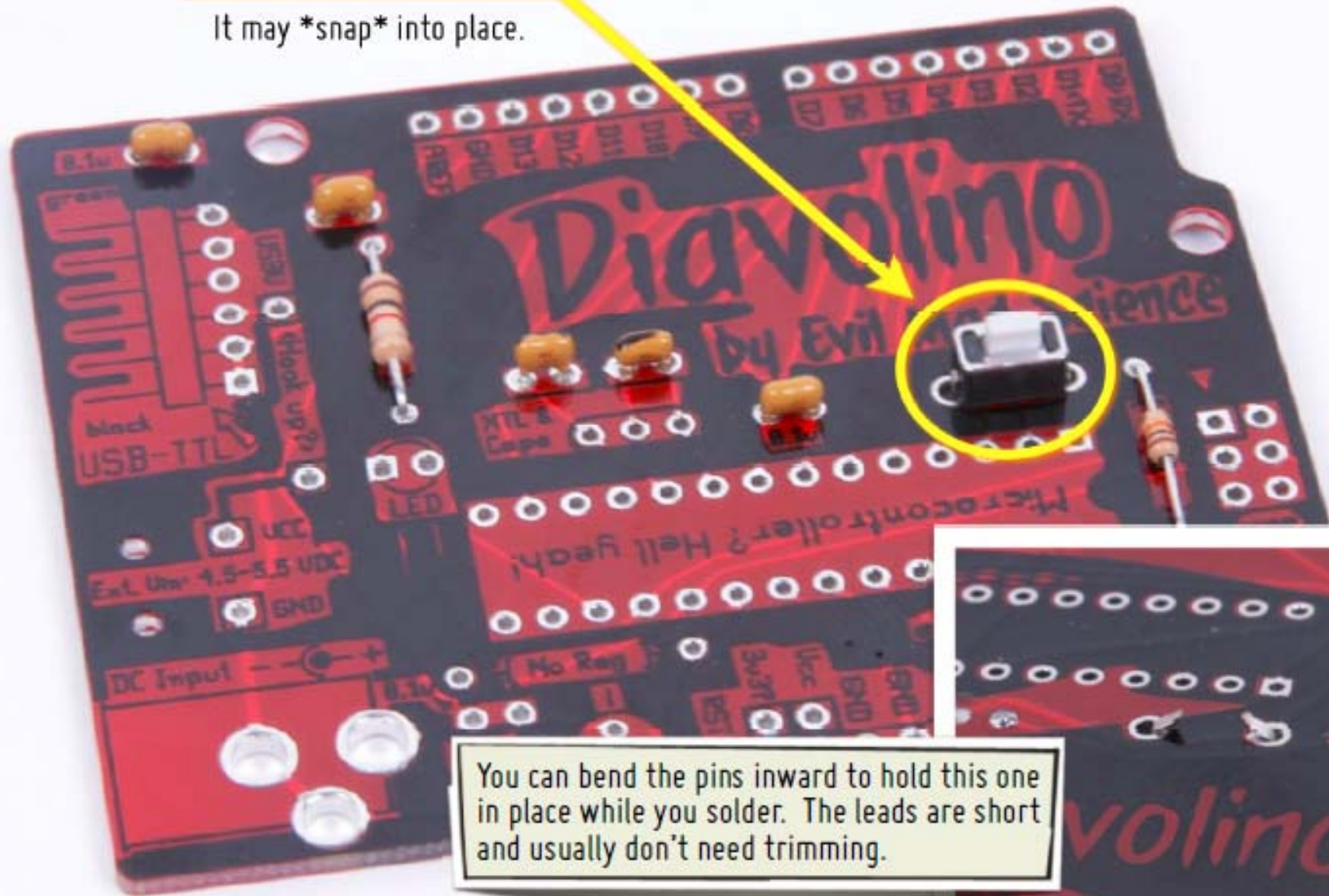


# Diavolino

Tactile button switch, #7

Insert the switch where shown.

It may \*snap\* into place.

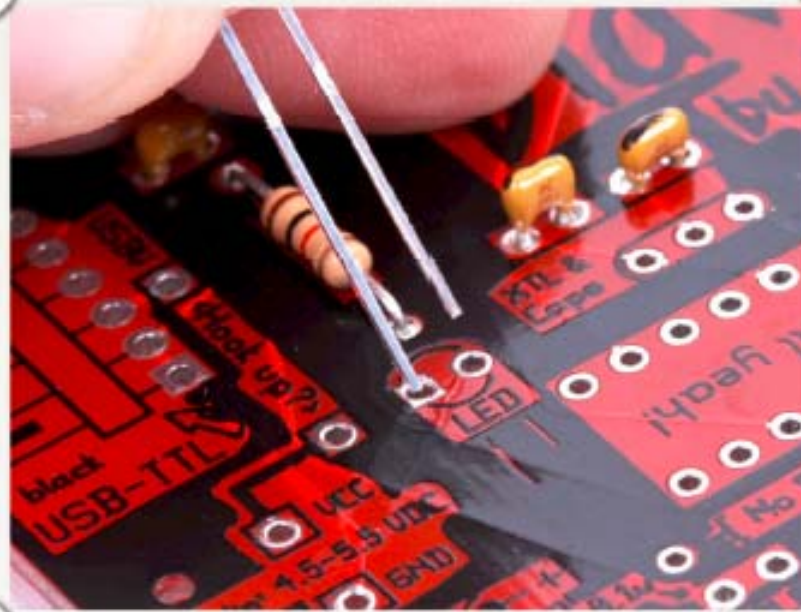


You can bend the pins inward to hold this one in place while you solder. The leads are short and usually don't need trimming.

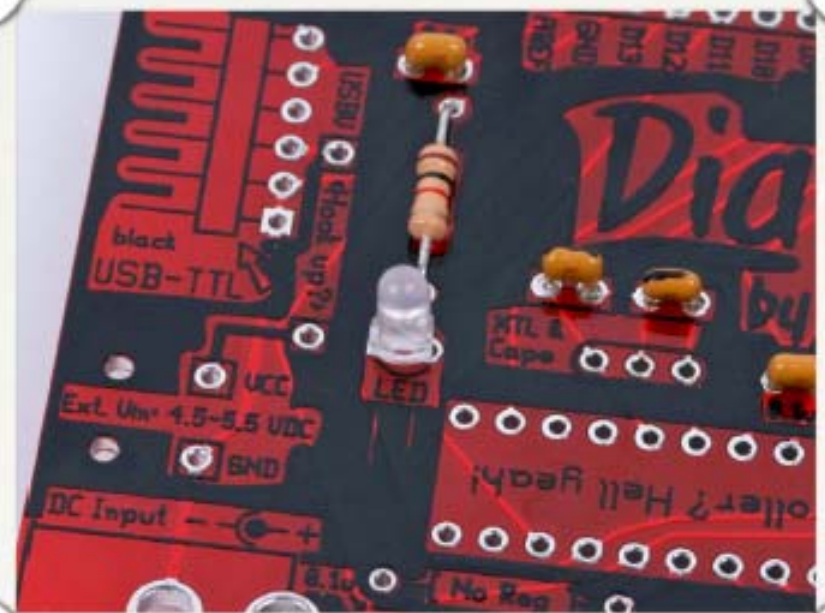
# Diavolino LED, #8



3 mm red-diffused LED.  
Note the short and long leads:  
Orientation matters!



Put the long lead in the square hole.



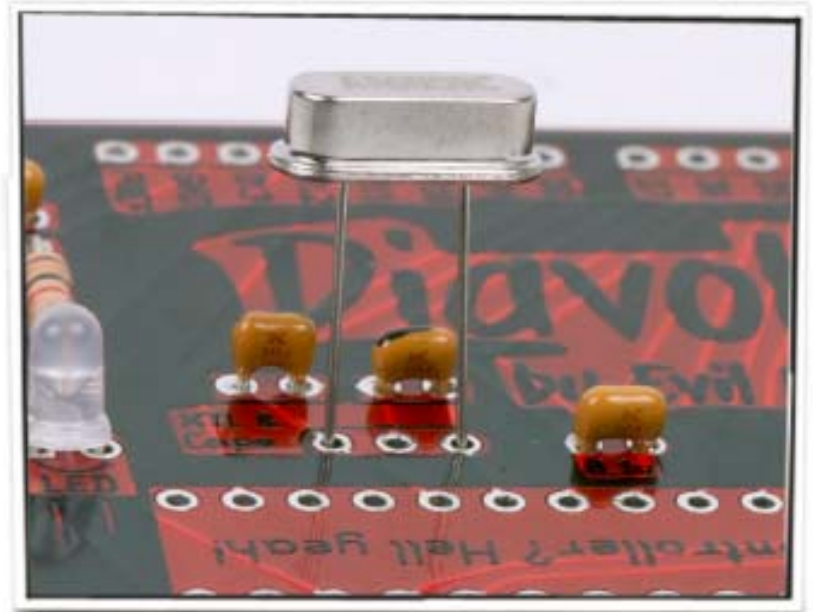
Then push flush, solder & trim as usual.

# Diavolino

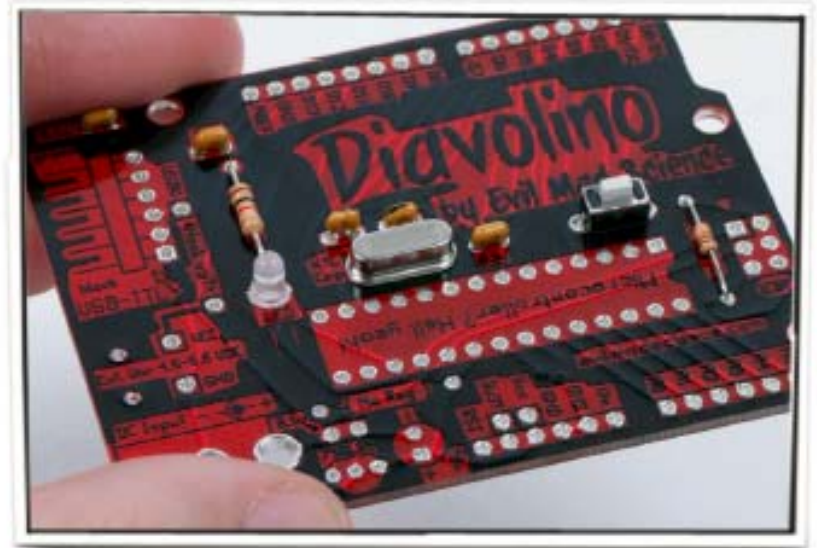
16 MHz Quartz crystal oscillator, #9



A shiny little can with two leads



Orientation does not matter, but the two pins go in the outer two holes of the three available.



Then push flush, solder & trim as usual.



# Diavolino

Header #10

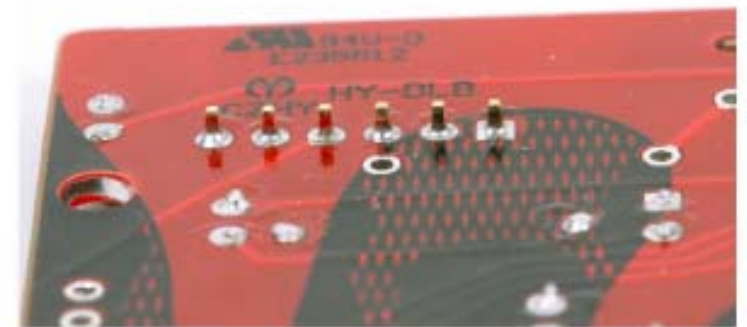
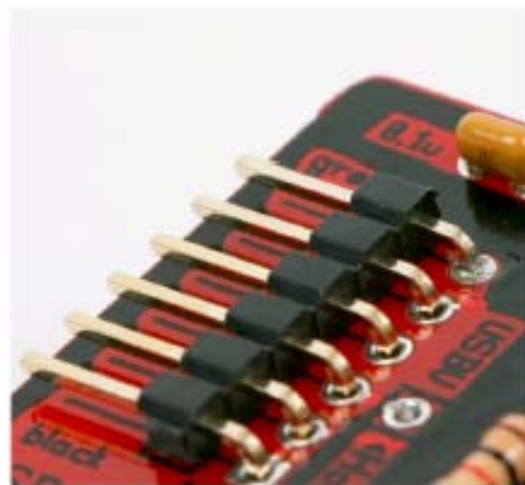
This is the connector for the USB-TTL cable.



Test-fit it in place so that you see where it goes.

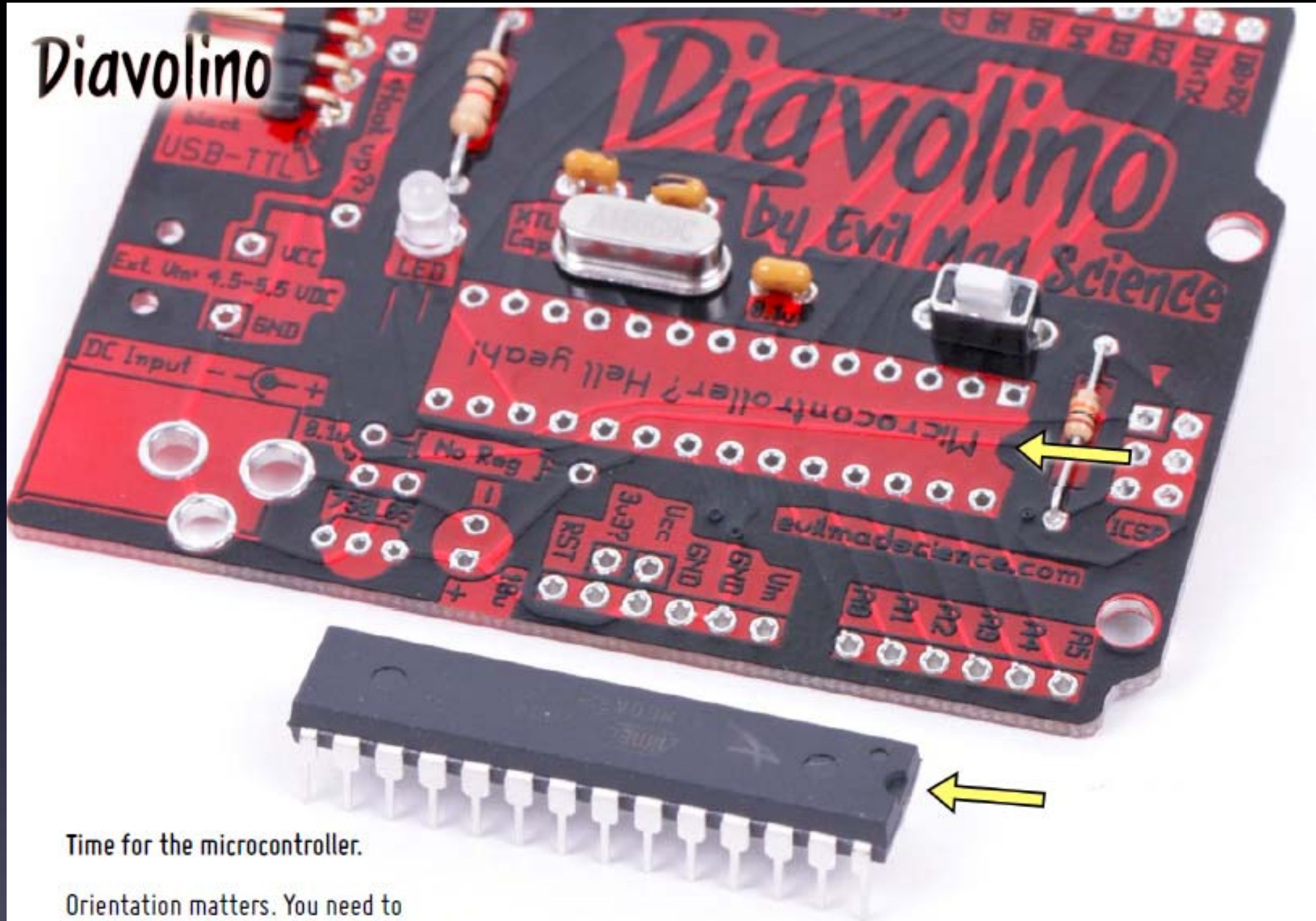


These pins don't bend. So, to hold it in place when you solder, first solder one of the pins from the top to tack it in place.



Solder the other five pins from the back. You shouldn't need to trim them after soldering.

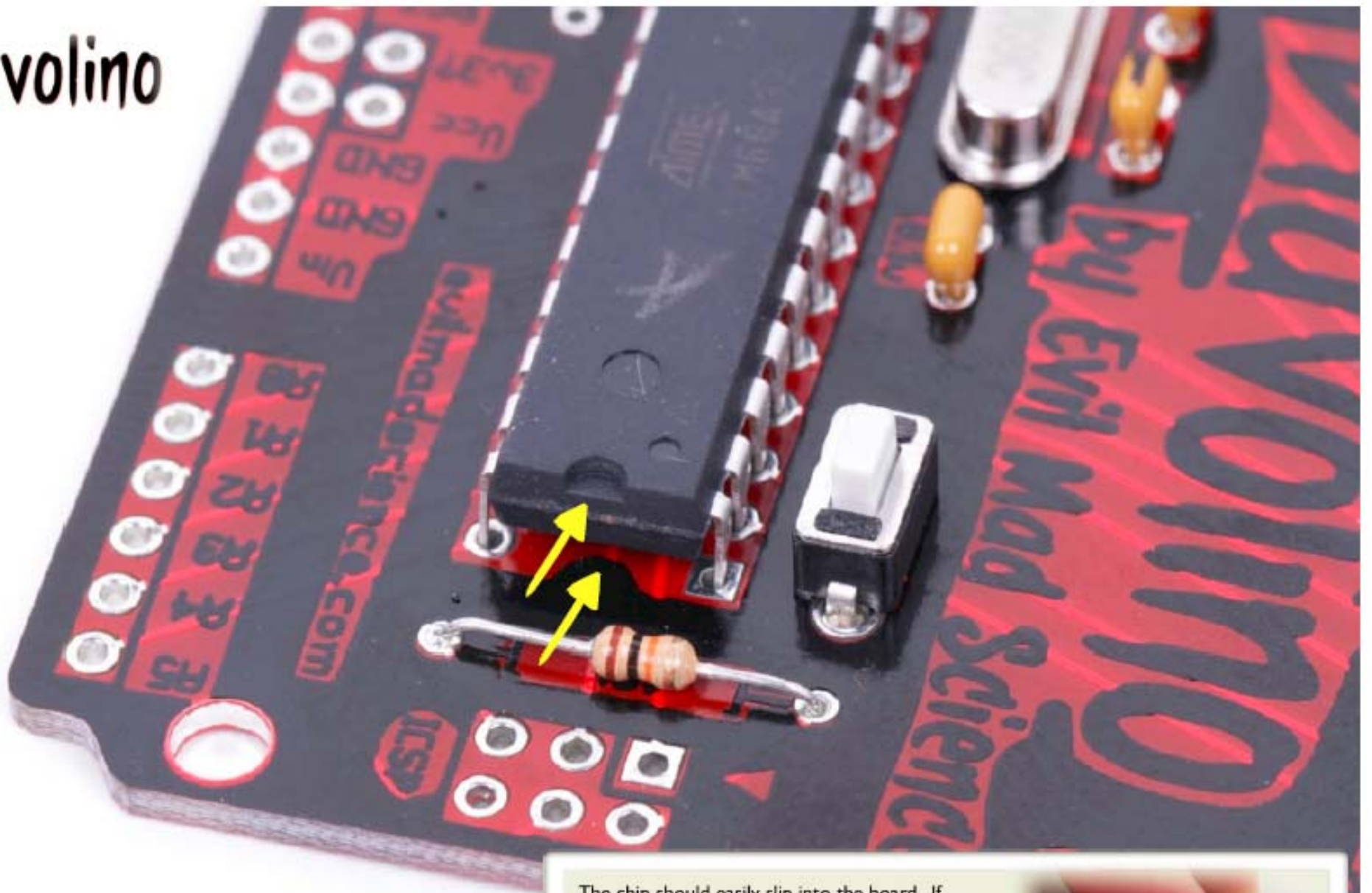
# Diavolino



Time for the microcontroller.

Orientation matters. You need to orient it with the half moon shape on one end of the chip matching that on the circuit board.

# Diavolino

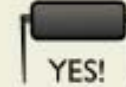


Carefully insert the chip.

Again, double-check the orientation.

The chip should easily slip into the board. If necessary, bend the pins of the chip to straight up and down before inserting the chip. Do not bend them by hand; bend all pins on one side at a time by pushing them against a hard flat surface.

From end of chip:



# Diavolino

Flip the board over and solder the chip in place—  
all 28 pins.

**Tip:** Gently bend over the corner pins to hold the  
chip in place while you solder.

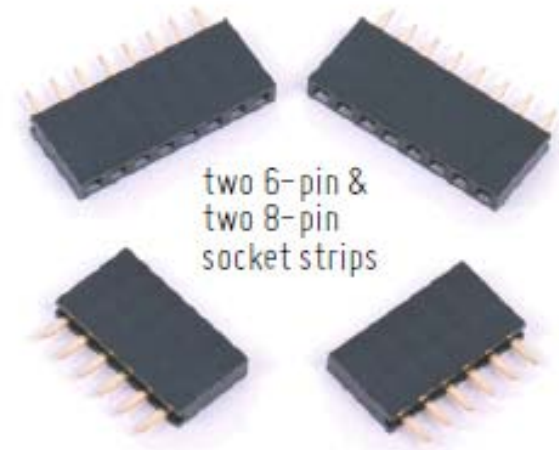
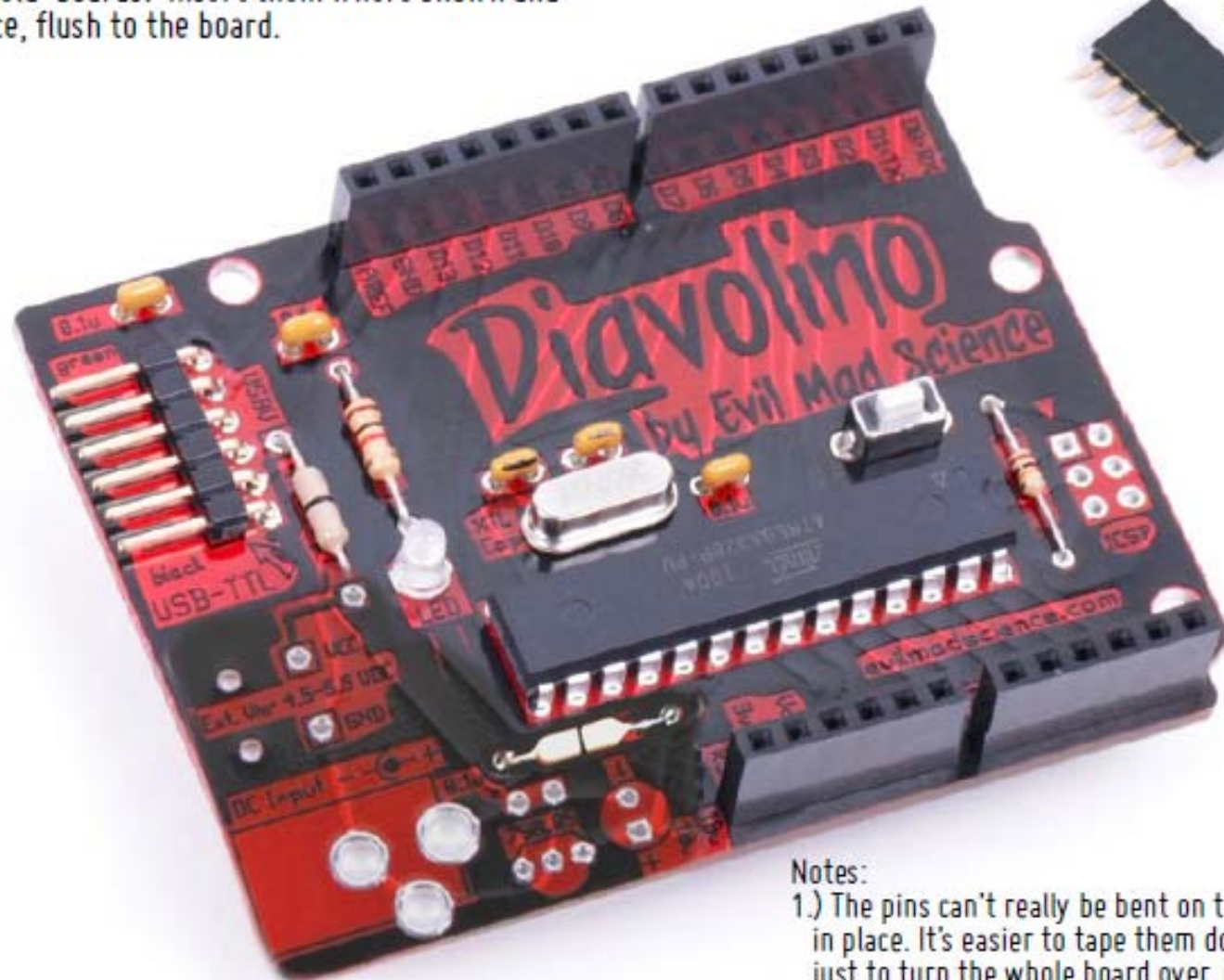
HY HY-DLB



# Diavolino

## Adding socket strips

These socket strips are an optional extra for connecting to Arduino-style "shield" boards. Insert them where shown and solder them in place, flush to the board.



### Notes:

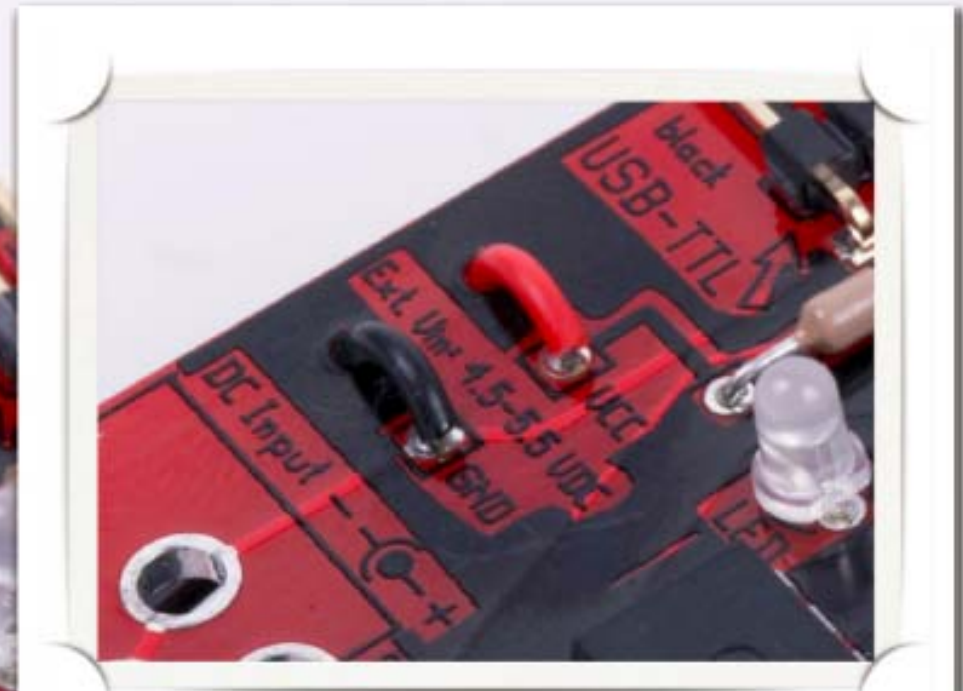
- 1.) The pins can't really be bent on the back side to hold them in place. It's easier to tape them down with masking tape or just to turn the whole board over, resting on them.
- 2.) It's best to solder one pin on each first, to make sure that they're straight and flush, before soldering the rest.
- 3.) The pins are short enough that they don't normally need trimming.

# Diavolino

How to add a battery box (continued)

Whether or not you trim the leads, here's the procedure:

First, bring the wire leads up through the strain-relief holes at the edge of the board as shown.



Then, solder the red wire in location VCC and the black wire in location GND.

Pull any excess wire back through the strain-relief holes to take out the slack.

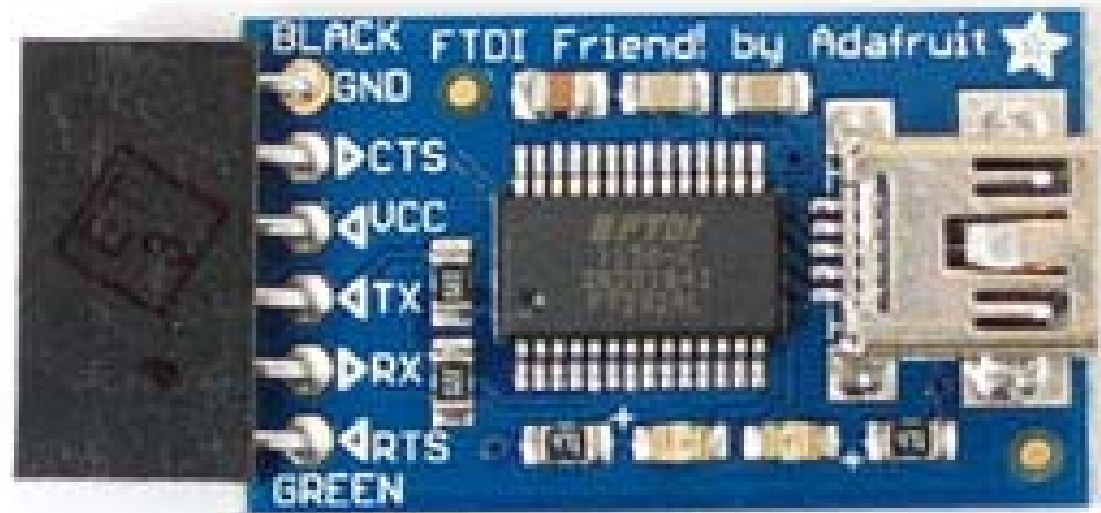




Now we can  
connect parts to our Arduino,  
and program it!

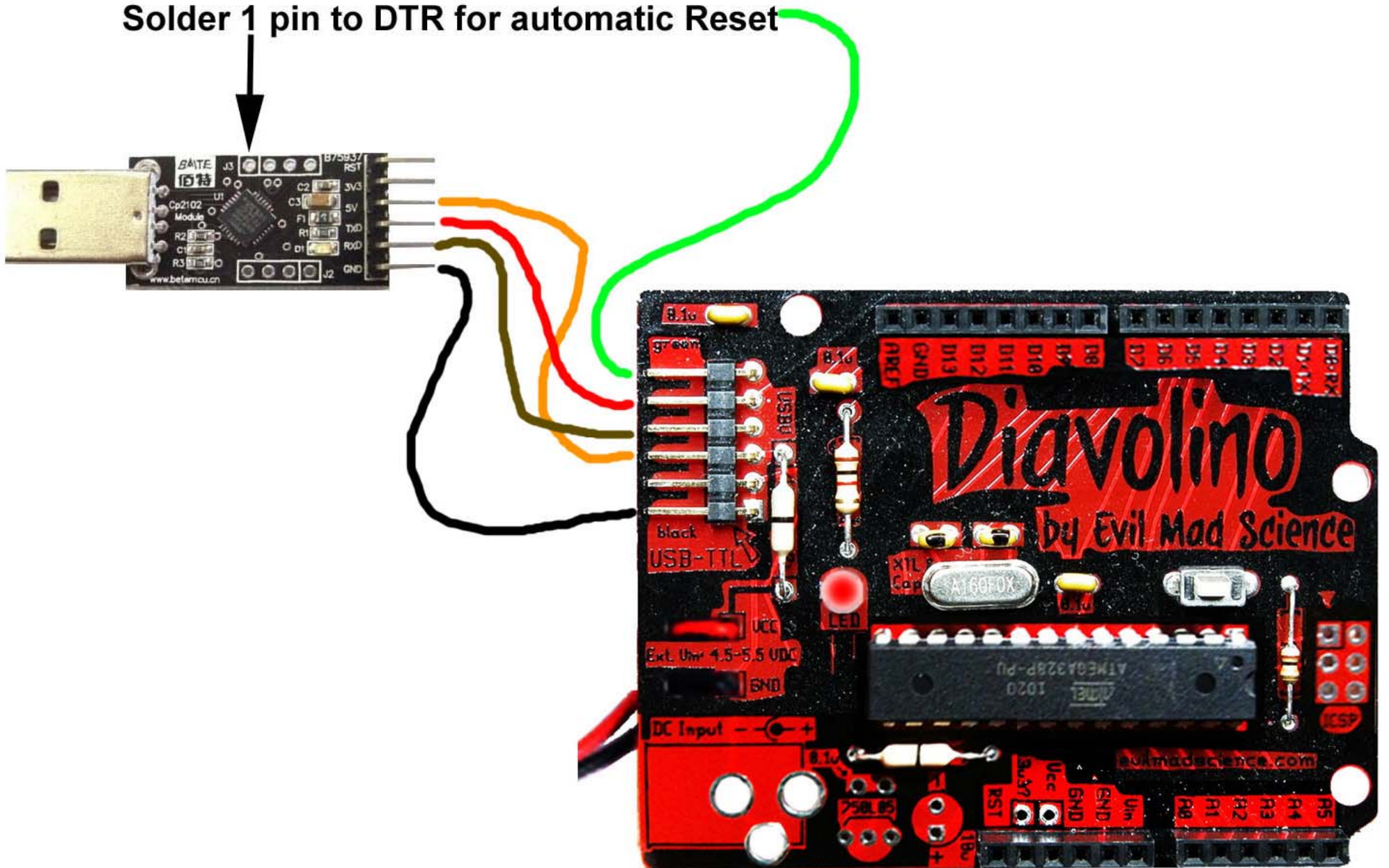


# Connecting with FTDI Friend board

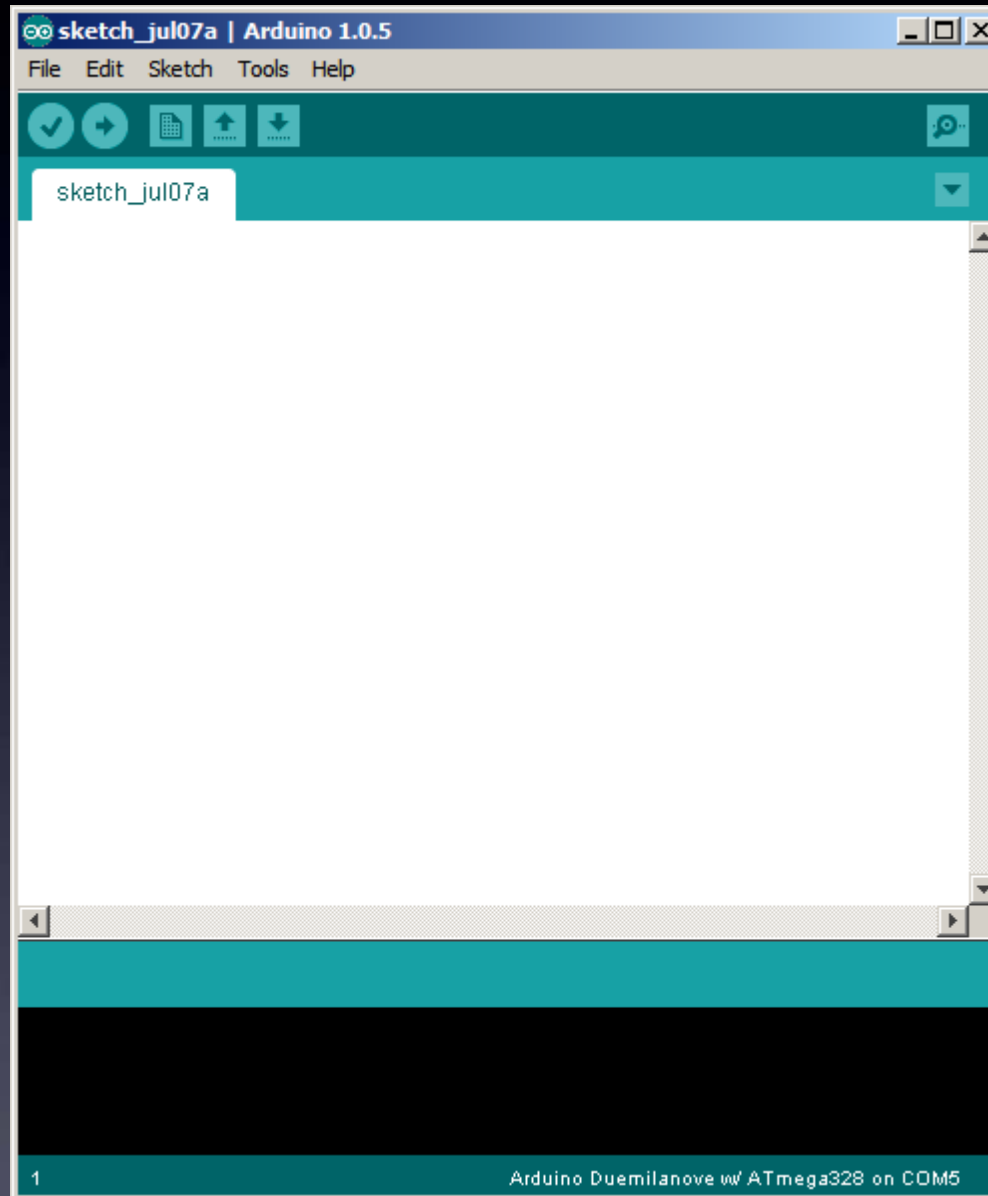


# Connecting with SiLabs board

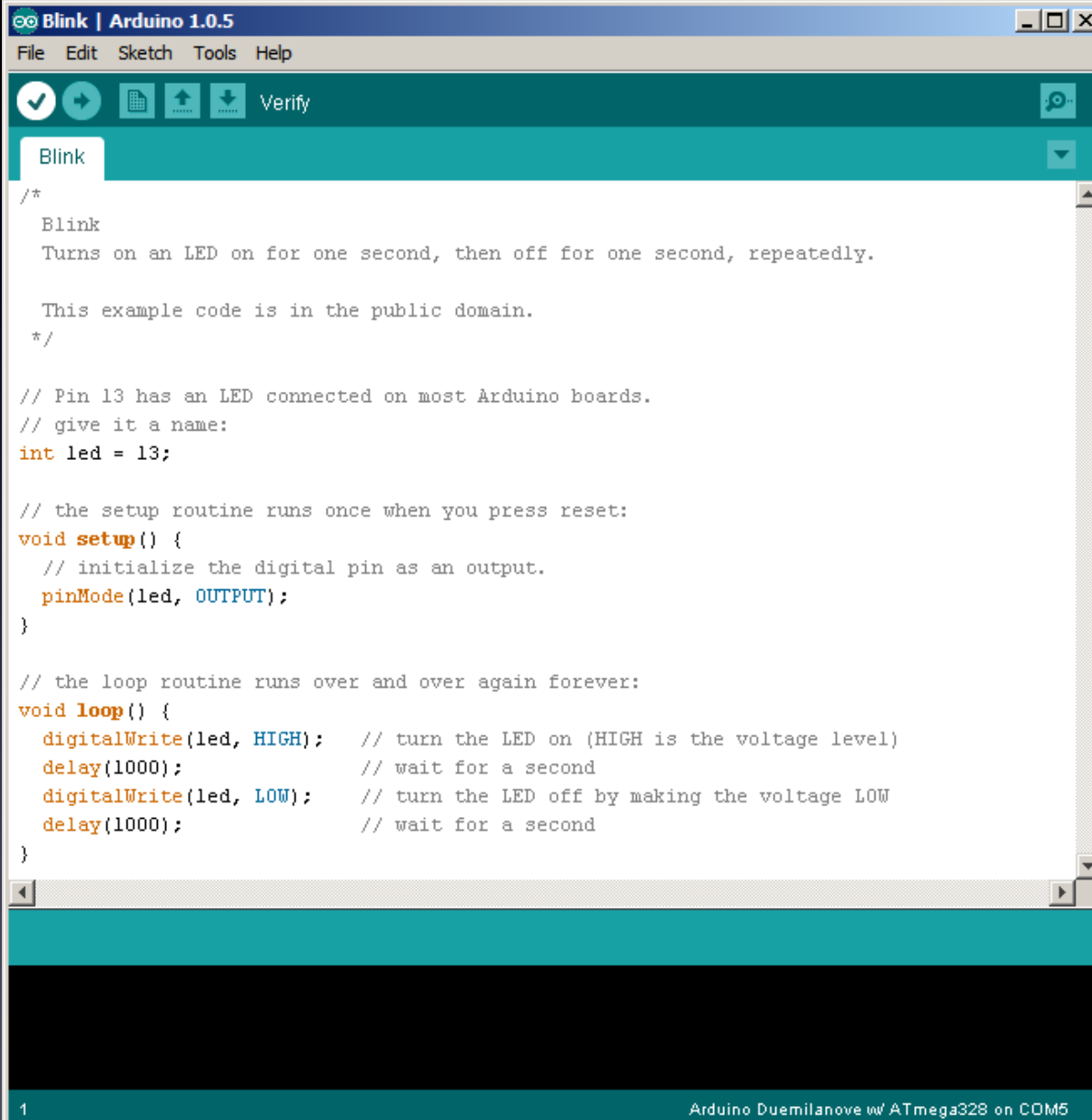
Solder 1 pin to DTR for automatic Reset



# How to Set Up and Use the Arduino Software



# How to Hack Arduino Programs (“Sketches”)



The image shows a screenshot of the Arduino IDE interface. The window title is "Blink | Arduino 1.0.5". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for a checkmark, a play button, a document with a plus sign, a document with a minus sign, and a "Verify" button. The main text area contains the following code:

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

  This example code is in the public domain.
  */

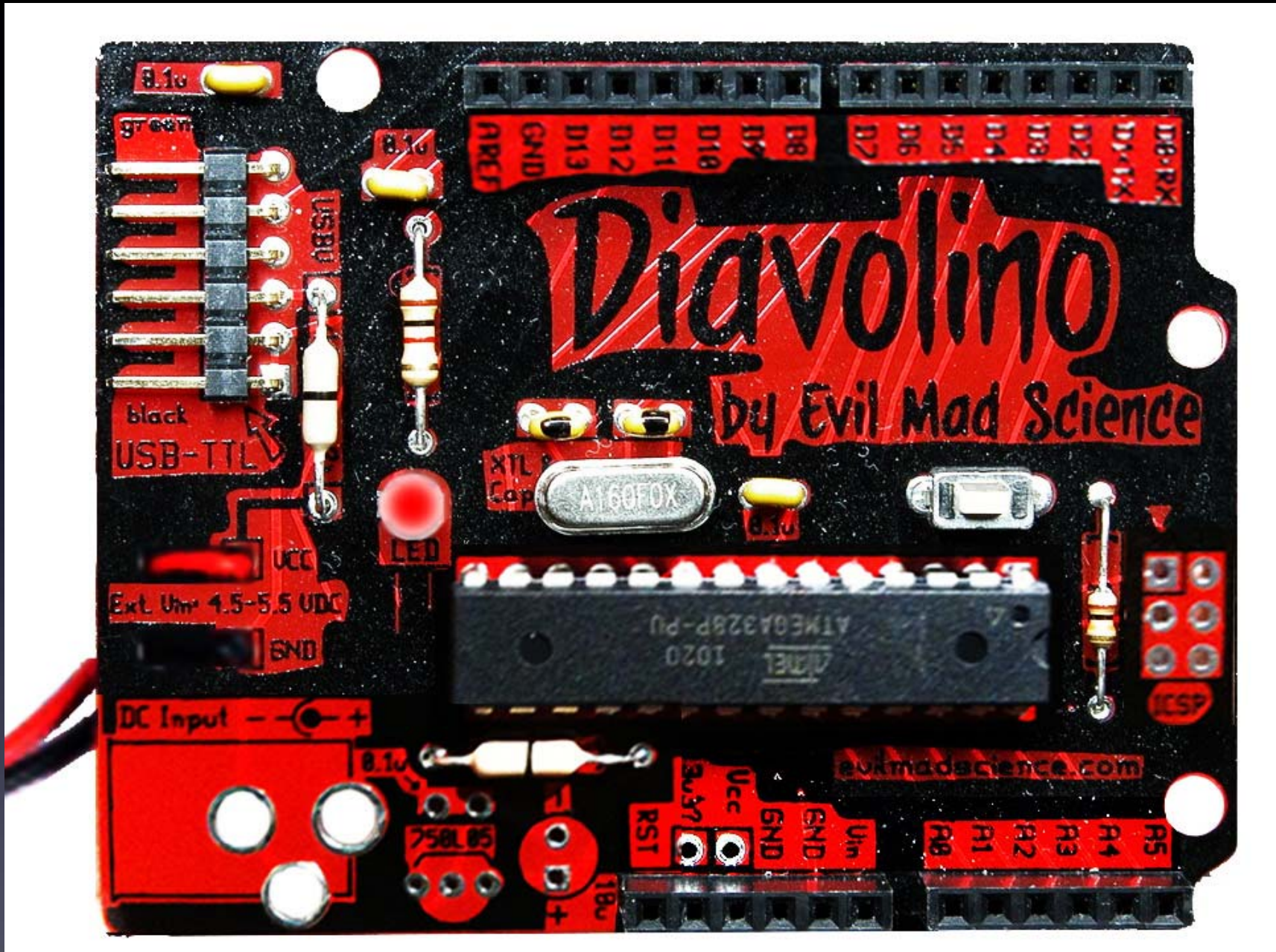
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000);             // wait for a second
  digitalWrite(led, LOW);  // turn the LED off by making the voltage LOW
  delay(1000);             // wait for a second
}
```

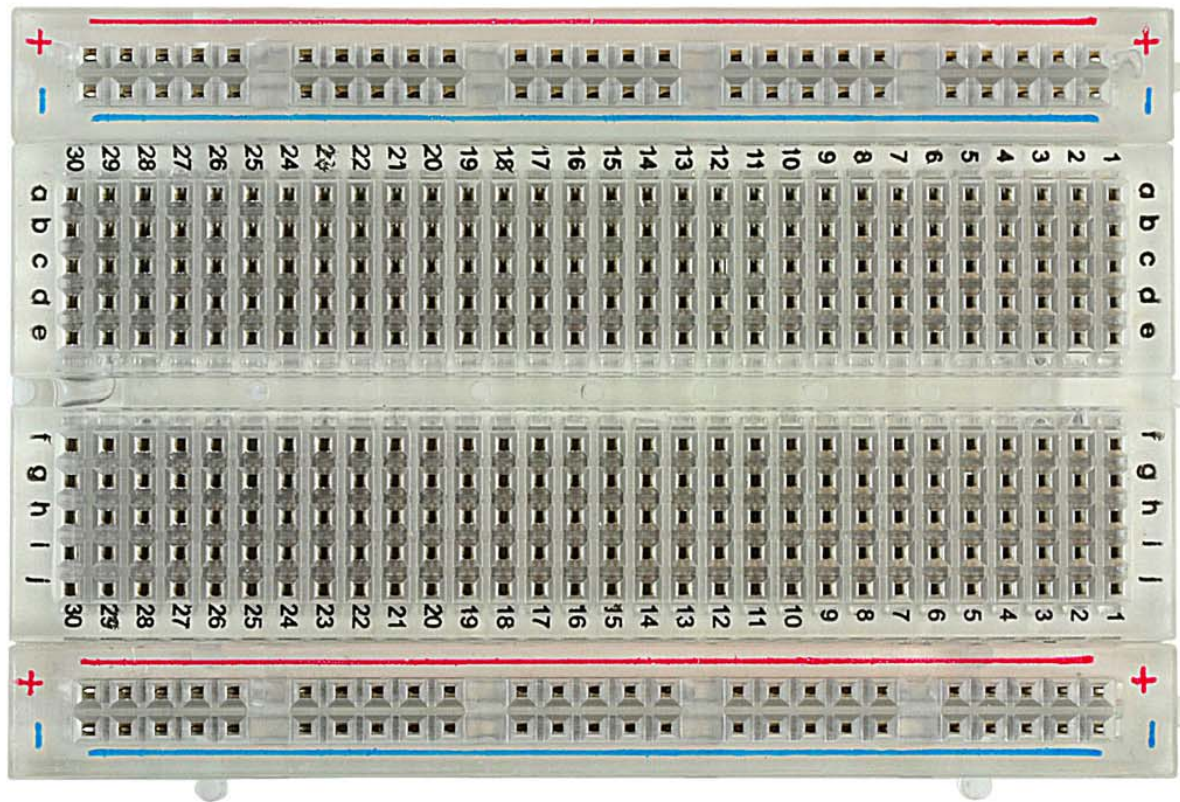
At the bottom of the window, the status bar shows "1" on the left and "Arduino Duemilanove w/ ATmega328 on COM5" on the right.

# How to Hack Arduino Programs (“Sketches”)



# How to Use Solderless Breadboards

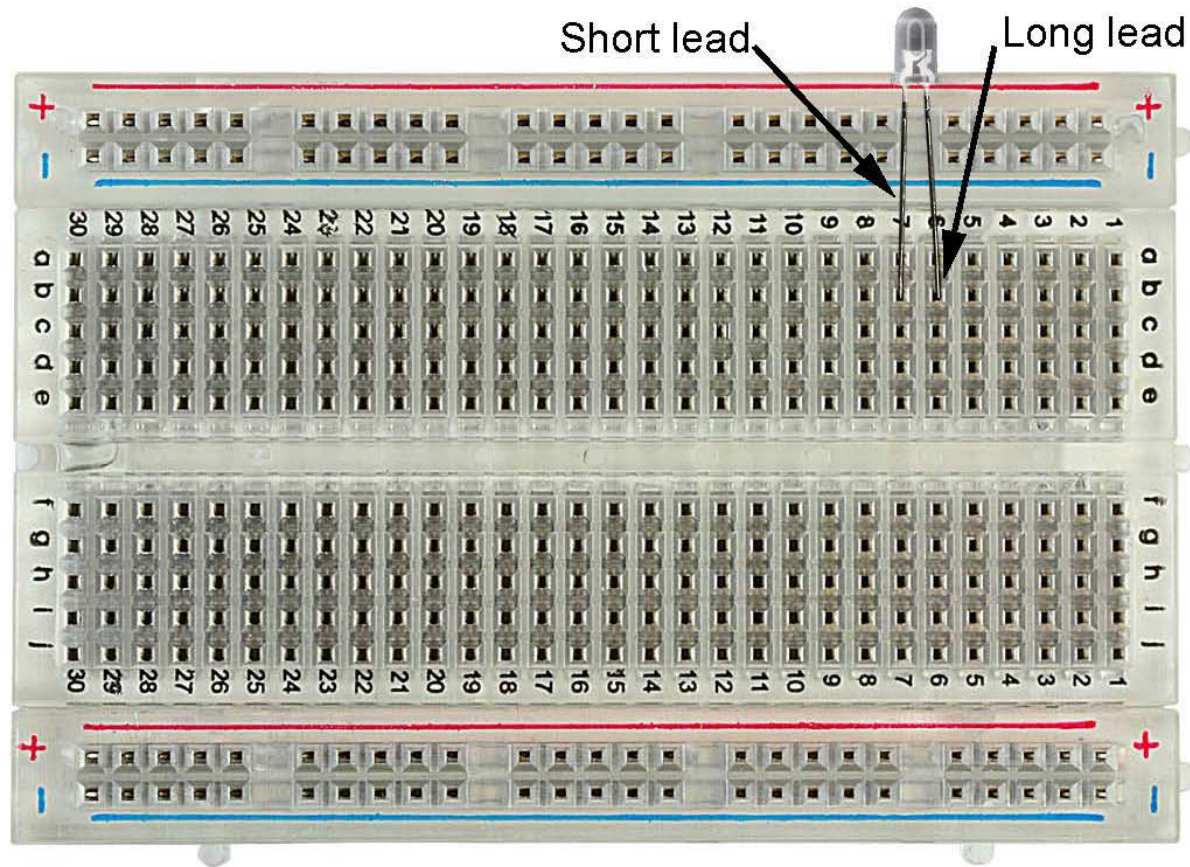
## Solderless Breadboard





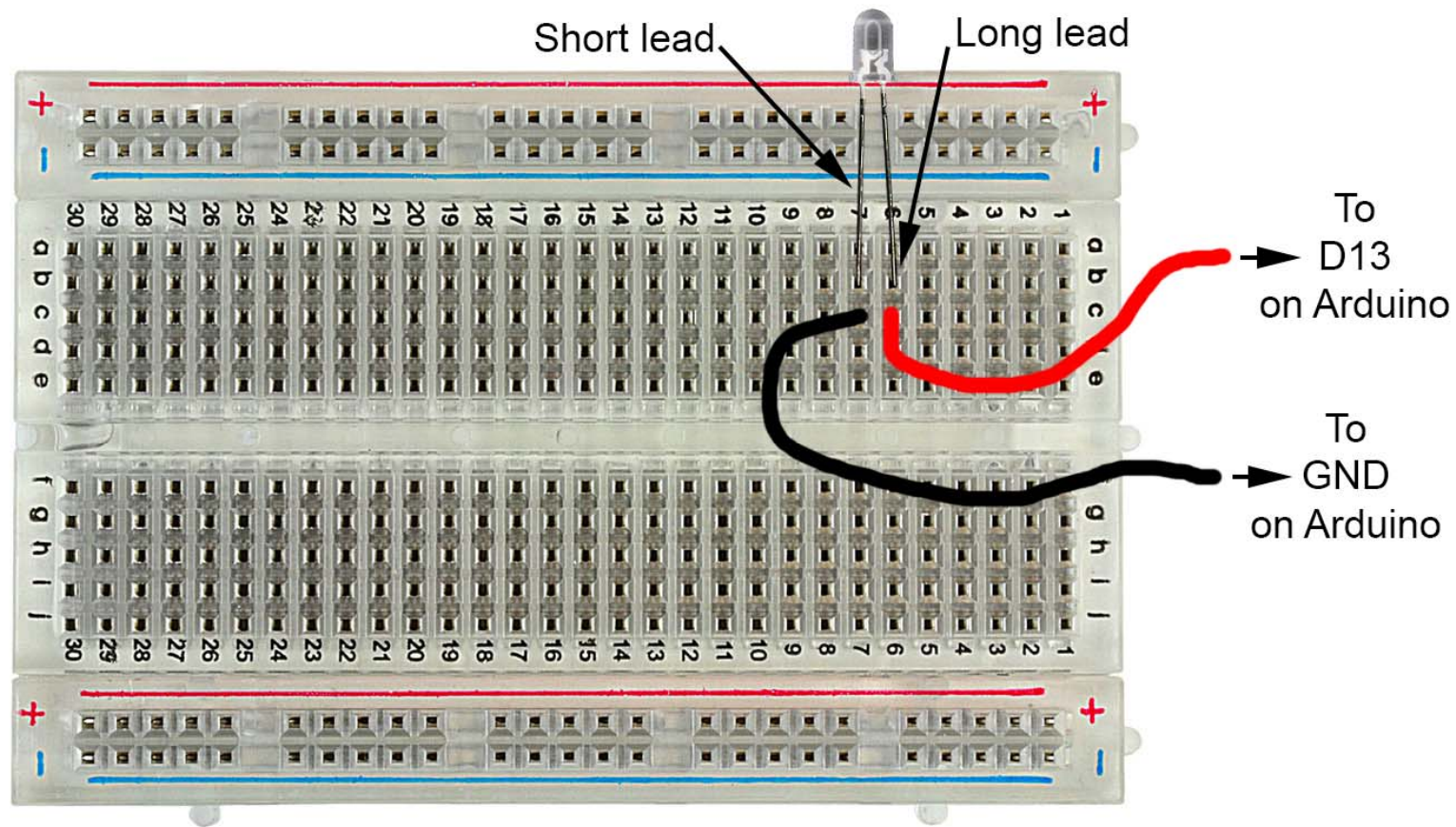
# How to Use Solderless Breadboards

## Solderless Breadboard with LED



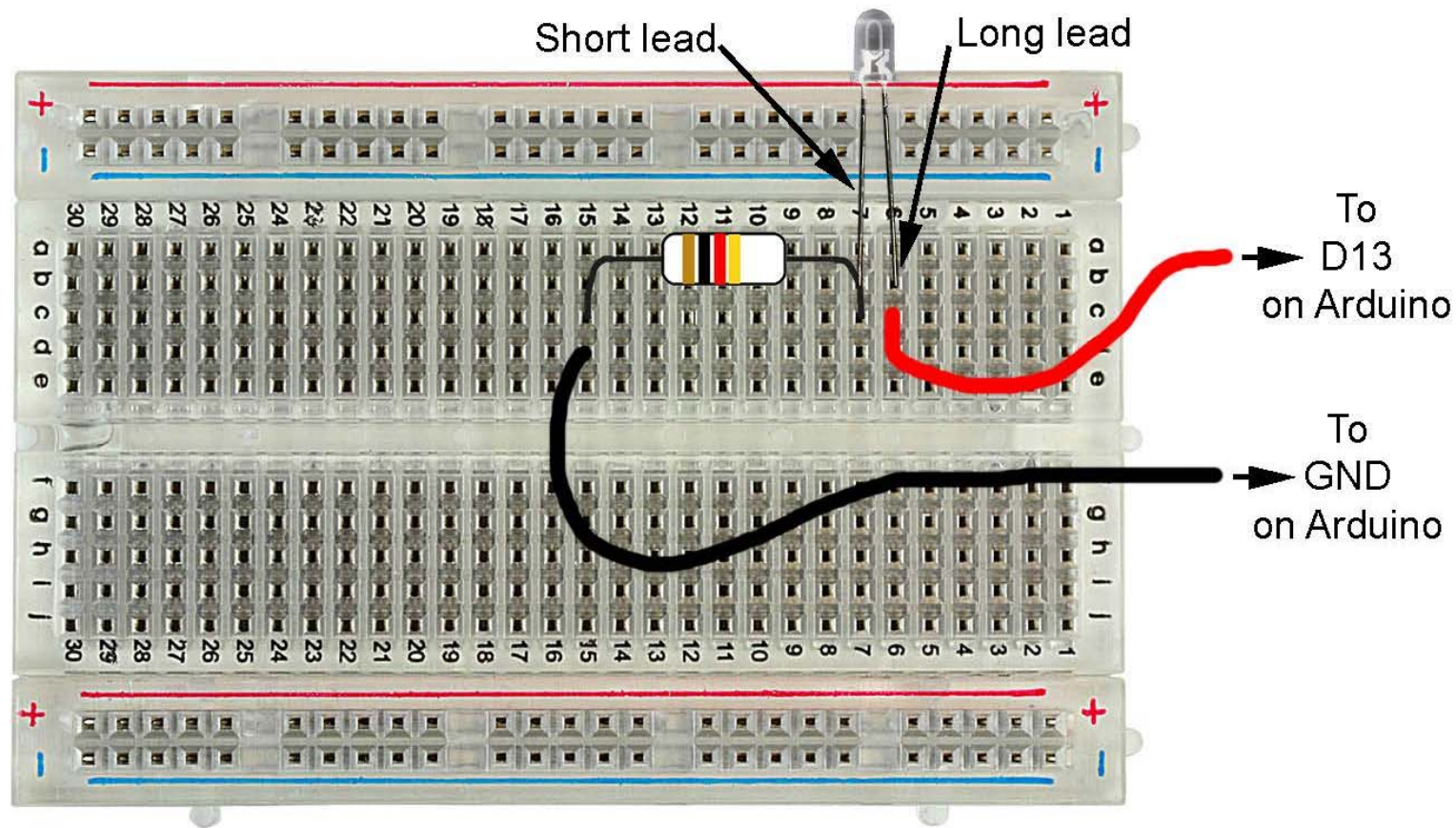
# How to Use Solderless Breadboards

## Solderless Breadboard with LED and wires

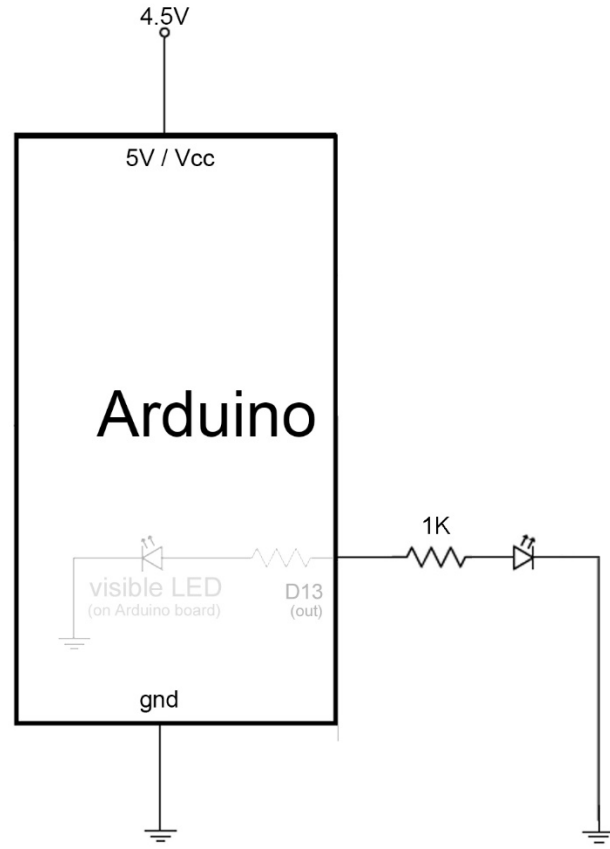


# How to Use Solderless Breadboards

## Solderless Breadboard with LED and Resistor and wires



# How to Read a Schematic



# How to Read a Schematic

## Arduino For Total Newbies

4-Sep-2015

Mitch Altman (original TV-B-Gone hardware and firmware, modified TV-B-Gone Arduino design)  
Limore Fried (firmware modifications, kit design)  
Ken Shirriff (original modifications for Arduino)  
Johannes Schneemann (documentation)

