

# 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

Co-founder of **3Ware** (successful Silicon Valley startup)

Pioneer of **VR** (in the mid-1980s)

Founding mentor at **HAX** (1<sup>st</sup> and biggest hardware accelerator)

Co-founder of **Noisebridge** (San Francisco hackerspace)

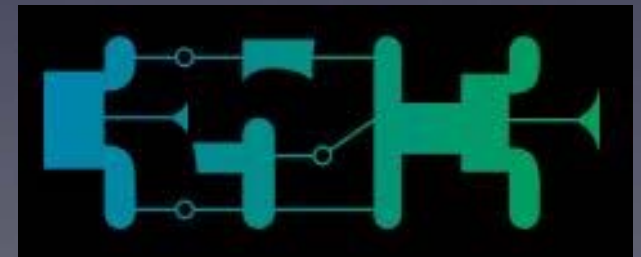
email: [mitch@CornfieldElectronics.com](mailto:mitch@CornfieldElectronics.com)

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

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

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

WeChat: [mitchaltman](#)



# 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

Bring all of this home with you!



U-Do-It-Duino kit

# Stuff!



Parts Pack

**DO NOT  
open this bag  
yet!**



USB-Serial  
cable

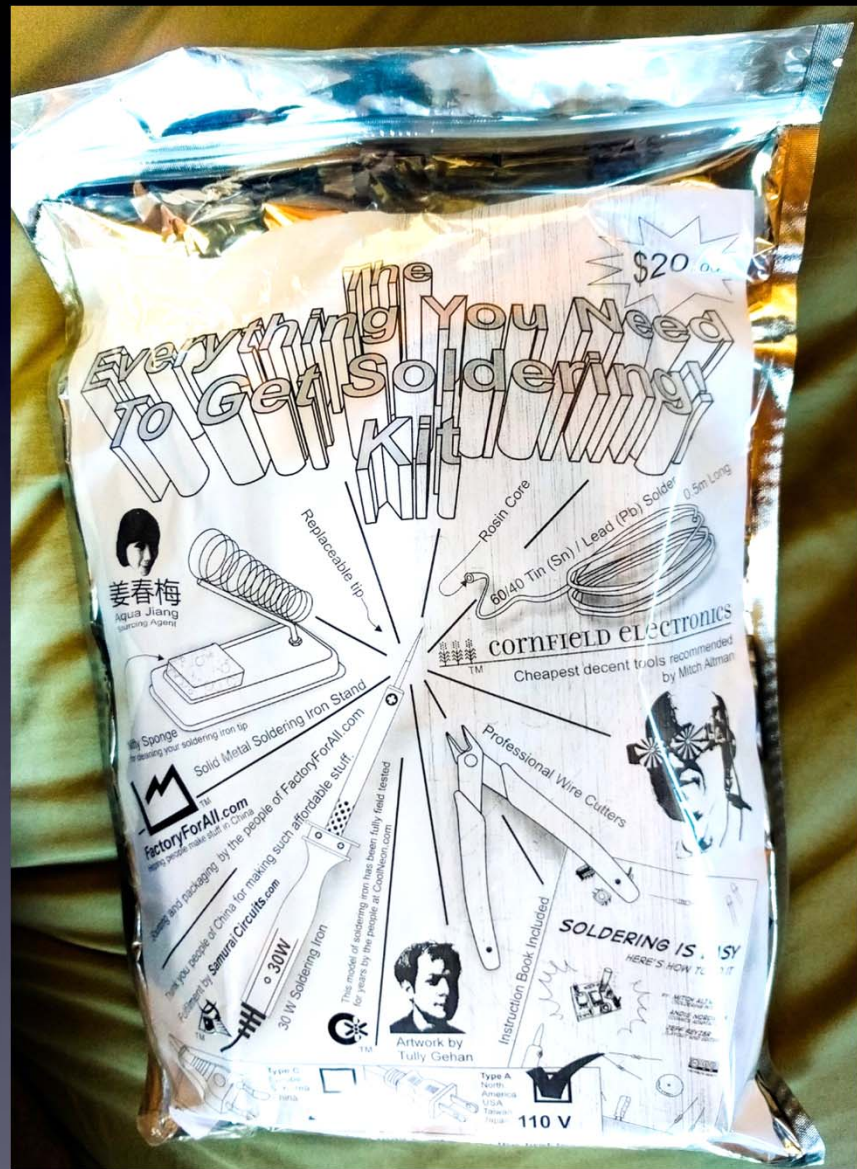
(Don't bring these  
home)

# Tools

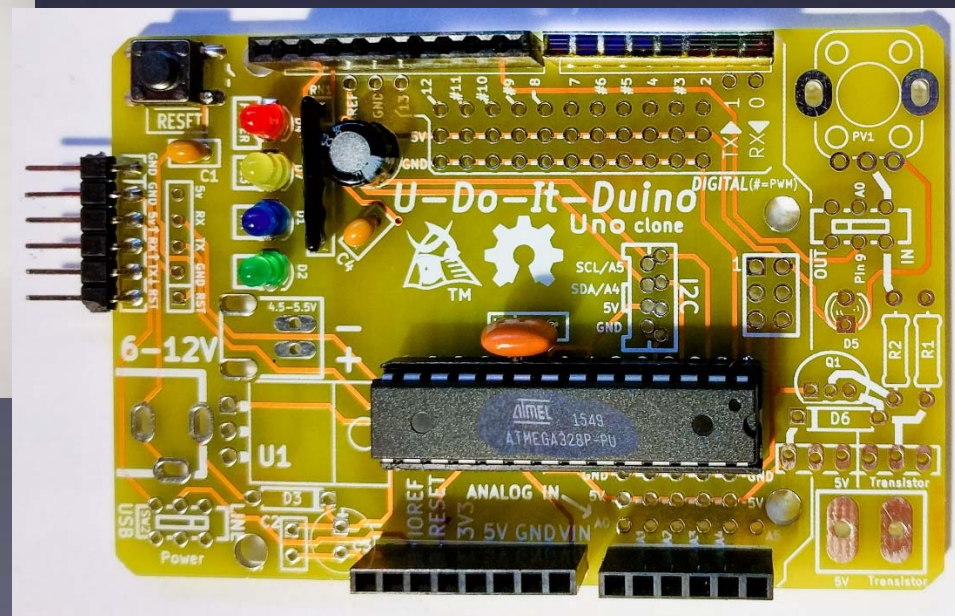
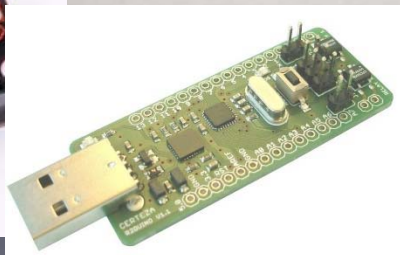
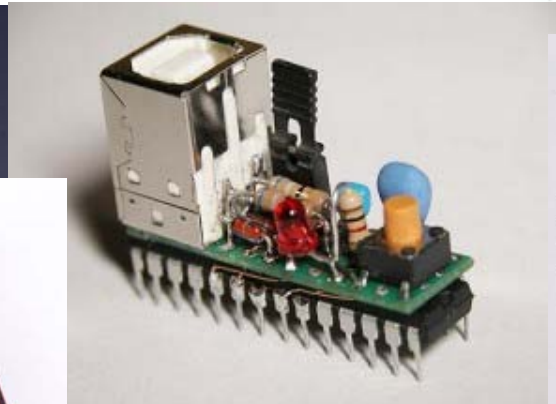
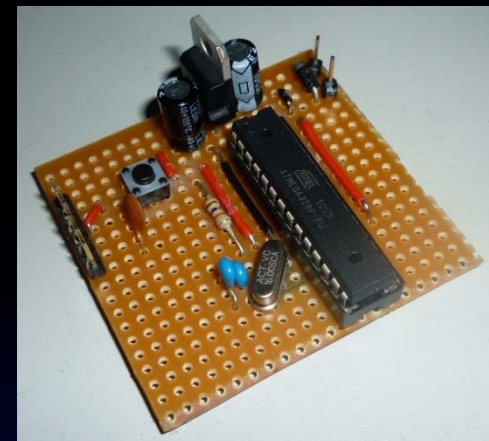
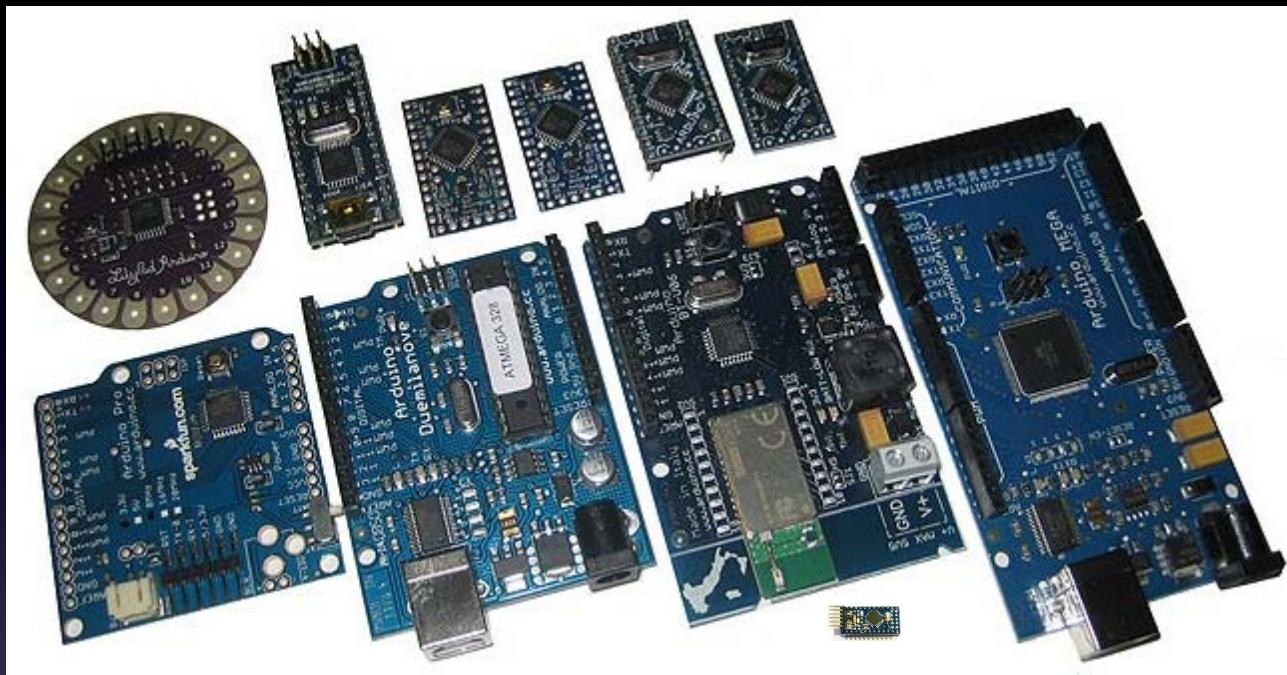


I have these  
Toolkits  
for sale

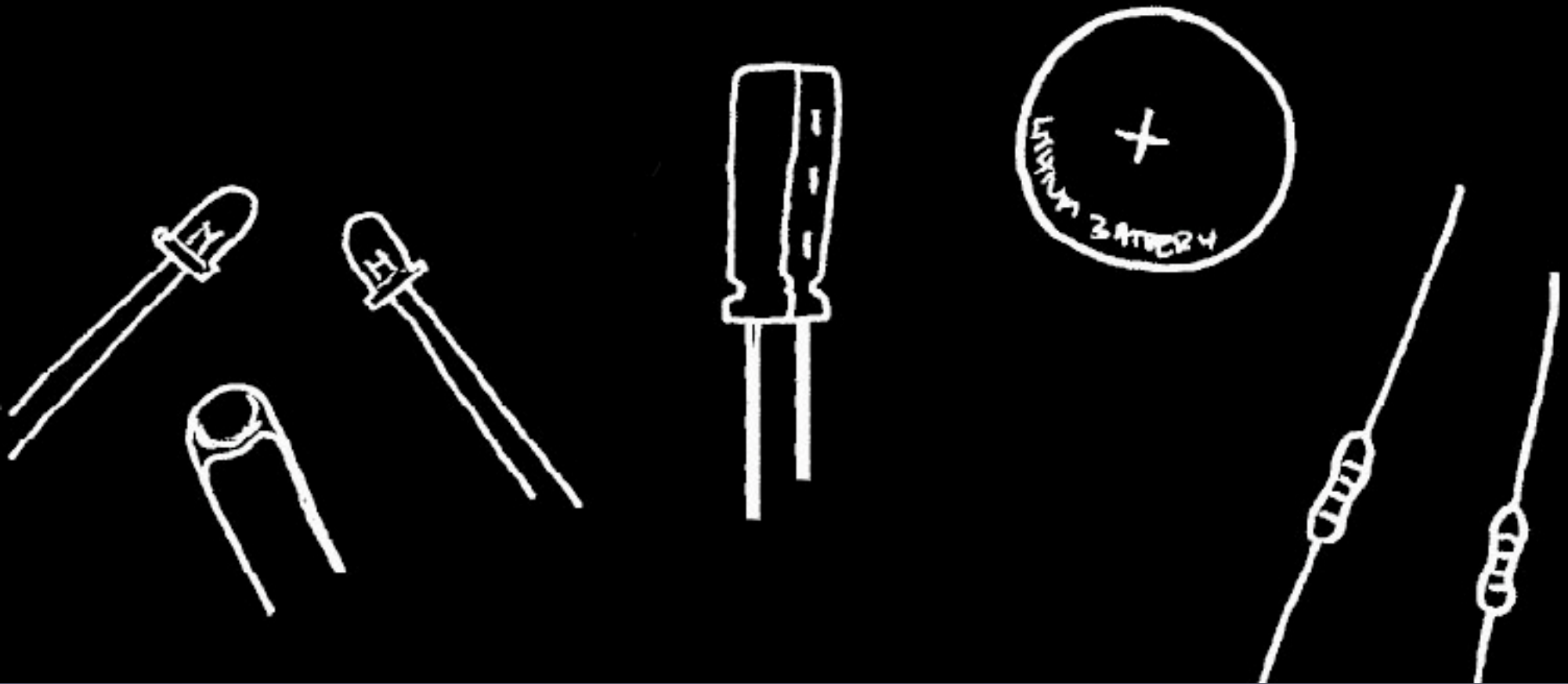
# Tools



# Intro



# *Everything You Need to Know About Electronics*





# **SOLDERING IS EASY**

*HERE'S HOW TO DO IT*



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

**ANDIE NORDGREN**  
(COMICS ADAPTATION)

**JEFF KEYZER**  
(LAYOUT AND EDITING)



DISTRIBUTE WIDELY!

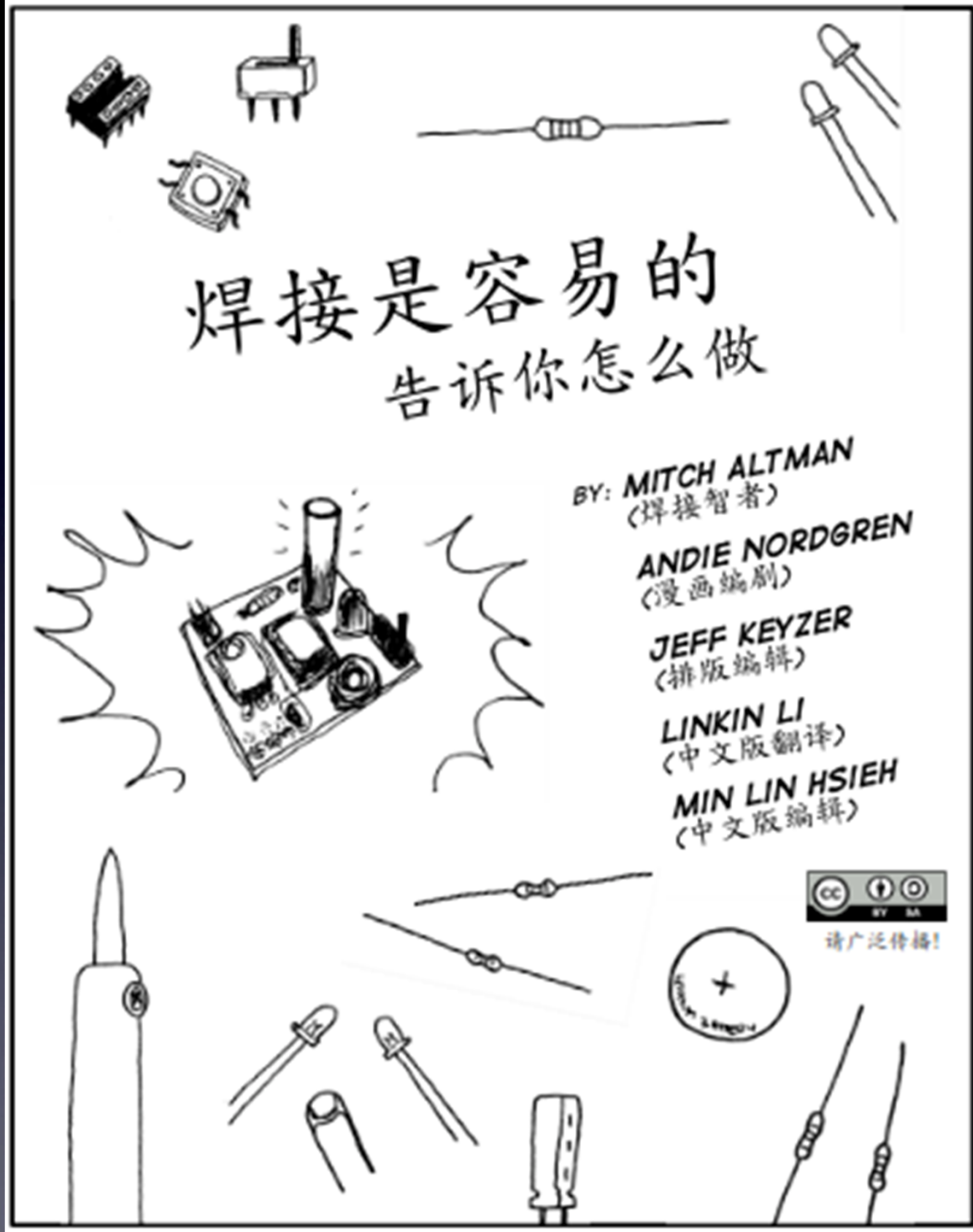
DOWNLOAD THIS COMIC BOOK AND  
SHARE IT WITH YOUR FRIENDS!

[HTTP://MIGHTYOHM.COM/SOLDERCOMIC](http://mightyohm.com/soldercomic)





# Learn To Solder



# Learn To Solder



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

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

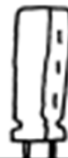
**ANDIE NORDGREN**  
(ADAPTATION BD)

**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)



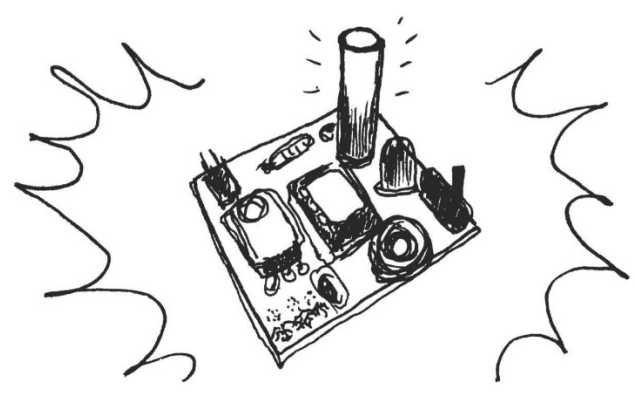
A DIFFUSER LARGEMENT !





# **SOLDAR ES FÁCIL!**

**APRENDE CÓMO HACERLO**



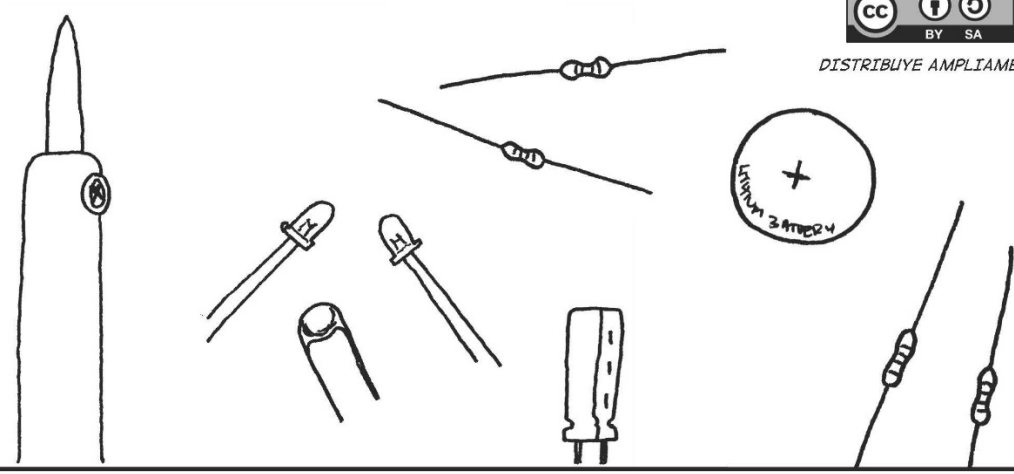
**POR: MITCH ALTMAN**  
(SABIDURÍA EN SOLDADO)

**ANDIE NORDGREN**  
(ADAPTACIÓN A COMIC)

**JEFF KEYZER**  
(DISEÑO Y EDICIÓN)



DISTRIBUYE AMPLIAMENTE!





# LÖTEN IST EINFACH SO WIRD ES GEMACHT

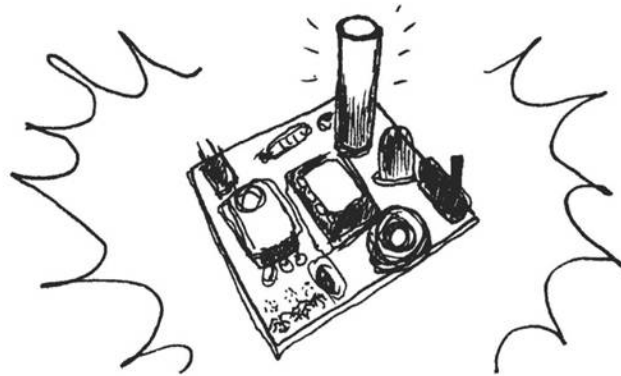
VON: MITCH ALTMAN  
(LÖTWEISHEITEN)

ANDIE NORDGREN  
(KOMIK-UMSETZUNG)

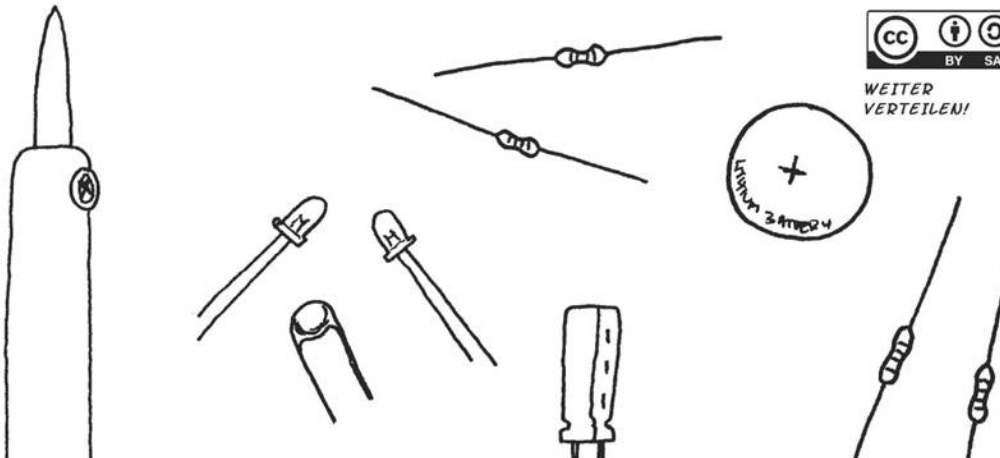
JEFF KEYZER  
(LAYOUT UND BEARBEITUNG)

ALEXANDER BODORA  
(ÜBERSETZUNG UND BEARBEITUNG)

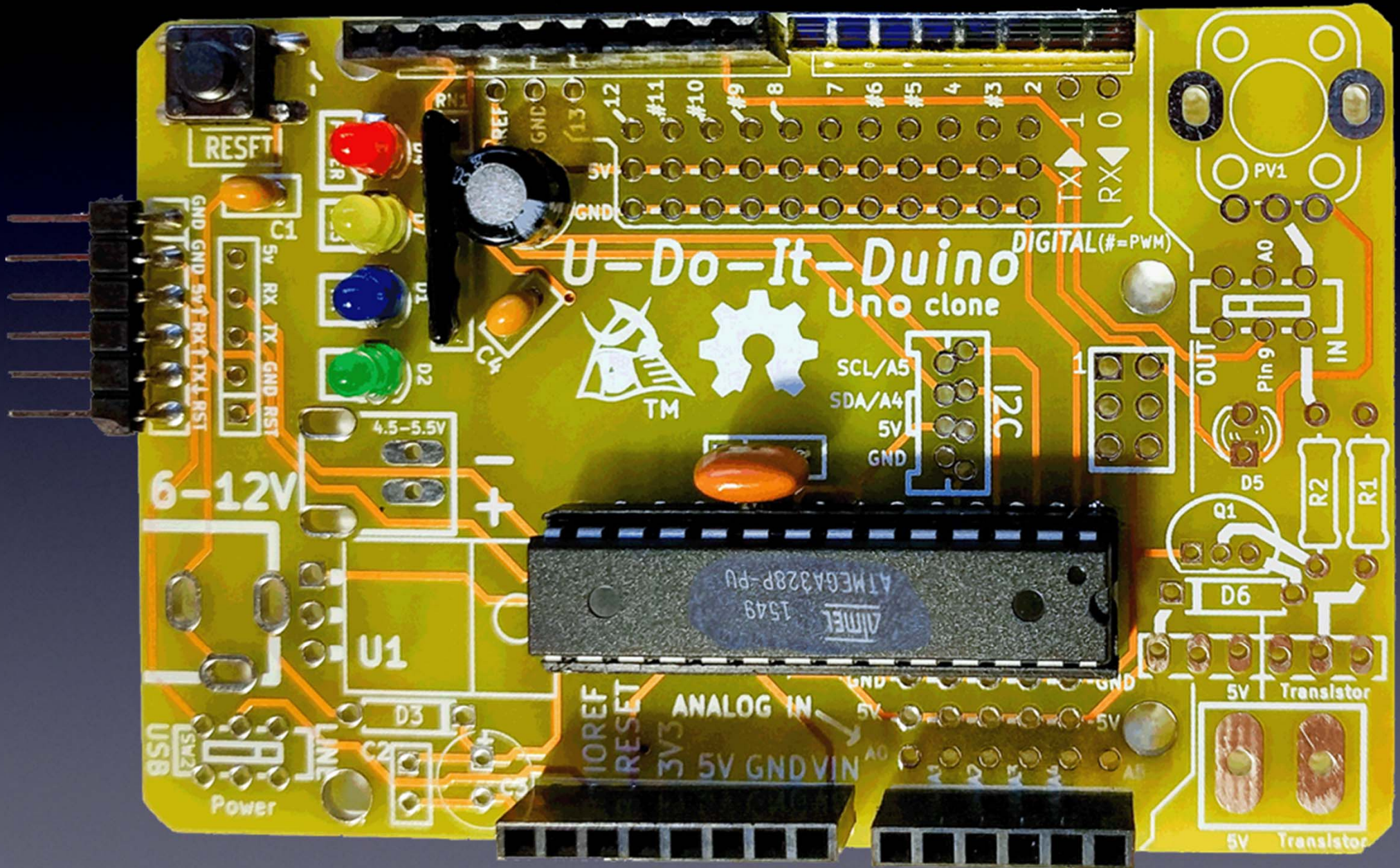
RICHARD MEINSEN  
(ÜBERARBEITUNG UND KORREKTUR)



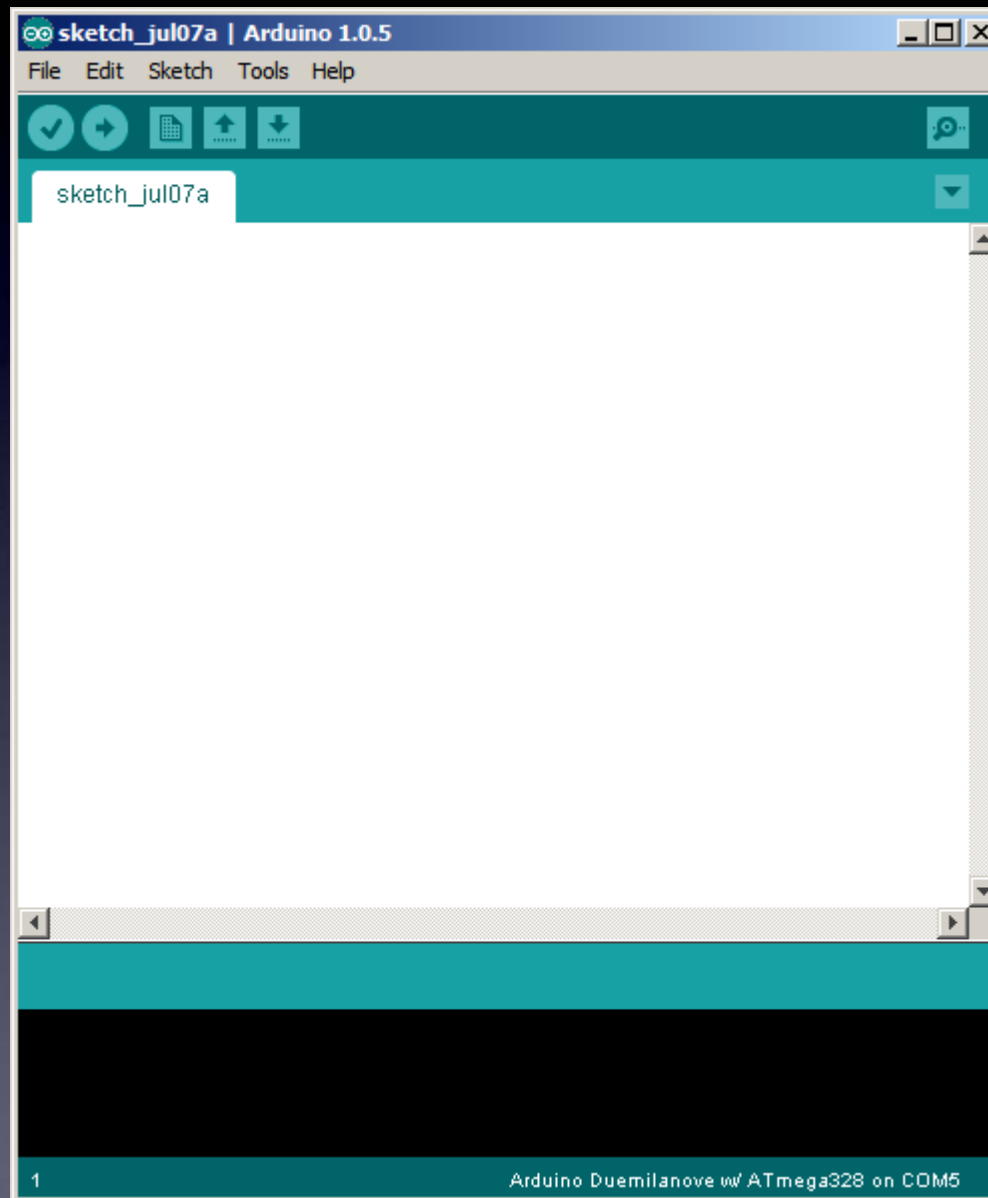
WEITER  
VERTEILEN!



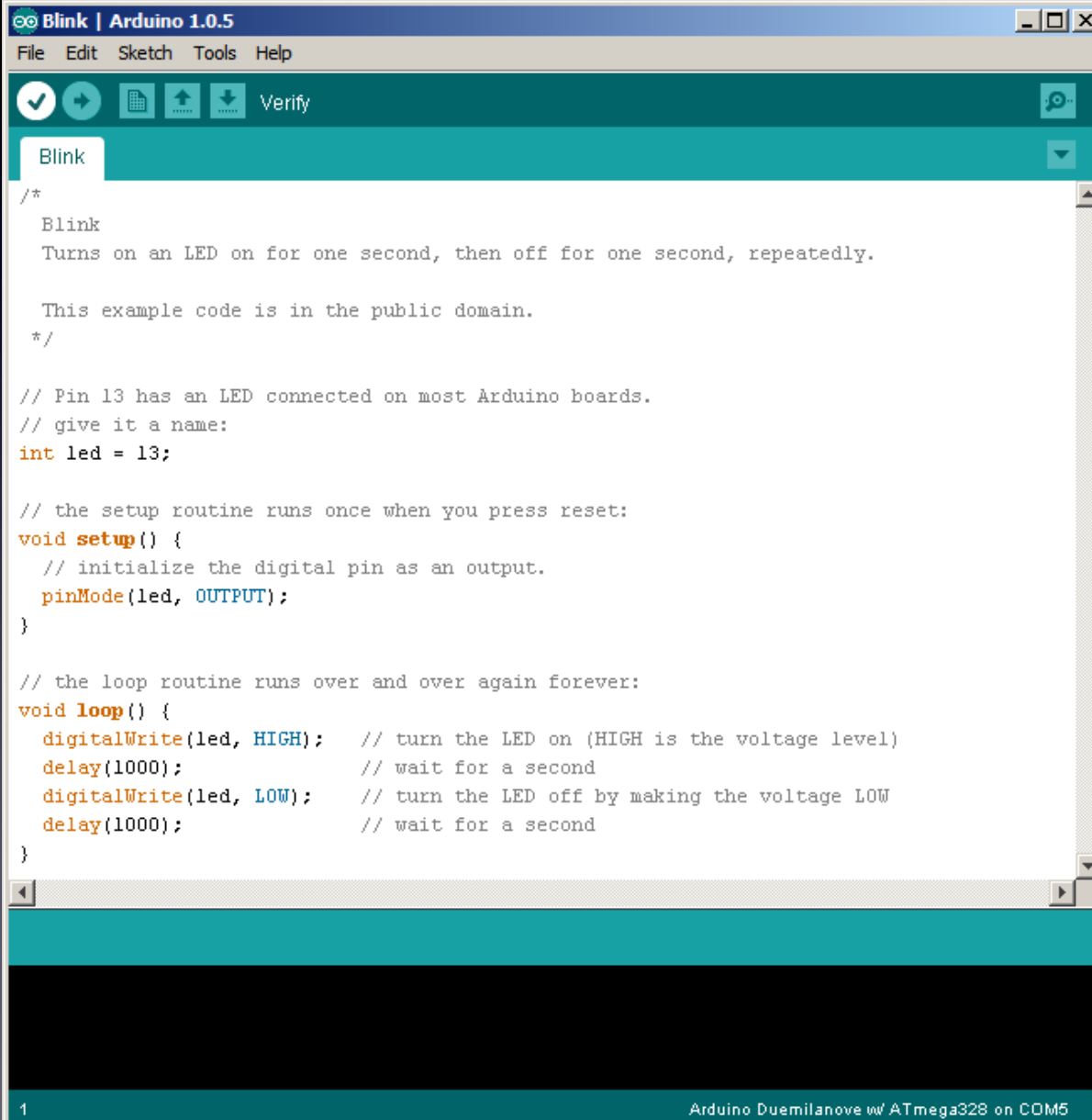
# Solder Your Arduino Clone



# 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;

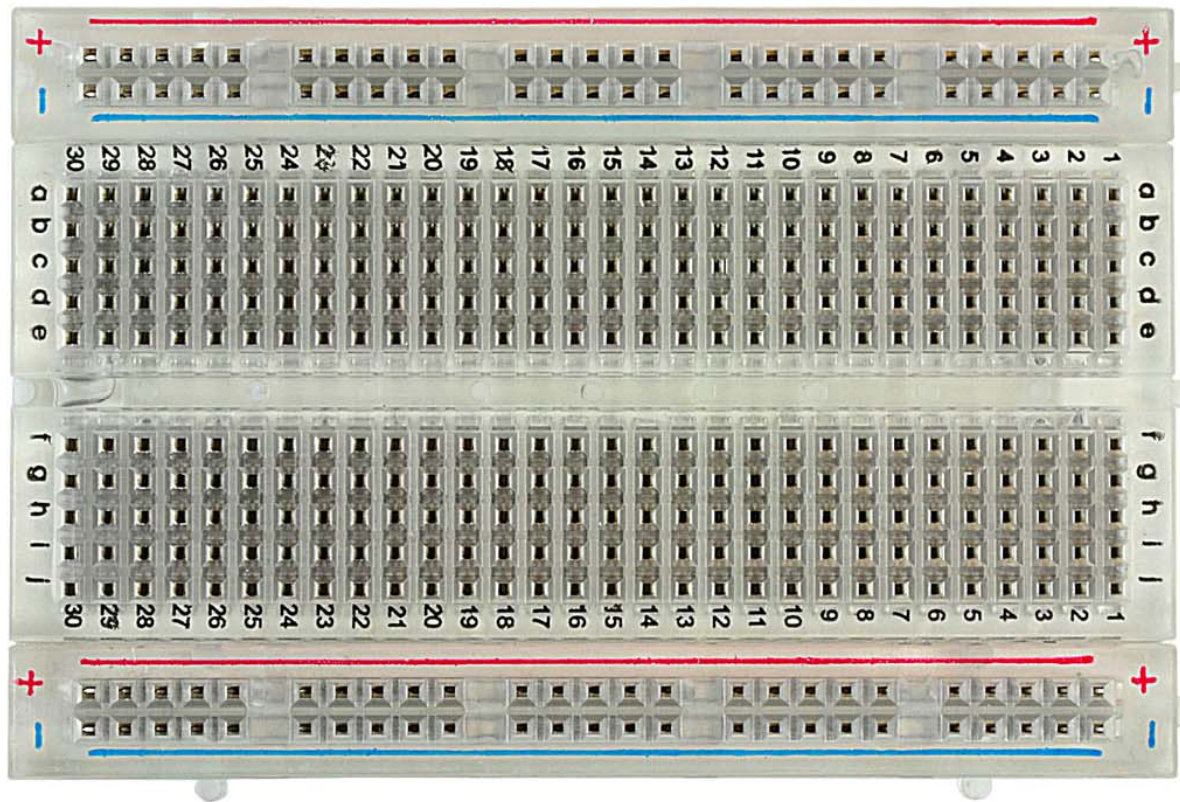
// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// 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

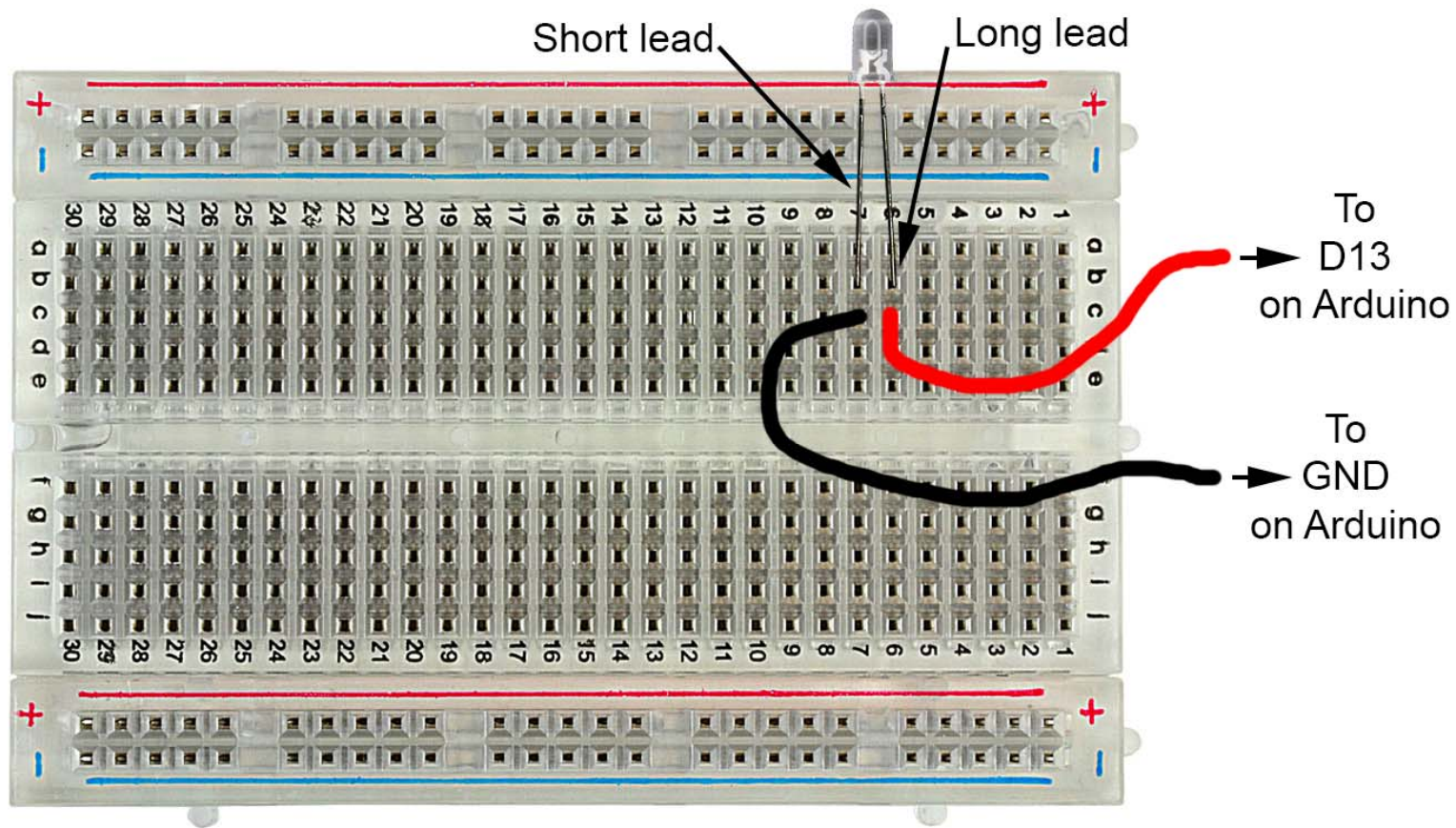
## Solderless Breadboard





# How to Use Solderless Breadboards

## Solderless Breadboard with LED and wires

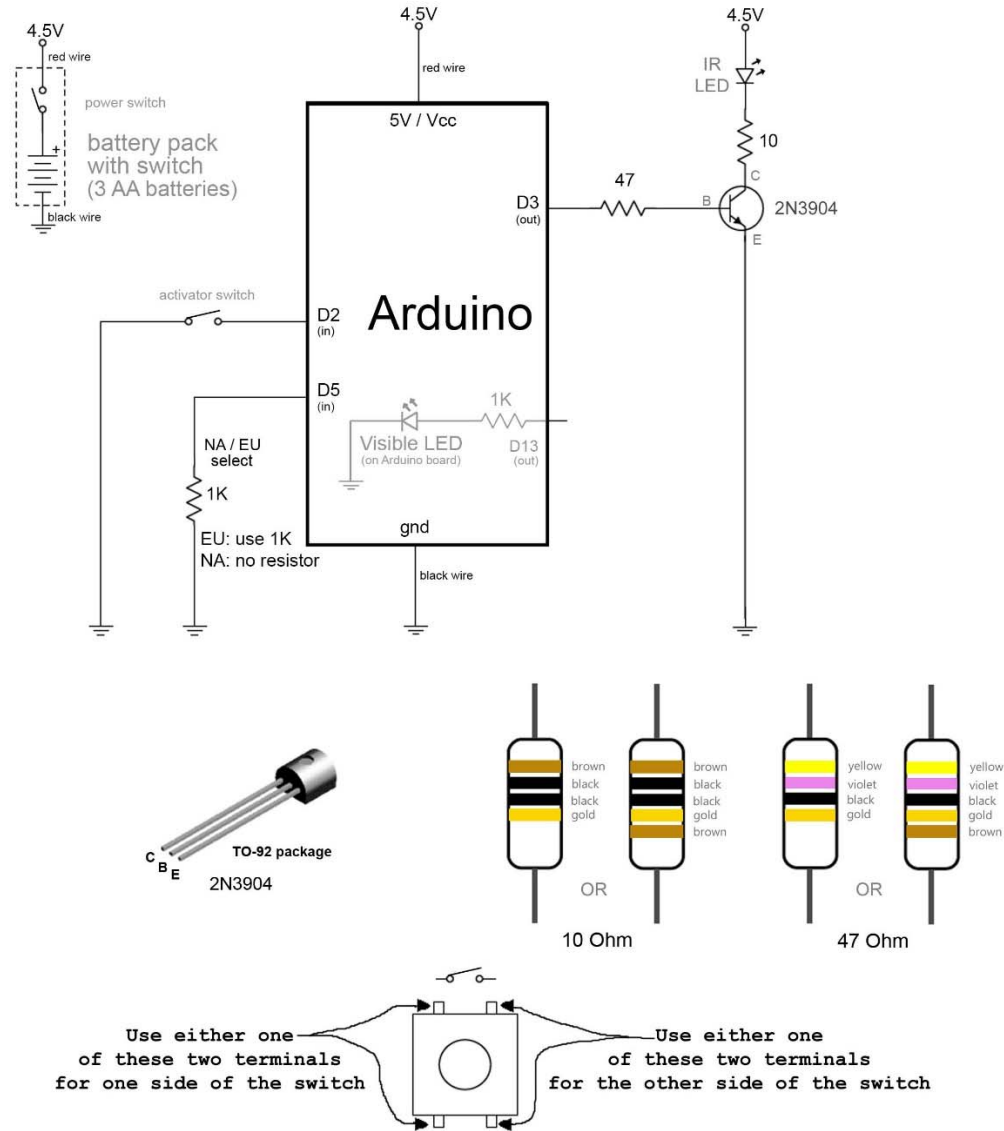


# How to Read a Schematic

## Arduino For Total Newbies

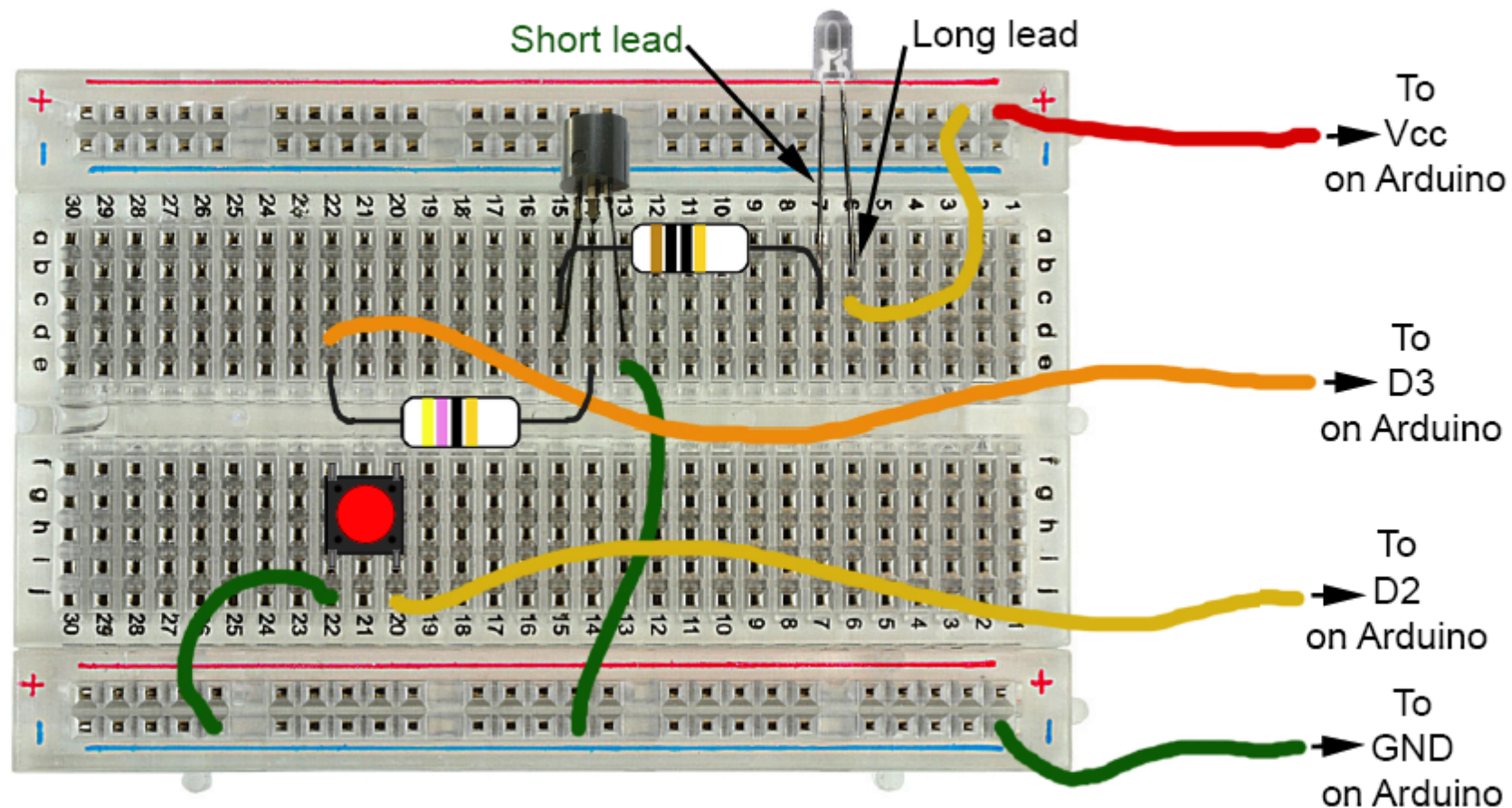
4-Sep-2015

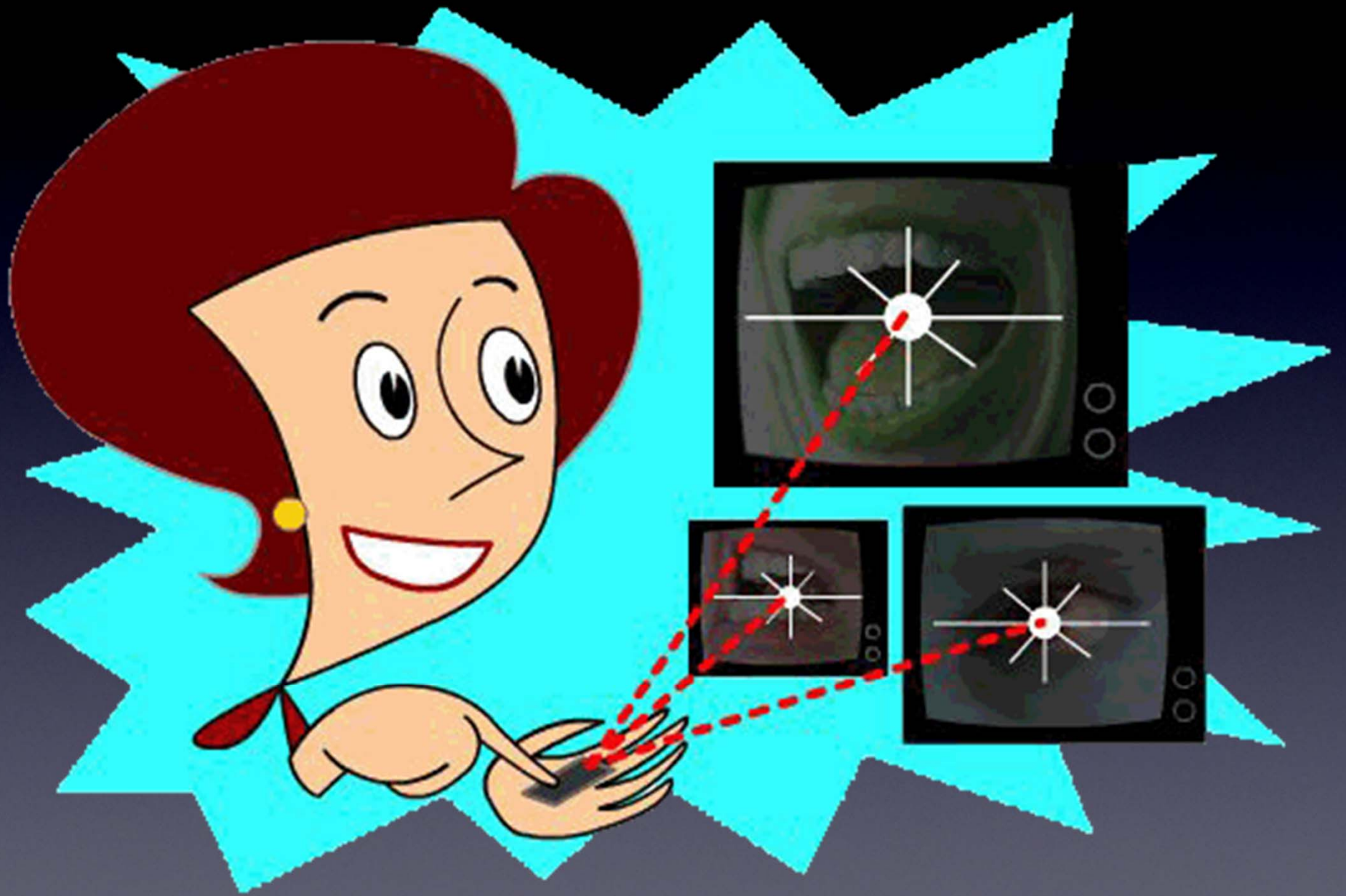
Mitch Altman (original TV-B-Gone hardware and firmware, modified TV-B-Gone Arduino design)  
Limore Fried (firmware modifications, kit design)  
Ken Shirriff (original modifications for Arduino)  
Johannes Schneemann (documentation)



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

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



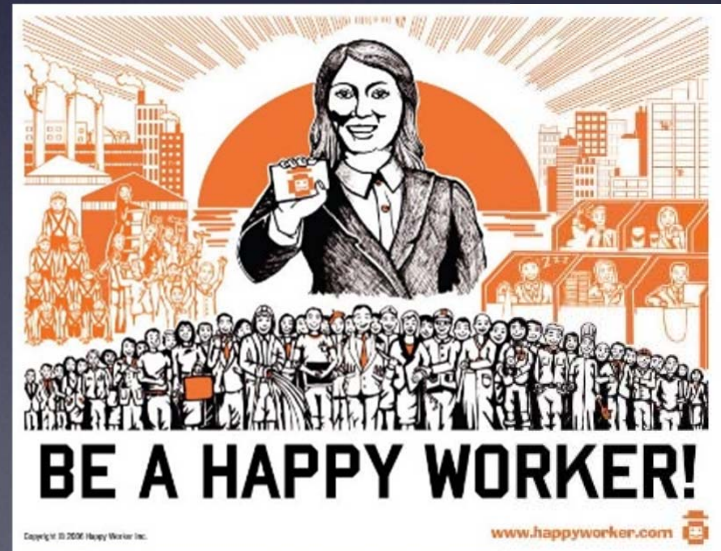


Questions?

# Intro



# Intro



# Intro

*Cornfield*  
 *Electronics, Inc.*

---

**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**

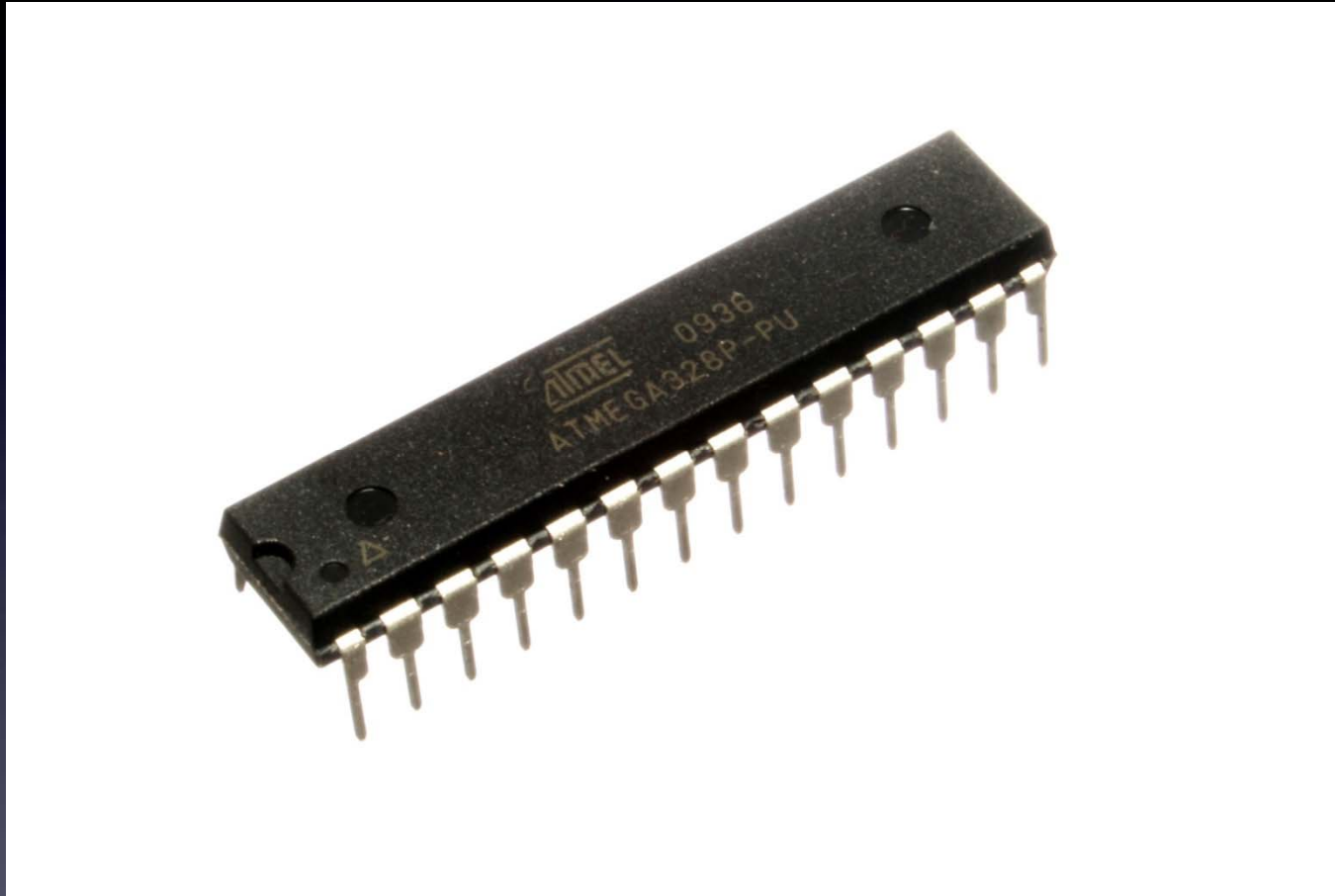


# Intro



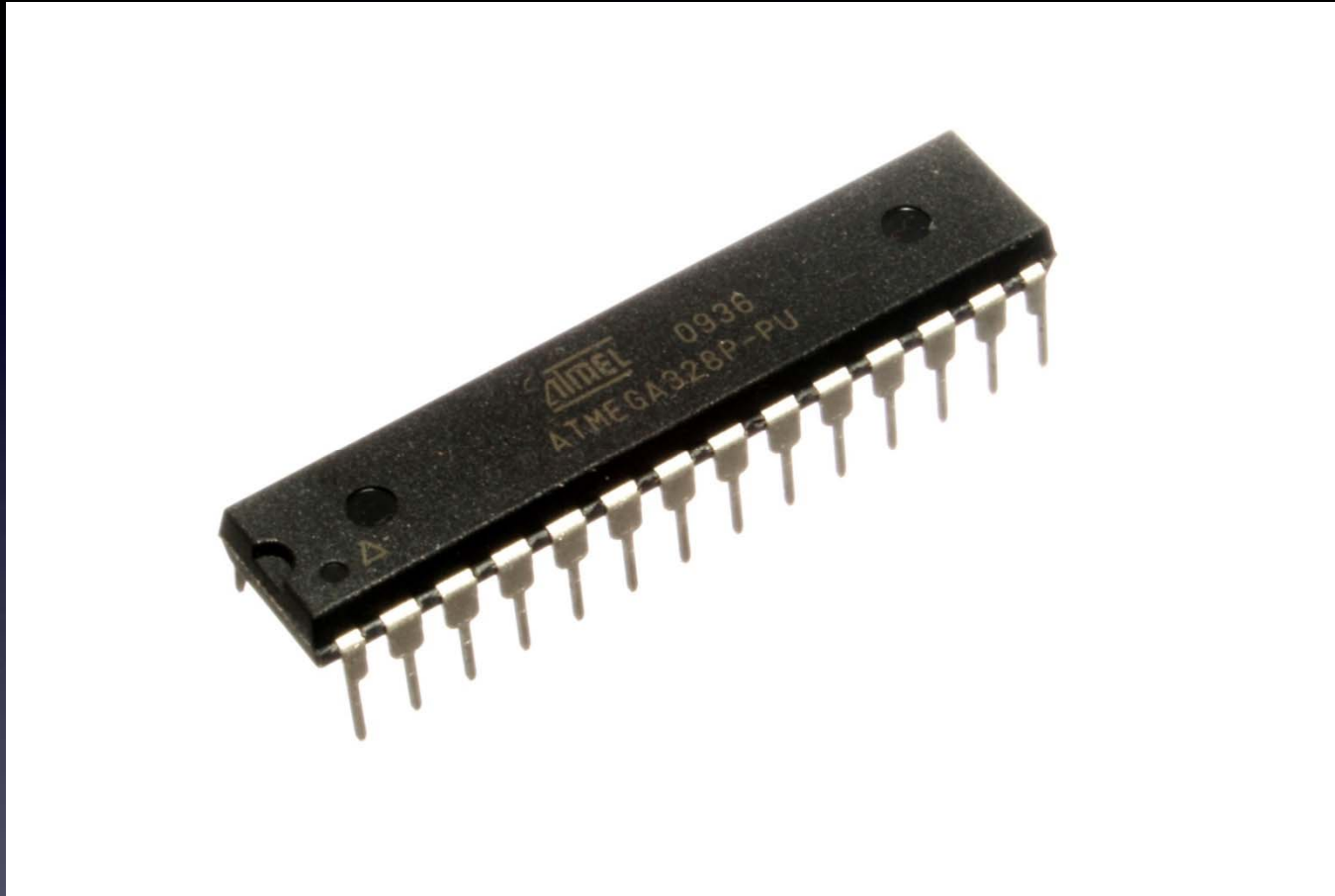
Arduino For Total Newbies Workshop at 30C3, Hamburg Germany

# Intro to Arduino: microcontrollers



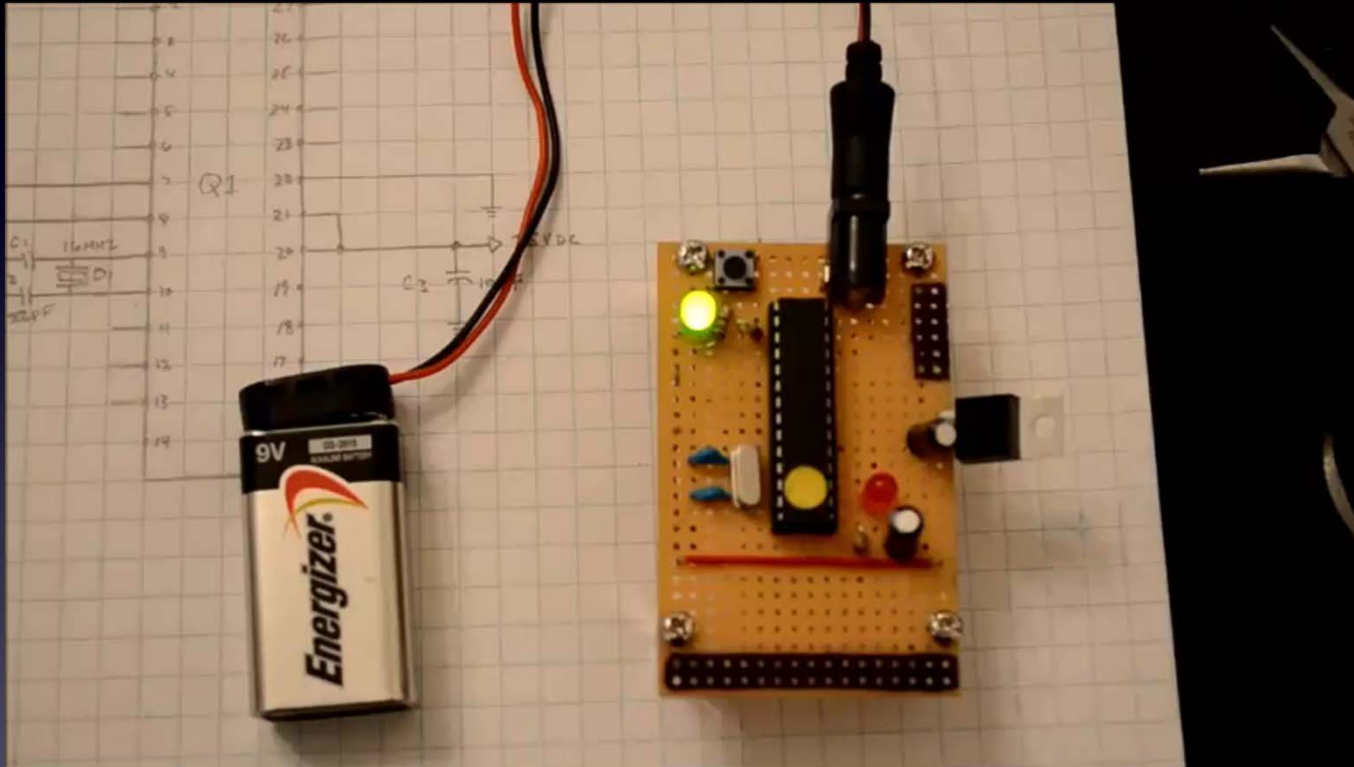
A complete computer on a chip

# Intro to Arduino: microcontrollers



**A complete computer on a chip:**  
they control parts connected to their pins

# Intro to Arduino: microcontrollers



Intro to Arduino:  
microcontrollers

-- *some of Mitch's projects* --



*Trippy RGB Waves kit*

# Intro to Arduino: microcontrollers

*-- some of Mitch's projects --*

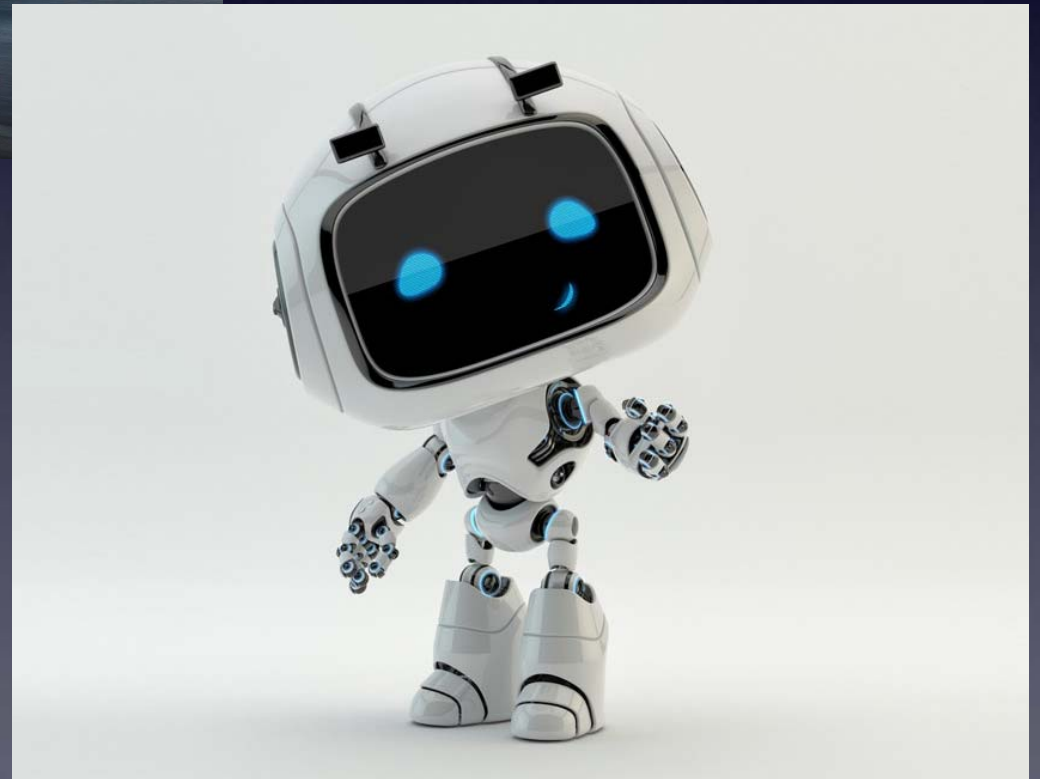
*ArduTouch  
music  
synthesizer  
kit*



# Intro to Arduino: microcontrollers



# Intro to Arduino: microcontrollers





# Intro to Arduino: microcontrollers



# Intro to Arduino: microcontrollers



# Intro to Arduino: microcontrollers

-- *some of Mitch's projects* --

*TV-B-Gone*



# Intro to Arduino: microcontrollers

*-- some of Mitch's projects --*

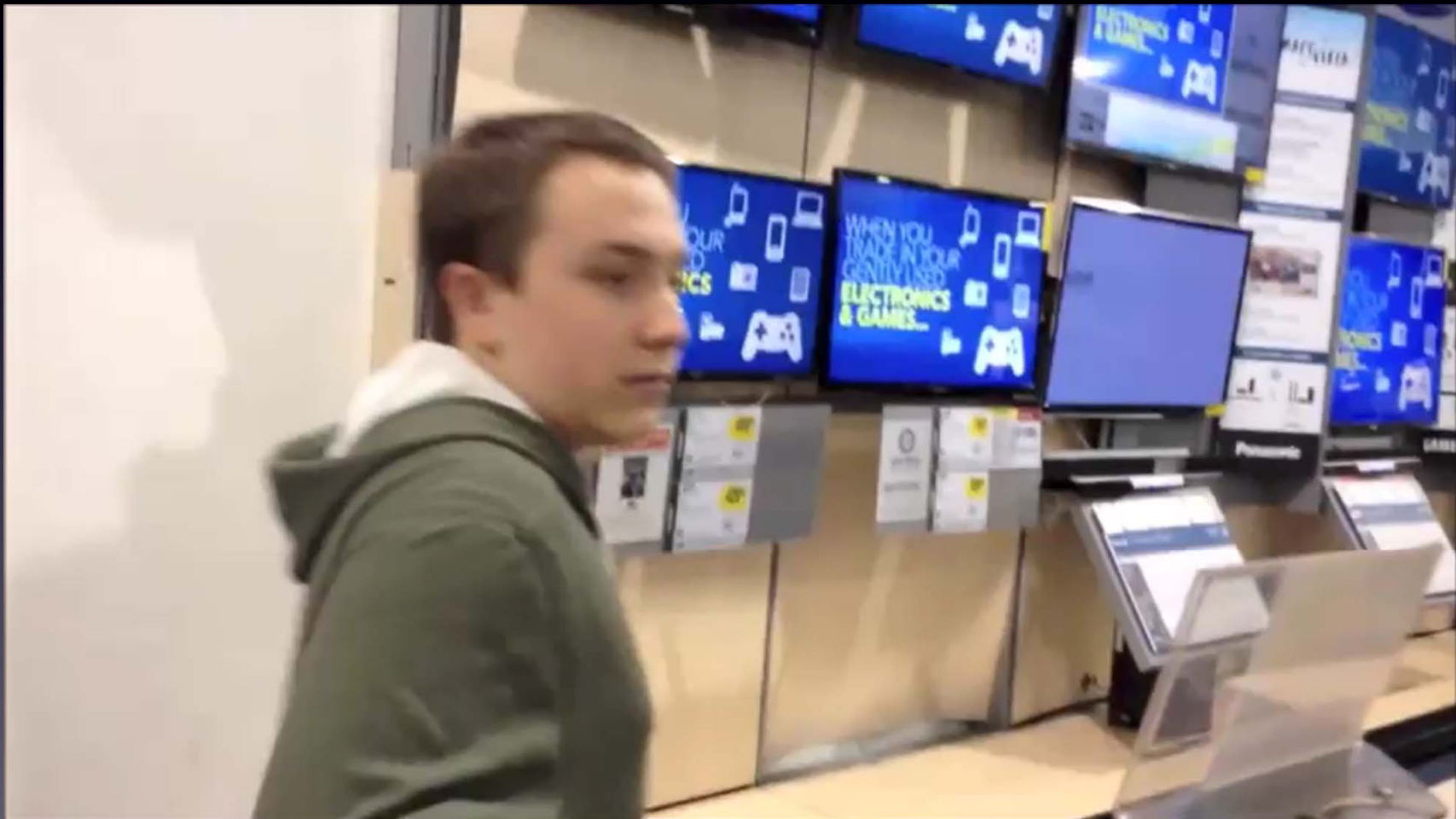


## *TV-B-Gone*

*Just a remote control,  
but only one button:  
OFF !*

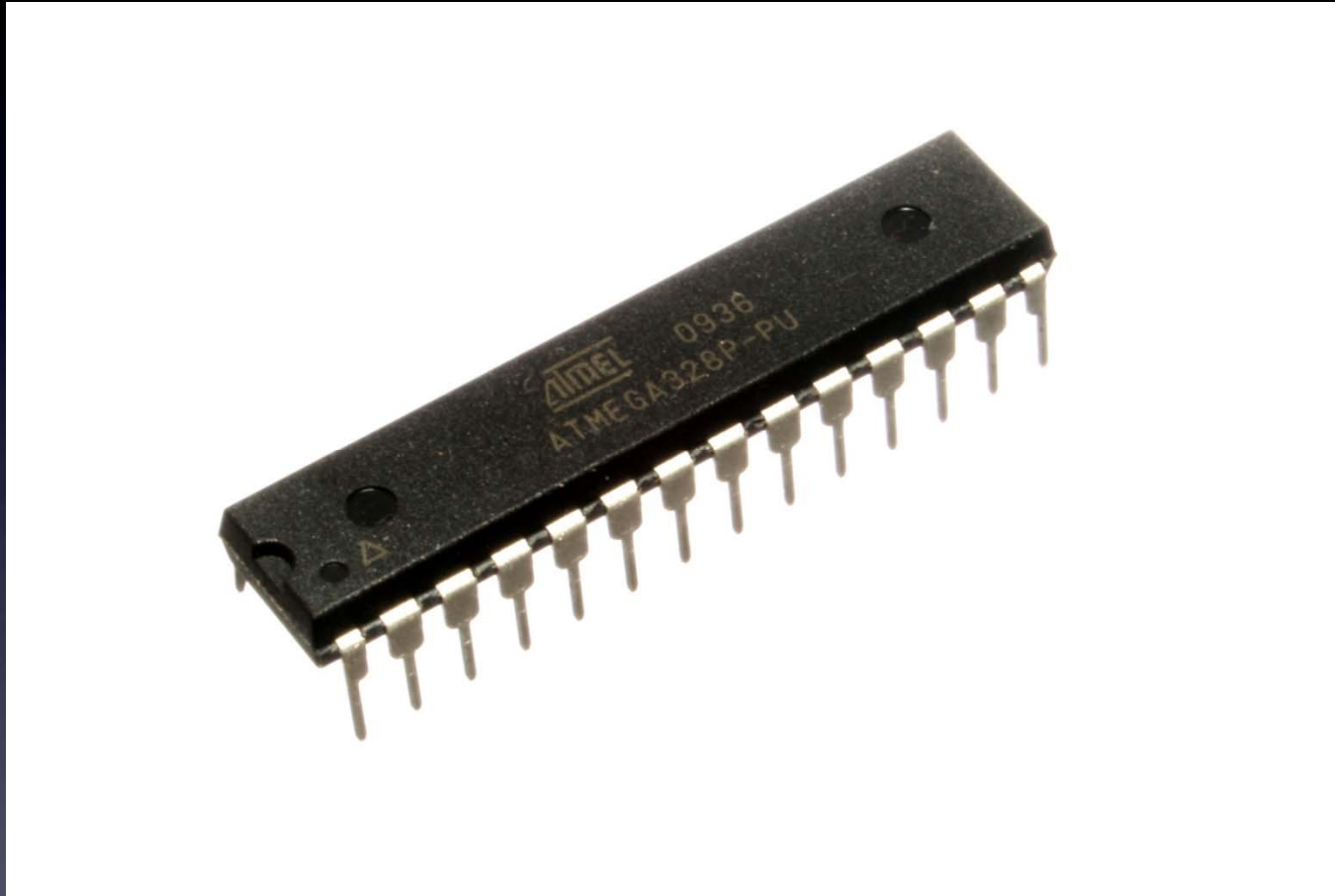


Intro to Arduino:  
microcontrollers  
*-- some of Mitch's projects --*



*TV-B-Gone*

# Intro to Arduino: microcontrollers

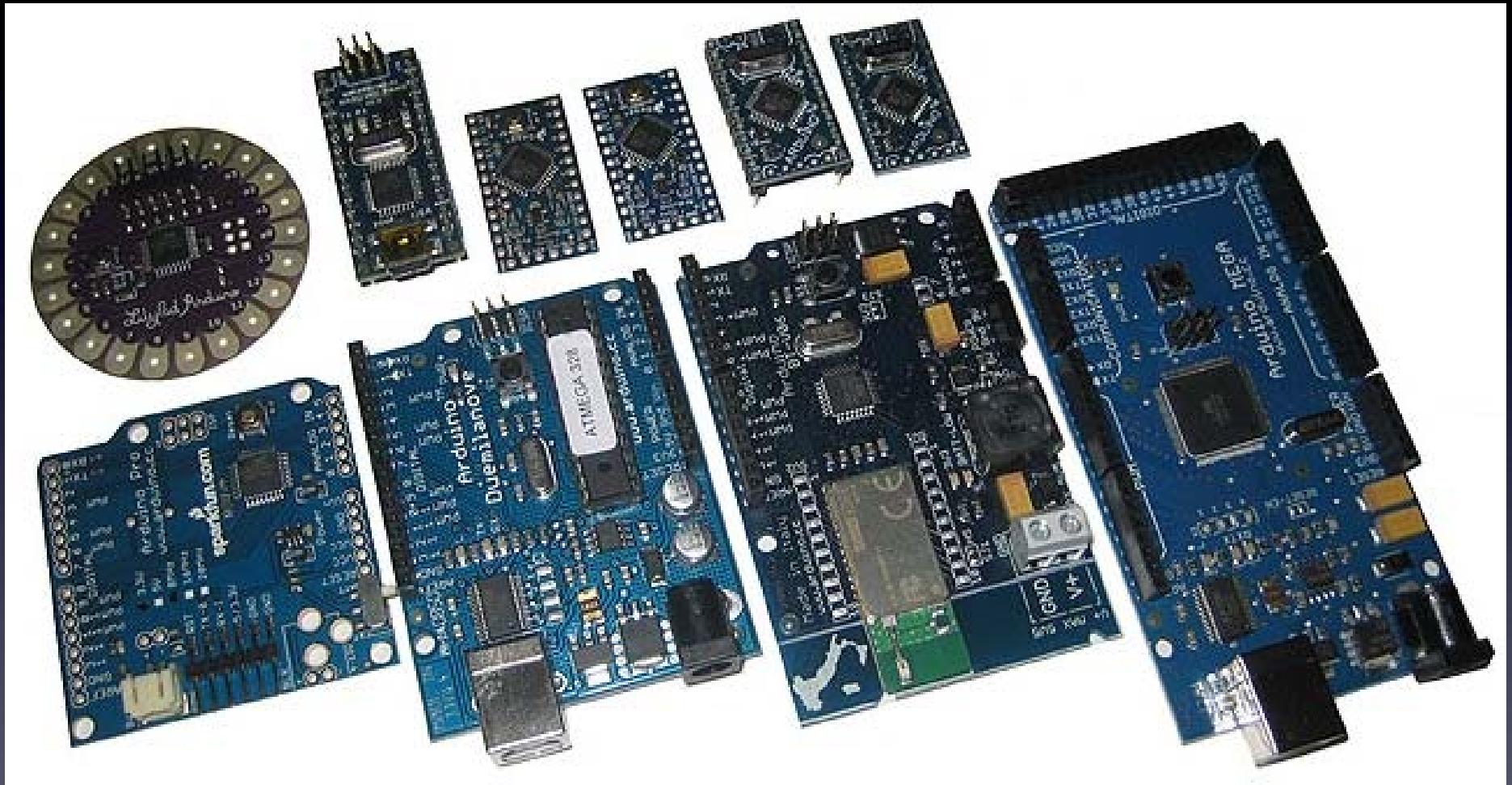


**A complete computer on a chip:**  
they control parts connected to their pins

# Intro to Arduino

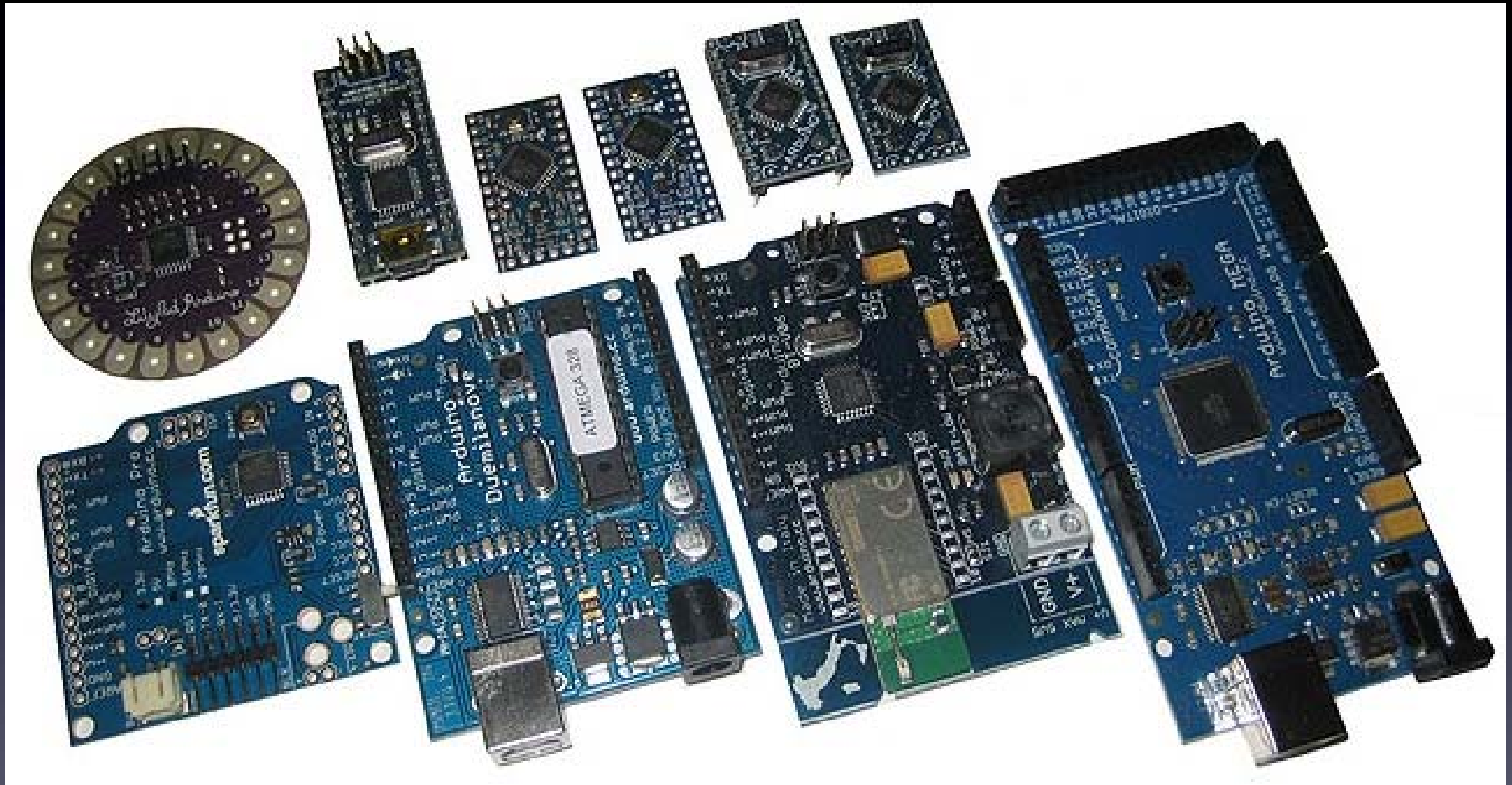


# Intro to Arduino



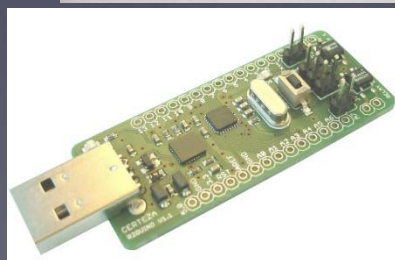
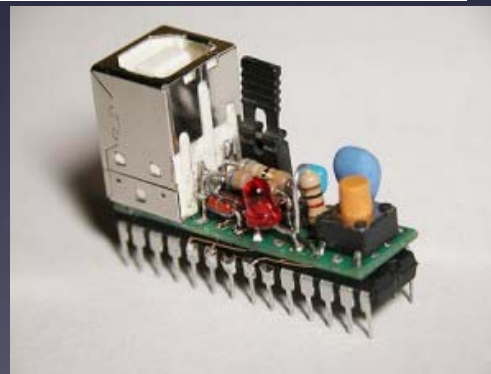
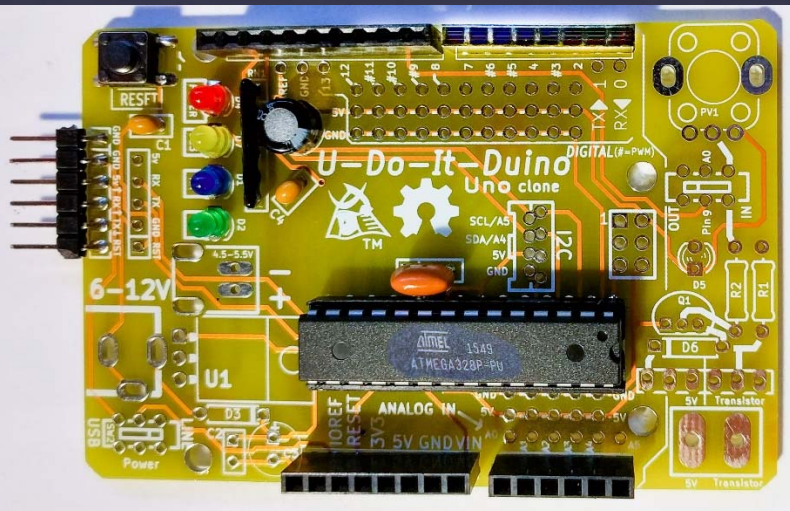
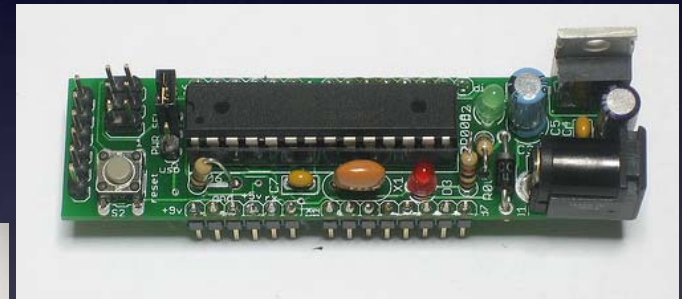
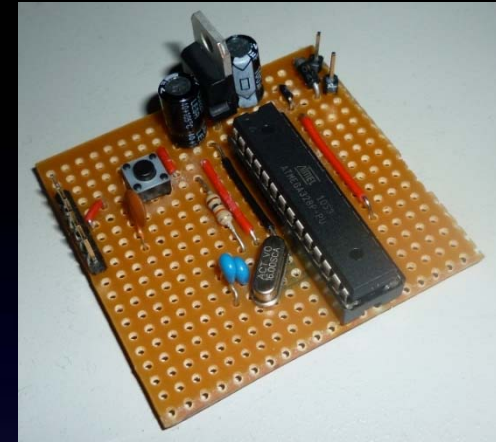
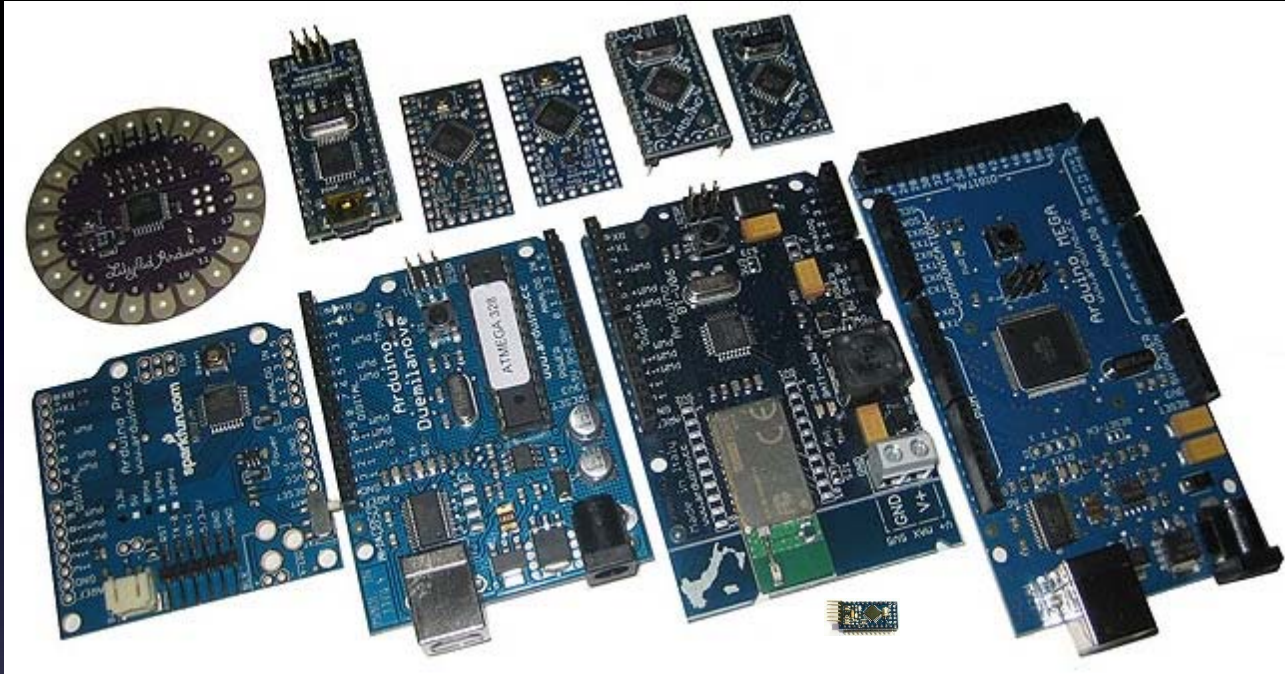


# Intro to Arduino



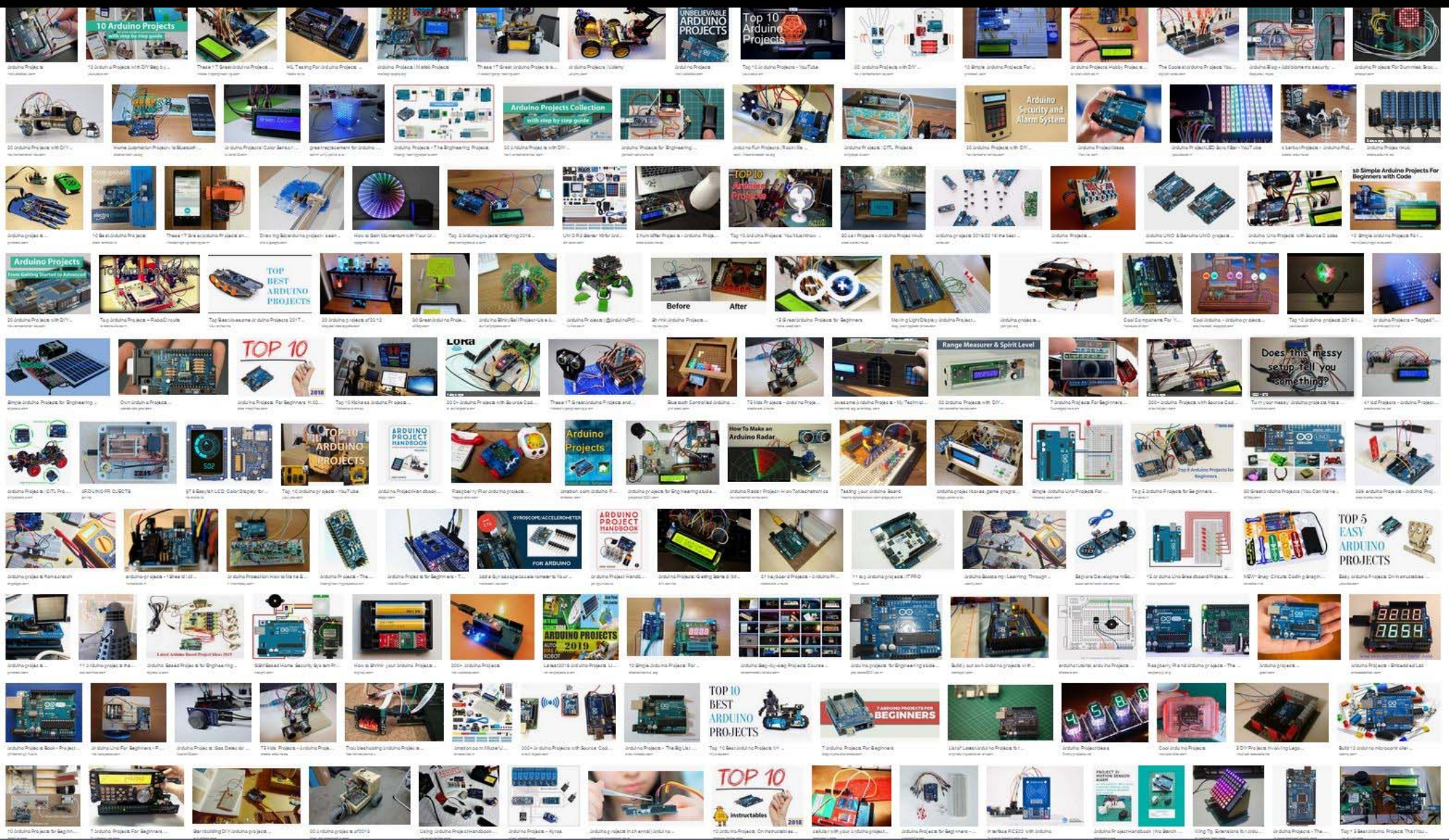
Open Source

# Intro to Arduino



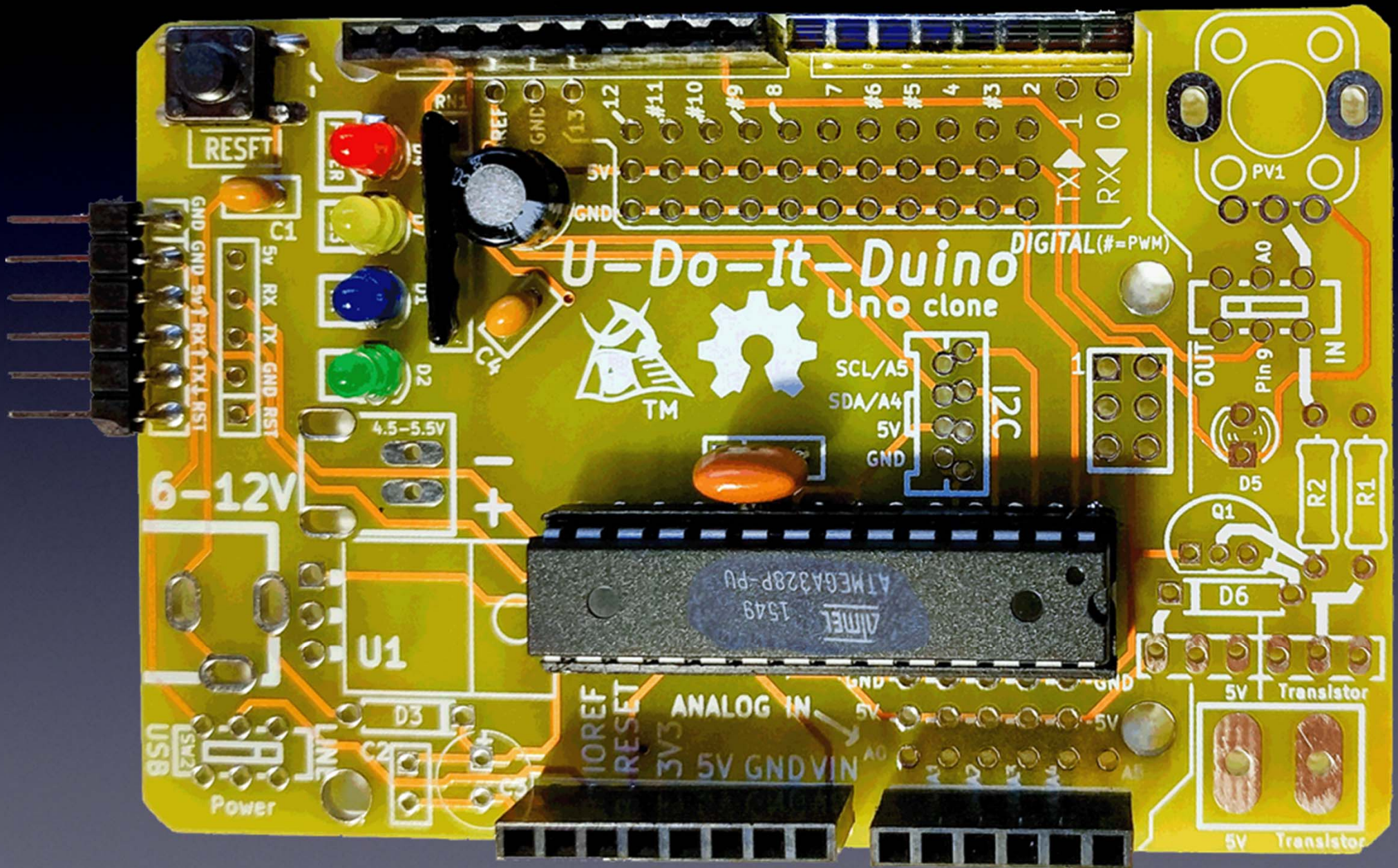
Open Source

# Intro to Arduino



*hundreds of thousands of projects online!*

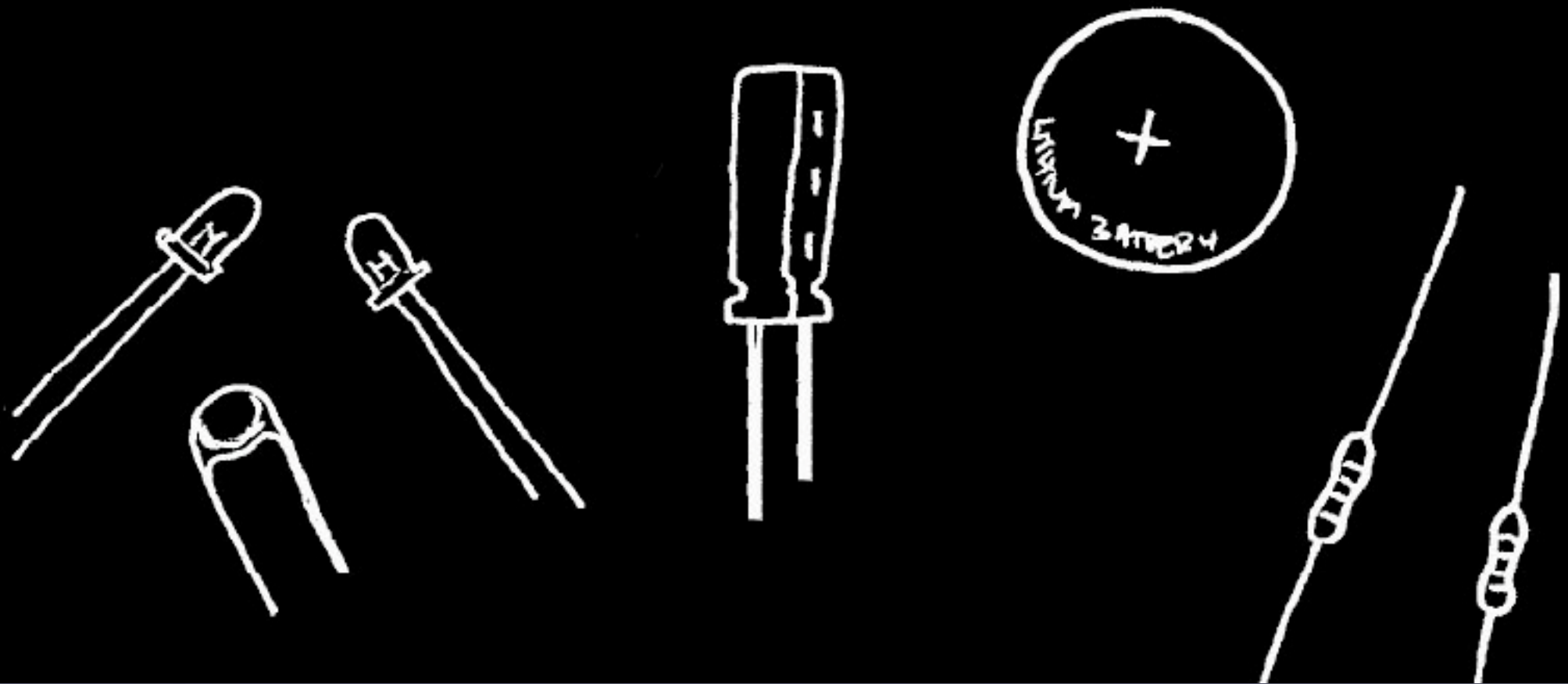
# Intro



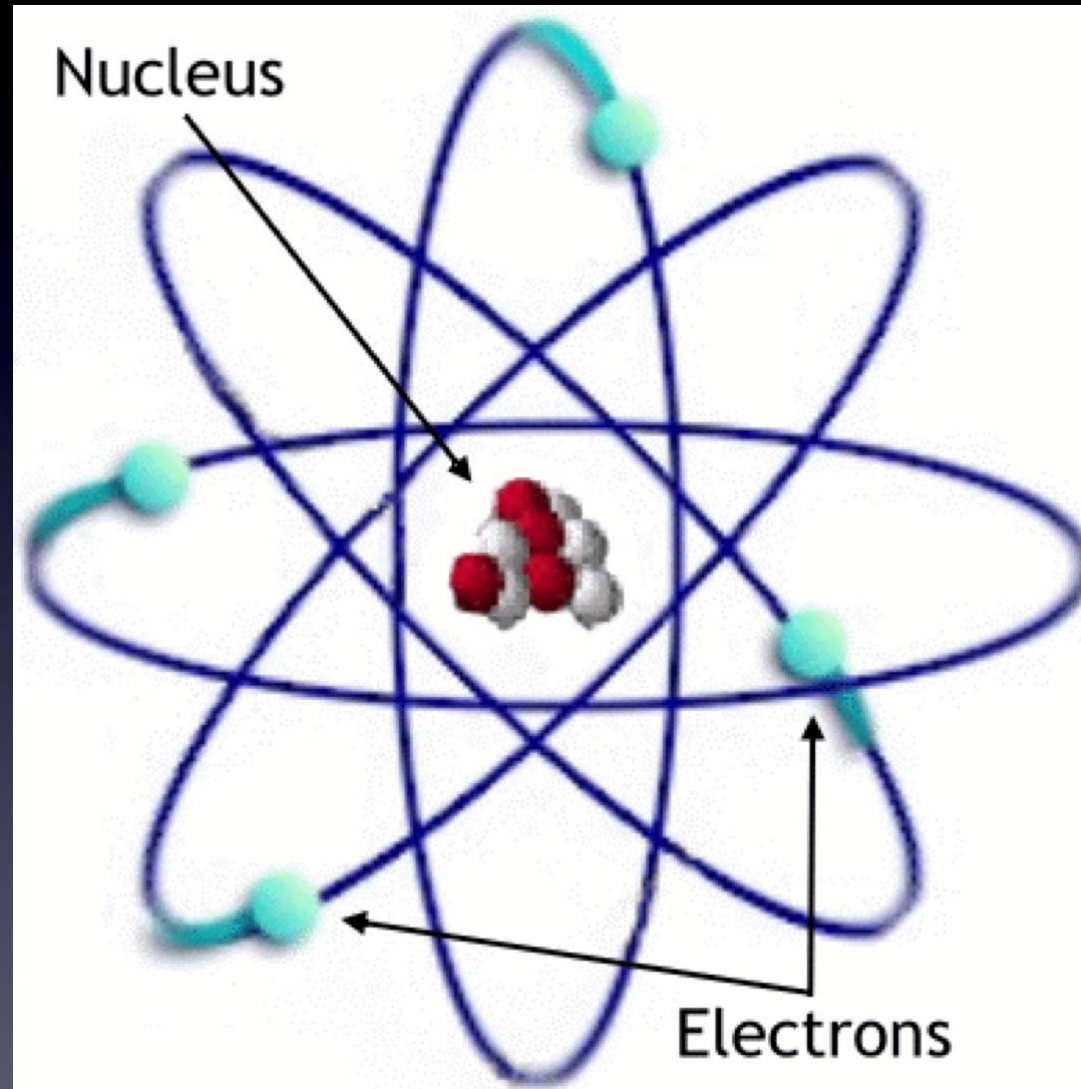
Intro

Questions?

# *Everything You Need to Know About Electronics*

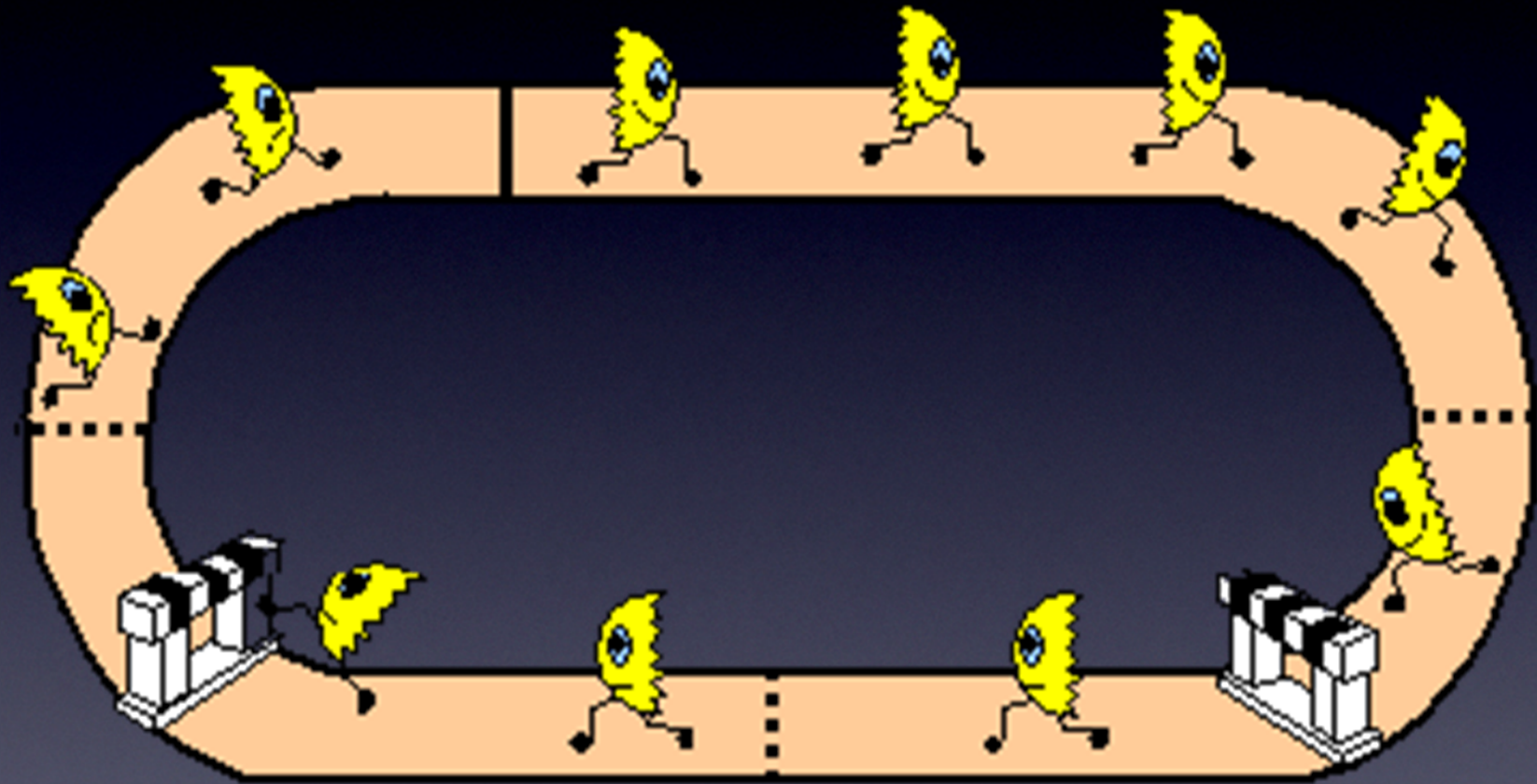


# Everything You Need to Know About Electronics



Electrons

# Everything You Need to Know About Electronics



Circuits = Electrons going in circles = Magic!

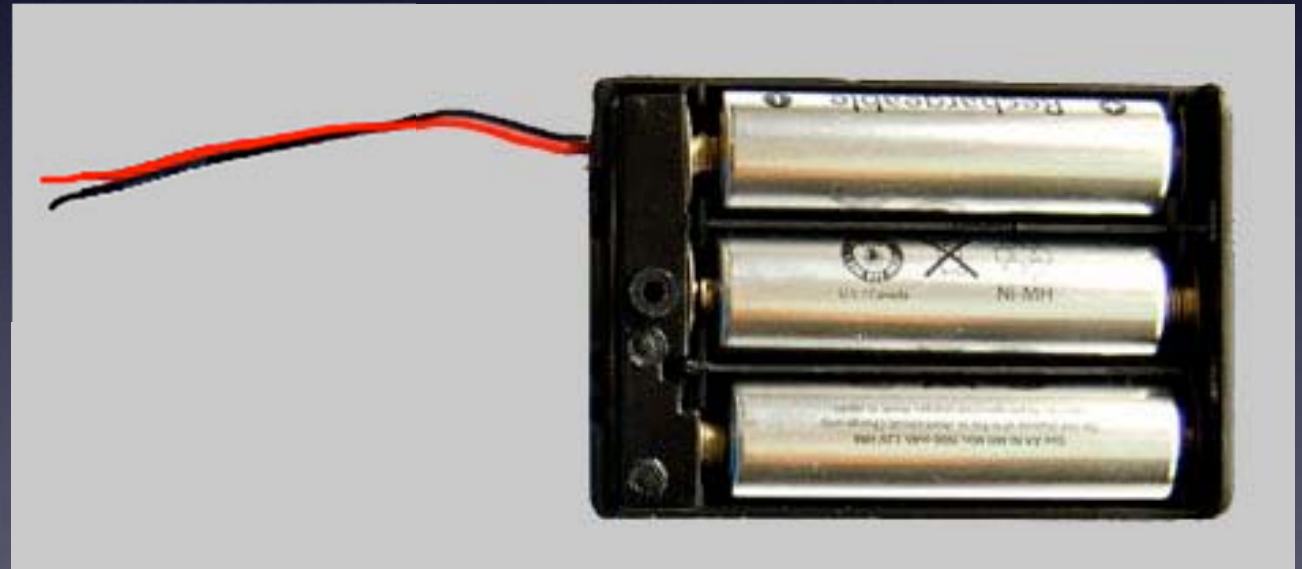


# Everything You Need to Know About Electronics



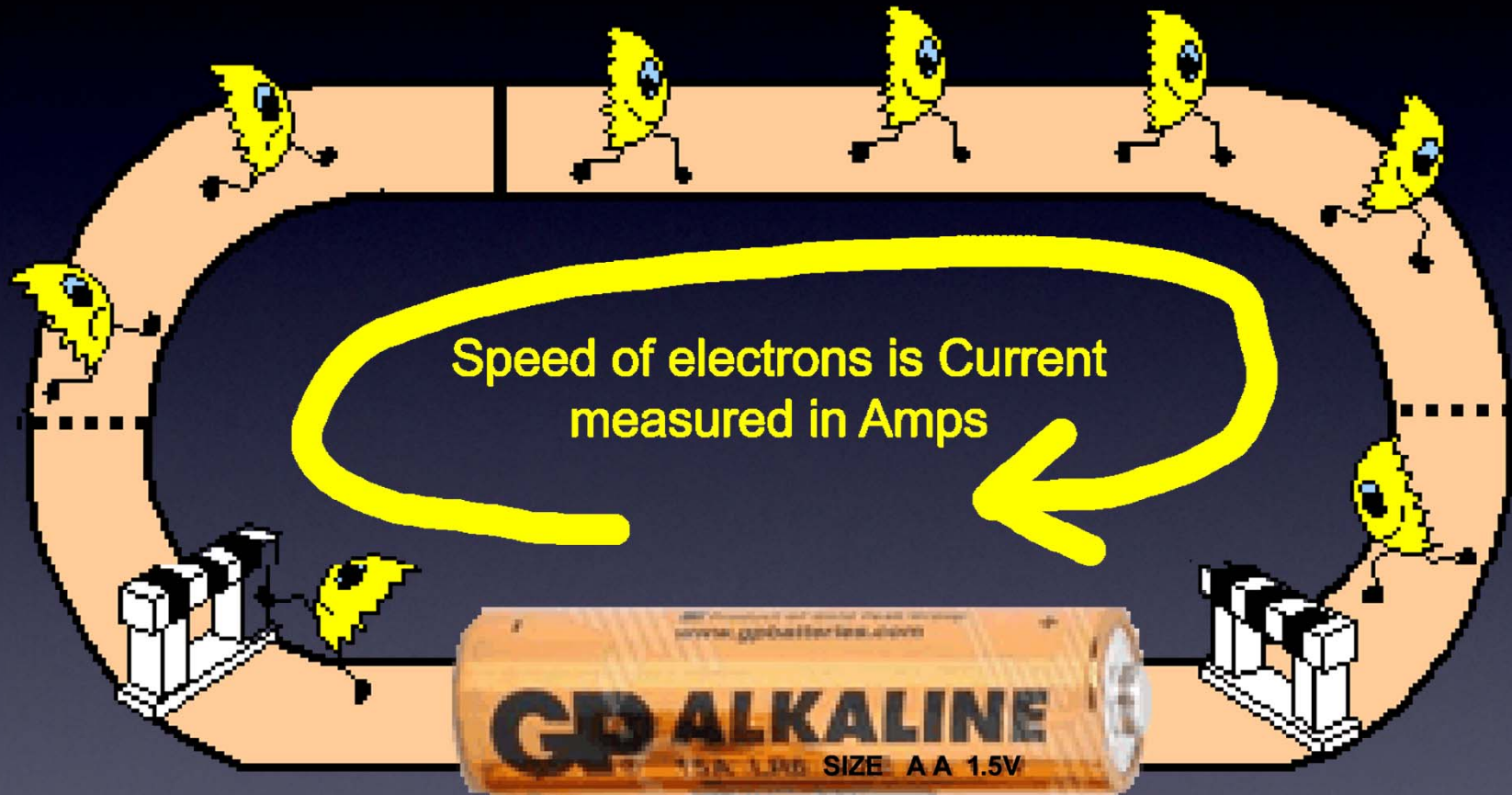
## Power Supplies

# Everything You Need to Know About Electronics



Volts / Voltage

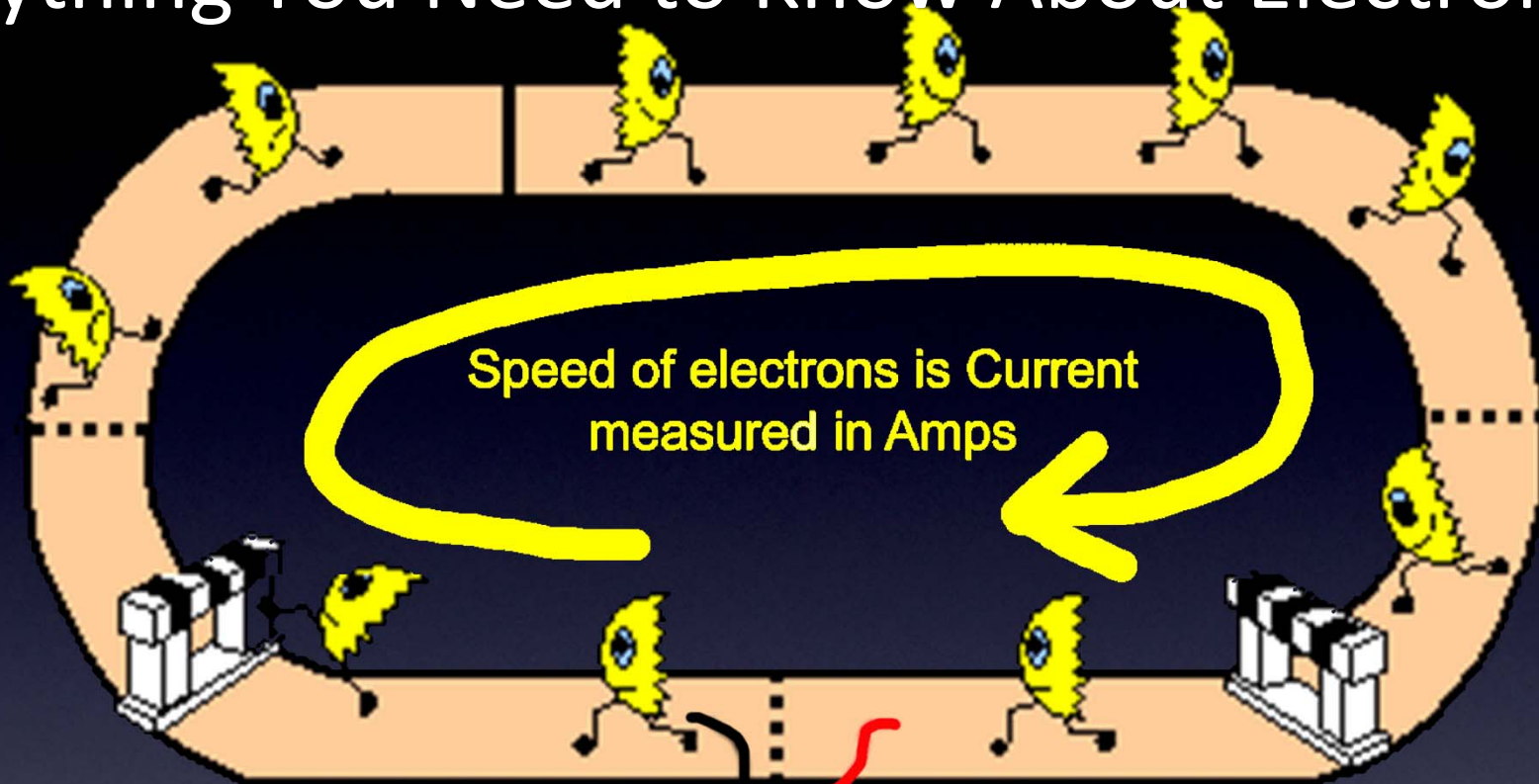
# Everything You Need to Know About Electronics



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

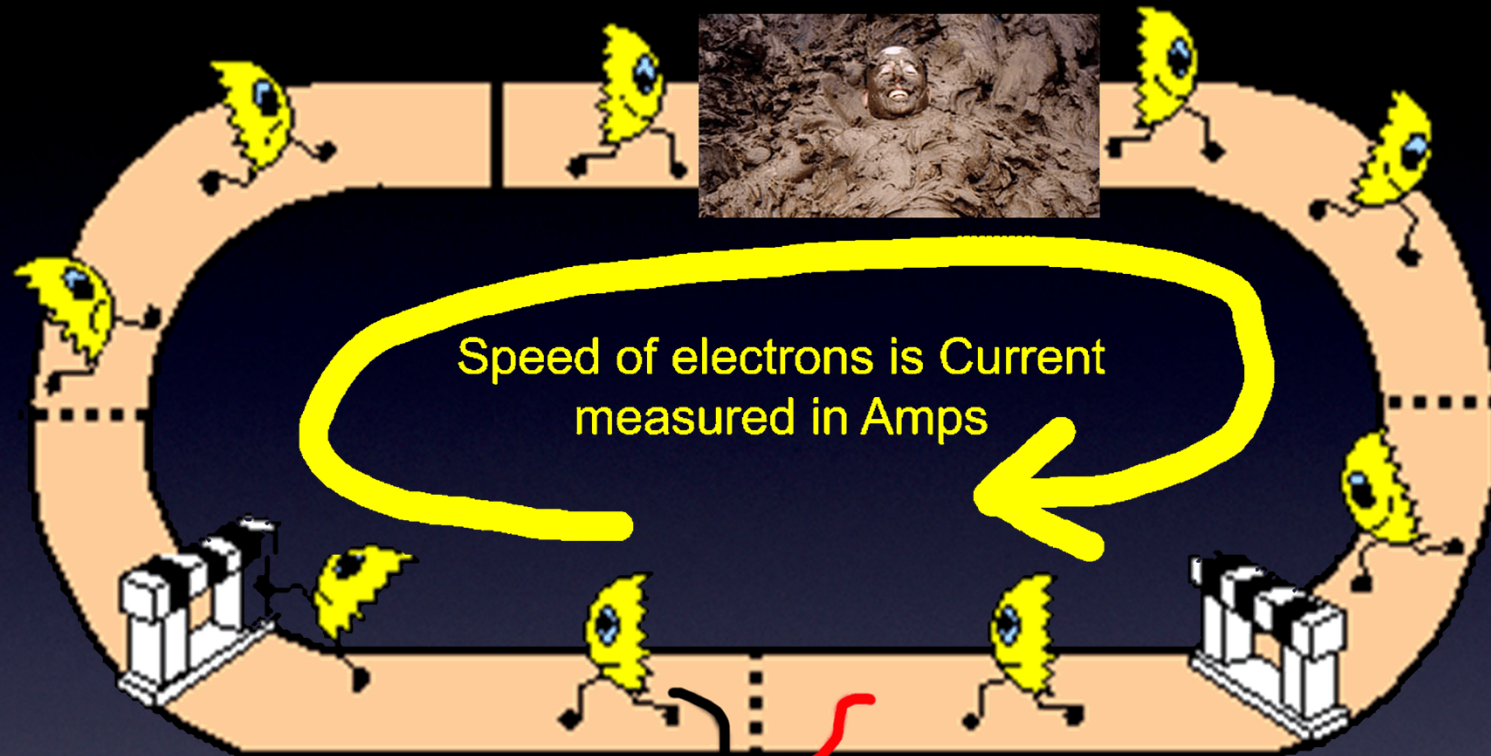
# Everything You Need to Know About Electronics

**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

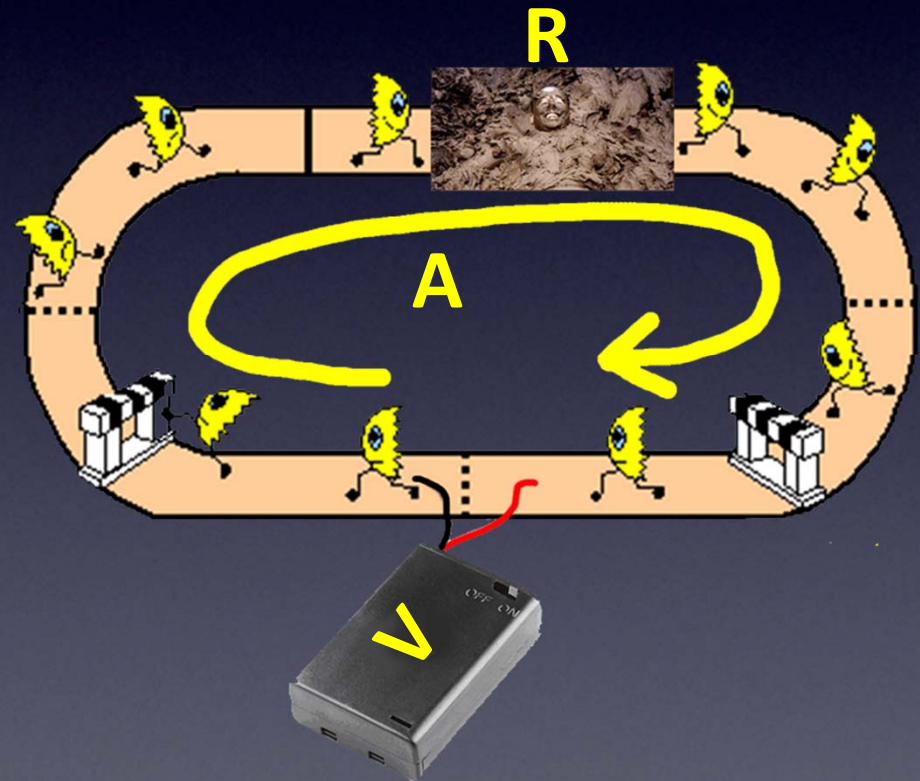
# Everything You Need to Know About Electronics

## Ohm's Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

**Ohms** -- *Resistance* to flow of electrons



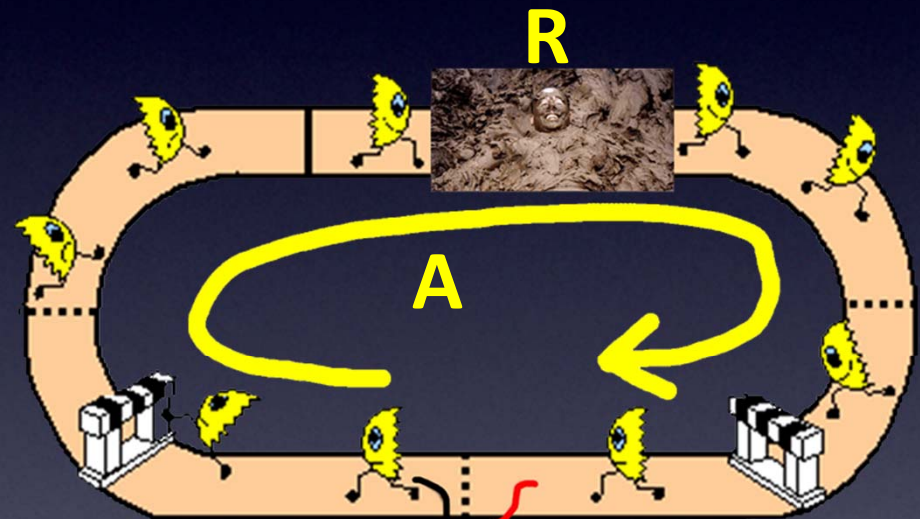
# Everything You Need to Know About Electronics

## Ohm's Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

**Ohms** -- *Resistance* to flow of electrons



$$\mathbf{Volts} = \mathbf{Amps} \times \mathbf{R}$$

(Ohms)



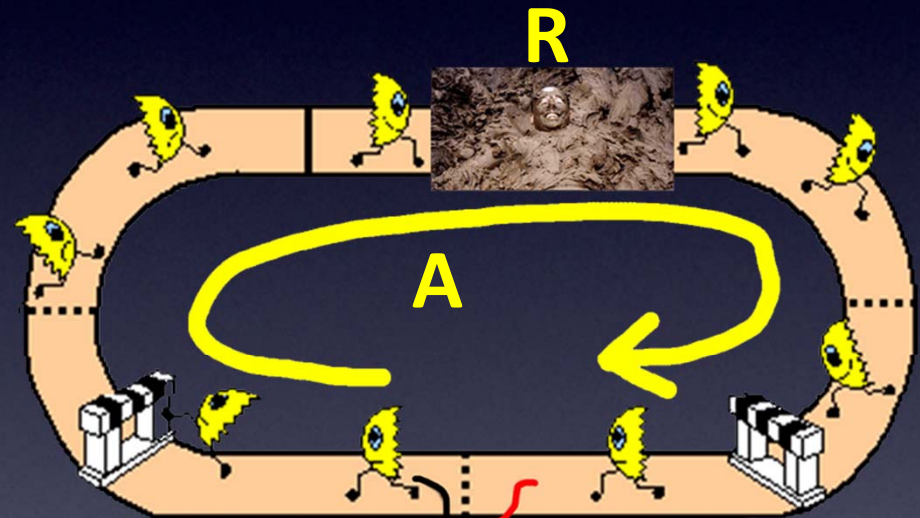
# Everything You Need to Know About Electronics

## Ohm's Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

**Ohms** -- *Resistance* to flow of electrons



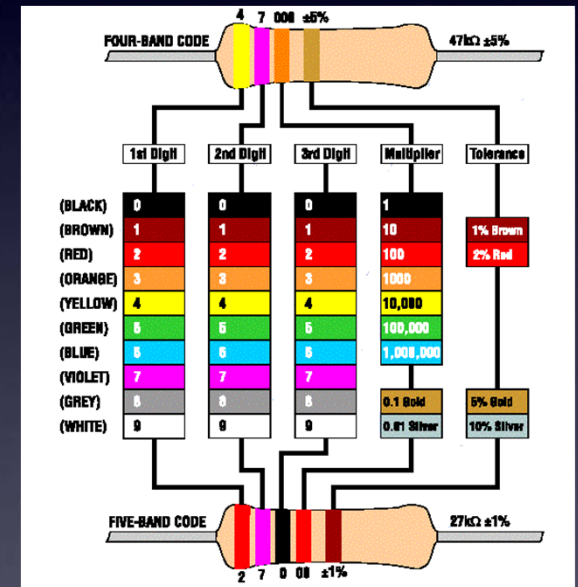
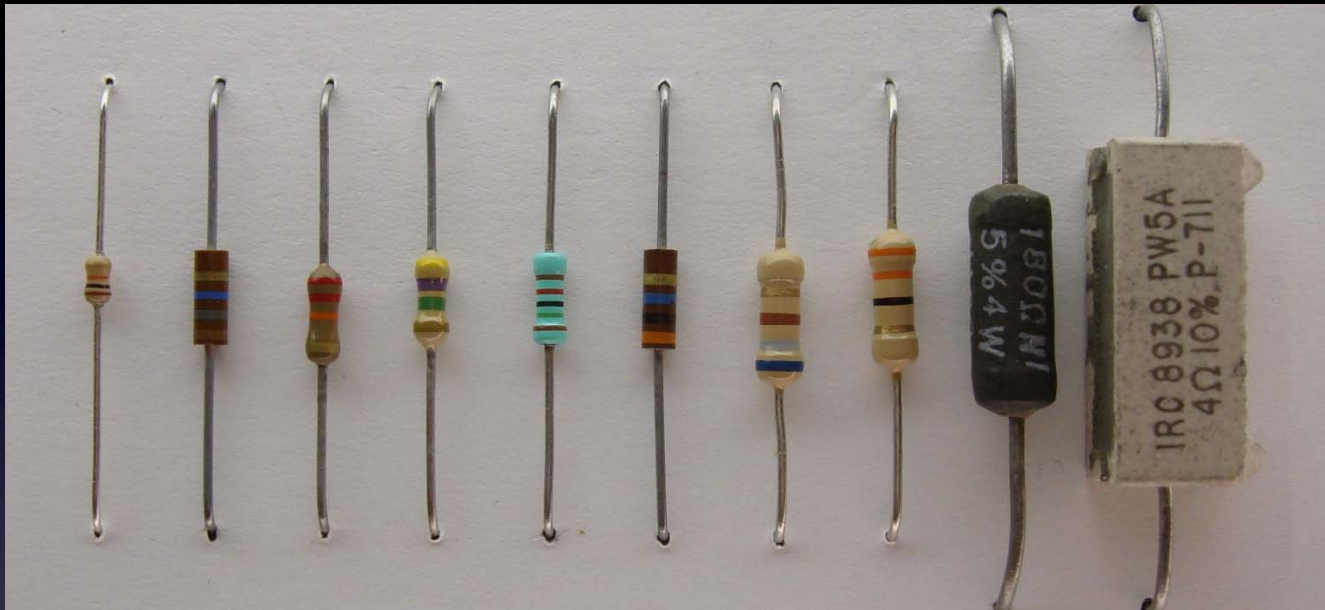
$$\text{Volts} = \text{Amps} \times \text{R}$$

Also commonly written:  $\text{E} = \text{I} \times \text{R}$



(Ohms)

# Everything You Need to Know About Electronics

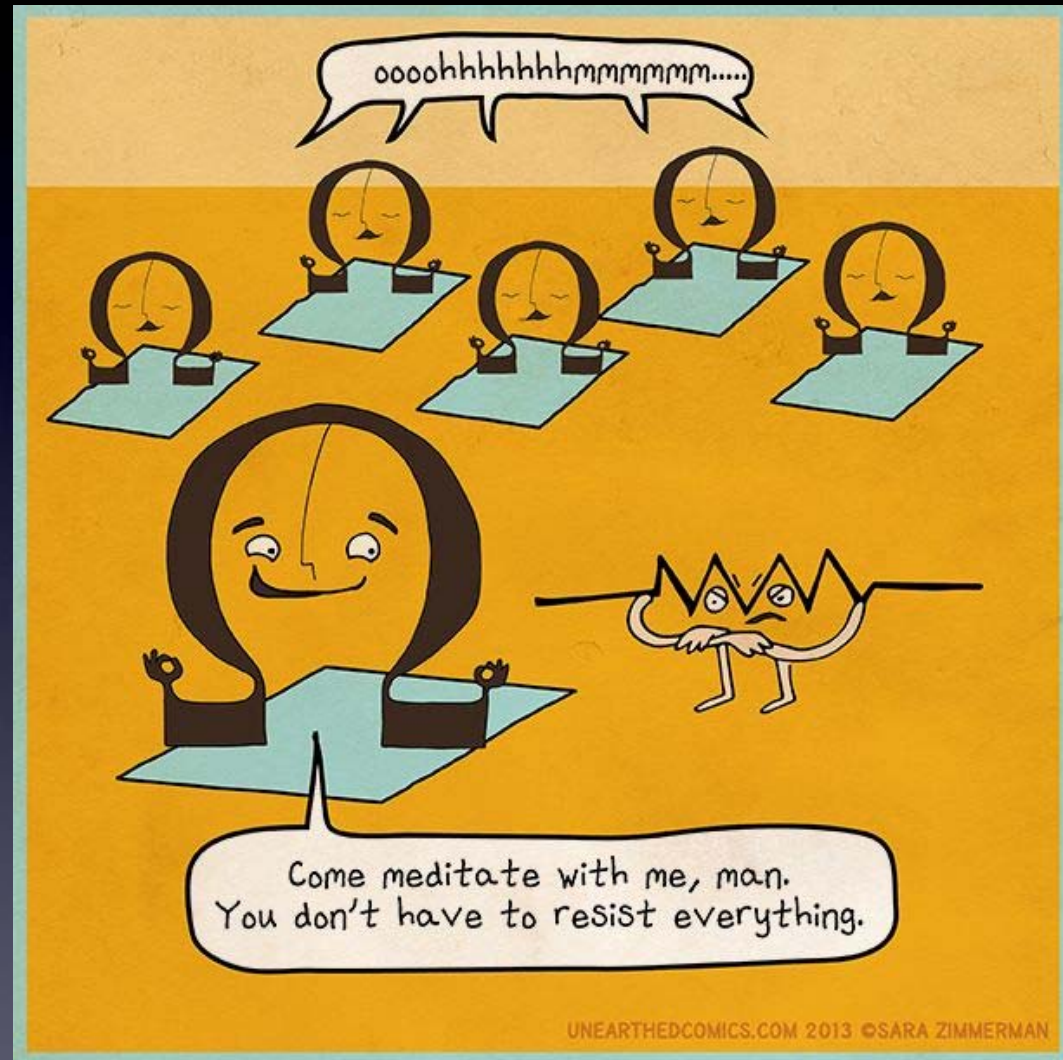


Resistors / Ohms

# Everything You Need to Know About Electronics

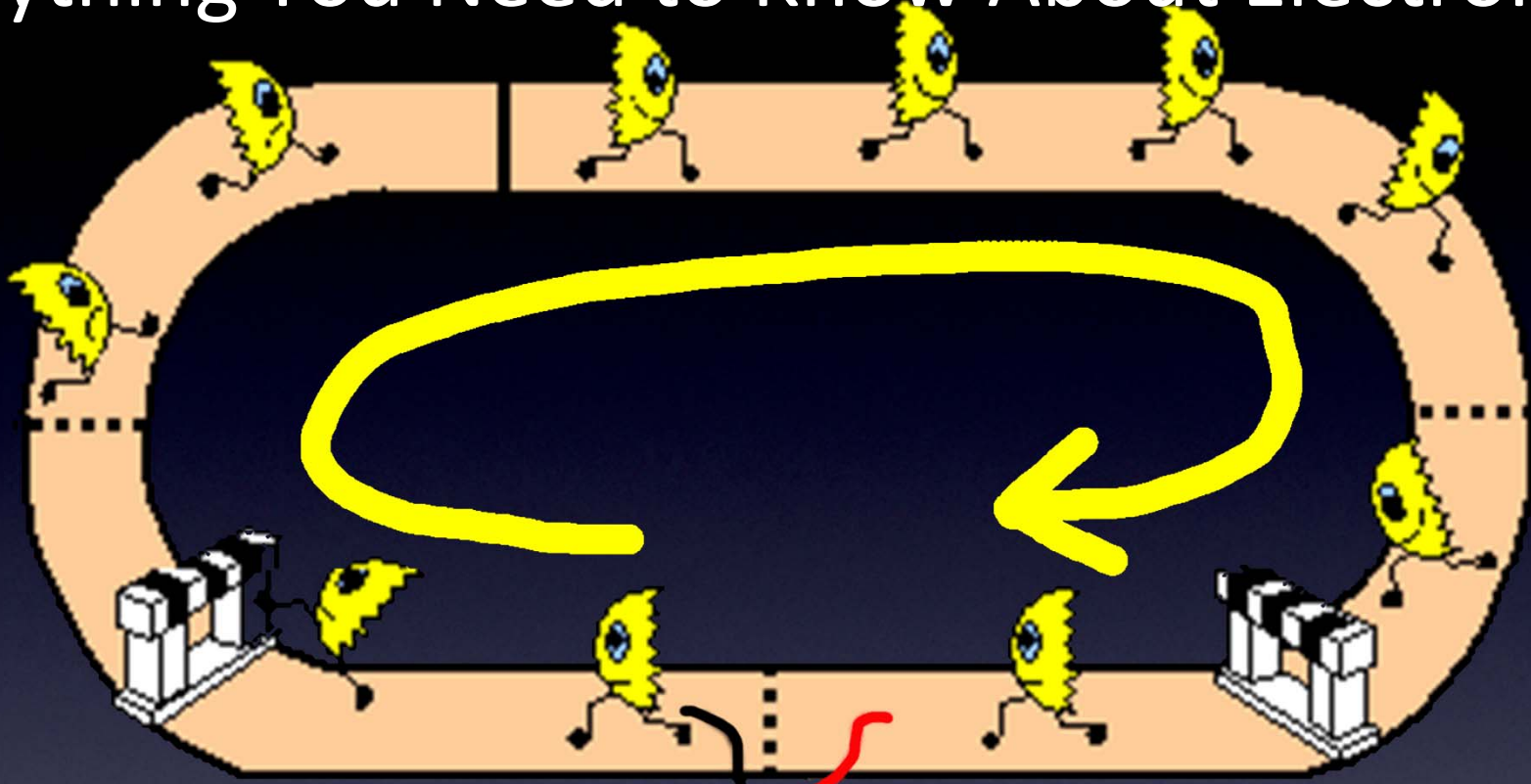
The symbol for  
**Resistance:**

$\Omega$



Resistors / Ohms

# 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

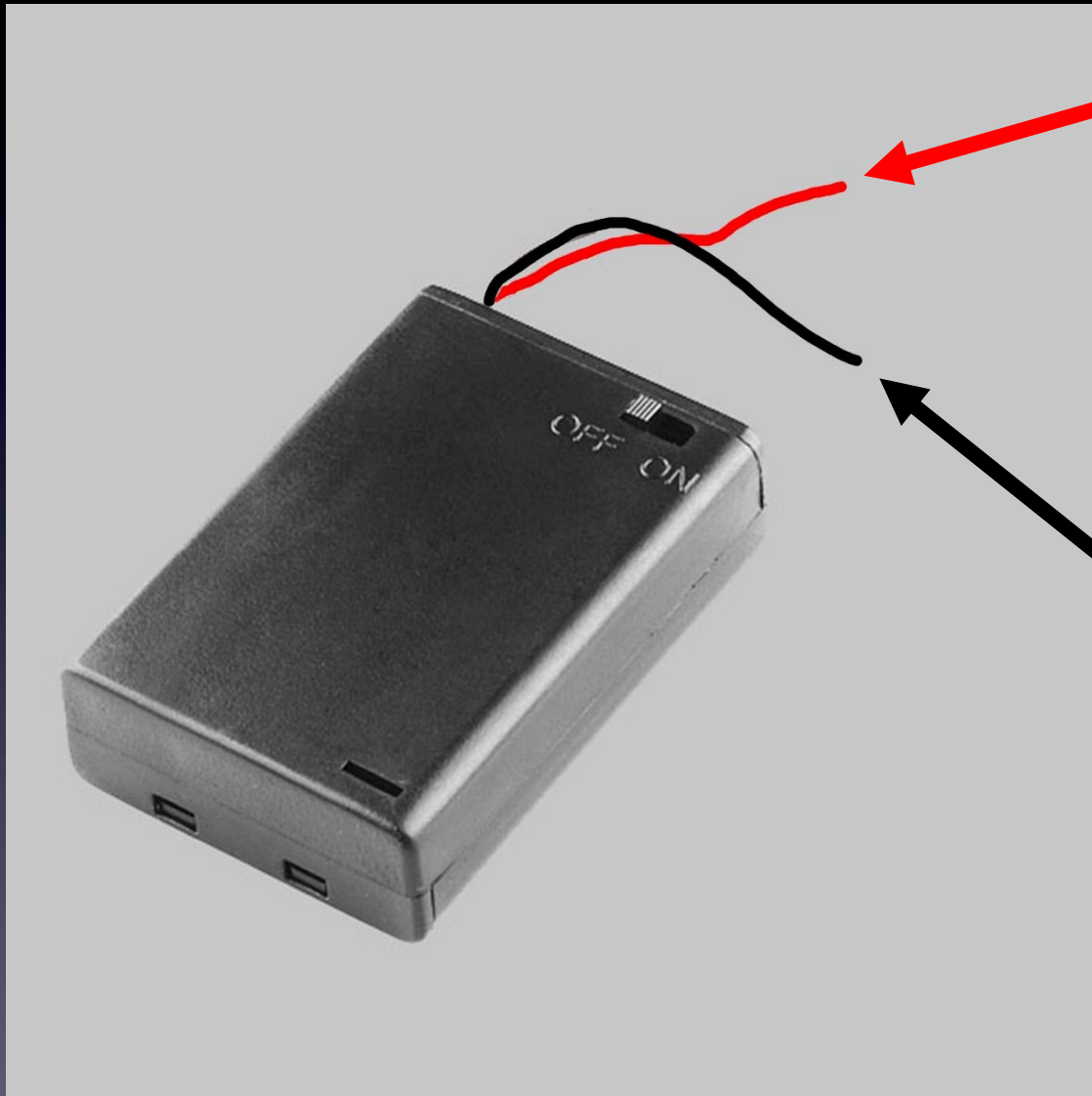


## What happens?

*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 (GND)**

Power Supply – it matters how you connect it!

# Everything You Need to Know About Electronics



or



or

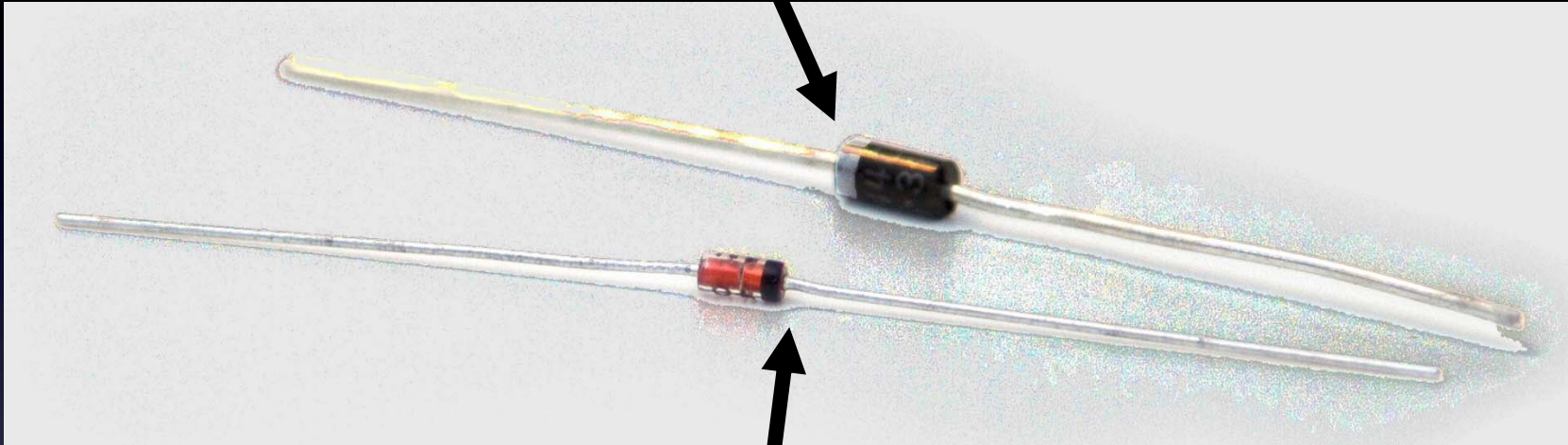


(electrons slowed down the same either way)

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!

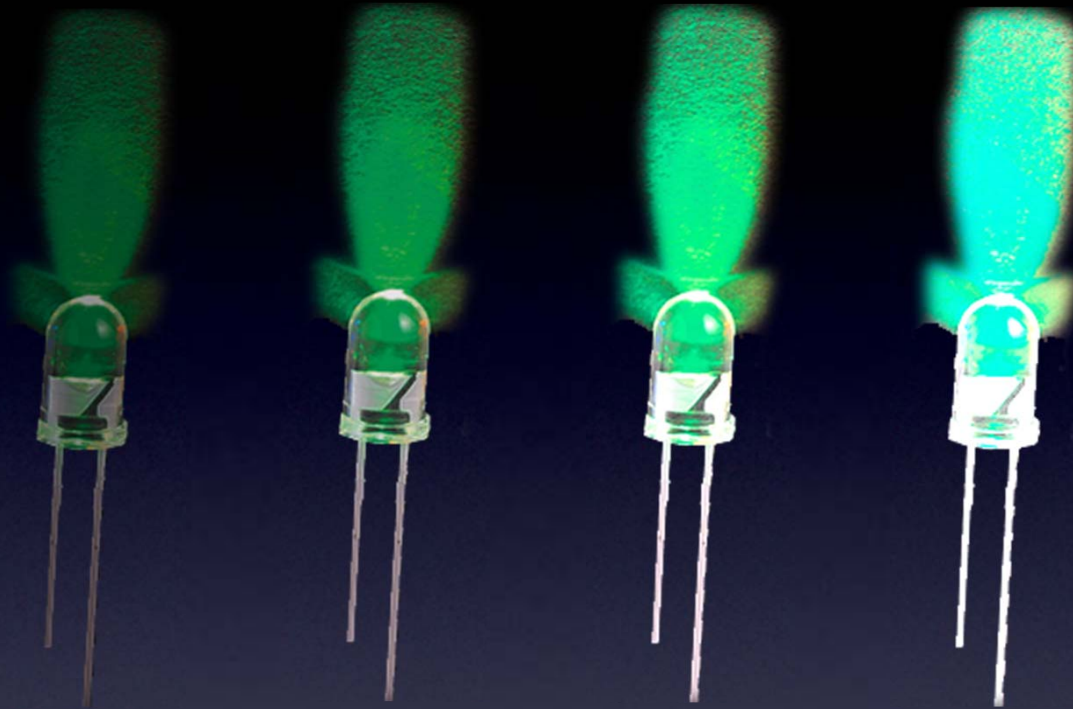
# Everything You Need to Know About Electronics



Lots of different colored LEDs! (including IR)

LED

# Everything You Need to Know About Electronics



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

LED

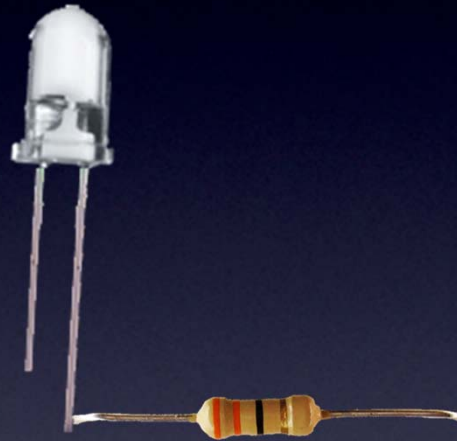
# Everything You Need to Know About Electronics



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

LED

# Everything You Need to Know About Electronics

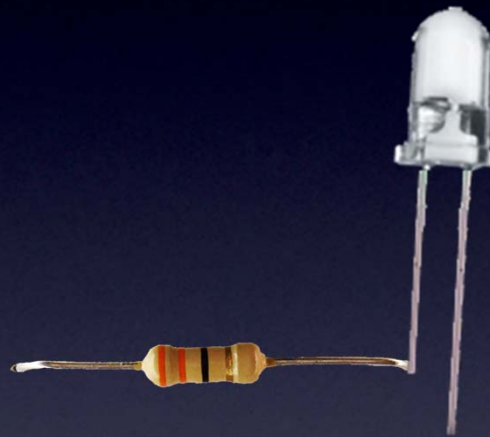


*(with a resistor  
so no magic smoke goes away)*

This is why we put a resistor in line with an LED

LED

# Everything You Need to Know About Electronics



*(the resistor can go on either side)*

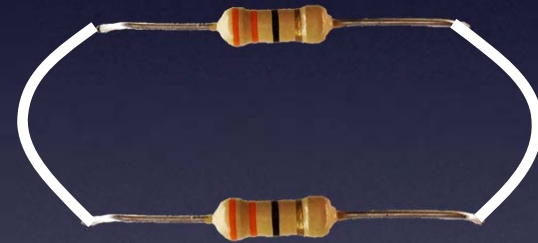
This is why we put a resistor in line with an LED

LED

# Everything You Need to Know About Electronics

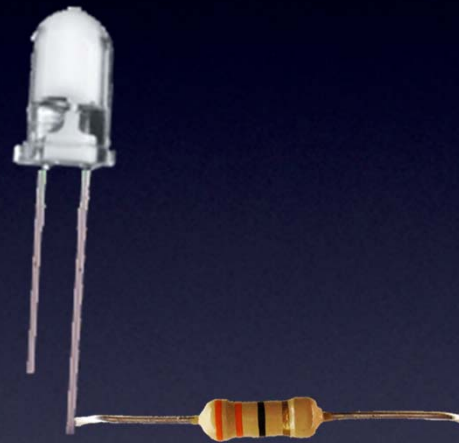


Series = in line



Parallel = across

# Everything You Need to Know About Electronics



Let's make this light up!

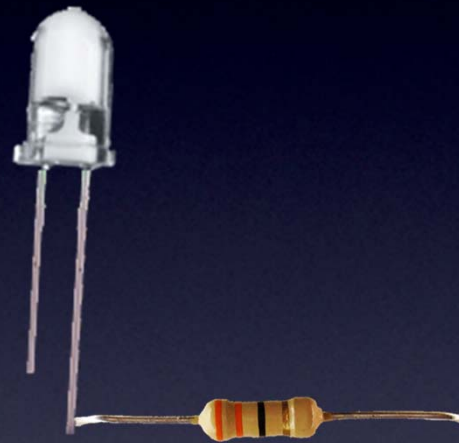
LED



# Everything You Need to Know About Electronics



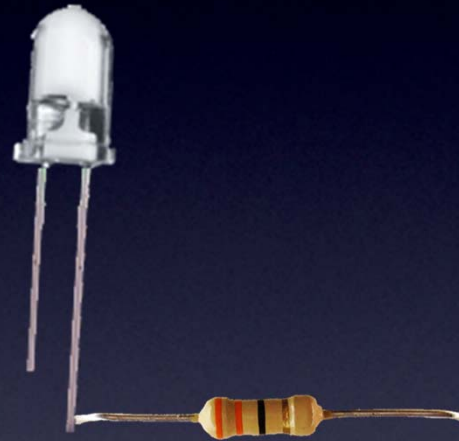
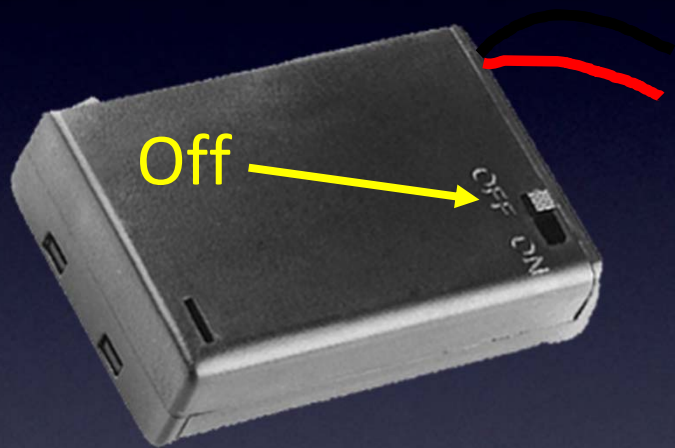
*(add a power supply)*



## Let's make this light up!

LED

# Everything You Need to Know About Electronics



Let's make this light up!

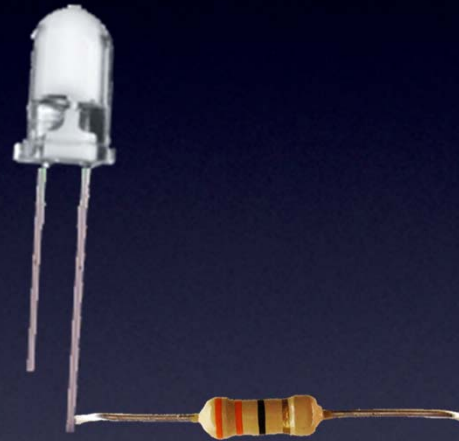
LED

# Everything You Need to Know About Electronics

Black wire: “-” (ground)



Red wire: “+” power)



## Let's make this light up!

LED

# Everything You Need to Know About Electronics

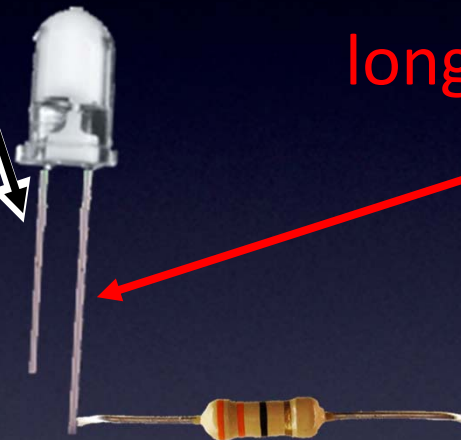
short lead: “-”

Black wire: “-” (ground)



Red wire: “+” power)

long lead: “+”



## Let's make this light up!

LED

# Everything You Need to Know About Electronics

short lead: “-”

Black wire: “-” (ground)

long lead: “+”



Red wire: “+” power)



## Let's make this light up!

LED

# Everything You Need to Know About Electronics

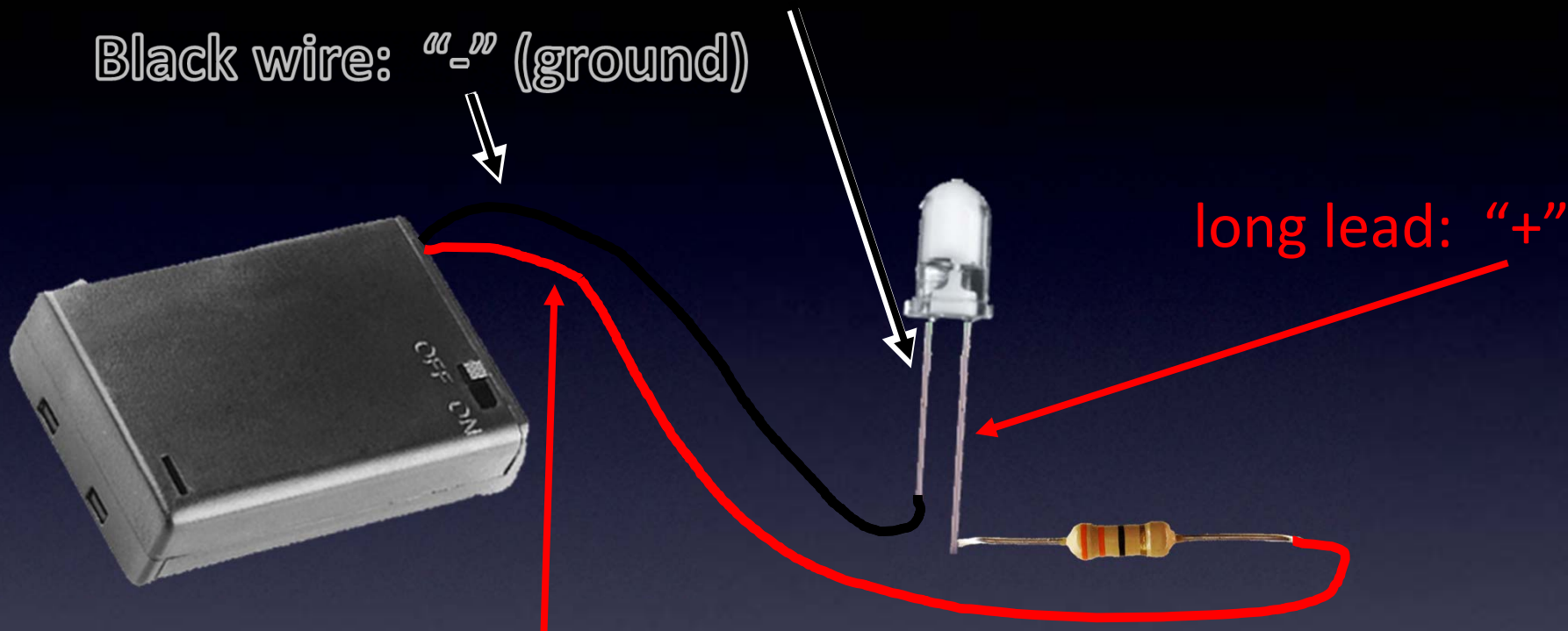
short lead: “-”

Black wire: “-” (ground)

long lead: “+”



Red wire: “+” power)



## Let's make this light up!

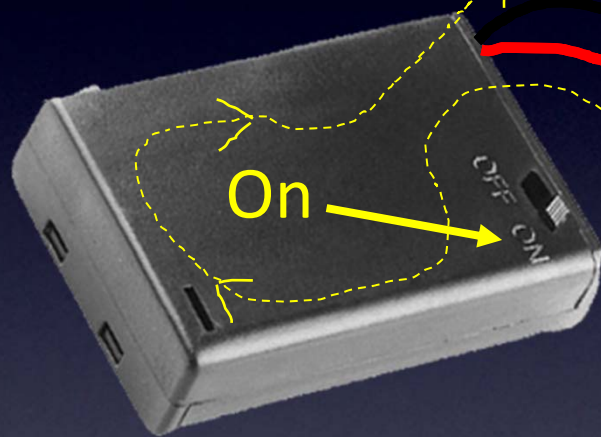
LED

# Everything You Need to Know About Electronics

short lead: “-”

Black wire: “-” (ground)

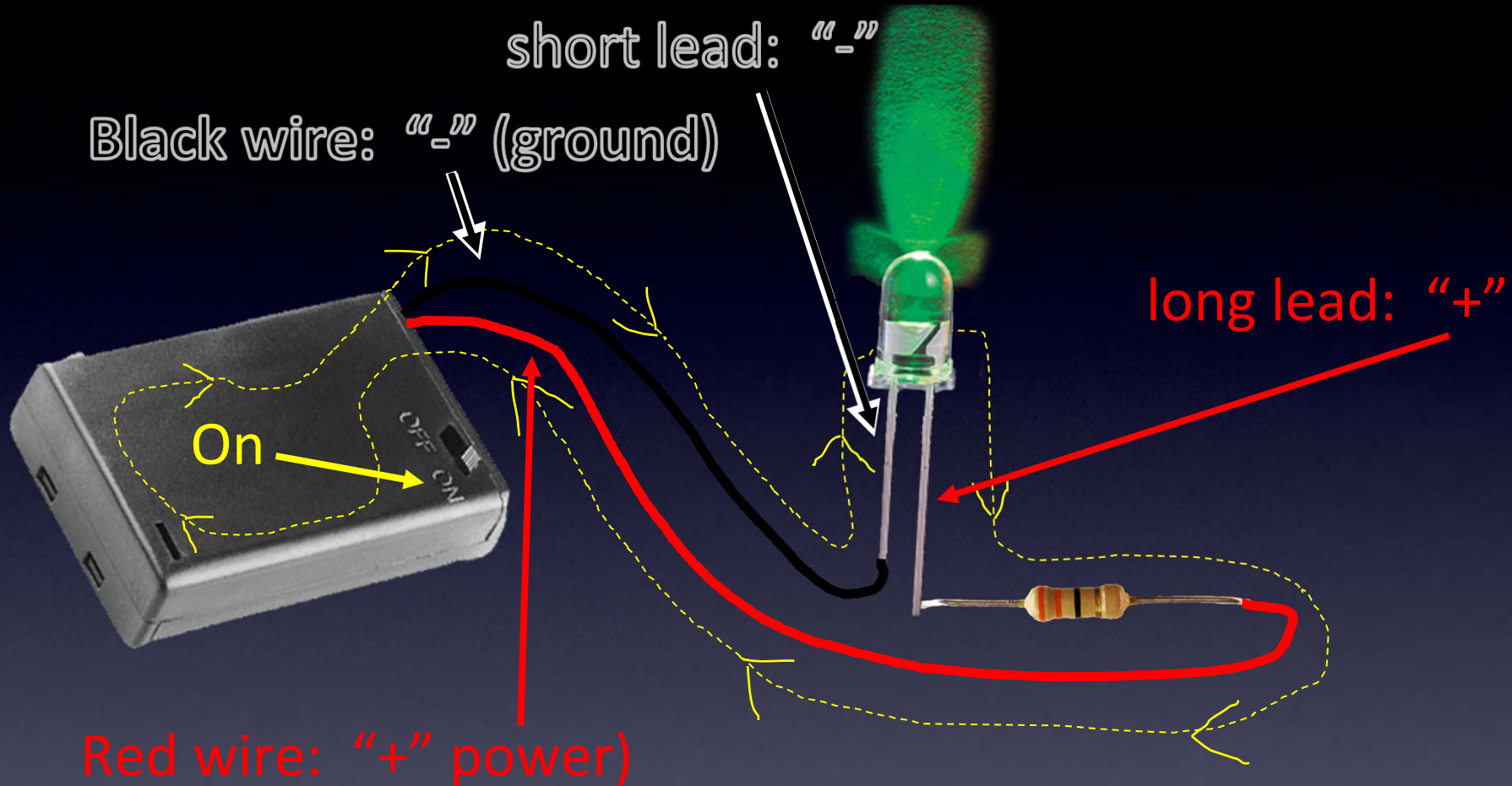
long lead: “+”



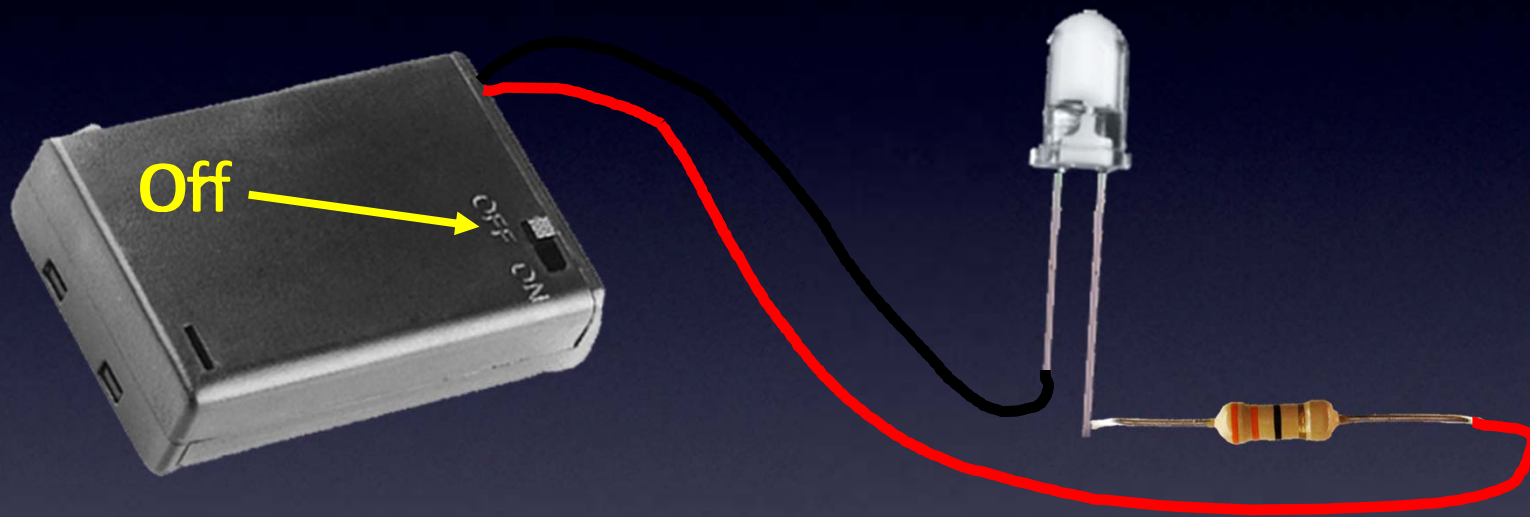
Red wire: “+” power)

## It lights!

### LED



# Everything You Need to Know About Electronics



It's off

LED



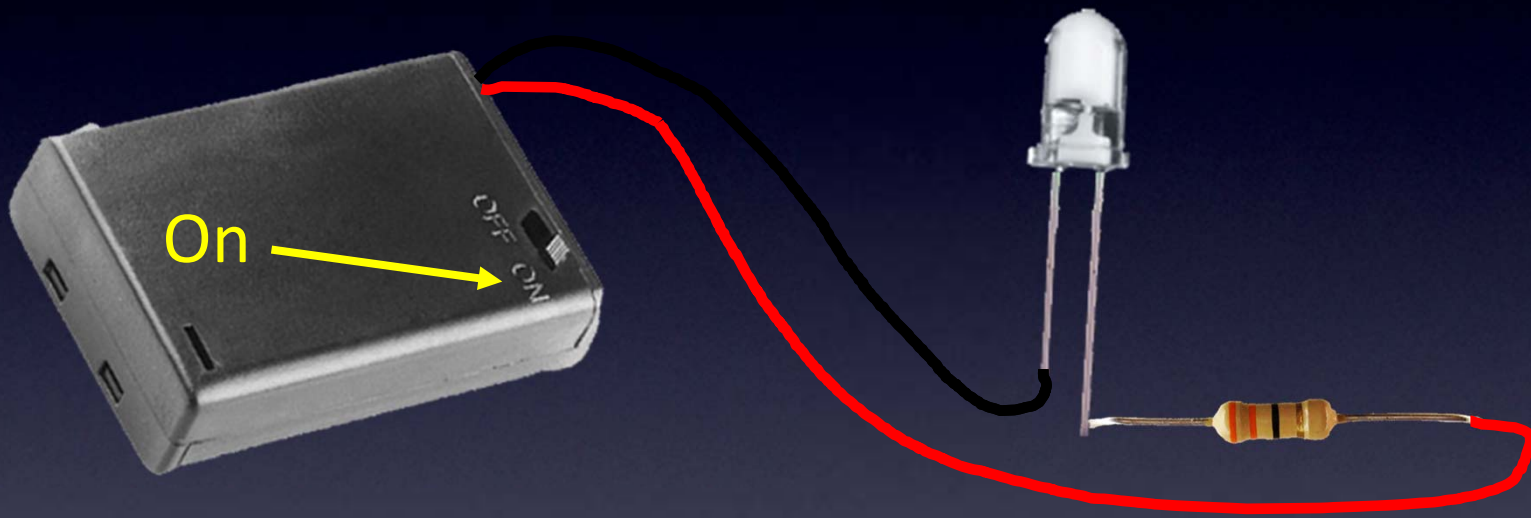
# Everything You Need to Know About Electronics



LED & battery

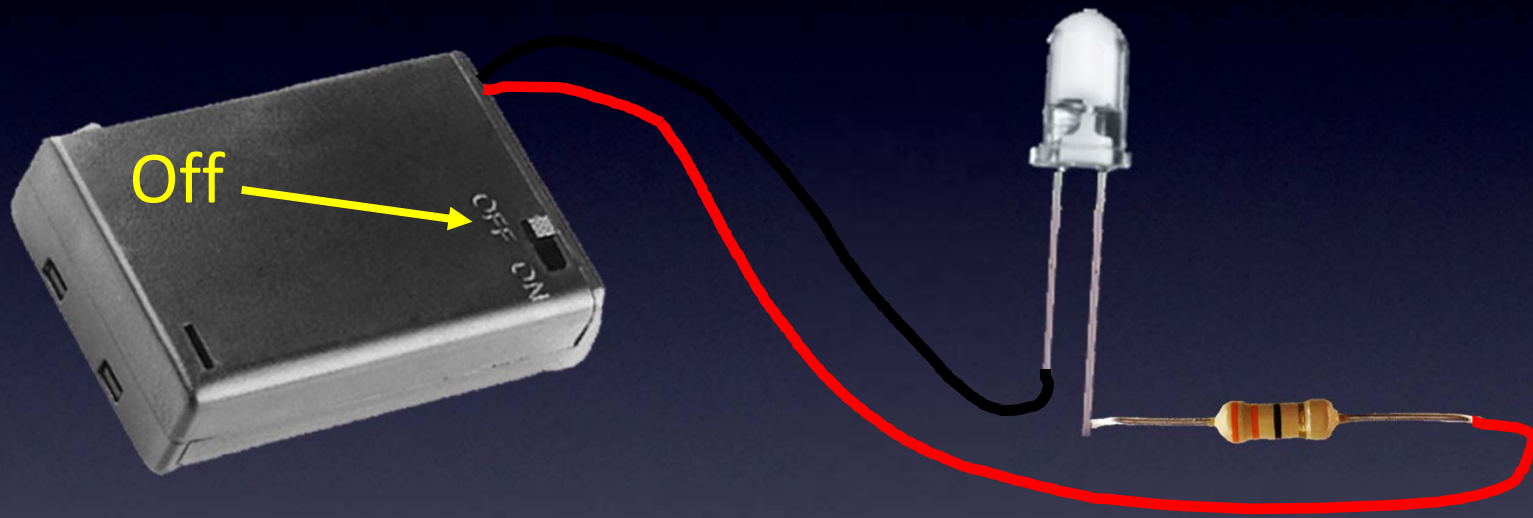
Our first circuit

# Everything You Need to Know About Electronics



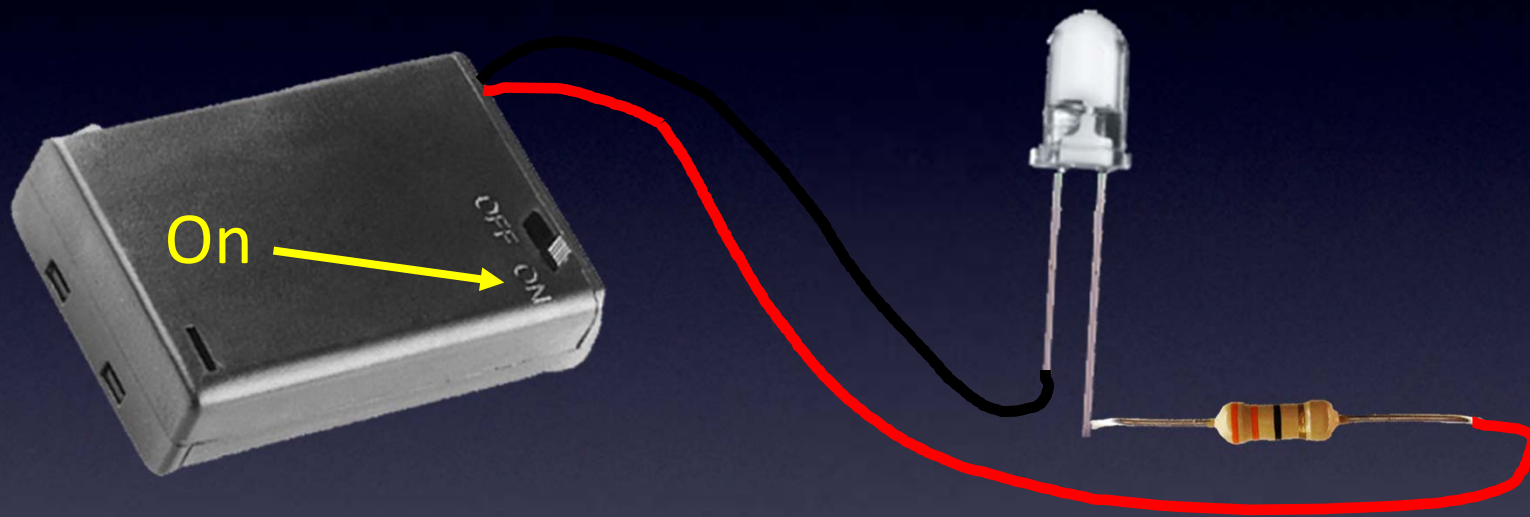
IR LED

# Everything You Need to Know About Electronics



IR LED

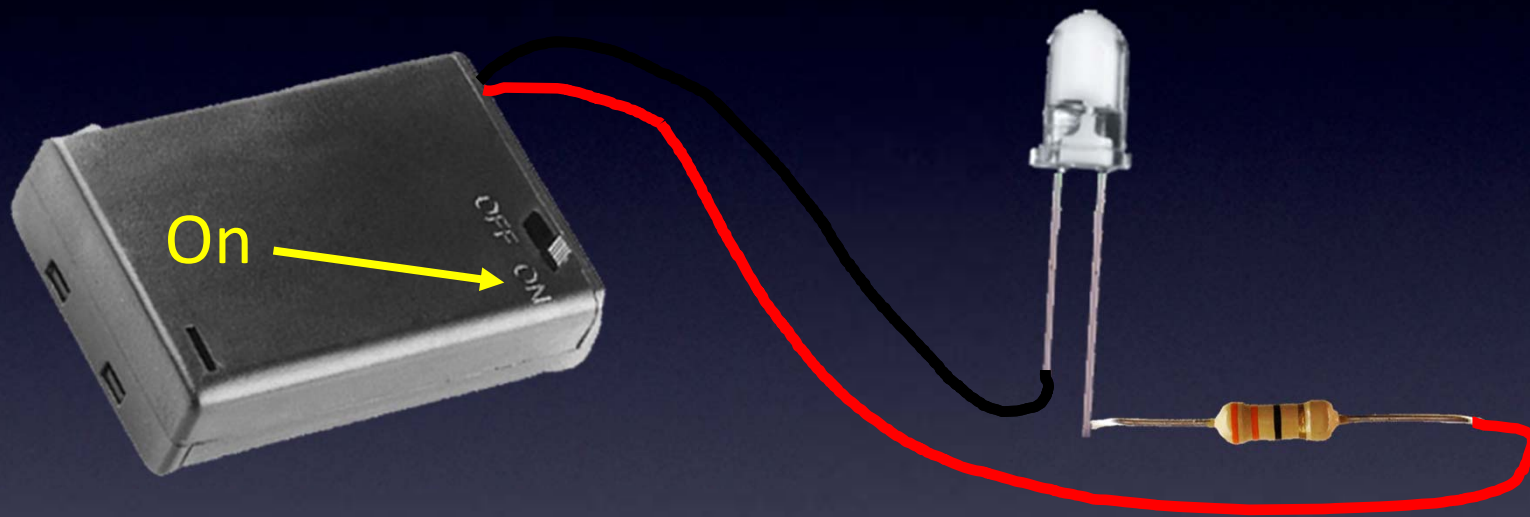
# Everything You Need to Know About Electronics



A "code" is IR light blinking on-off-on-off

IR Remote Control

# Everything You Need to Know About Electronics



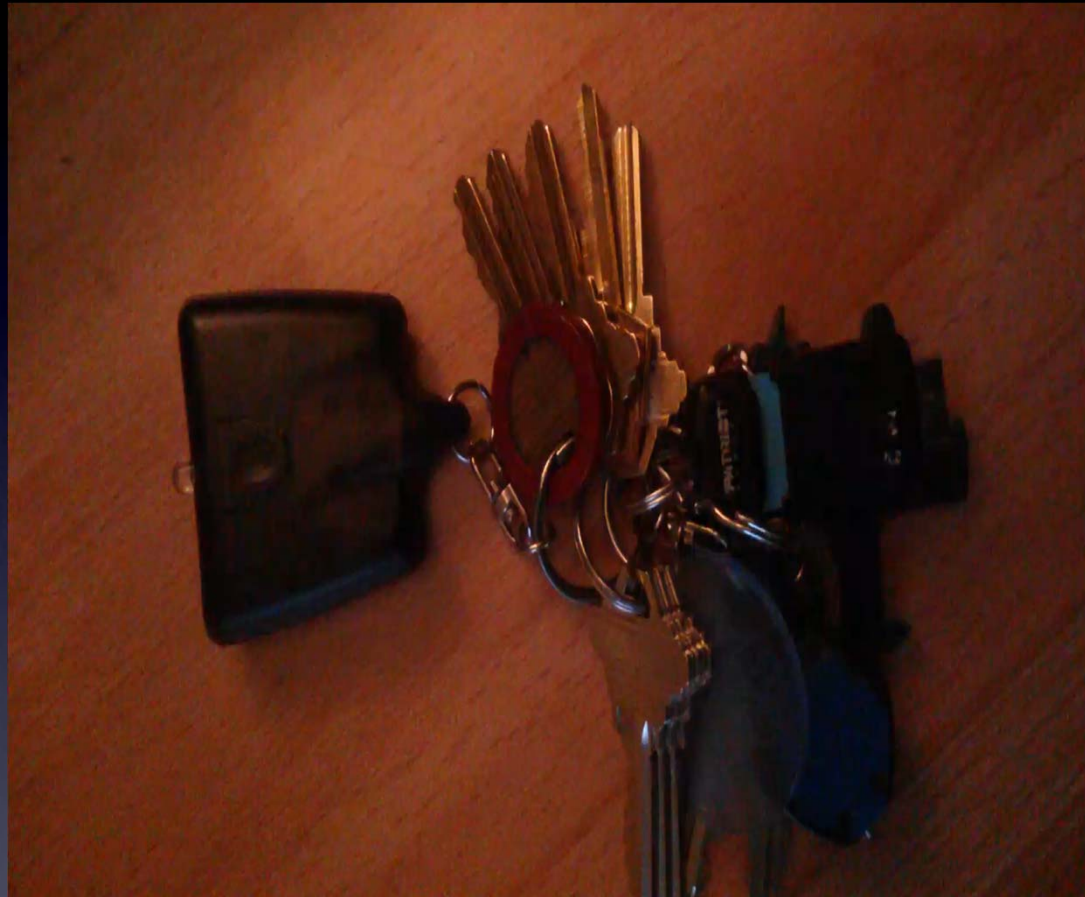
A "code" is IR light blinking on-off-on-off

*(we can't do this, but microcontrollers can!)*

## IR Remote Control

# Everything You Need to Know About Electronics

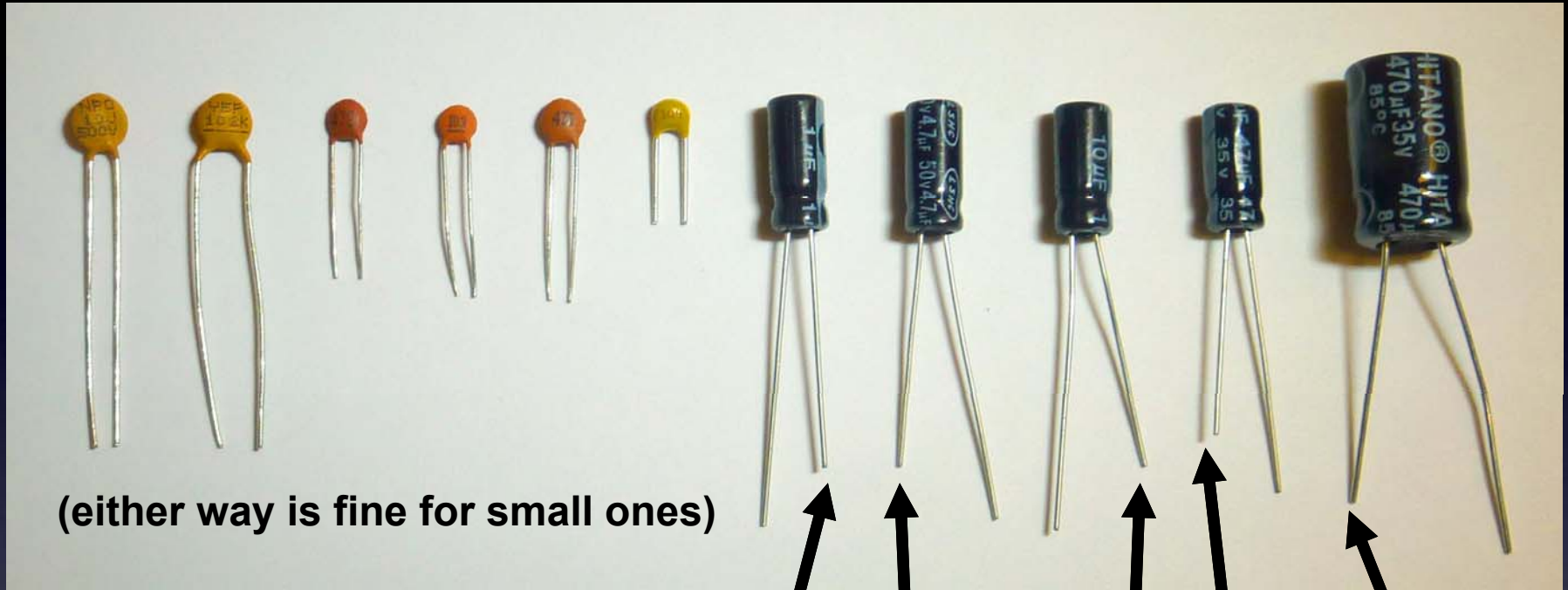
Takes about 60 seconds



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

TV-B-Gone universal remote control

# Everything You Need to Know About Electronics



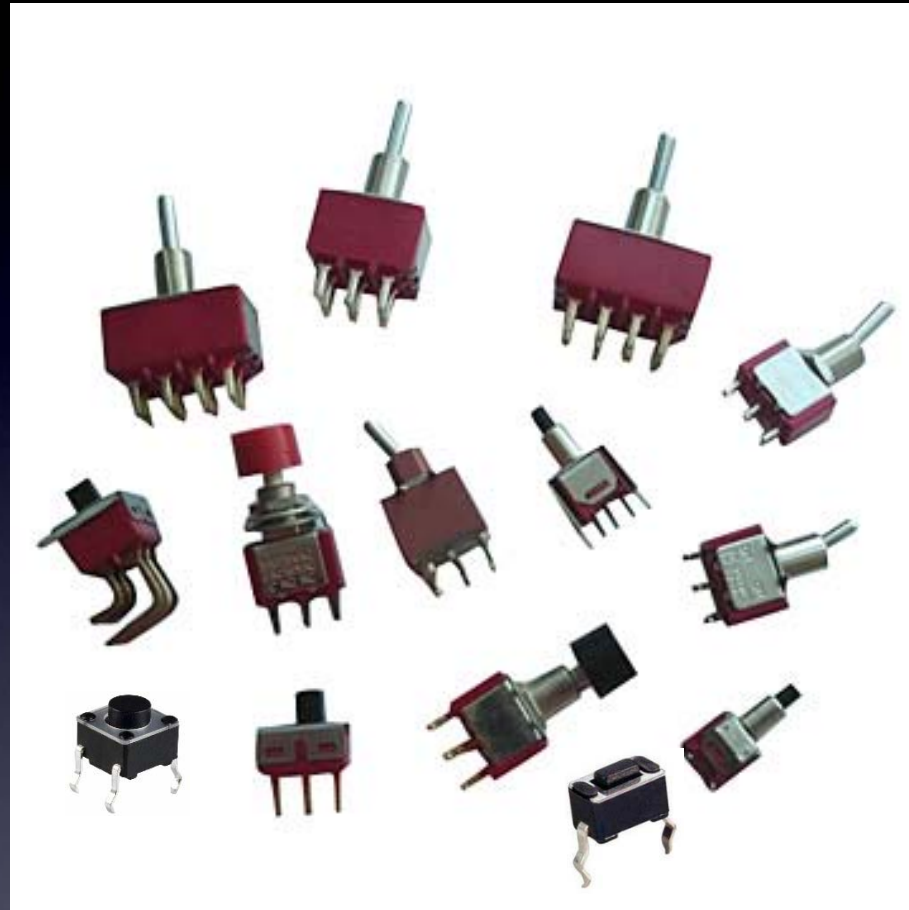
(either way is fine for small ones)

**Short wire is Minus / Negative**

Little buckets for electrons

Capacitor / Farads

# Everything You Need to Know About Electronics

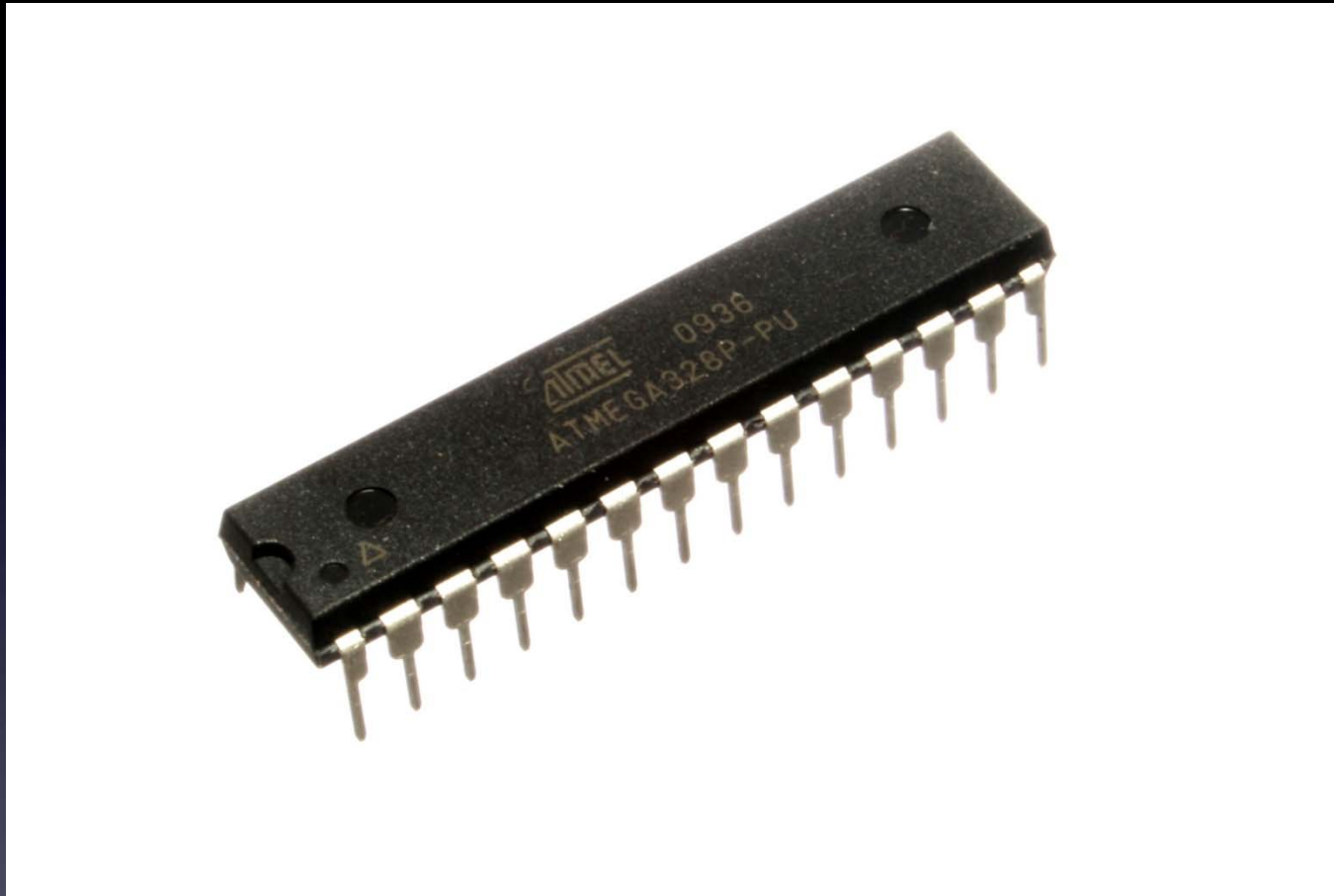


Strips of metal connected together – or not

Switch



# Everything You Need to Know About Electronics



A complete computer on a chip

Microcontroller

# Everything You Need to Know About Electronics



**It runs programs**

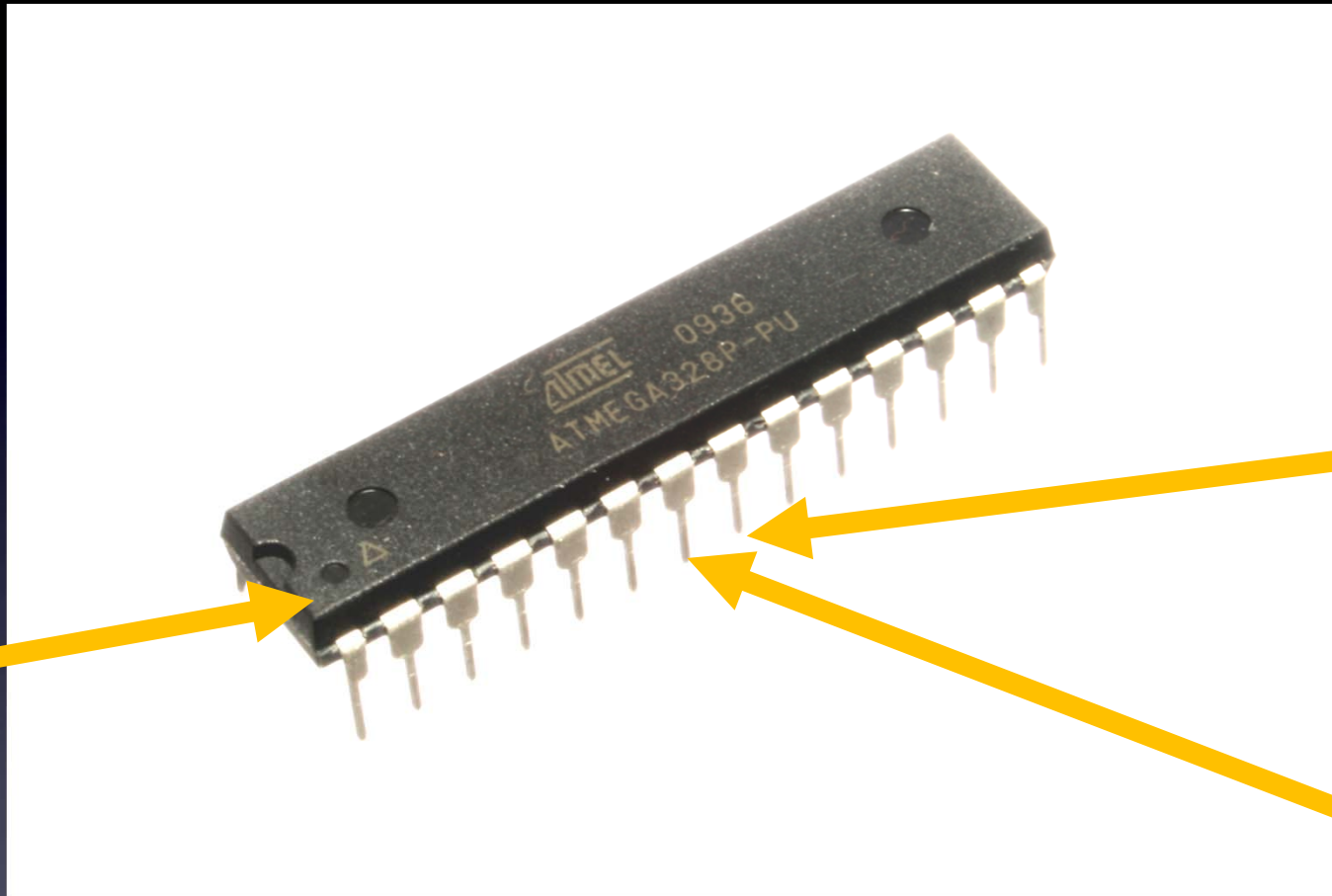
to control electronic parts connected to its pins.

Microcontroller

# Everything You Need to Know About Electronics

**2 special pins:**

**Pin 1**



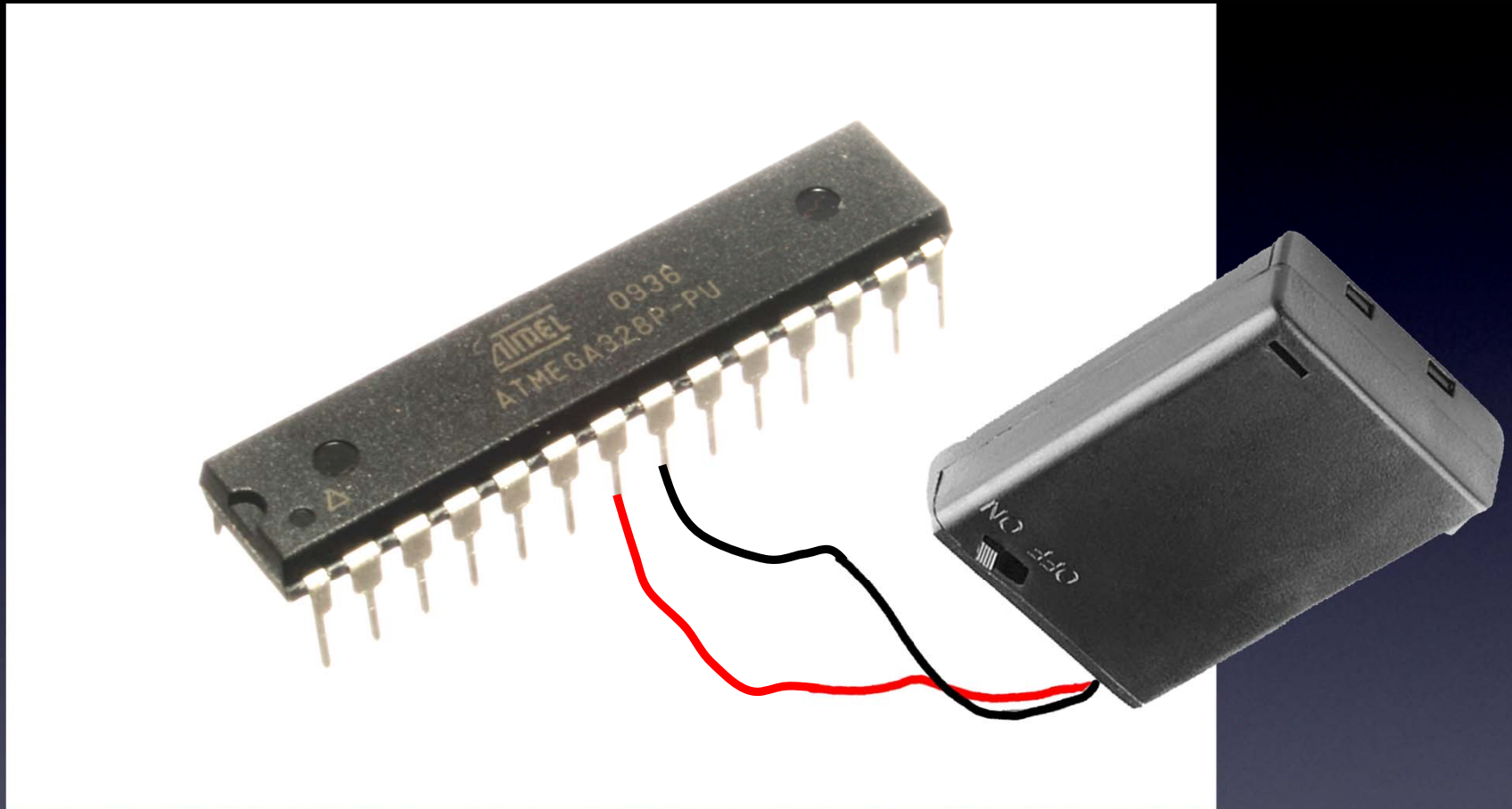
**Pin 8 =  
Ground**

**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  $V_{cc}$

## **Digital Electronics:**

Only 2 choices: Ground (0V) or  $V_{cc}$

2 types of electronics

# Everything You Need to Know About Electronics

Ground (0V)

**Low**

**Off**

**0**

Power / Vcc

**High**

**On**

**1**

(without Voltage / with Voltage)

(without current / with current)

**Digital Electronics:**

Only 2 choices: Ground (0V) or Vcc

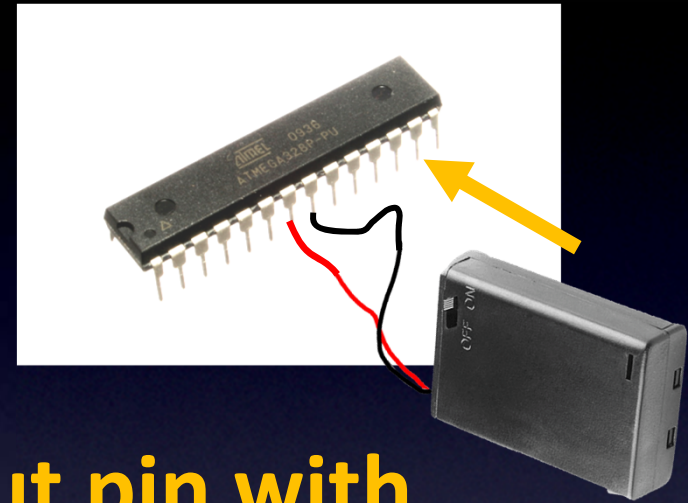
Digital Electronics

# 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 pins



# Everything You Need to Know About Electronics

Low

**Off**

(0V)

High

**On**

(Power supply voltage)

-- like the Red wire of our power supply  
-- *but controlled by our program!*

Only 2 choices: High or Low

Microcontroller – Output pins

# 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**

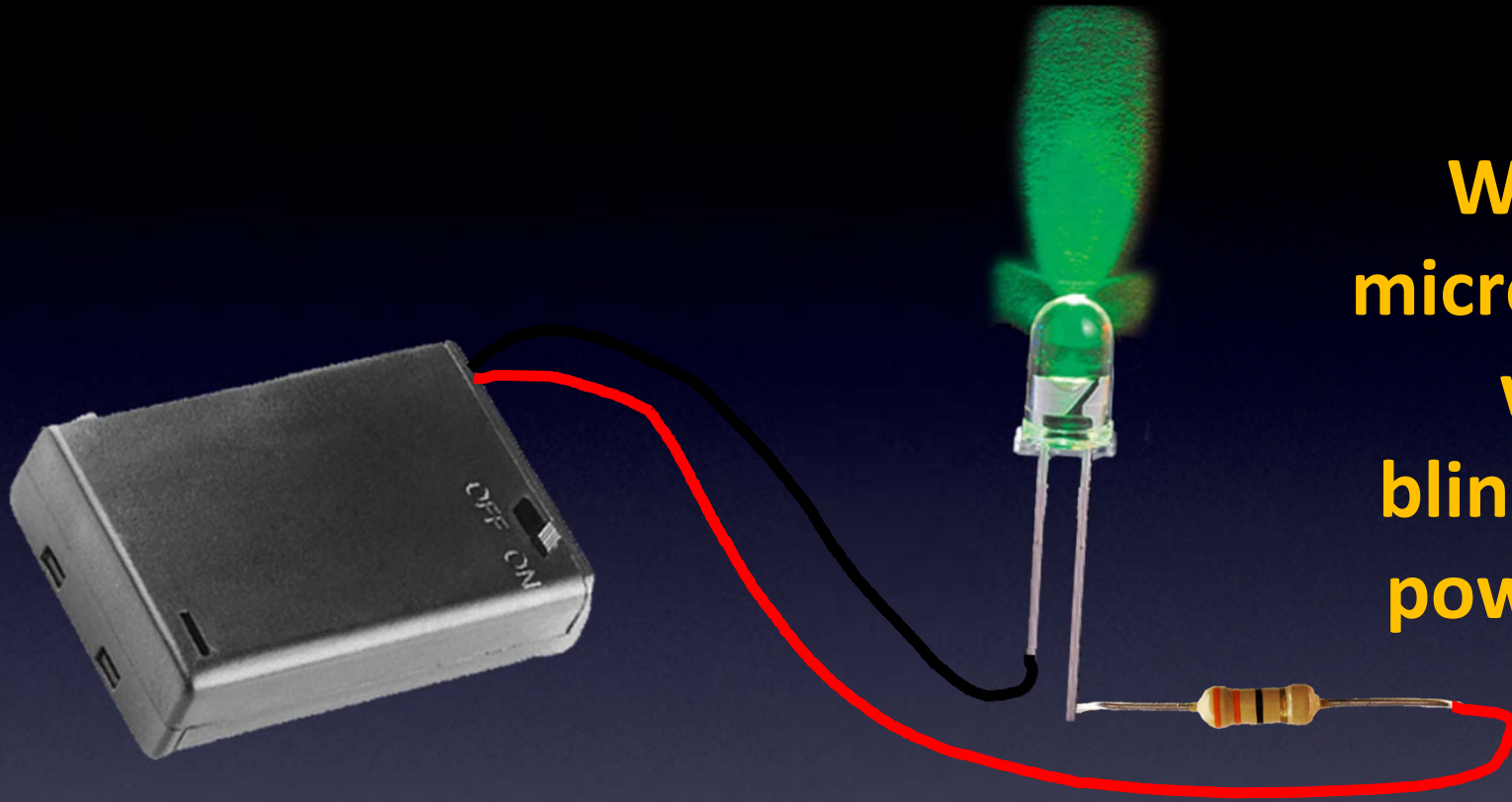
## Microcontrollers

**make an LED blink**

Hello World

Microcontroller

# Everything You Need to Know About Electronics



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

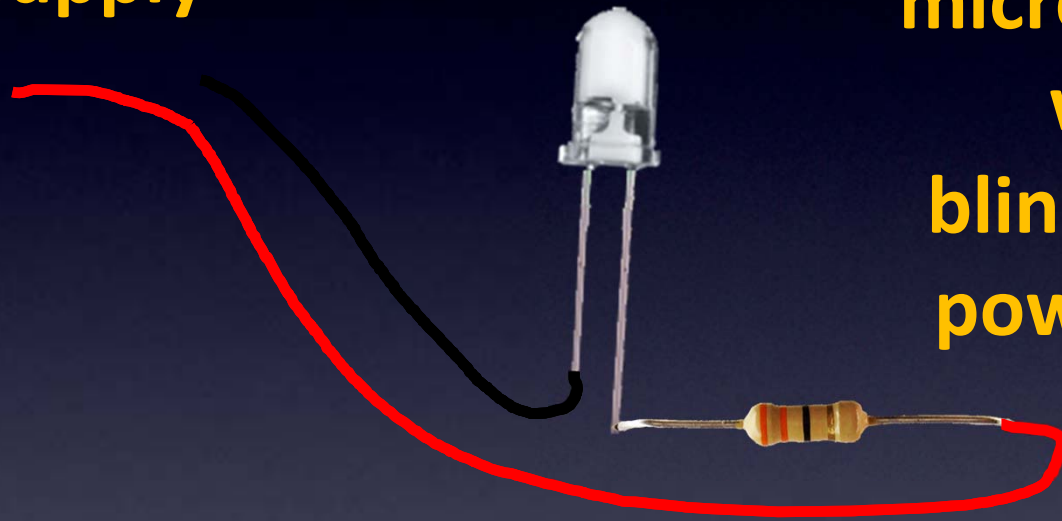
**Turning an LED on and off**

(Leading up to Hello World)

# Everything You Need to Know About Electronics

**Let's replace  
the power supply**

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

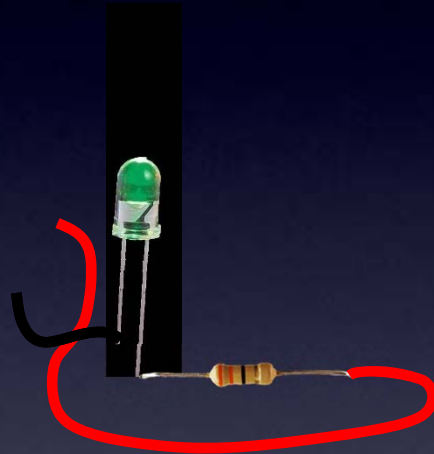


**Turning an LED on and off**

(Leading up to Hello World)

# Everything You Need to Know About Electronics

**Since an Output pin  
is 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**

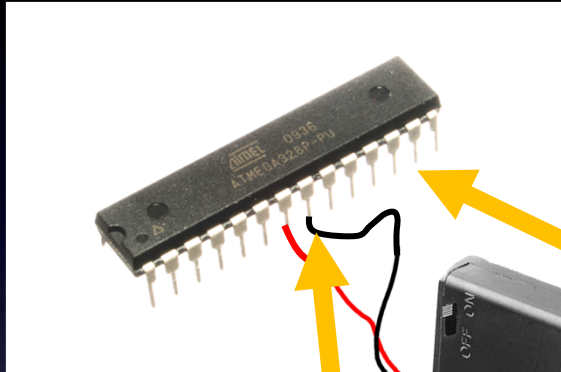
*(with a resistor  
so no magic smoke goes away)*

**And make it blink!**

**Turning an LED on and off**

(Leading up to Hello World)

# Everything You Need to Know About Electronics



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

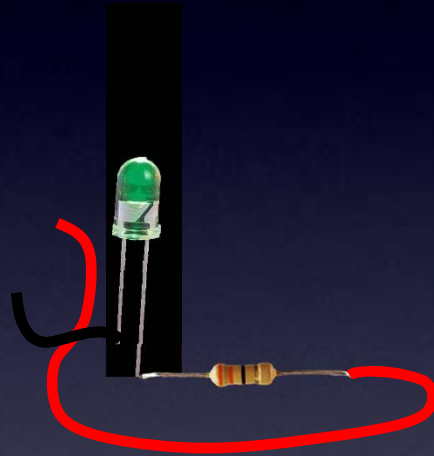
**Let's use Pin 13**

**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

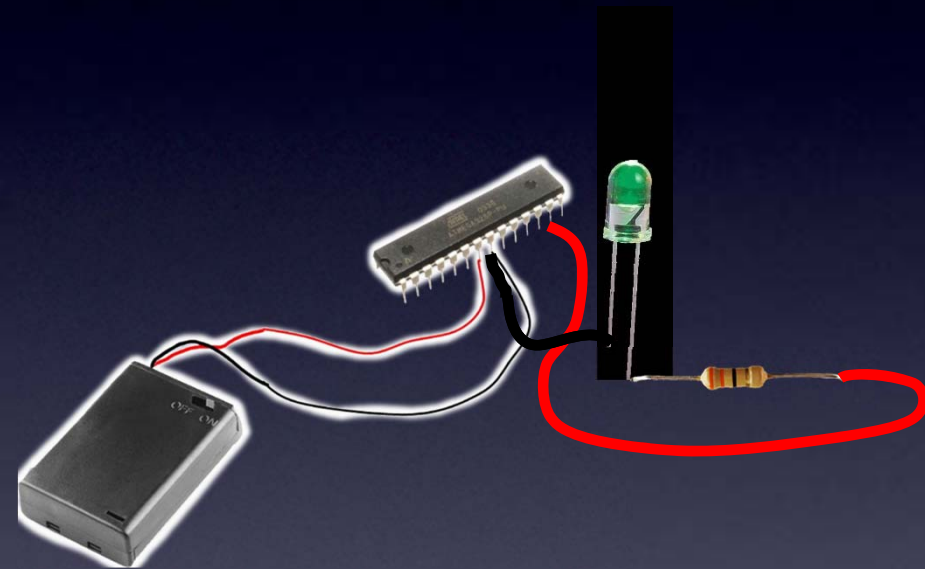


Turning an LED on and off

(Leading up to Hello World)



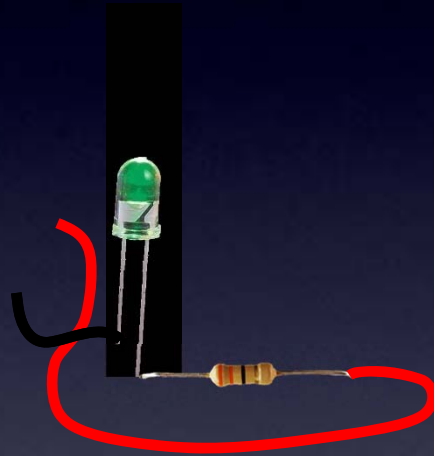
# Everything You Need to Know About Electronics



Turning an LED on and off

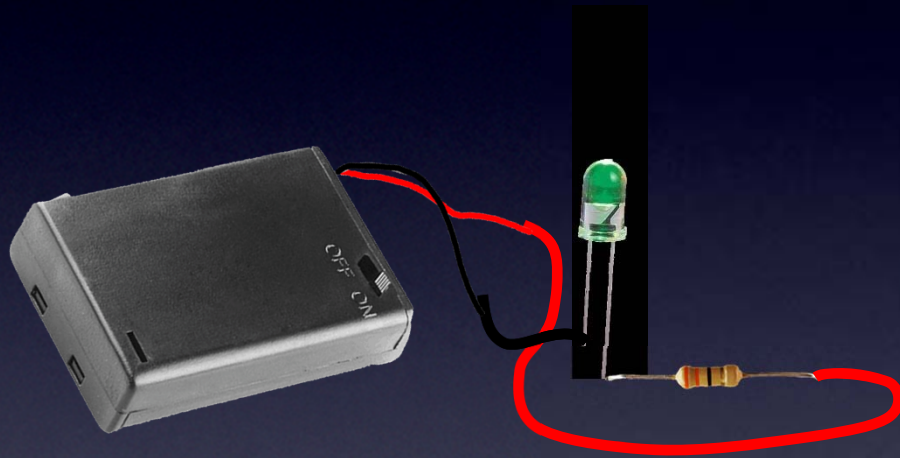
Hello World

# Everything You Need to Know About Electronics



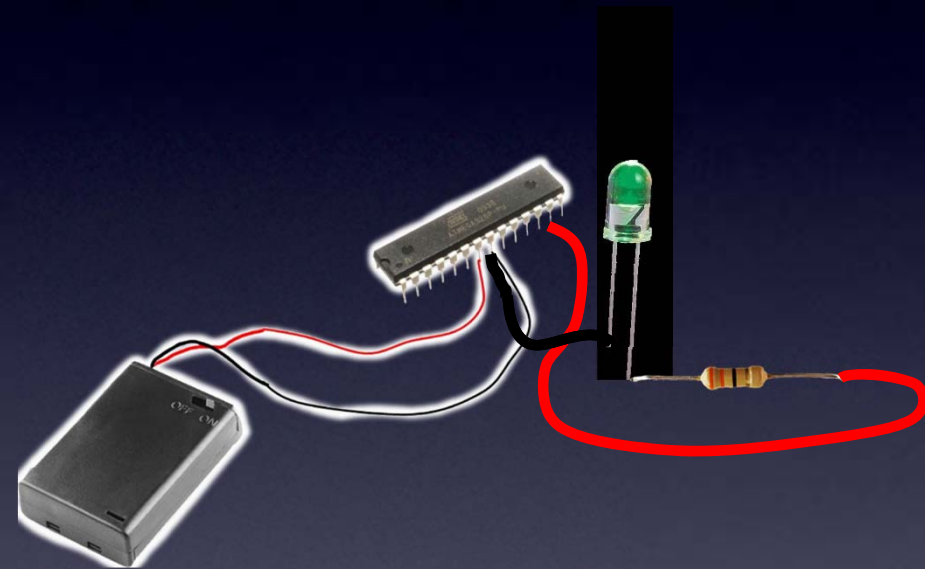
Turning an LED on and off

# Everything You Need to Know About Electronics



Turning an LED on and off

# Everything You Need to Know About Electronics

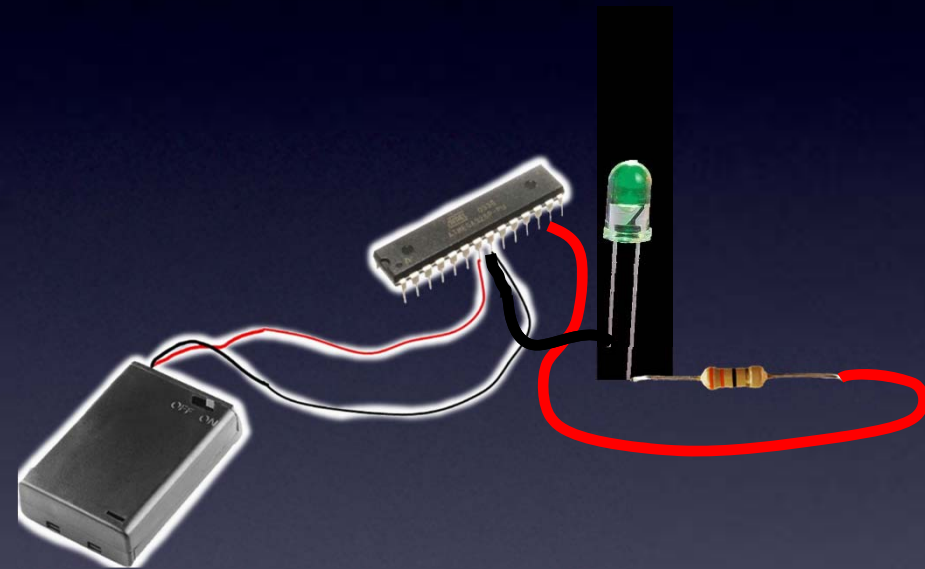


Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

This is our Hardware for Hello World!

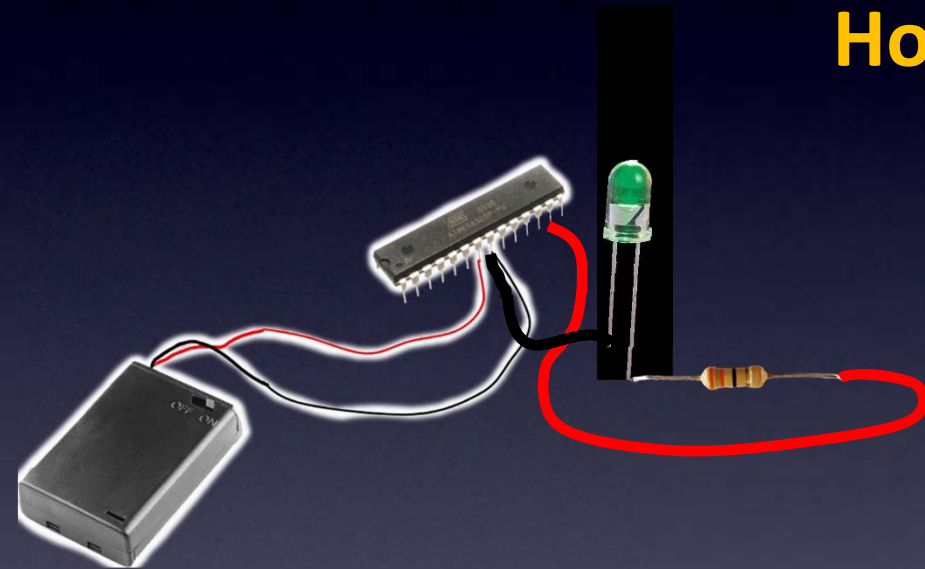


Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

How about our program?

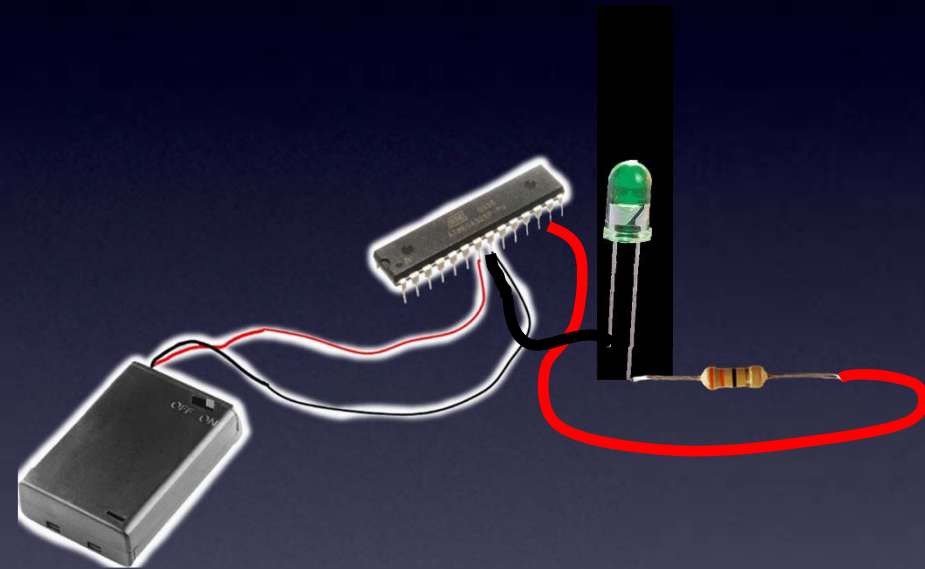


Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

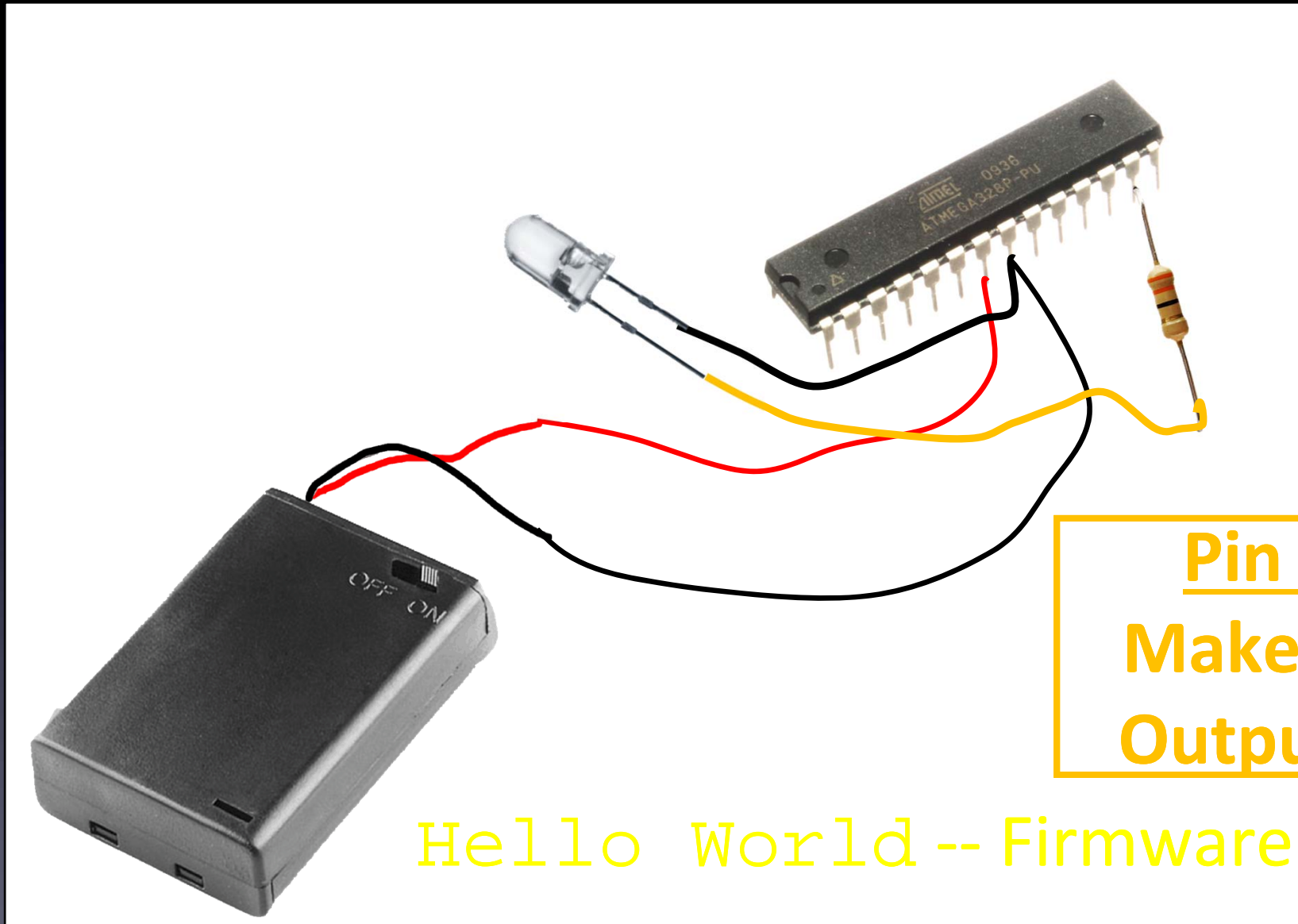
Programs on microcontrollers are called **“Firmware”**



Turning an LED on and off

Hello World

# Everything You Need to Know About Electronics

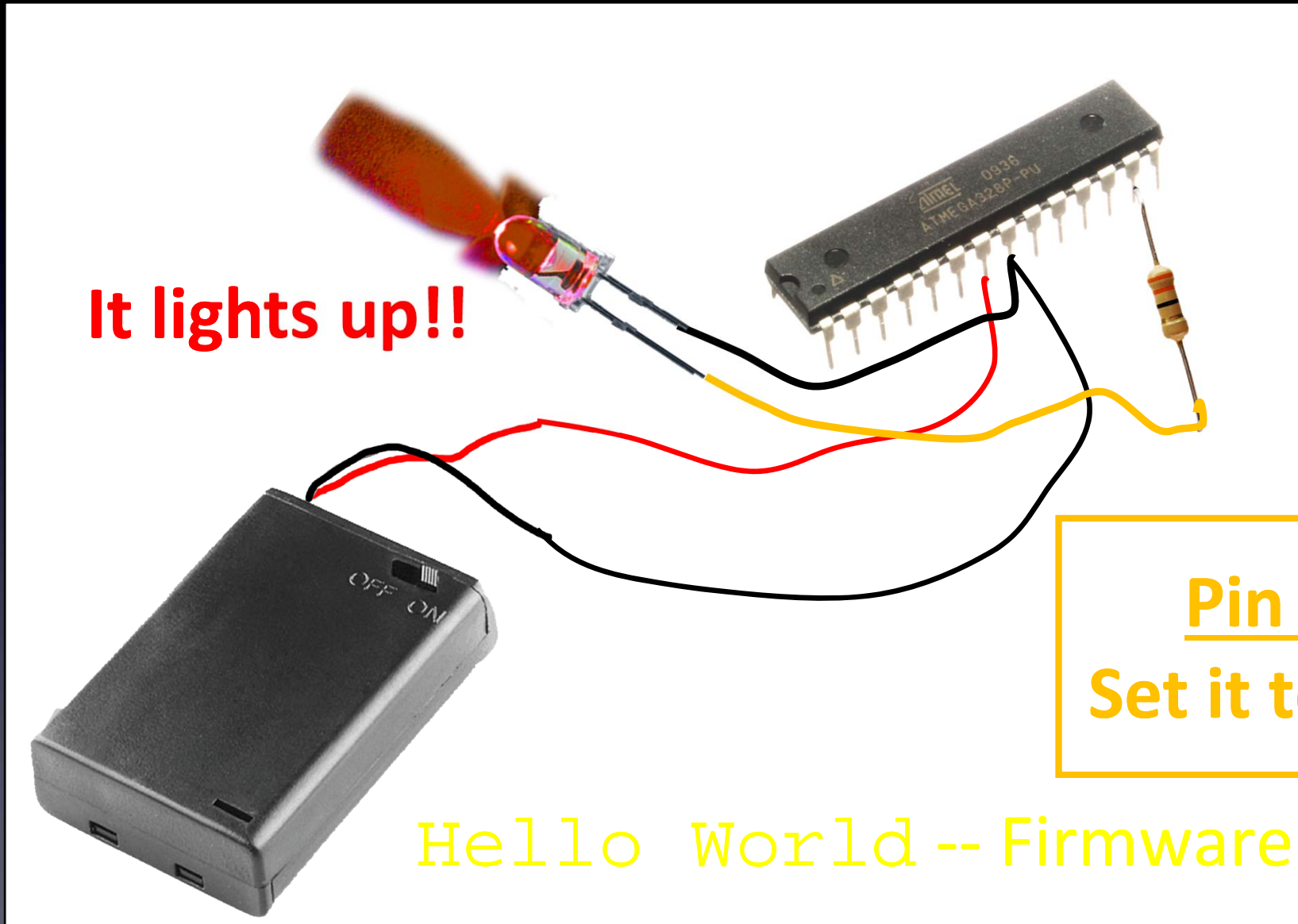


Hello World -- Firmware

Microcontroller



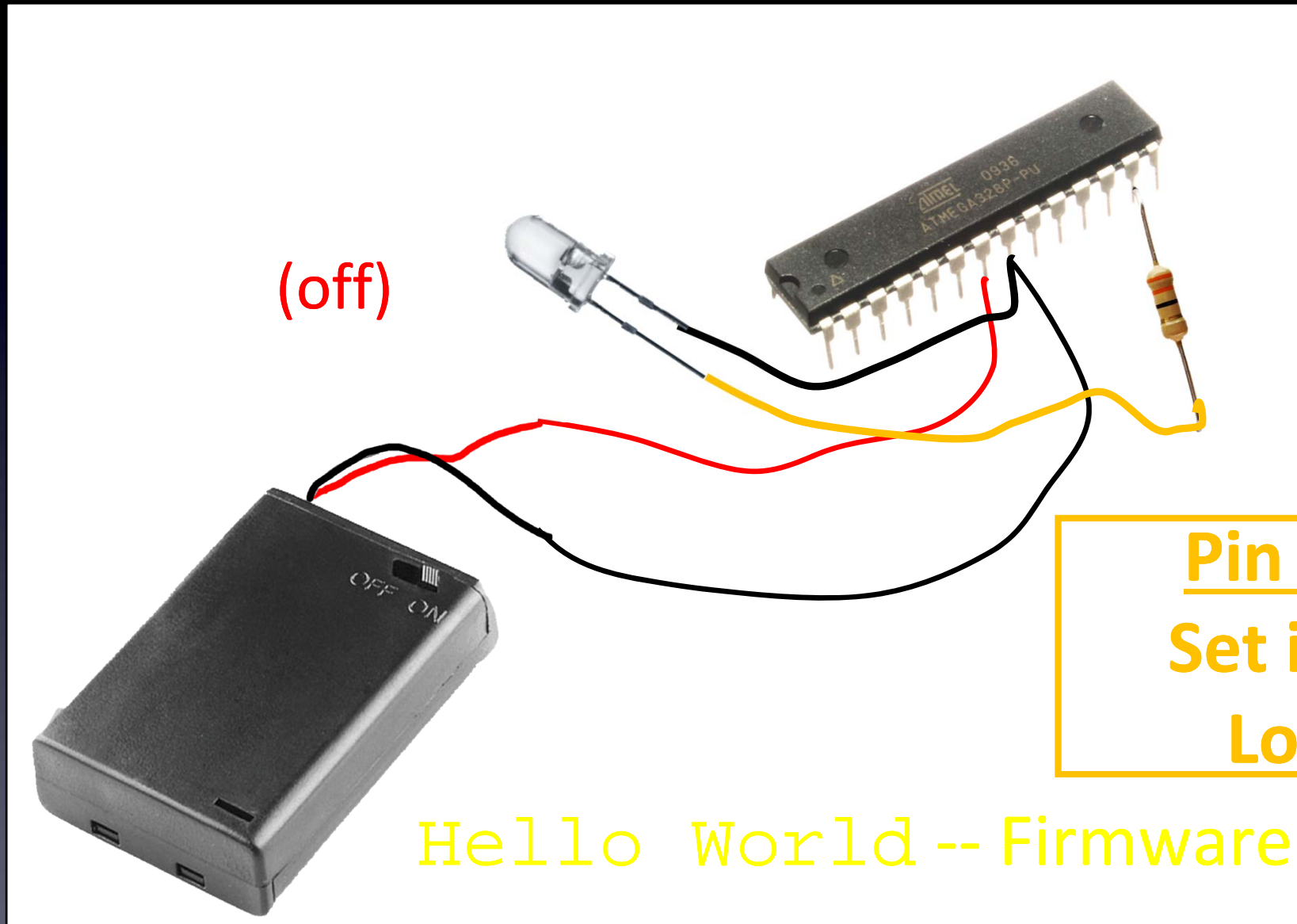
# Everything You Need to Know About Electronics



Hello World -- Firmware

Microcontroller

# Everything You Need to Know About Electronics



Microcontroller

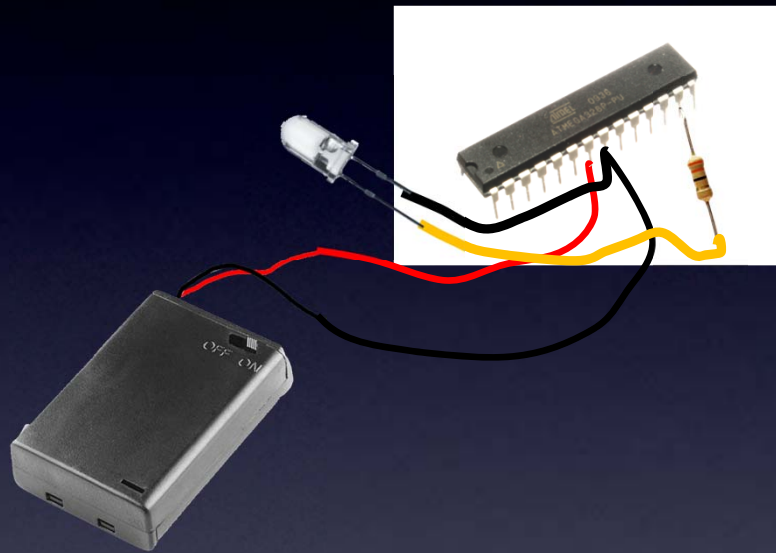
# Everything You Need to Know About Electronics



We now have  
Hello World !

Microcontroller

# Everything You Need to Know About Electronics



We now have  
Hello World !

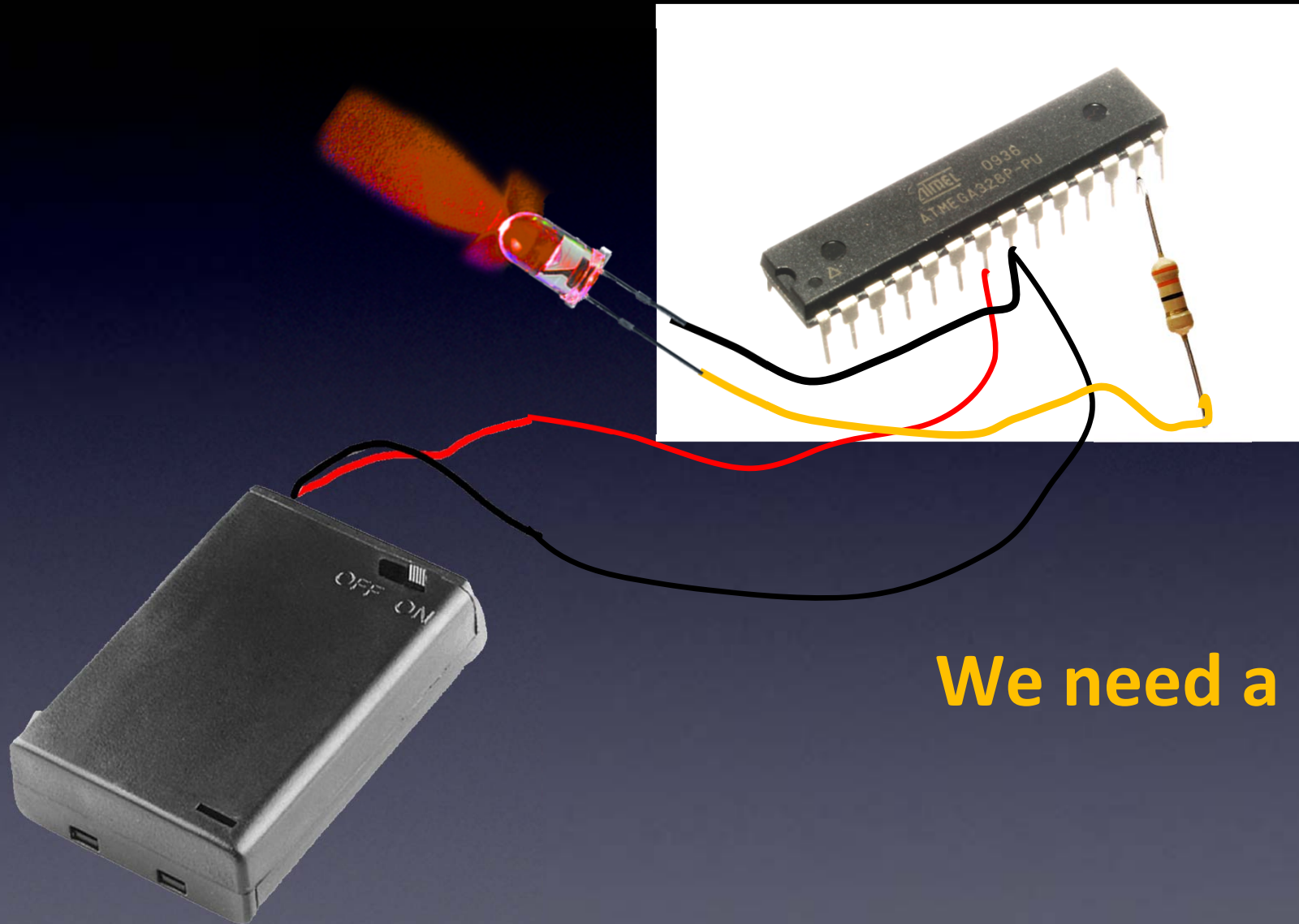
**Except**

We won't see it



Microcontroller

# Everything You Need to Know About Electronics

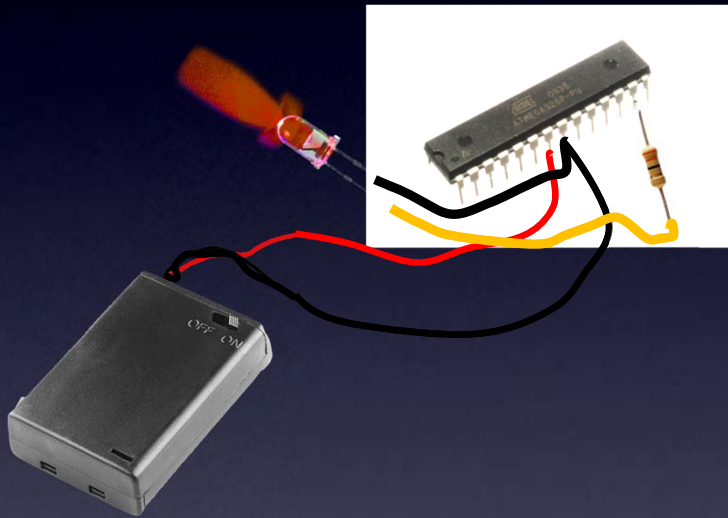


**We need a delay**

Microcontrollers – they go really fast!

# Everything You Need to Know About Electronics

## Hardware



## Firmware

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

Hello World – for real now!

Microcontroller – Firmware

# Everything You Need to Know About Electronics

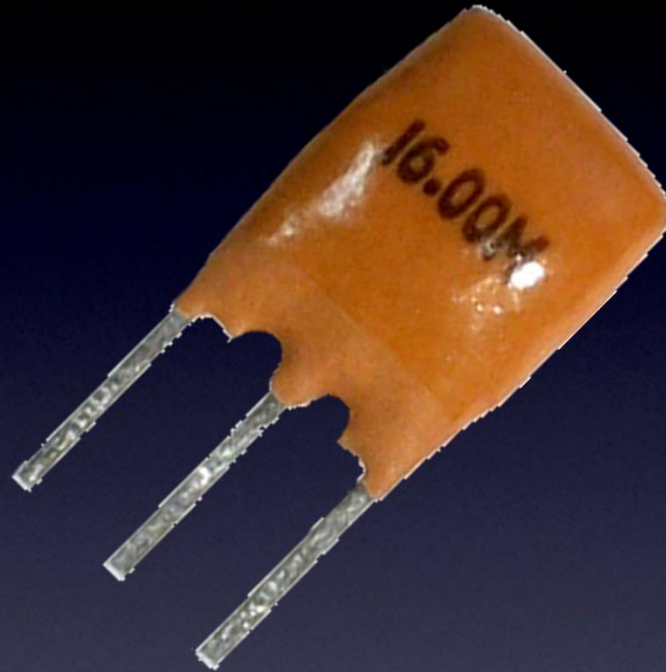


**A precision cut piece of quartz crystal**

**For precise timing**

Crystal

# Everything You Need to Know About Electronics



**A bunch of resistors and capacitors**

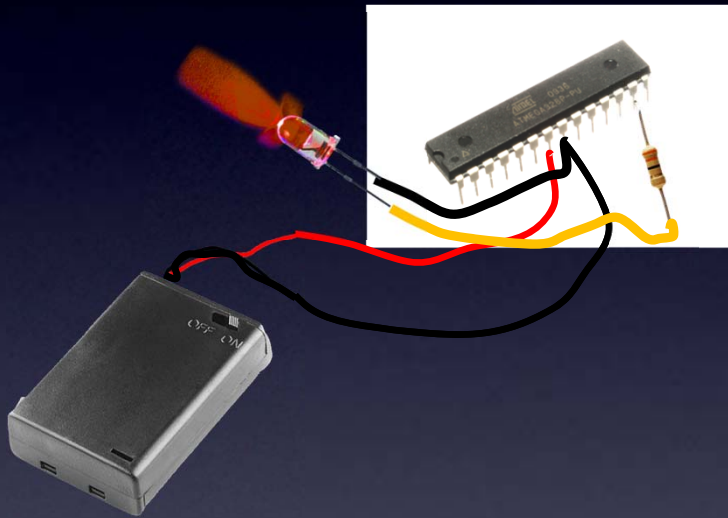
For precise timing (but less than a crystal)

Ceramic Resonator



# Everything You Need to Know About Electronics

## Hardware



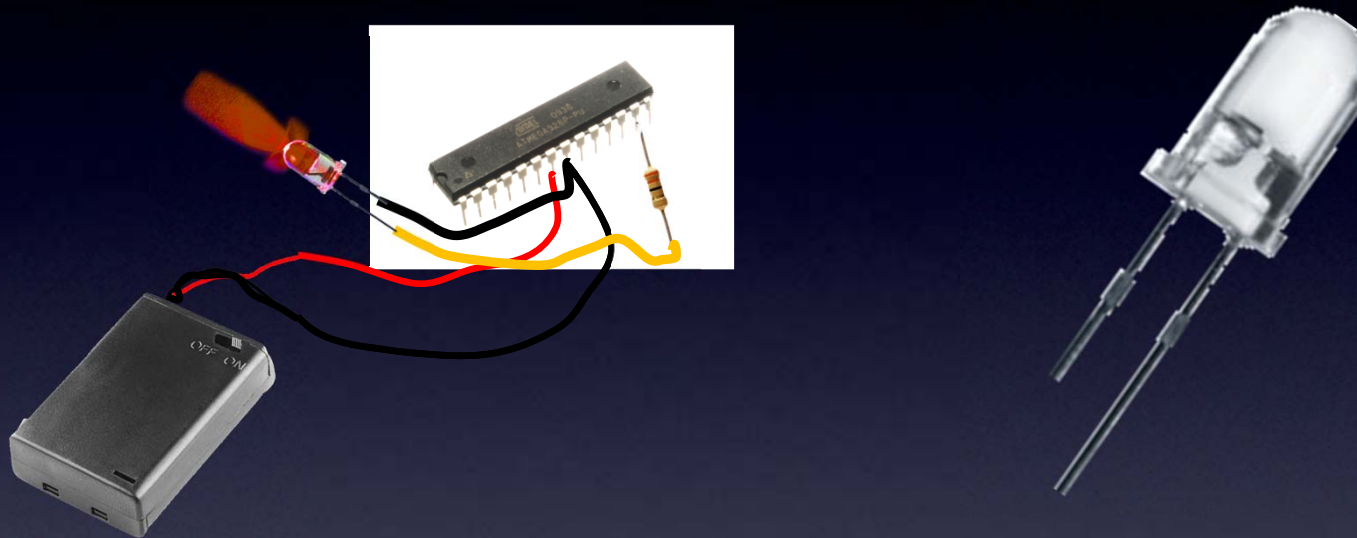
## Firmware

- 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

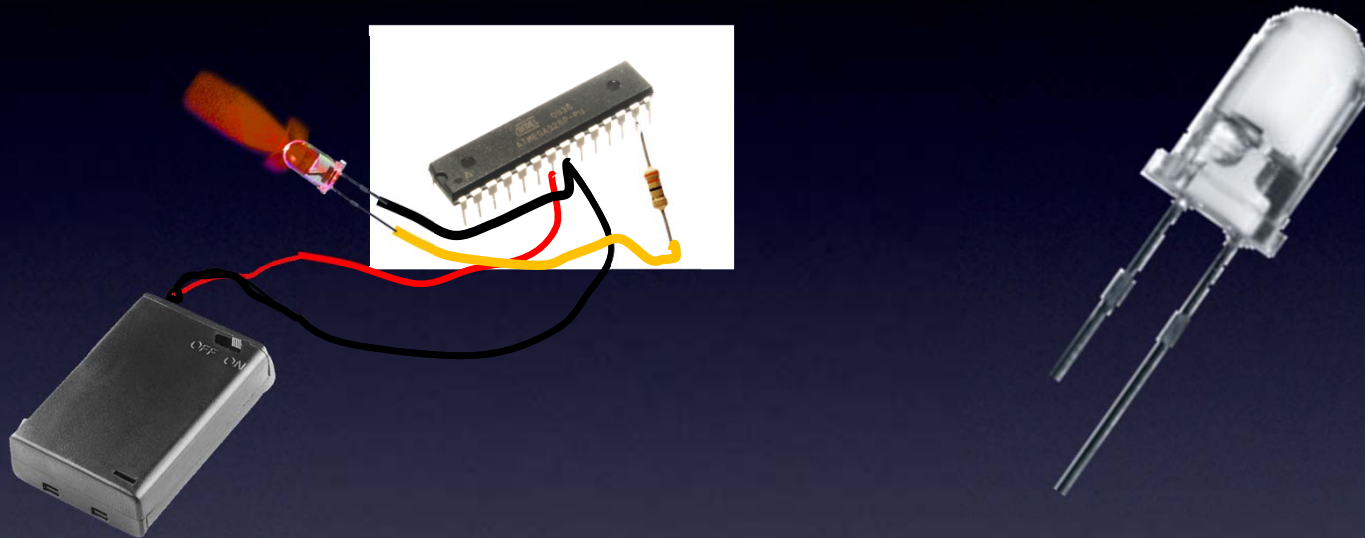


**Add an IR LED to another pin**

**IR "OFF" codes**

Microcontroller

# Everything You Need to Know About Electronics

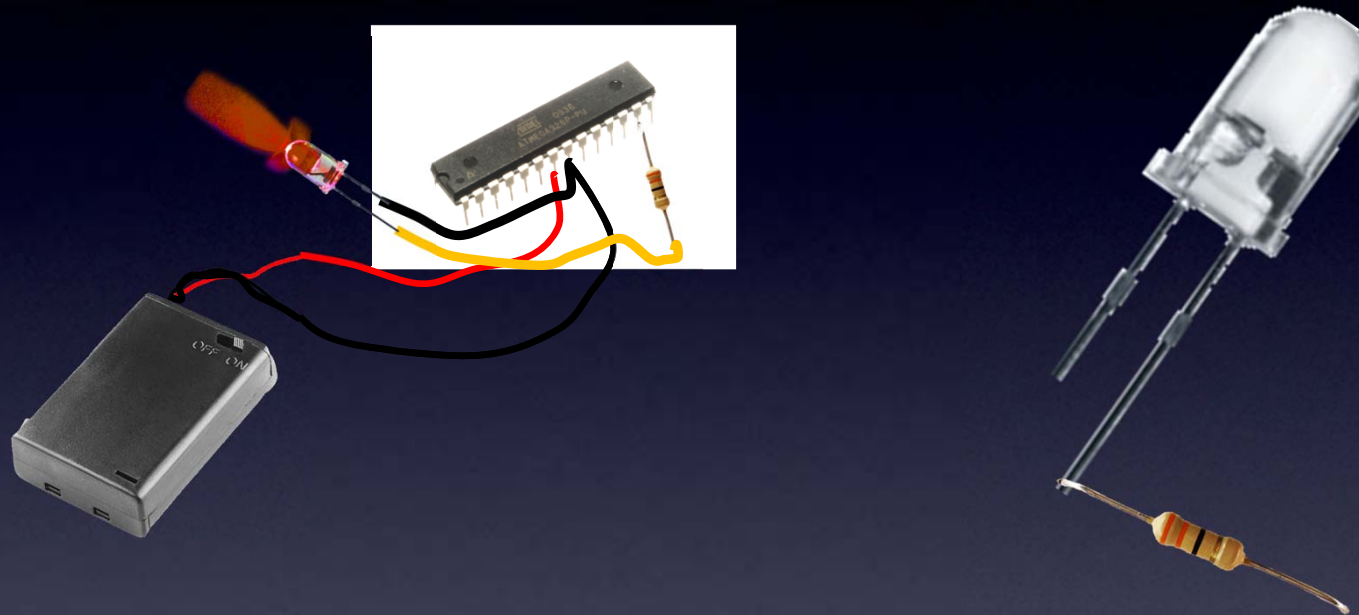


**Add an IR LED to another pin (say, pin3)**

IR “OFF” codes

Microcontroller

# Everything You Need to Know About Electronics

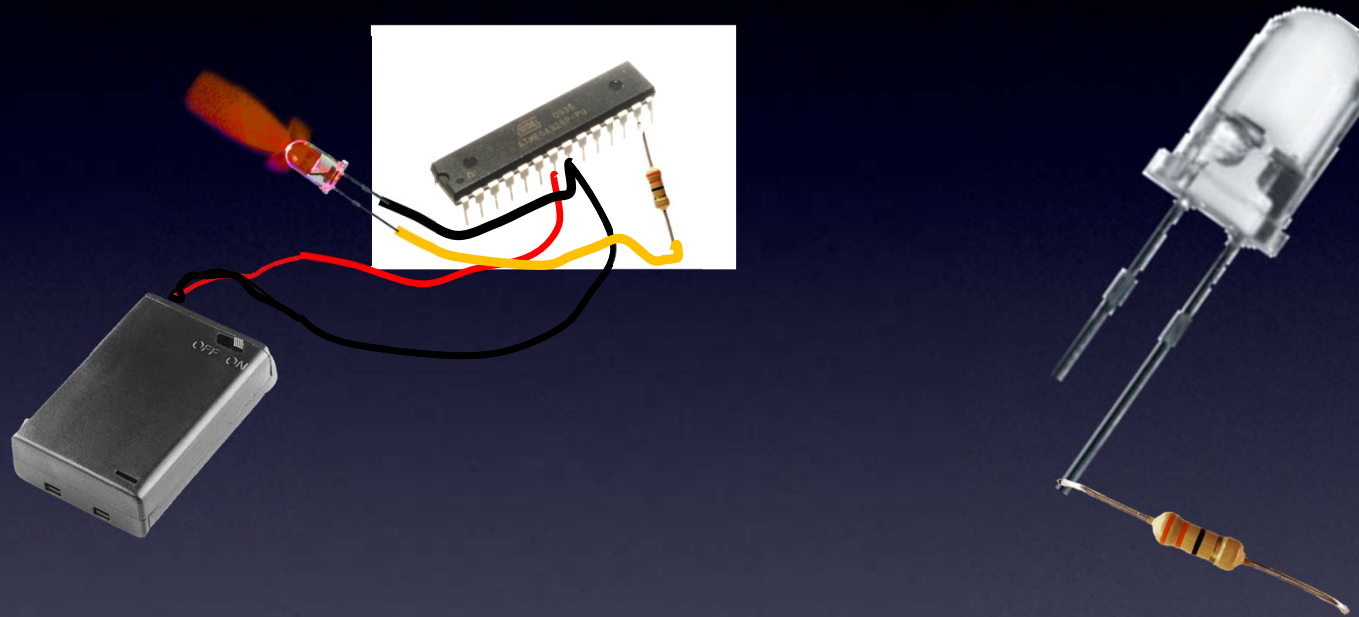


**Add an IR LED to another pin (say, pin3)**  
*and a resistor so no magic smoke goes away*

**IR “OFF” codes**

**Microcontroller**

# Everything You Need to Know About Electronics

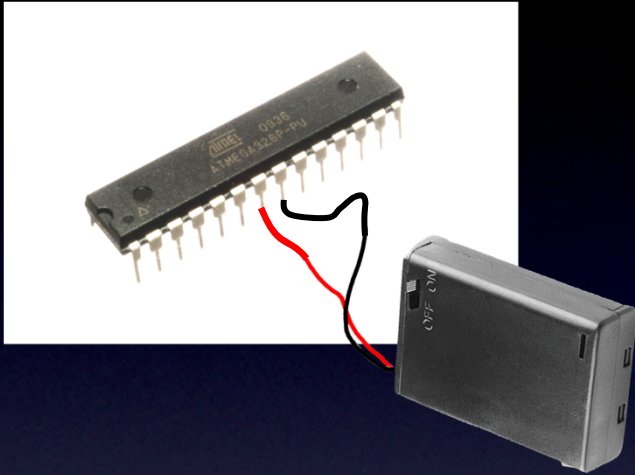


But, *When?*

IR "OFF" codes

Microcontroller

# Everything You Need to Know About Electronics



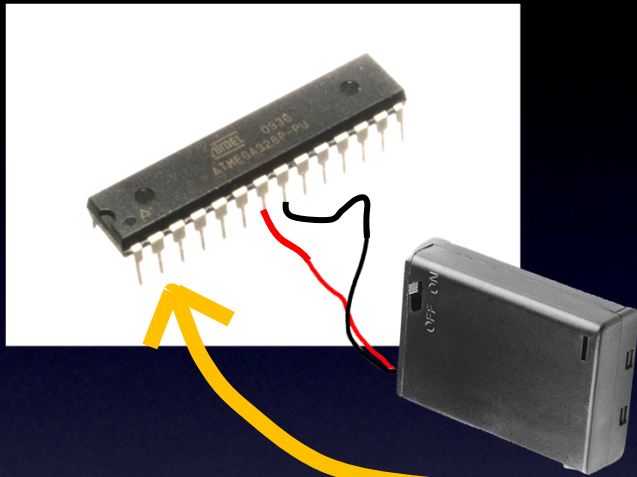
Let's add an Input pin!

and

We can add a Start button

Microcontroller

# Everything You Need to Know About Electronics



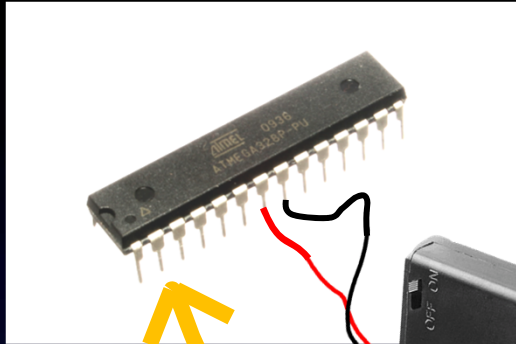
**How do we make a pin an Input pin?**

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

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

Microcontroller – Input pins

# Everything You Need to Know About Electronics



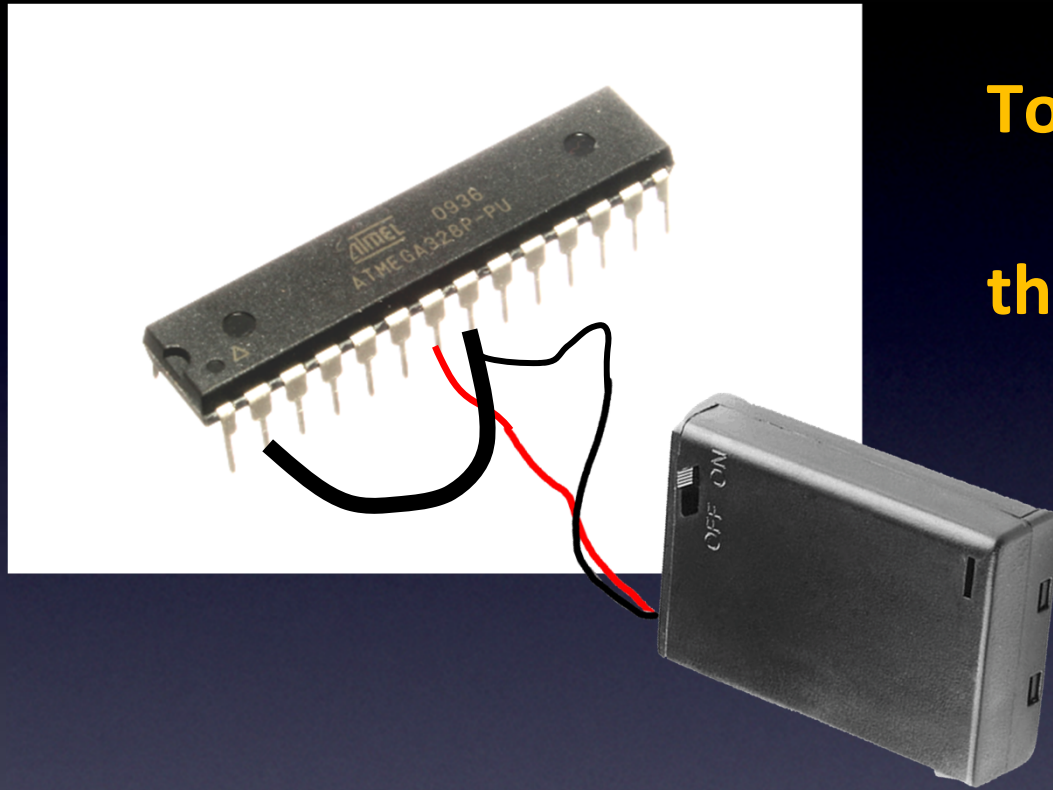
Once we have an **Input pin** (like, pin 2):

only 2 choices – is the Input pin: **High** or **Low** ?

Microcontroller – Input pins



# Everything You Need to Know About Electronics

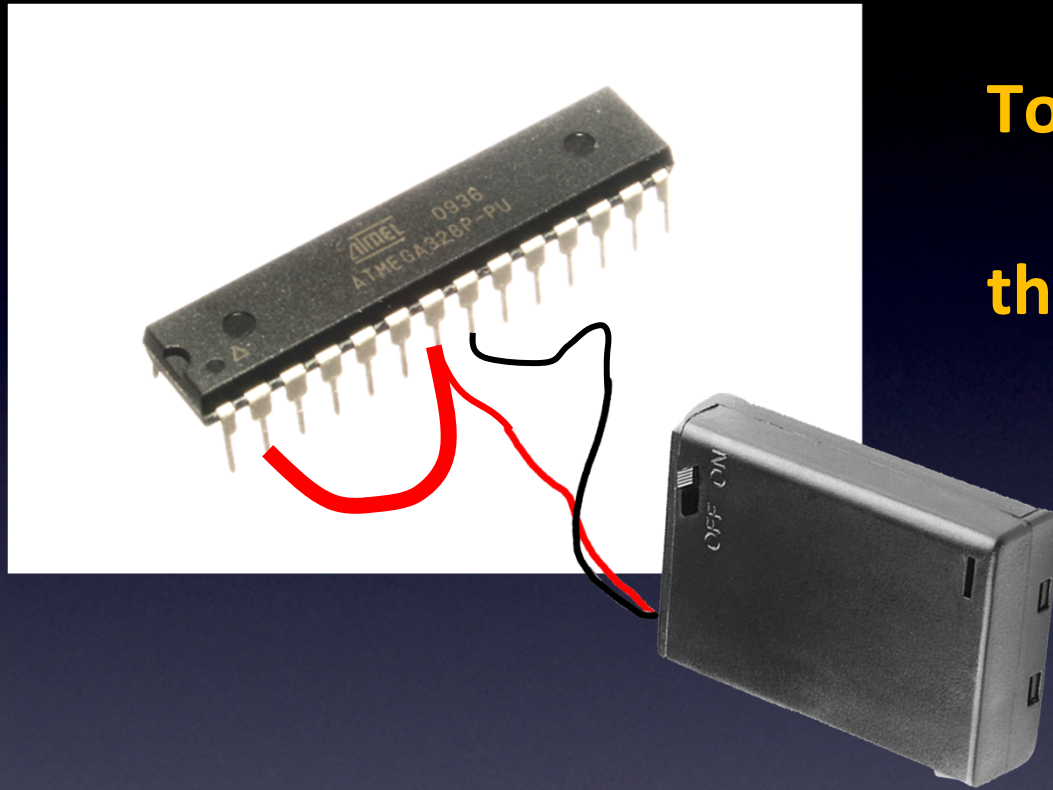


**To make the Input pin Low,  
connect it to  
the Black wire of our power  
supply (Ground).**

**Low**

Microcontroller – Input pins

# Everything You Need to Know About Electronics

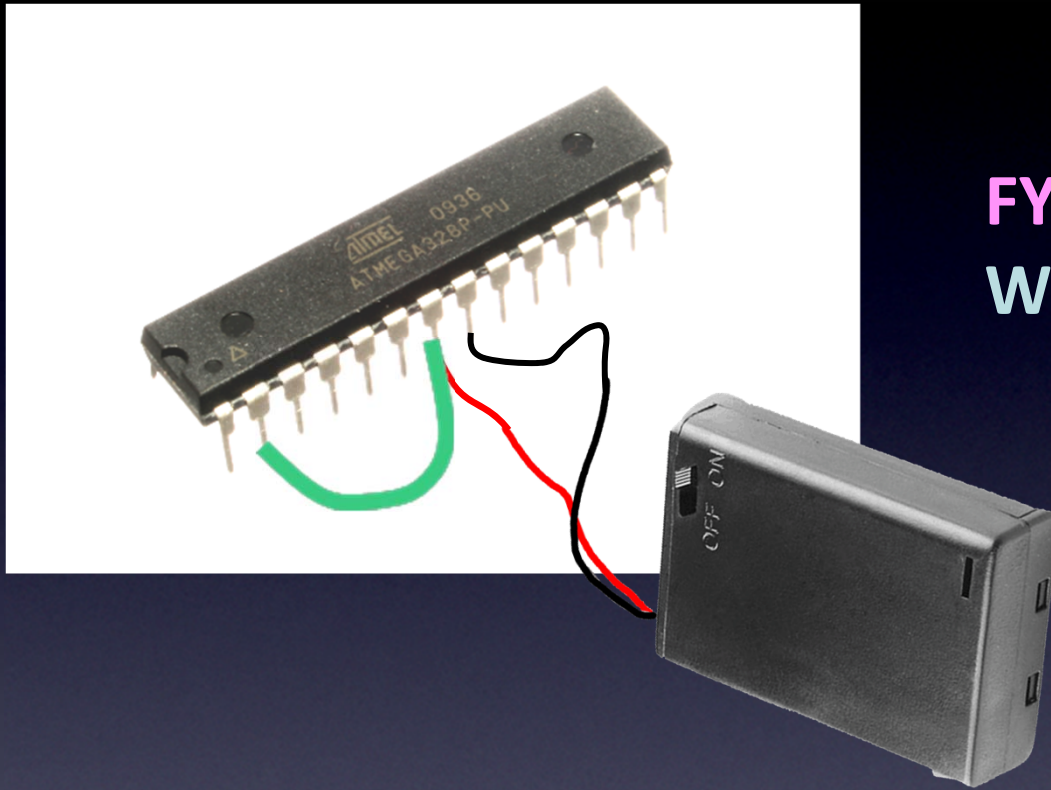


To make the Input pin High,  
connect it to  
the Red wire of our power  
supply (Vcc).

**High**

Microcontroller – Input pins

# Everything You Need to Know About Electronics



FYI:

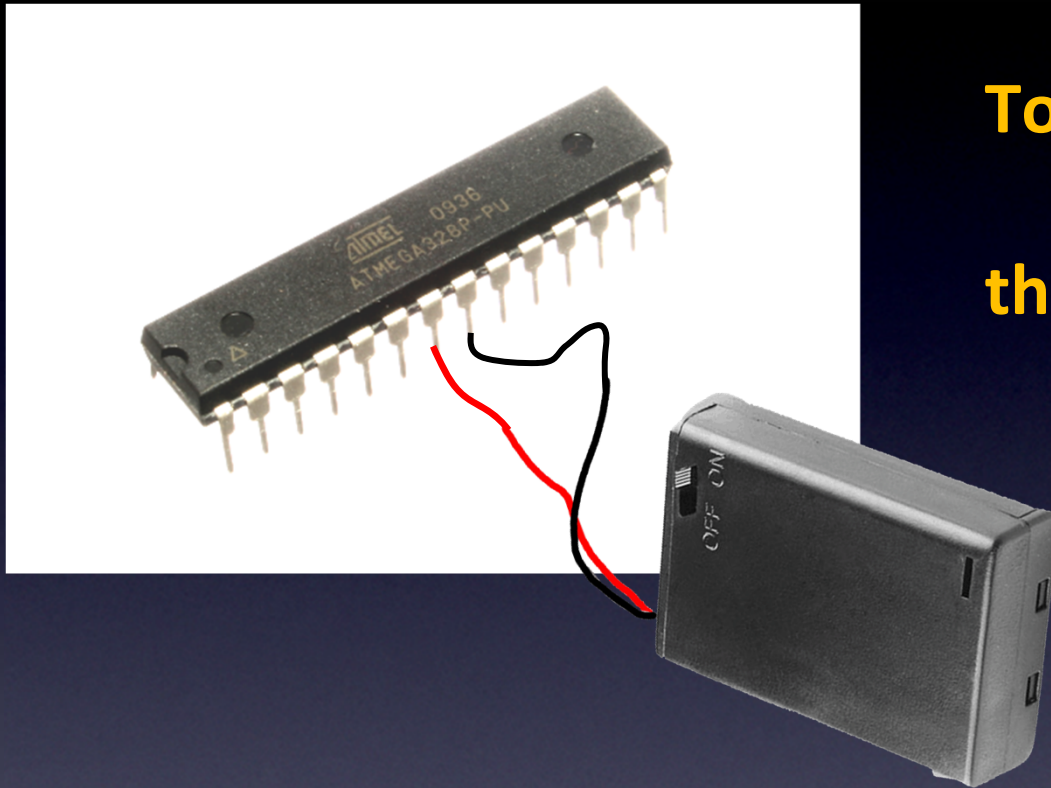
Wire color does **not** matter !

(electrons don't care)

**High**

Microcontroller – Input pins

# Everything You Need to Know About Electronics



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

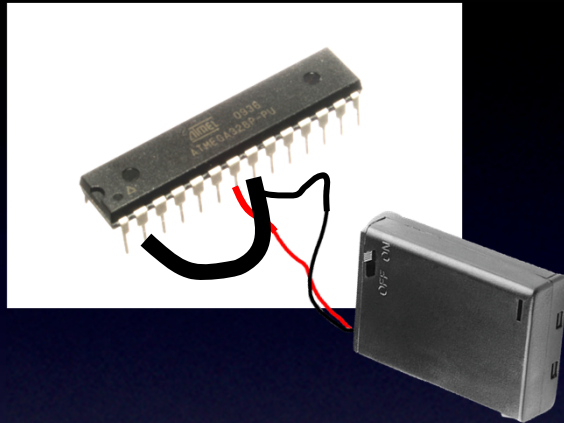
OR:

just leave it blank  
(built-in resistors on each pin)

**High**

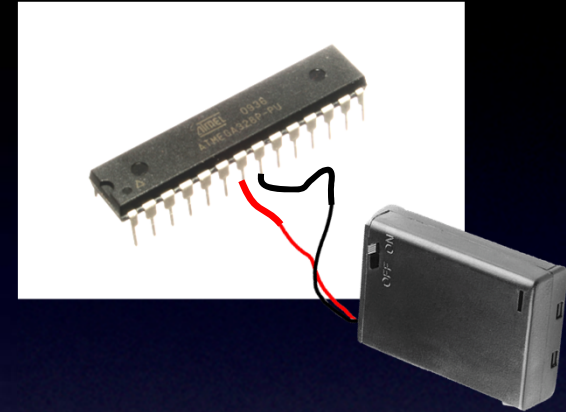
Microcontroller – Input pins

# Everything You Need to Know About Electronics



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

**Low**



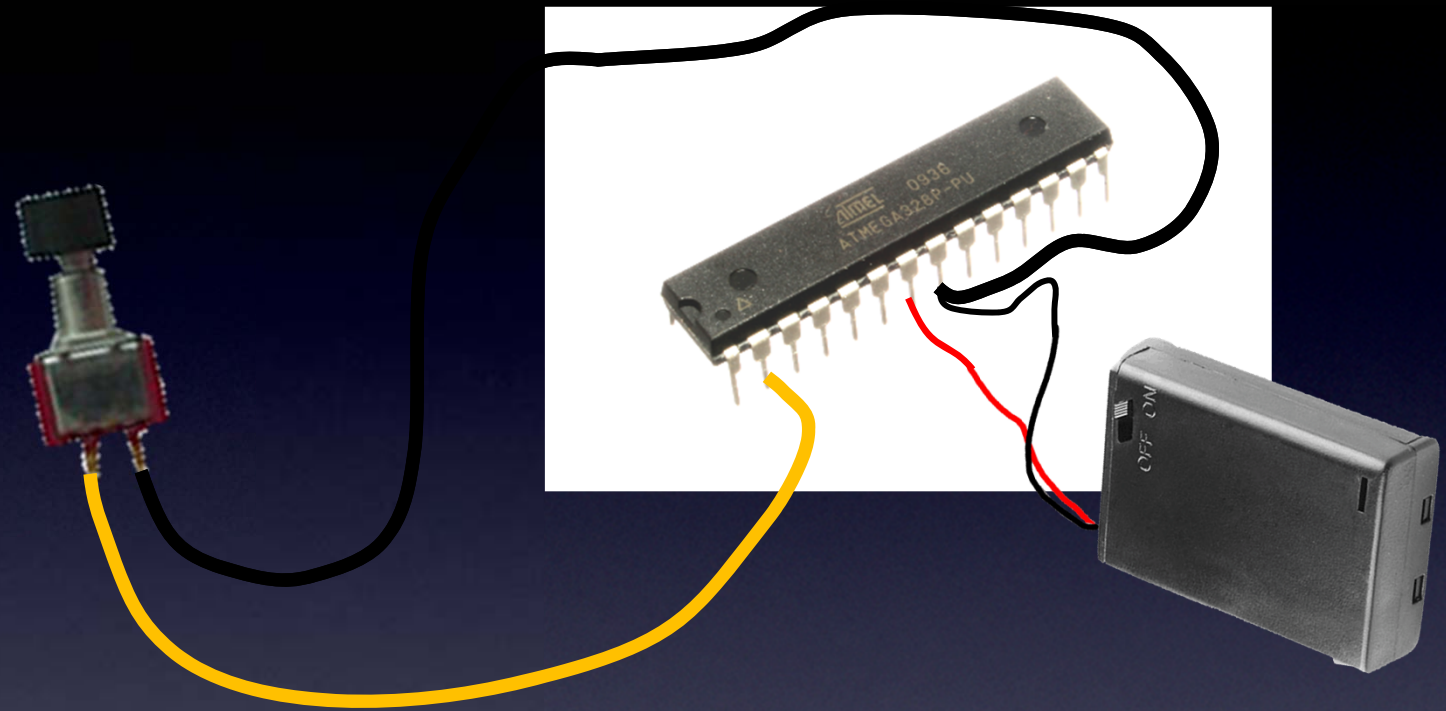
If firmware looks at Pin 2 when it's like this, it reports back:

**High**

Reading the Input pin

Microcontroller – Input pins

# Everything You Need to Know About Electronics

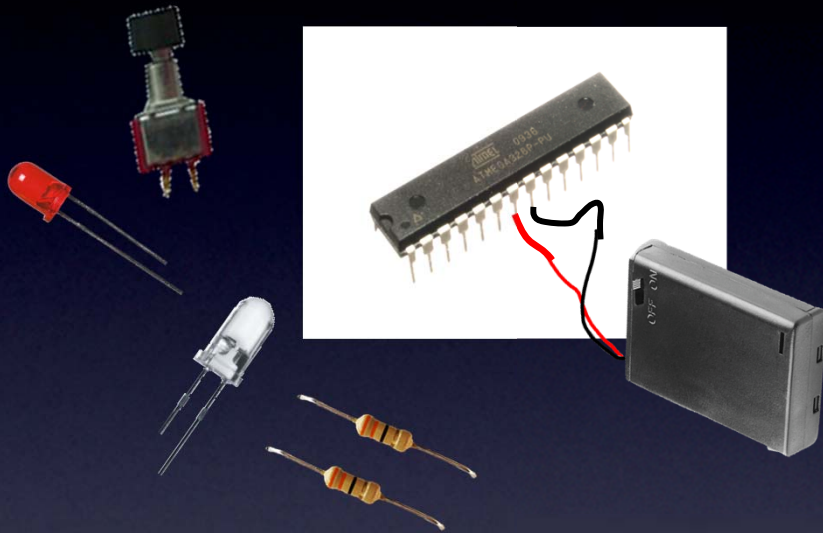


Reading the Input pin with a Switch

Microcontroller – Input pins

# 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...

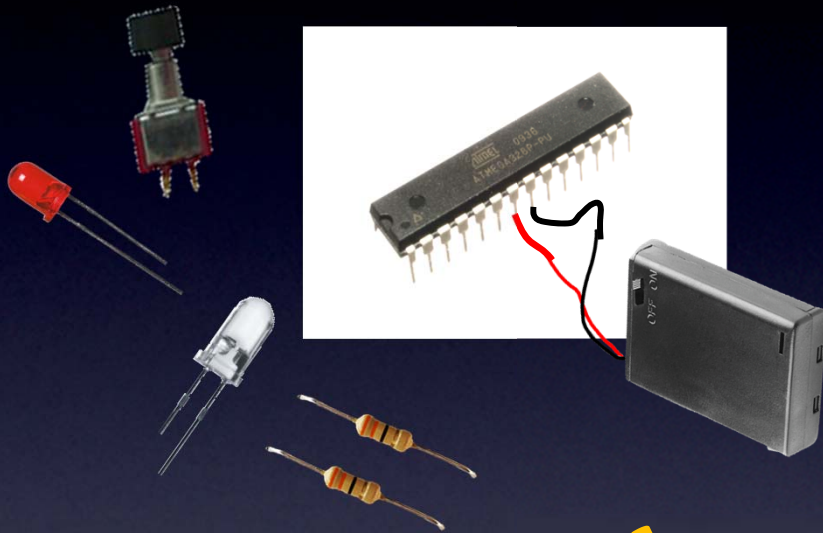
Etc for all “OFF” codes

## TV-B-Gone remote control

## Microcontroller

# Everything You Need to Know About Electronics

## Hardware



**Except**  
doesn't go very far

## 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

**Review:**



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

LED

# Everything You Need to Know About Electronics

## Review:

Output pin – only 2 choices:

Low

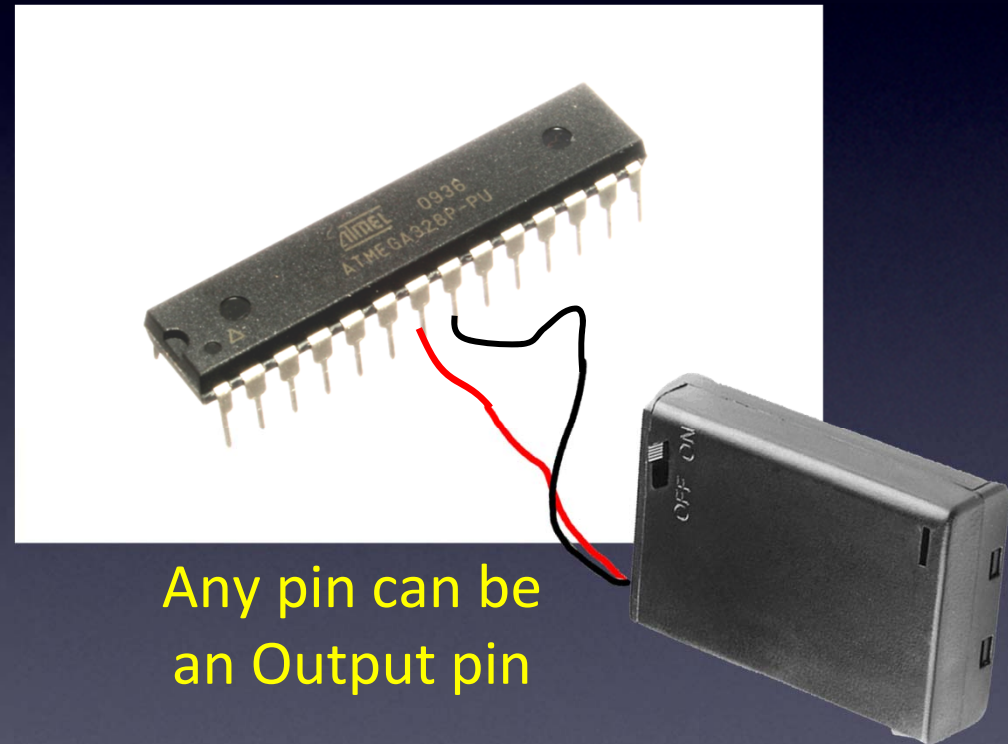
High

Off

On

(0V)

(Power supply voltage  
-- *controlled by our Firmware!*)



Microcontroller – Output pins

# Everything You Need to Know About Electronics

Output pin – only 2 choices:

Low

High

Off

On

(0V)

(Power supply voltage

-- *controlled by our Firmware!*)

Output pins

only allow

limited current

(built-in resistors on each pin)



Microcontroller – Output pins

# Everything You Need to Know About Electronics

Output pin – only 2 choices:

Low

High

Off

On

(0V)

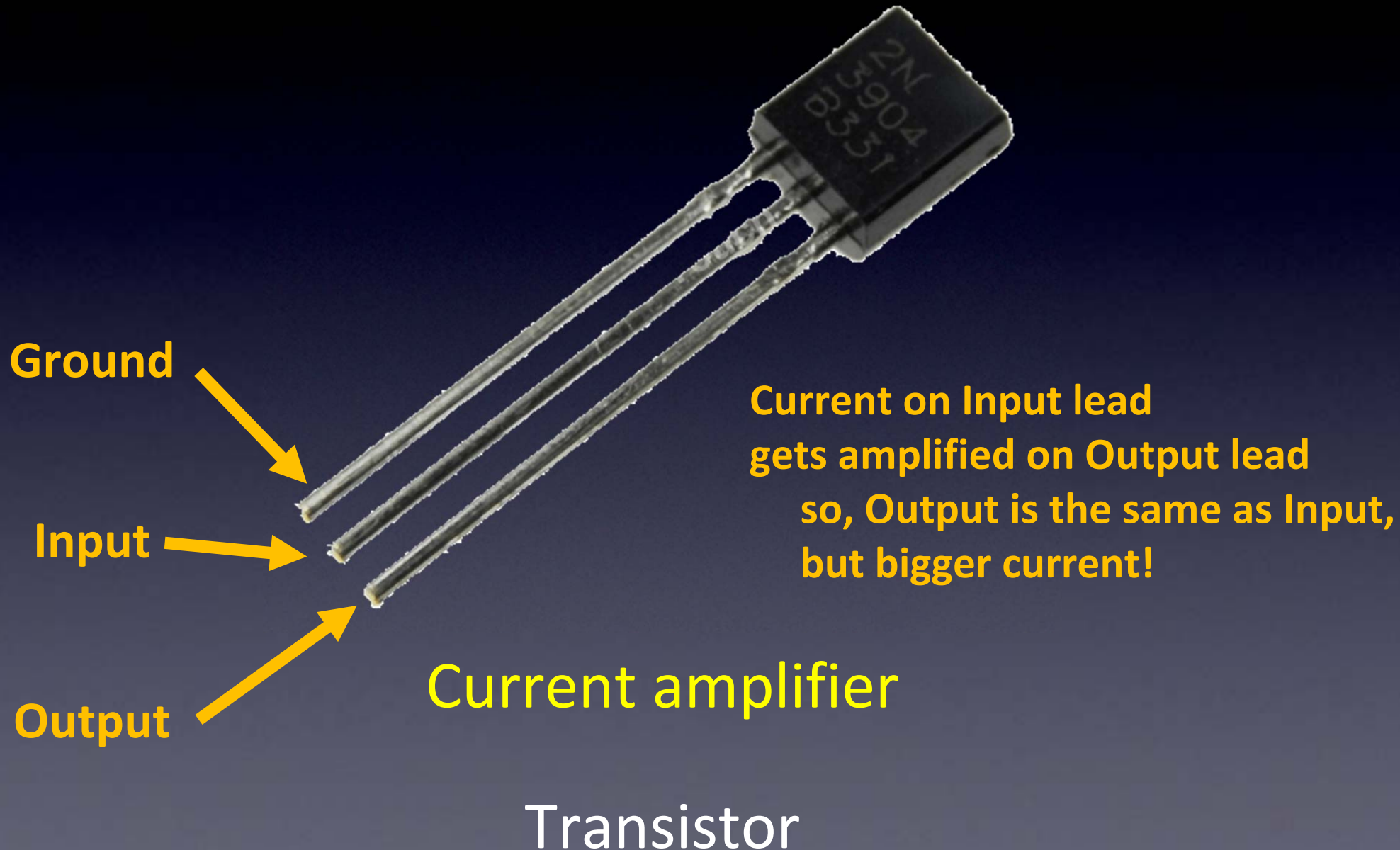
(Power supply voltage  
-- controlled by our Firmware!)

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

Output pin – only limited current

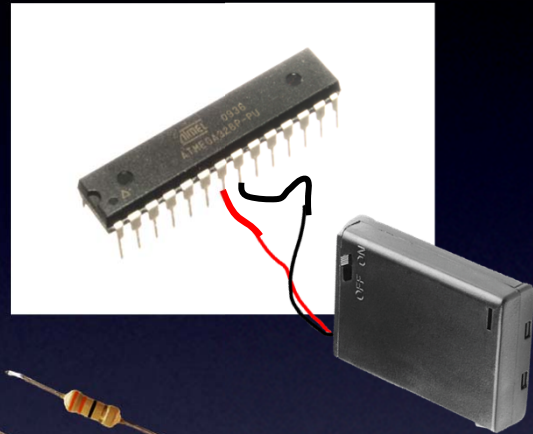
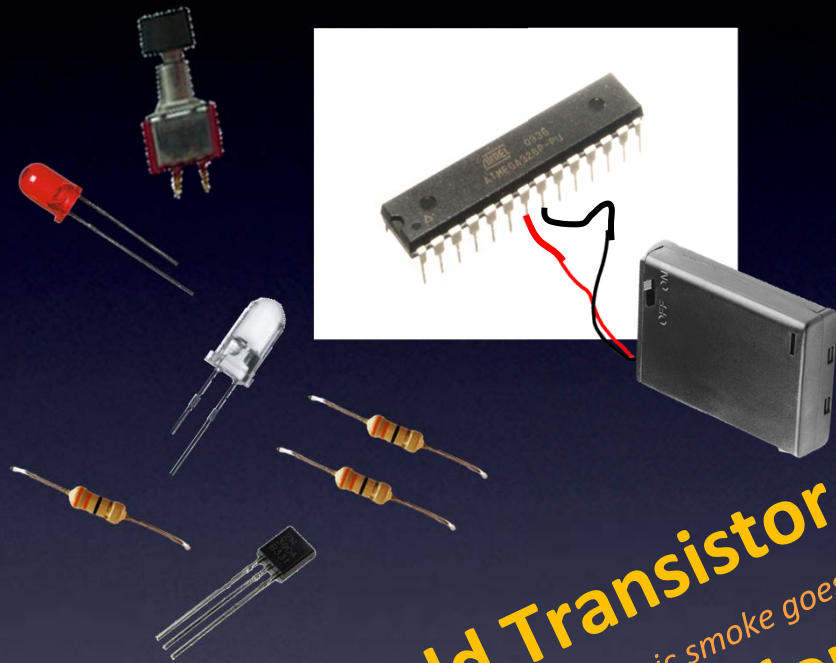
Microcontroller – Output pins

# Everything You Need to Know About Electronics



# Everything You Need to Know About Electronics

## Hardware



**Add Transistor**  
(and a resistor so no magic smoke goes away)  
**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

And, that is

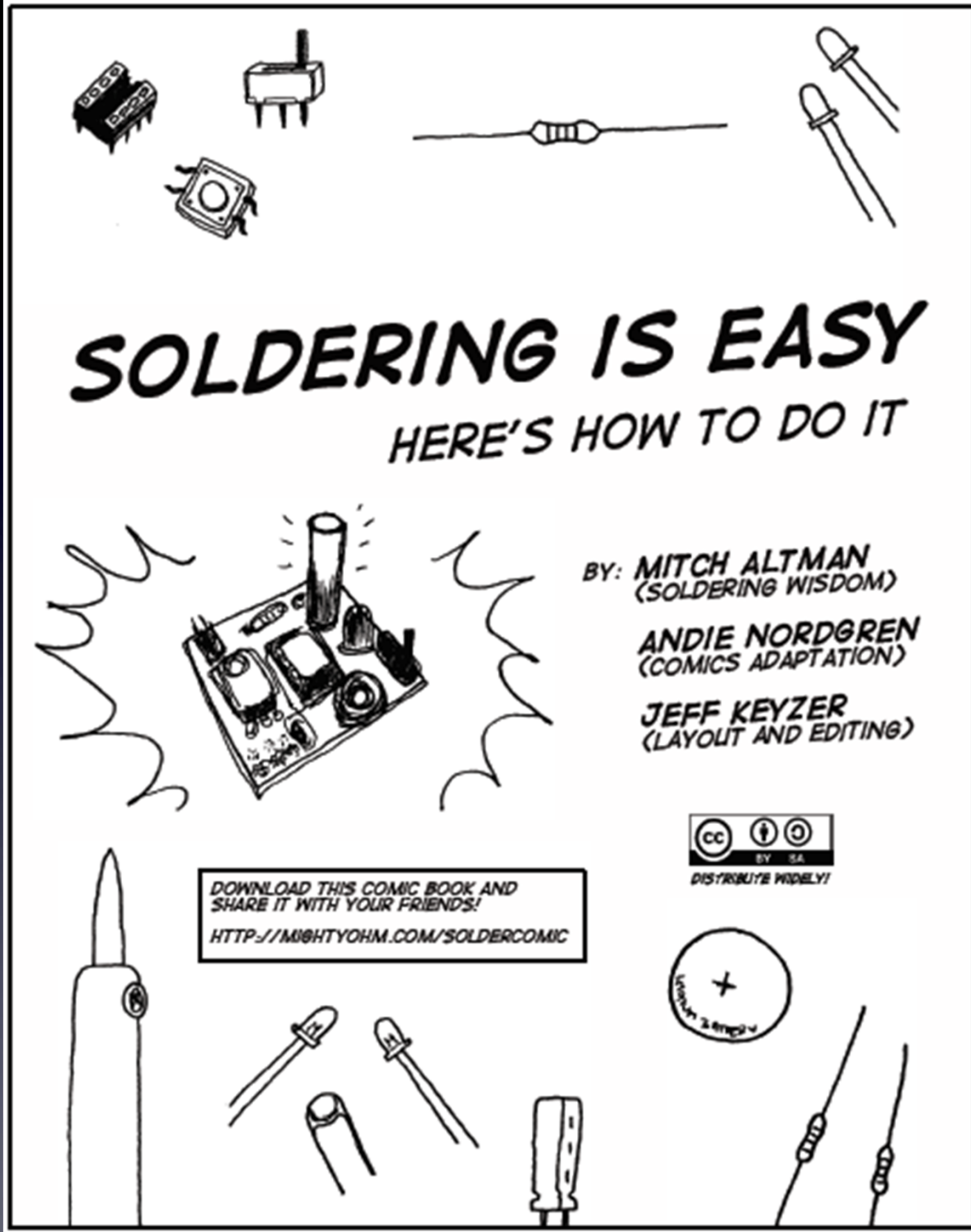
And, that is

*Everything You Need to Know About*  
***Electronics***

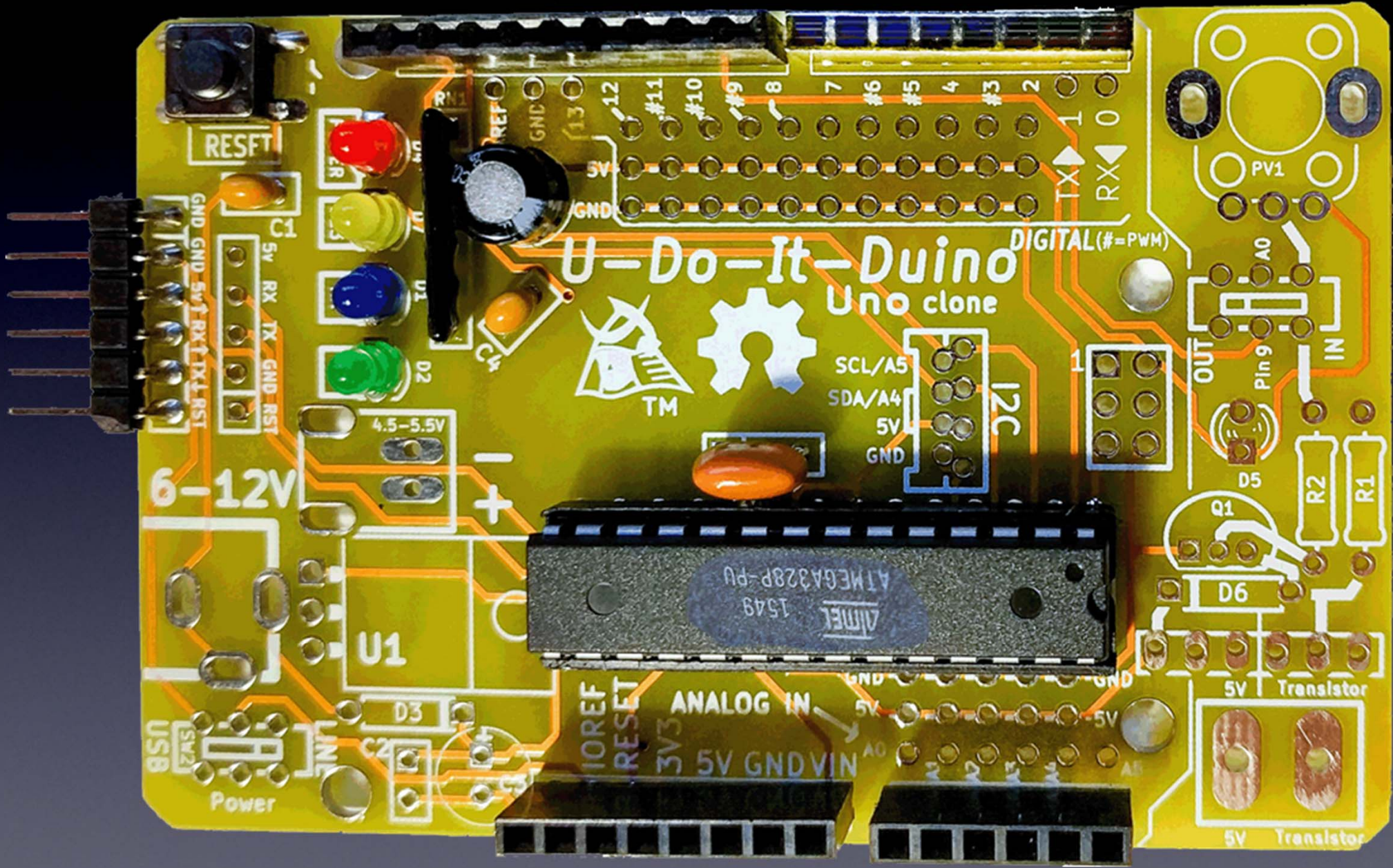


Questions?

# Learn To Solder



download for free at:  
<http://mightyohm.com/soldercomic>



U-Do-It-Duino  
Uno clone

ATMEL  
1549  
ATMEGA328P-PU

6-12V

RESFT

DIGITAL (#=PWM)

I2C

IOREF  
RESET  
3V3  
5V  
GND  
VIN  
A0

5V Transistor

5V Transistor

USB

Power

U1



TM

PV1

A0

Pin 9

D5

D6

5V

5V

12  
#11  
#10  
#9  
8  
7  
#6  
#5  
4  
#3  
2  
1  
TX  
RX  
0

GND 5V RX TX GND RST  
GND 5V RX TX GND RST

SCL/A5  
SDA/A4  
5V  
GND

OUT  
IN

IN

R2

R1

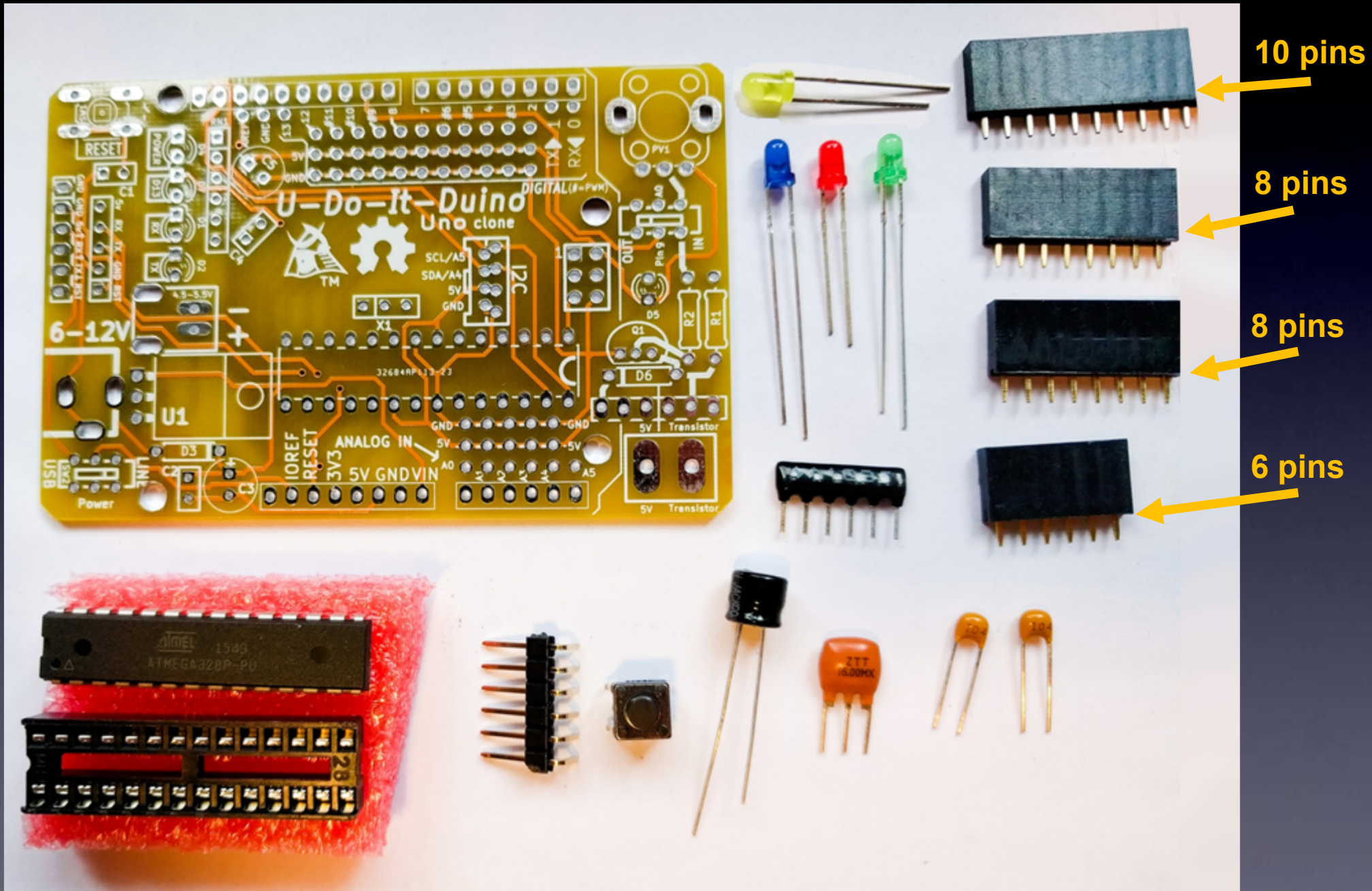
5V

Transistor

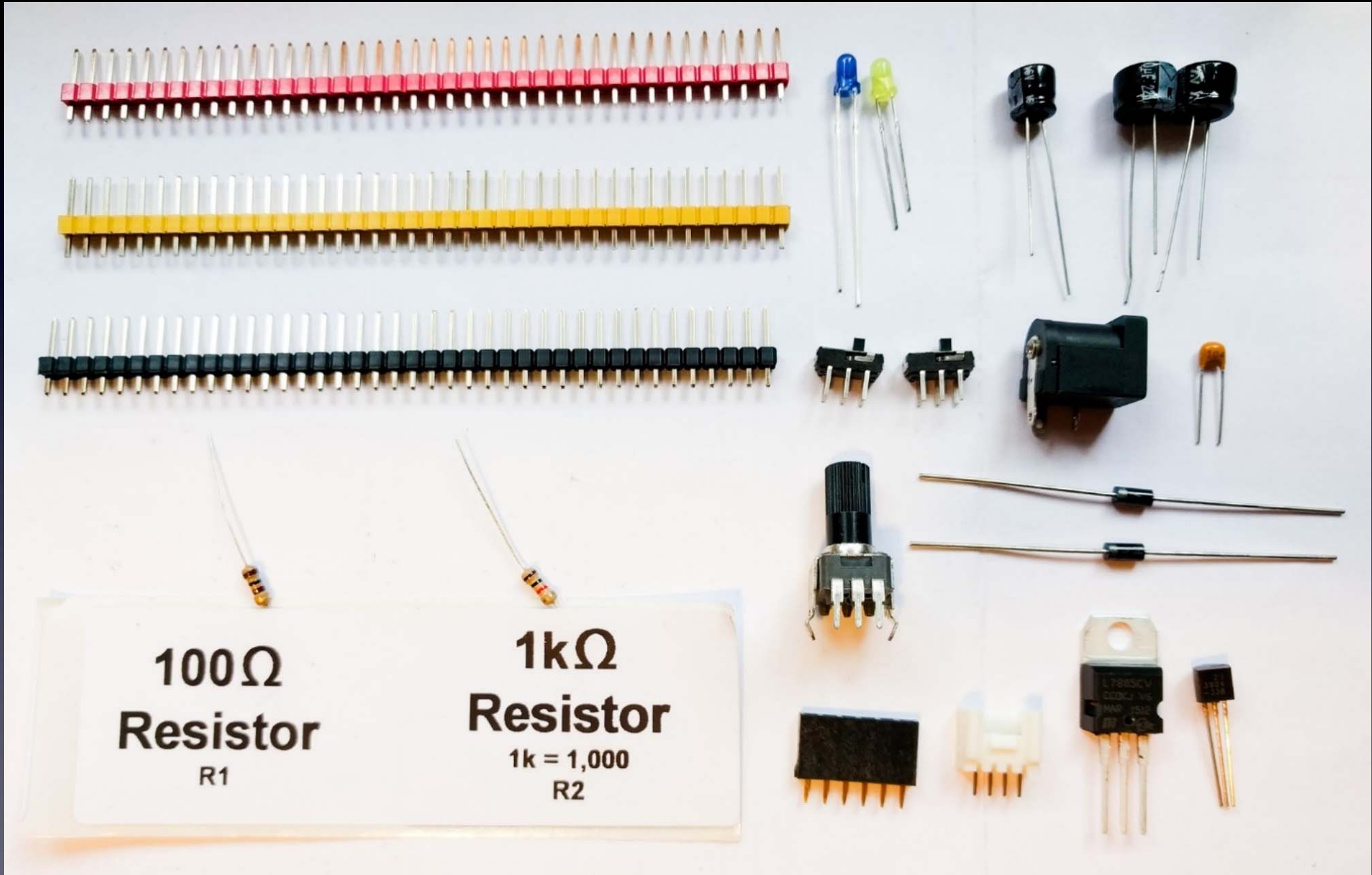
5V

Transistor

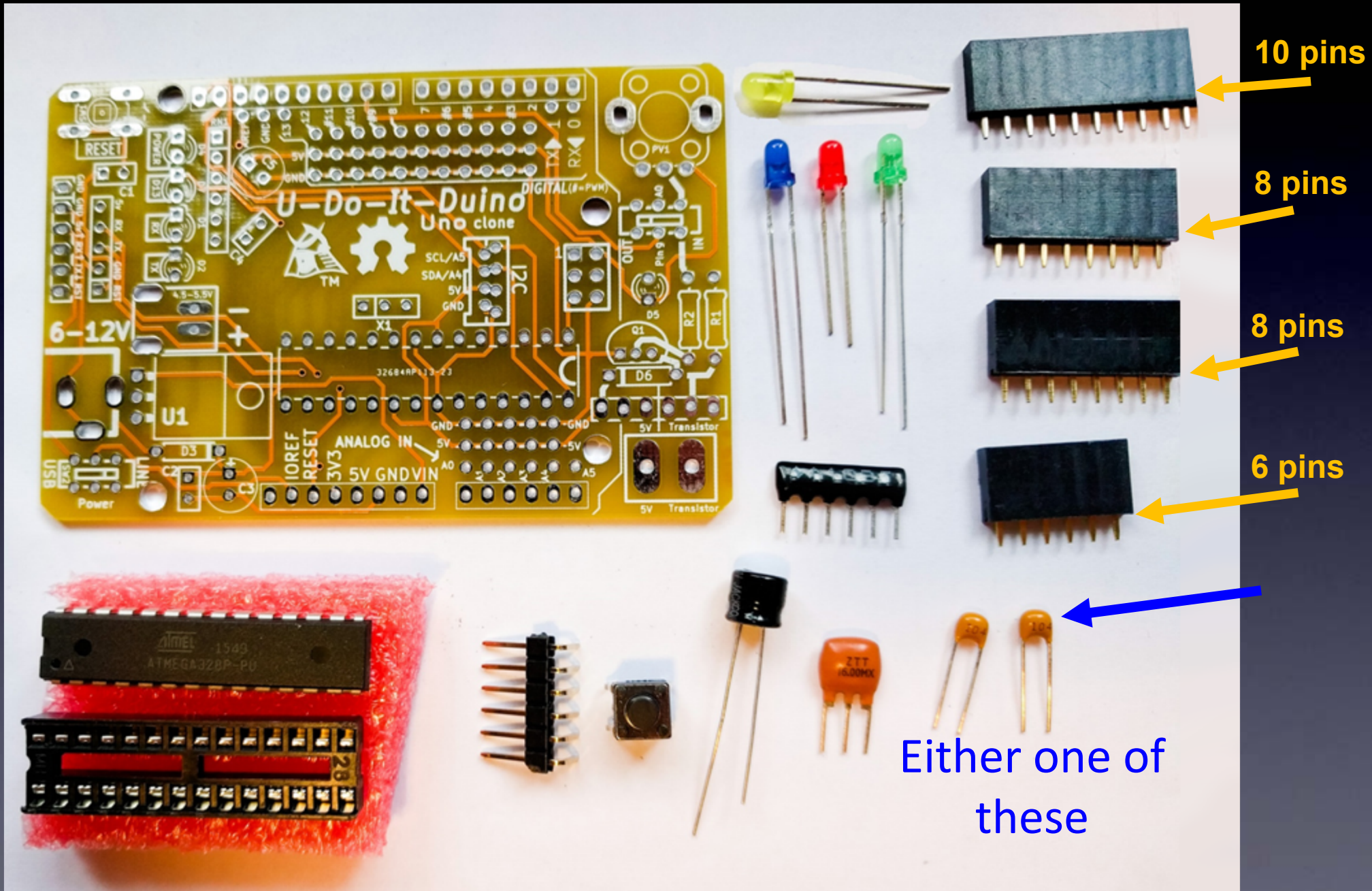
# Parts to use



# Unused parts



# Our first part to solder: C1



**C1: Look down at the shape of this part**



RESET

POWER

D13

RX

TX

TX↑

RX↓

GND

5V

5V

RX

TX

GND

RST

6-12V

USB

SW2

Power

C1

C2

C3

LINE

AREF

GND

5V

GND

13

12

#11

#10

#9

8

7

#6

#5

4

#3

2

1

TX

1

0

RX

DIGITAL (#=PWM)

# U-Do-It-Duino

## Uno clone



SCL/A5

SDA/A4

5V

GND

I2C

1

X1

32684AP114-31

IOREF

RESET

3V3

5V

GND

VIN

A0

A1

A2

A3

A4

A5

PV1

A0

OUT

Pin 9

IN

D5

R2

R1

Q1

D6

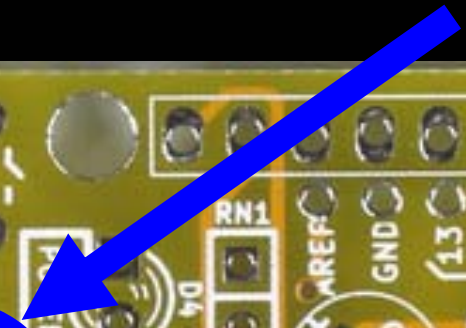
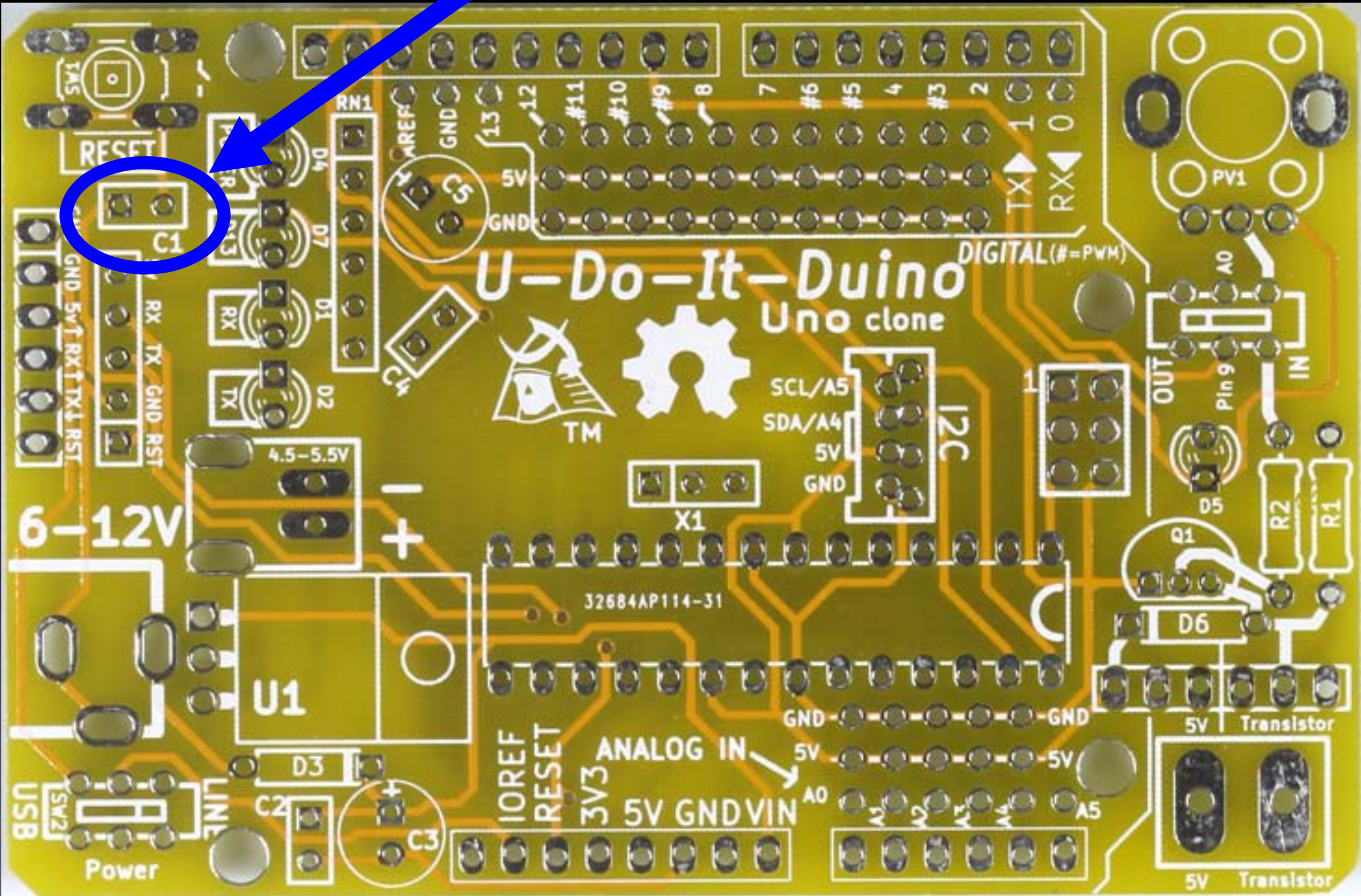
5V

Transistor

5V

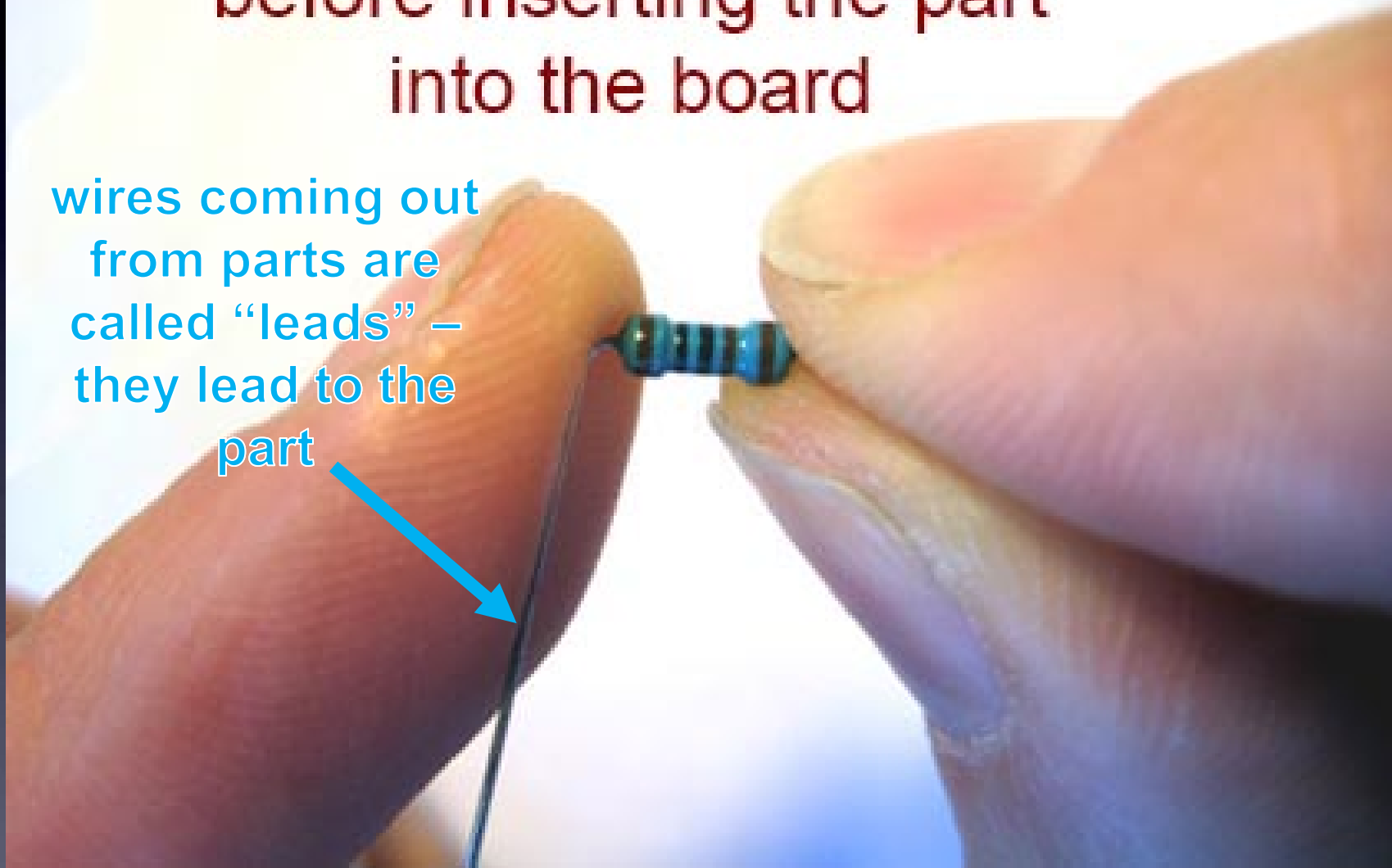
Transistor





Bend leads  
before inserting the part  
into the board

wires coming out  
from parts are  
called "leads" –  
they lead to the  
part





**This is how a resistor look before  
inserting it into the board**

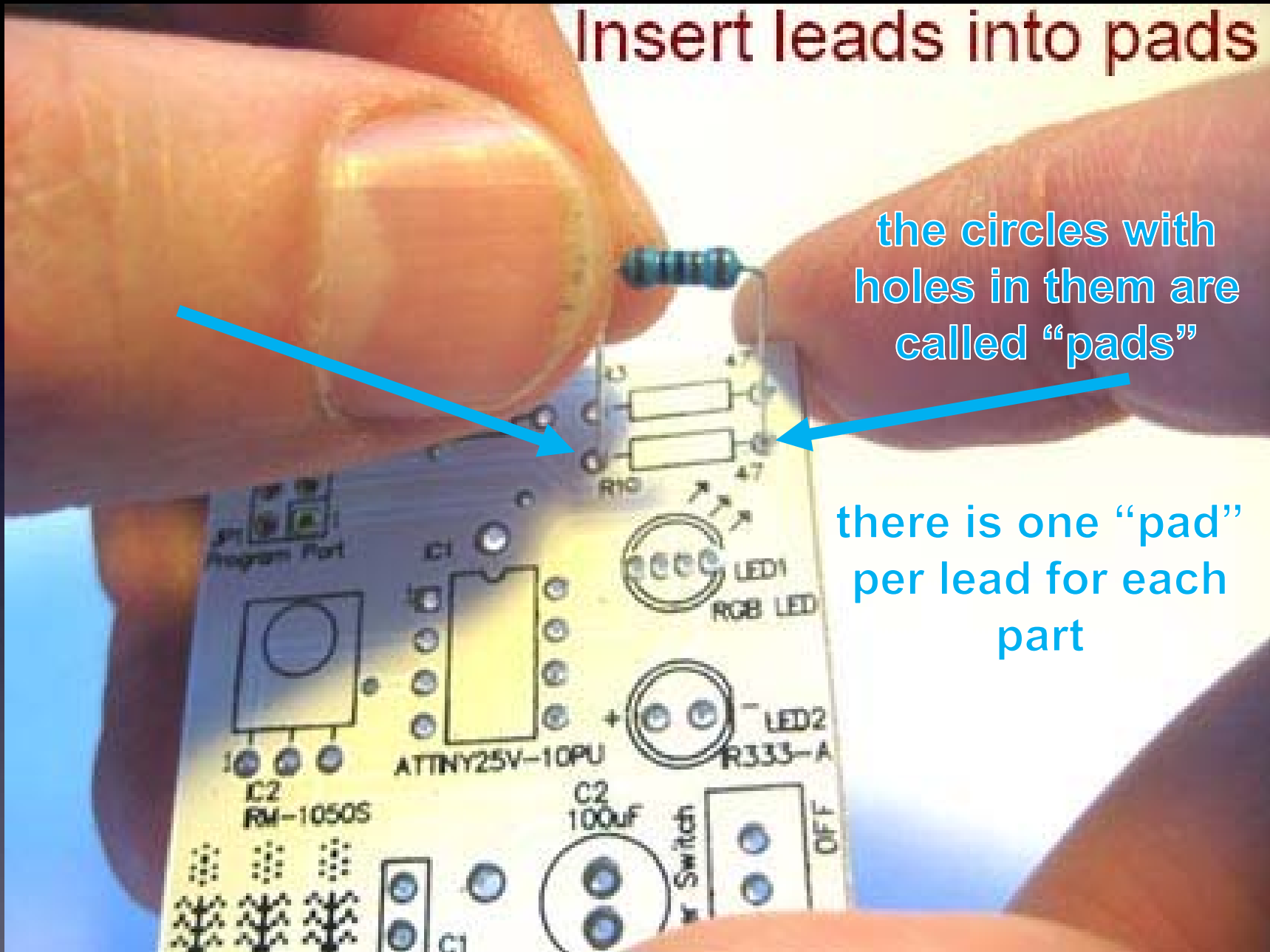
# C1: No need to bend leads first



Insert leads into pads

the circles with holes in them are called "pads"

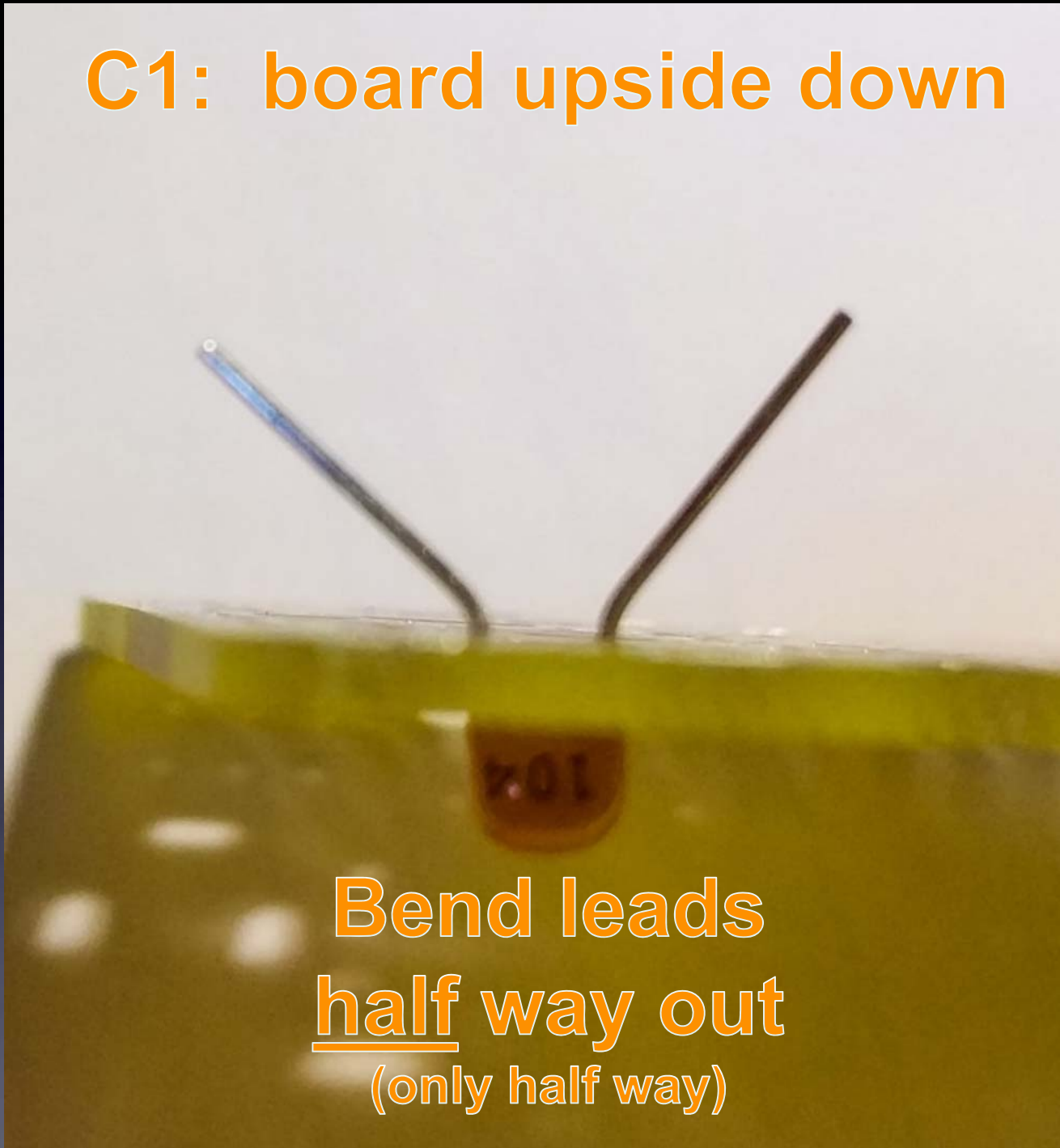
there is one "pad" per lead for each part



C1: leads inserted  
into their pads



C1: board upside down



Bend leads  
half way out  
(only half way)

# How to hold a soldering iron

(Like a pencil – held from underneath)

**Important**





The perfect kind of solder for  
electronics:

60/40 rosin core,

0.031" (0.7mm) diameter (or smaller)

*(63/37 is also good)*

Important:

Use solder WITH lead (Pb) !!  
lead-free solder  
has very poisonous fumes!

# 3 Safety Tips...

Safety Tip #1:

Hot !!

(When you touch the tip,  
*you will* let go quickly -- every time!)

# Safety Tip #2:

Lead (Pb) is toxic

But it easily washes off your hands  
with soap and water

Safety Tip #3:

*(coming soon)*

2 secrets  
to good soldering...

# Secret #1:


## Clean the tip!

(before every solder connection)

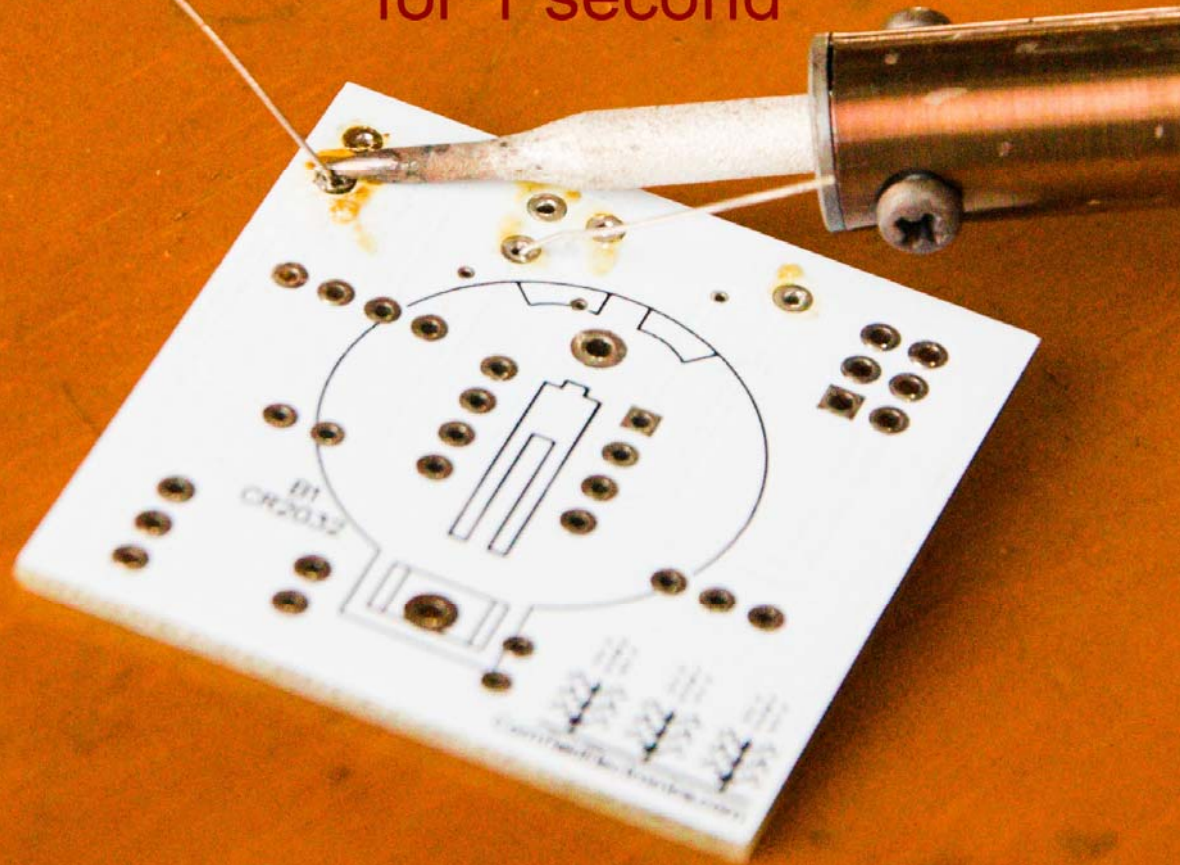
Bang (lightly) 3 times,

Swipe, Rotate, Swipe:

Keep the tip shiny silver!

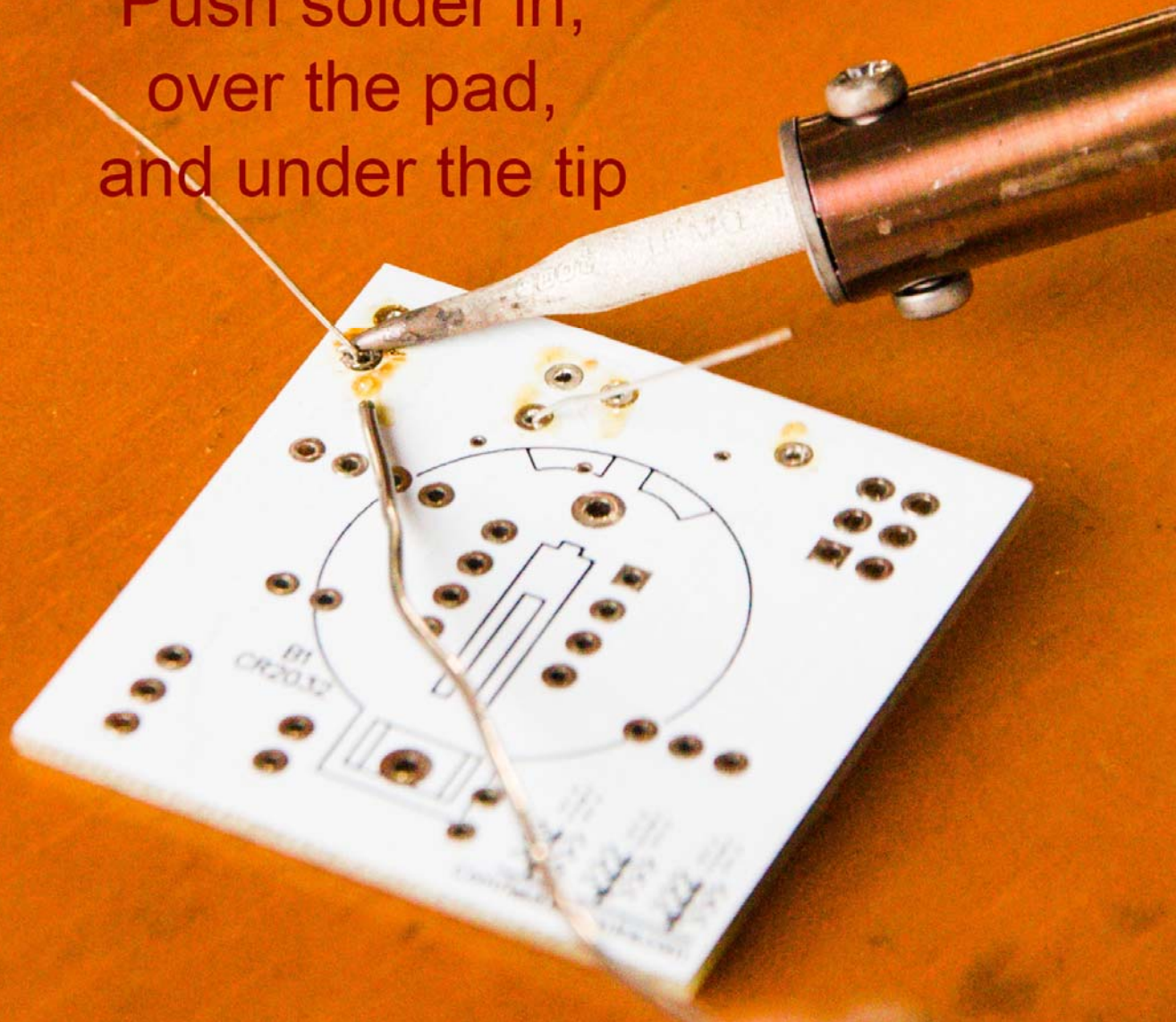
 knock solder off the tip

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

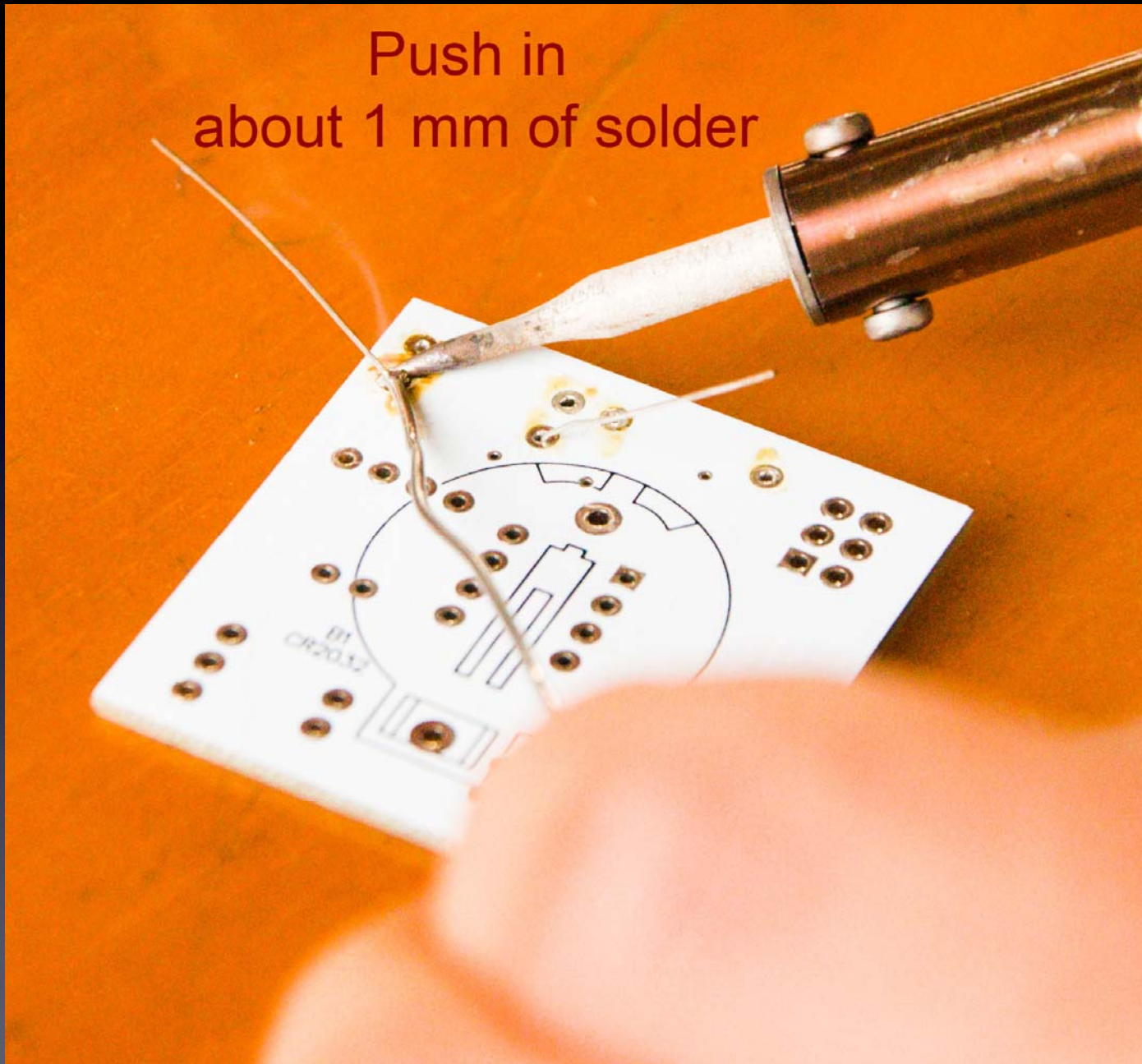




Push solder in,  
over the pad,  
and under the tip



Push in  
about 1 mm of solder



Make sure solder melts on the underside of the soldering iron  
(not the side or top of the soldering iron tip)!



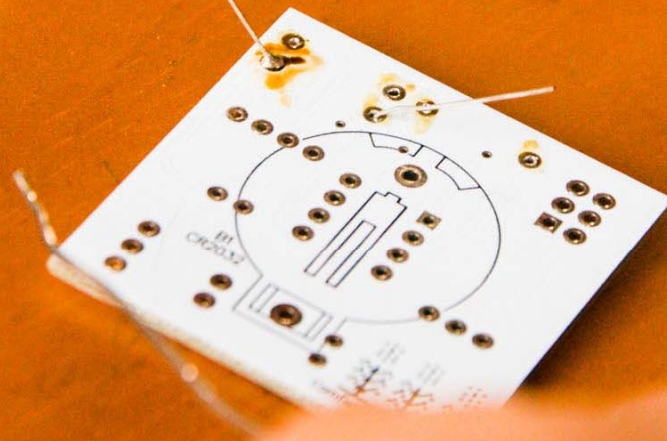
Pull solder away,  
***But*** keep holding soldering iron down  
for 1 more second

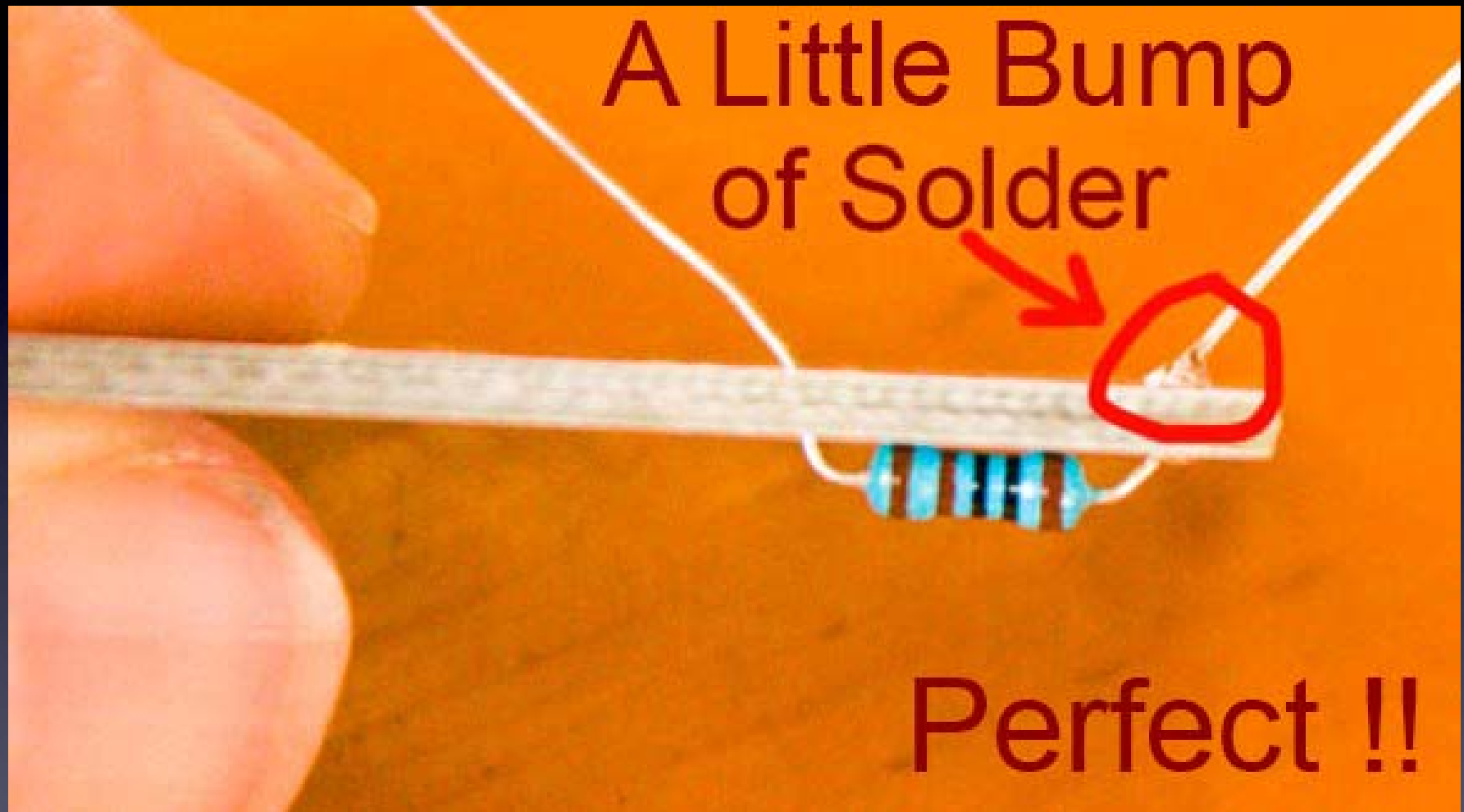
Secret #2:

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

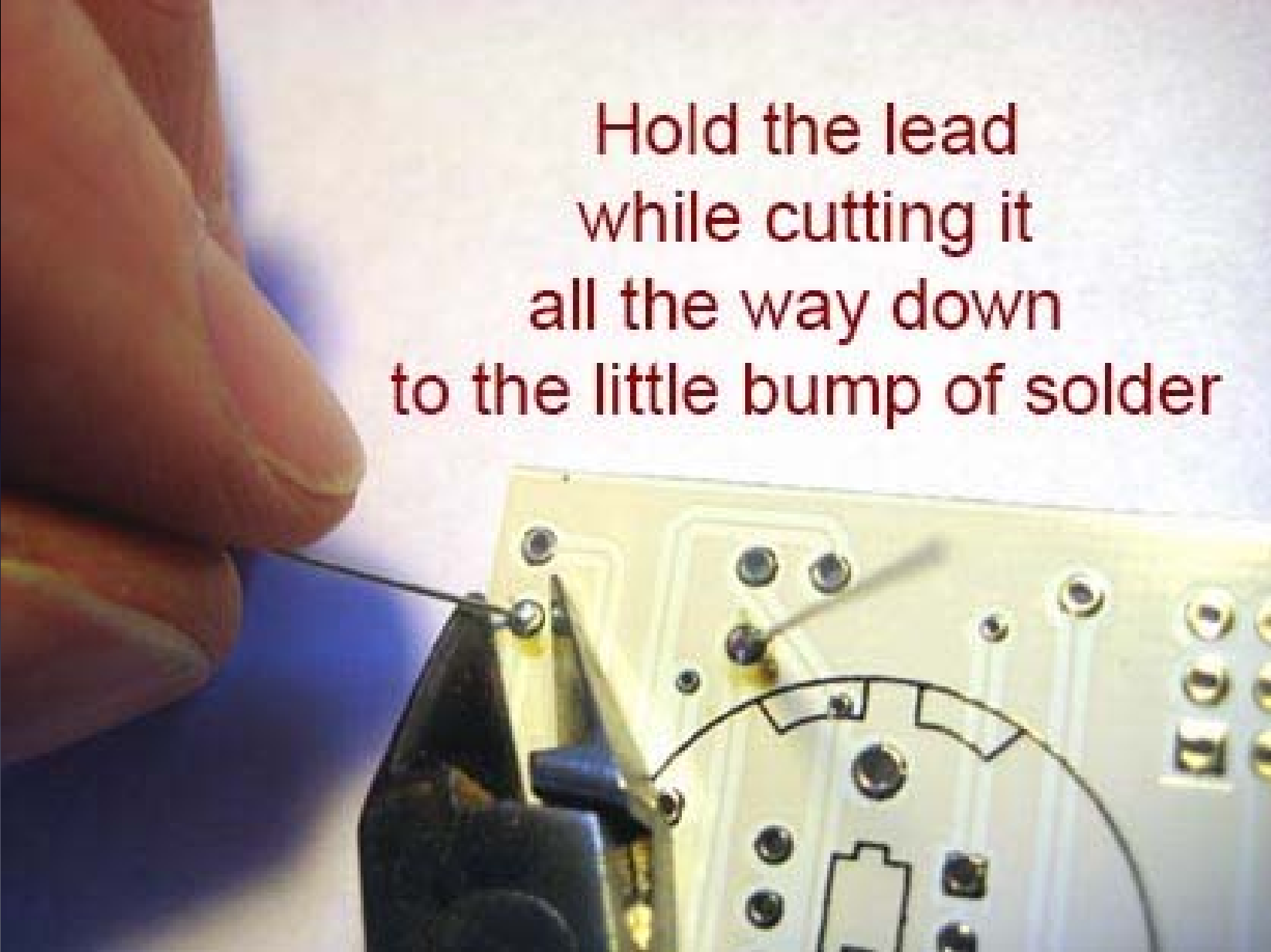
**Now**

**Lift soldering iron**





If you can see any of the pad, or the hole, you need more solder  
– so, just do all the steps again to make it perfect.



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

Cutting with the tip of the wire cutter gives you more control

# Safety Tip #3:

**Hold or cover the lead !**

(Keep the leads from turning into missiles that go into your eyes!)





All done !

No wire sticking out

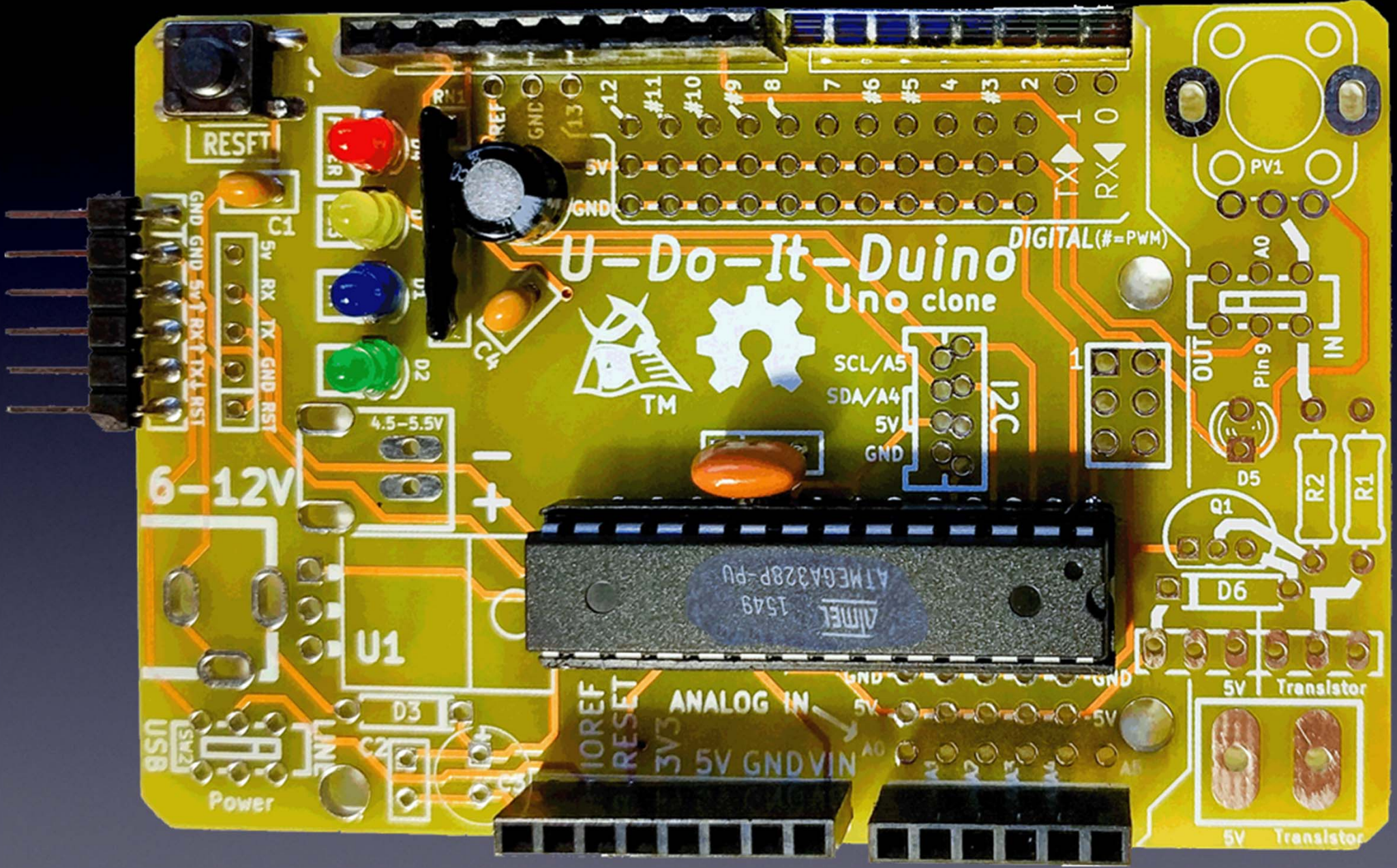
A close-up photograph of a microchip. The chip is a small, rectangular, light-colored component with a central, rounded, brownish-gold feature. A thin, gold wire is bonded to the chip, extending from the central feature and curving downwards. The background is a blue surface with a grid of white dots. The text "C1: All done !" is overlaid in orange on the blue background.

**C1: All done !**

No wire sticking out

One part at a time

Till all the parts are soldered



U-Do-It-Duino  
Uno clone



ATMEL  
1549  
ATMEGA328P-PU

RESET

6-12V

USB

Power

U1

D3

C2

Z1

LINE

REF0

GND

5V

GND

12

#11

#10

#9

8

7

#6

#5

4

#3

2

1

TX

RX

0

DIGITAL(#=PWM)

SCL/A5

SDA/A4

5V

GND

I2C

IOREF  
RESET  
3V3  
5V  
GND  
VIN

ANALOG IN

A0

PV1

A0

IN

OUT

Pin 9

D5

Q1

D6

R2

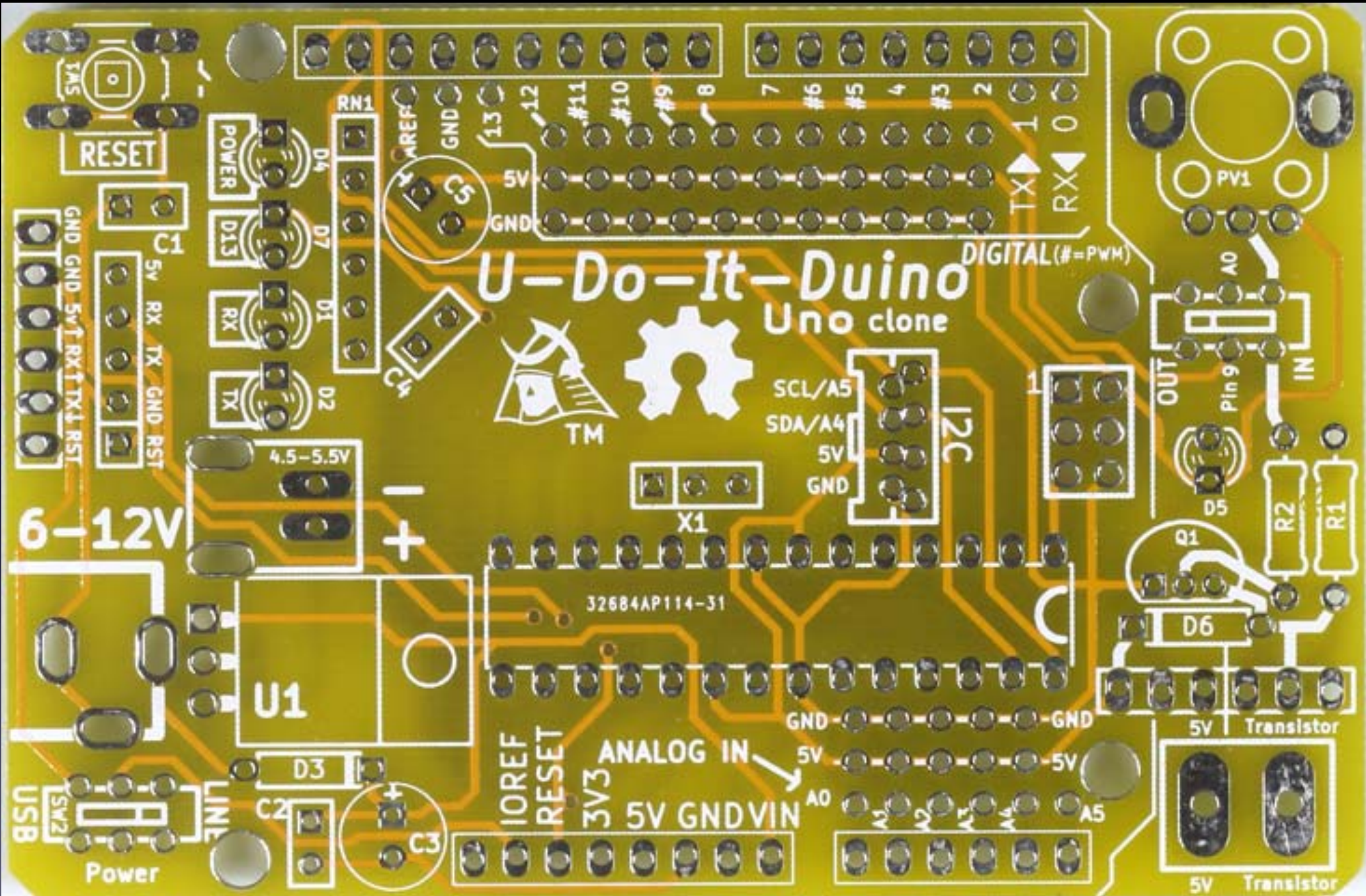
R1

5V

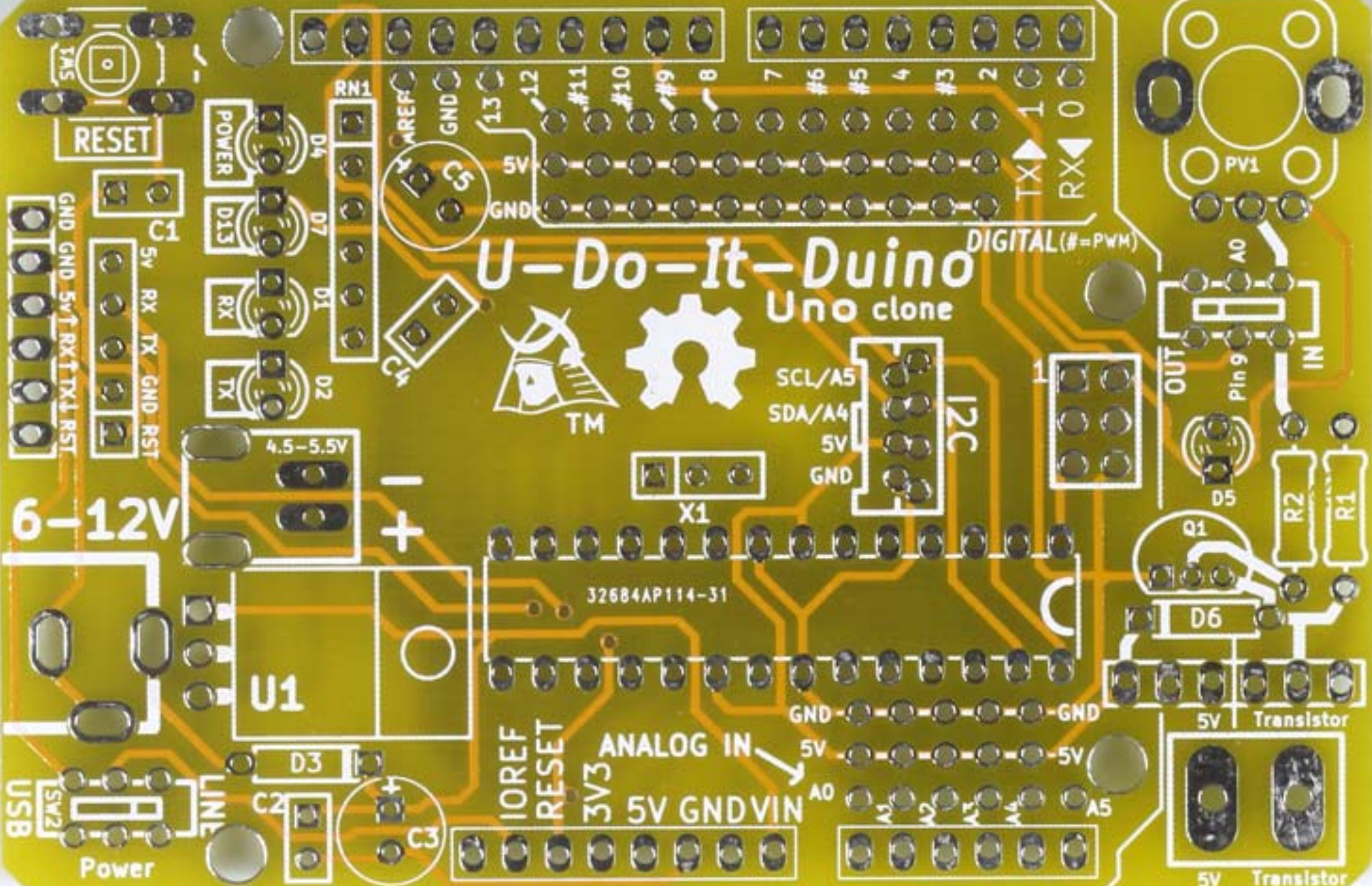
Transistor

5V

Transistor



# U-Do-It-Duino Uno clone



32684AP114-31

U1

DIGITAL(#=PWM)

I2C

6-12V

Power  
USB  
LINE

IOREF  
RESET  
3V3  
5V  
GND  
VIN

SCL/A5  
SDA/A4  
5V  
GND

5V Transistor

Q1  
D6  
R2  
R1

OUT  
IN  
Pin 9

PV1

TX  
RX

POWER  
D13  
RX  
TX  
D2

5v  
RX  
TX  
GND  
RST

GND  
5v  
RX  
TX  
GND  
RST

RESET  
TAS

AREF  
GND  
5V  
GND

13  
12  
#11  
#10  
#9  
8

7  
#6  
#5  
4  
#3  
2  
1

#1  
#2  
#3  
#4  
#5  
#6  
#7

GND  
5v  
RX  
TX  
GND  
RST

Power  
USB  
LINE

IOREF  
RESET  
3V3  
5V  
GND  
VIN

SCL/A5  
SDA/A4  
5V  
GND

5V Transistor

Q1  
D6  
R2  
R1

OUT  
IN  
Pin 9

PV1

TX  
RX

POWER  
D13  
RX  
TX  
D2

5v  
RX  
TX  
GND  
RST

GND  
5v  
RX  
TX  
GND  
RST

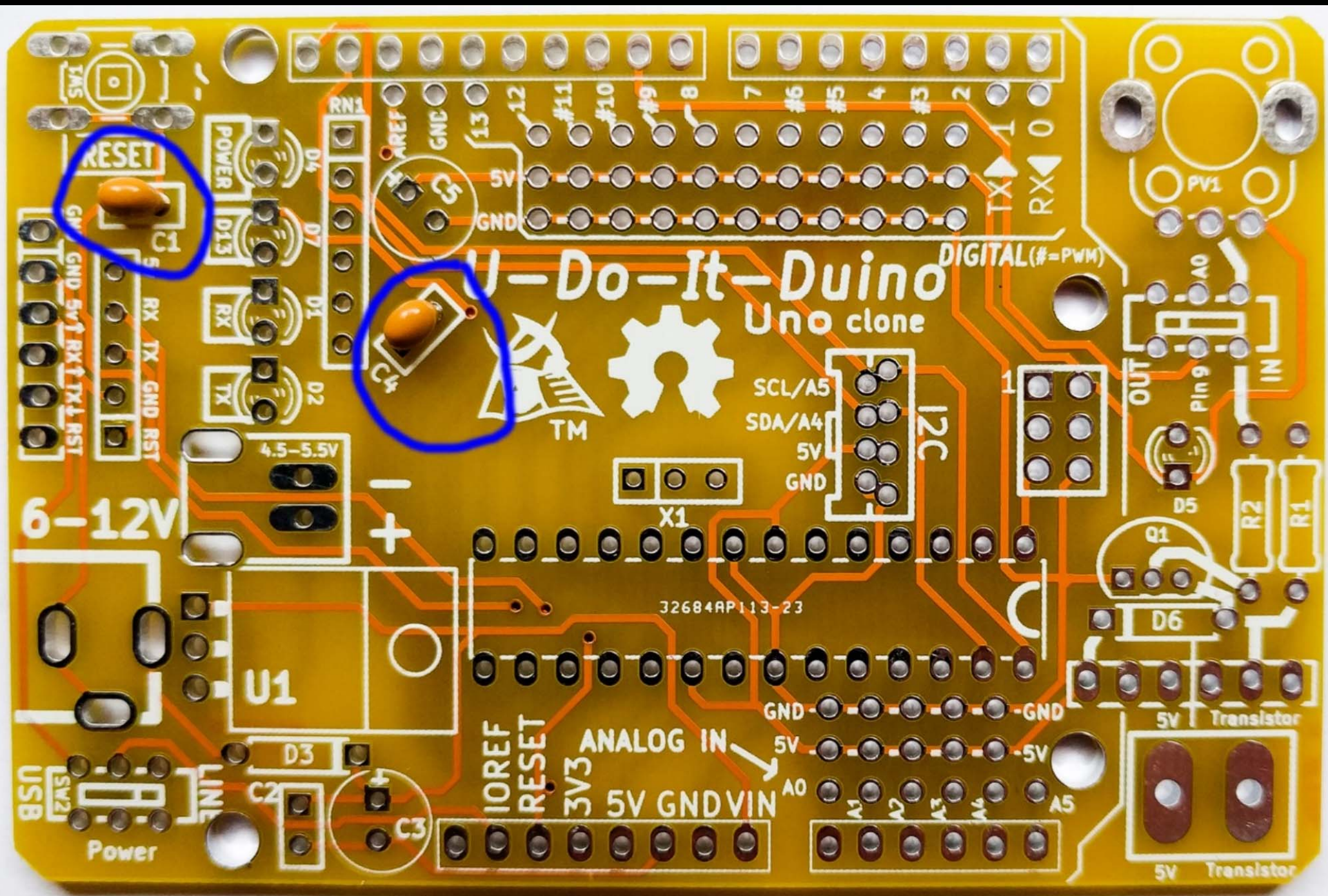
RESET  
TAS

AREF  
GND  
5V  
GND

13  
12  
#11  
#10  
#9  
8

7  
#6  
#5  
4  
#3  
2  
1

#1  
#2  
#3  
#4  
#5  
#6  
#7



U-Do-It-Duino  
Uno clone



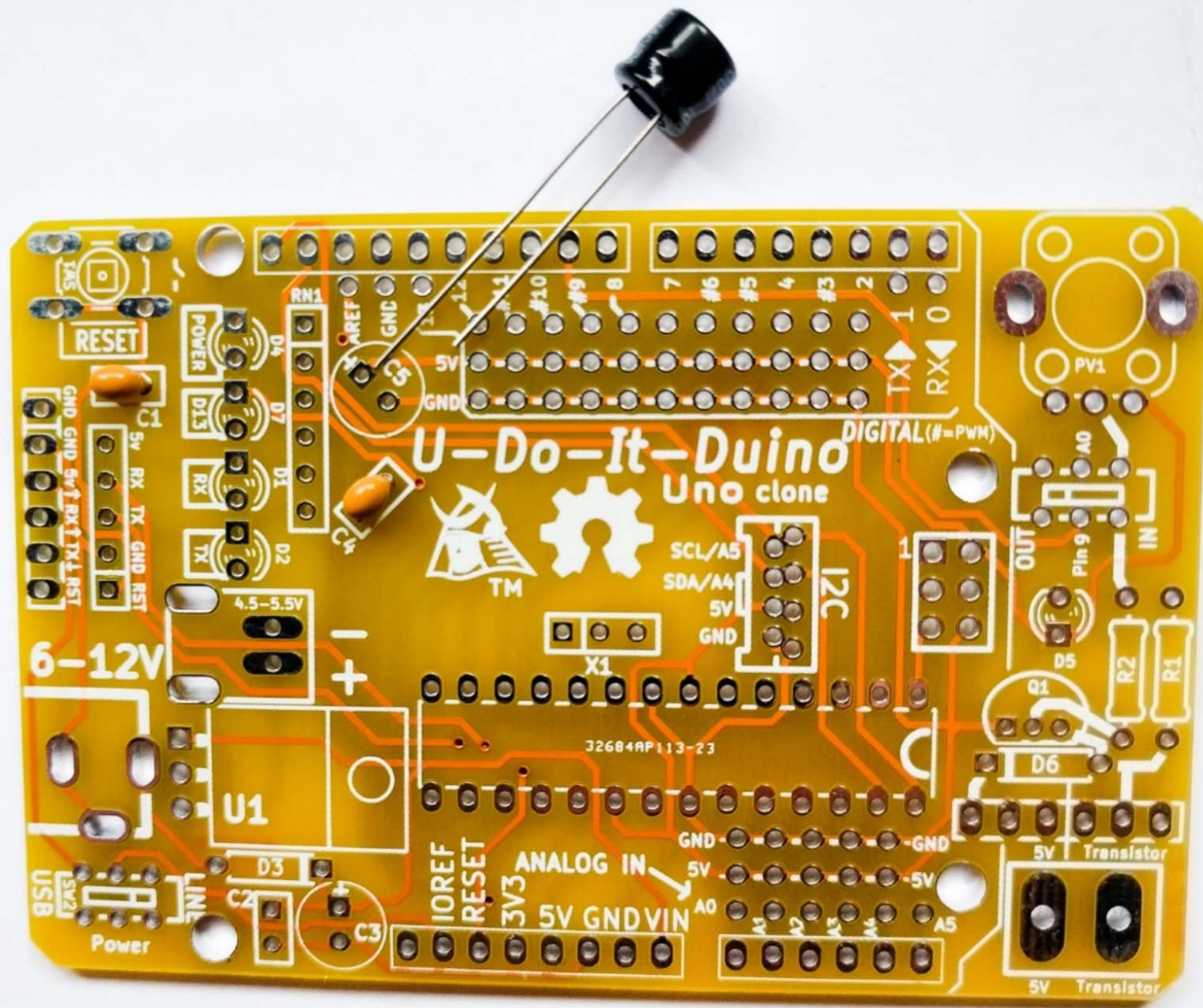
DIGITAL (#=PWM)

I2C  
SCL/A5  
SDA/A4  
5V  
GND

32684RP113-23

IOREF  
RESET  
3V3  
5V  
GND  
VIN

5V Transistor  
5V Transistor



U-Do-It-Duino  
Uno clone



6-12V

DIGITAL (#-PWM)

SCL/A5  
SDA/A4  
5V  
GND

I2C

32684AP113-23

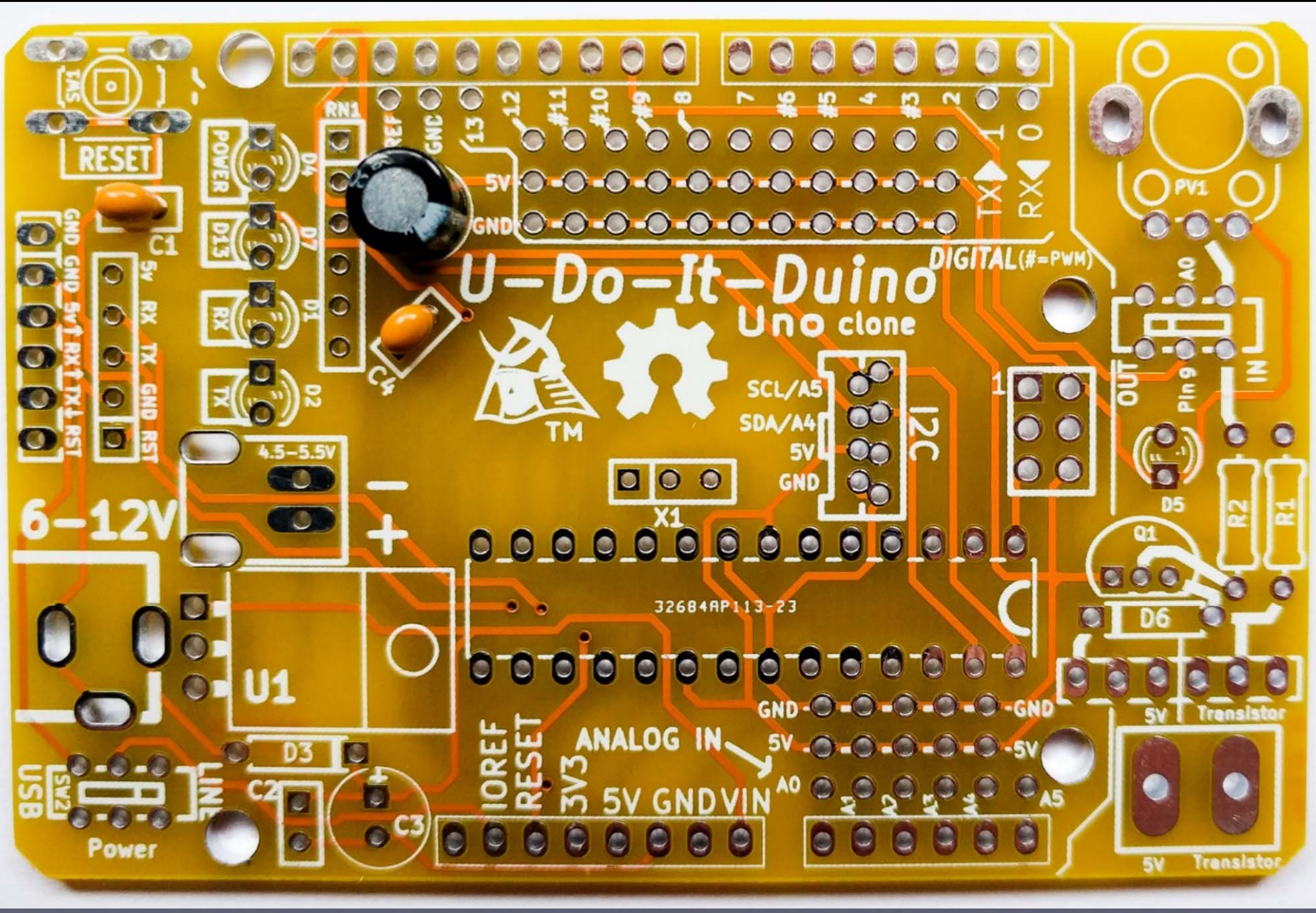
IOREF  
RESET  
3V3  
5V GND VIN

GND -5V -5V

5V Transistor

5V Transistor





U-Do-It-Duino  
Uno clone



32684RP113-23

6-12V

USB

Power

U1

IOREF  
RESET  
3V3

ANALOG IN  
5V GND VIN

SCL/A5  
SDA/A4  
5V  
GND

I2C

DIGITAL(#=PWM)

1

5V Transistor

5V Transistor

D6

Q1

R2

R1

D5

OUT

Pin 9

PV1

0

1

TX

RX

2

3

4

5

6

7

8

9

10

11

12

13

GND

REF

RN1

0

1

2

3

4

5

6

7

RESET

POWER

D13

RX

TX

D2

4.5-5.5V

+

0

D3

C2

C3

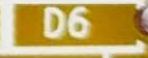
GND GND 5V RX TX GND RST  
5V RX TX GND RST

LINE

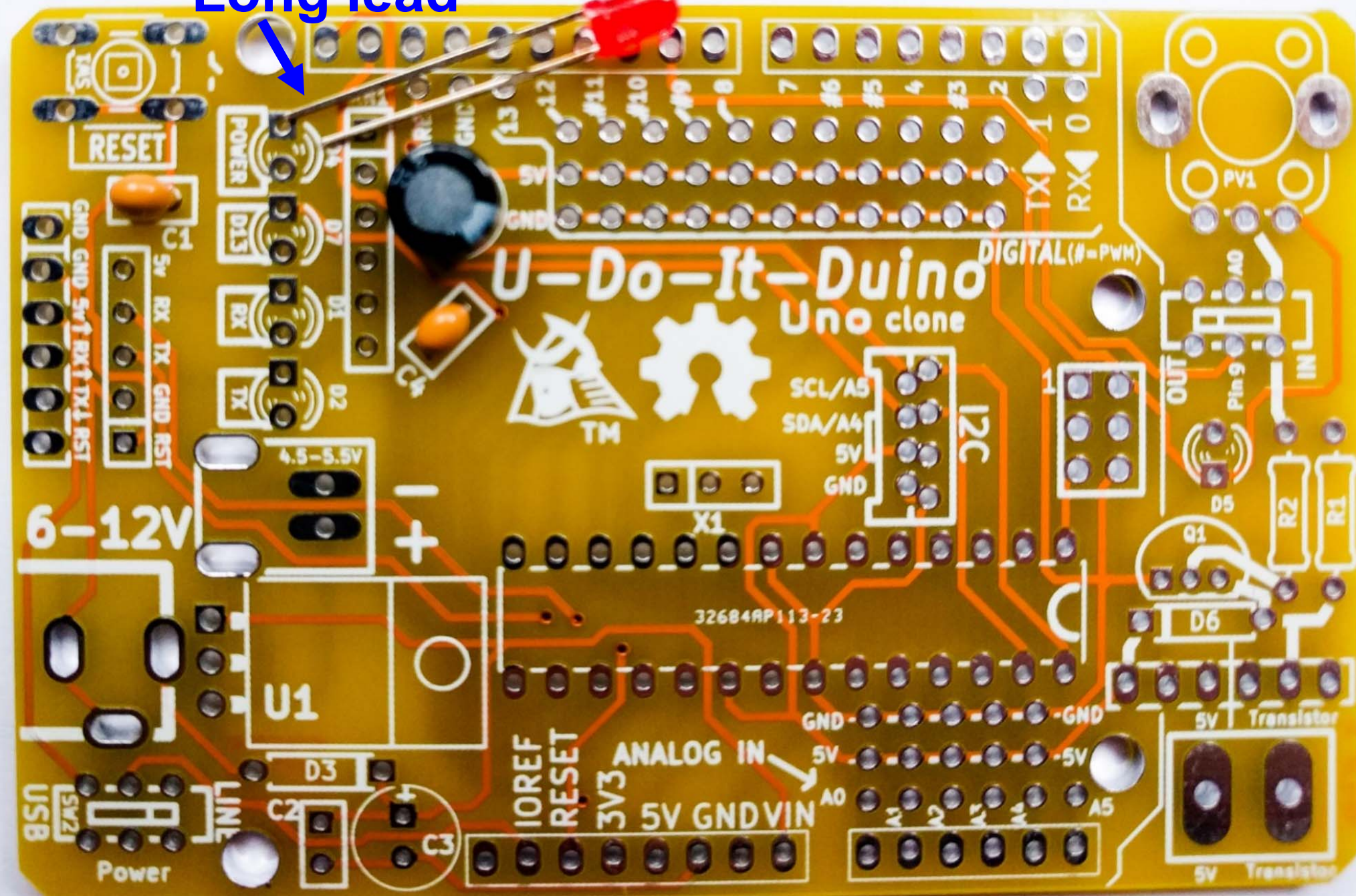
Power

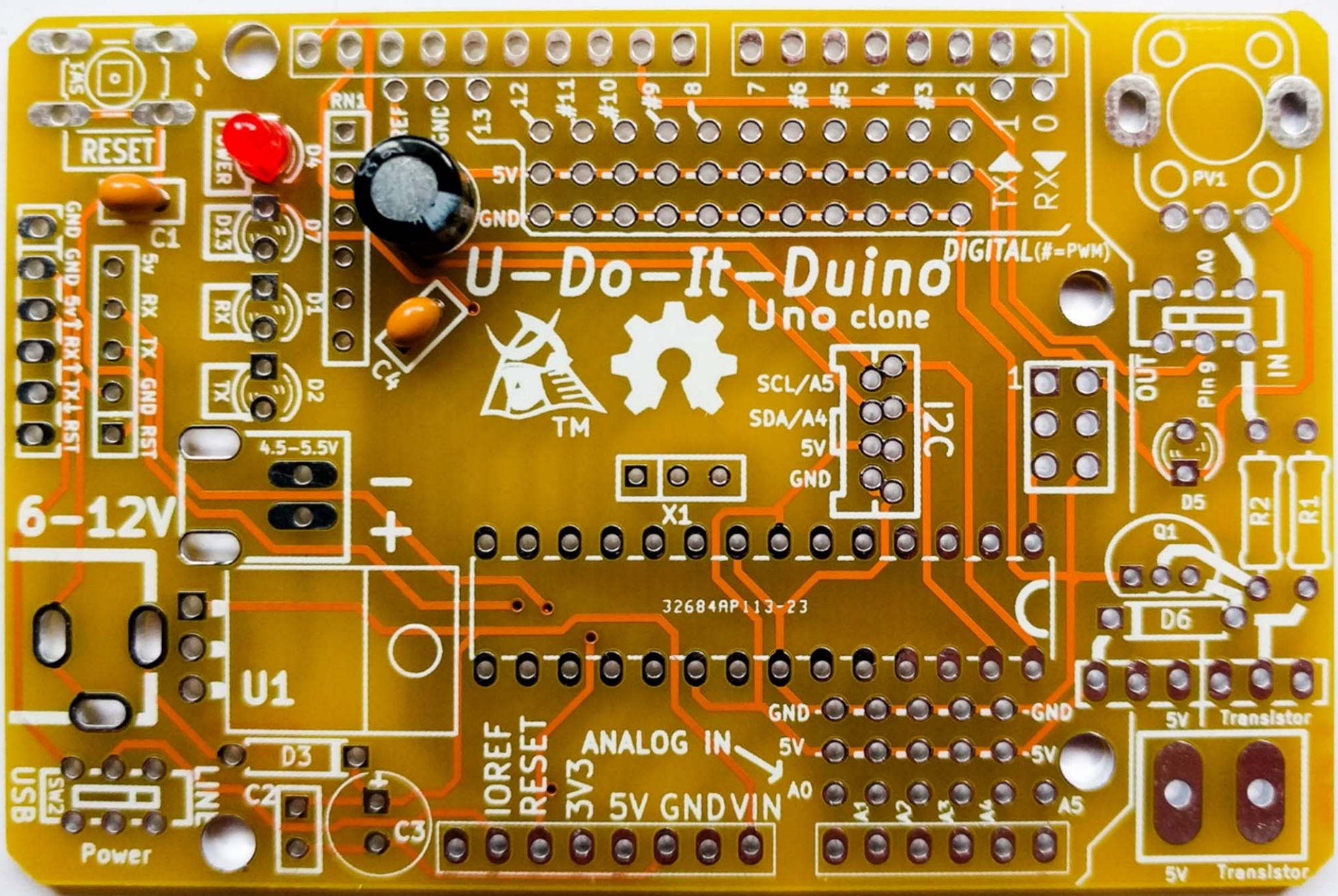
USB

SWZ1



Long lead





# U-Do-It-Duino

Uno clone



32684AP113-23

6-12V

U1

DIGITAL (#=PWM)

I2C

IOREF  
RESET  
3V3  
5V  
GND  
VIN

ANALOG IN

5V Transistor

5V Transistor

USB

Power

RESET

POWER

D13

RX

TX

4.5-5.5V

D3

LINE

C3

RN1

REF

GND

13

12

#11

#10

#9

8

7

#6

#5

4

#3

2

1

TX

RX

PV1

A0

Pin 9

OUT

D5

D6

5V

5V

IN

R2

R1

5V

5V

SCL/A5

SDA/A4

5V

GND

X1

GND

GND

5V

5V

A0

A1

A2

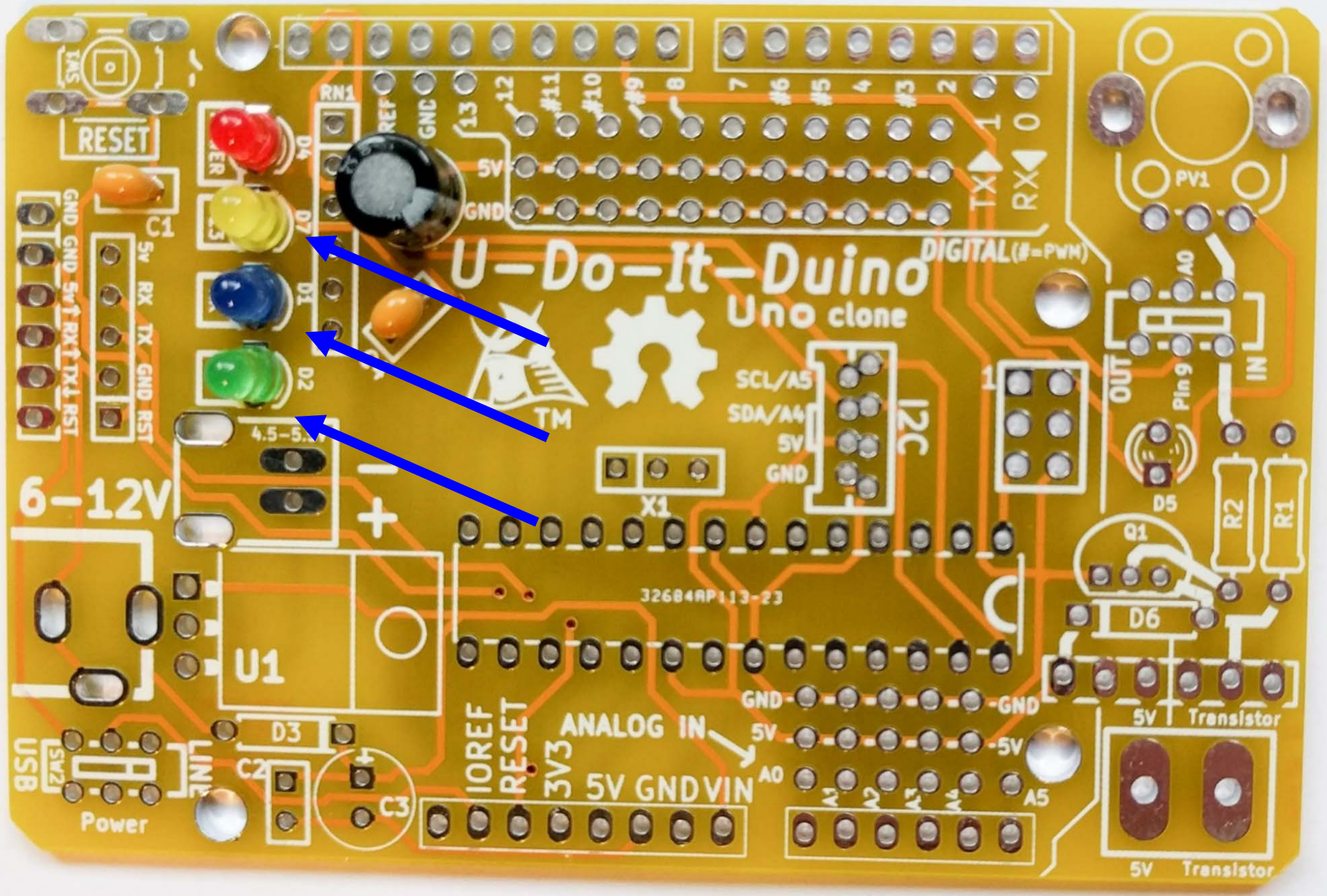
A3

A4

A5

5V

5V



U-Do-It-Duino  
Uno clone

6-12V

U1

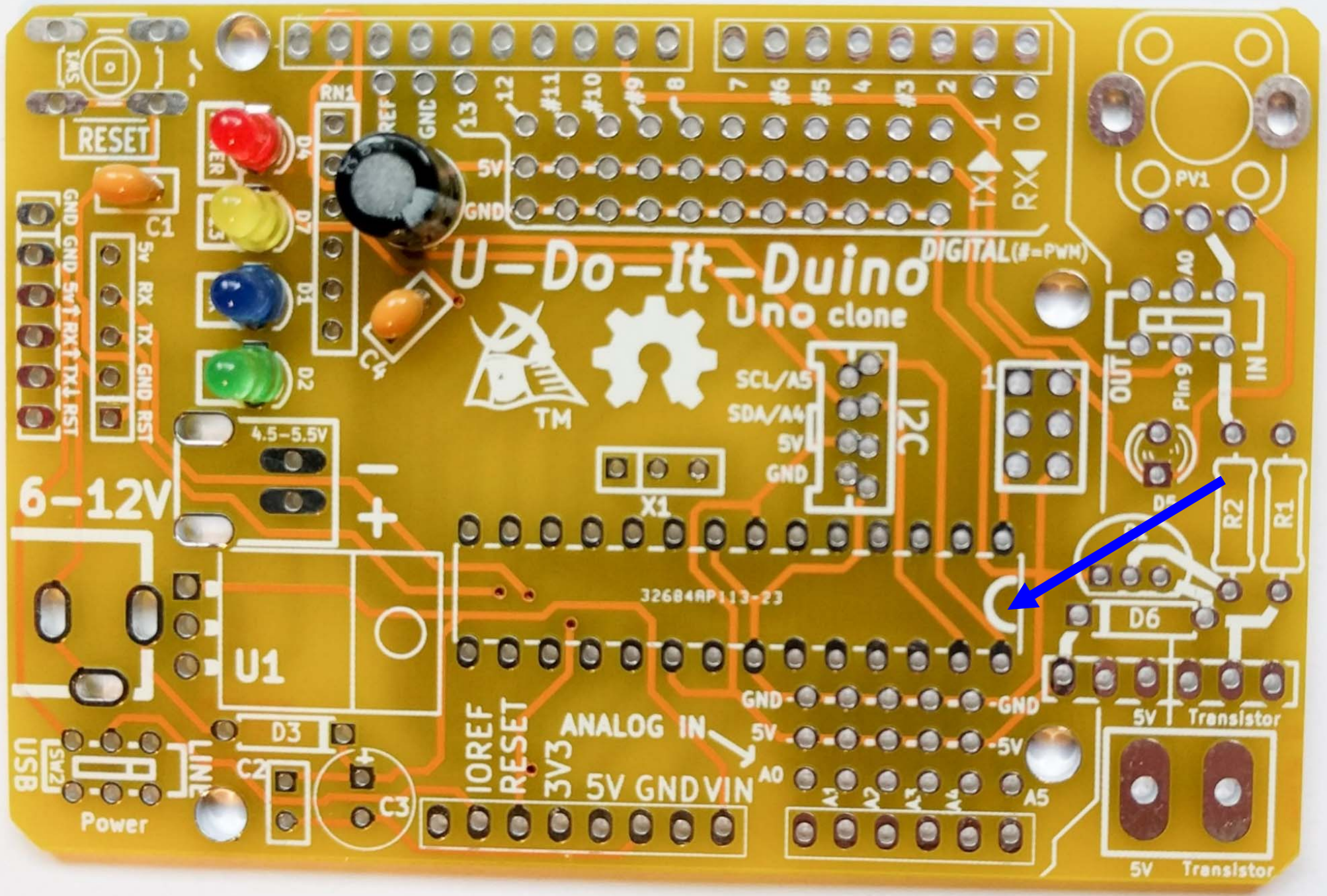
IOREF  
RESET  
3V3  
5V GND VIN

SCL/A5  
SDA/A4  
5V  
GND

DIGITAL (#=PWM)

5V Transistor





U-Do-It-Duino  
Uno clone



SCL/A5  
SDA/A4  
5V  
GND

DIGITAL (#=PWM)

I2C

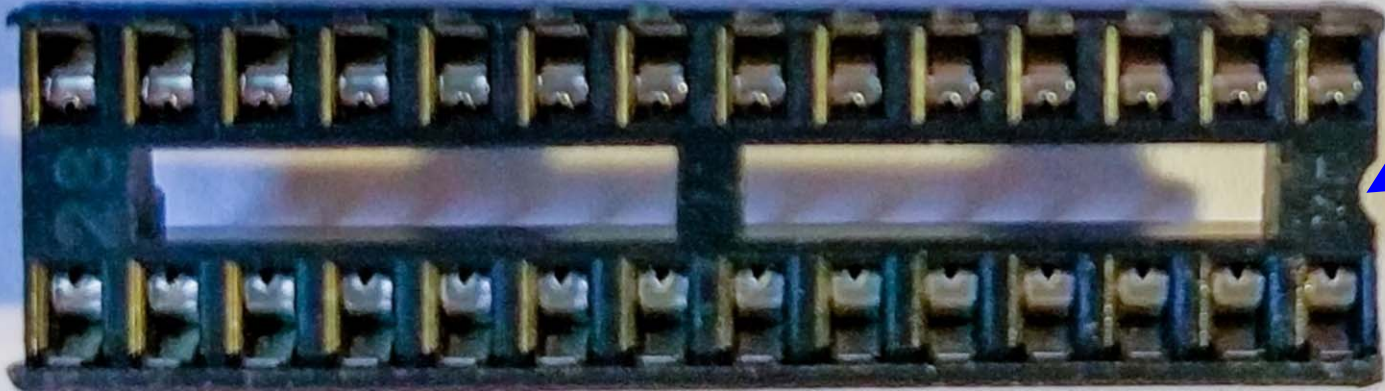
32684RP113-23

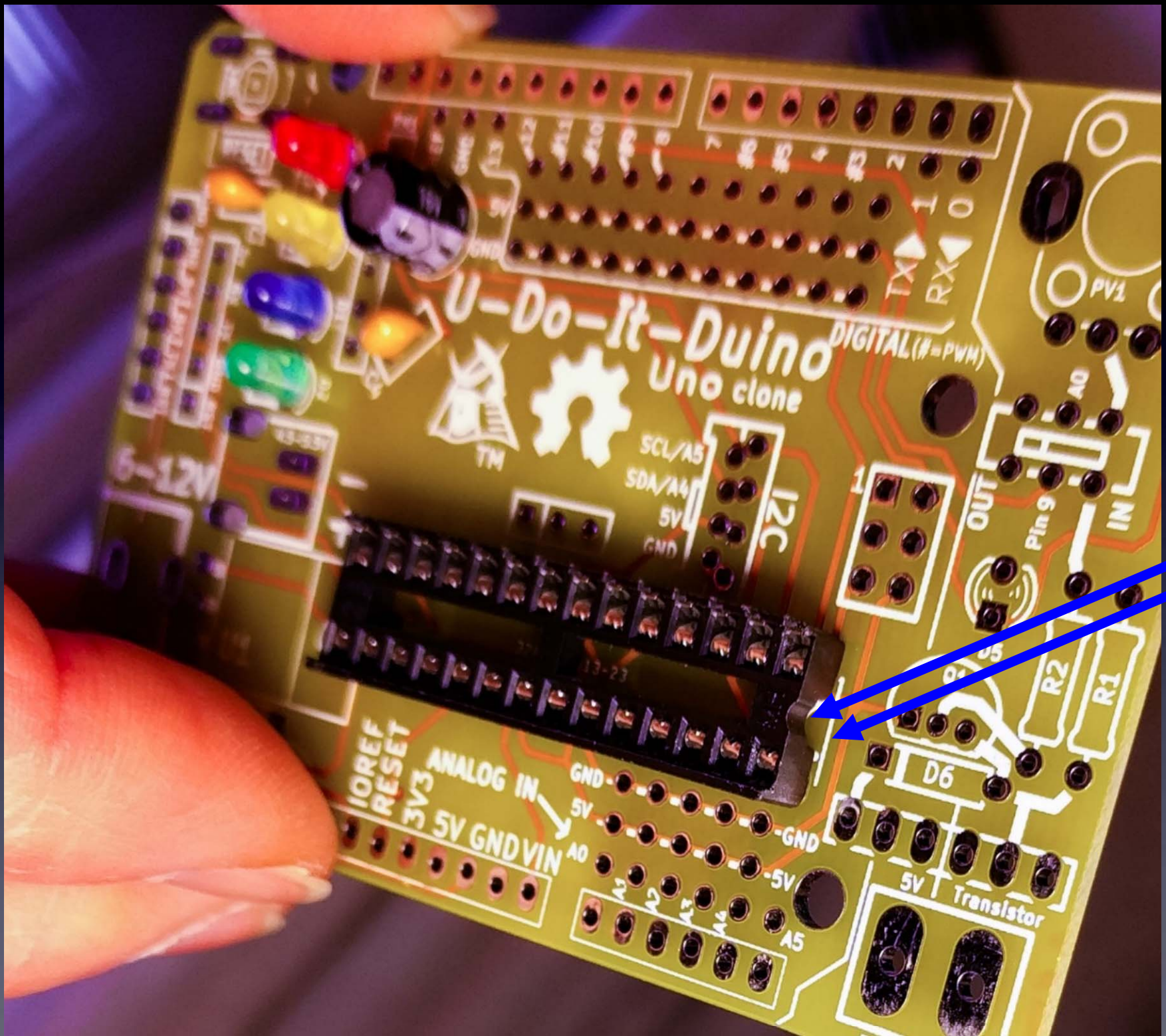
IOREF  
RESET  
3V3  
5V GND VIN

5V Transistor

5V Transistor







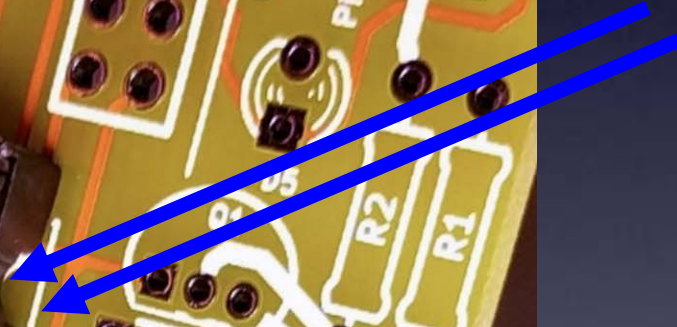
U-Do-It-Duino  
Uno clone

DIGITAL (#-PWM)

I2C  
SCL/A5  
SDA/A4  
5V  
GND

IOREF  
RESET  
3V3  
ANALOG IN  
5V  
GND  
VIN

Transistor

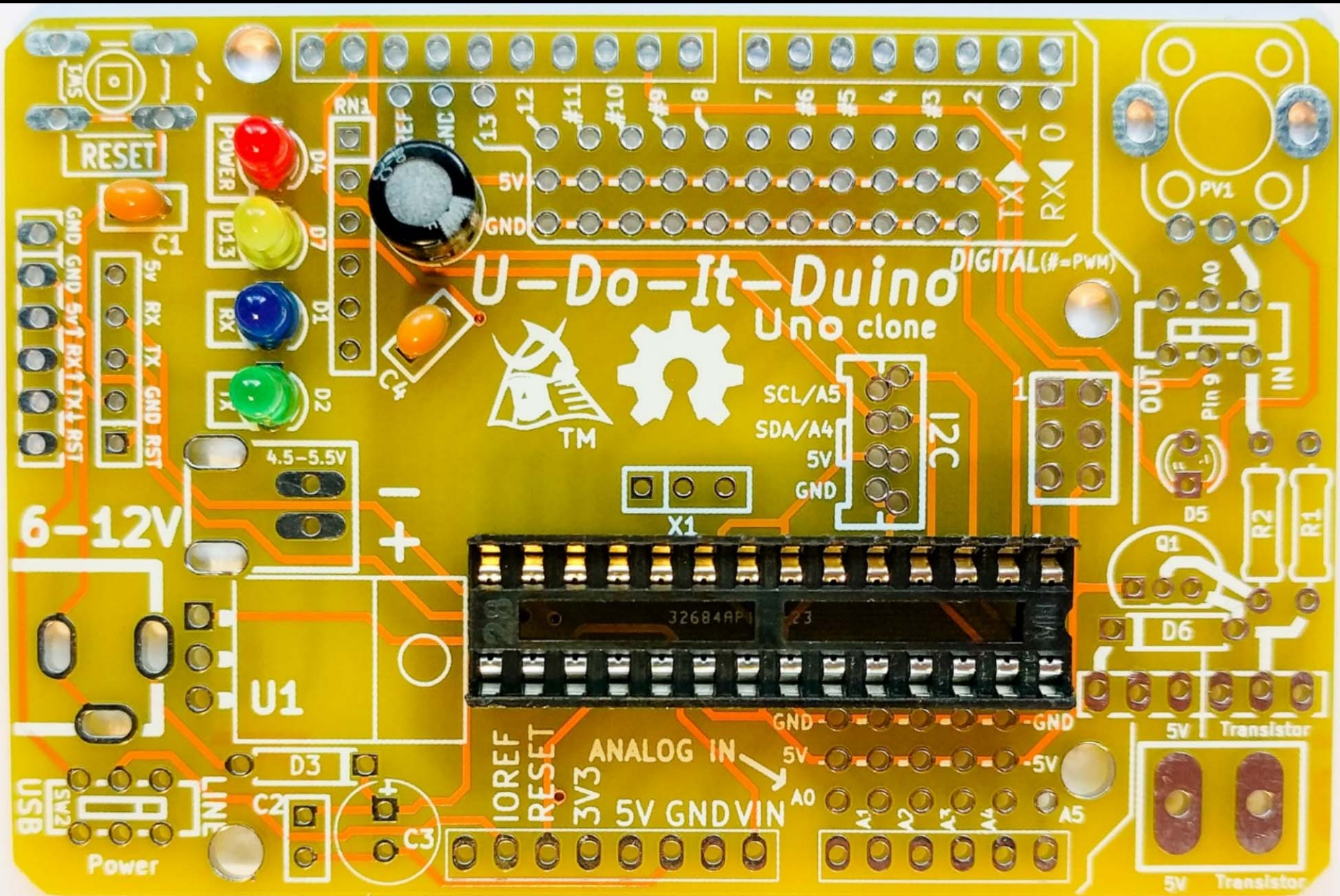


# Bend pins down on two opposite corners



- Solder all 28 pins.
- Only need to clean the tip after it gets dirty.
- No need to cut the pins short after soldering.





U-Do-It-Duino  
Uno clone



6-12V

Power  
USB

IOREF  
RESET  
3V3  
5V GND VIN

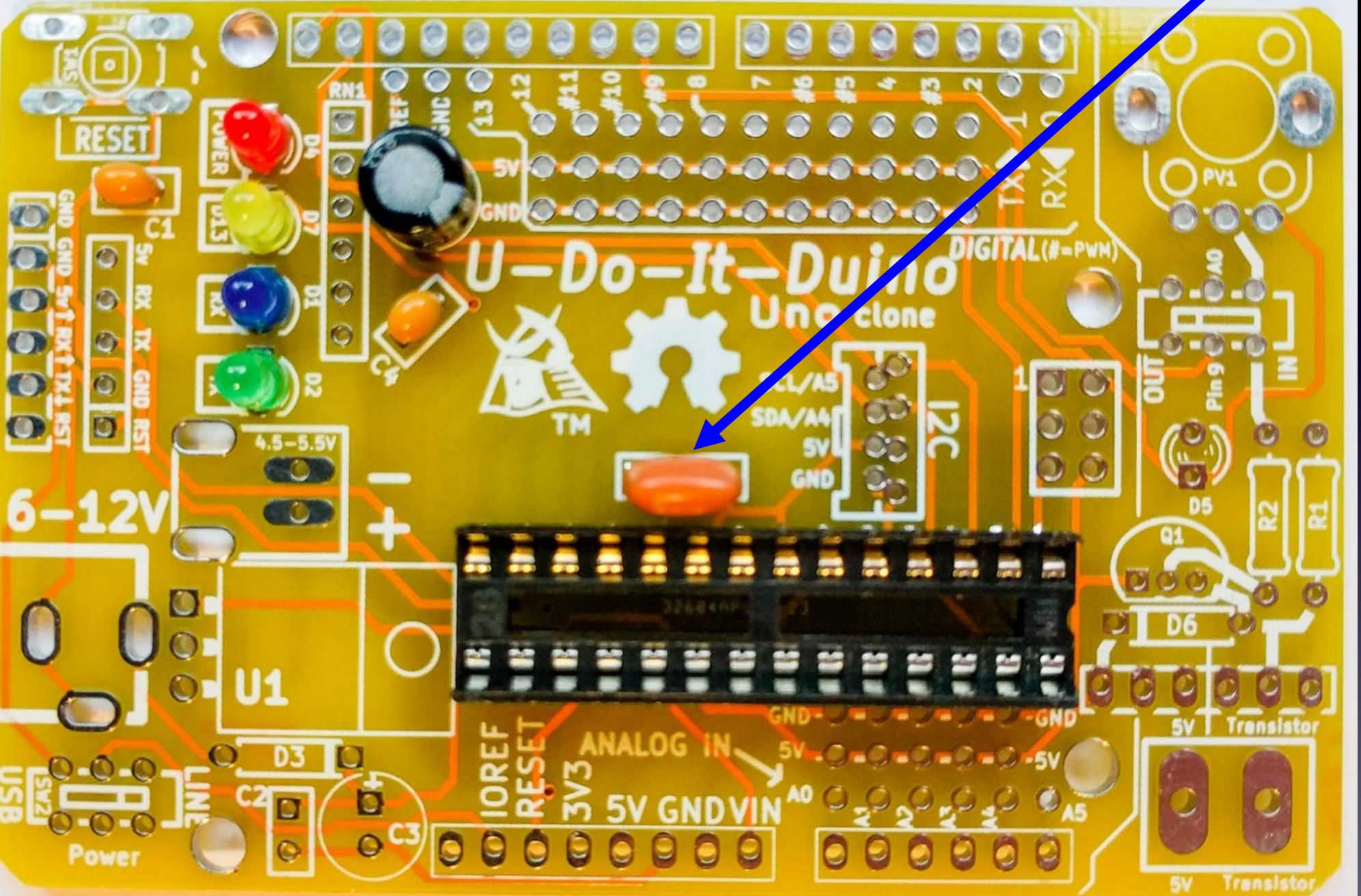
SCL/A5  
SDA/A4  
5V  
GND

I2C

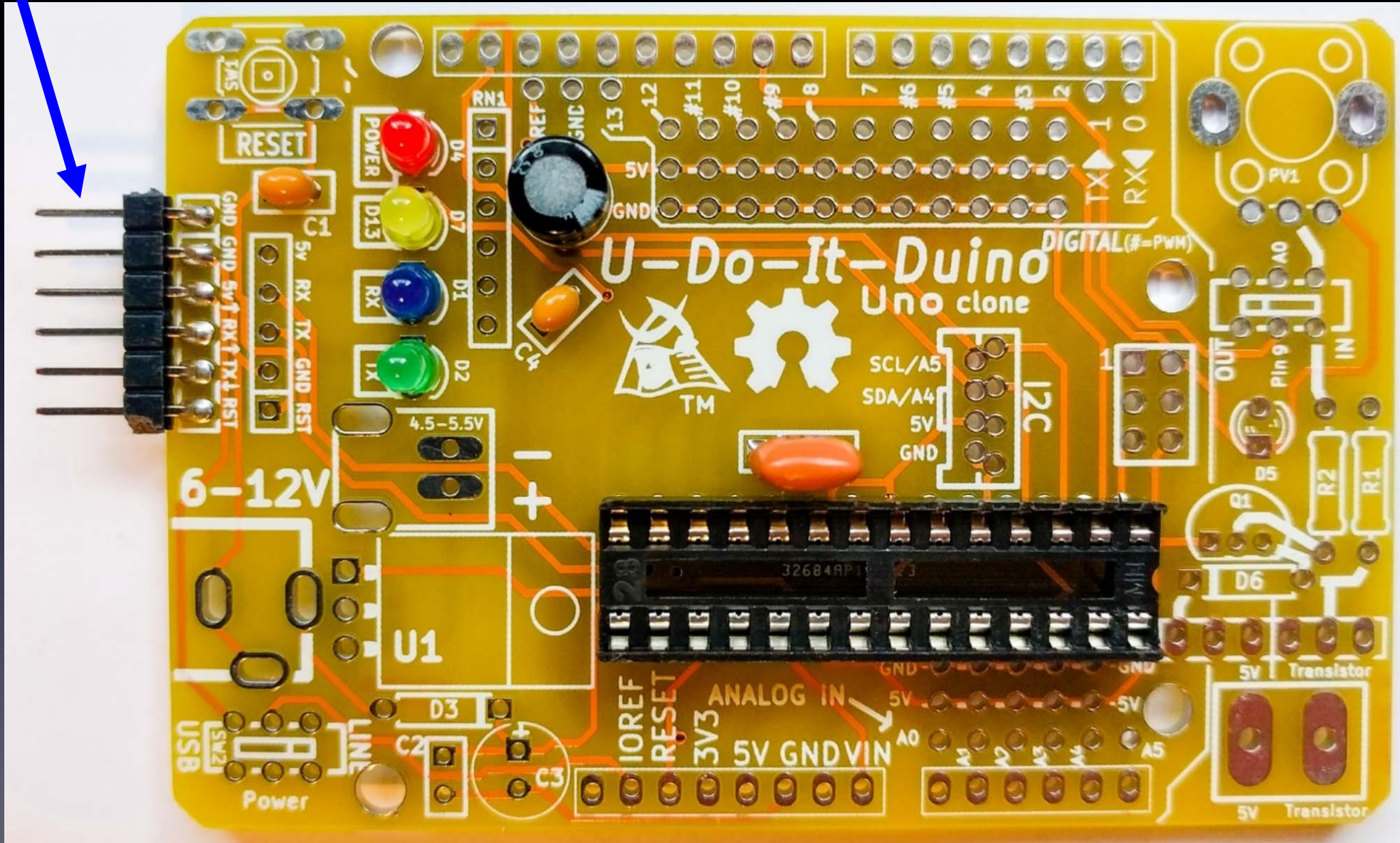
DIGITAL (#=PWM)

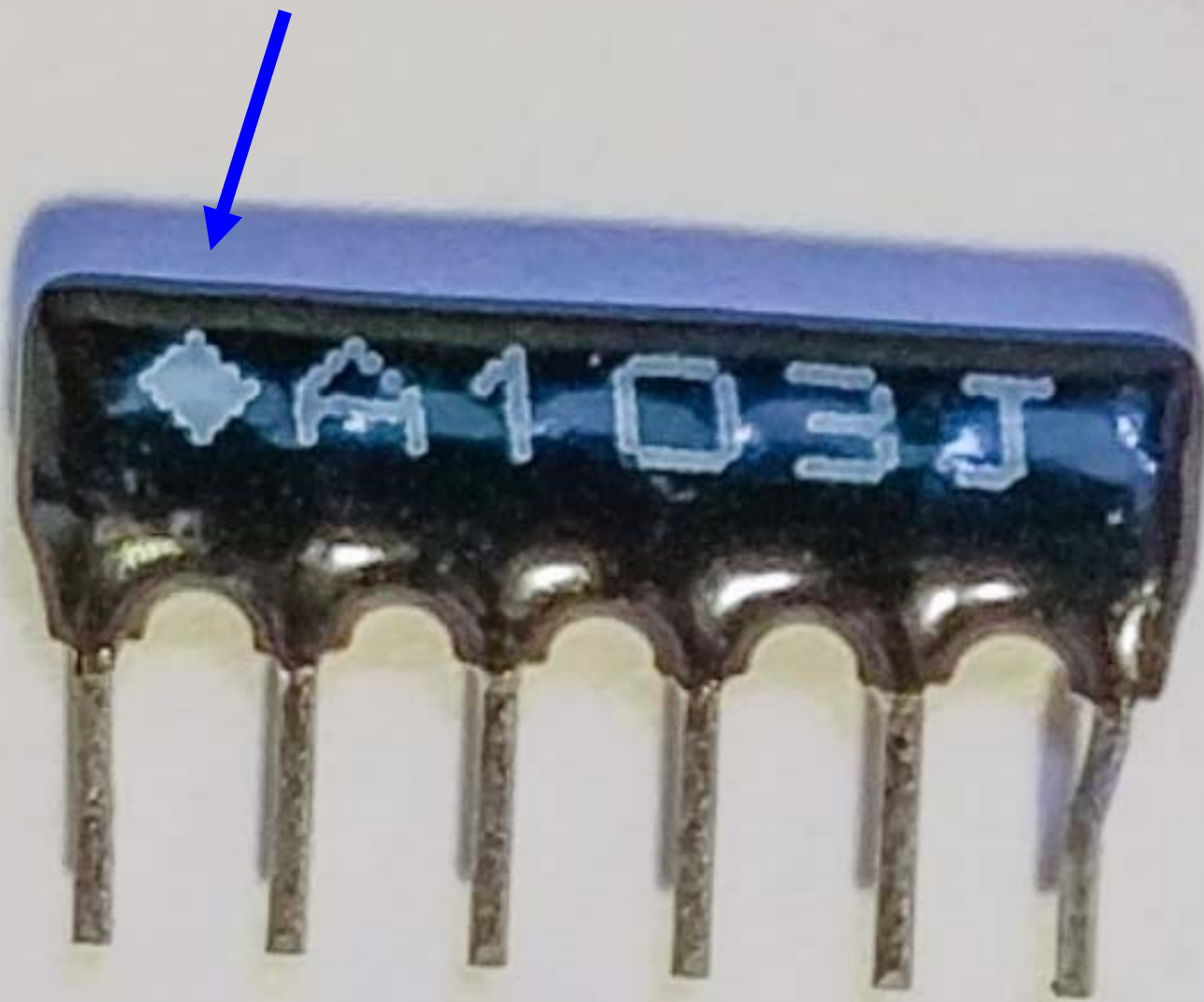
5V Transistor

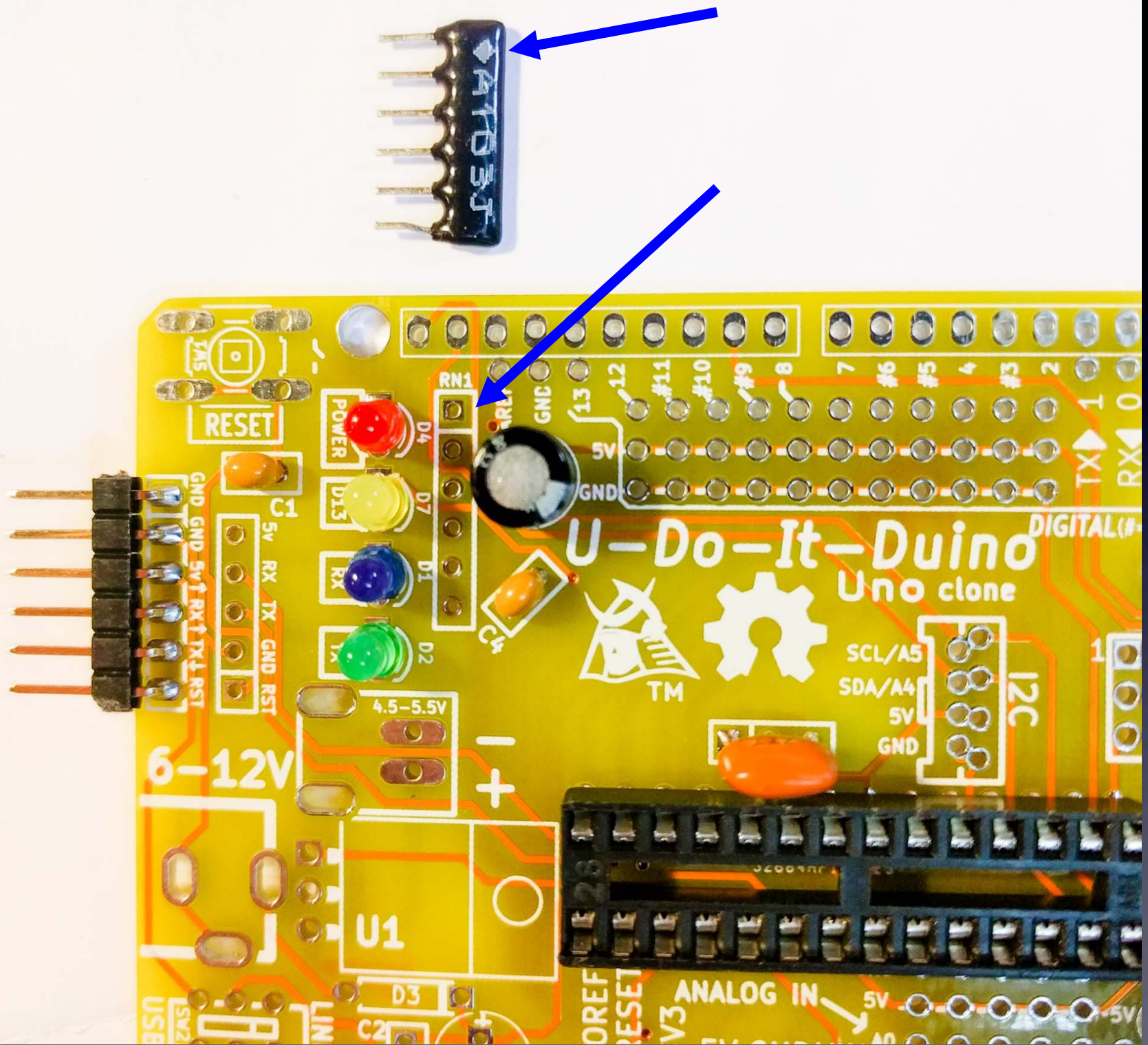
5V Transistor

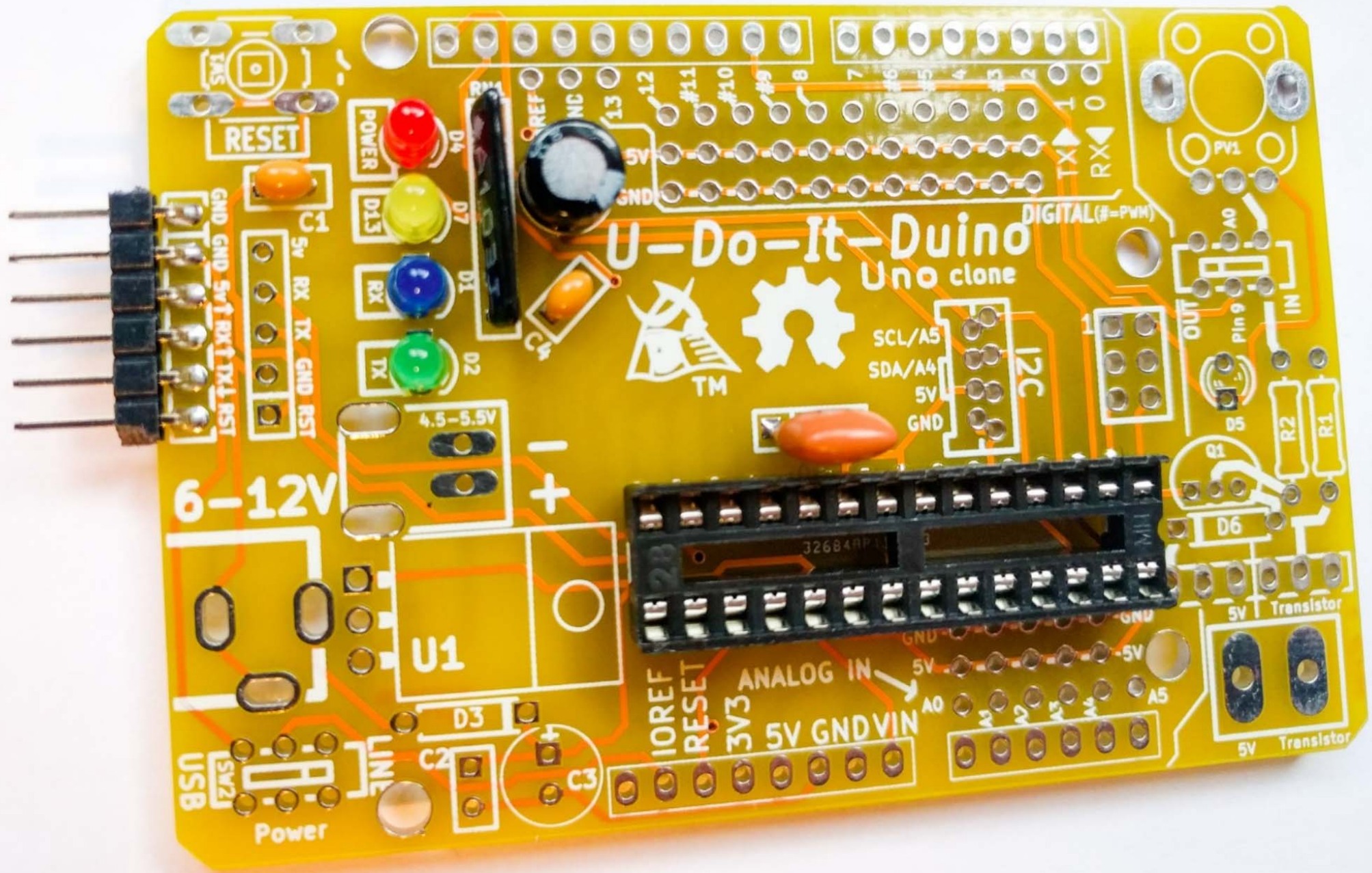


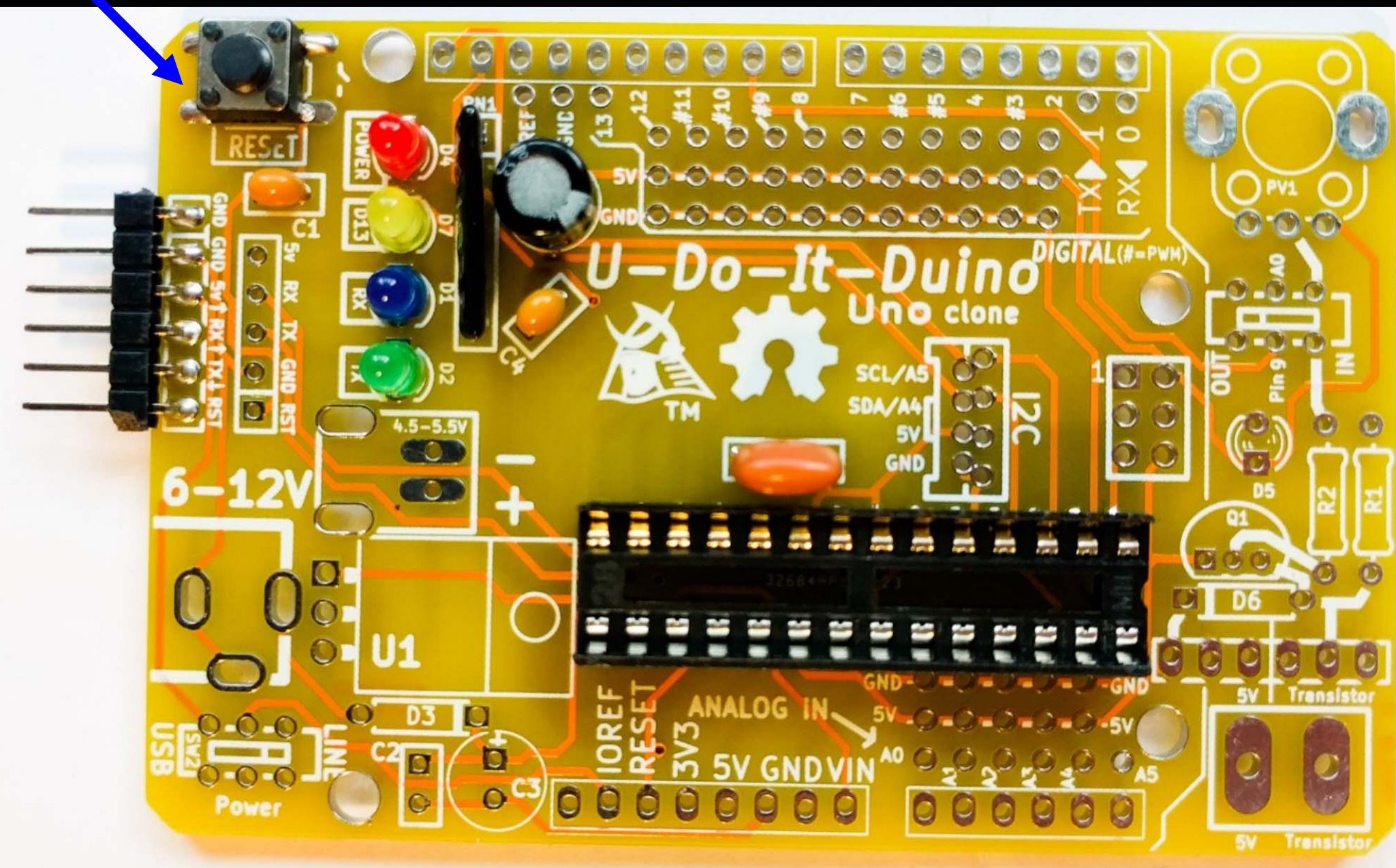
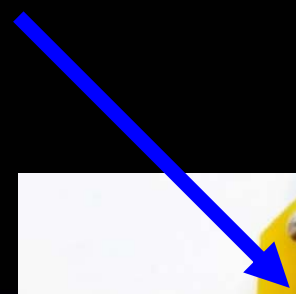
Solder on top of board if it falls out upside down



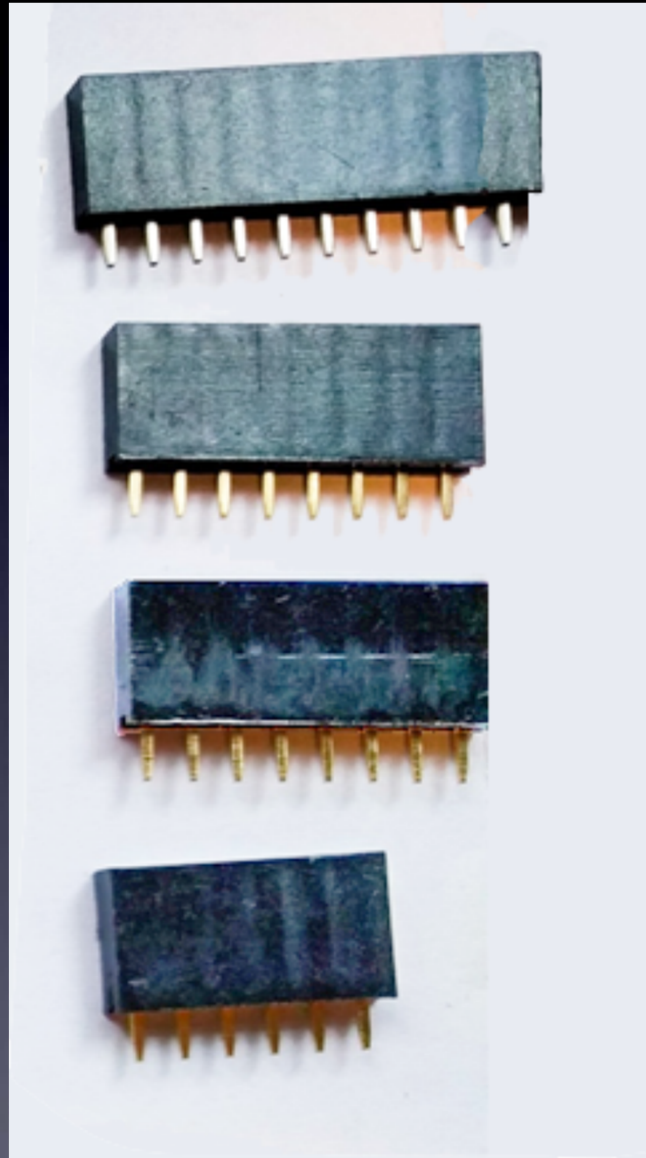






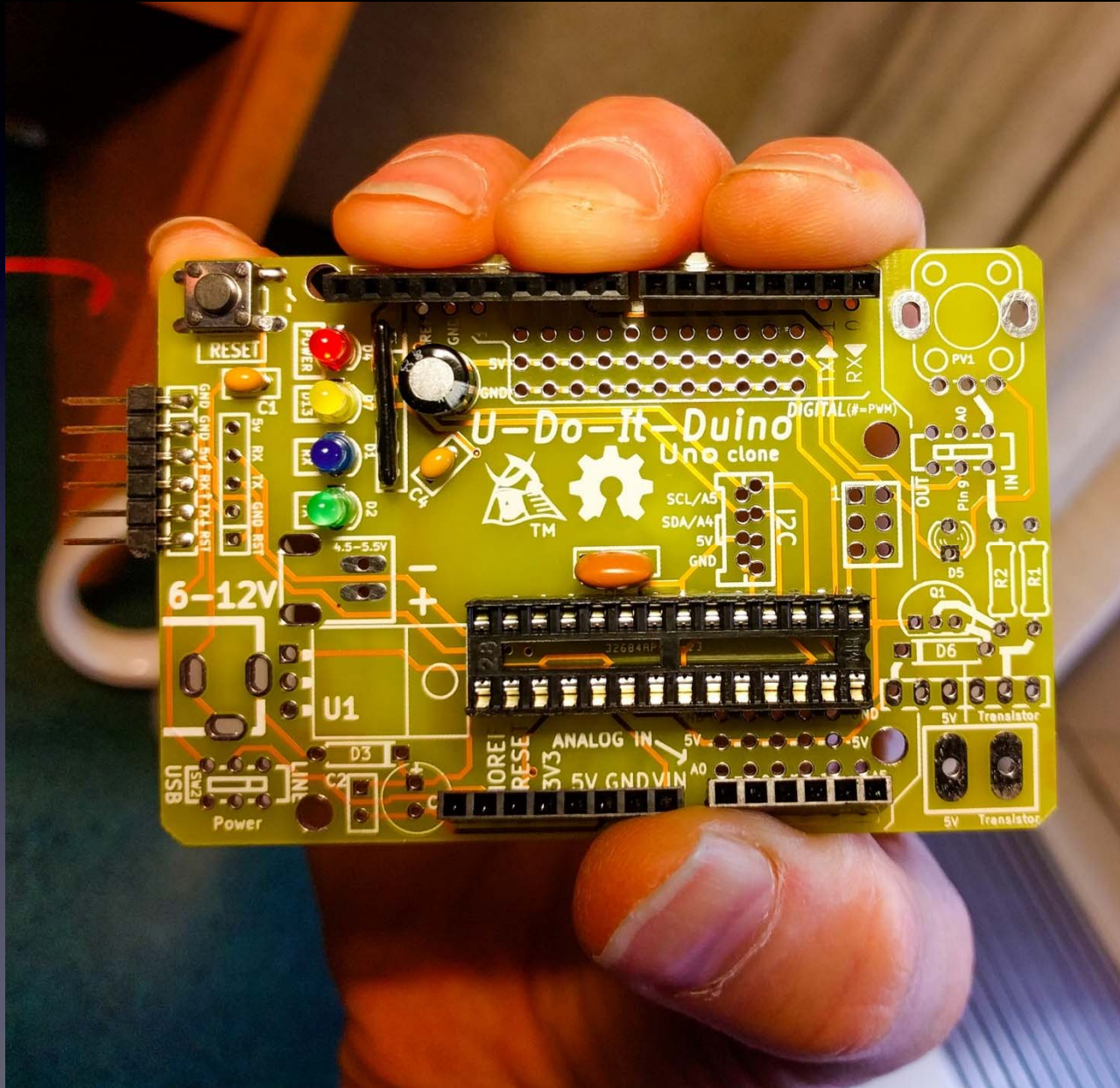


# Headers

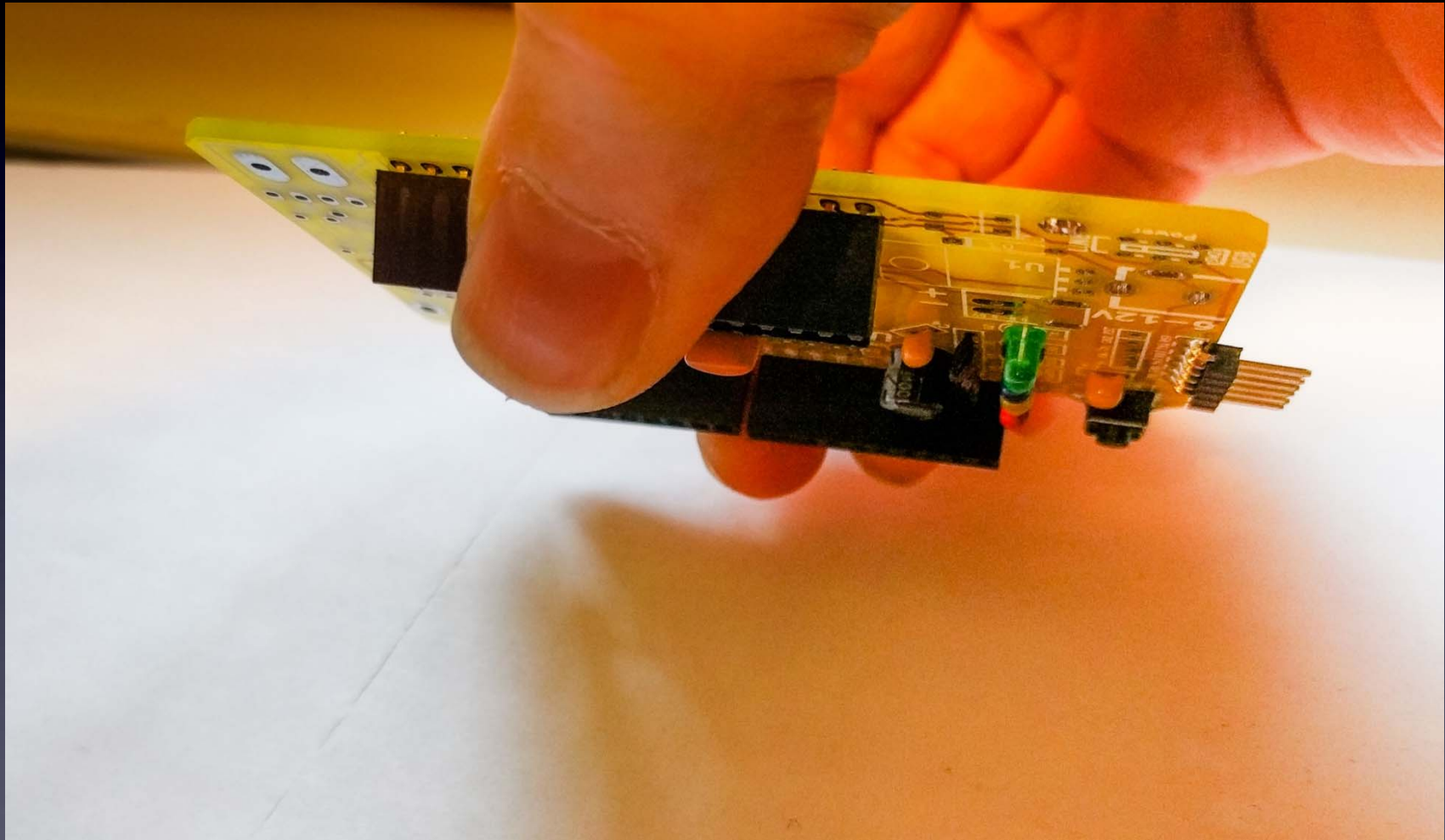




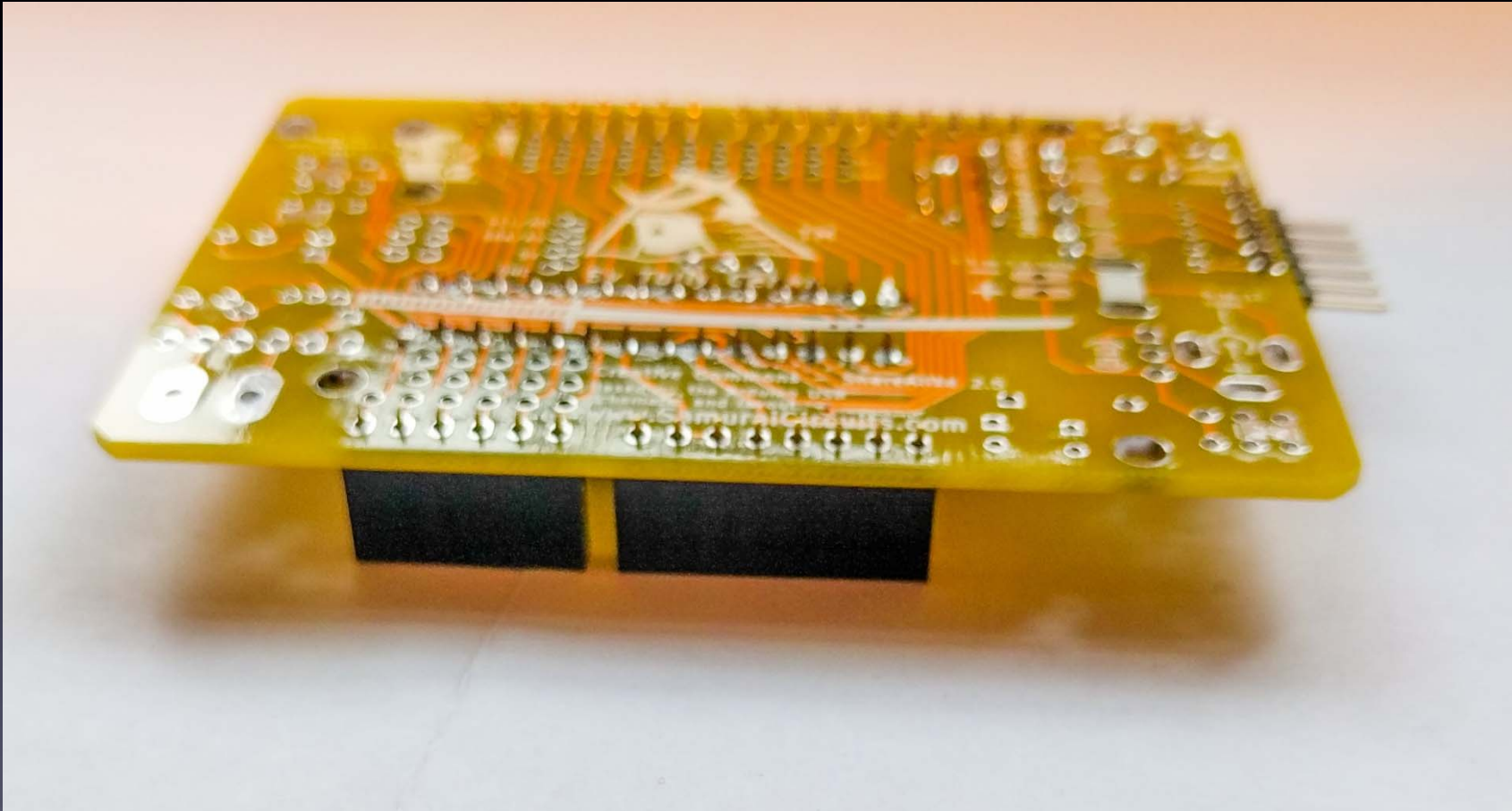
# Headers

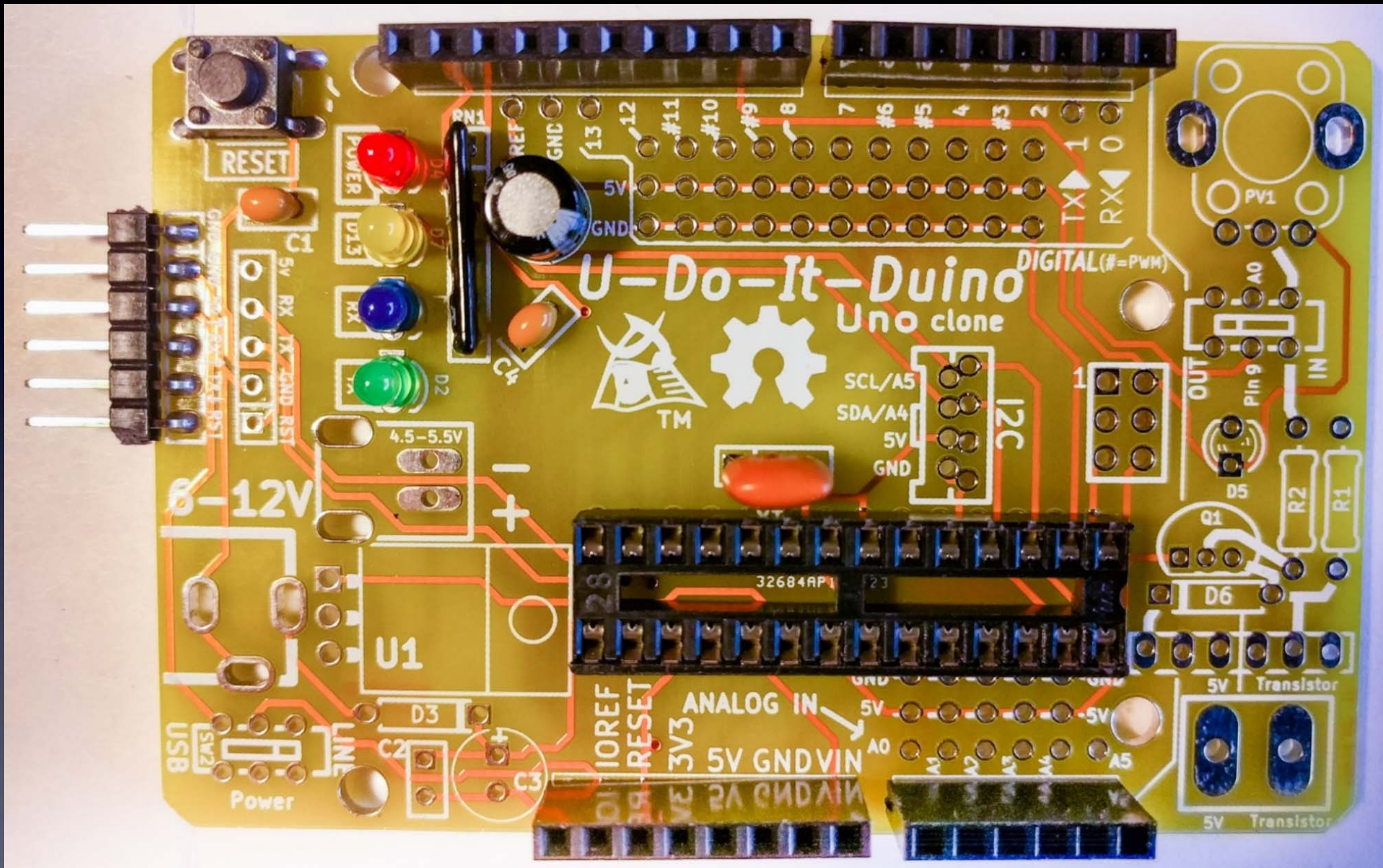


# Headers

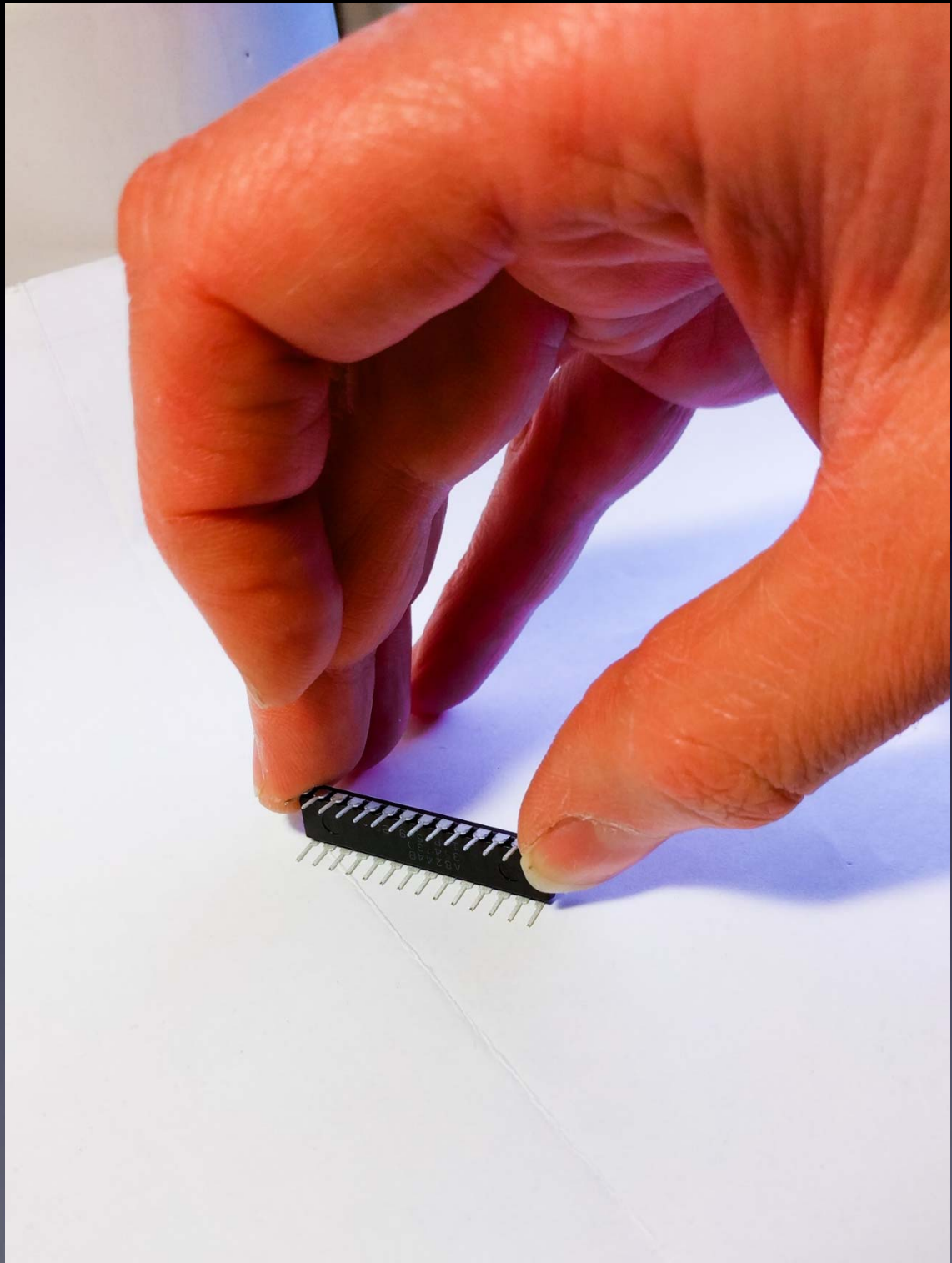


# Headers

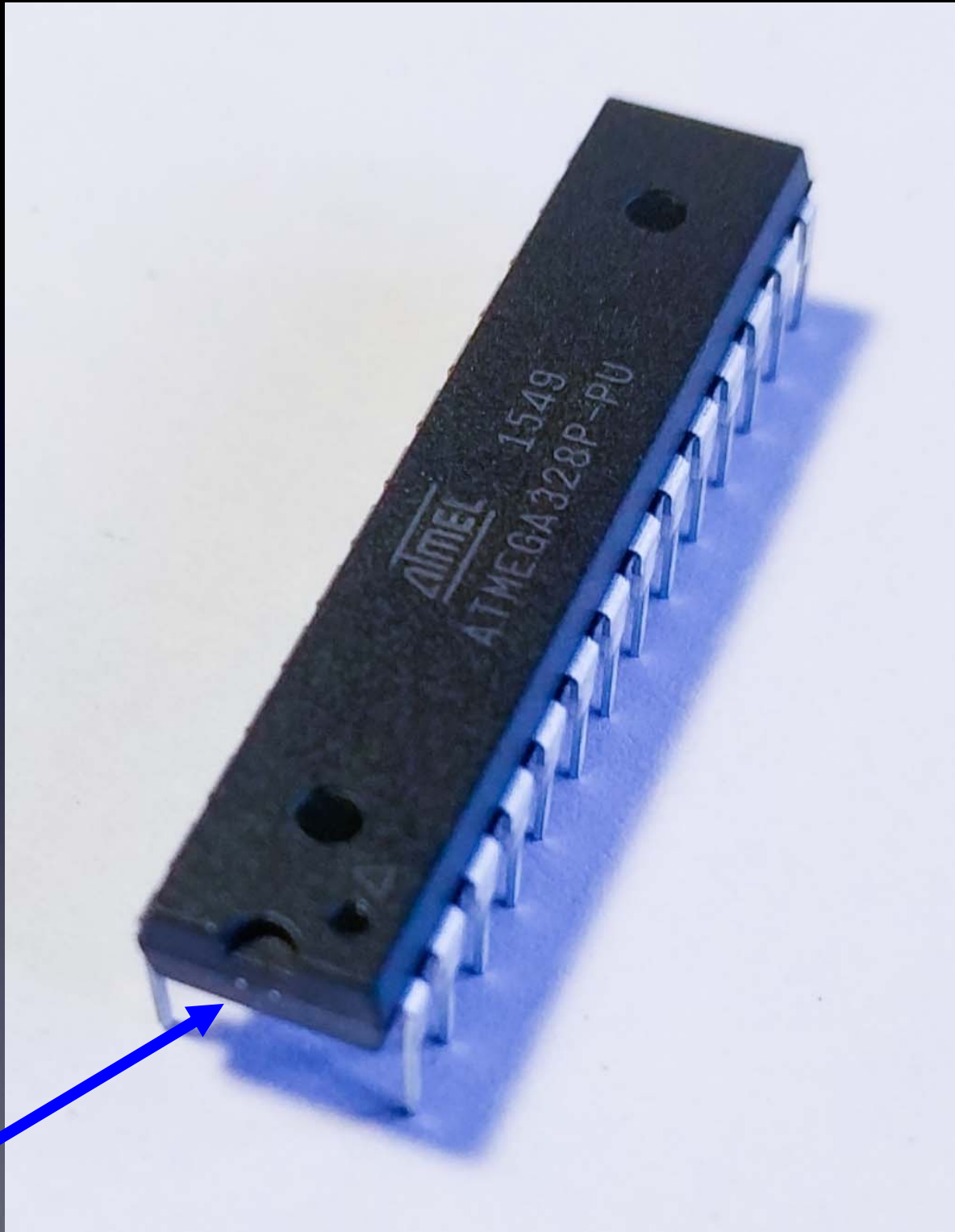






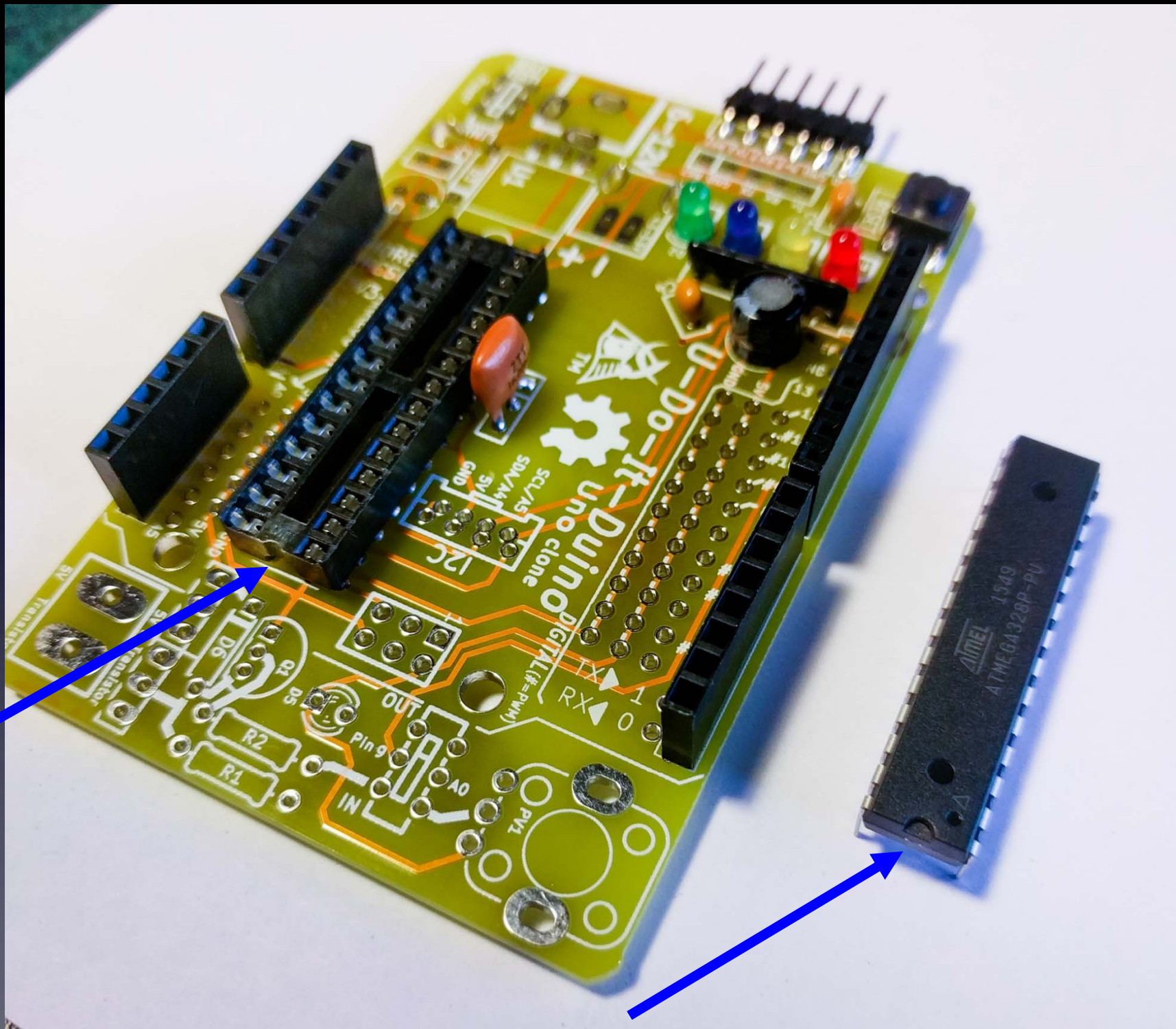




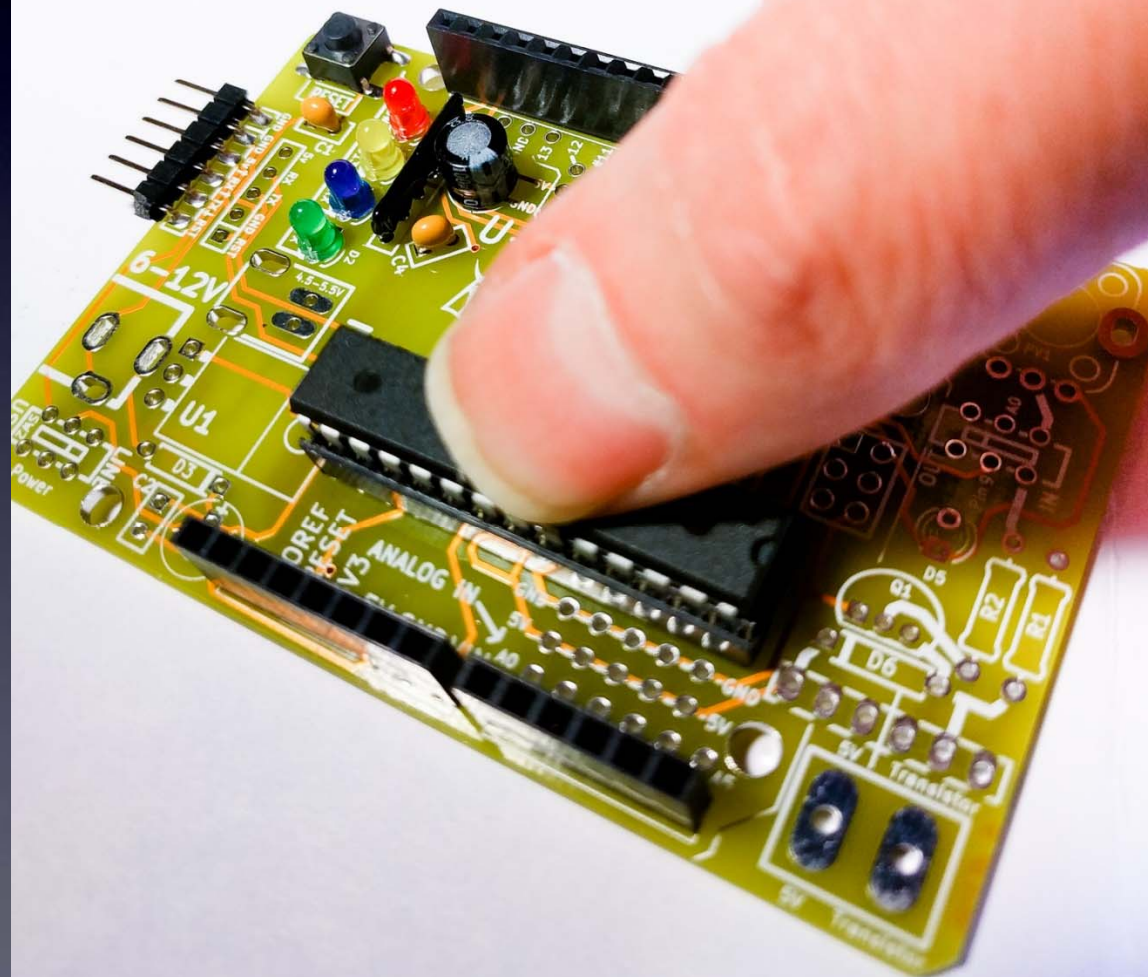


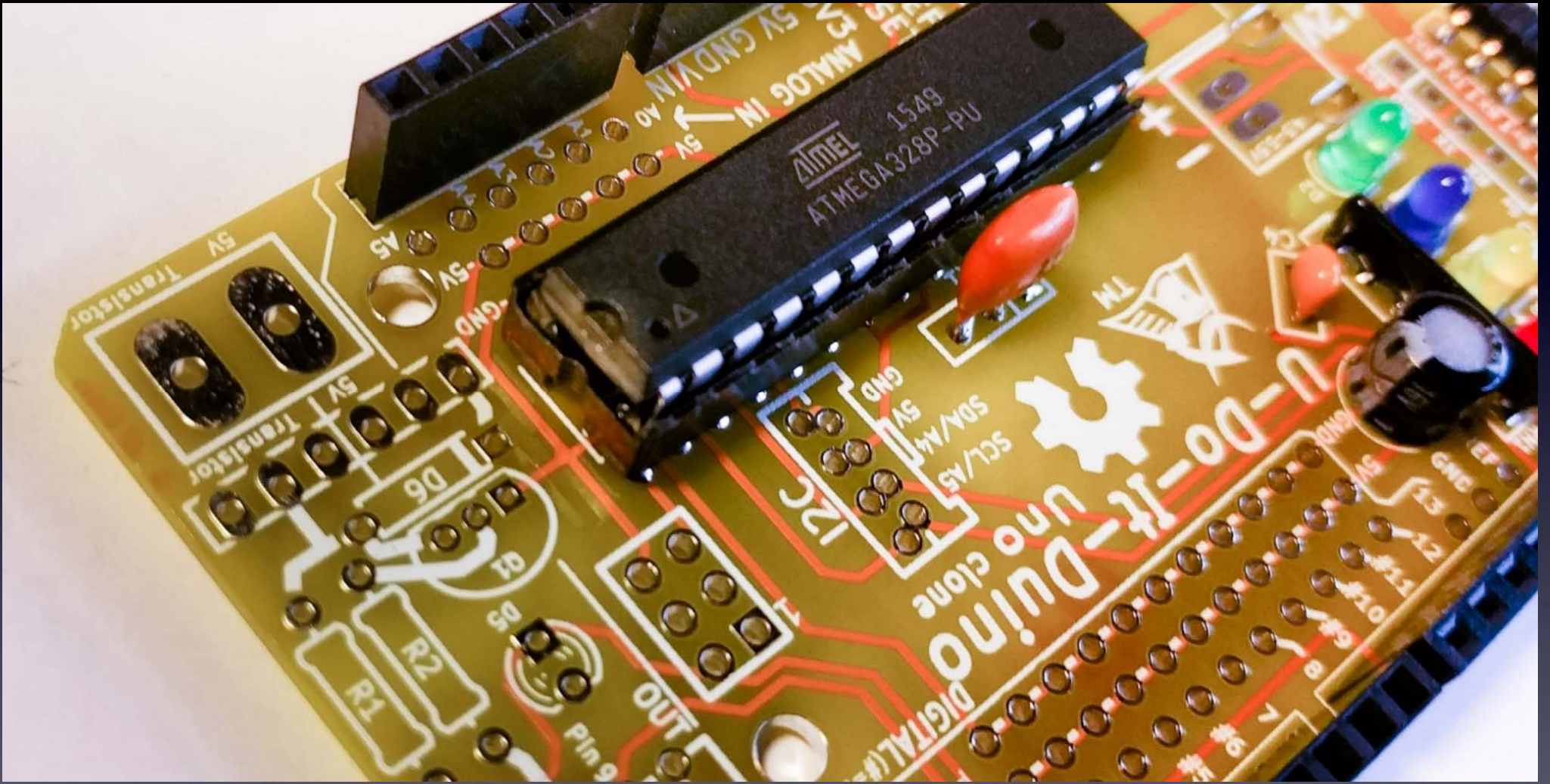
ATMEL  
ATMEGA328P-PU  
1549



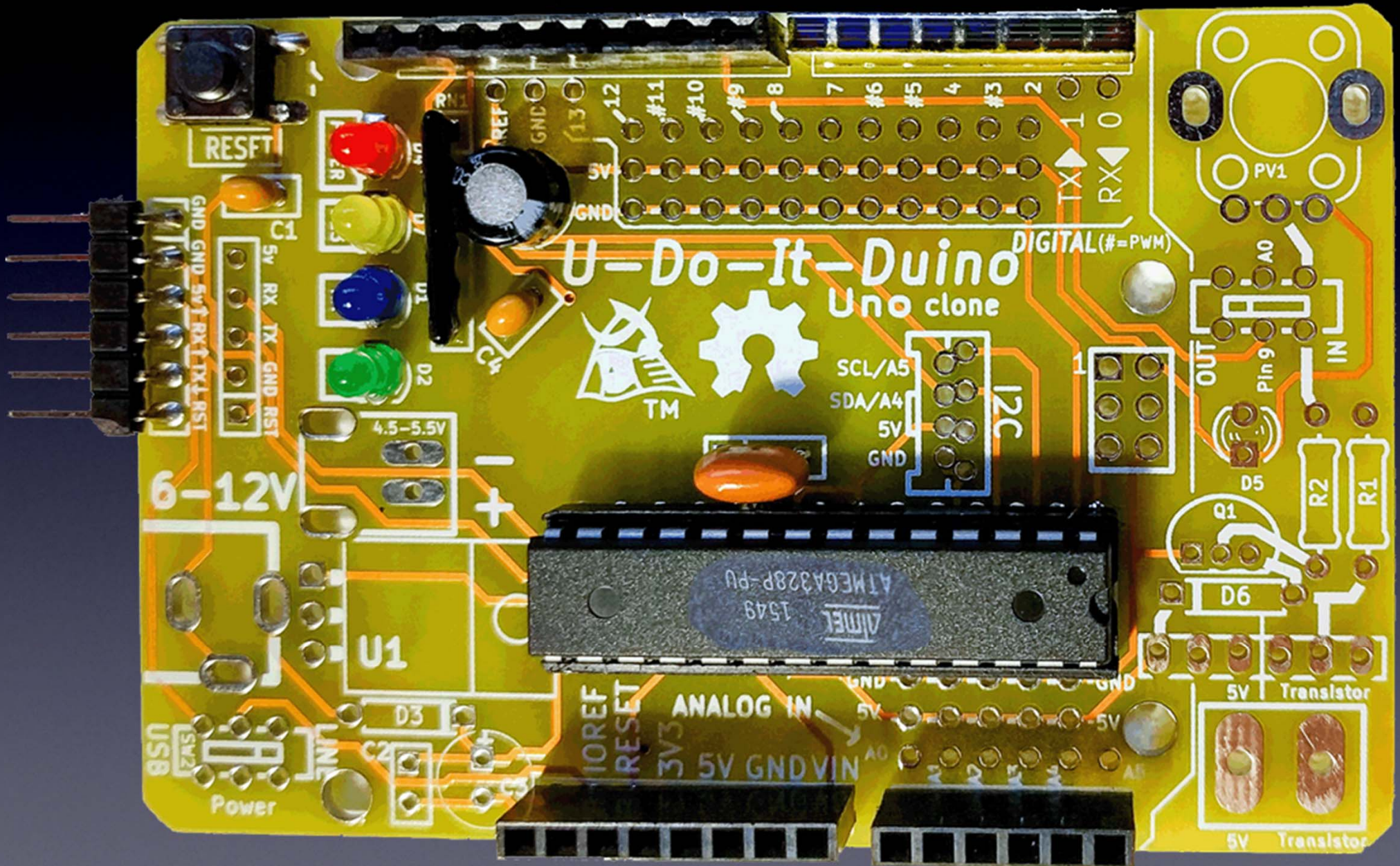


**Use both thumbs  
to push chip  
into socket**

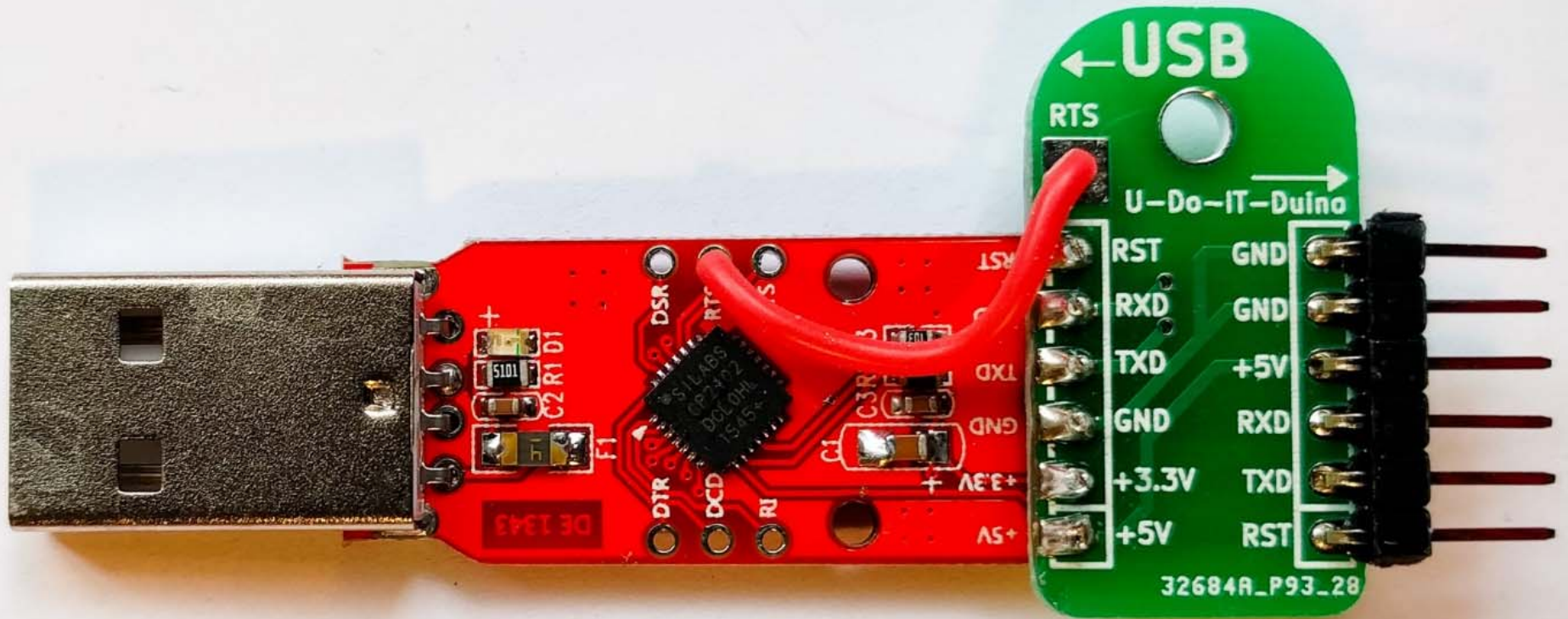




We're done!



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

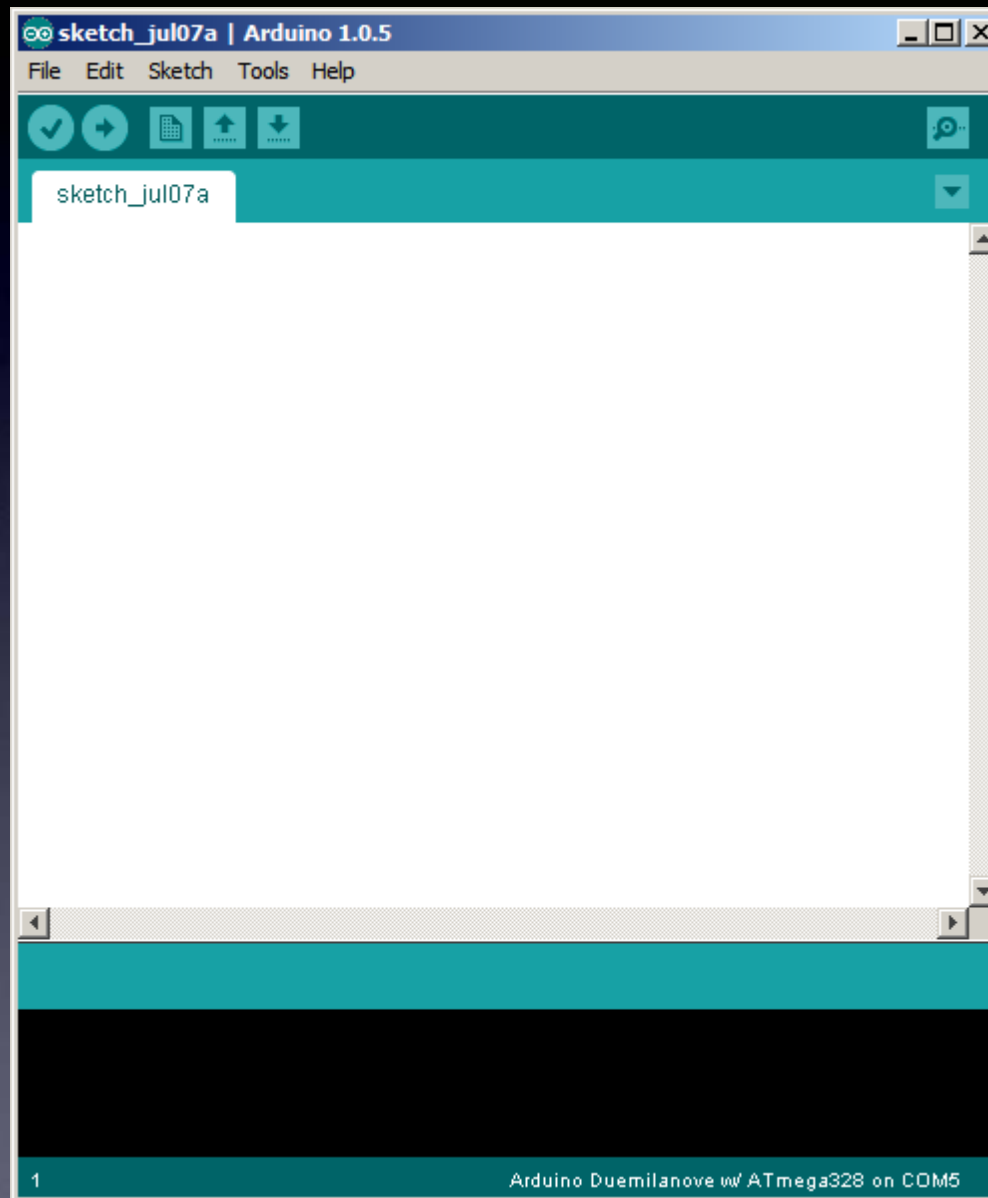




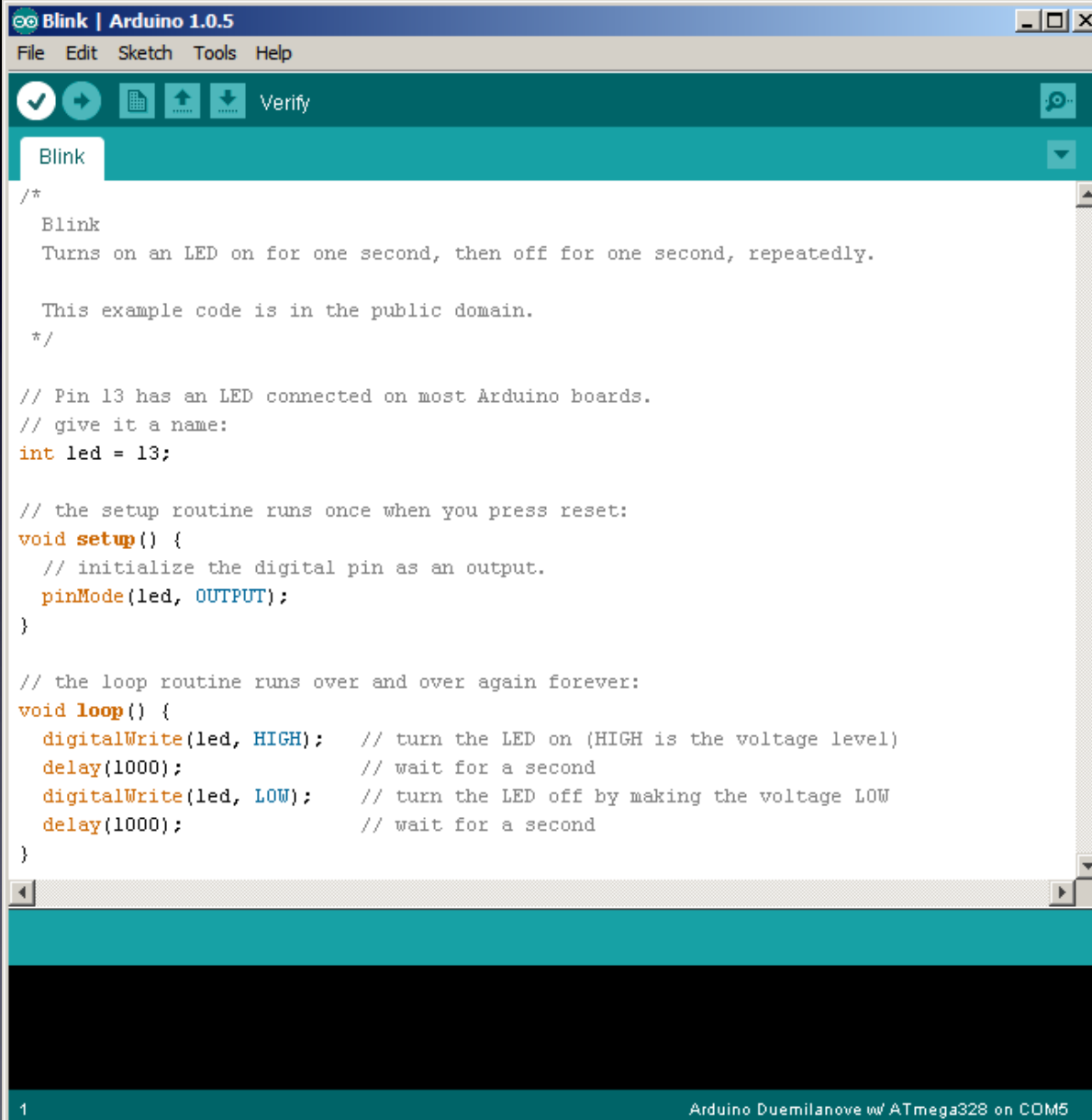




# How to Set Up and Use the Arduino Software



# 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.
  */

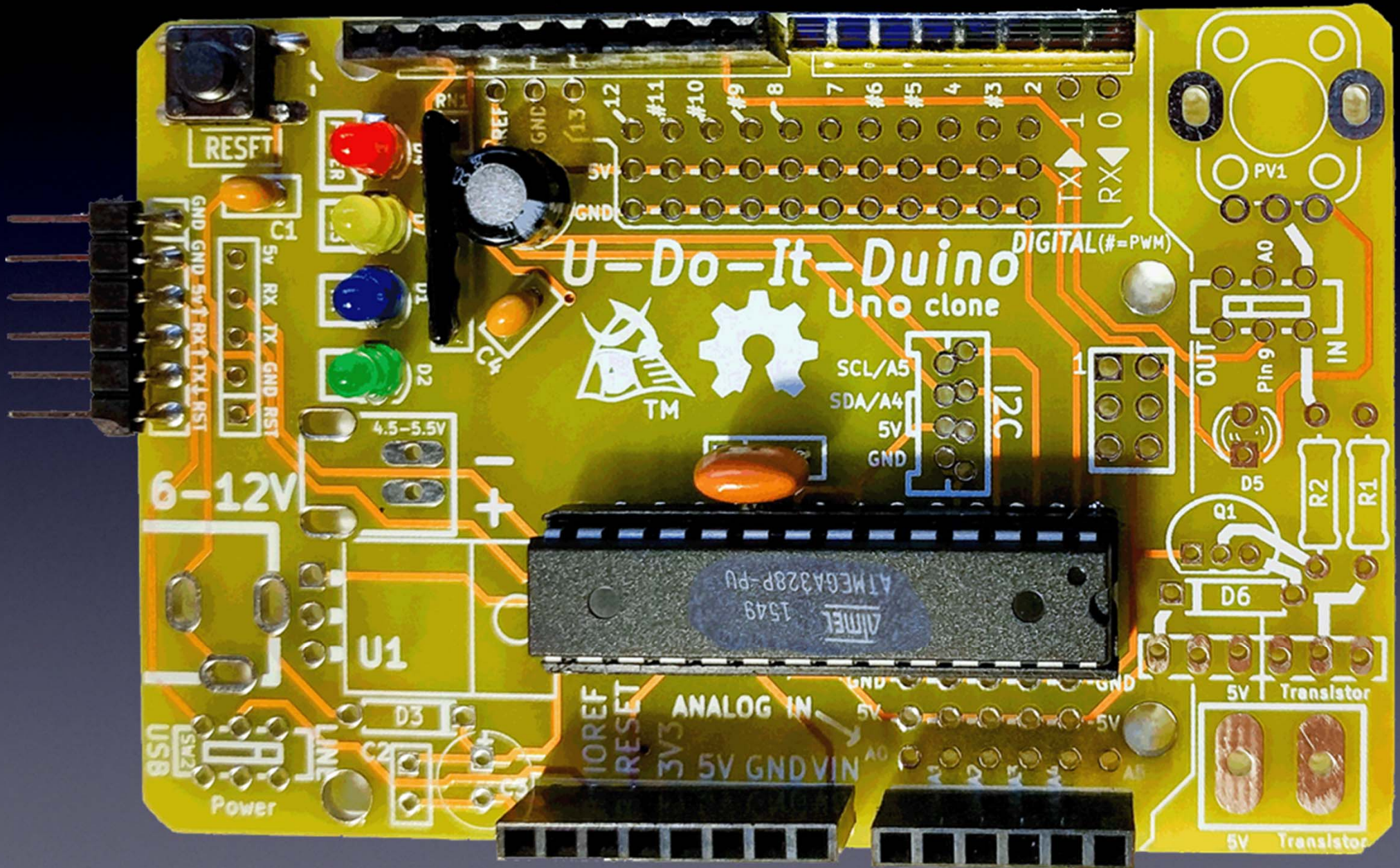
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// 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
}
```

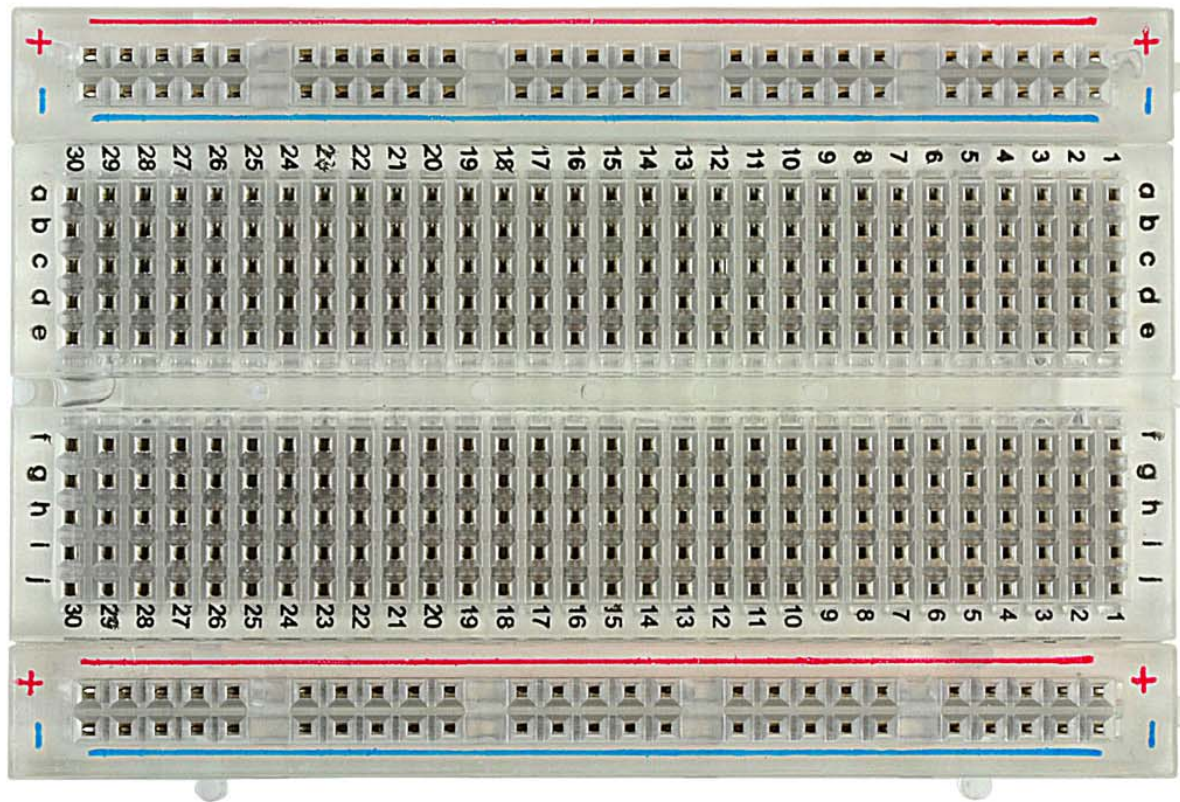
At the bottom of the window, the status bar shows "1" on the left and "Arduino Duemilanove w/ ATmega328 on COM5" on the right.

# How to Hack Arduino Programs (“Sketches”)



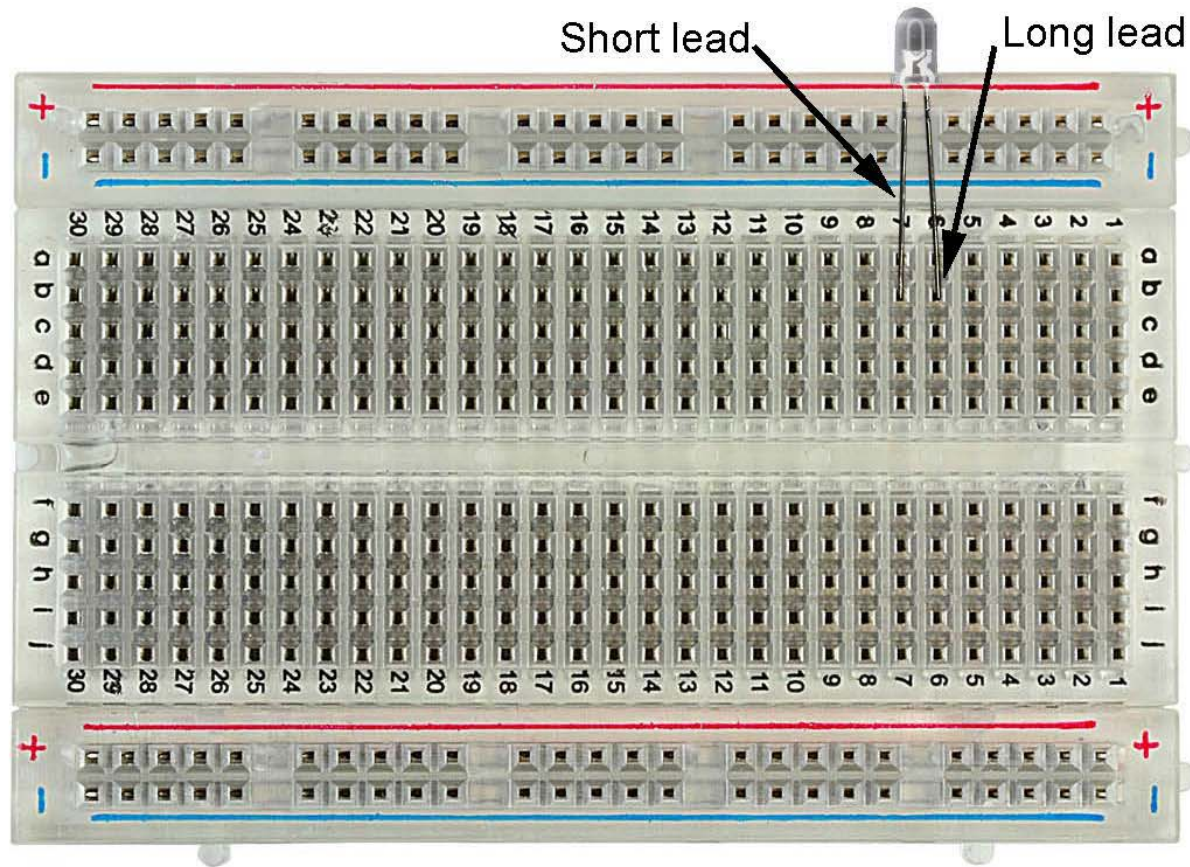
# How to Use Solderless Breadboards

## Solderless Breadboard



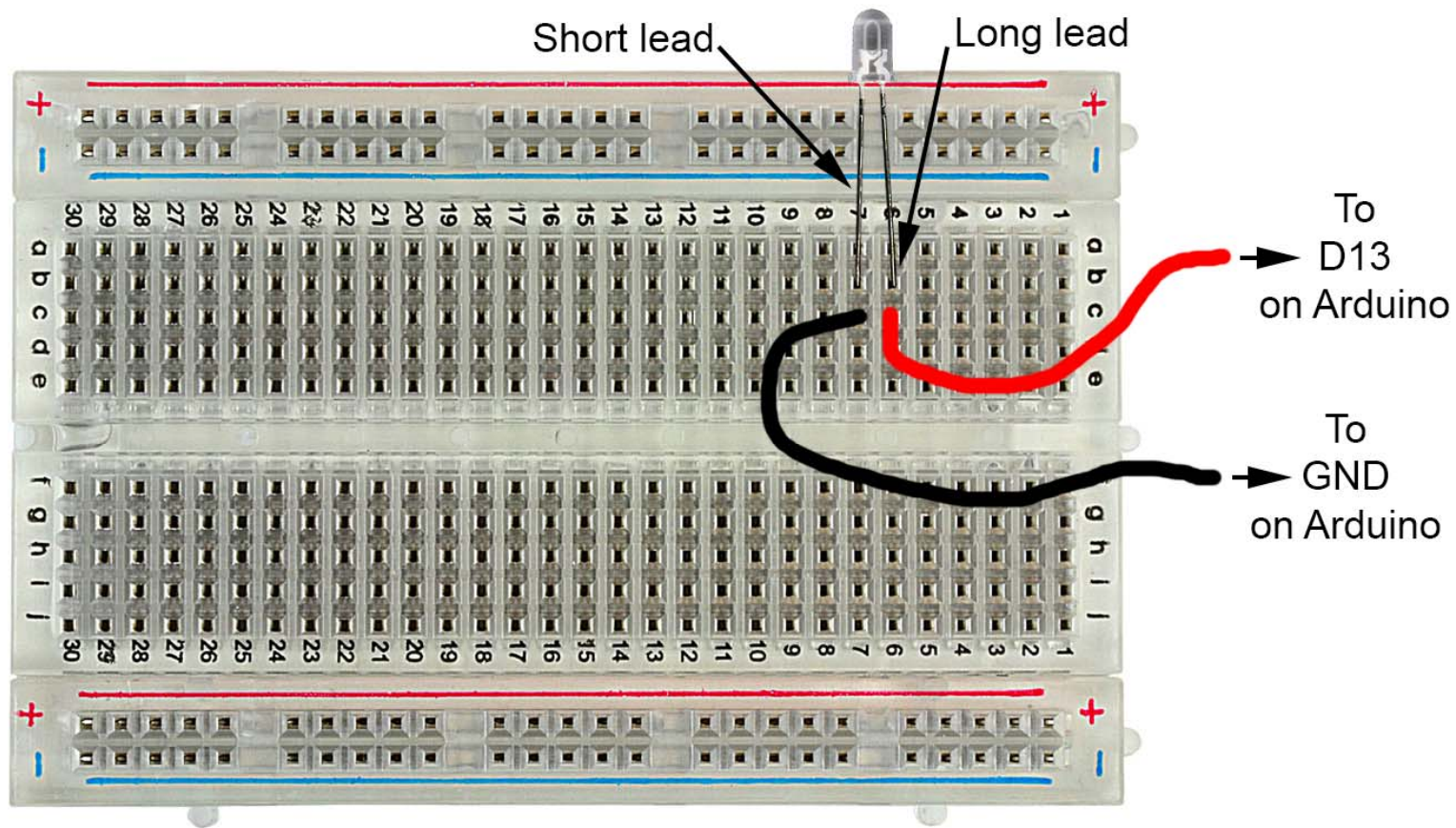
# How to Use Solderless Breadboards

## Solderless Breadboard with LED



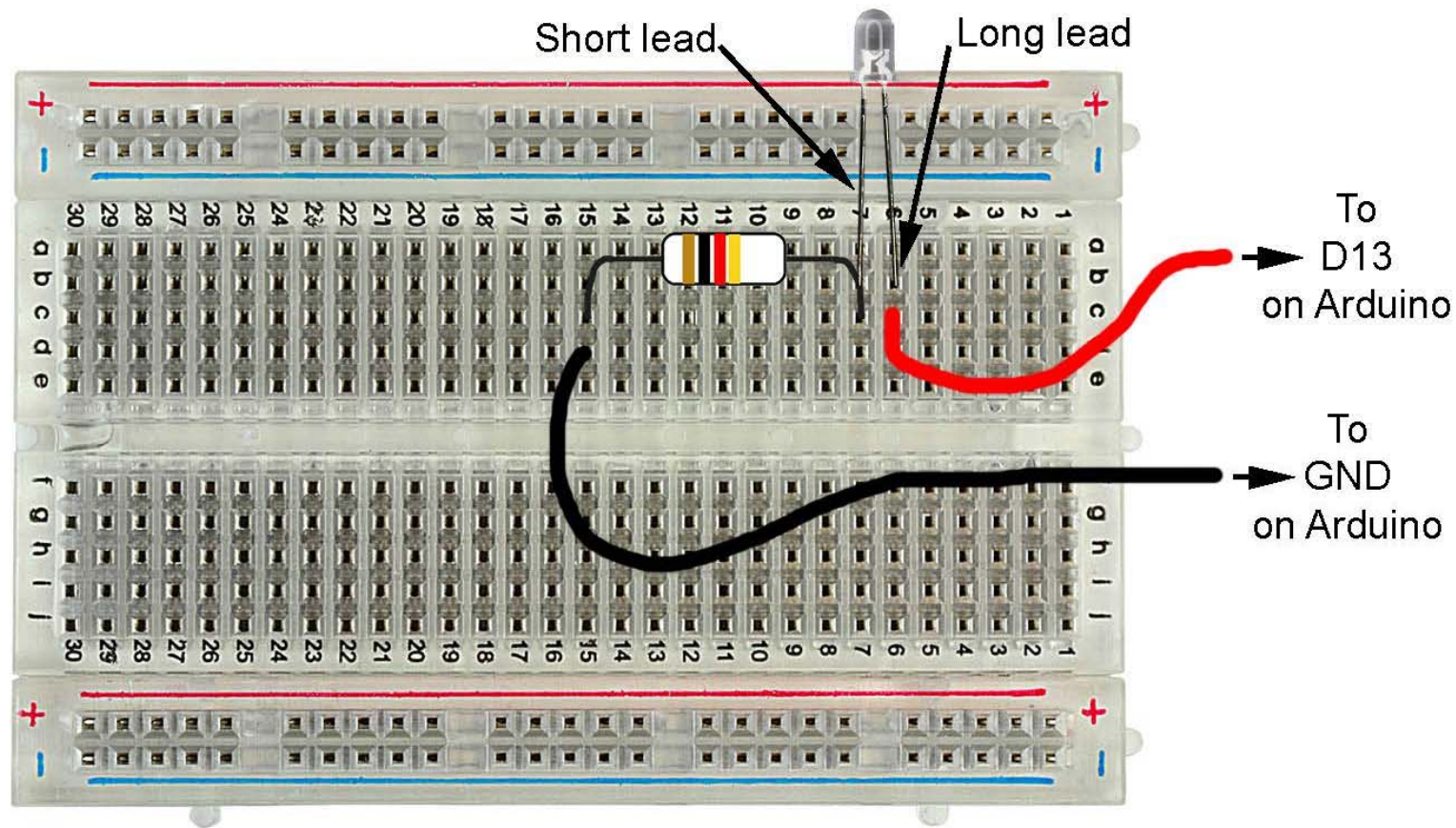
# How to Use Solderless Breadboards

## Solderless Breadboard with LED and wires

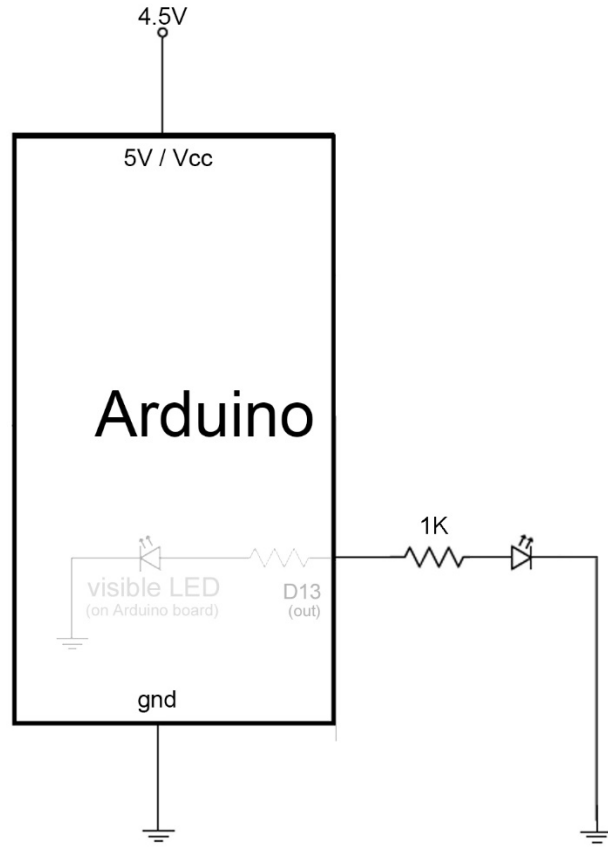


# How to Use Solderless Breadboards

## Solderless Breadboard with LED and Resistor and wires



# How to Read a Schematic



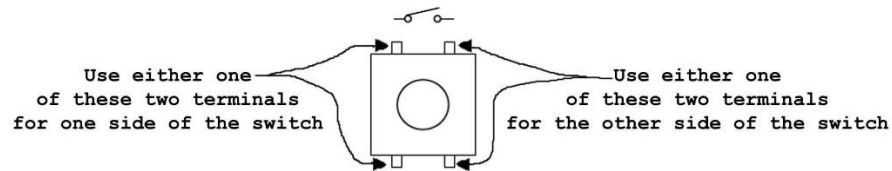
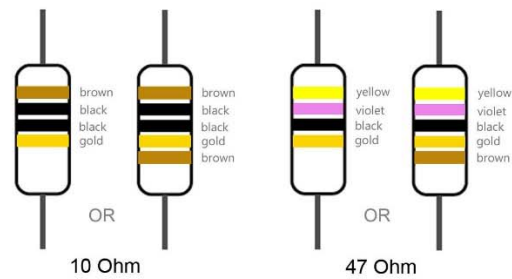
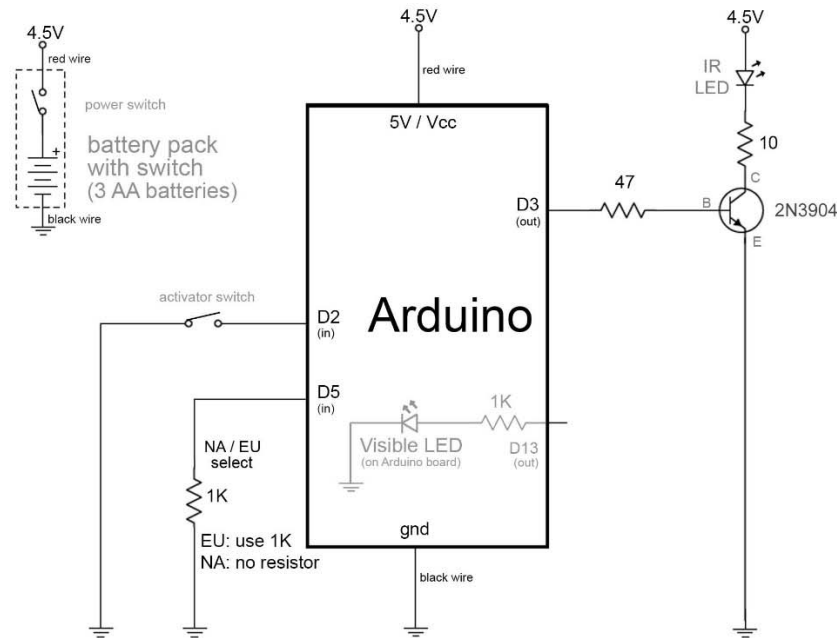


# How to Read a Schematic

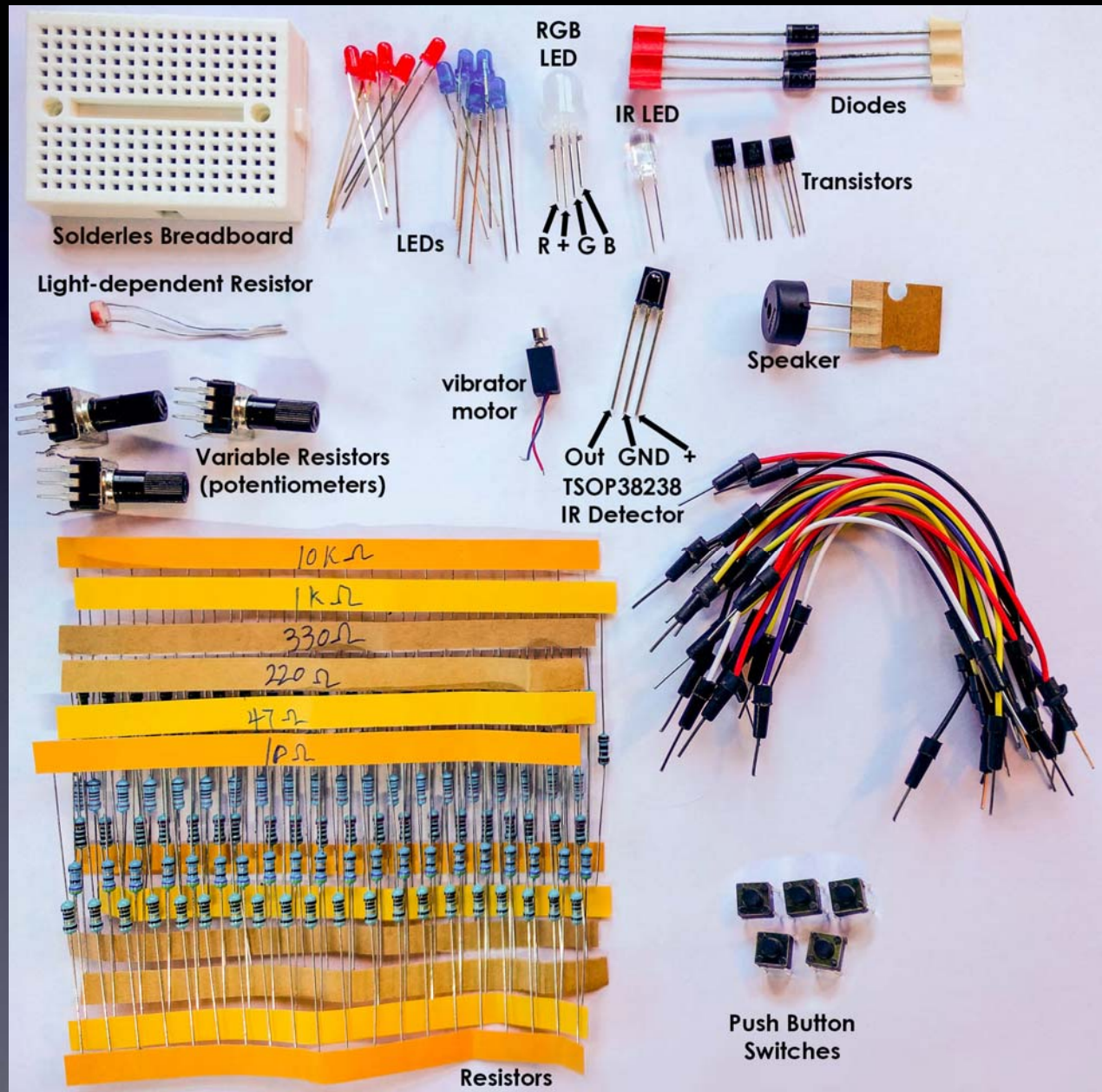
## Arduino For Total Newbies

4-Sep-2015

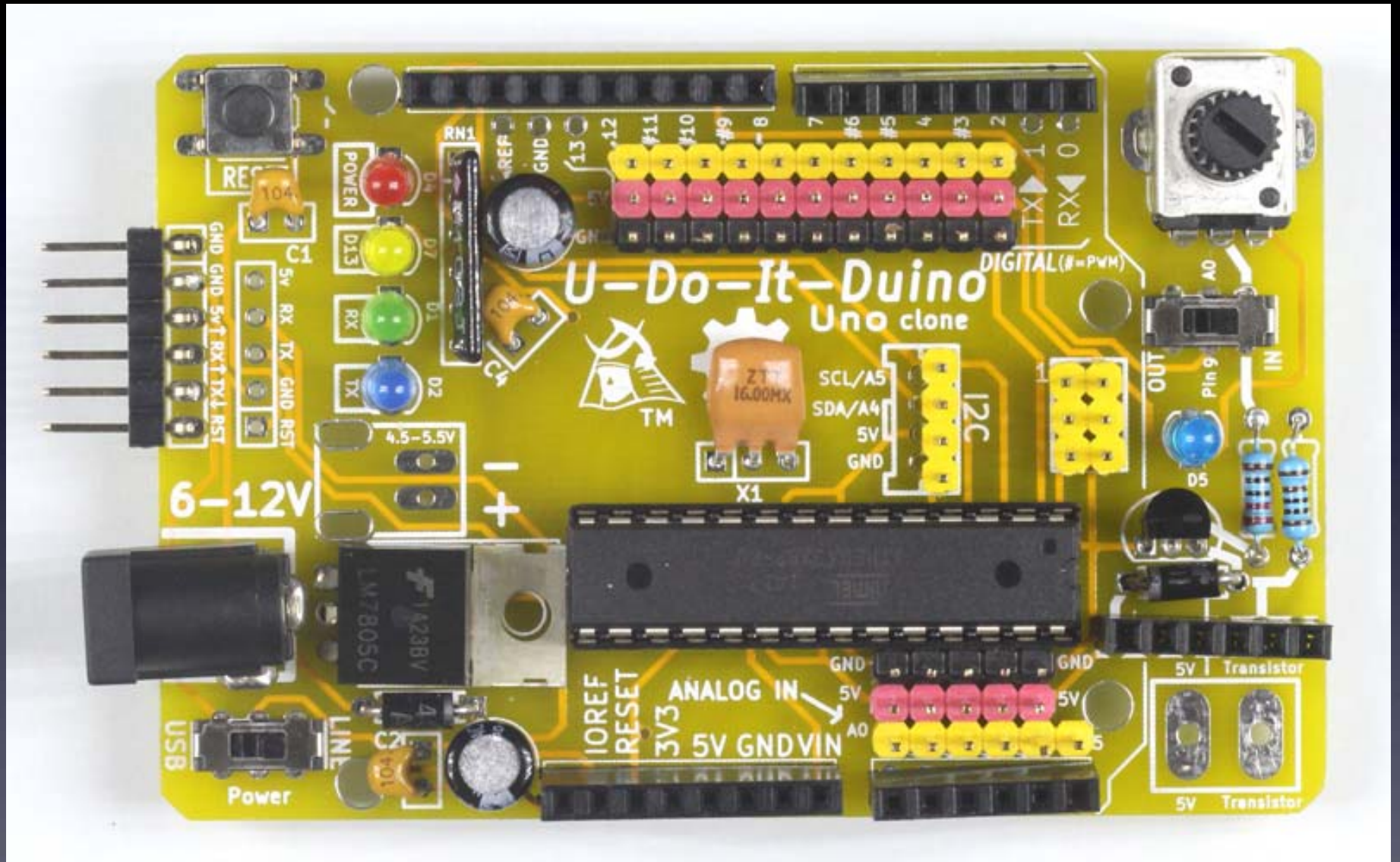
Mitch Altman (original TV-B-Gone hardware and firmware, modified TV-B-Gone Arduino design)  
 Limore Fried (firmware modifications, kit design)  
 Ken Shirriff (original modifications for Arduino)  
 Johannes Schneemann (documentation)



# Parts Pack Contents



# If you want to:



<http://www.samuraicircuits.com/MediaWiki/index.php?title=U-Do-It-Duino>

Please Remember:

to

**Wash your hands**

I have these  
Toolkits  
for sale

# Tools

