2-Dec-2024

Make your own

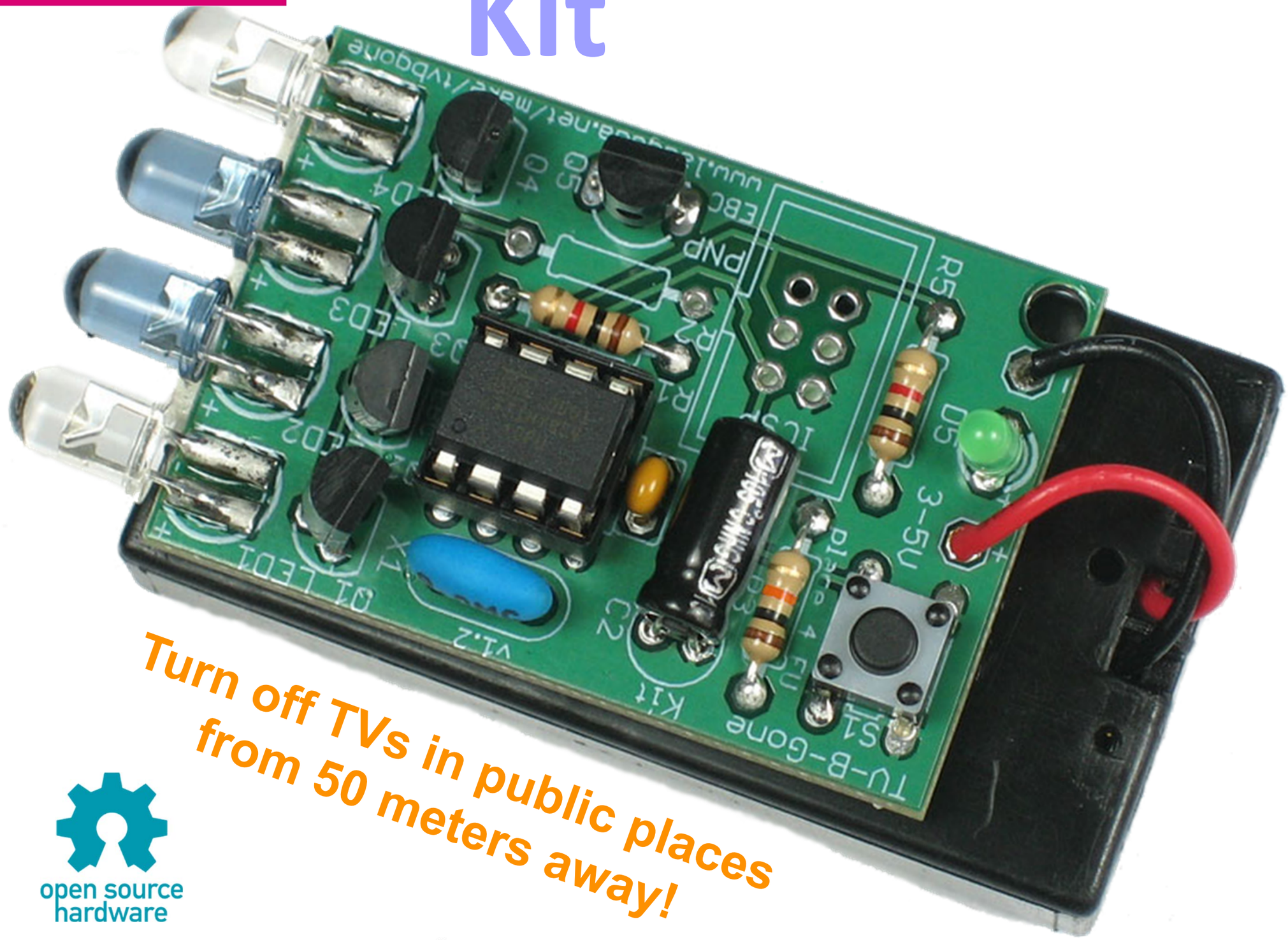
Mitch Altman

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** (1st and biggest hardware accelerator)
Co-founder of **Noisebridge** (San Francisco hackerspace)
email: **mitch@CornfieldElectronics.com**
site: **www.CornfieldElectronics.com**
facebook: **maltman23**
flickr: **maltman23**
WeChat: **mitchaltman**
Fediverse: **@maltman23@mastodon.social**
Patreon: mitchaltman

Syllabus

- Intro to TV-B-Gone kit
- Intro to IR remote controls
- Brief intro to electronics
- How to solder
- Target practice is available all over the world after the workshop

TV B GONE® Kit



Turn off TVs in public places from 50 meters away!

open source hardware

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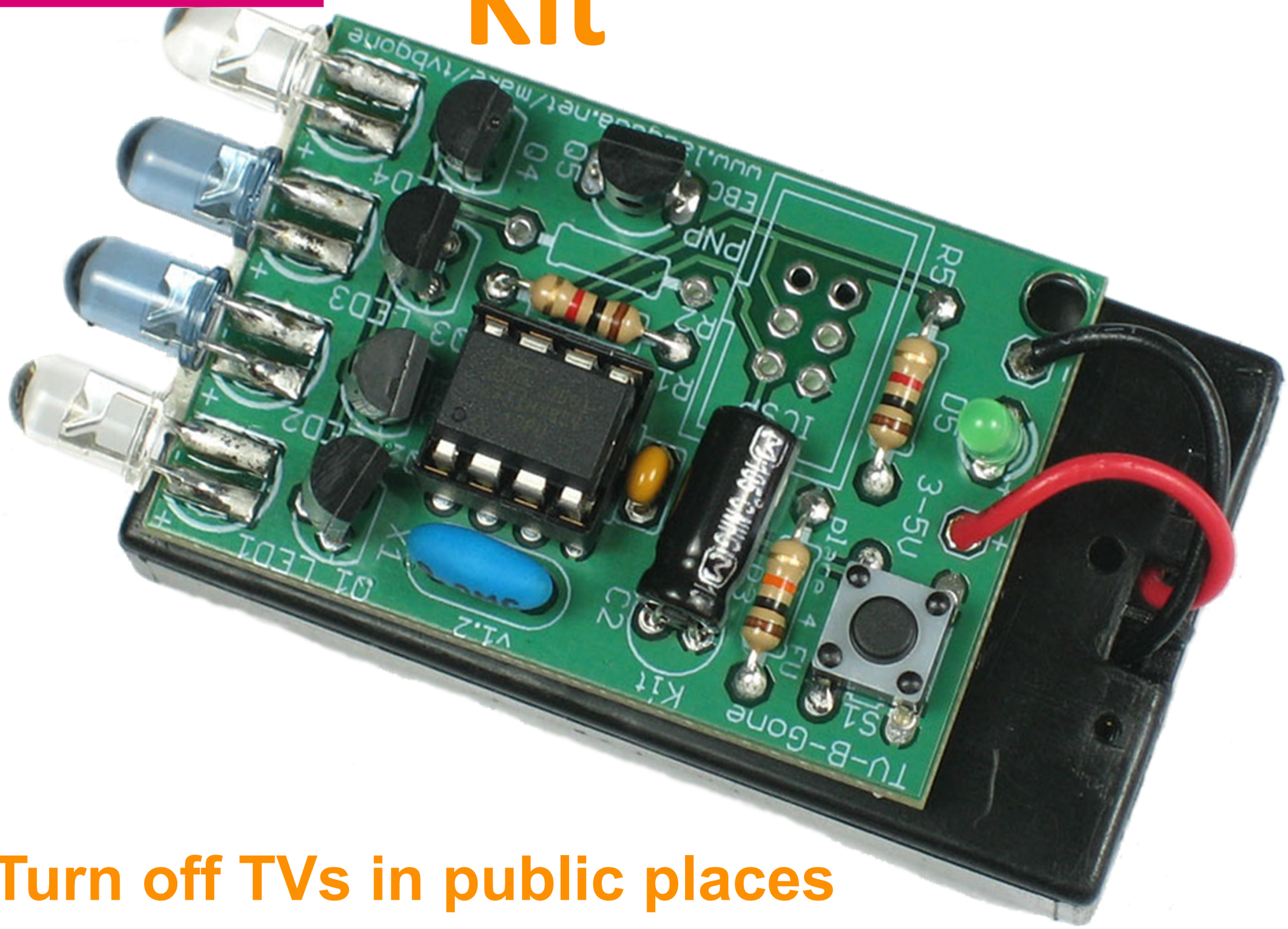
adafruit & CORNFIELD ELECTRONICS

TV B GONE®

TV-B-Gone

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

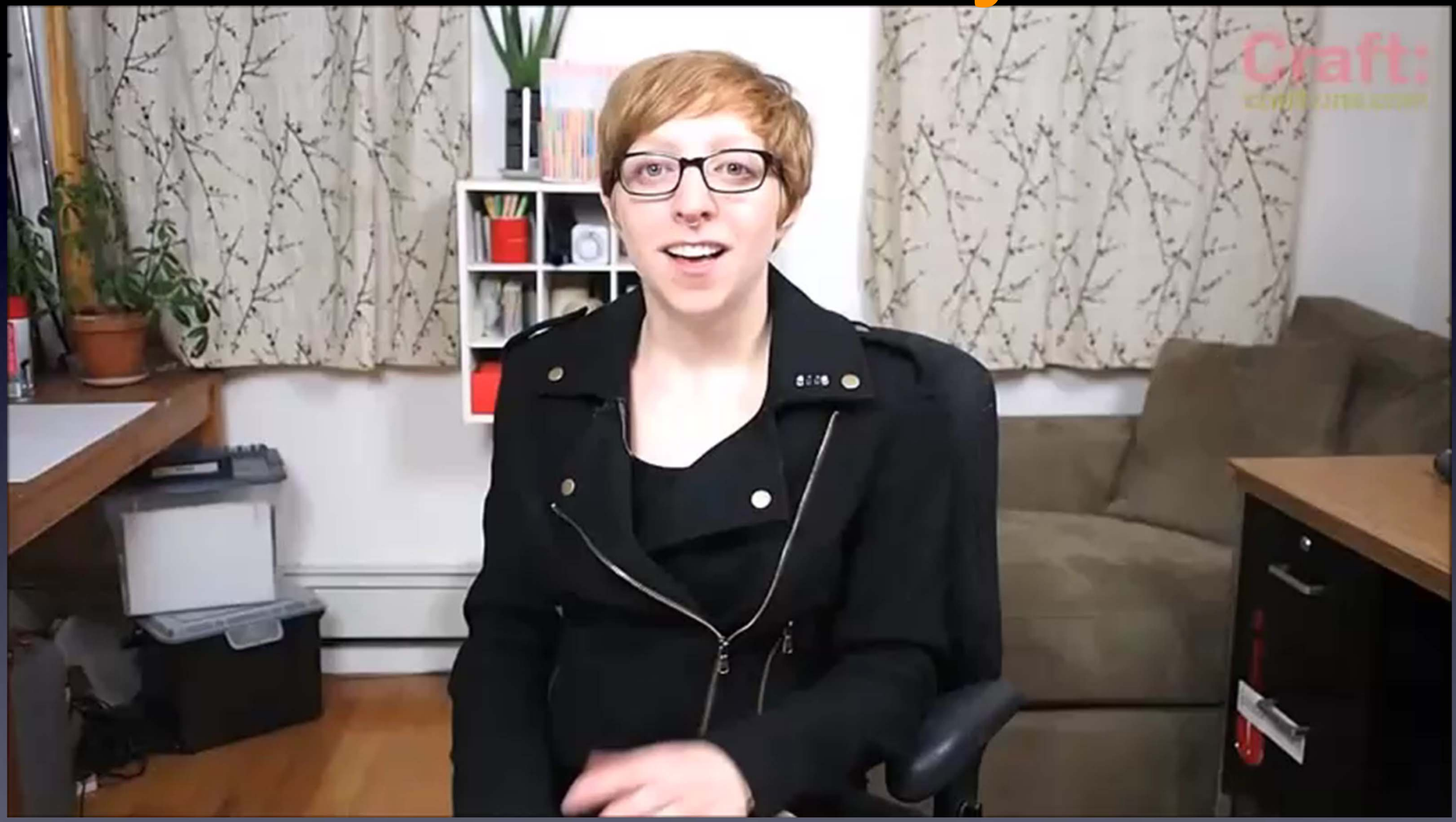
TV B GONE® Kit



Turn off TVs in public places from 50 meters away!

TV B GONE®

Kit: in a jacket



forbes.com – Turning Off Any TV You Want - Without Getting Caught

TV B GONE®

Kit: in a hat

makezine.com – TV-B-Gone Hat

Kit: Sonic Screwdriver

hackaday.com – Sonic Screwdriver Meets TV-B-Gone

TV B GONE®

Takes about 60 seconds

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

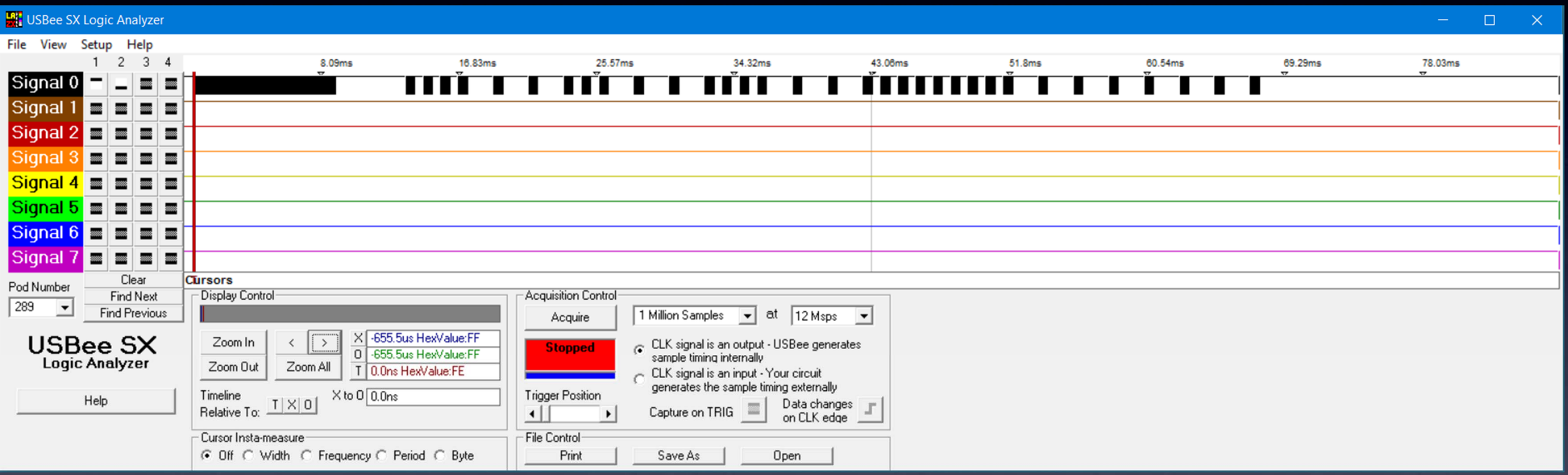
TV-B-Gone universal remote control

IR Remote control codes

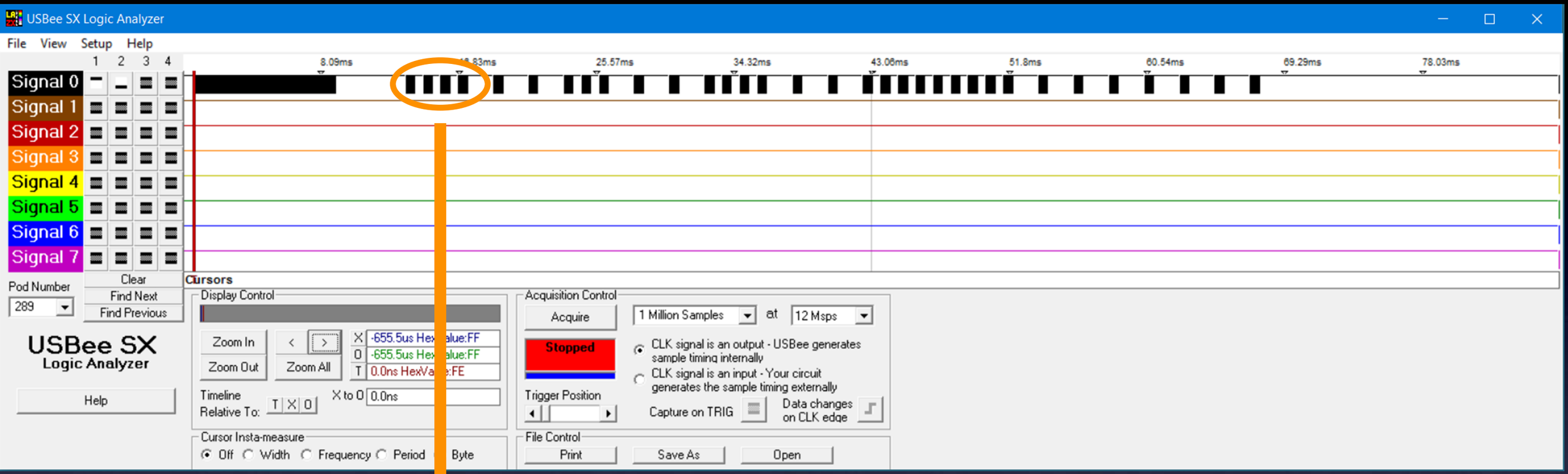
Allen Hall

NEC TV remote control

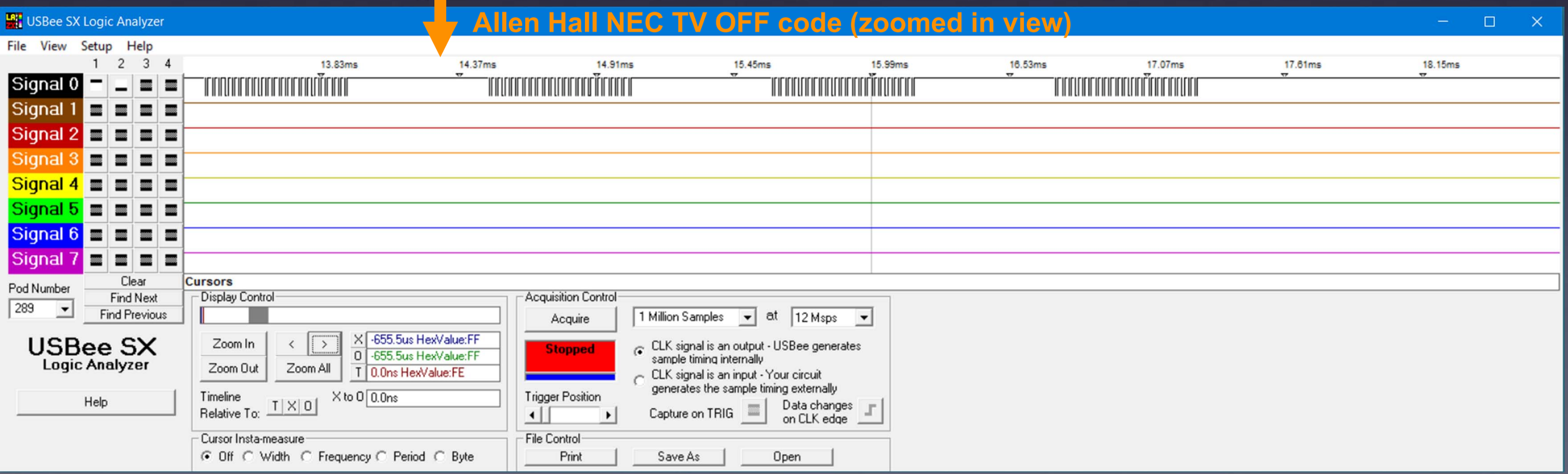
Allen Hall NEC TV OFF code



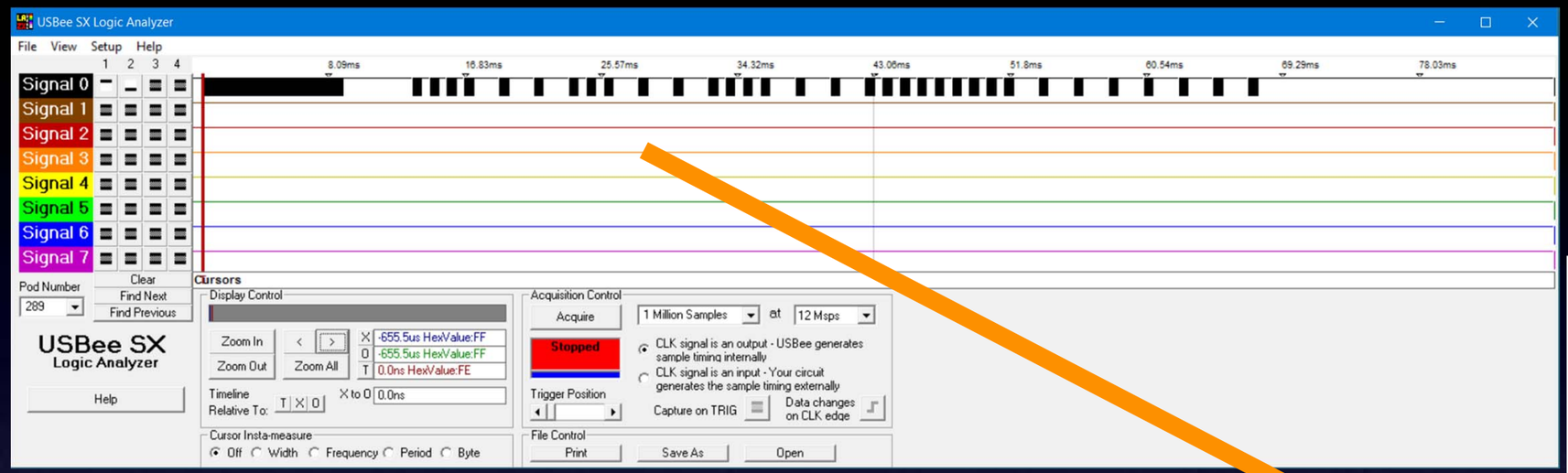
Allen Hall NEC TV OFF code



Allen Hall NEC TV OFF code (zoomed in view)

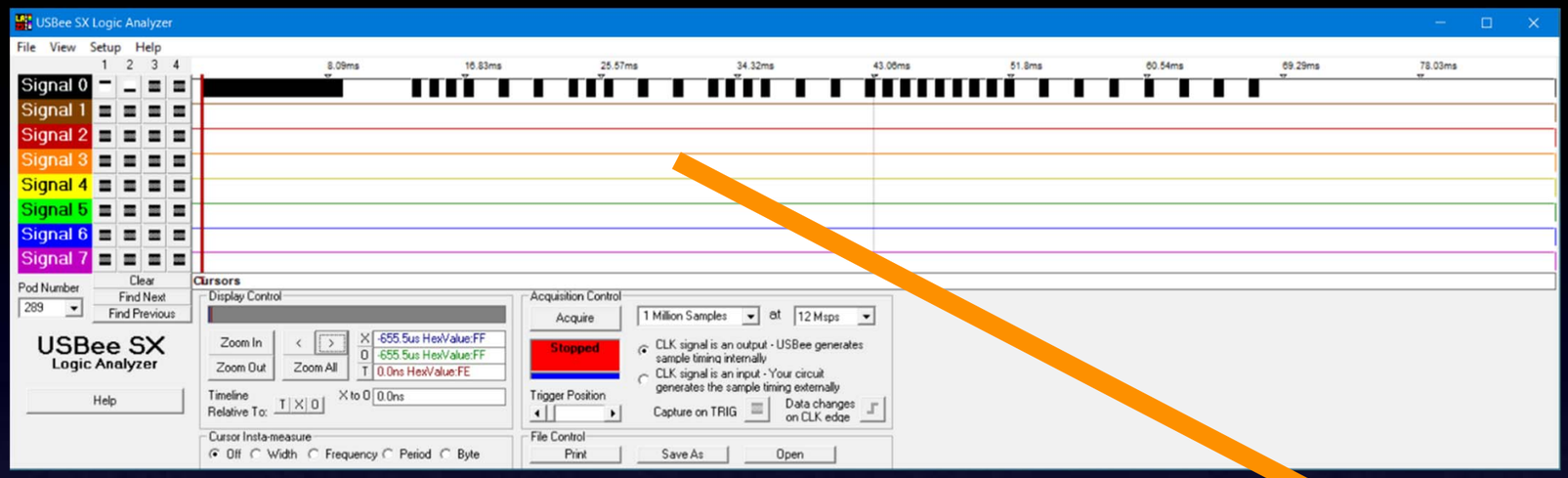


Allen Hall NEC TV OFF code



pair #	on-time	off-time
1	8,920 usec	4,450 usec
2	560 usec	560 usec
3	560 usec	560 usec
4	560 usec	560 usec
5	560 usec	1,680 usec
6	560 usec	1,680 usec
7	560 usec	1,680 usec
8	560 usec	560 usec
9	560 usec	560 usec
10	560 usec	1,680 usec
11	560 usec	1,680 usec
12	560 usec	1,680 usec
13	560 usec	560 usec
14	560 usec	560 usec
15	560 usec	560 usec
16	560 usec	560 usec
17	560 usec	1,680 usec
18	560 usec	1,680 usec
19	560 usec	560 usec
20	560 usec	560 usec
21	560 usec	560 usec
22	560 usec	560 usec
23	560 usec	560 usec
24	560 usec	560 usec
25	560 usec	560 usec
26	560 usec	560 usec
27	560 usec	1,680 usec
28	560 usec	1,680 usec
29	560 usec	1,680 usec
30	560 usec	1,680 usec
31	560 usec	1,680 usec
32	560 usec	1,680 usec
33	560 usec	1,680 usec
34	560 usec	560 usec

Allen Hall NEC TV OFF code

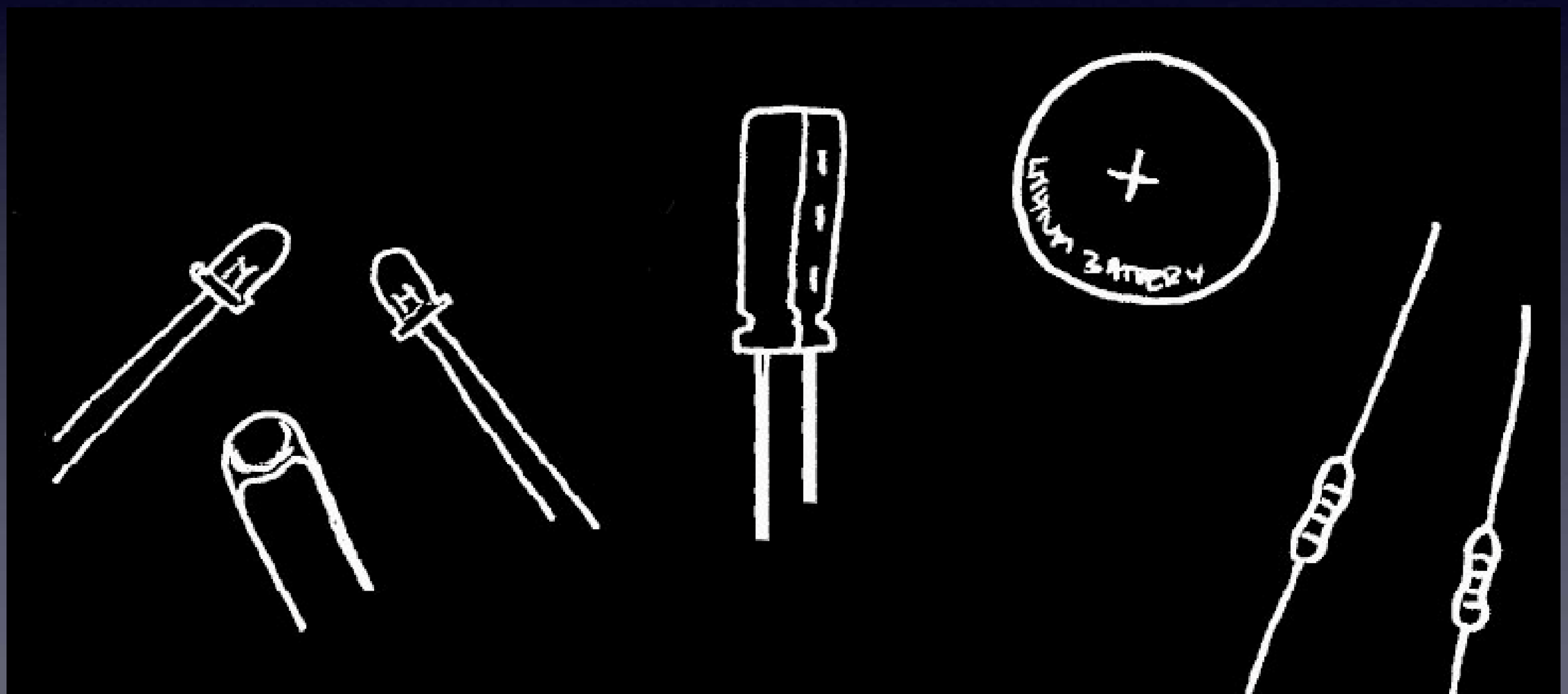


pair #	on-time	off-time	index
1	8,920 usec	4,450 usec	0
2	560 usec	560 usec	1
3	560 usec	560 usec	1
4	560 usec	560 usec	1
5	560 usec	1,680 usec	2
6	560 usec	1,680 usec	2
7	560 usec	1,680 usec	2
8	560 usec	560 usec	1
9	560 usec	560 usec	1
10	560 usec	1,680 usec	2
11	560 usec	1,680 usec	2
12	560 usec	1,680 usec	2
13	560 usec	560 usec	1
14	560 usec	560 usec	1
15	560 usec	560 usec	1
16	560 usec	560 usec	1
17	560 usec	1,680 usec	2
18	560 usec	1,680 usec	2
19	560 usec	560 usec	1
20	560 usec	560 usec	1
21	560 usec	560 usec	1
22	560 usec	560 usec	1
23	560 usec	560 usec	1
24	560 usec	560 usec	1
25	560 usec	560 usec	1
26	560 usec	560 usec	1
27	560 usec	1,680 usec	2
28	560 usec	1,680 usec	2
29	560 usec	1,680 usec	2
30	560 usec	1,680 usec	2
31	560 usec	1,680 usec	2
32	560 usec	1,680 usec	2
33	560 usec	1,680 usec	2
34	560 usec	560 usec	1

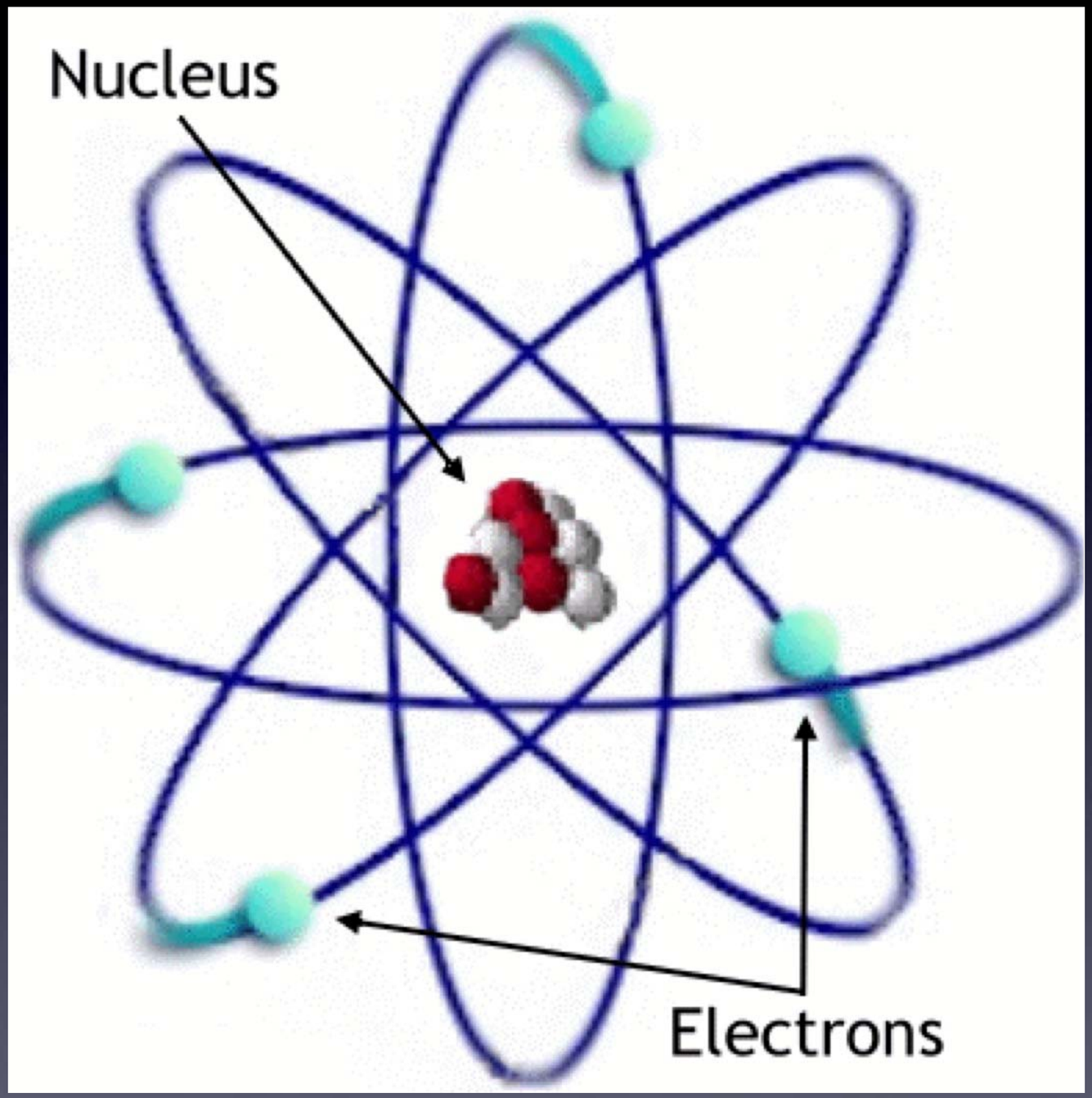
index			
0	1	1	1
2	2	2	1
1	2	2	2
1	1	1	1
2	2	1	1
1	1	1	1
1	1	2	2
2	2	2	2
2	1		

A Little About

Electronics

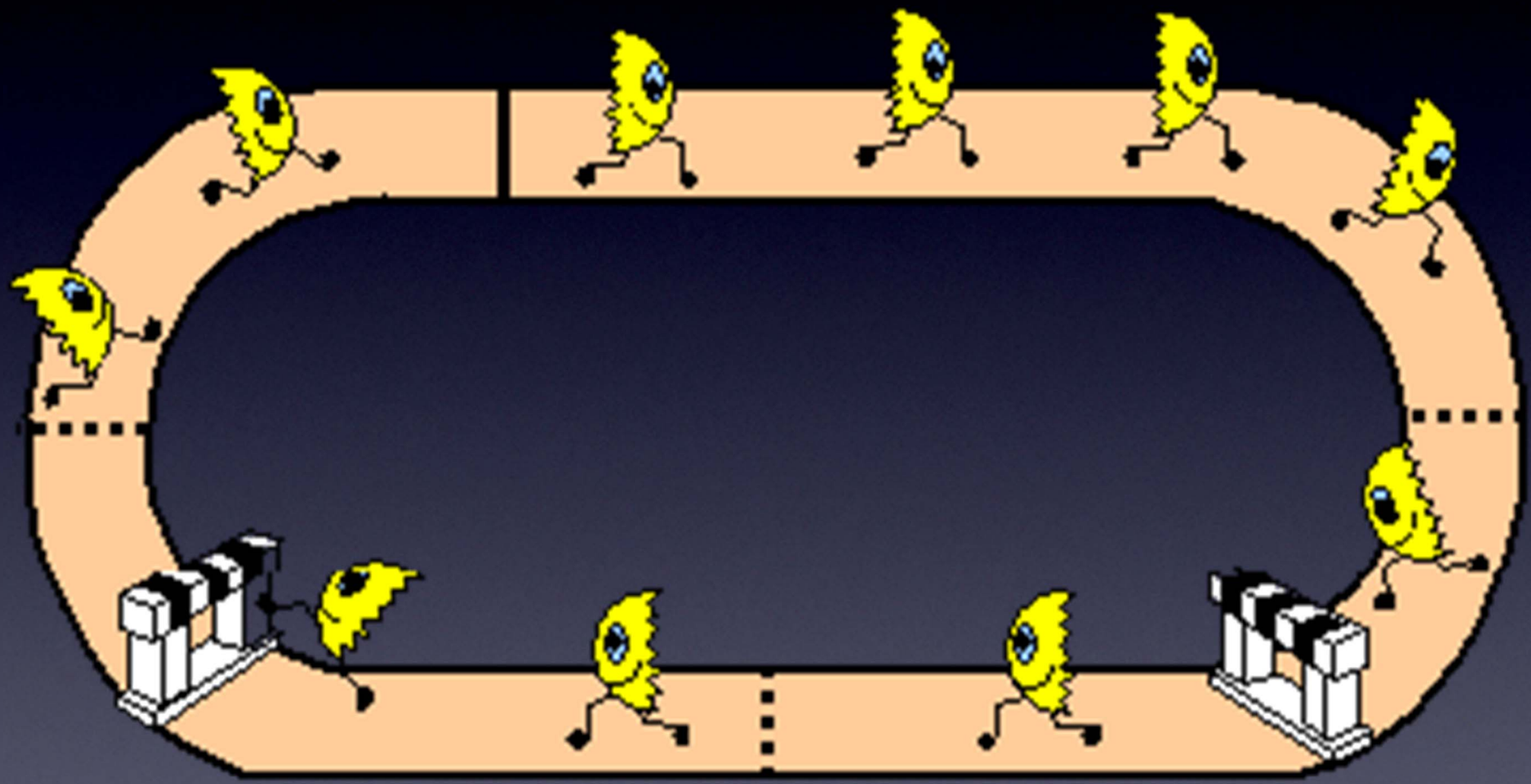


A Little About Electronics



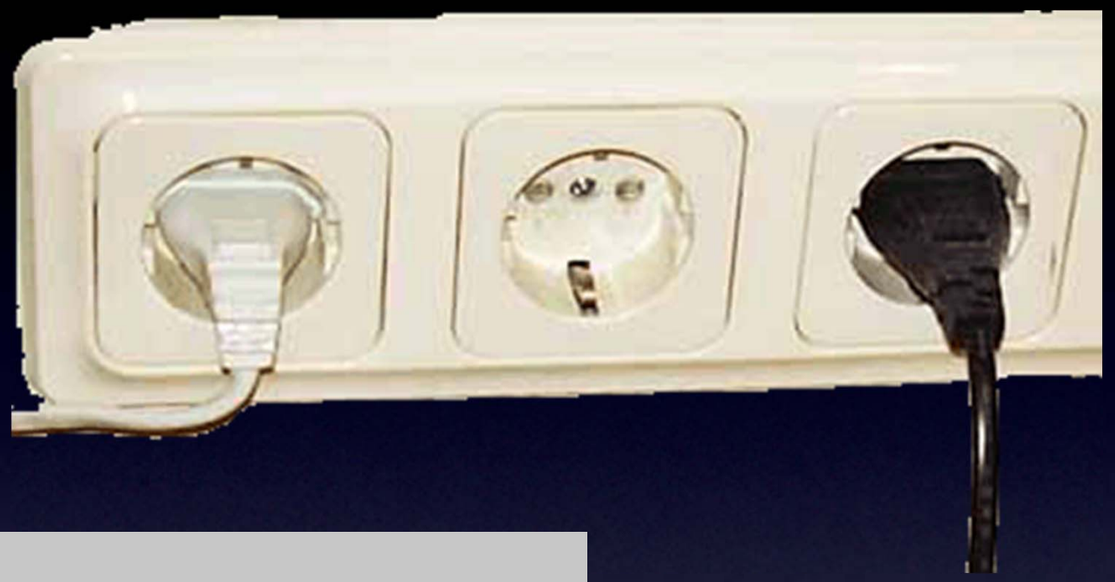
Electrons

A Little About Electronics



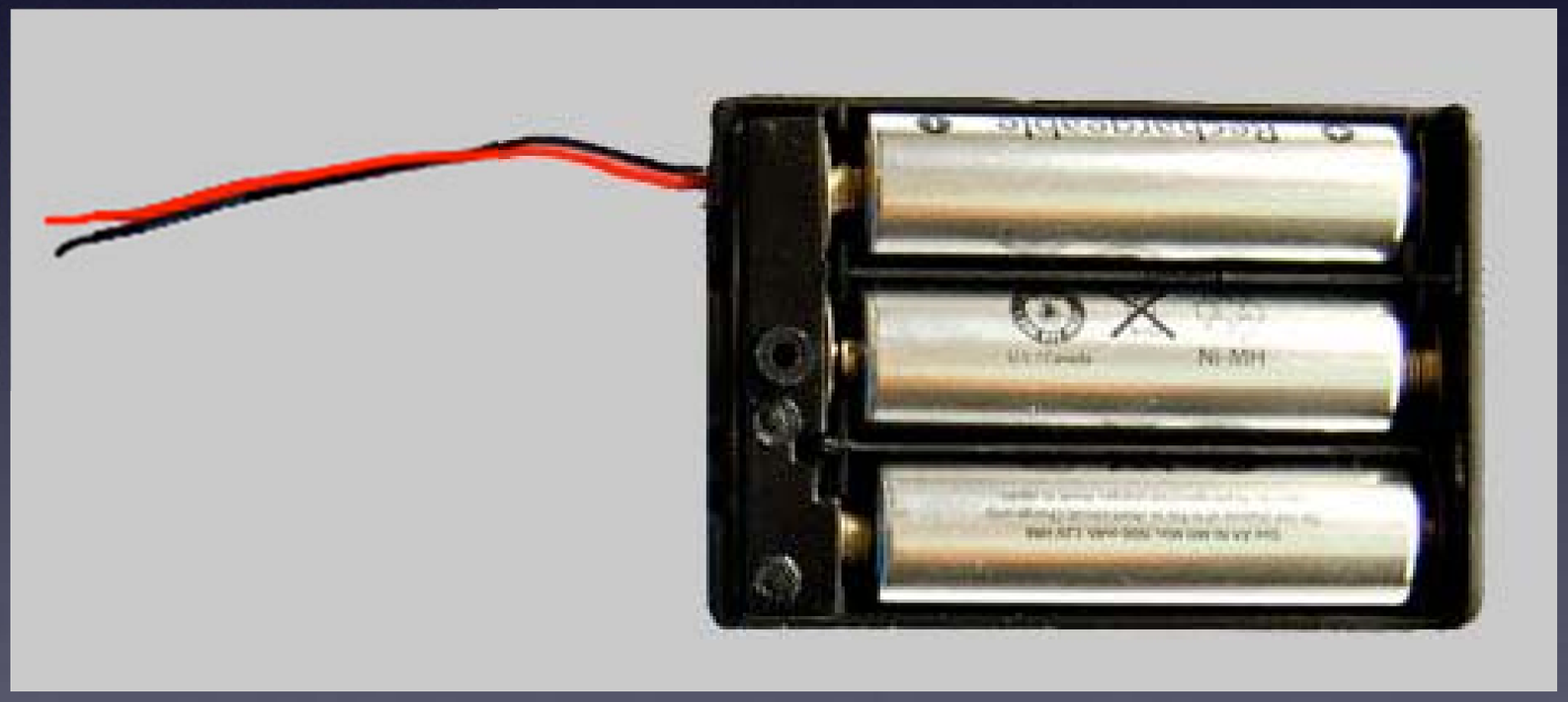
Circuit = Electrons going in complete circle = Magic!

A Little About Electronics



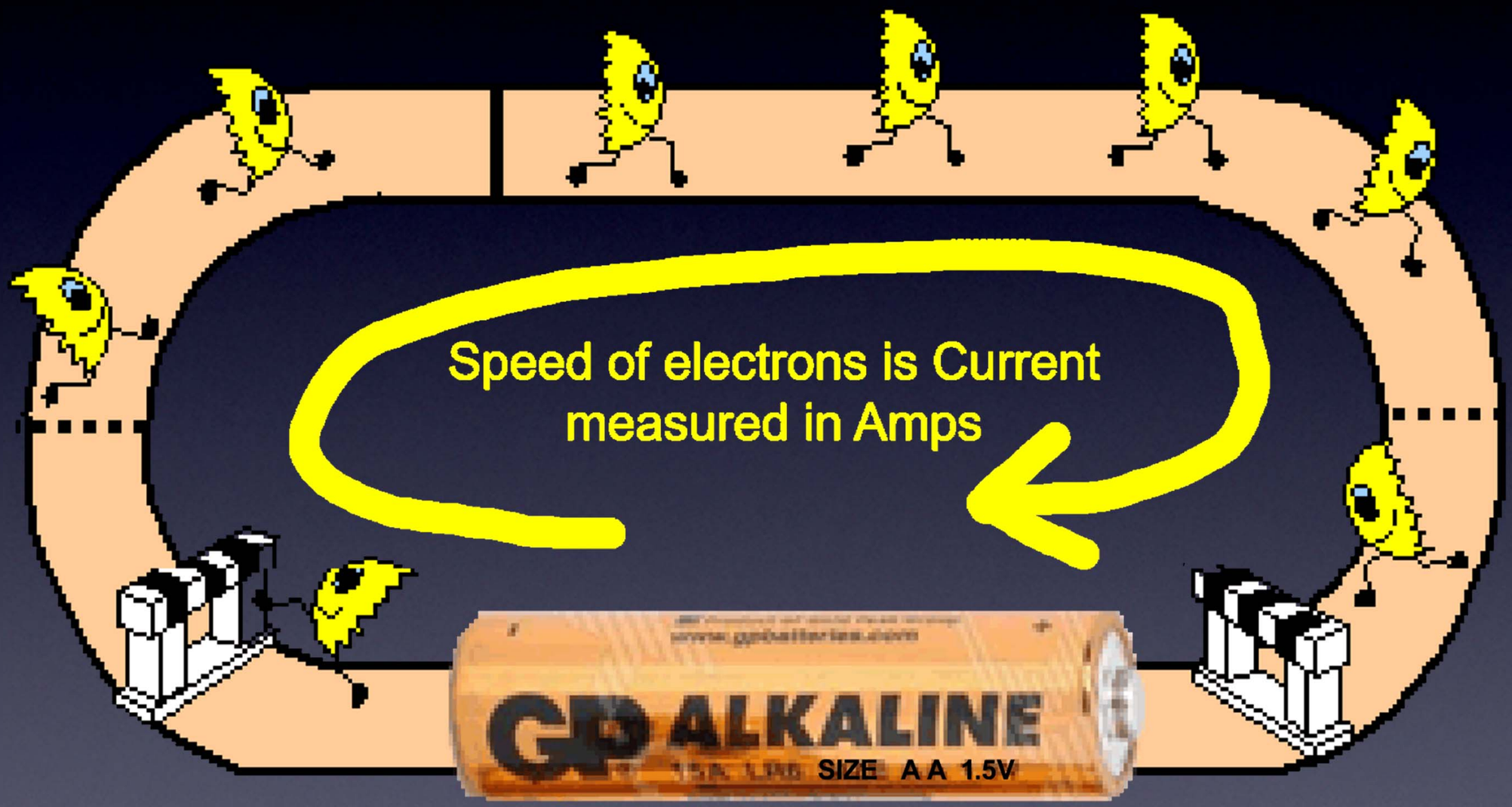
Power Supplies

Everything You Need to Know About Electronics



Voltage / **Volts**

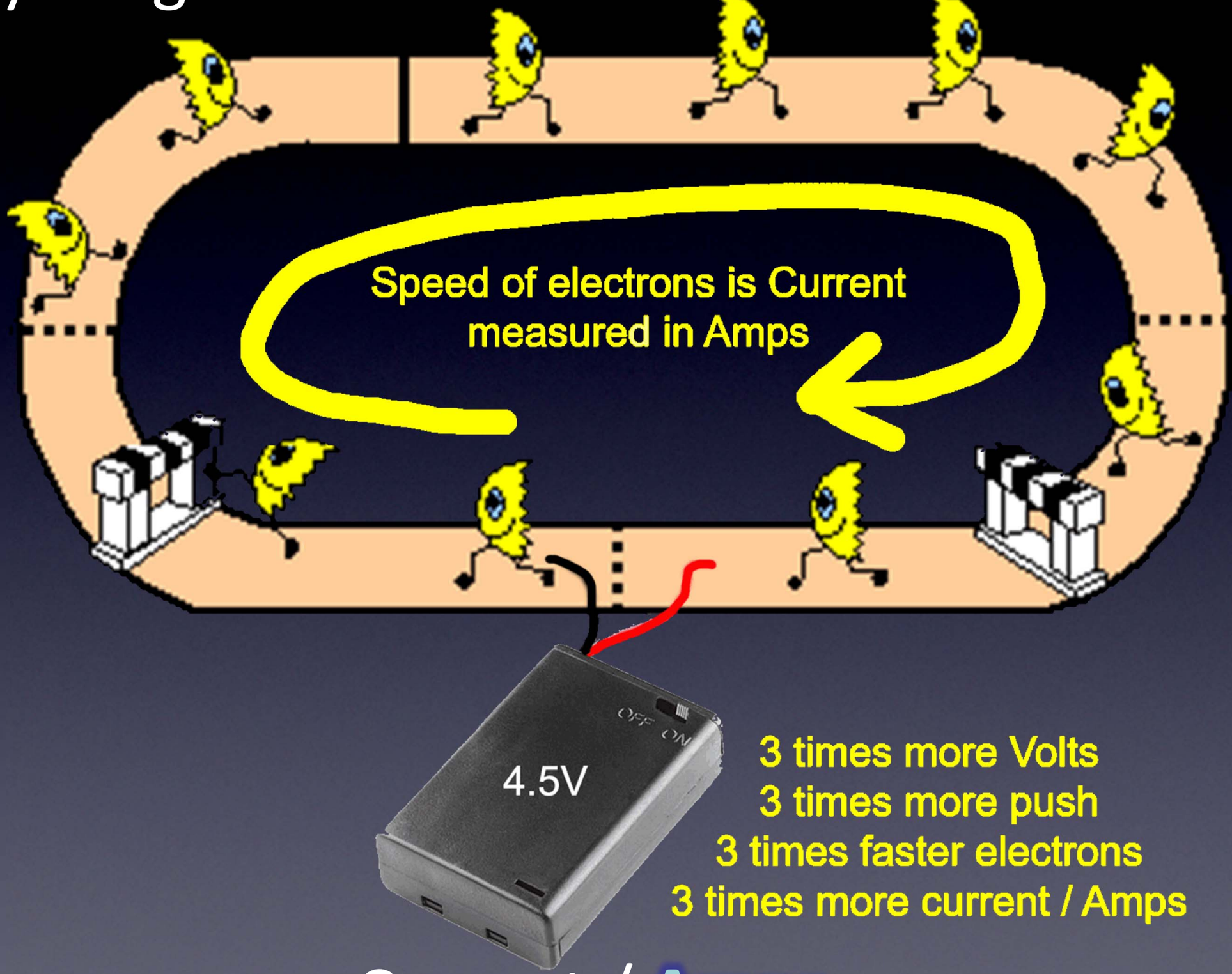
Everything You Need to Know About Electronics



Electrons pushed with 1.5V.
So, they move!

Current / **Amps**

Everything You Need to Know About Electronics

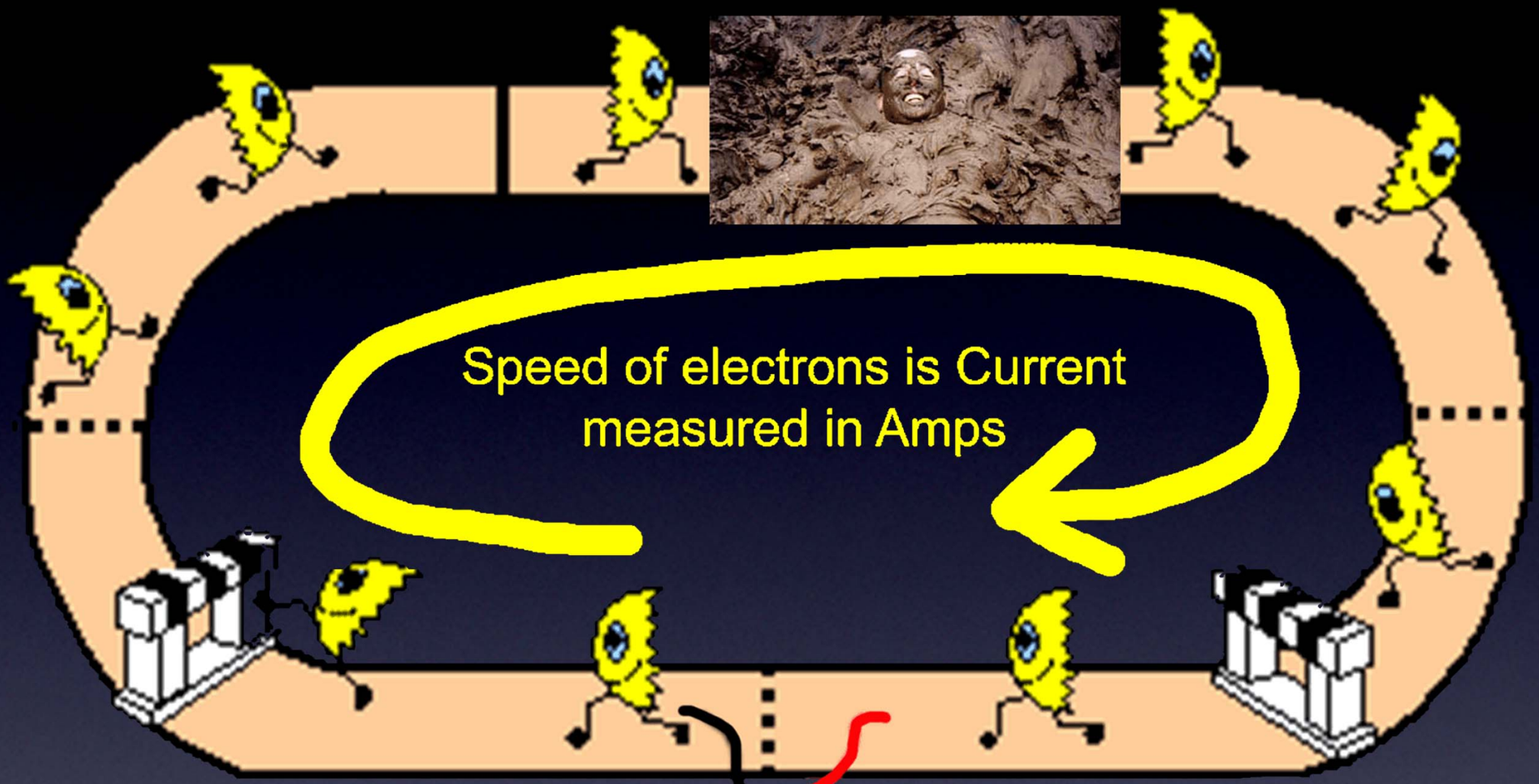


Current / **Amps**

Everything You Need to Know About Electronics

Current / **Amps**

Everything You Need to Know About Electronics



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

Resistance / **Ohms**

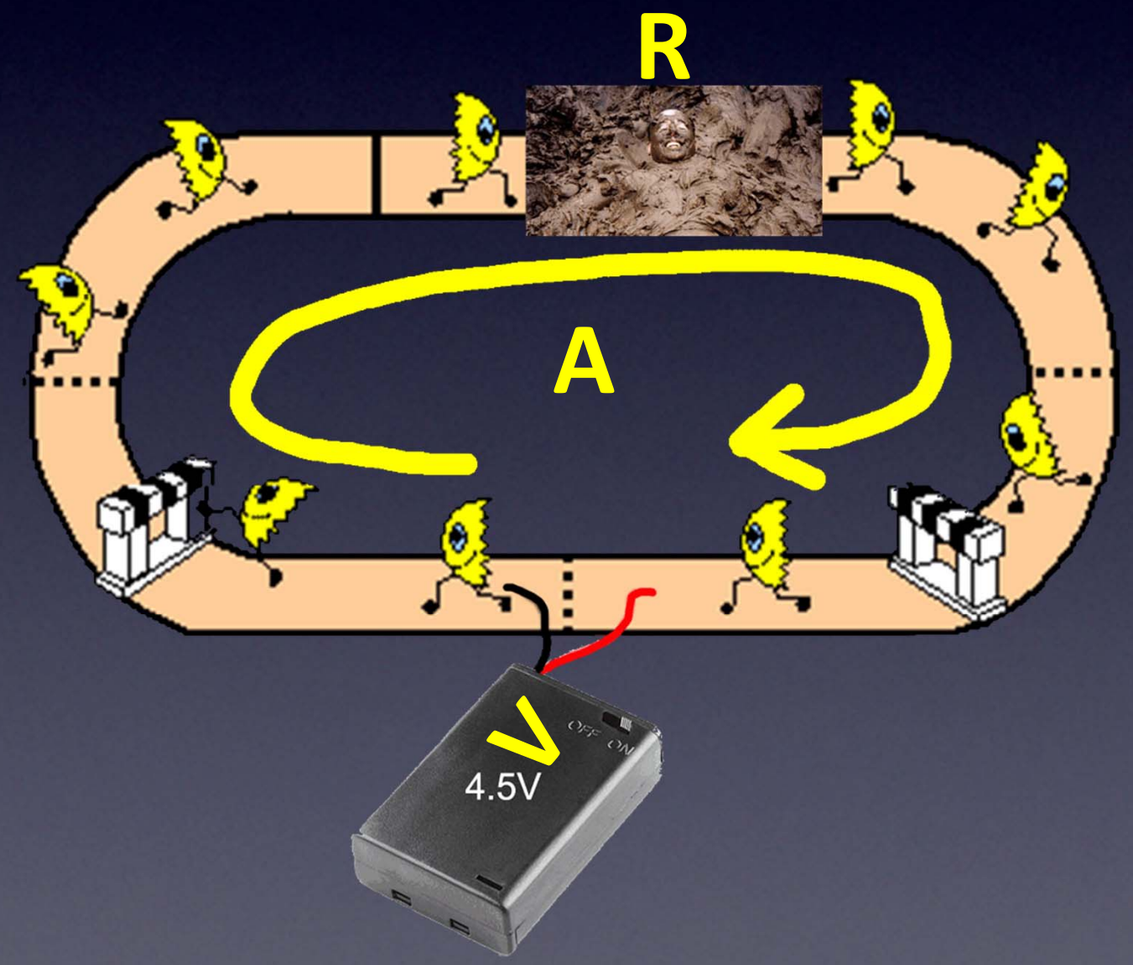
A Little About Electronics

Ohm's Law

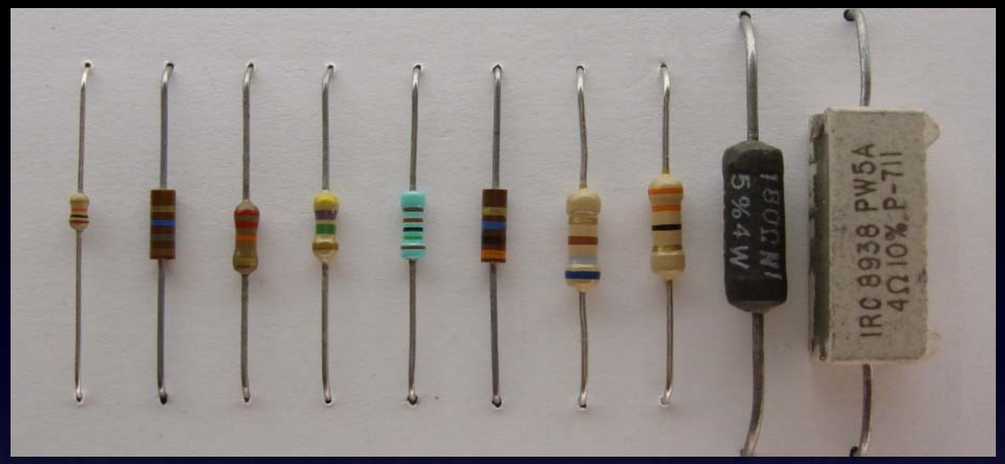
Volts -- ***force*** pushing electrons

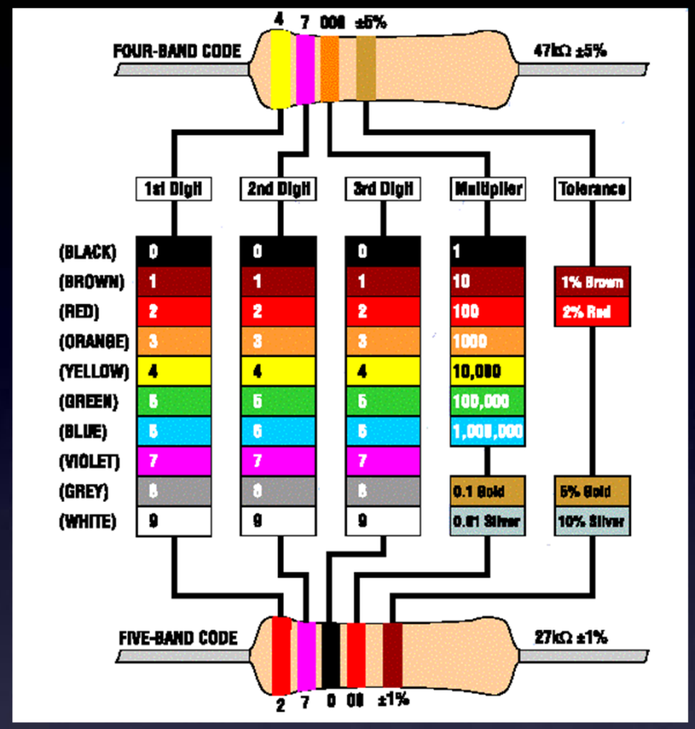
Amps -- ***speed*** of electrons

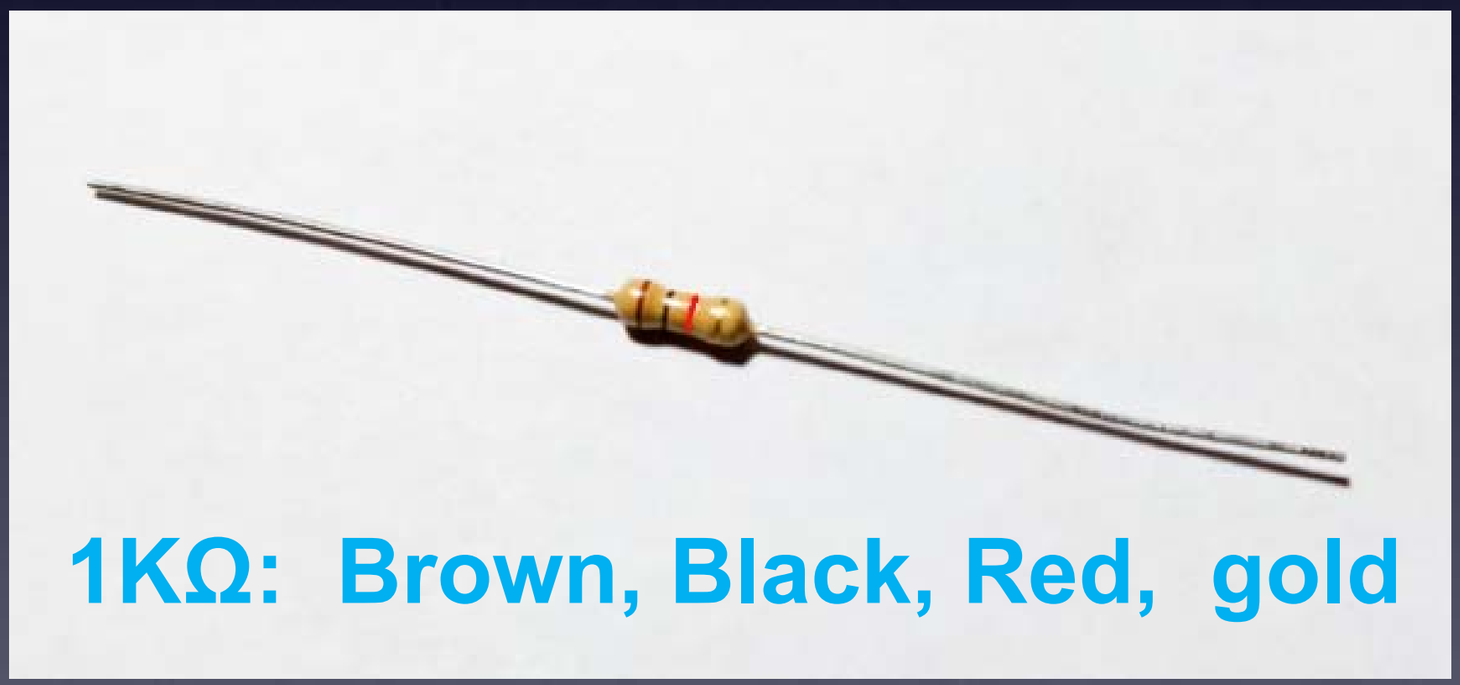
Ohms -- ***Resistance*** to flow of electrons



What You Need to Know About Electronics







1KΩ: Brown, Black, Red, gold

Resistor / **Ohms**

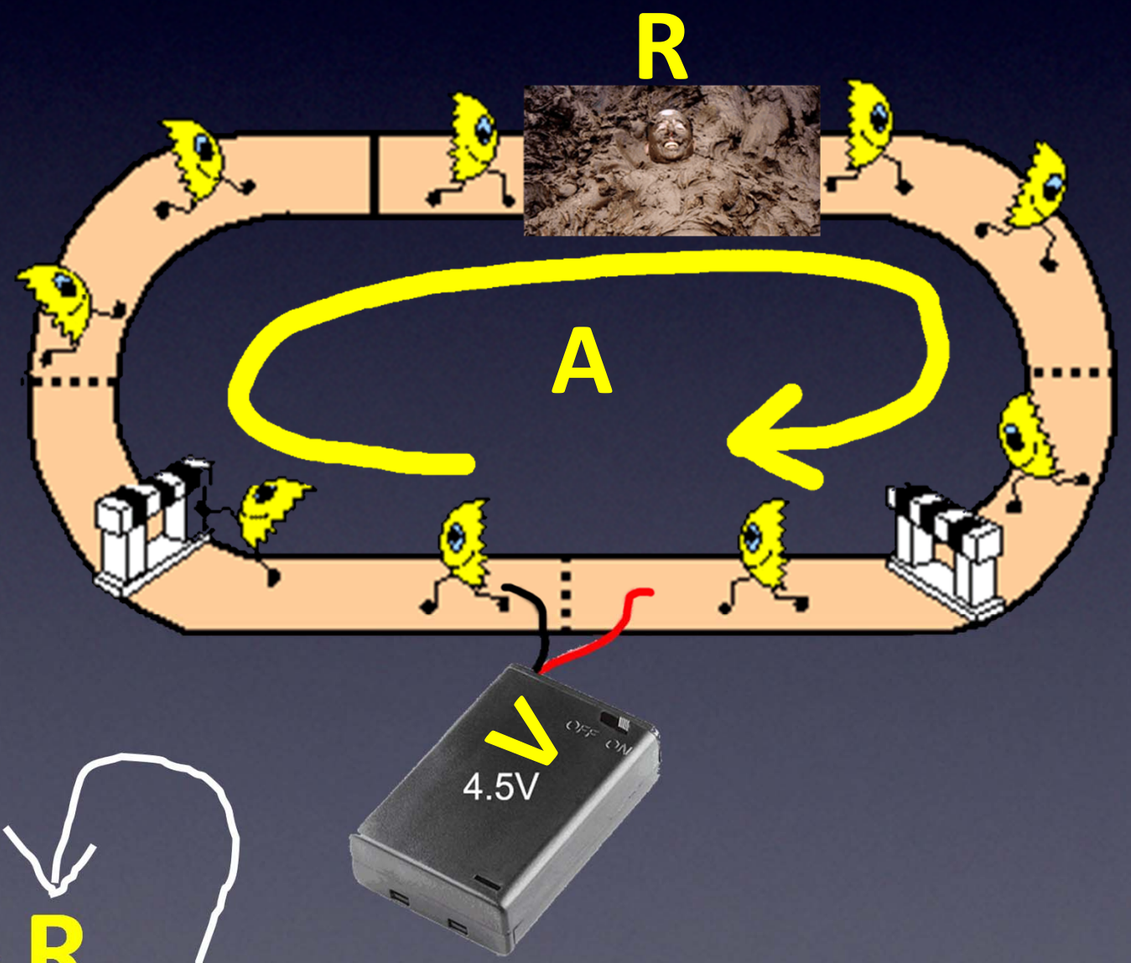
A Little About Electronics

Ohm's Law

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

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

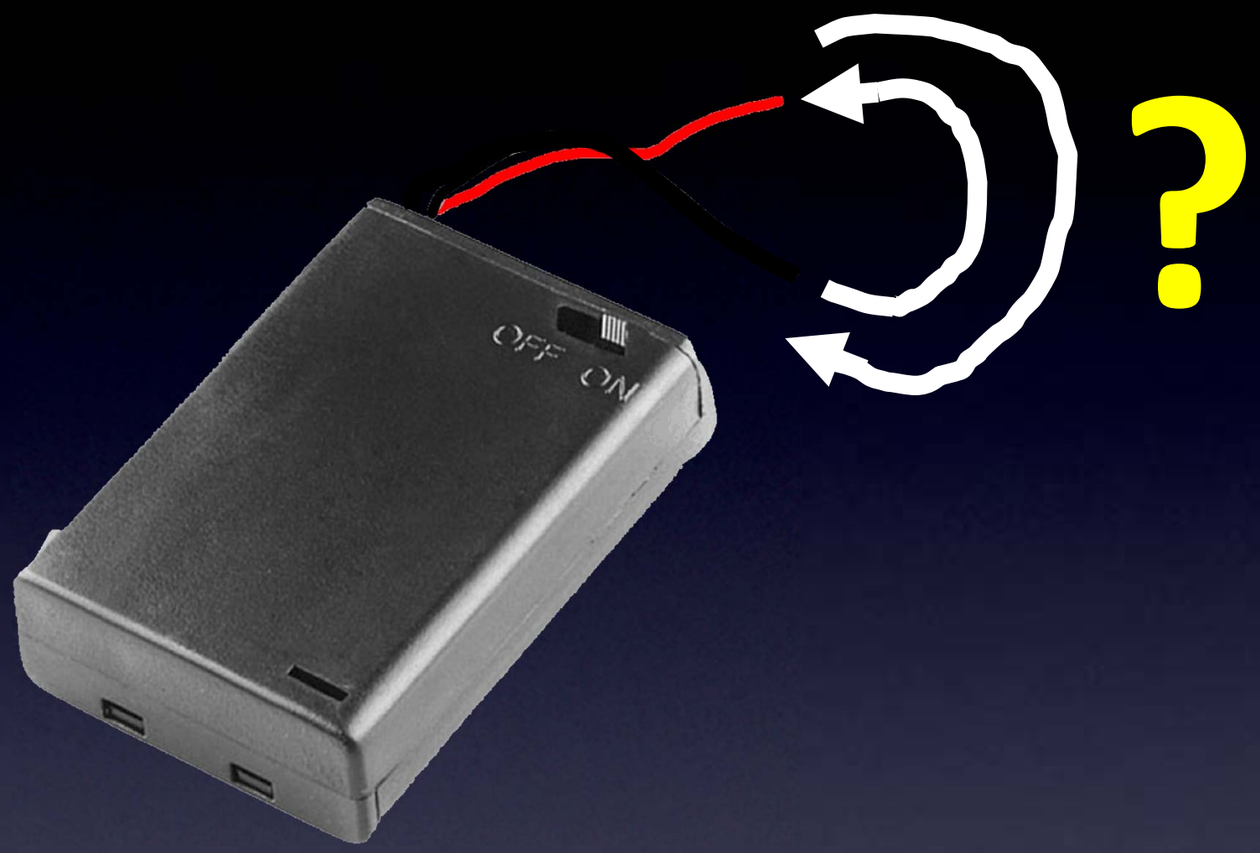
Ohms -- ***Resistance*** to flow of electrons



Volts = **A**mps x **R**

(Ohms)

A Little About Electronics

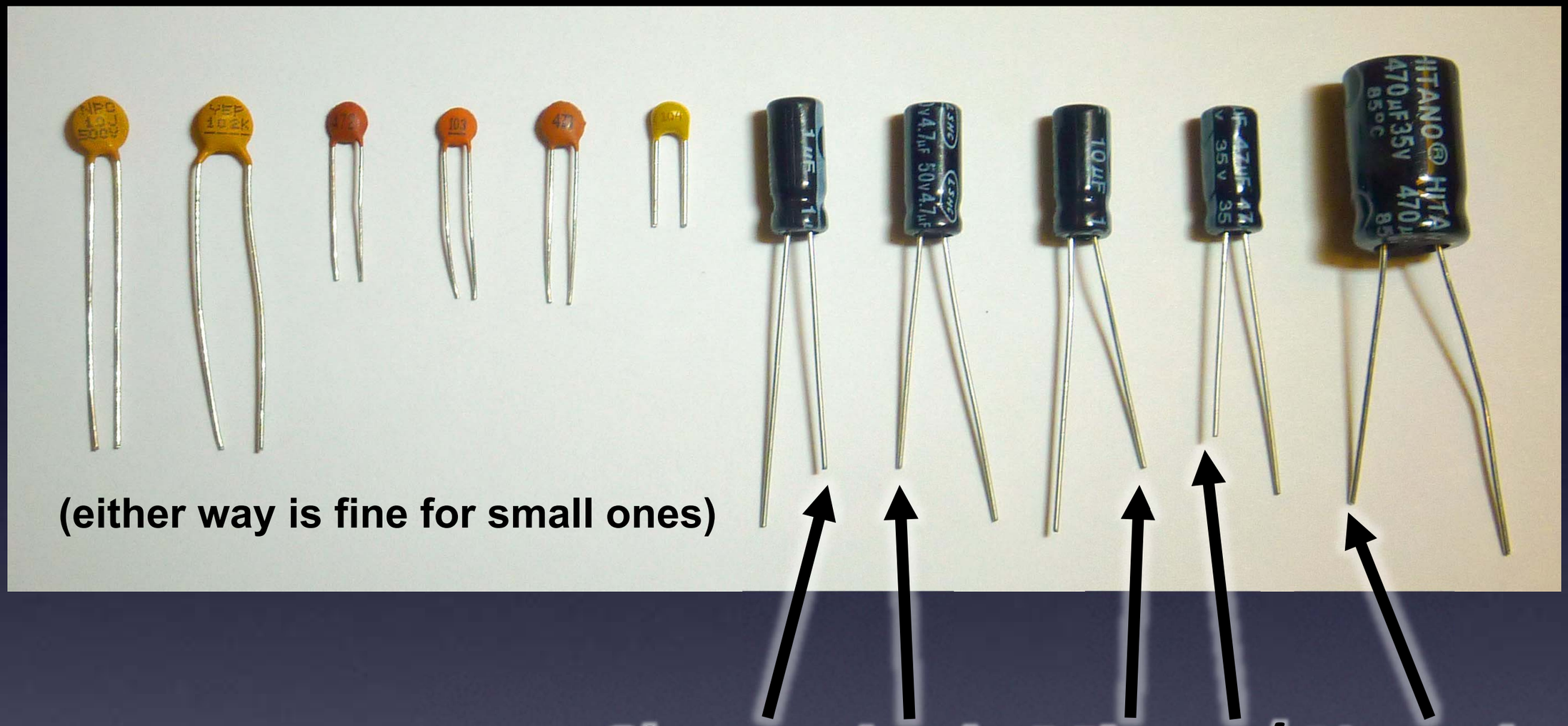


What happens?

Polarity

Power Supply – it matters how you connect it!

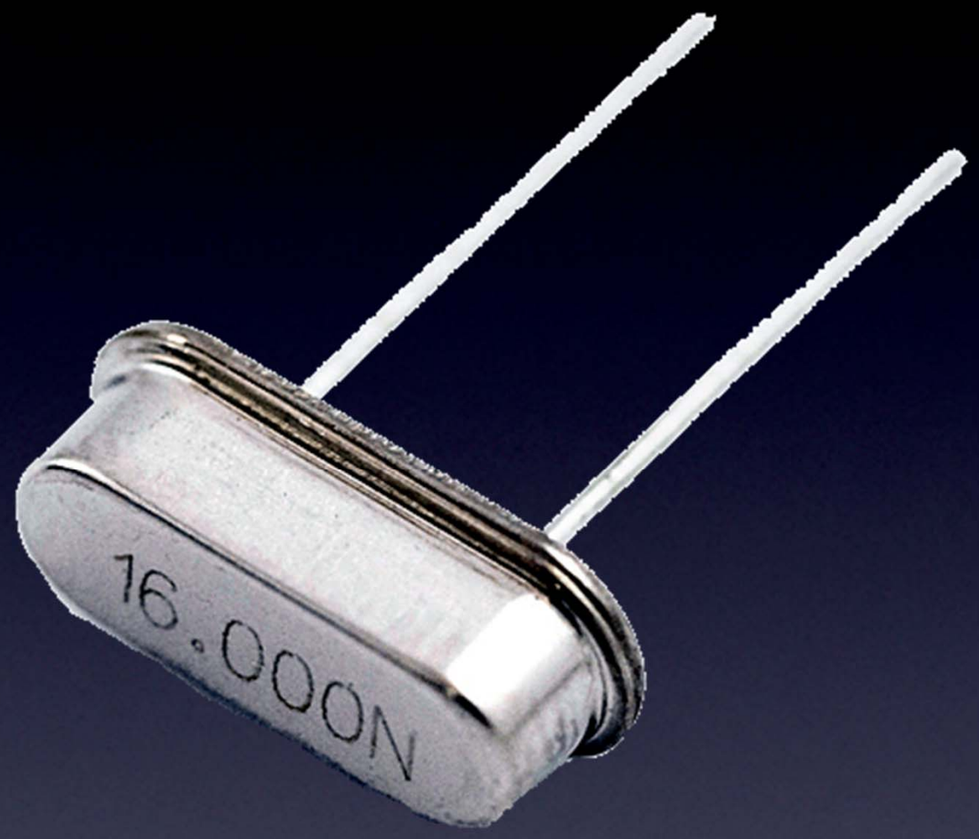
A Little About Electronics



Little buckets for electrons

Capacitor / **Farads**

A Little About Electronics

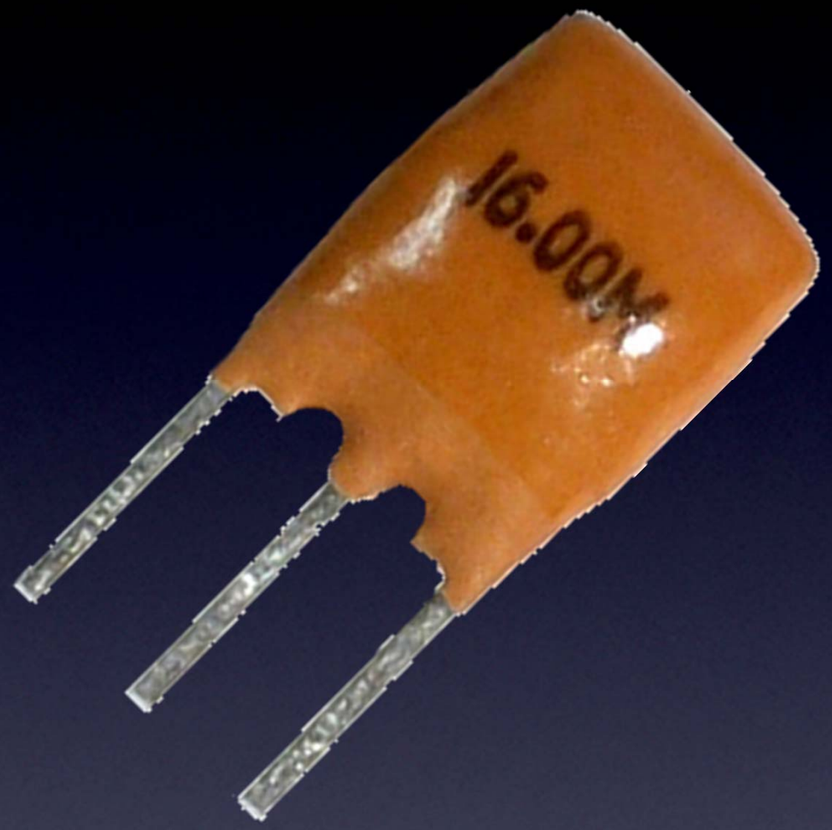


A precision cut piece of quartz crystal

For precise timing

Crystal / **Hertz**

A Little About Electronics

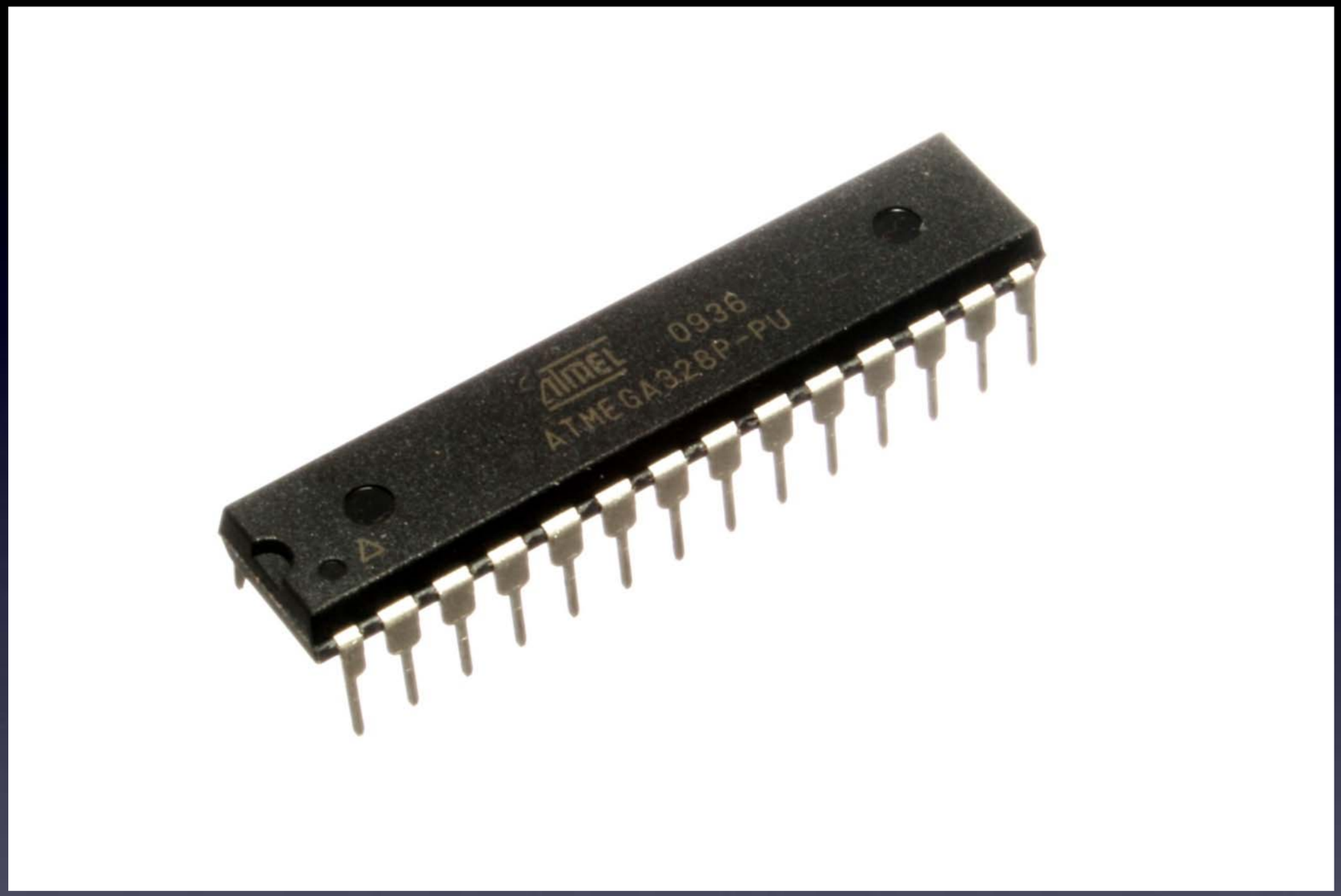


A bunch of resistors and capacitors

For precise timing (but less than a crystal)

Ceramic Resonator / **Hertz**

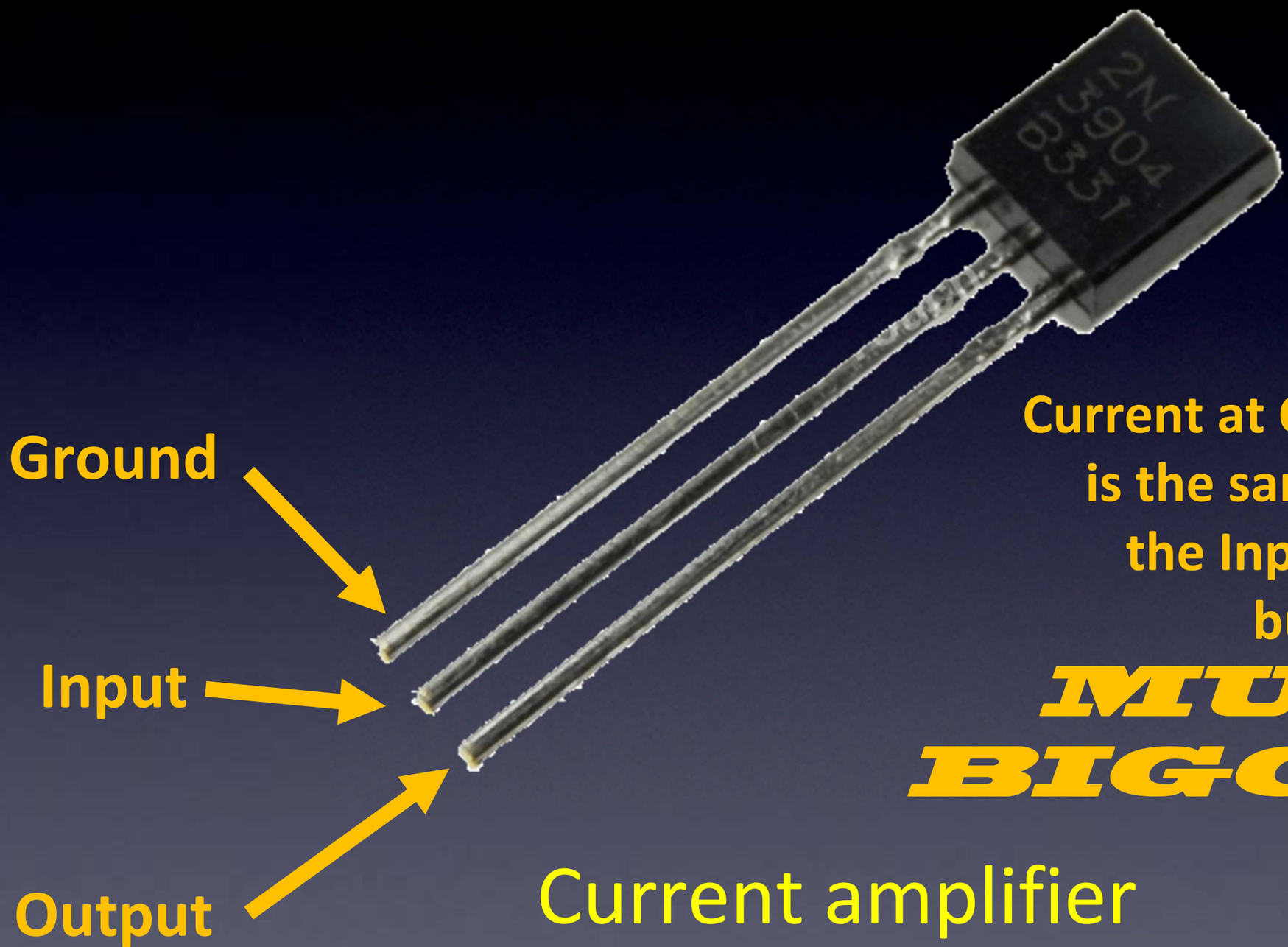
A Little About Electronics



A complete computer on a chip

Microcontroller

A Little About Electronics



Ground

Input

Output

Current at Output lead is the same as for the Input lead but

MUCH BIGGER !

Current amplifier

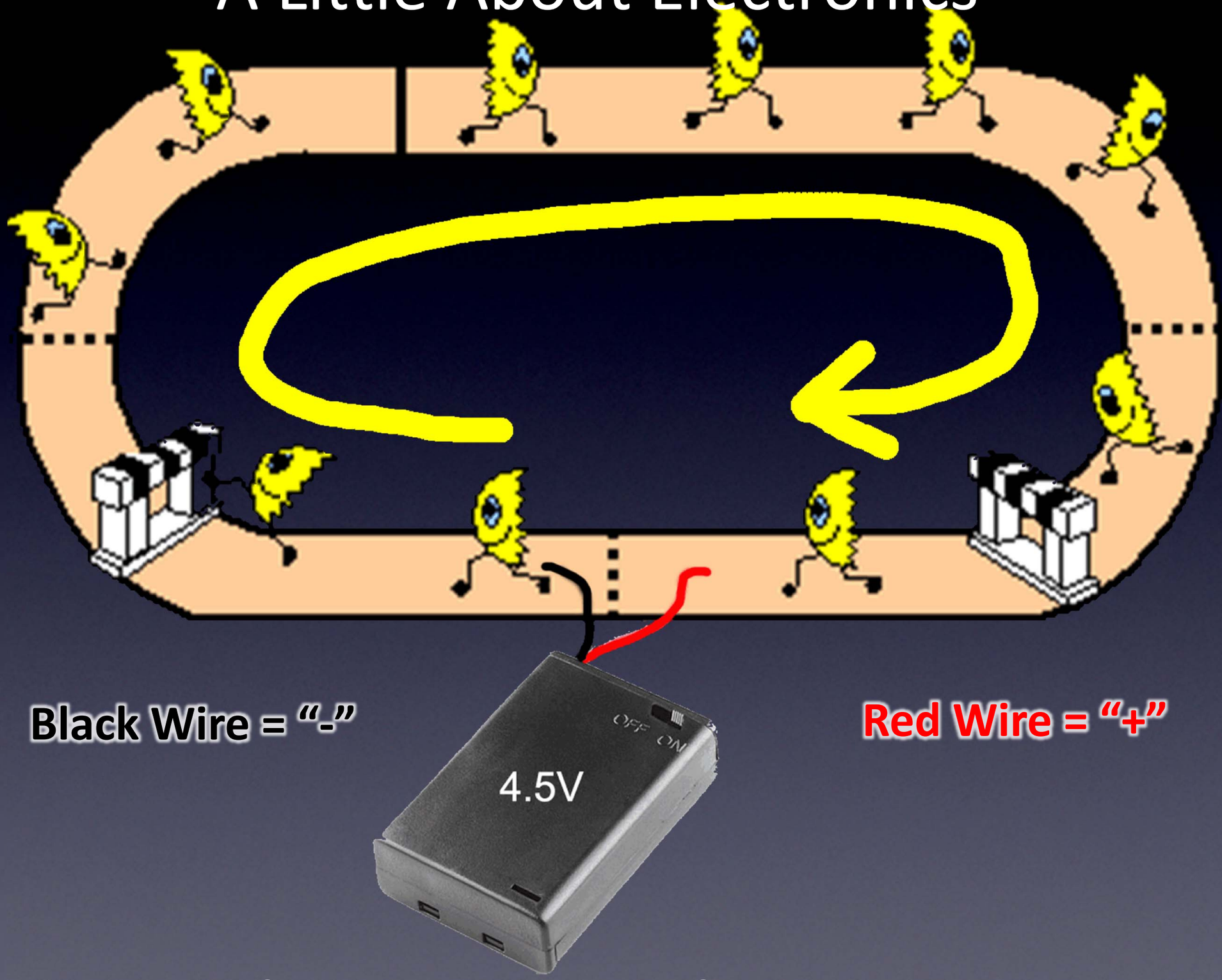
Transistor

LED

Plus / Positive (+)

Minus / Negative (-)

A Little About Electronics

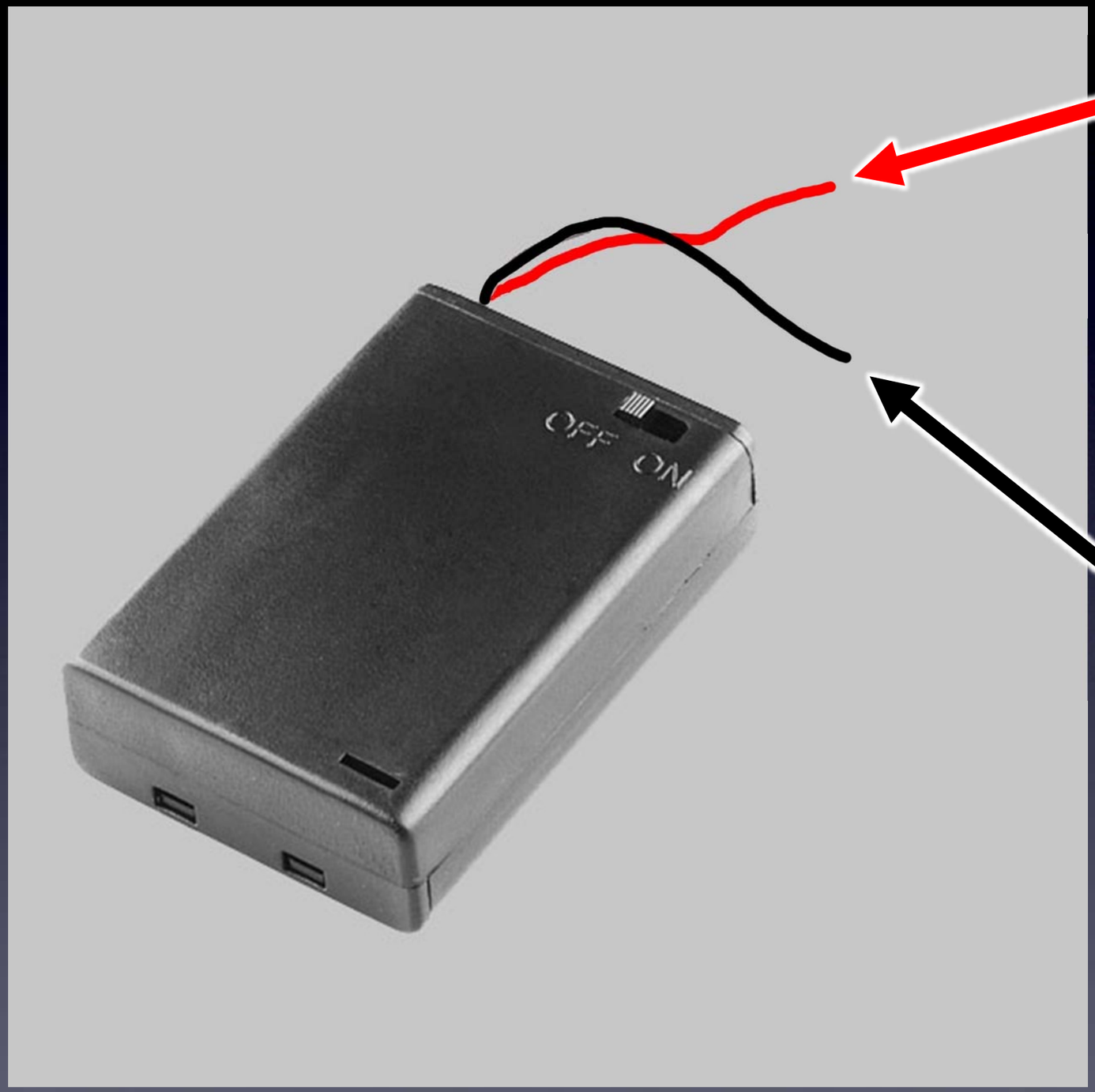


Black Wire = “-”

Red Wire = “+”

Power Supply – it matters how you connect it!

A Little About Electronics



<u>Red wire</u>:
Power,
Plus, Positive,
4.5V,
Vcc

<u>Black wire</u>:
Minus, Negative,
0V,
Ground (GND)

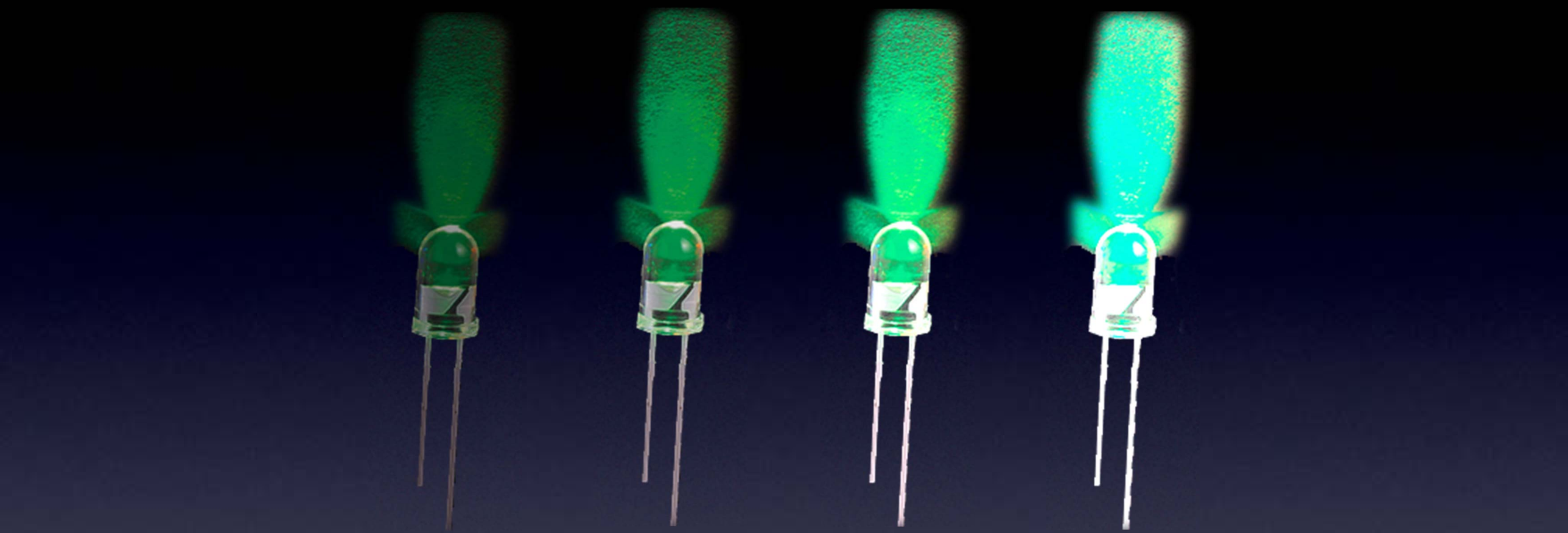
Power Supply – it matters how you connect it!

A Little About Electronics

Lots of different colored LEDs!

LED

A Little About Electronics



More current → More brightness! (until…)

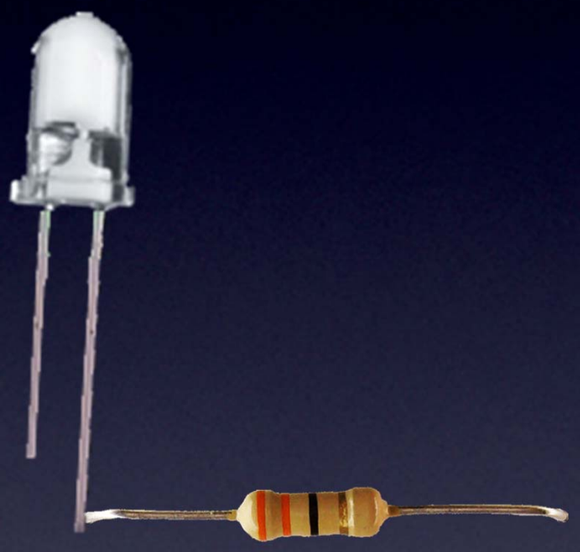
LED

A Little About Electronics

More current → More brightness! (until…)

LED

A Little About Electronics

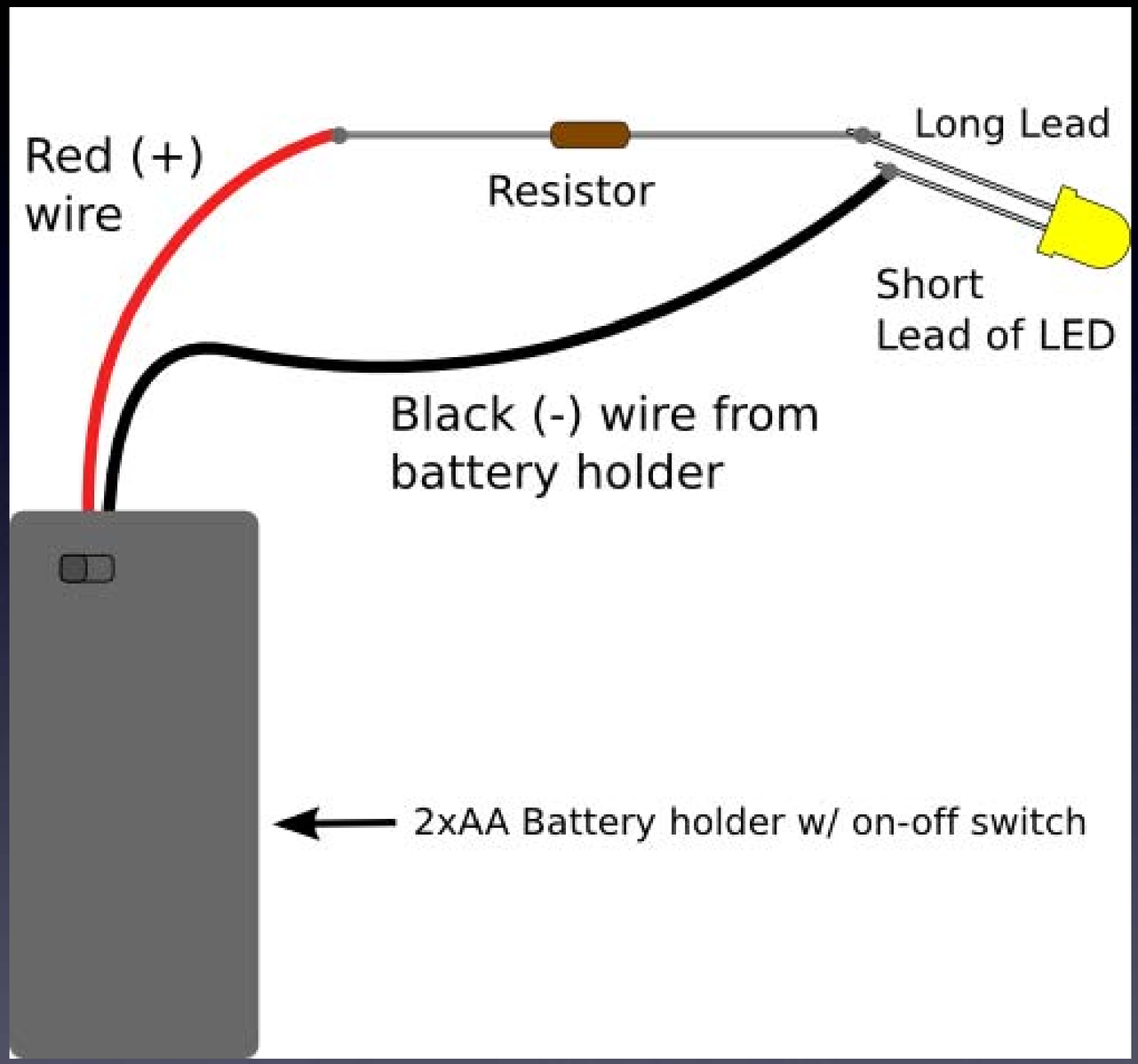


(with a resistor
so no magic smoke goes away)

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

LED

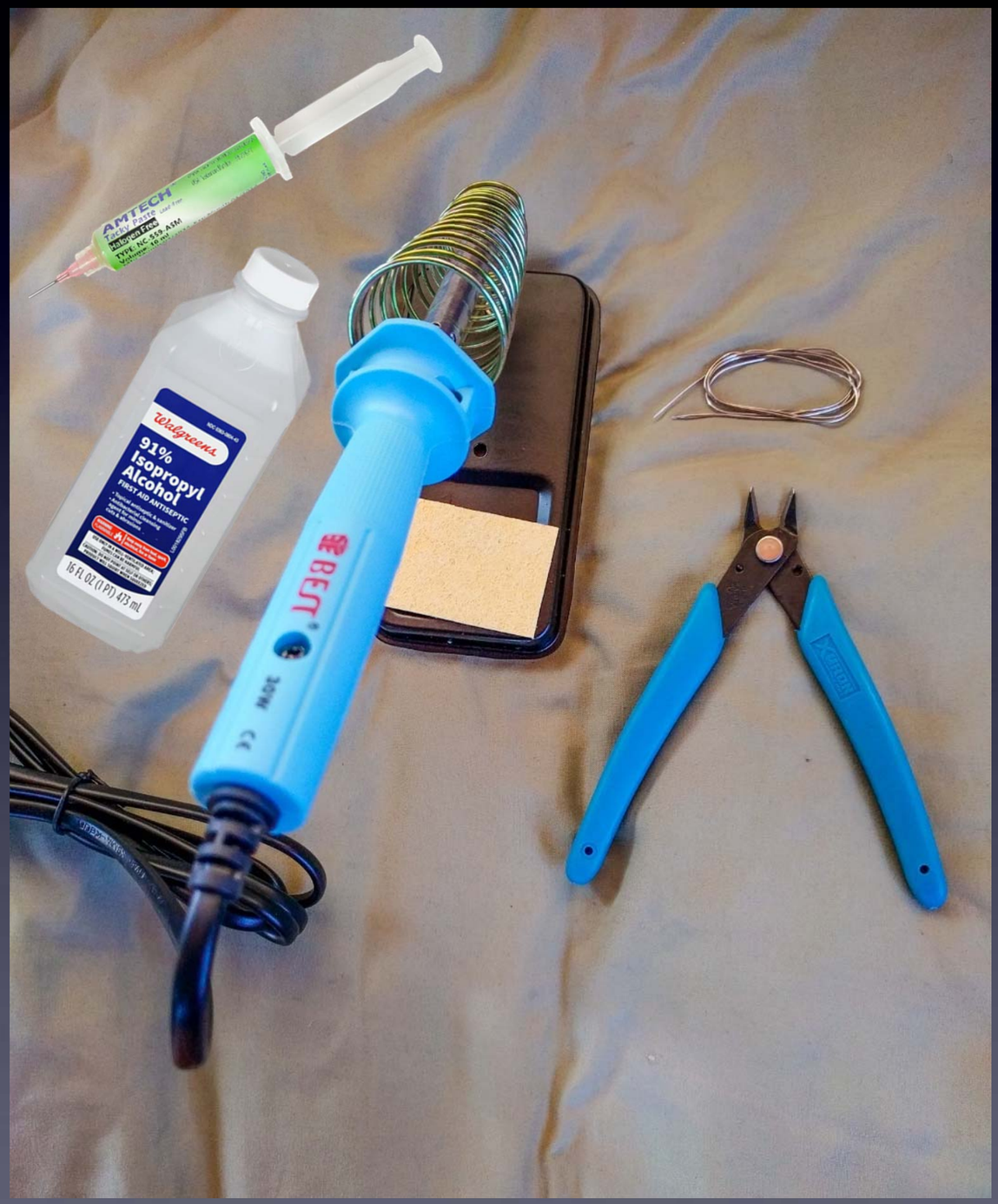
A Little About Electronics



Making an LED light up

(Don’t bring these home)

Tools



Learn To Solder

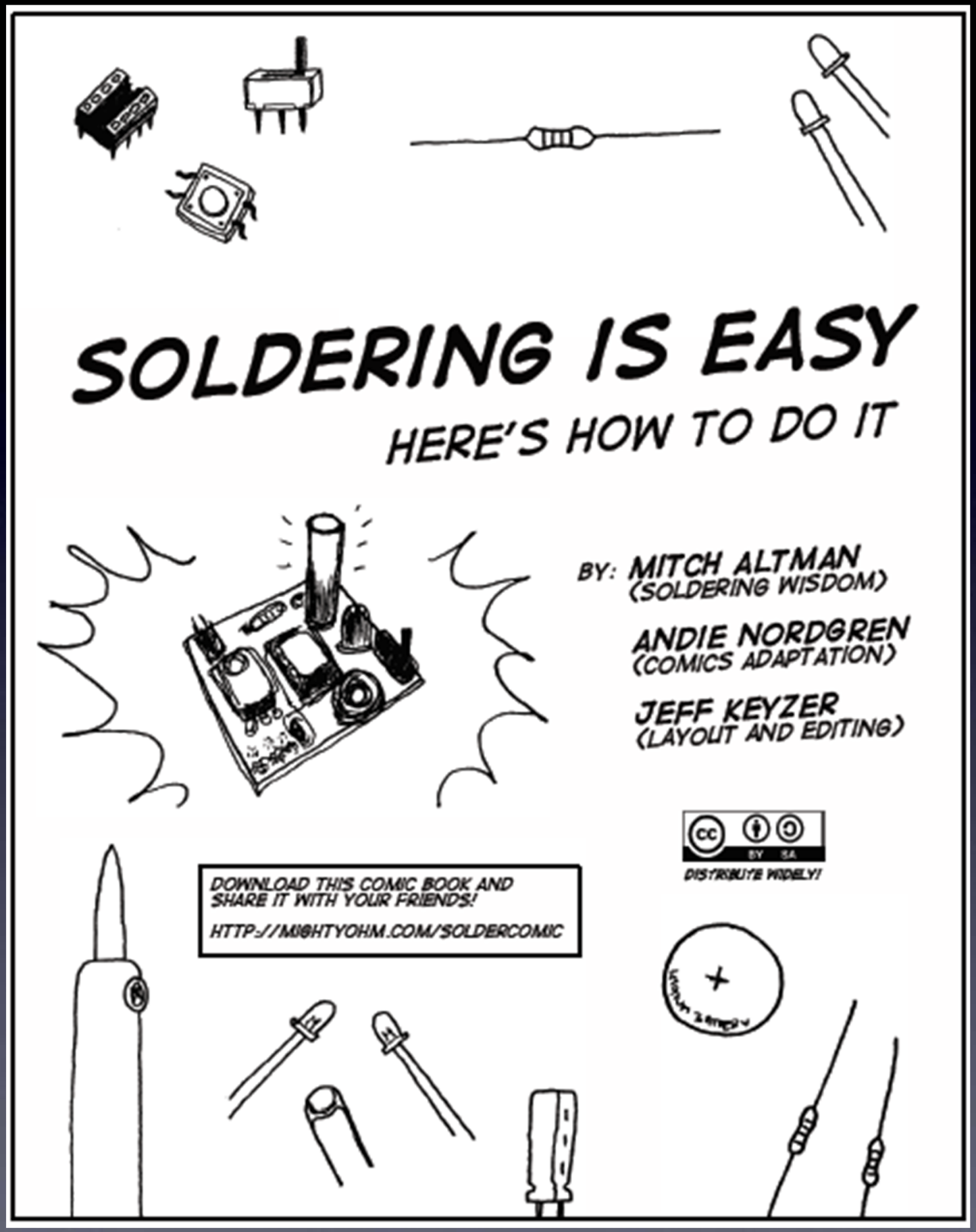
The following photos will
show you how to solder.

But feel free to download
the “Soldering Is Easy” comic book
for free!

(In many different languages.)

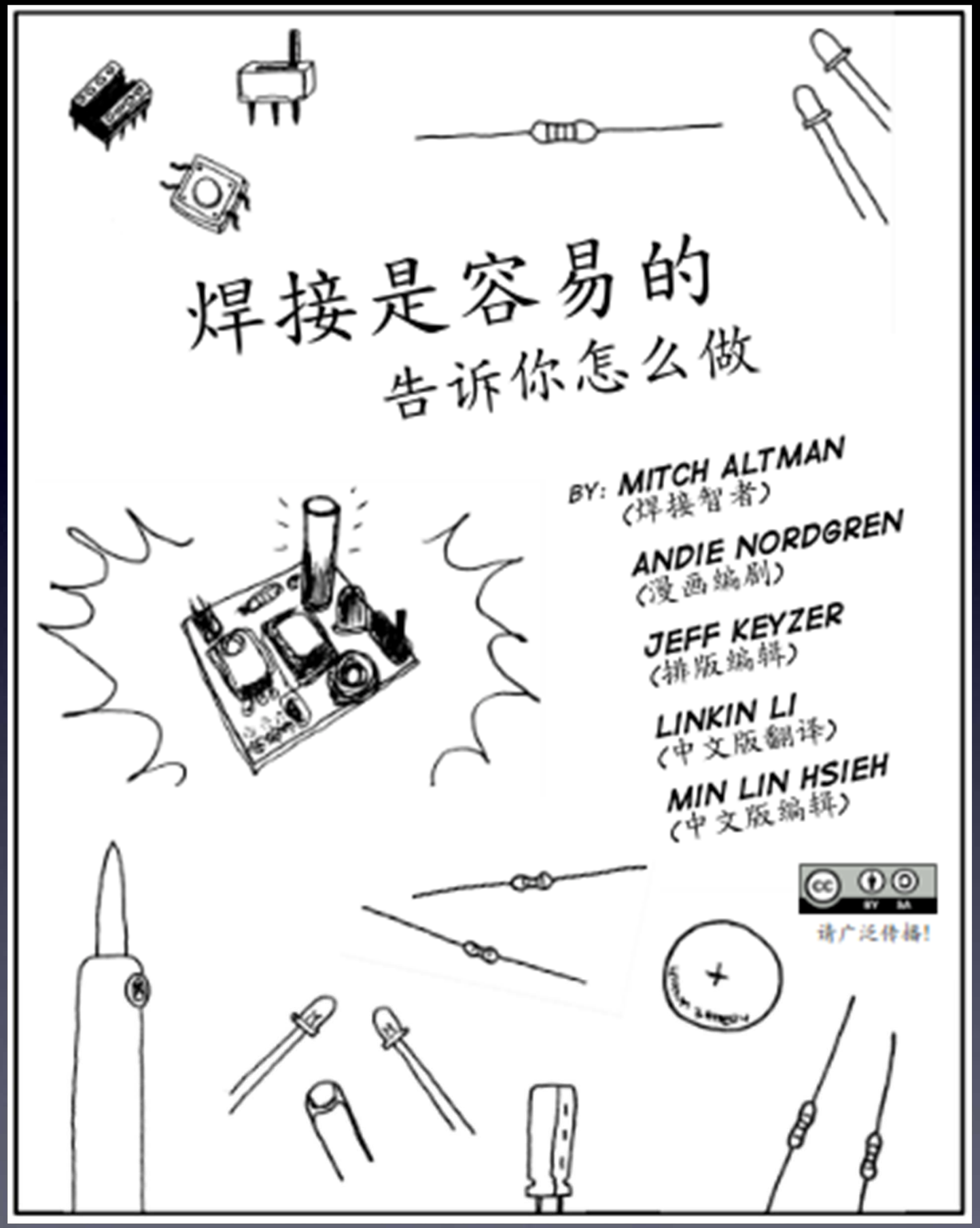
download for free at:
http://mightyohm.com/soldercomic

Learn To Solder



download for free at:
http://mightyohm.com/soldercomic
(In many different languages.)

Learn To Solder



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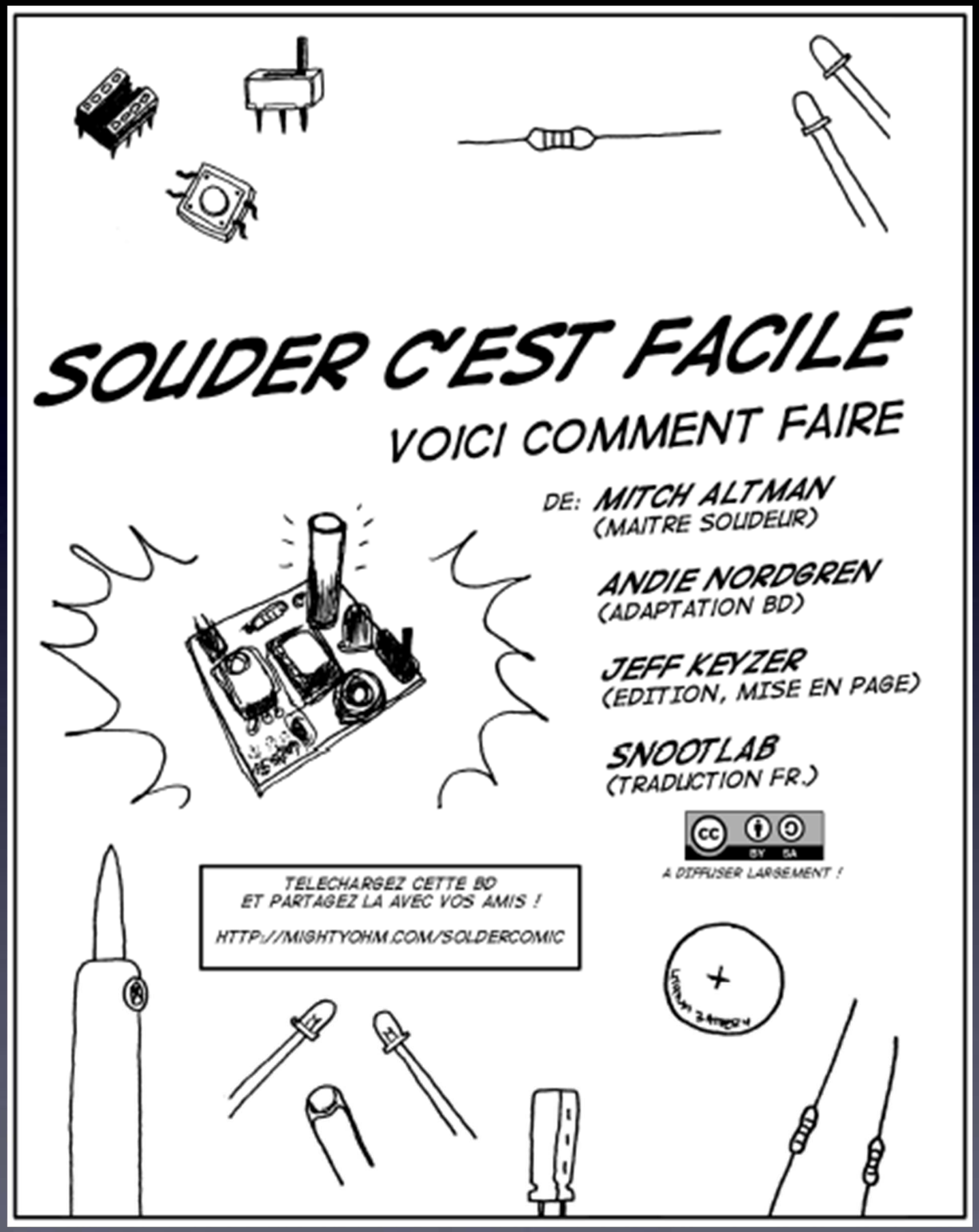
Learn To Solder



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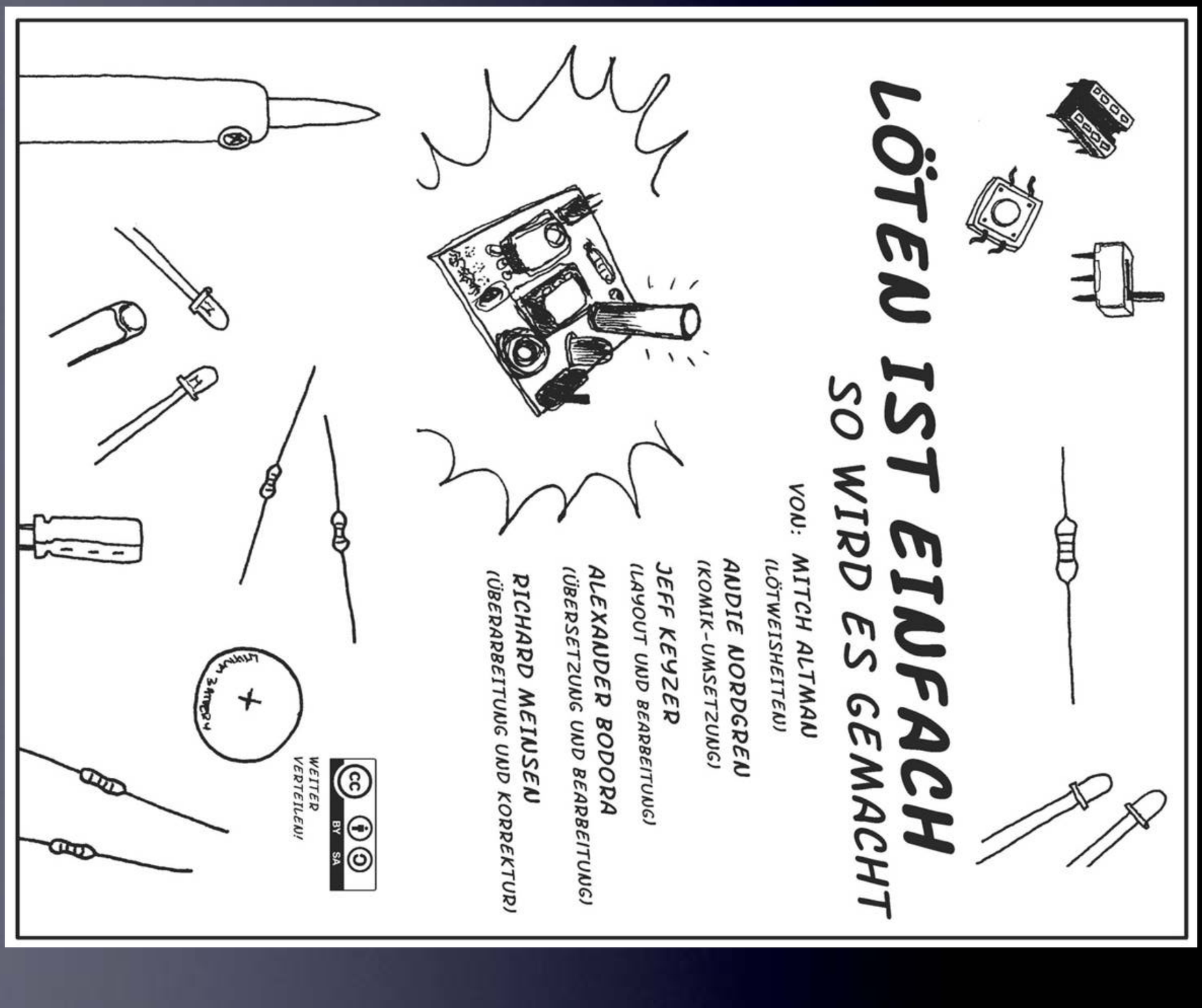
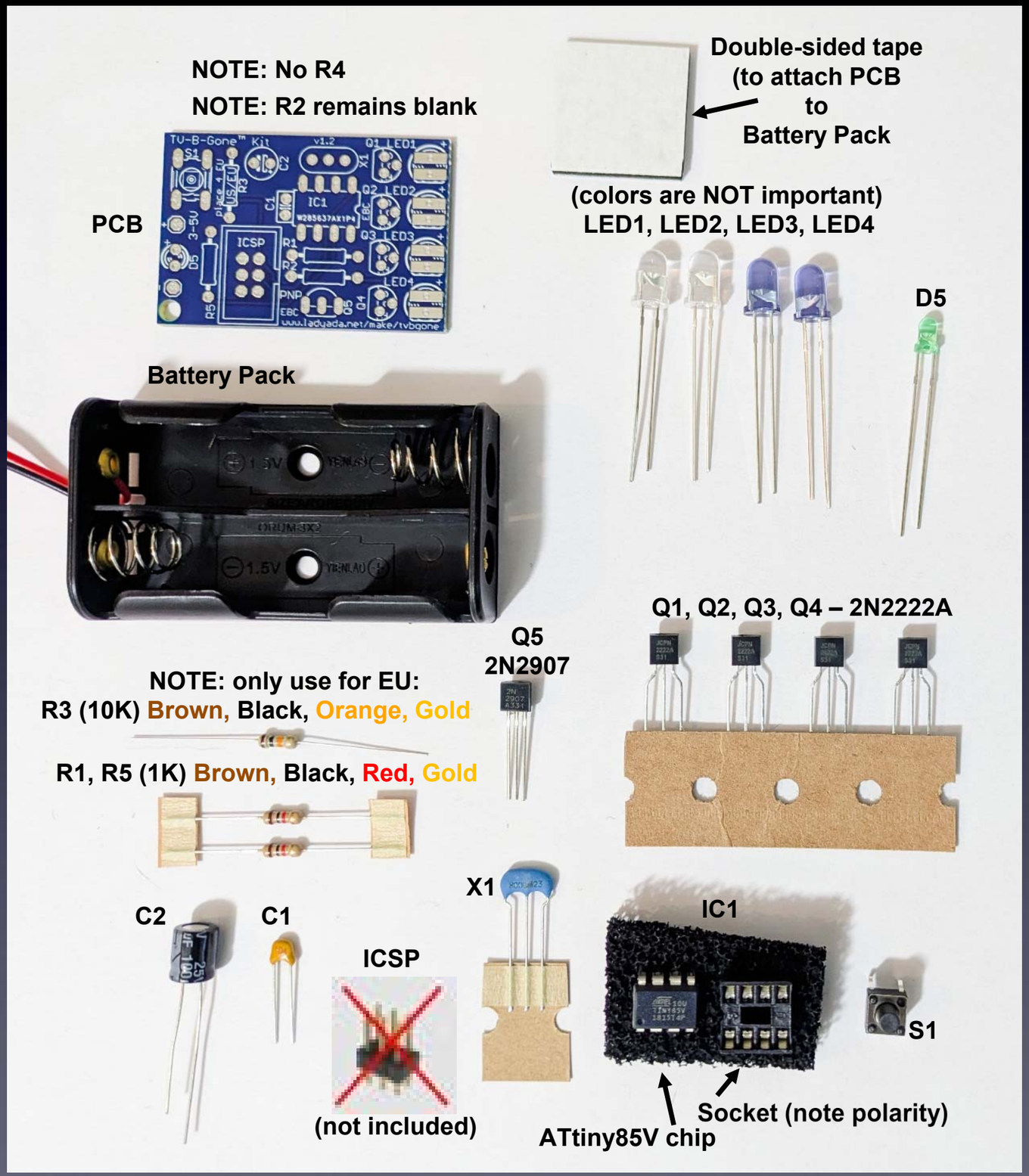


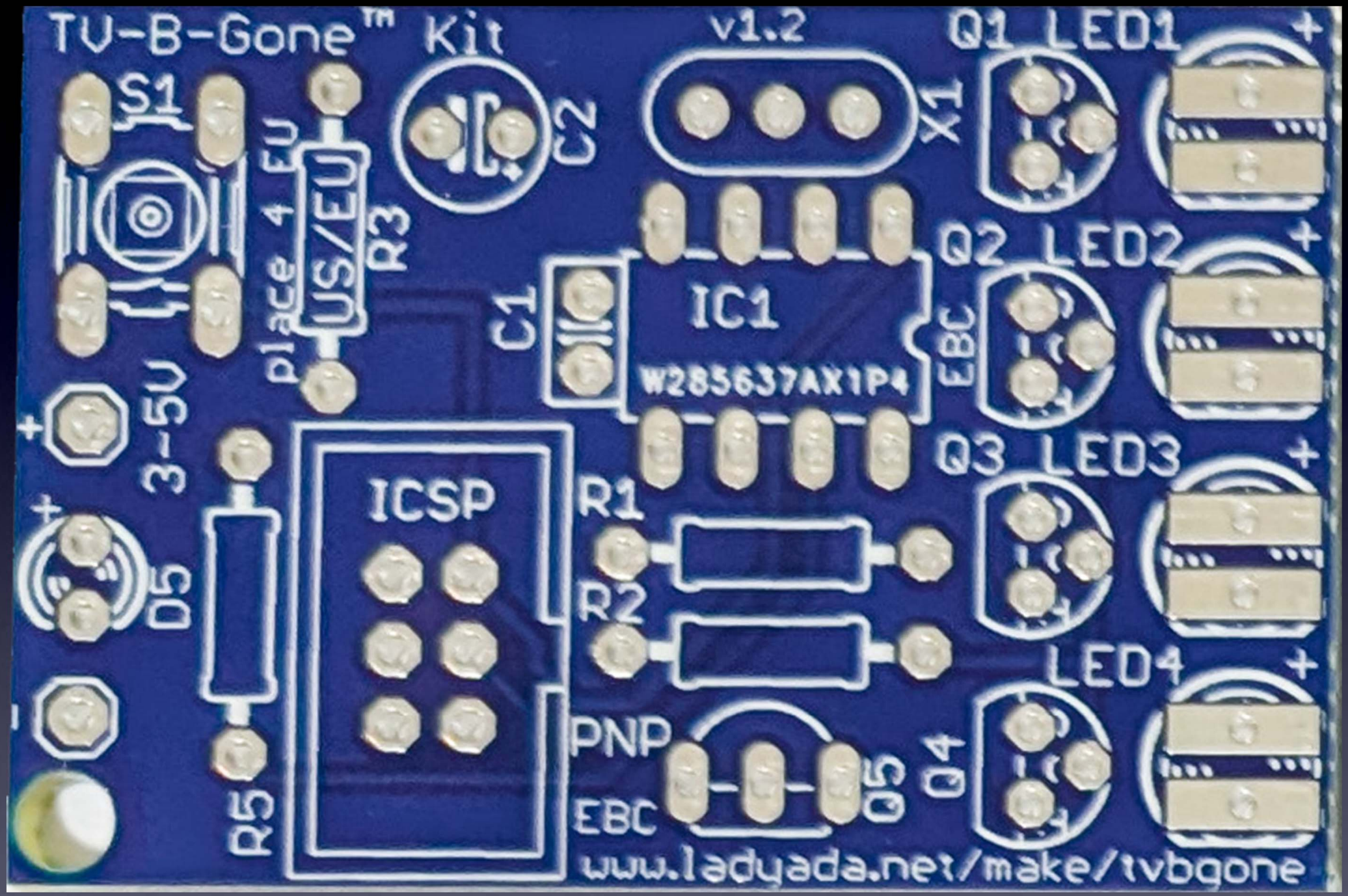
download for free at:
http://mightyohm.com/soldercomic

(In many different languages.)

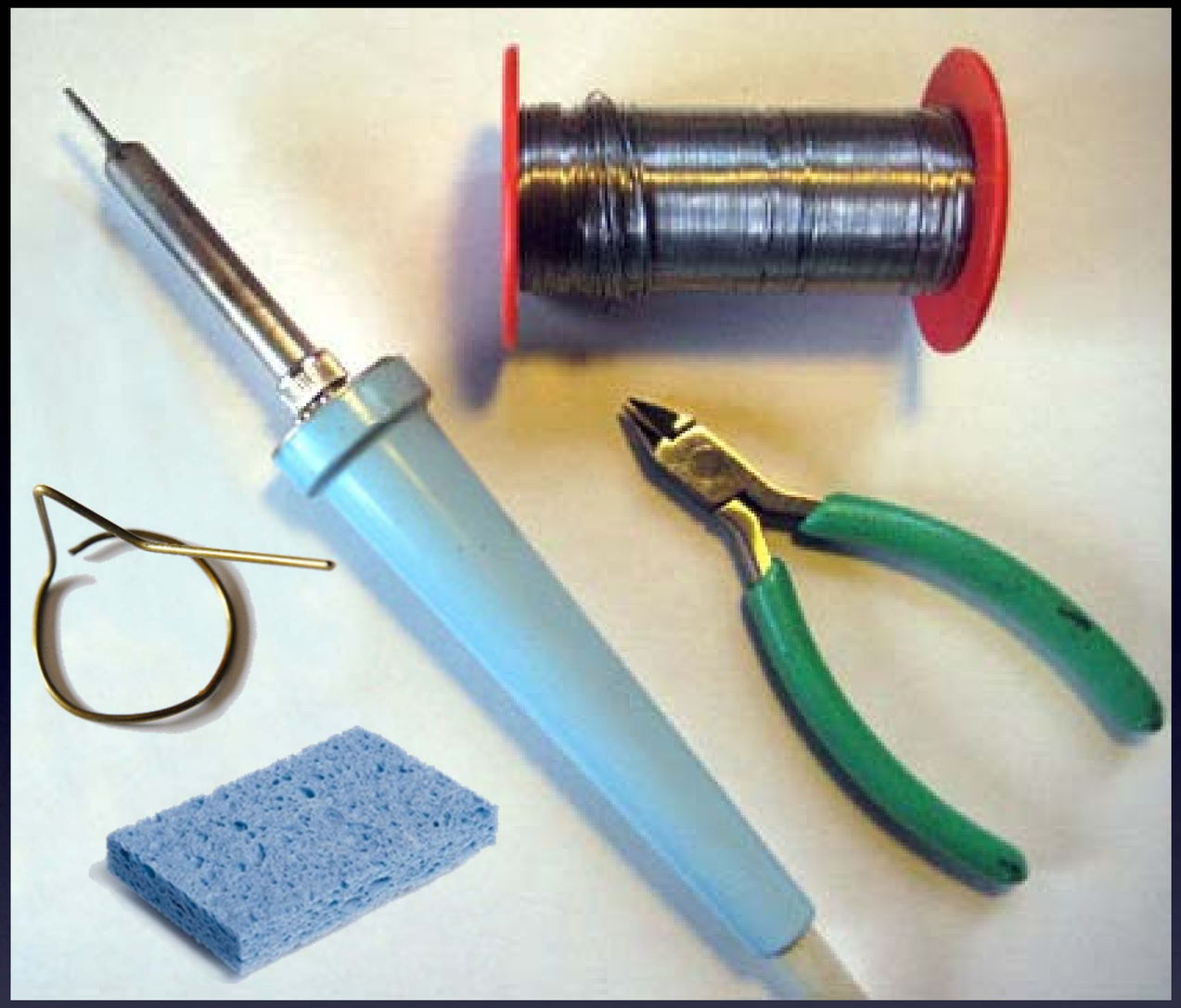
Parts



All of the parts



The board we'll solder the parts to



Note:

Since we are using Lead-Free solder it is very helpful to also have flux paste in a syringe And Isopropyl Alcohol

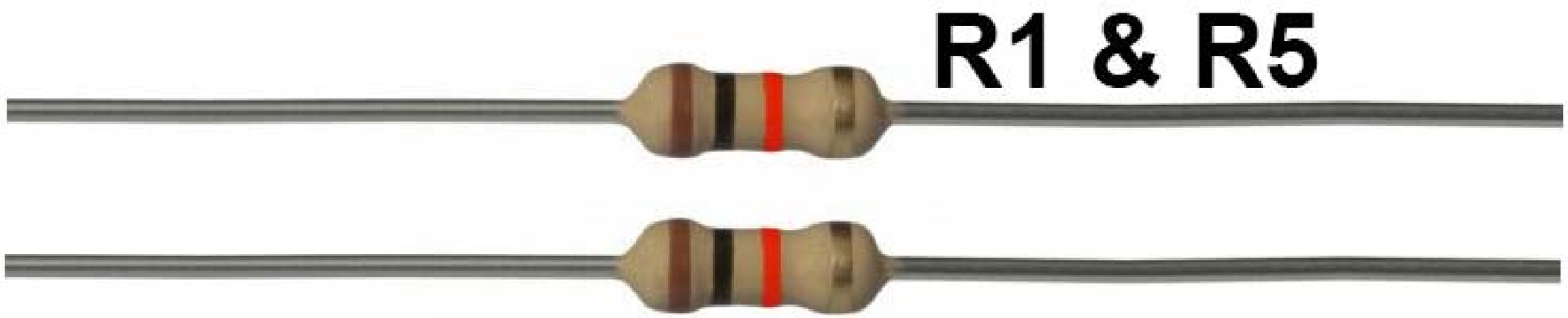
The tools you'll need:

- soldering Iron (35W or less)
- solder (*more details coming*)
- soldering iron stand
- cellulose kitchen sponge *(not plastic!)*
- *small* wire cutter

3 Resistors in the kit

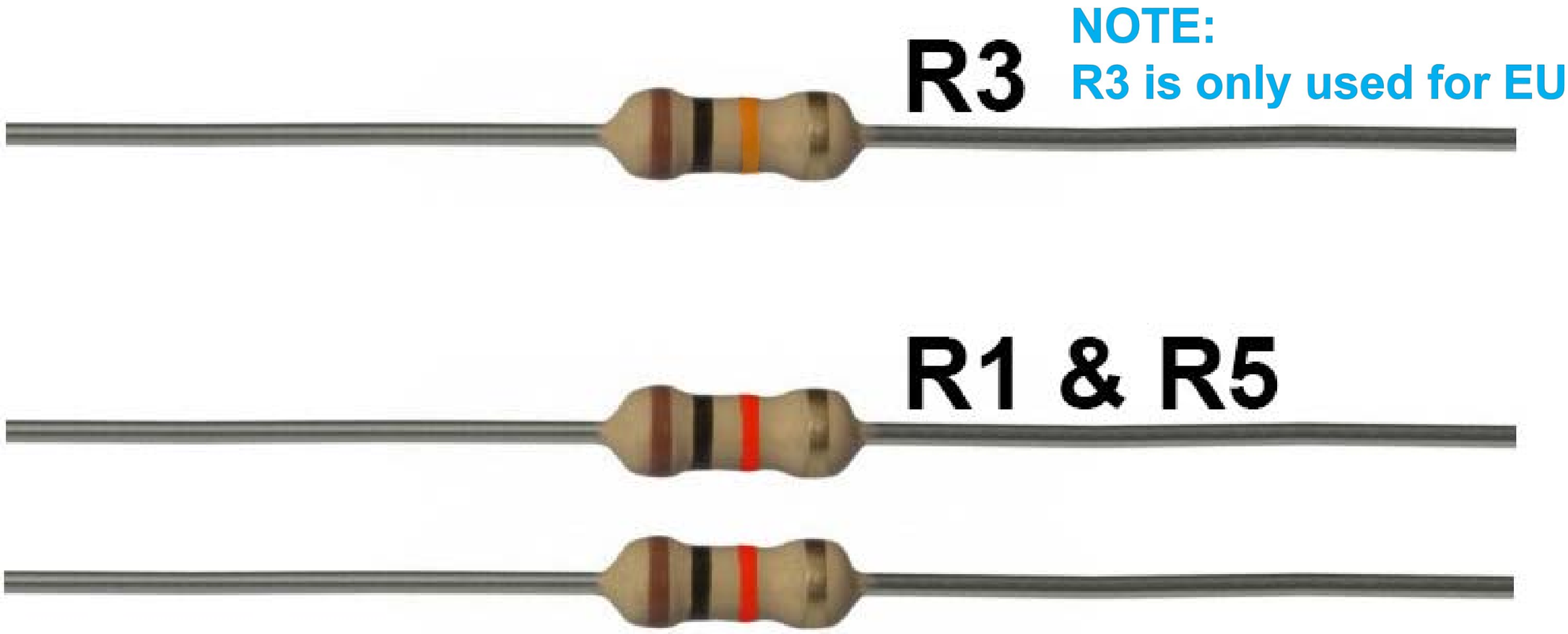
NOTE:
R3 is only used for EU

Brown, Black, Orange

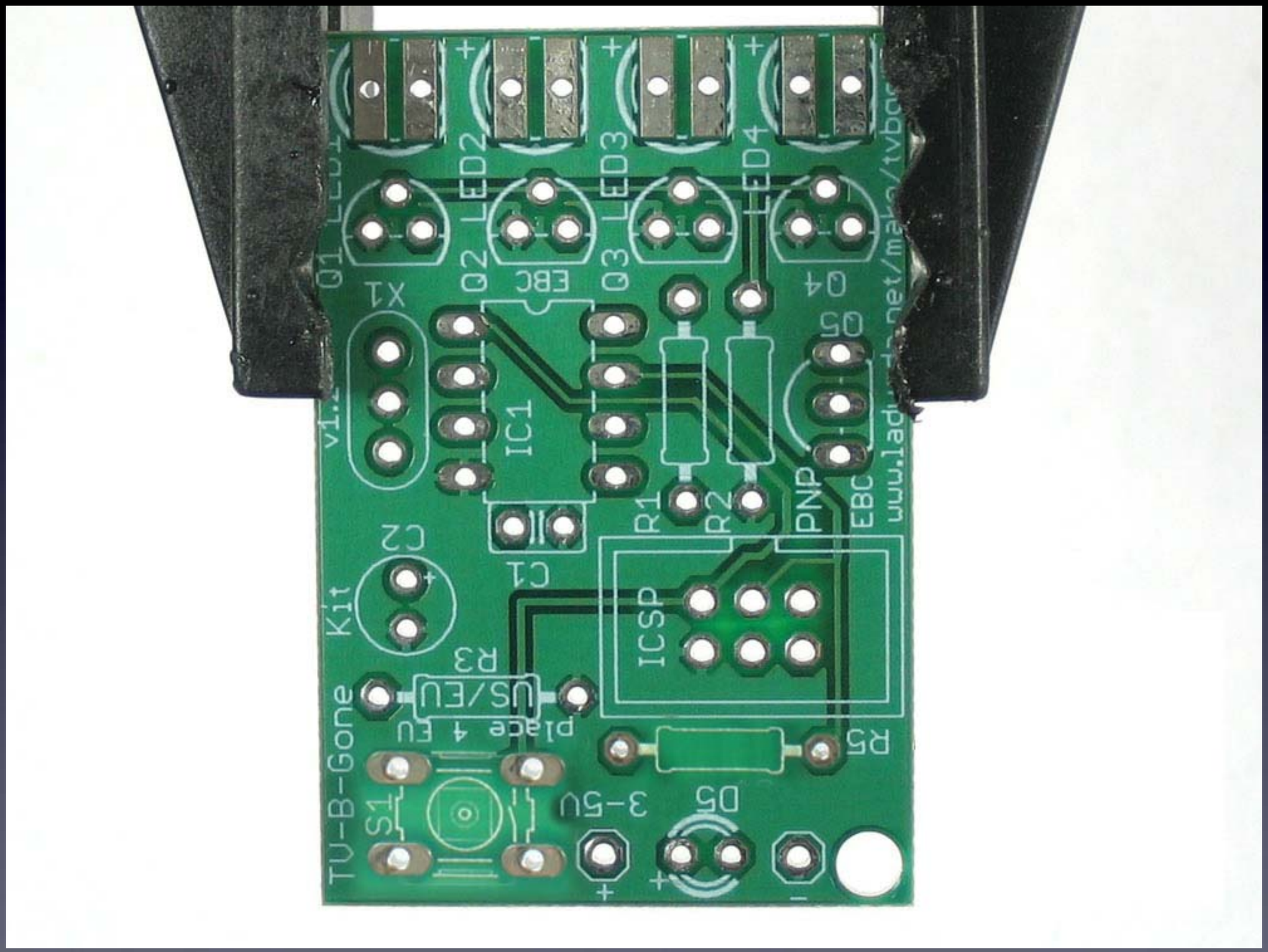


Brown, Black, Red

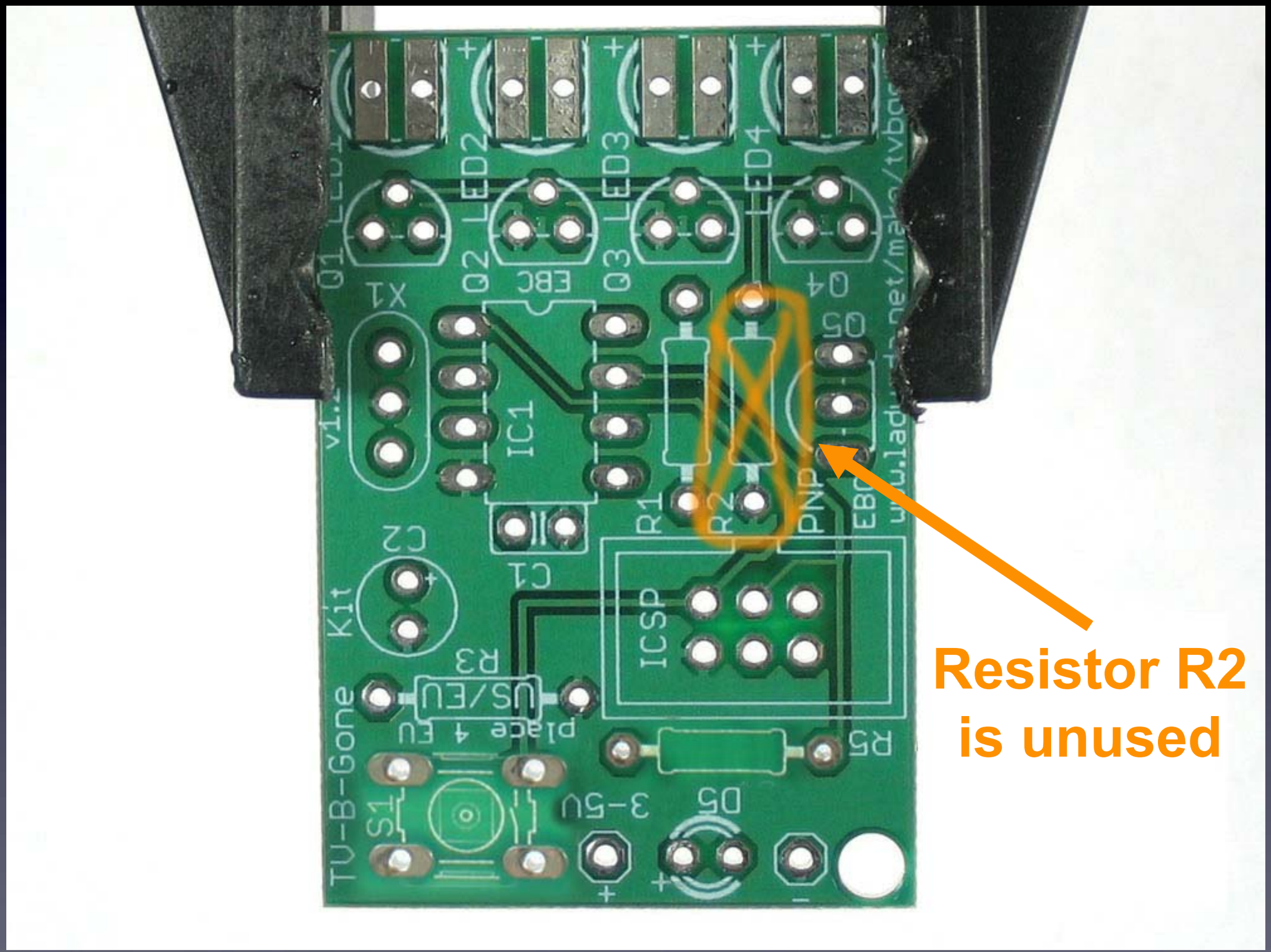
Look at the shape of these parts



See the same shapes on the PCB



Do NOT put anything in R2



Resistor R2 is unused

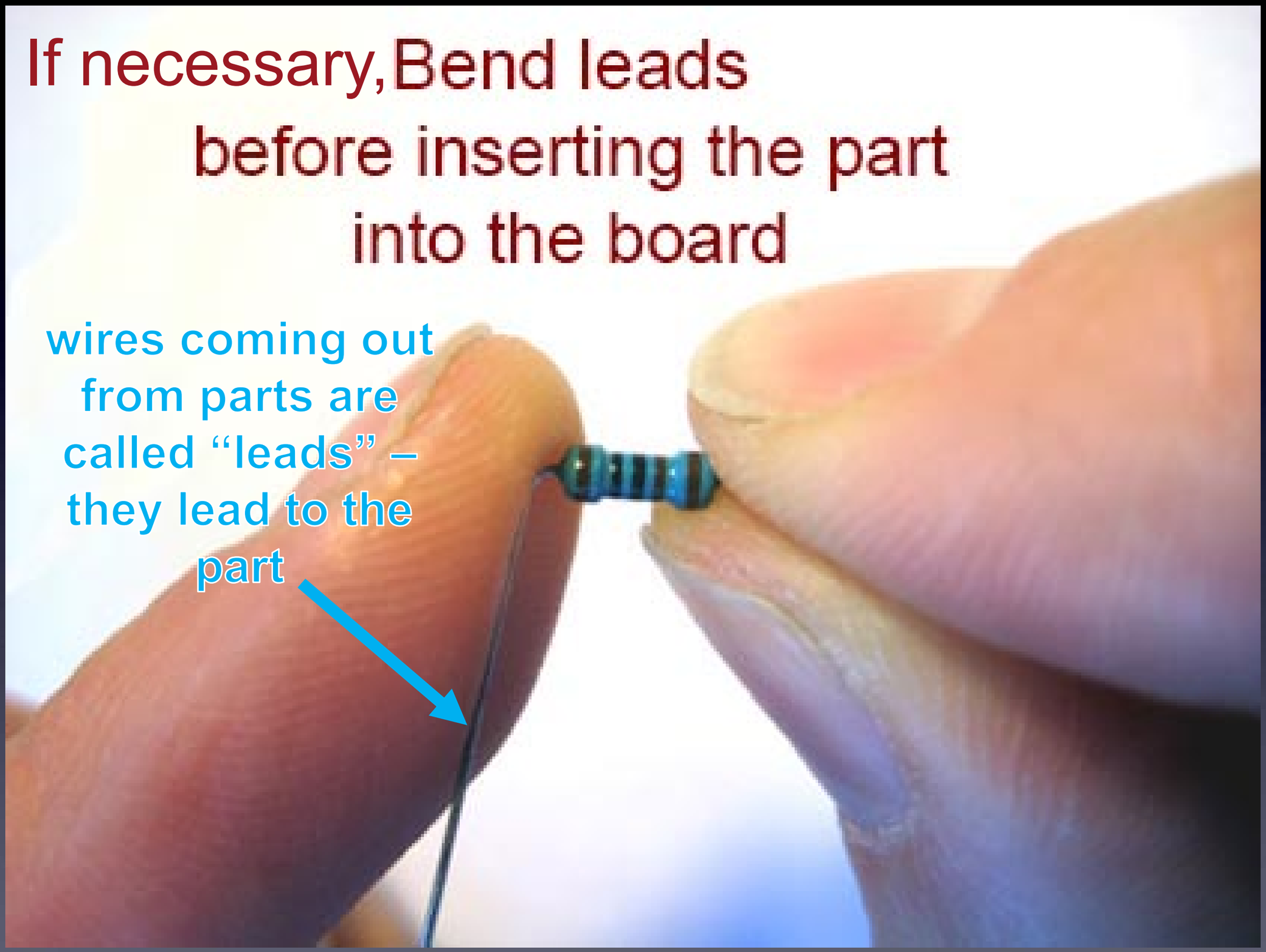
We will start with Resistors R1 & R5

R1 & R5

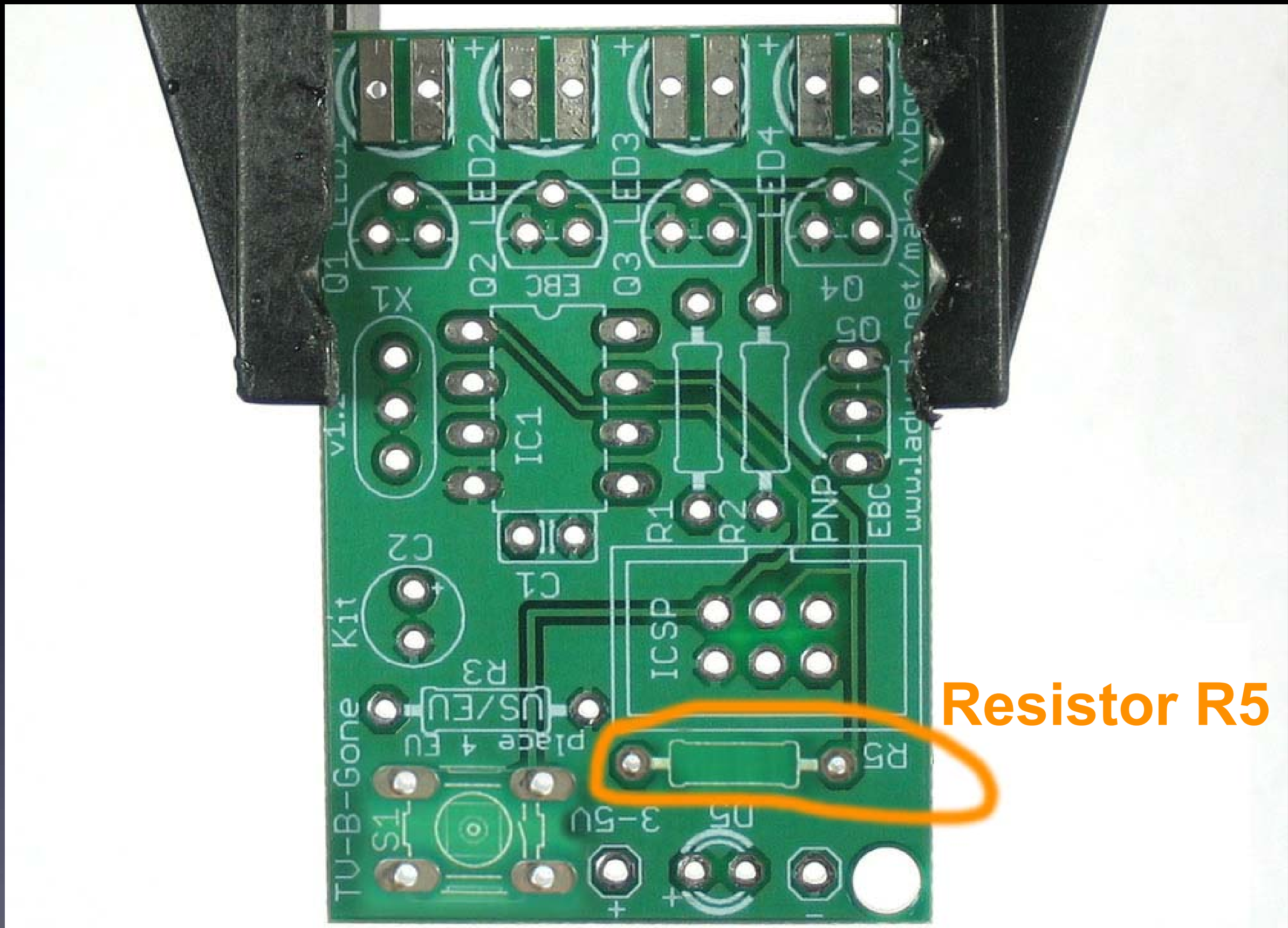
1K Ohm: Brown, Black, Red

NOTE: Do NOT use the [Brown, Black, Orange] resistor !

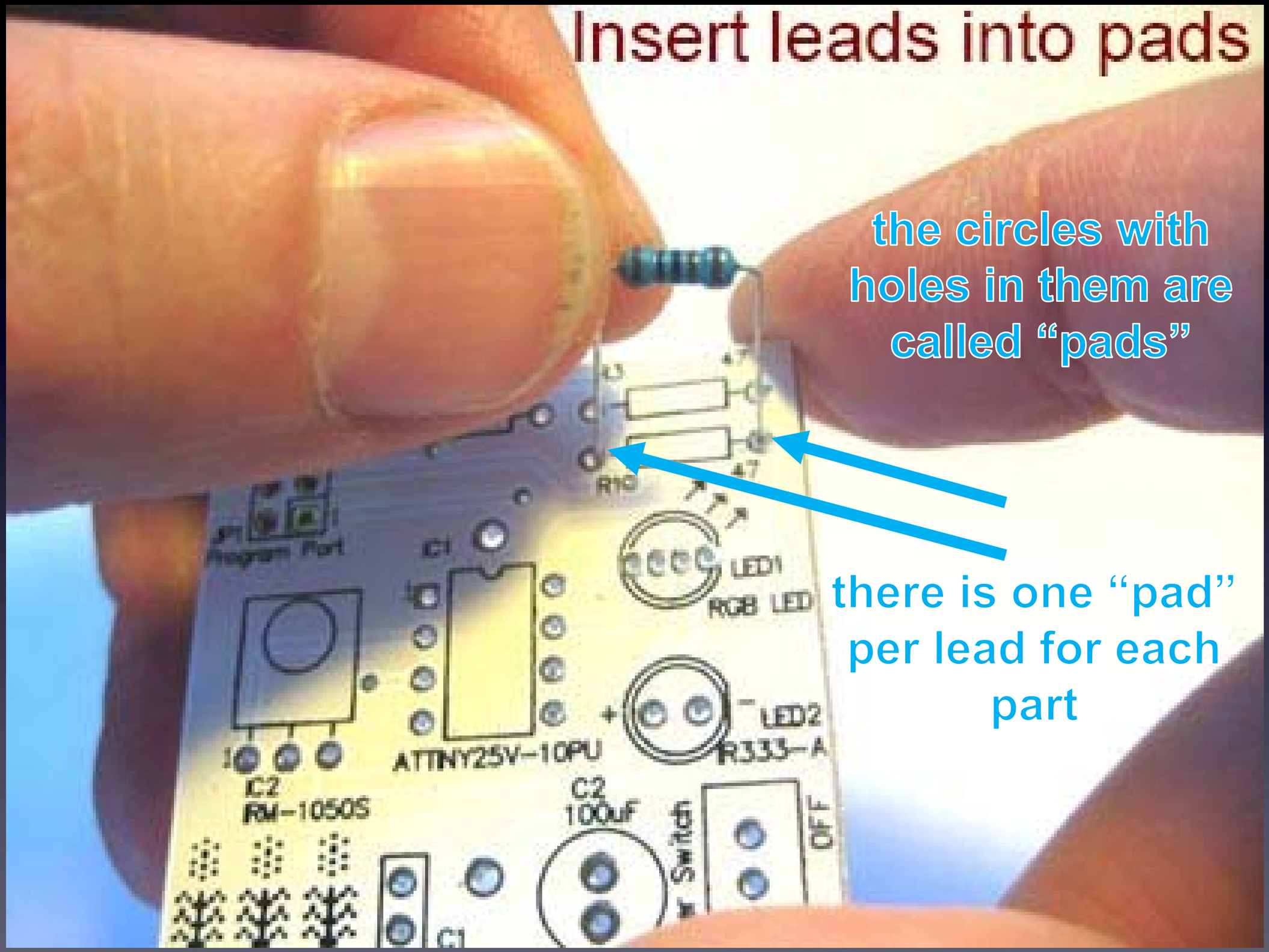
Some parts, such as resistors, need their leads bent first

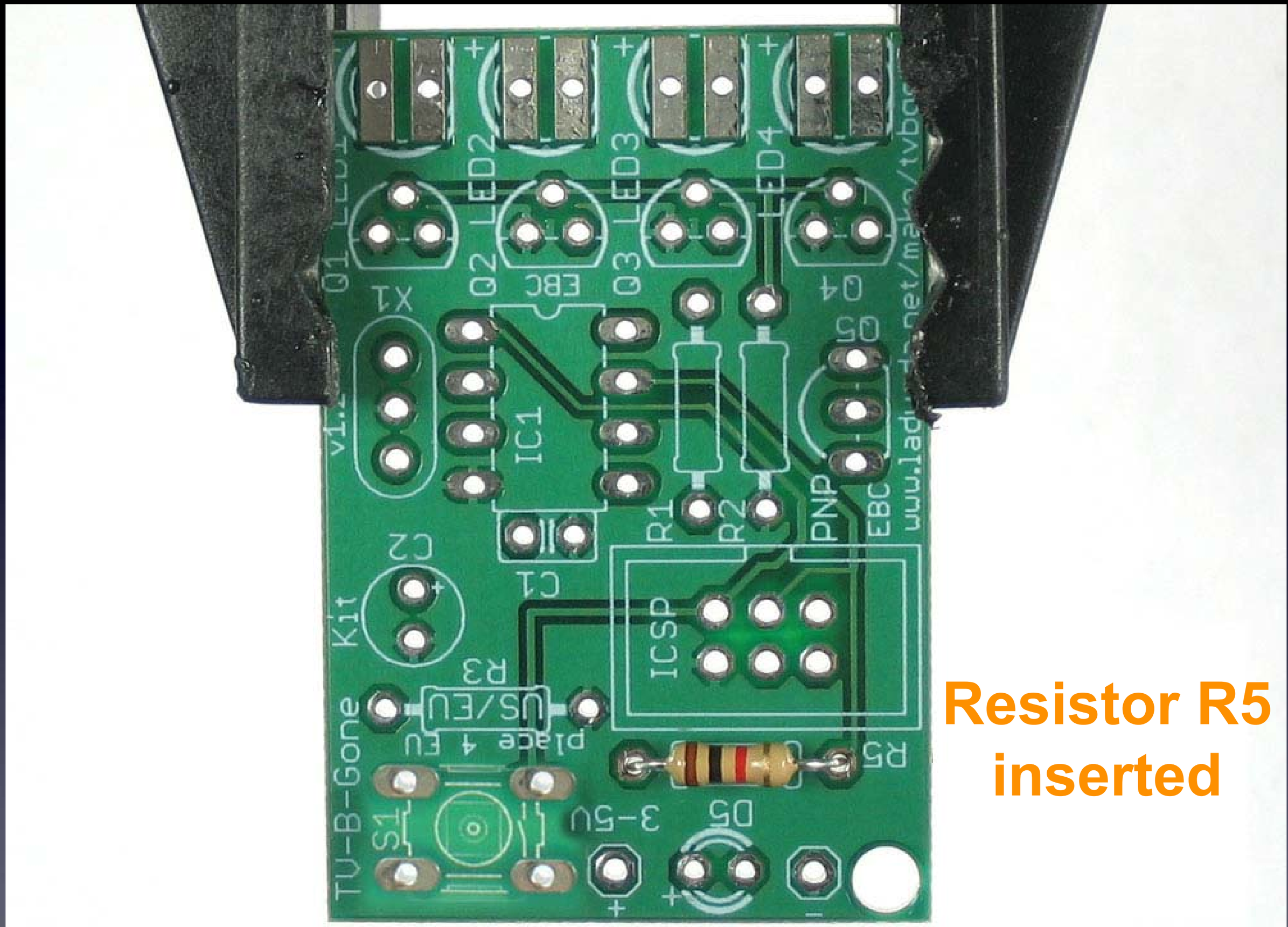


R5 – this is how it will look before inserting it into the board


Q1
LED2
Q2
LED3
Q3
LED4
Q4
X1
EBC
IC1
Q5
R1
R2
PNP
EBC
C2
C1
Kit
ICSP
R3
US/EU
place 4 EU
R5
TV-B-Gone
S1
3-5V
D5
+
+
-

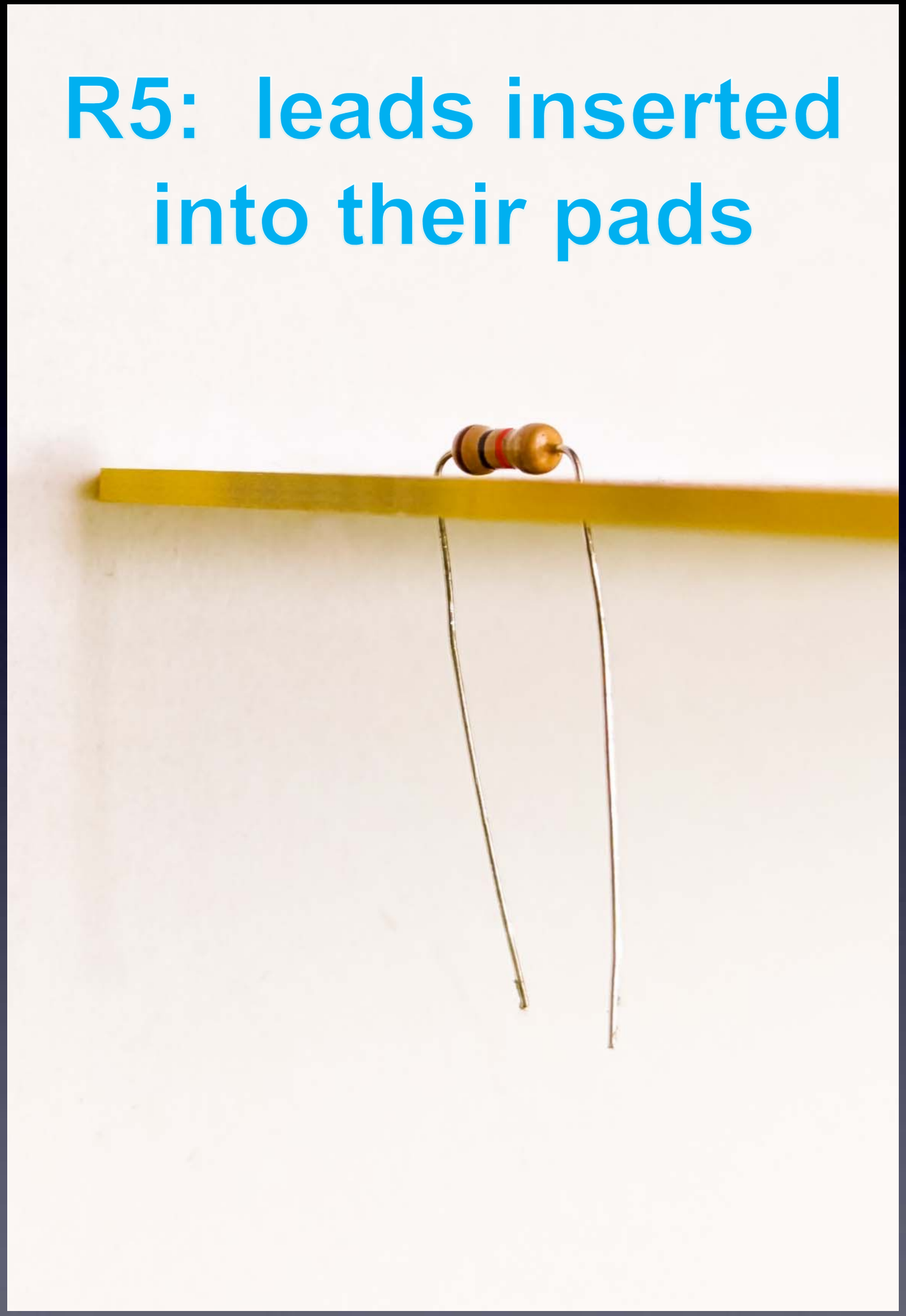
Resistor R5


Insert leads into pads
the circles with holes in them are called “pads”
there is one “pad” per lead for each part
R10
47
LED1
RGB LED
IC1
ATTINY25V-10PU
LED2
R333-A
IC2
RM-1050S
C2
100uF
C1
OFF



Resistor R5 inserted

R5: leads inserted into their pads



R5: board upside down

Bend leads
half way out
(only half way) like a “V”

so that the part won’t fall out while soldering it

R5: board upside down

Bend leads
half way out
(only half way) like a “V”

Ready to Solder !

How to hold a soldering iron

(Like a pencil – held from underneath)

Important

The best kind of solder for DIY electronics:

(Sn – Tin / Pb – Lead)

(60/40 is also good)

63/37 rosin core,

0.031” (0.8mm) diameter (or smaller)

<u>Note</u>:

Most
Lead-Free **solder**
has poisonous fumes!

A decent kind of solder for DIY electronics:

This is the only good Lead-Free solder I have found!

(after years of searching)

Chip Quik **Germanium-Doped** Solder

Sn99/Cu0.7/Ni0.05/Ge0.006

0.031” diameter (0.8mm)

A decent kind of solder for DIY electronics:

This is the only good Lead-Free solder I have found!

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Chip Quik **Germanium-Doped** Solder

Sn99/Cu0.7/Ni0.05/Ge0.006

0.031” diameter (0.8mm)

Note:

Since we will be using *Lead-Free* solder it is *very helpful* to also have *flux paste* in a syringe

And Isopropyl Alcohol

3 Safety Tips…

Safety Tip #1:

Hot !!

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

Safety Tip #2:

Soldering chemicals are toxic

But they easily wash 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)

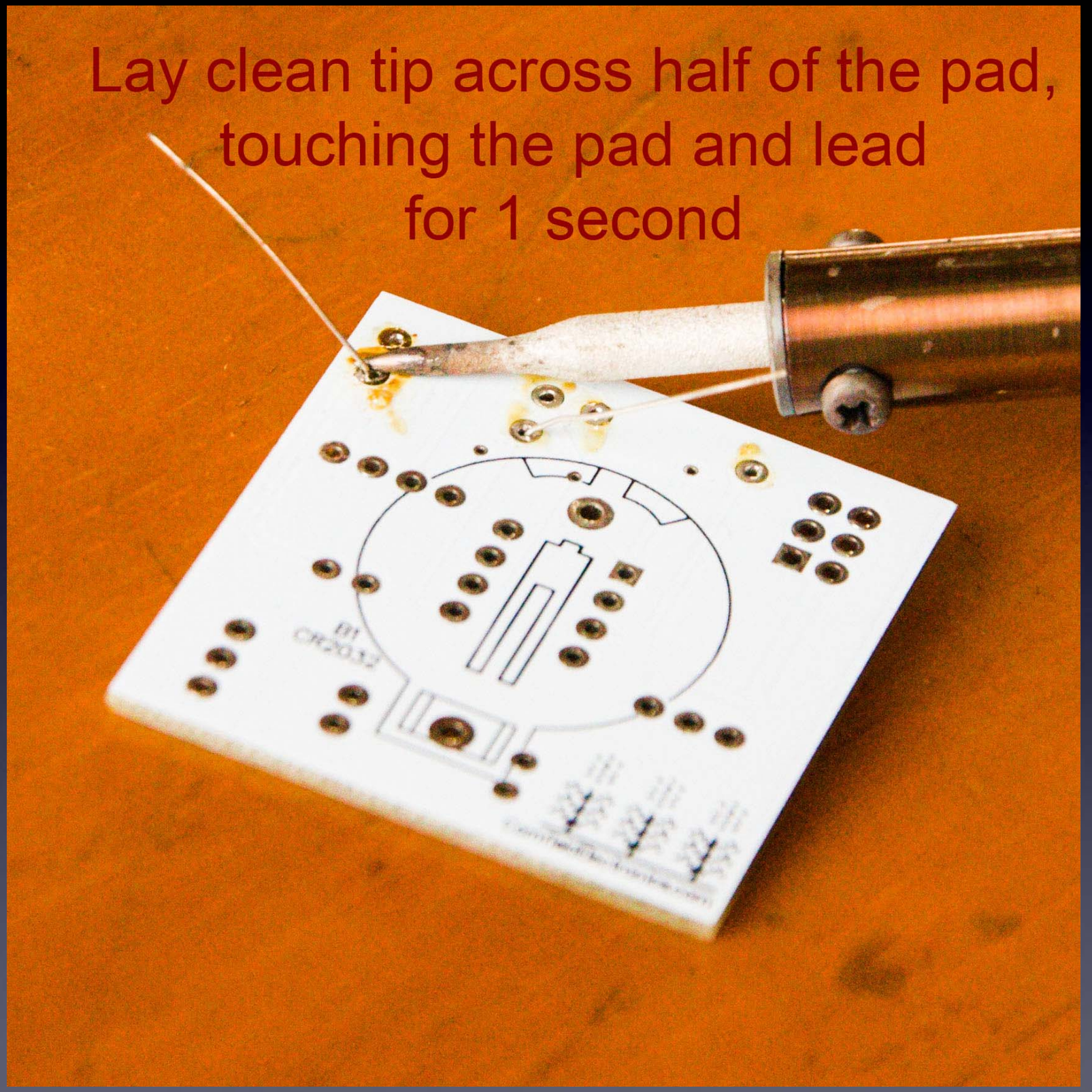
Bang (lightly) 3 times,

Swipe, Rotate, Swipe (on the sponge):

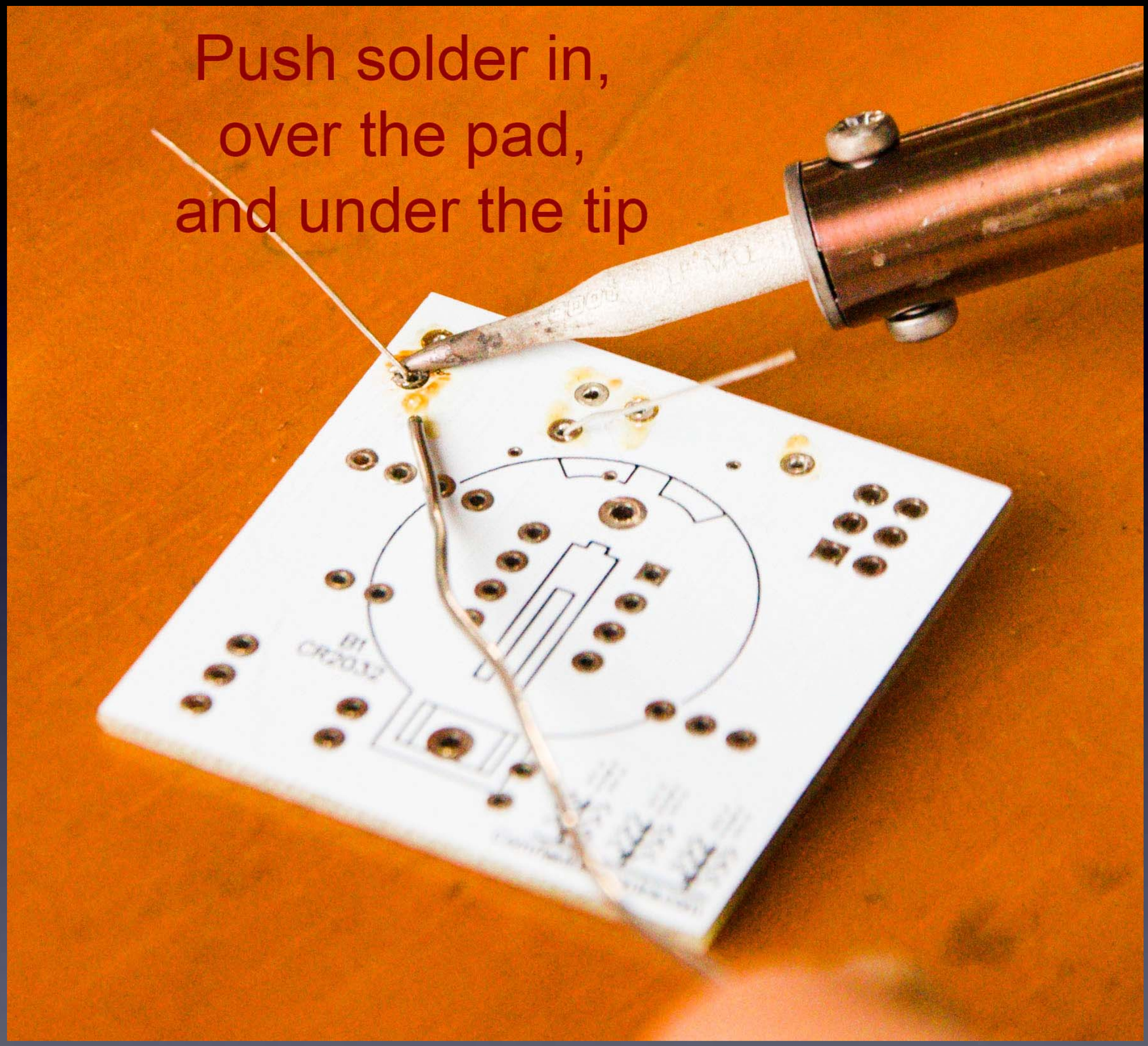
Keep the tip shiny silver!

knock solder off the tip

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

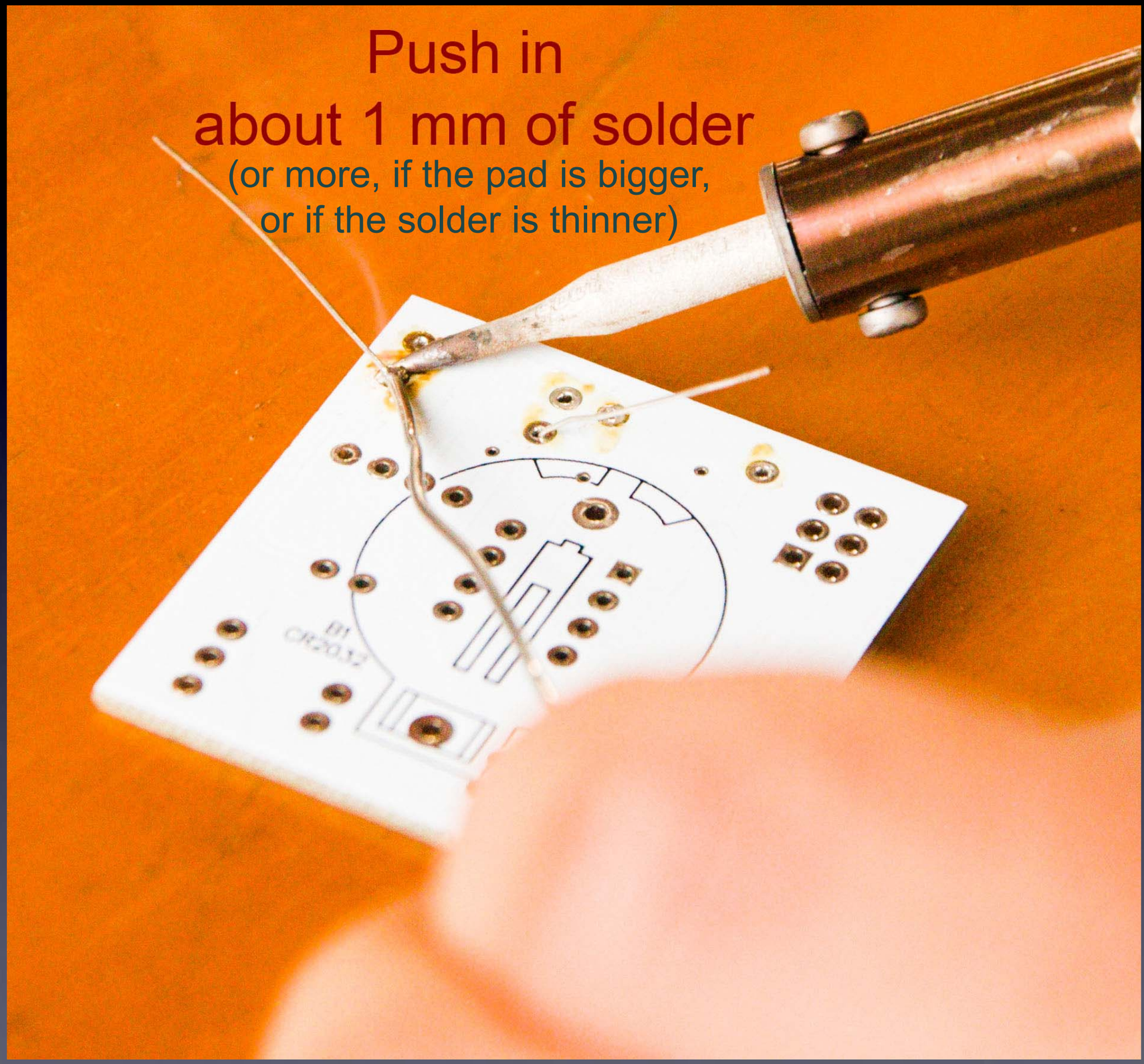


Do this quickly (slowly doesn't work well) – solder in & out in about 1 second

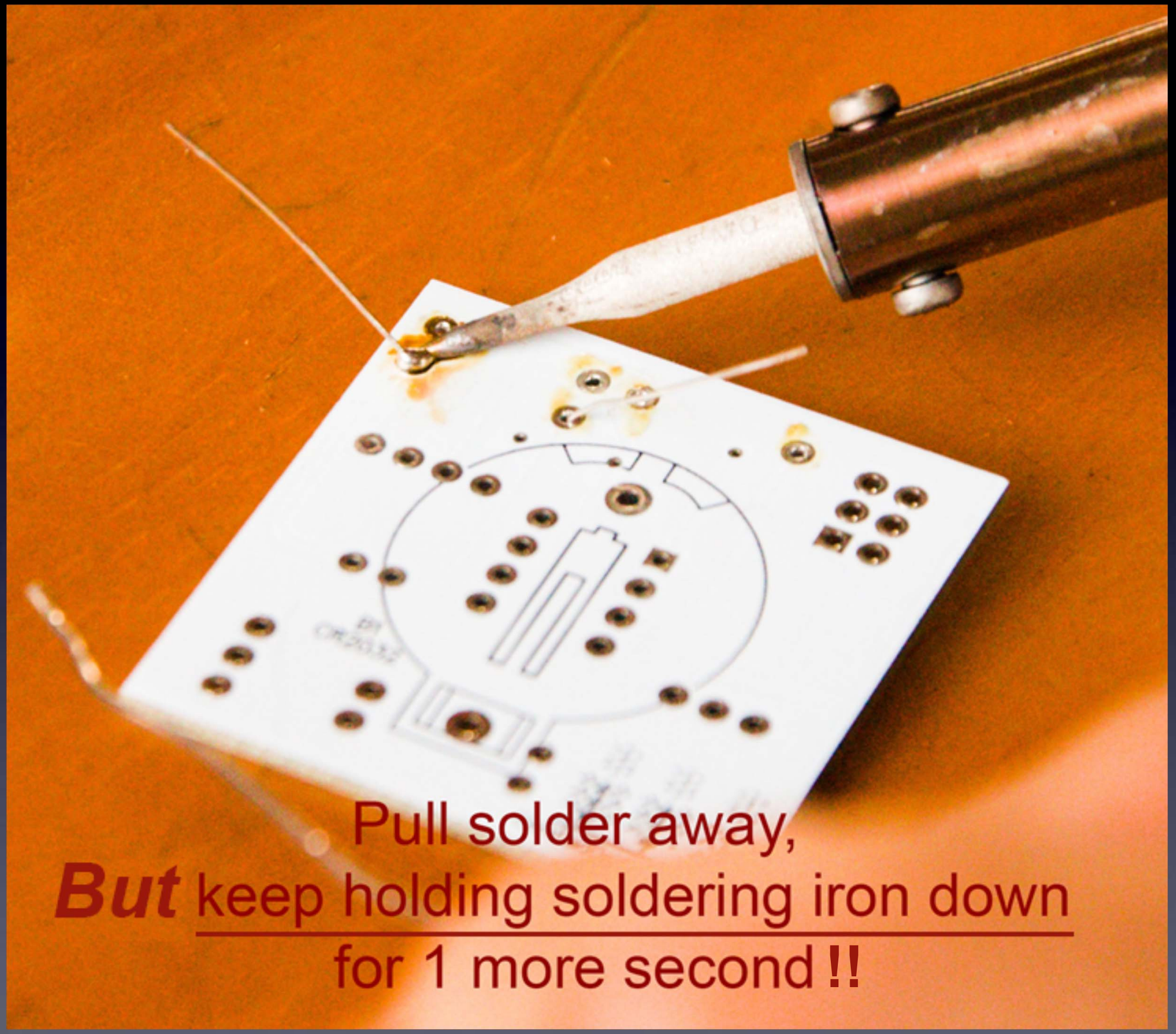


Make sure solder melts on the <u>underside</u> of the soldering iron tip
(not the side or top of the soldering iron tip)!

Do this quickly (slowly doesn't work well) – solder in & out in about 1 second



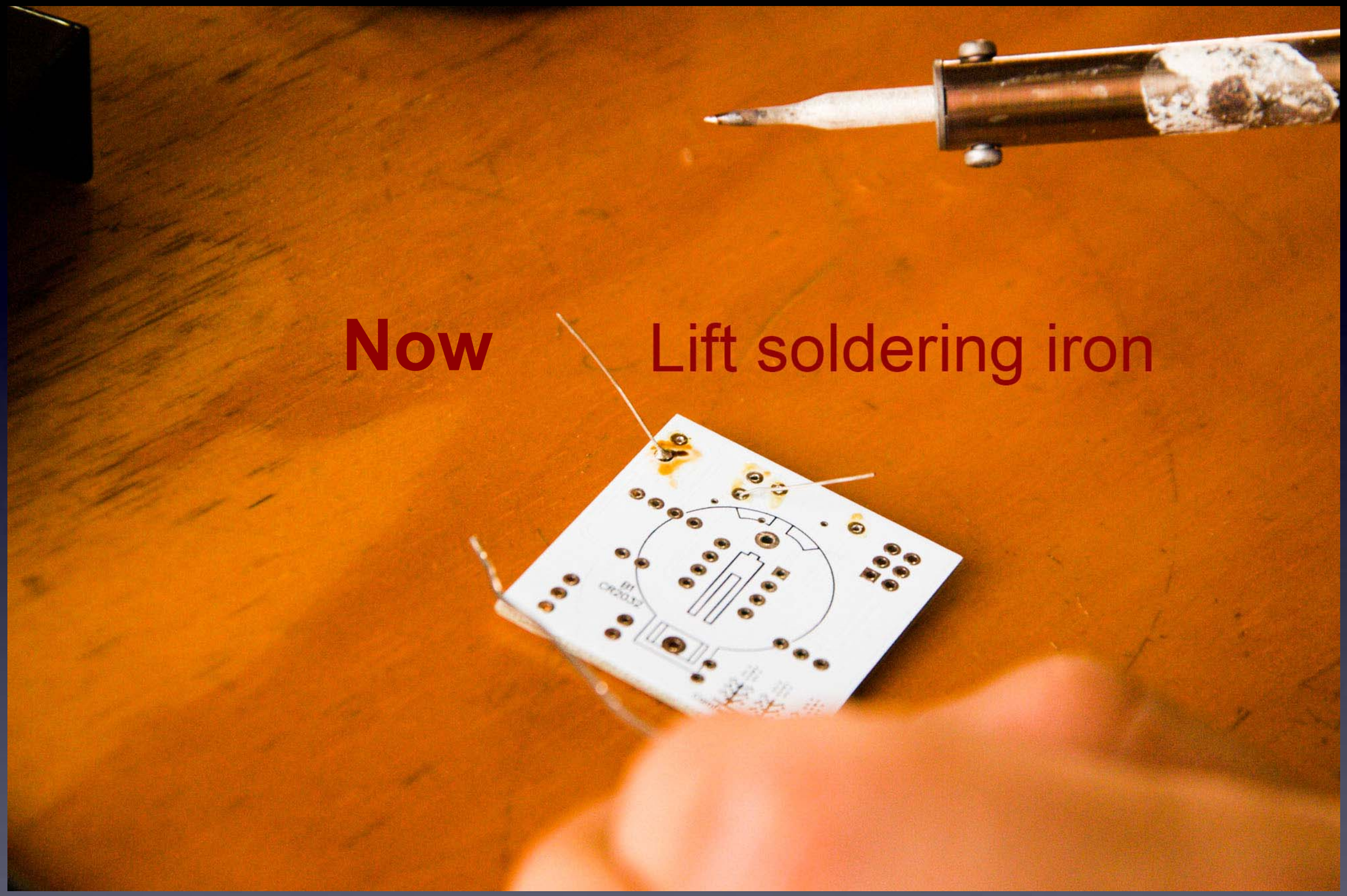
Make sure solder melts on the <u>underside</u> of the soldering iron tip
(not the side or top of the soldering iron tip)!

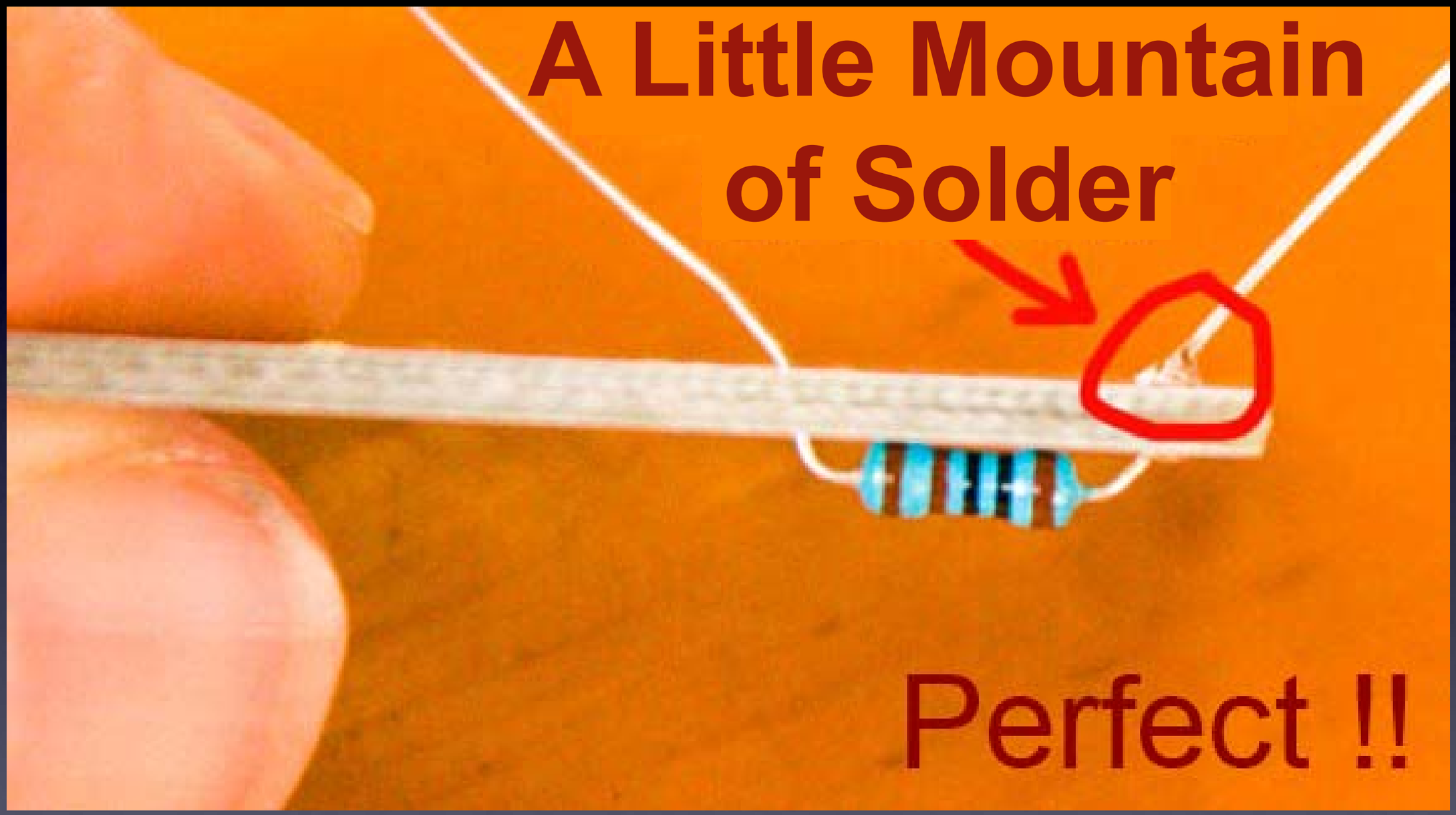

Pull solder away,
But keep holding soldering iron down
for 1 more second !!

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.

The Rhythm !

is just as important as the preceding steps!

The Rhythm !

and speed (about 1 second per step)

The Rhythm !

and speed (about 1 second per step)

Clean the tip

The Rhythm !

and speed (about 1 second per step)

Tip Down

The Rhythm !

and speed (about 1 second per step)

Solder In

The Rhythm !

and speed (about 1 second per step)

Solder Out

The Rhythm !

and speed (about 1 second per step)

WAIT !

The Rhythm !

and speed (about 1 second per step)

Lift Tip

The Rhythm !

and speed (about 1 second per step)

The Rhythm !

and speed (about 1 second per step)

Clean the tip

The Rhythm !

and speed (about 1 second per step)

Tip Down

The Rhythm !

and speed (about 1 second per step)

Solder In

The Rhythm !

and speed (about 1 second per step)

Solder Out

The Rhythm !

and speed (about 1 second per step)

WAIT !

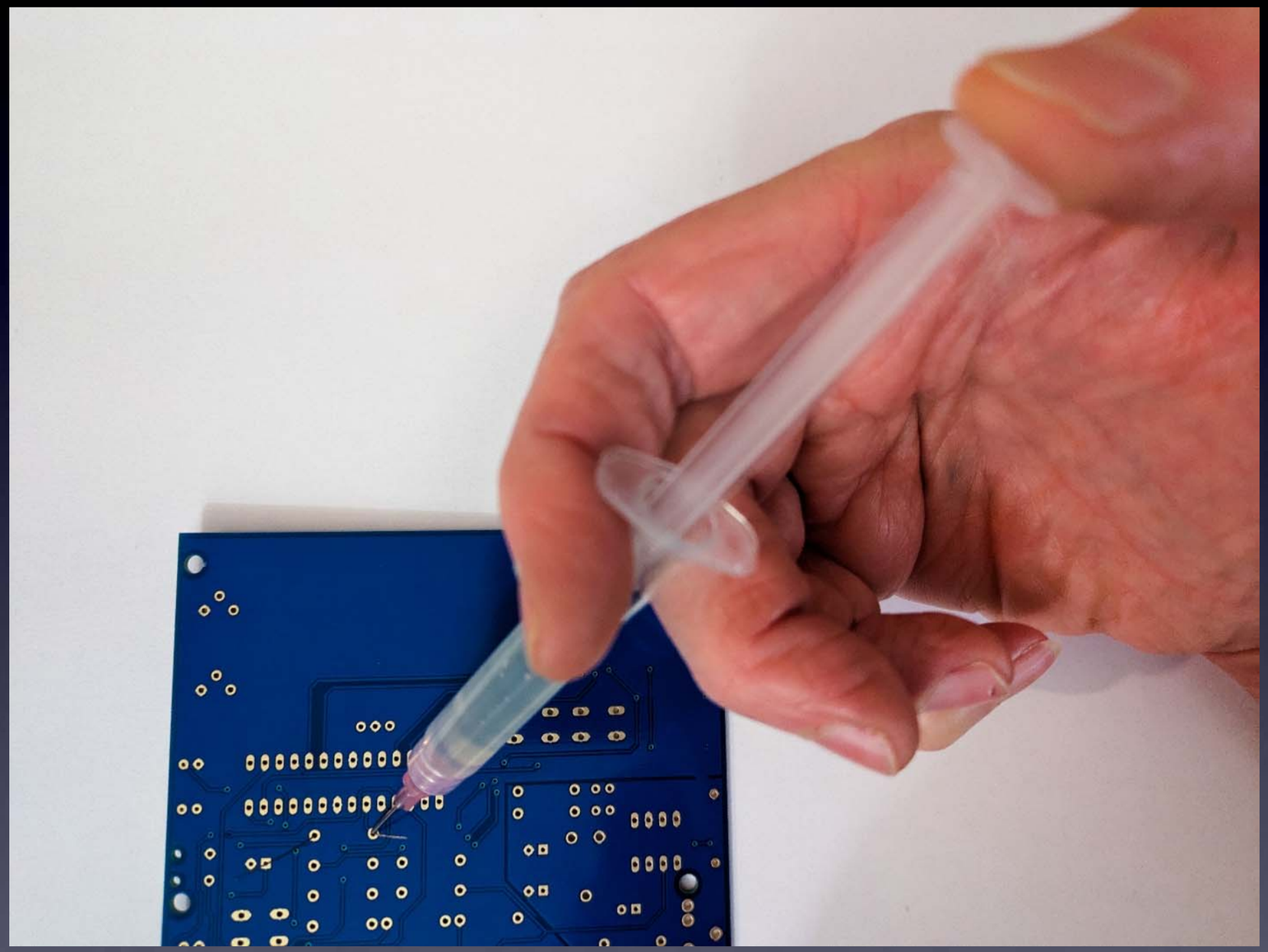
The Rhythm !

and speed (about 1 second per step)

Lift Tip

Since we are using *Lead-Free* solder:

First add flux !

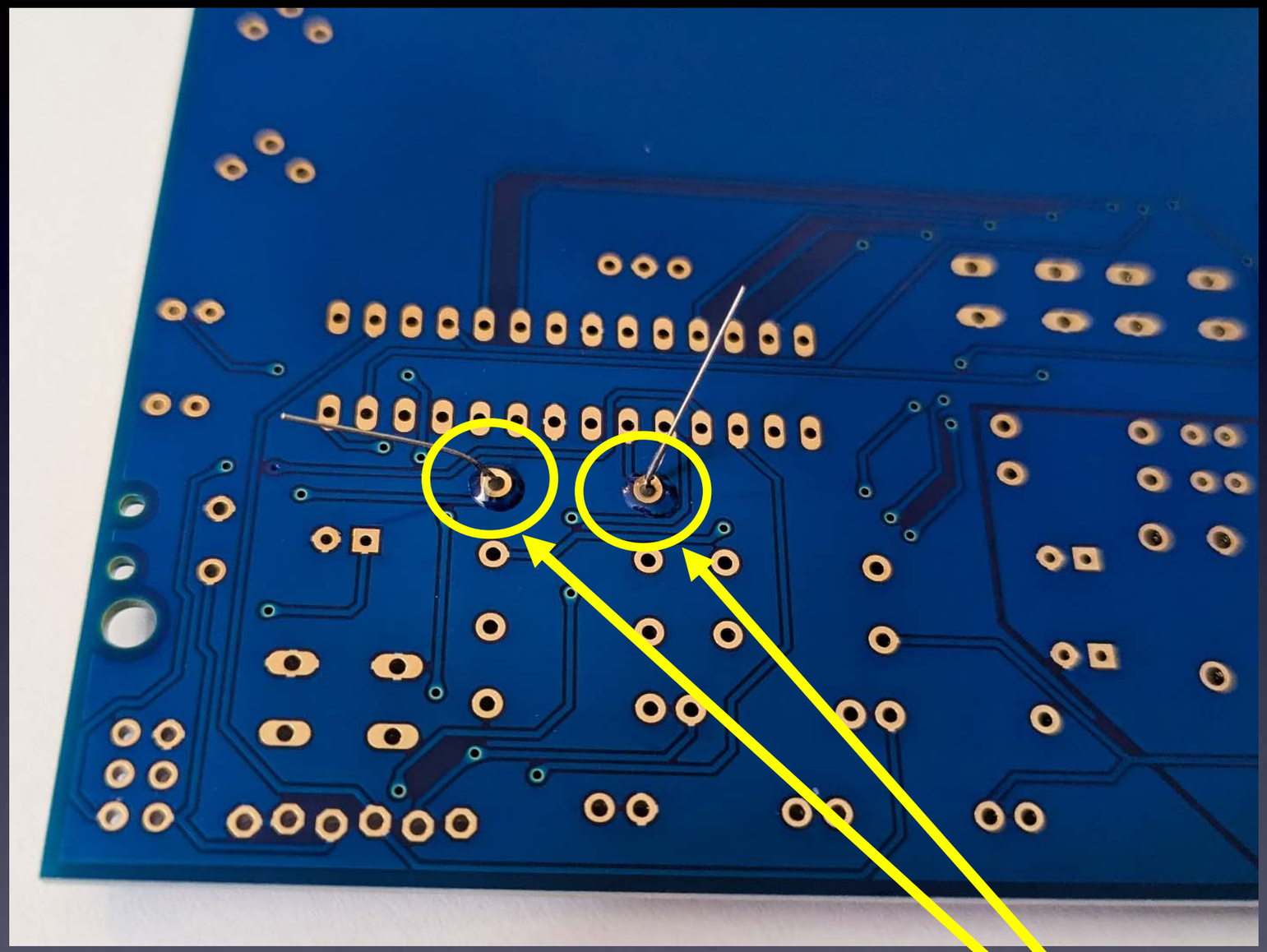


For *Lead-Free* solder, add flux to each pad before soldering !

For this part (R1) there are two pads

Since we are using *Lead-Free* solder:

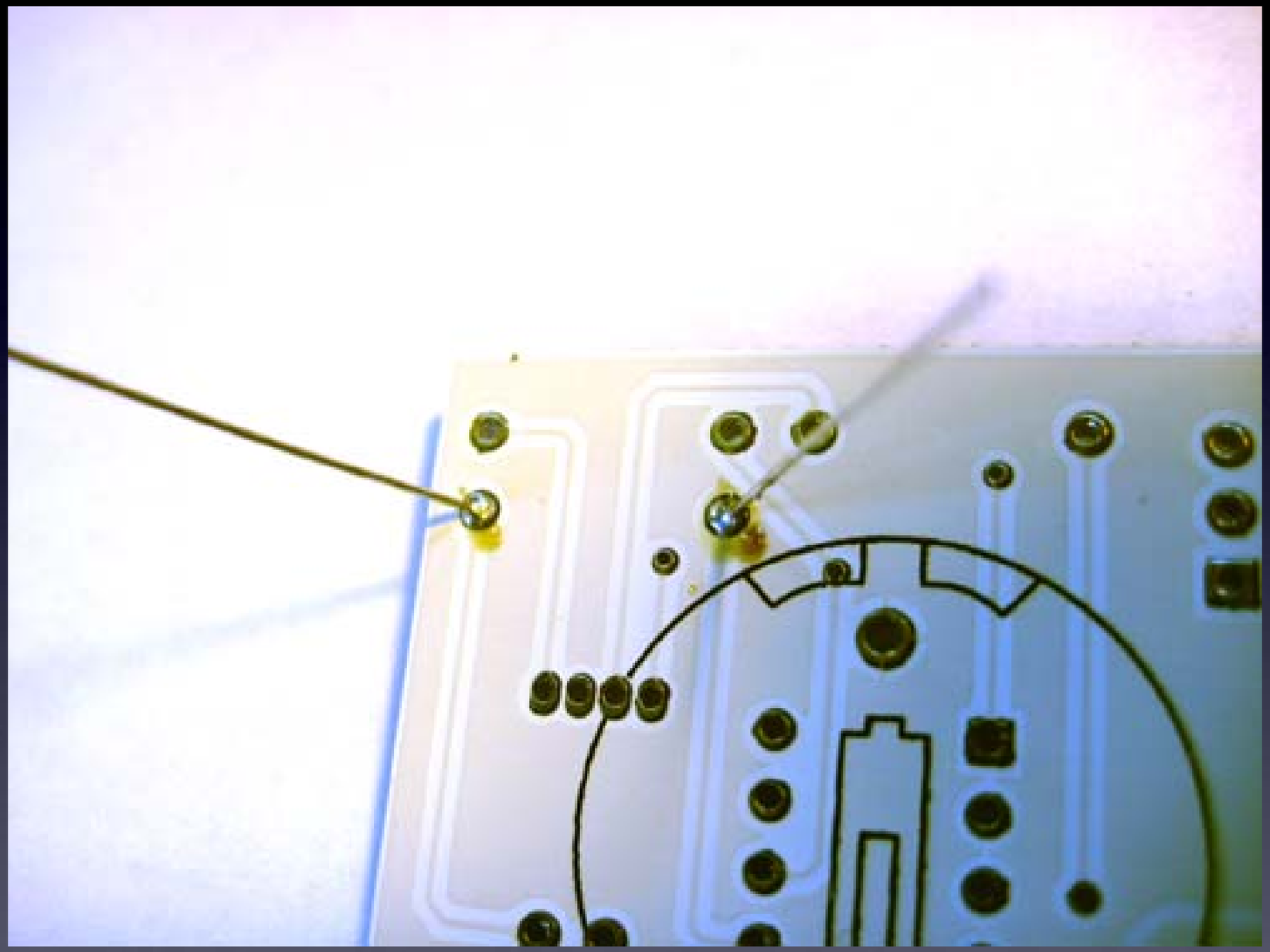
Add flux to the pads before soldering



Here you can see flux over each of the two pads.

Now these leads are ready to solder with your *Lead-Free* solder.

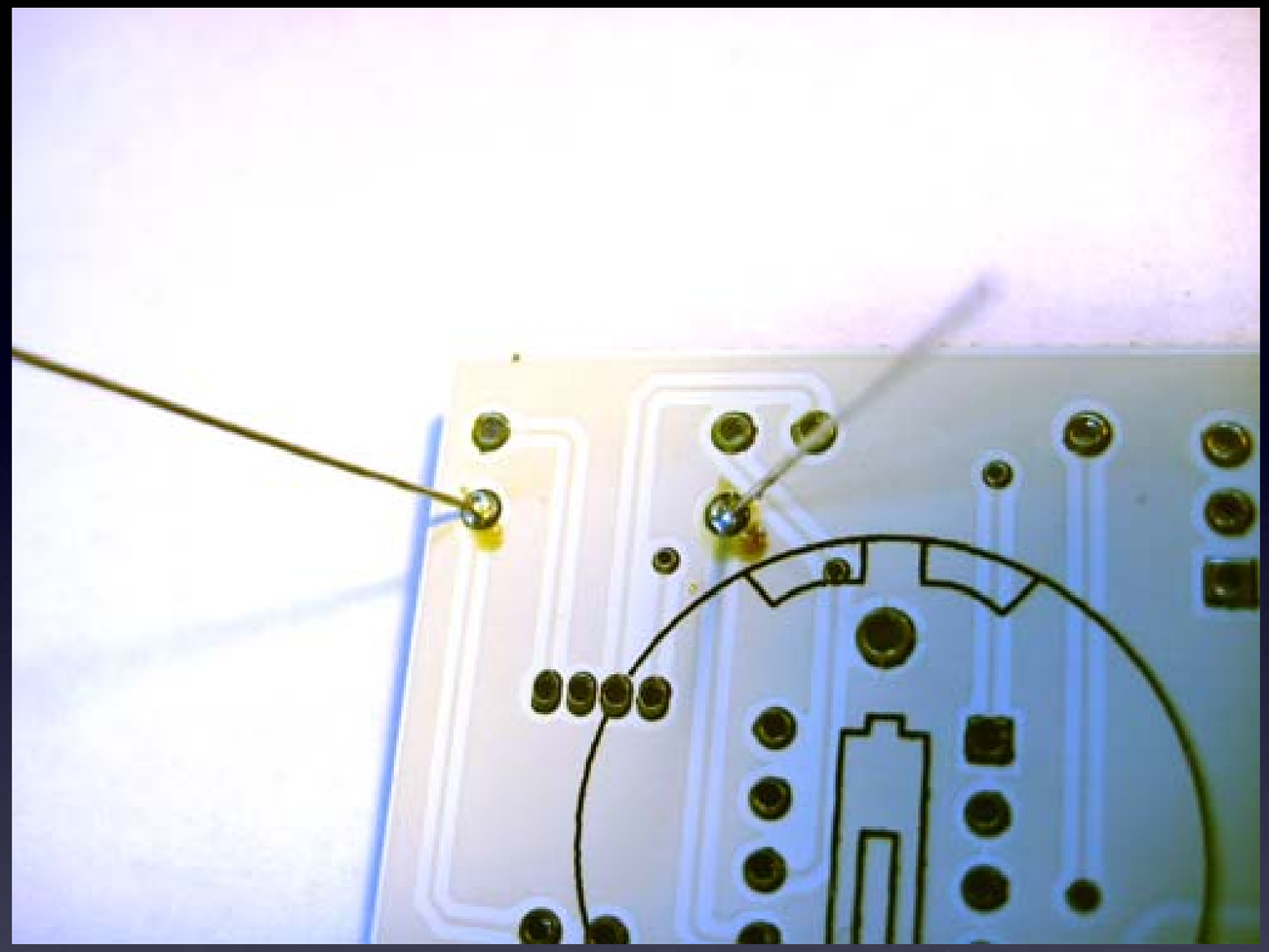
Solder all of the leads of the part to the board



For this part, there are two leads

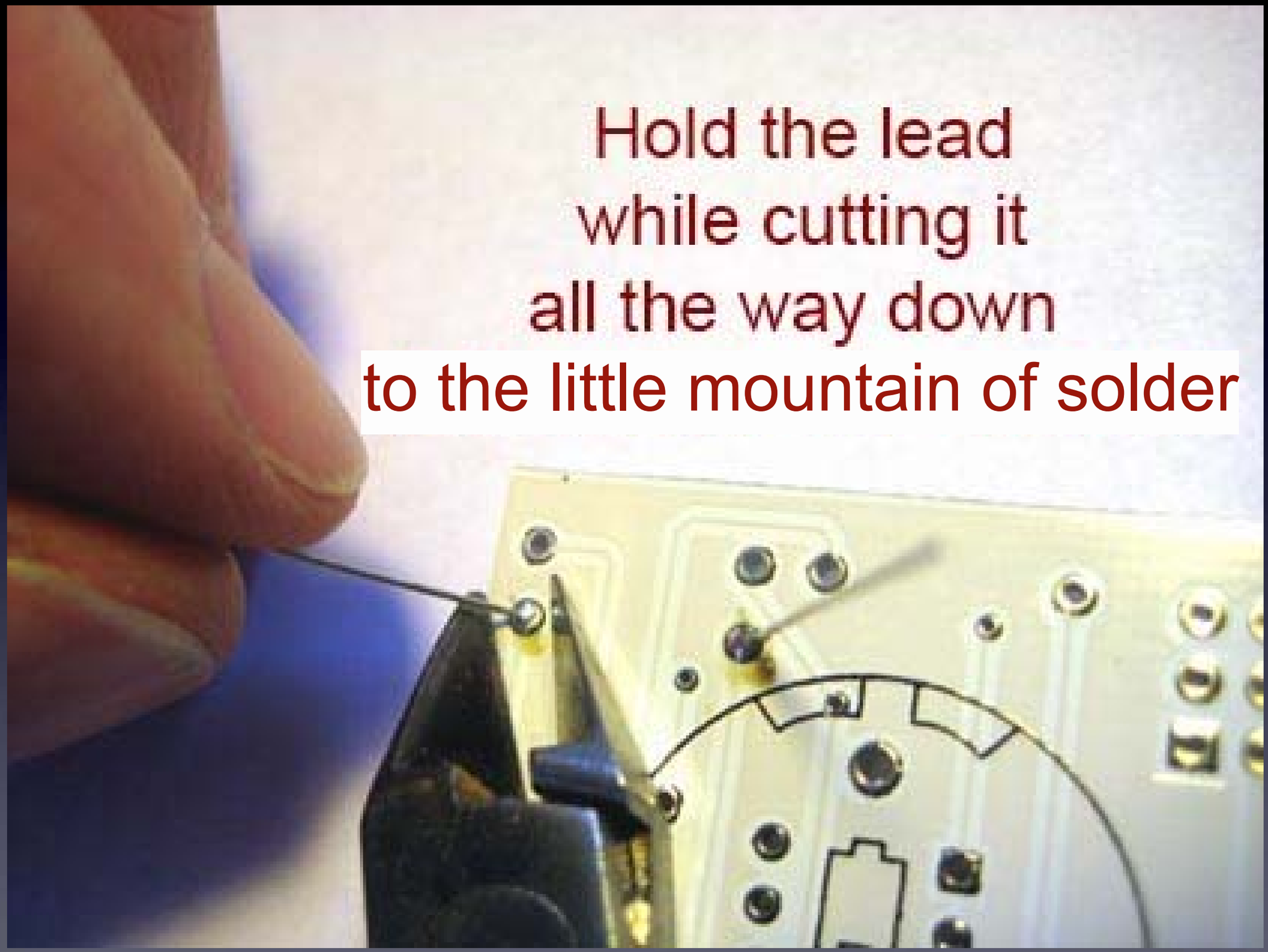
Here you can see two good solder connections

Two good solder connections



- Little mountains (not flat)
- Pads totally covered in solder
- Can’t see the hole
- No connections to other pads

Now cut the leads short



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

Safety Tip #3:

Hold or cover the lead !

(or it will fly into your eye!)

(They like doing that – so please hold or cover the lead when you cut.)

No wires sticking out

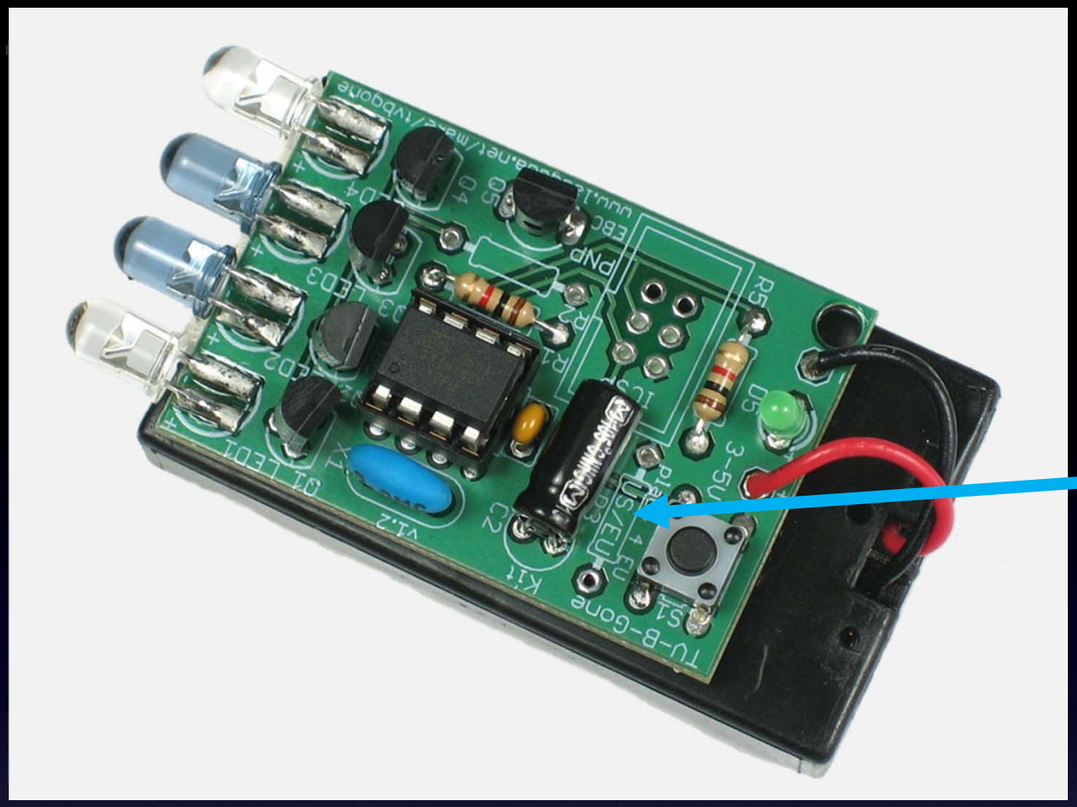
A closer look at good solder connections

Notice that:

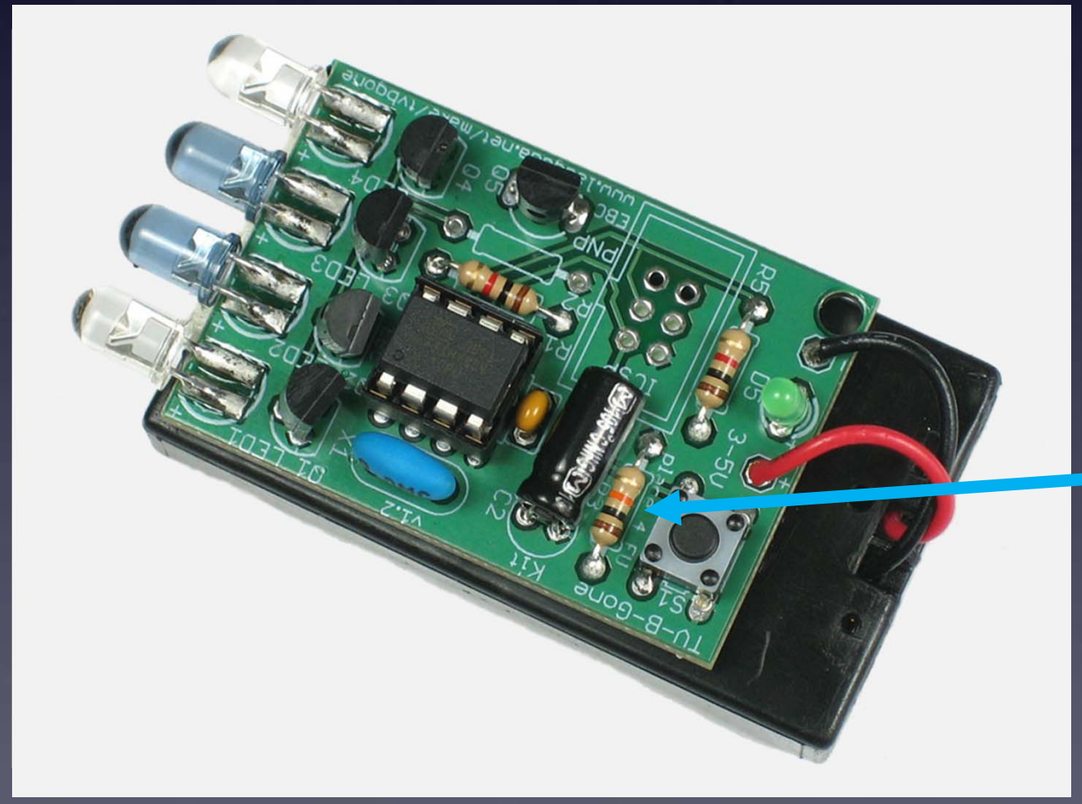
- Each connection is a small mountain (not flat)
- You cannot see any pad (they're totally covered with solder)
- You cannot see the holes (they're totally covered with solder)
- No connections to other pads

One part at a time

Till all the parts are soldered



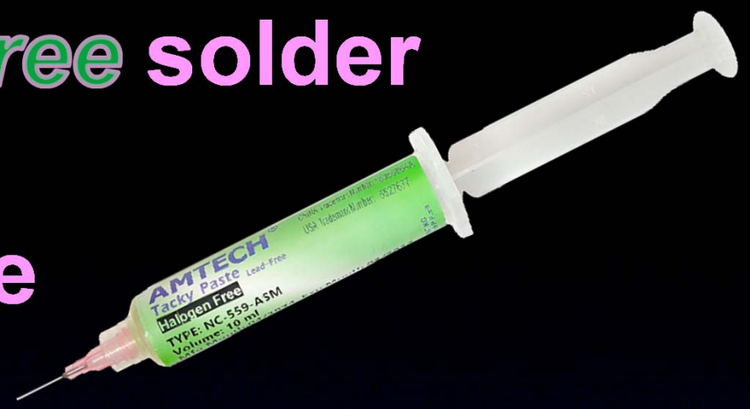
NA (R3 not soldered)



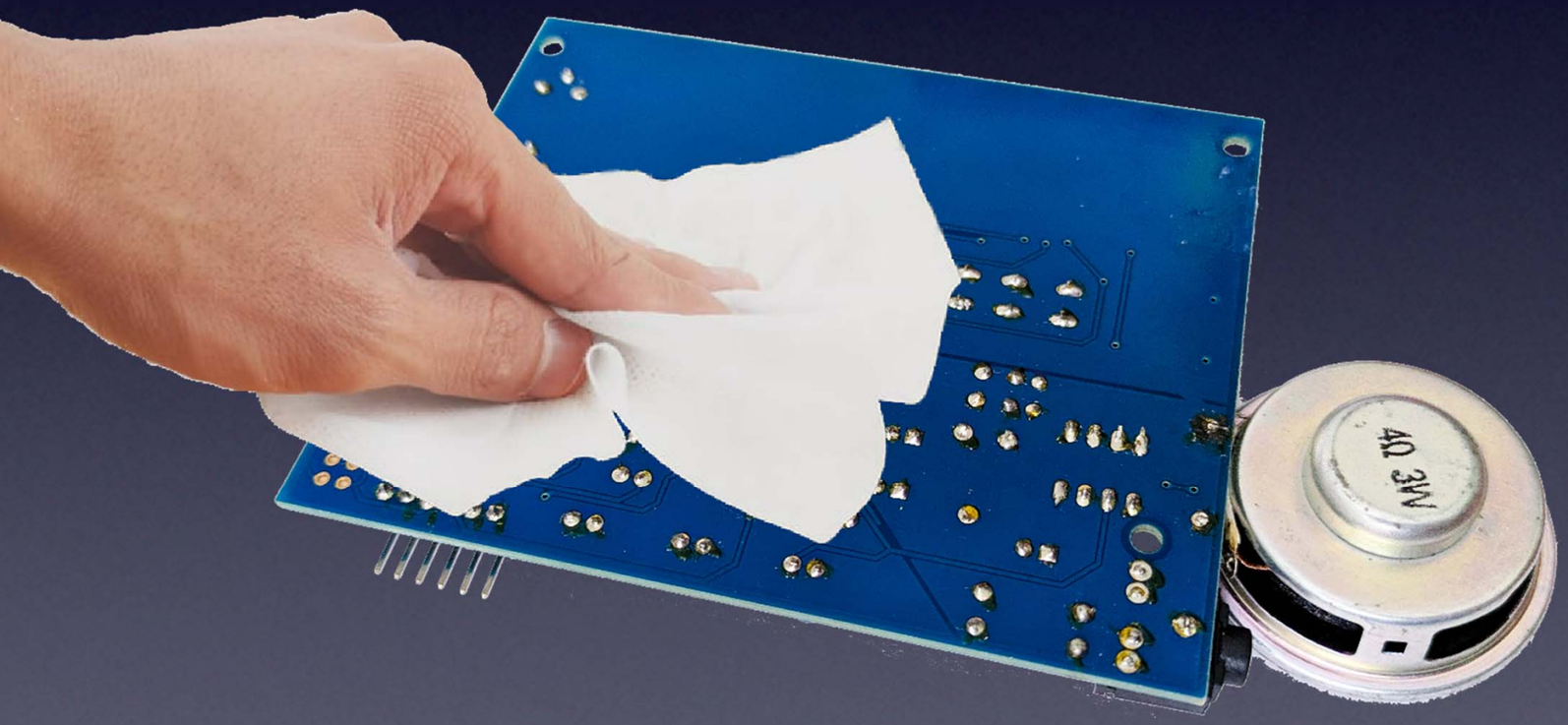
EU (R3 soldered in)

And it will look like this when you're done.

Since we will be using *Lead-Free* solder
and
***flux paste* in a syringe**



<u>The bottom of the PCB will be sticky from the flux</u>



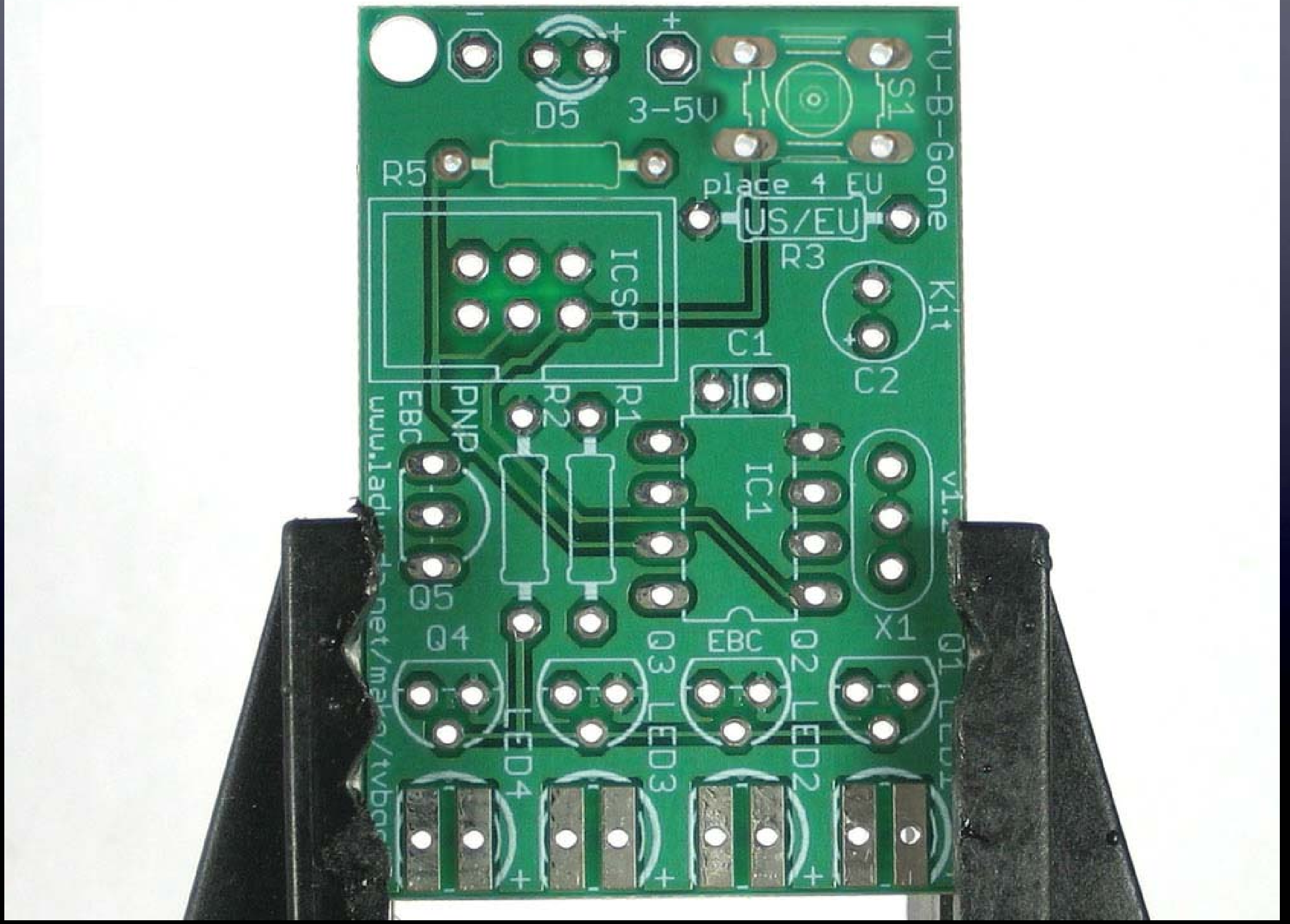
You can clean it with a cloth
wet with Isopropyl Alcohol

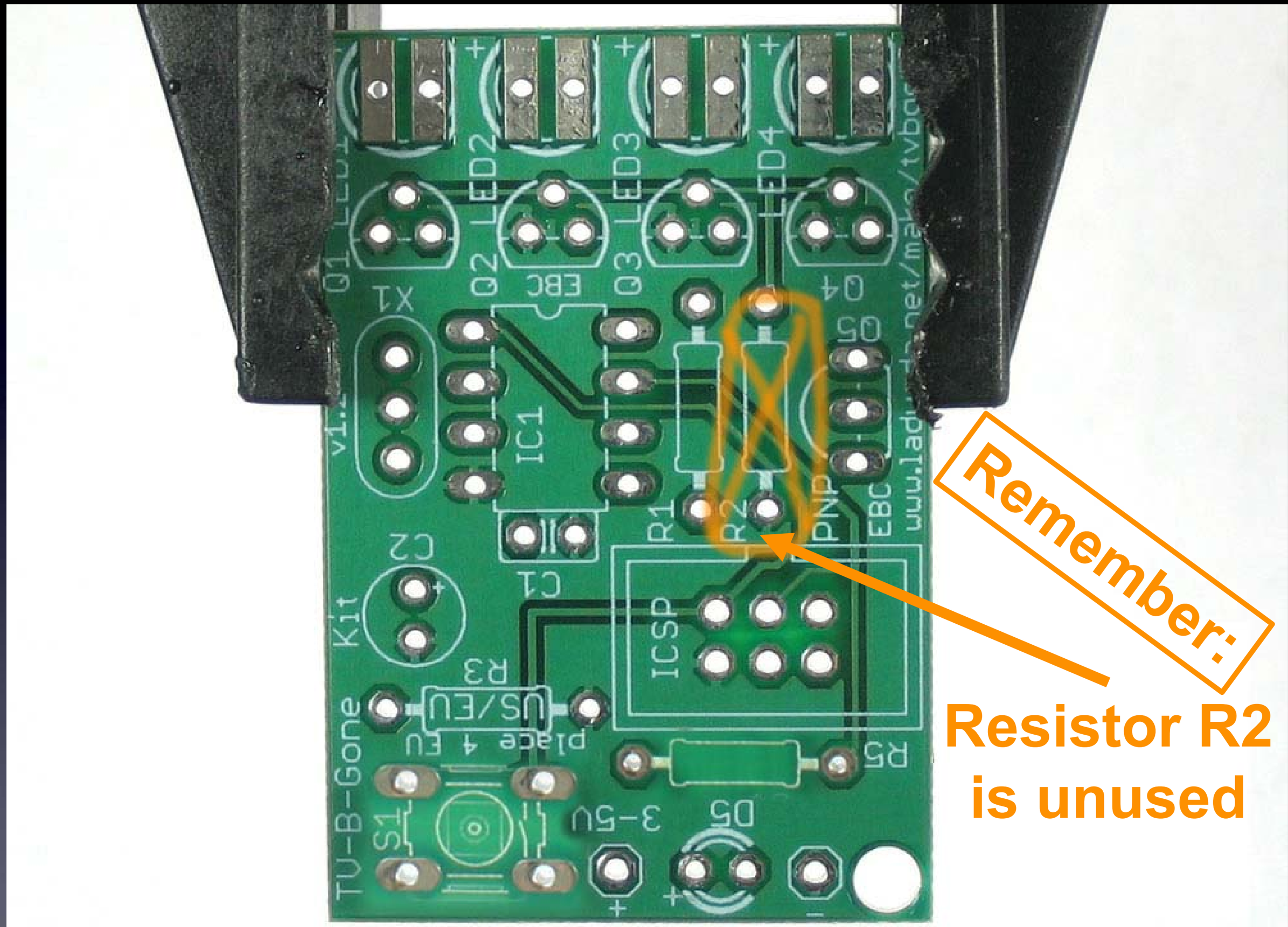
Then test with batteries,

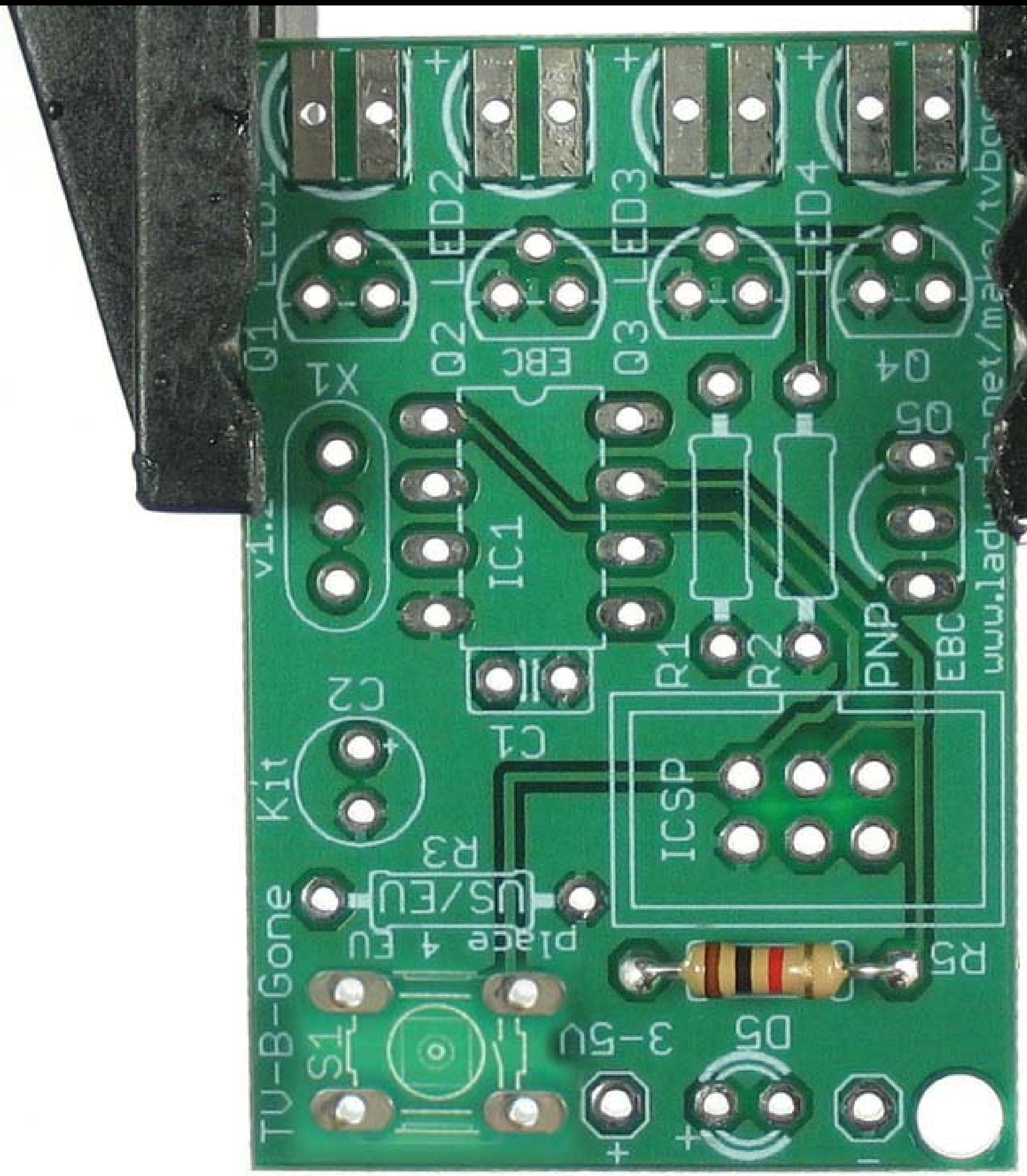
And it works!

(Or you start debugging.)

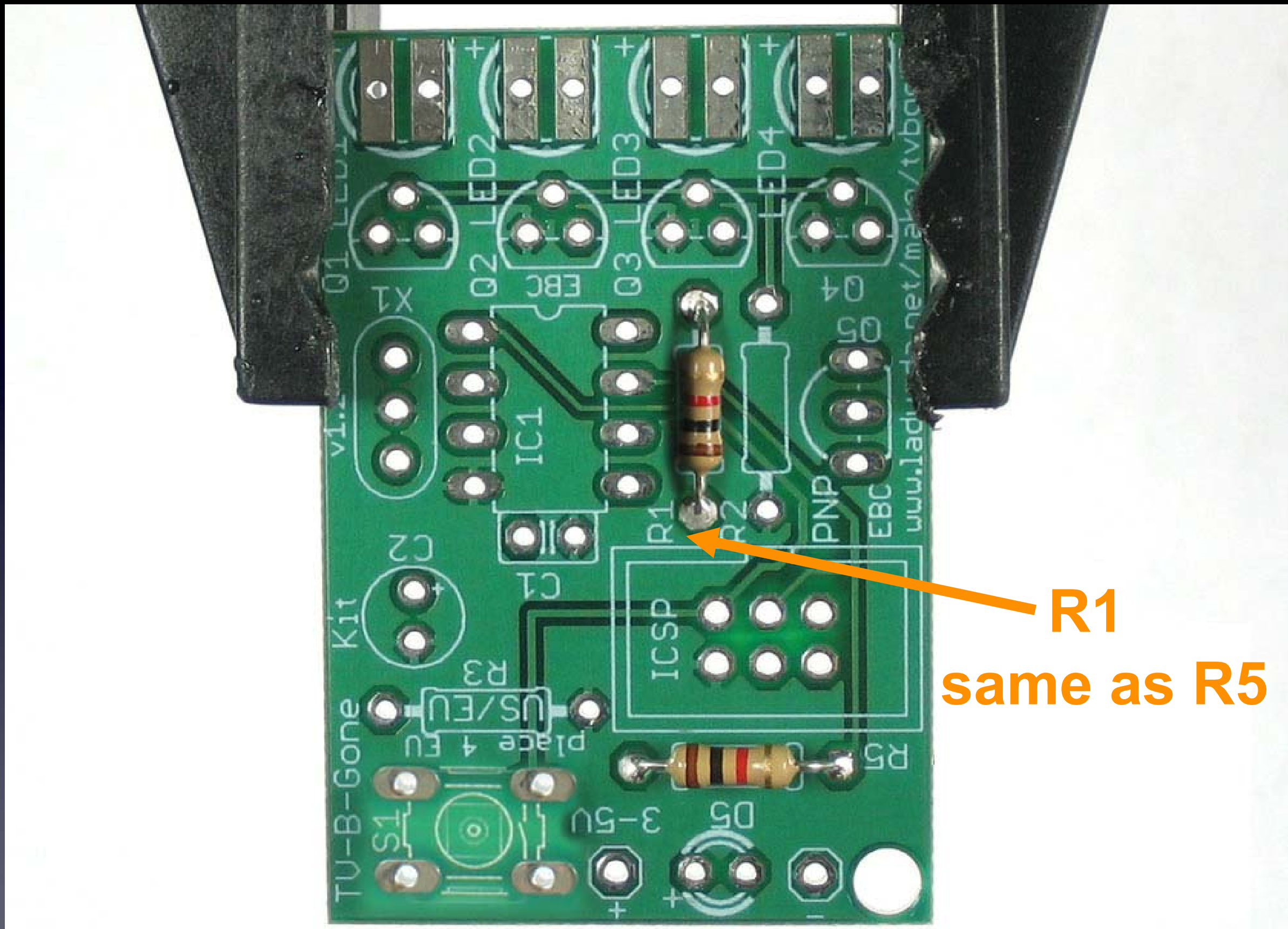
Let’s start!


TV-B-Gone
S1
D5
3-5V
R5
place 4 EU
US/EU
R3
ICSP
C1
C2
K11
R2
R1
IC1
Q5
Q4
Q3
EBC
Q2
X1
Q1
LED4
LED3
LED2
LED1
EBC
PWR
www.ladyada.net/make/tvbgone
v1.2


Remember:
Resistor R2
is unused

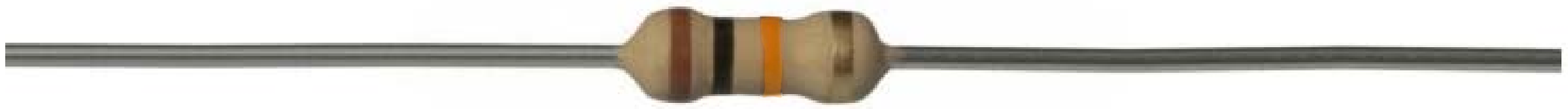

Q1
LED2
Q2
LED3
Q3
LED4
Q4
X1
EBC
IC1
R1
R2
PNP
EBC
C2
C1
Kit
ICSP
R3
US/EU
place 4 EU
R5
TV-B-Gone
S1
3-5V
D5

Resistor R5


R1
same as R5

Resistor R3
is ONLY for Europe

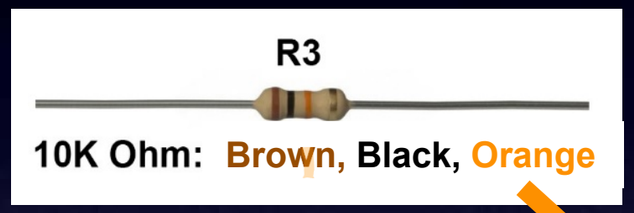
R3



10K Ohm: Brown, Black, Orange

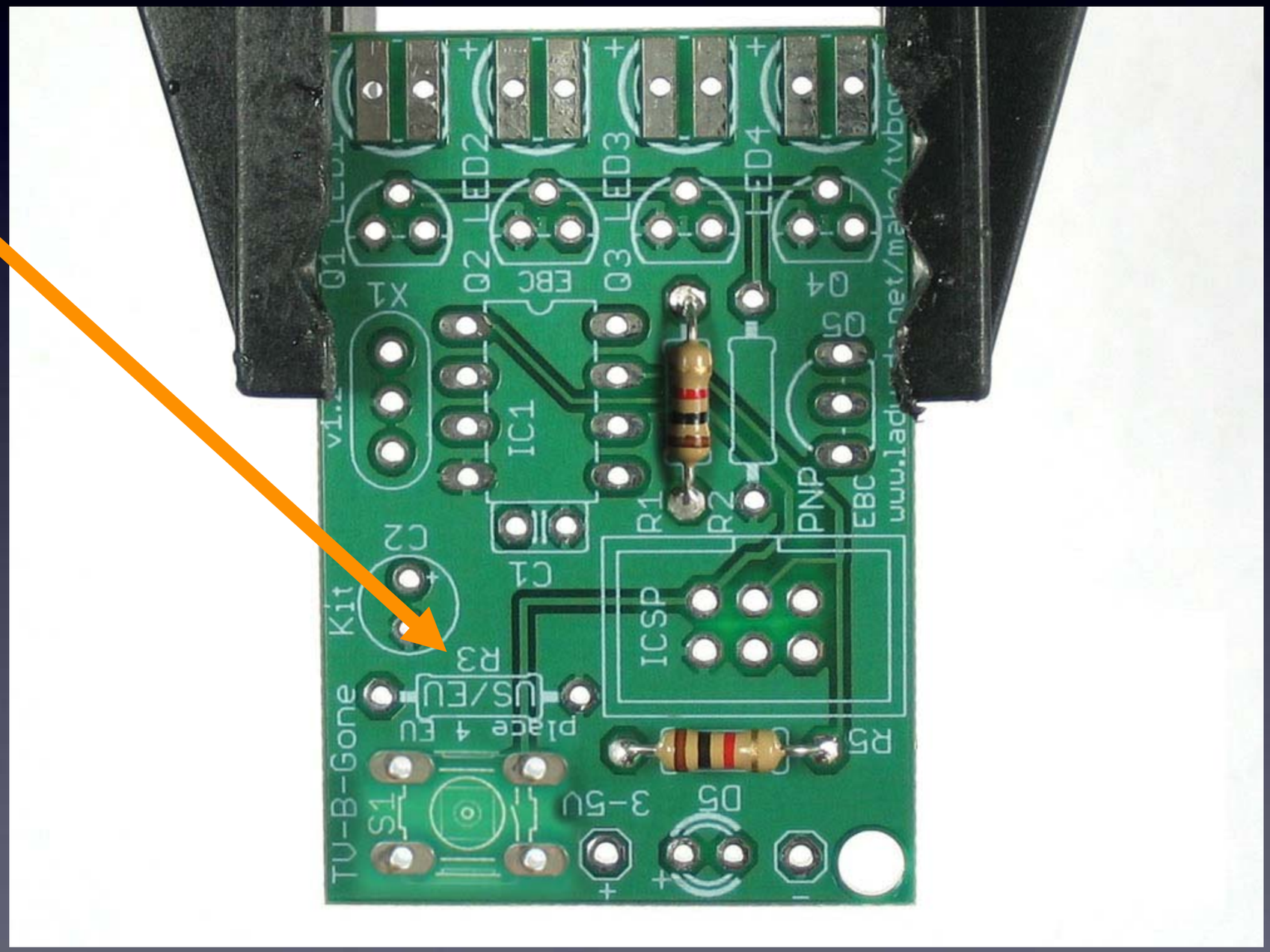
NOTE: Do NOT use the [Brown, Black, Red] resistor !

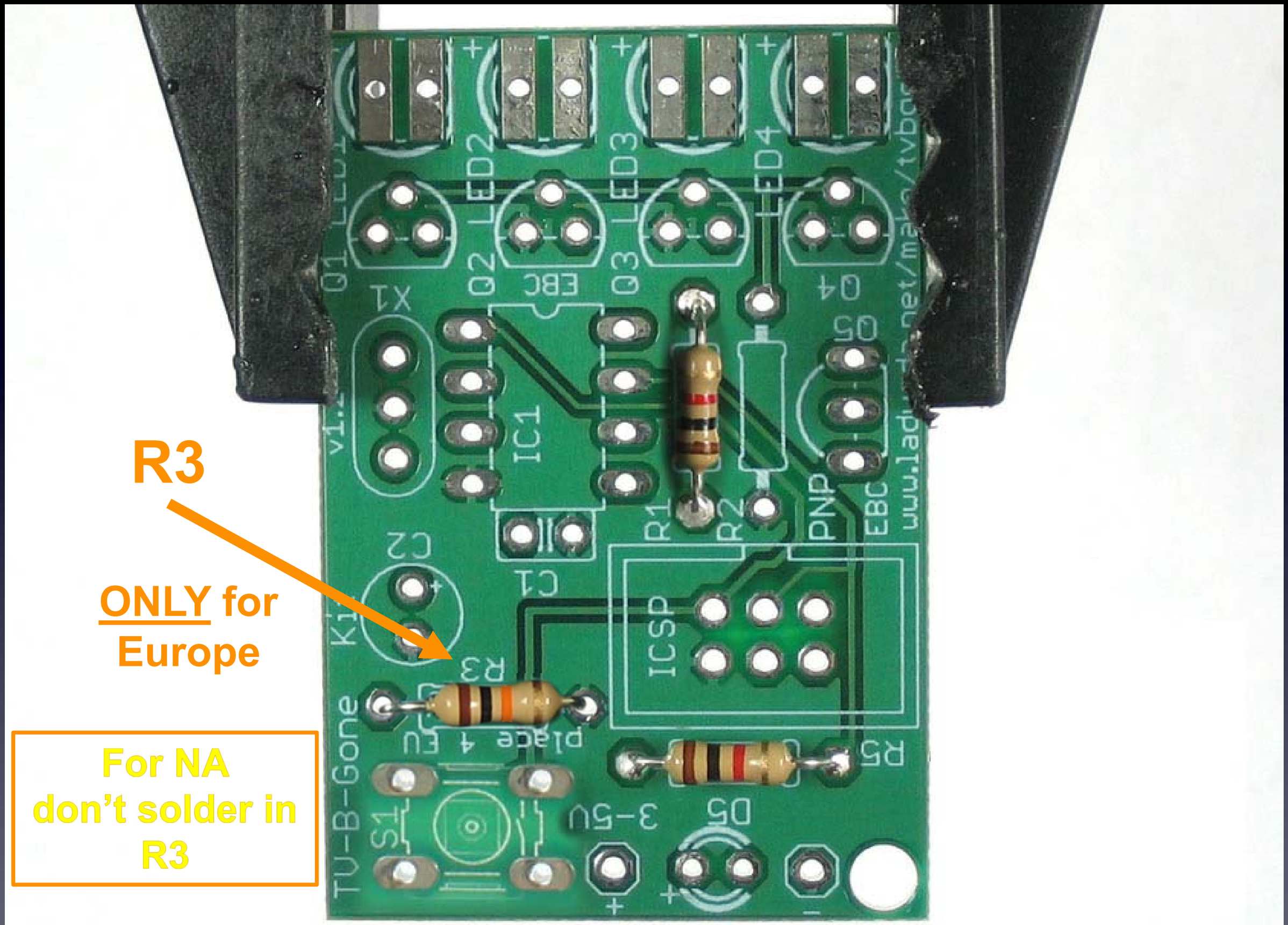
Resistor R3
is ONLY for Europe



For Europe:
use R3
(also for Middle-East, Australia, and Afrika)

For North America:
no R3
(also for Asia and South America)



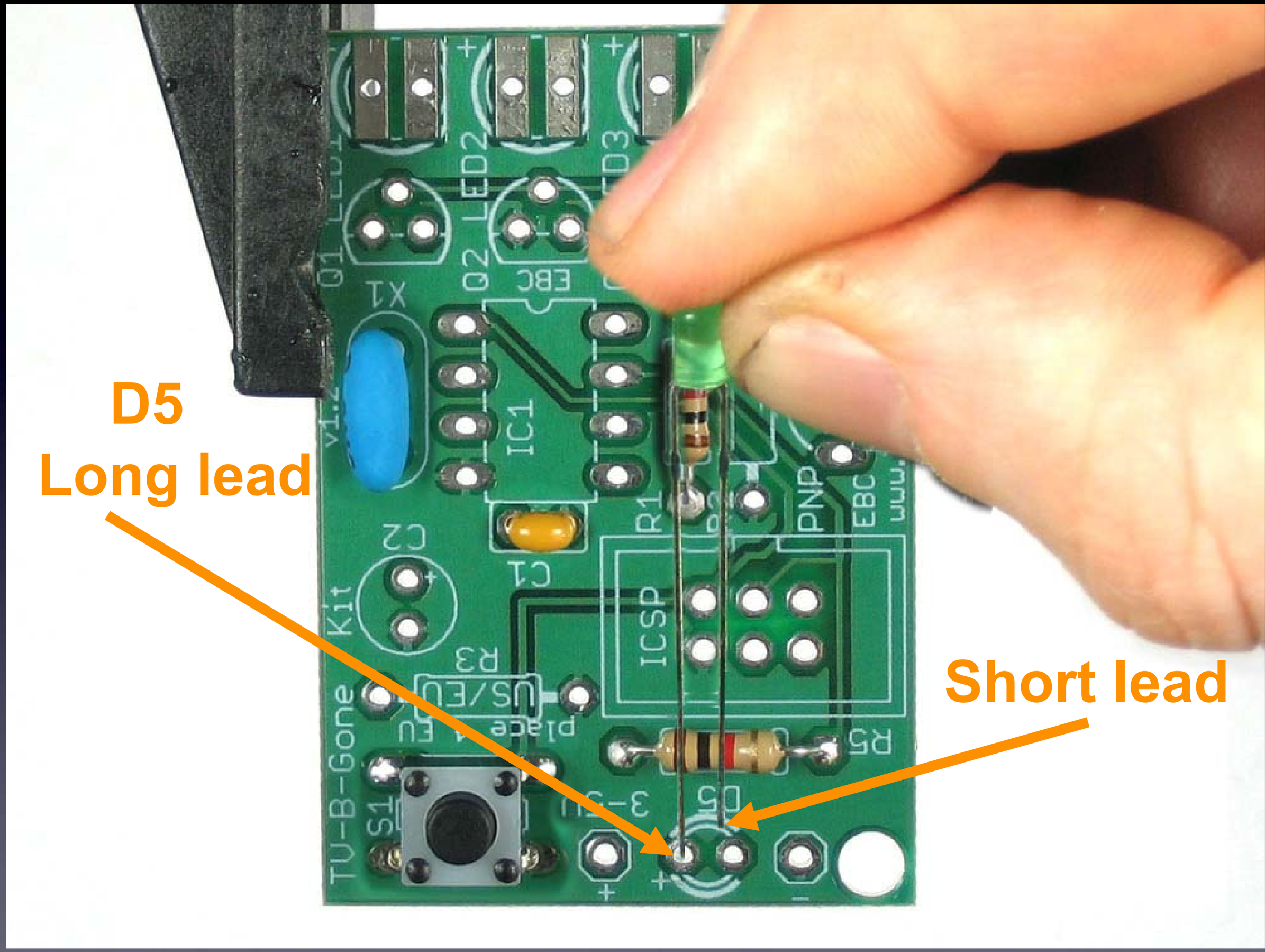

R3
ONLY for
Europe
For NA
don’t solder in
R3
Q1
LED2
Q2
LED3
Q3
LED4
Q4
Q5
X1
IC1
C1
C2
R1
R2
R5
ICSP
S1
D5
TV-B-Gone
place 4 EU
3-5V

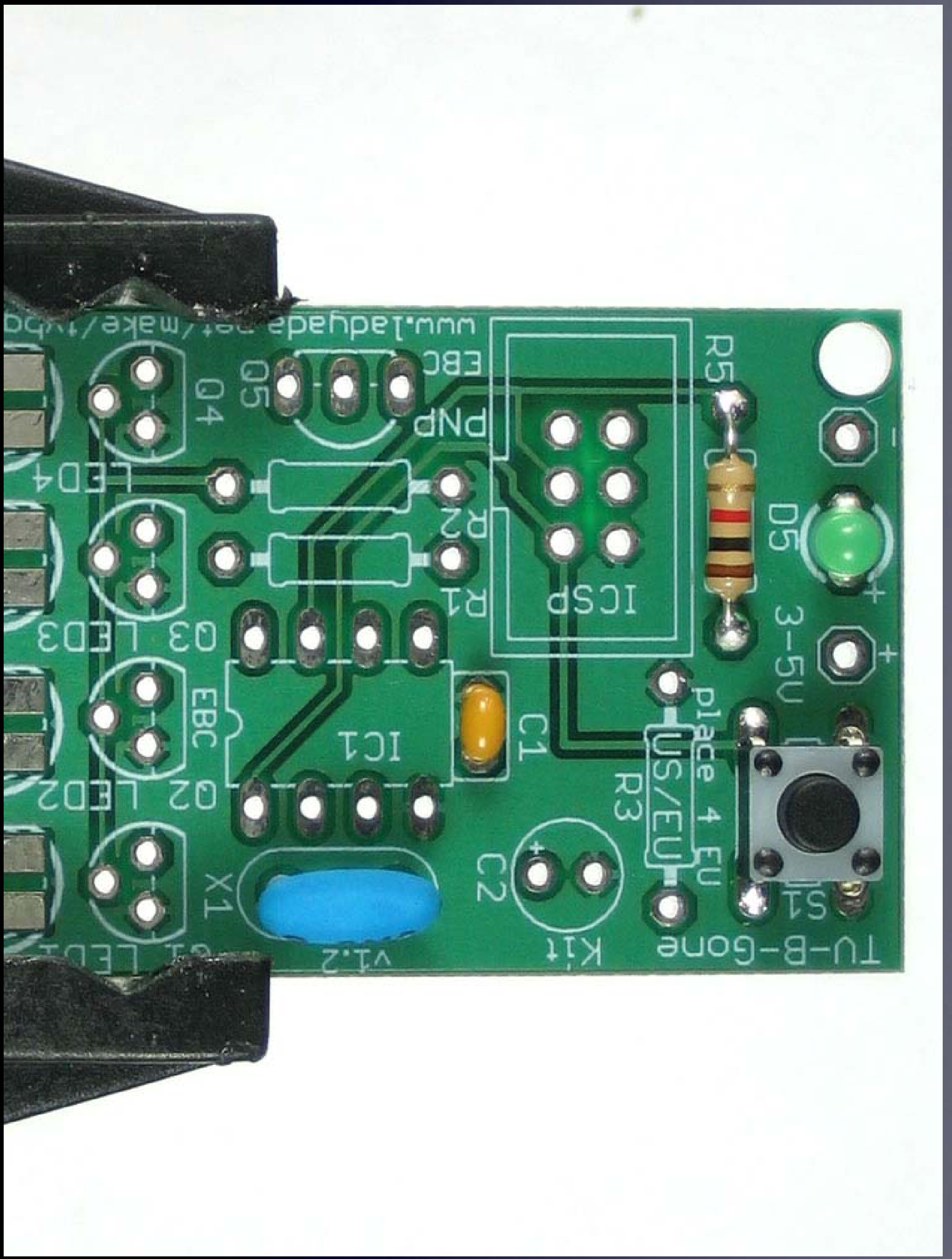
X1

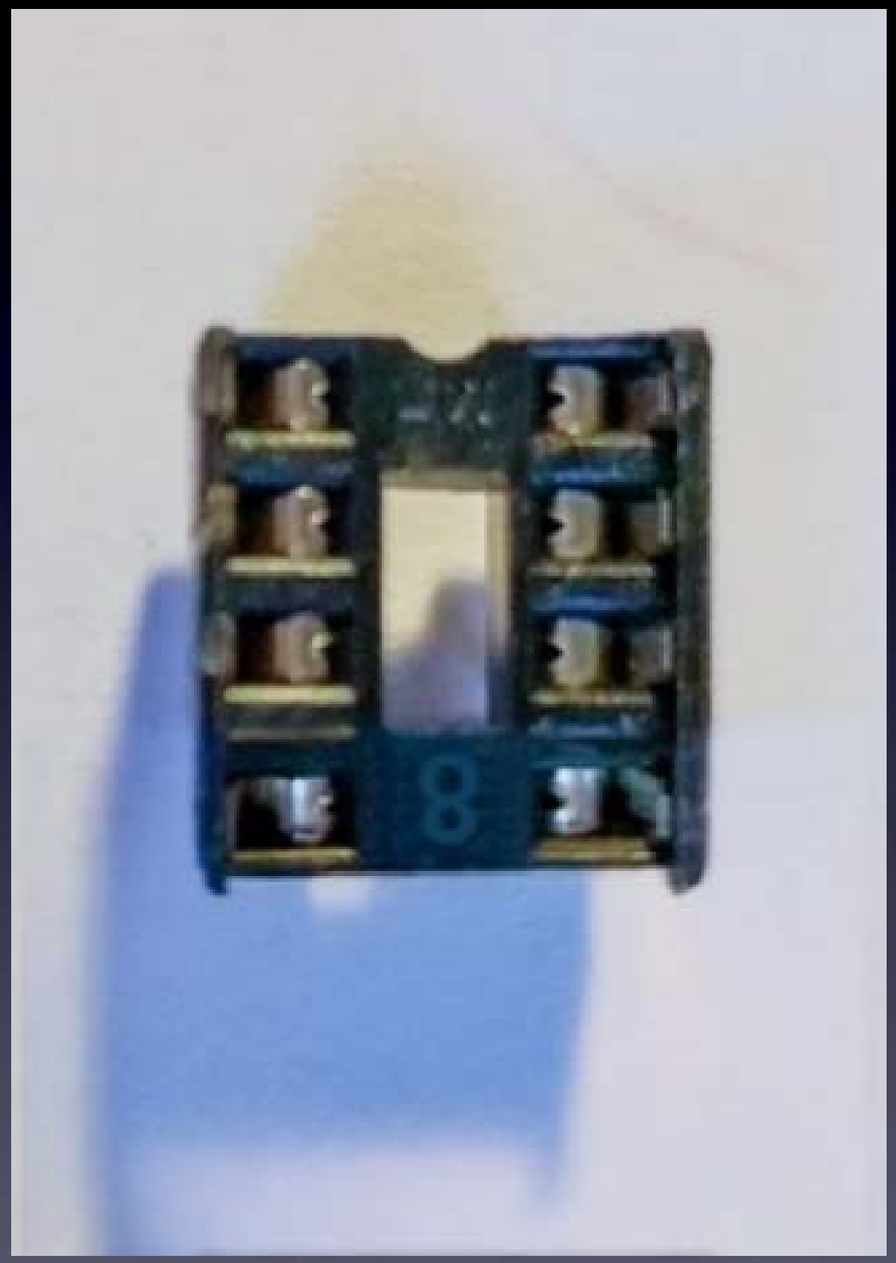
S1

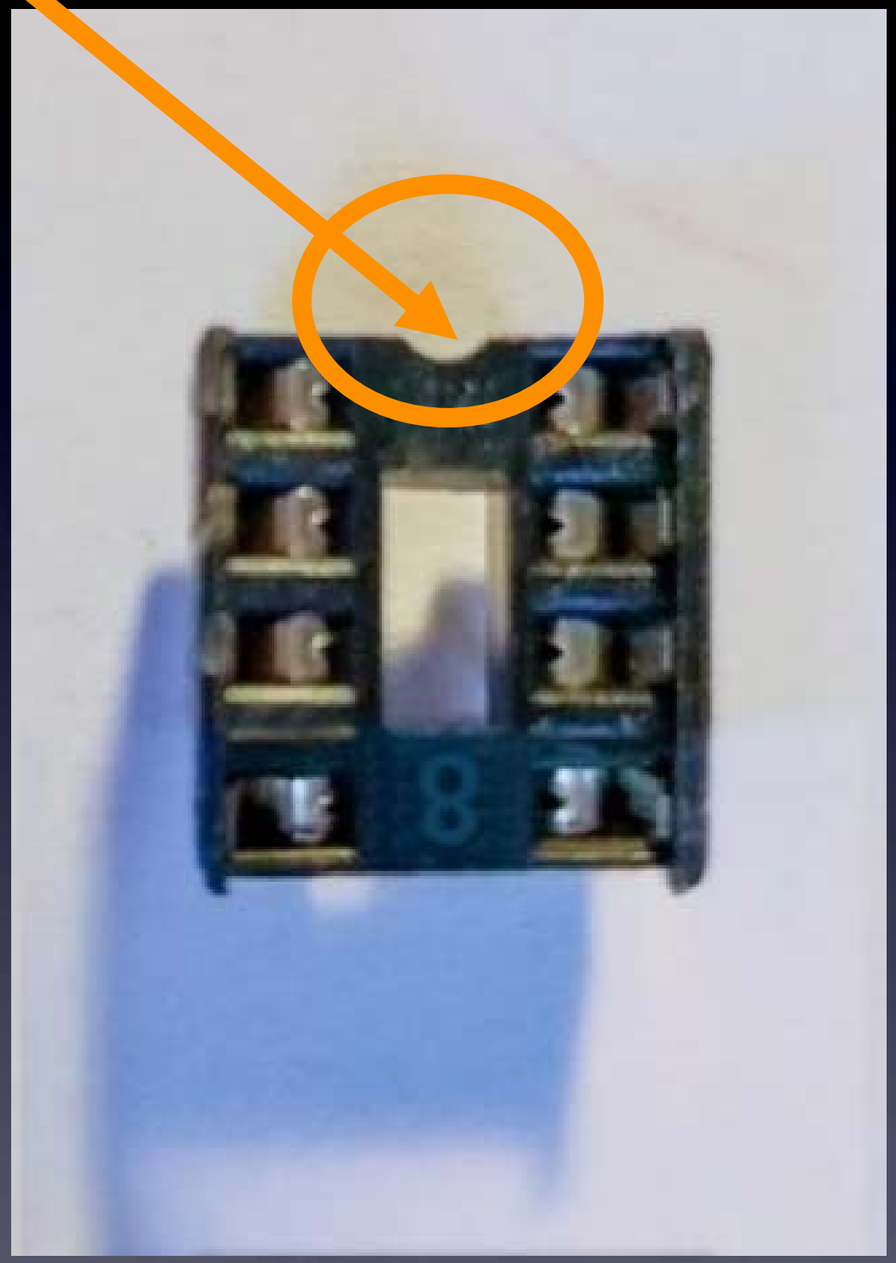
OK
either way
it fits

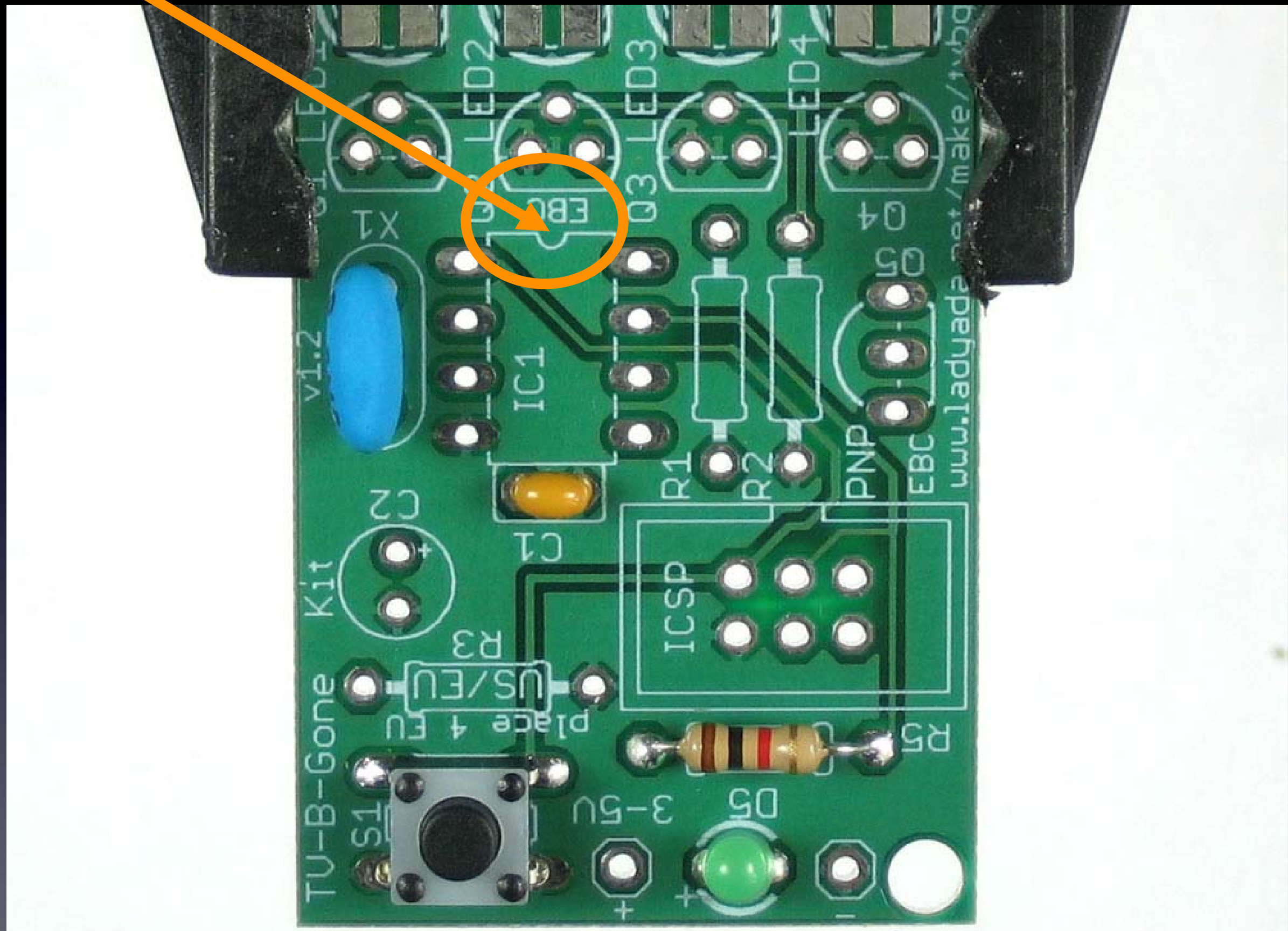
C1

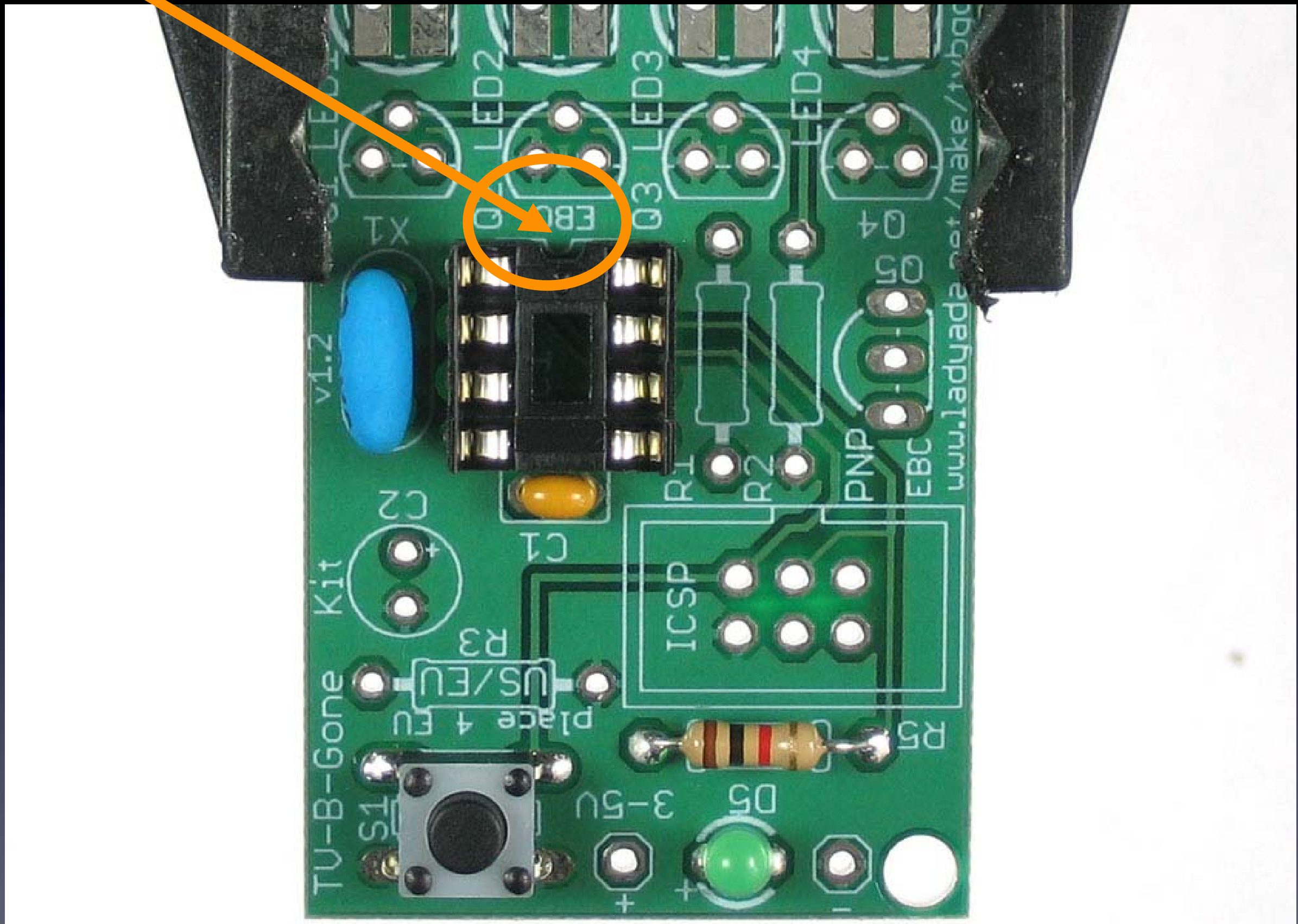

D5
Long lead
Short lead
TV-B-Gone Kit
IC1
ICSP
X1
Q1
Q2
LED2
D3
C1
C2
R1
R3
R5
S1
US/EU
3-5V
D5


www.ladyada.net/make/tvbg
Q4
Q5
EBC
PNP
LED4
R2
R1
ICSP
R5
D5
3-5V
Place 4 EU
US/EU
R3
C1
IC1
EBC
Q3 LED3
Q2 LED2
X1
C2
S1
v1.2
Kit
TV-B-Gone

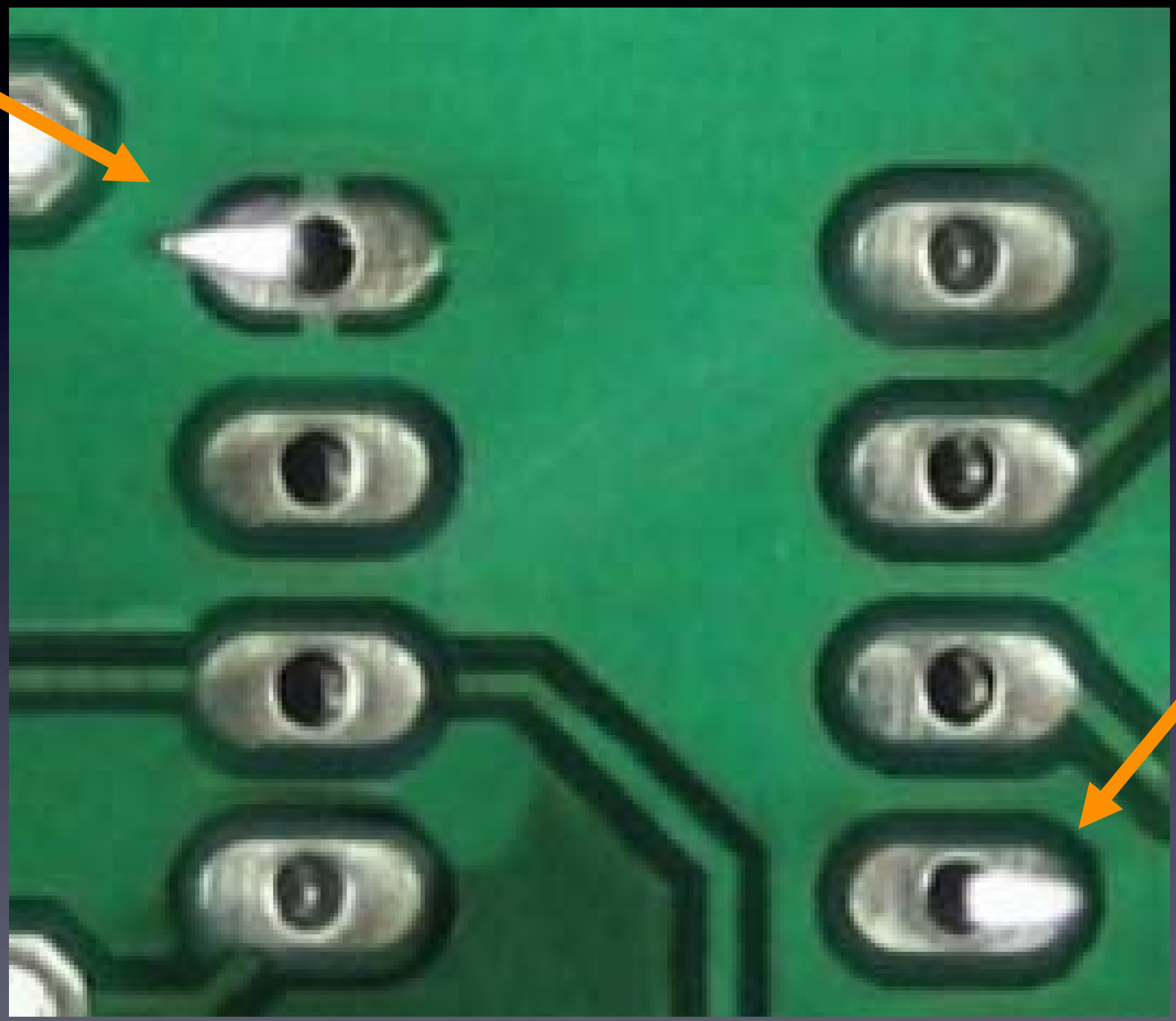

8


8


LED2
LED3
LED4
Q3
Q4
Q5
EBC
X1
IC1
C1
C2
R1
R2
R3
R5
PNP
ICSP
v1.2
Kit
TU-B-Gone
S1
US/EU
place 4 EU
3-5V
D5
www.ladyada.net/make/tvbg


LED2
LED3
LED4
X1
Q3
Q4
Q5
v1.2
R1
R2
PNP
EBC
www.ladyada.net/make/tvbg
C2
C1
Kit
ICSP
R3
US/EU
place 4 EU
R5
TV-B-Gone
S1
3-5V
D5
+
+
-

Bend pins on 2 opposite corners

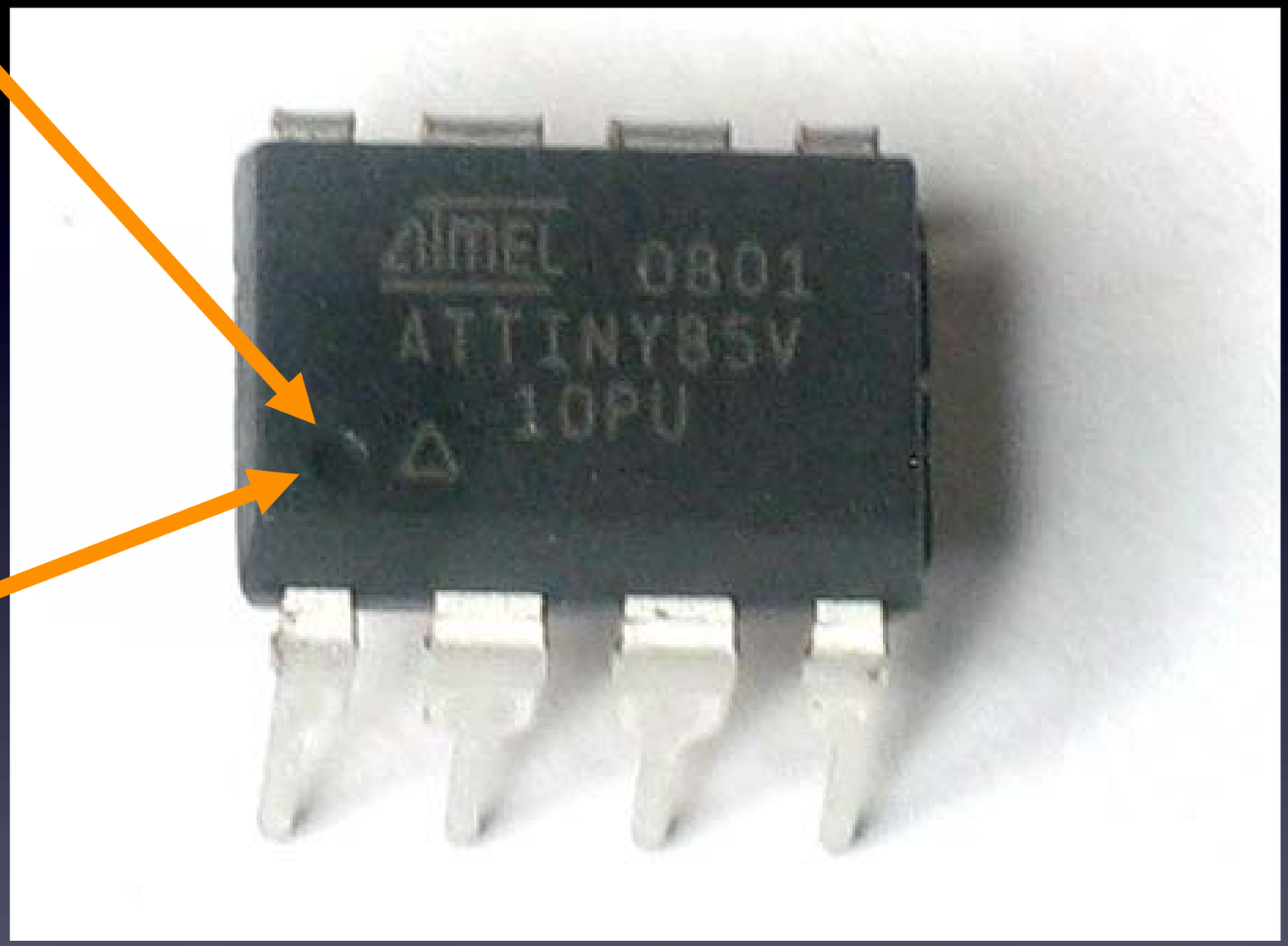


so socket won’t fall out while soldering

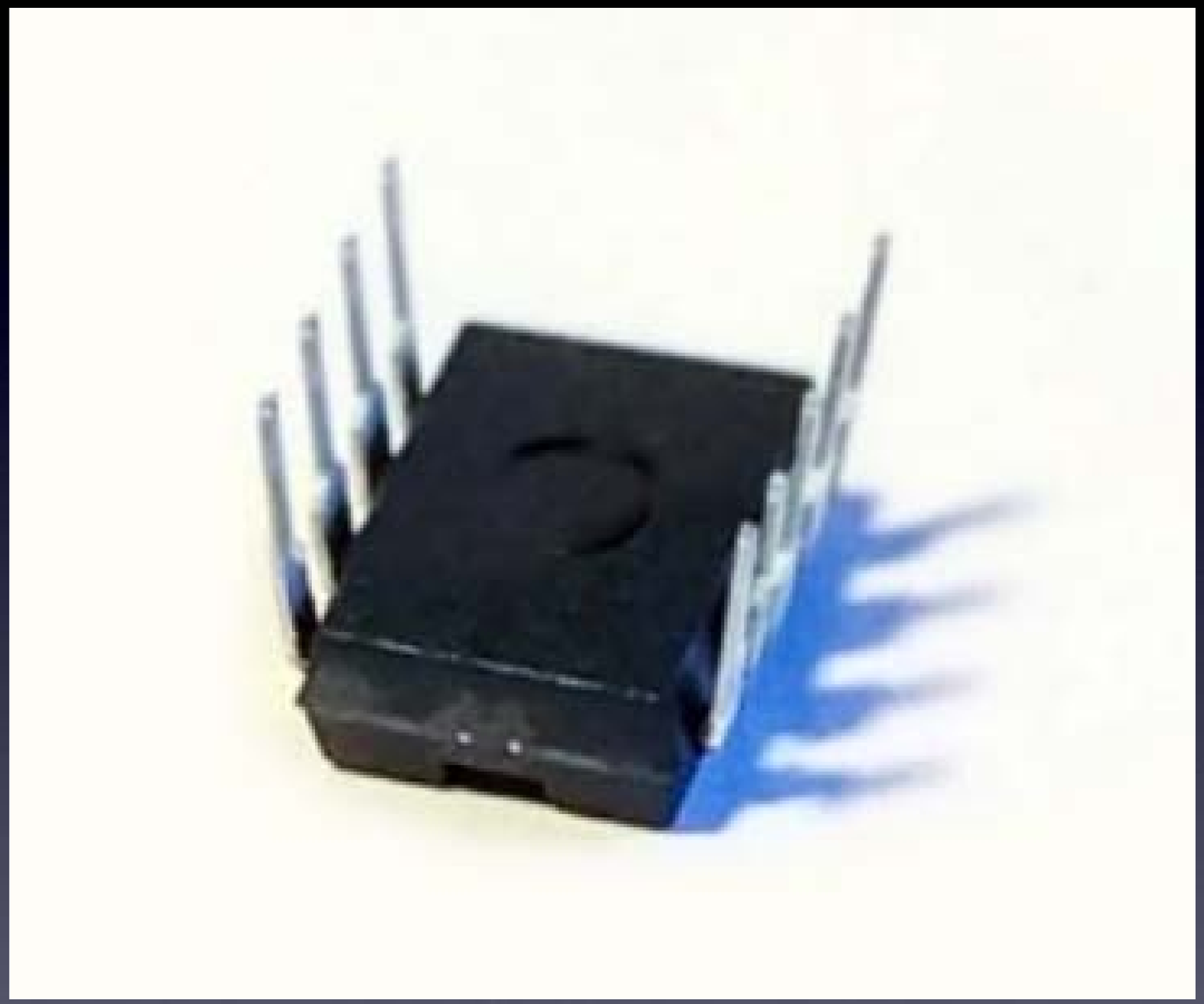
Pin 1

IC1

Indented
black dot

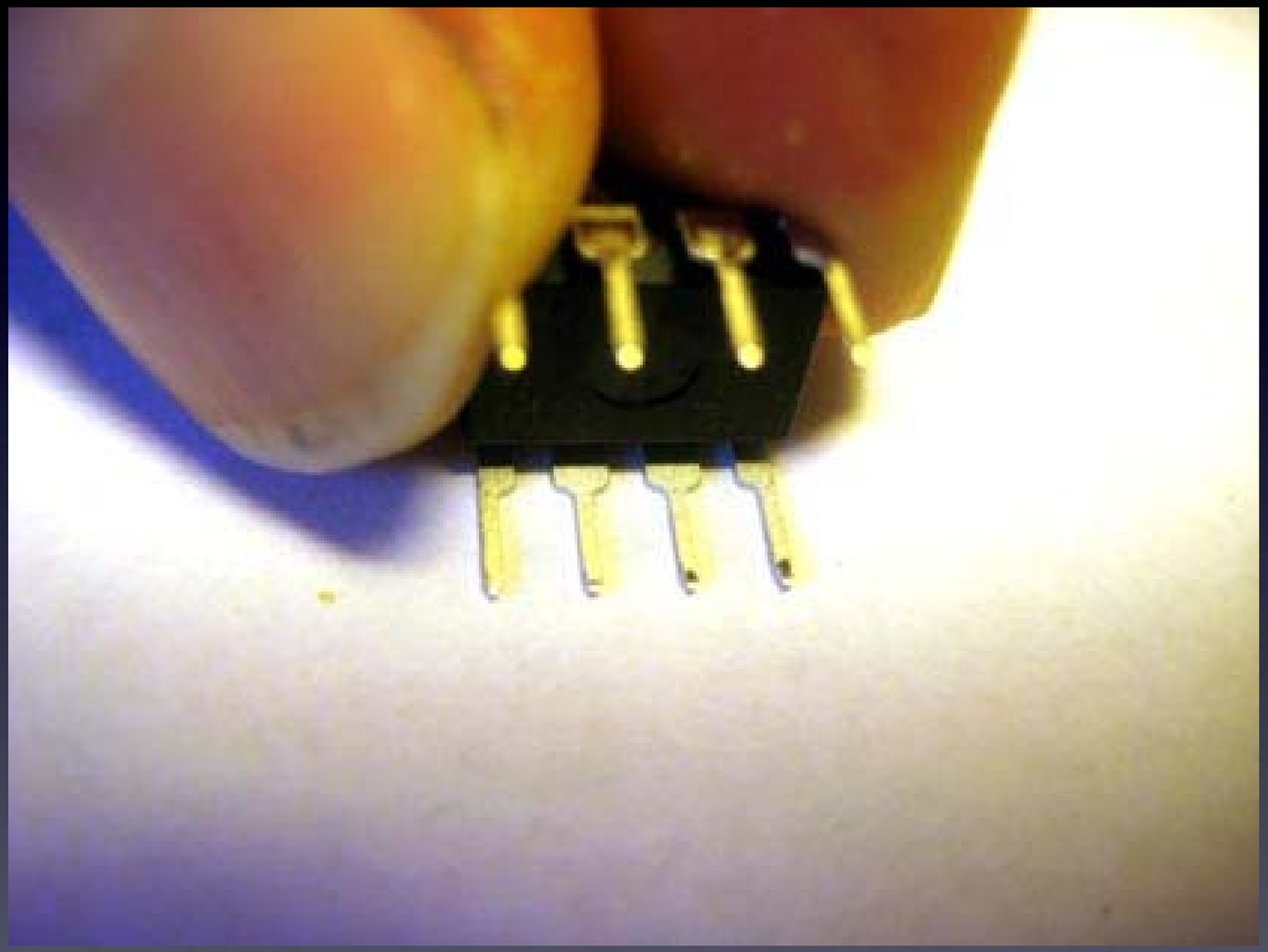


IC1



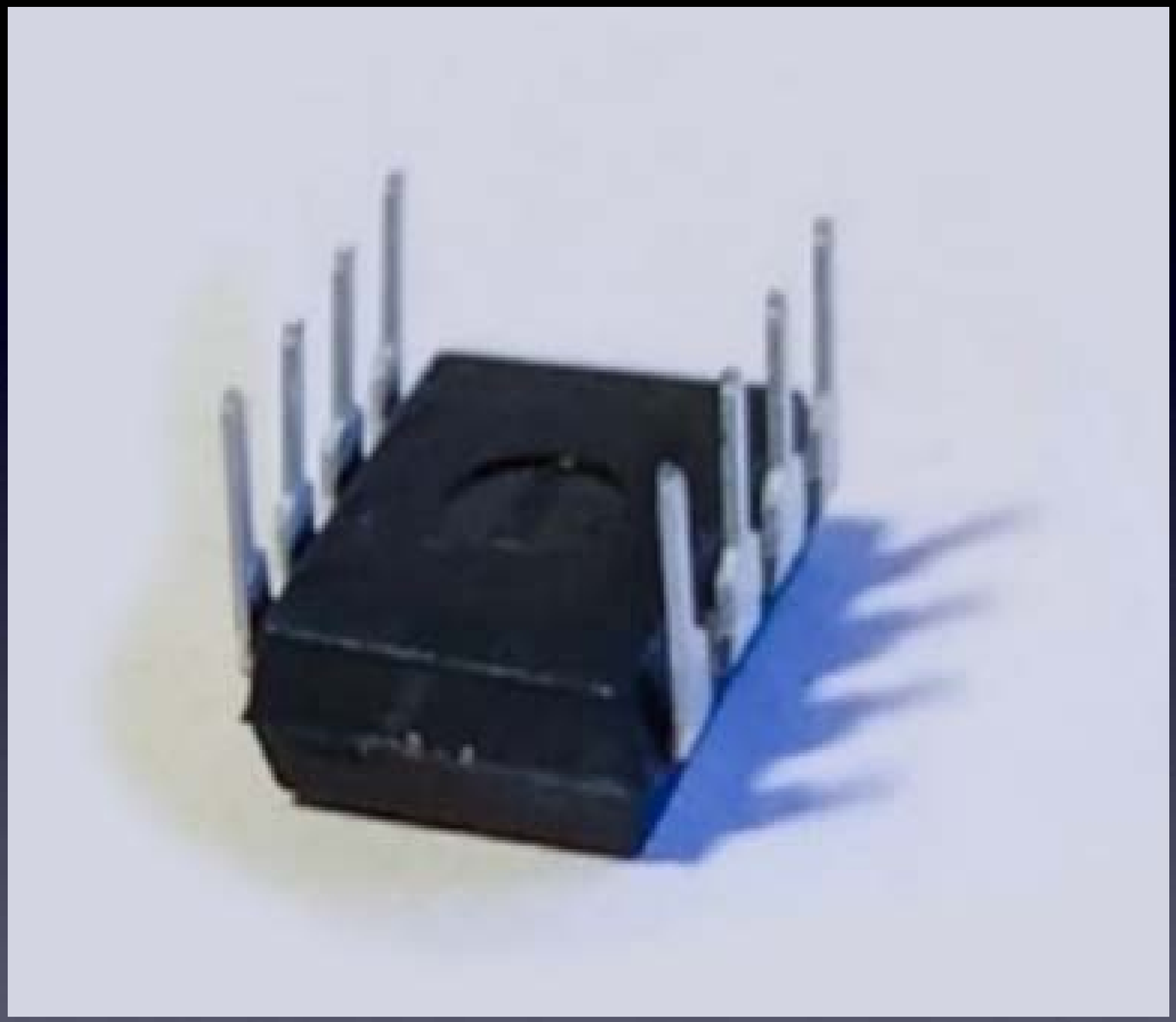
When chips are new,
their pins are bent out.

IC1



We need the pins bent straight and parallel.
Use your work table to (gently) bend the leads.

IC1



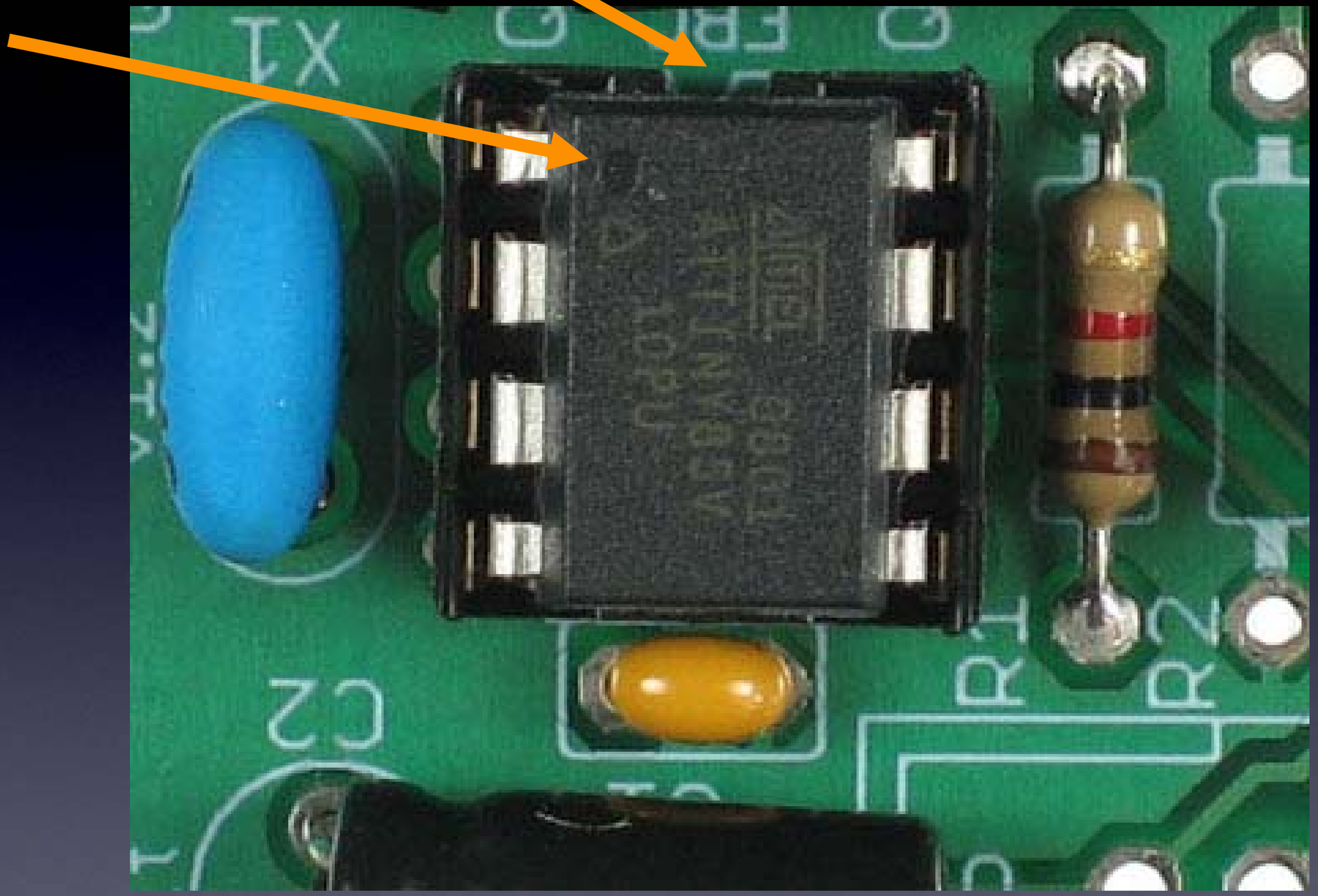
Gently bend leads so they’re straight and parallel

Pin 1

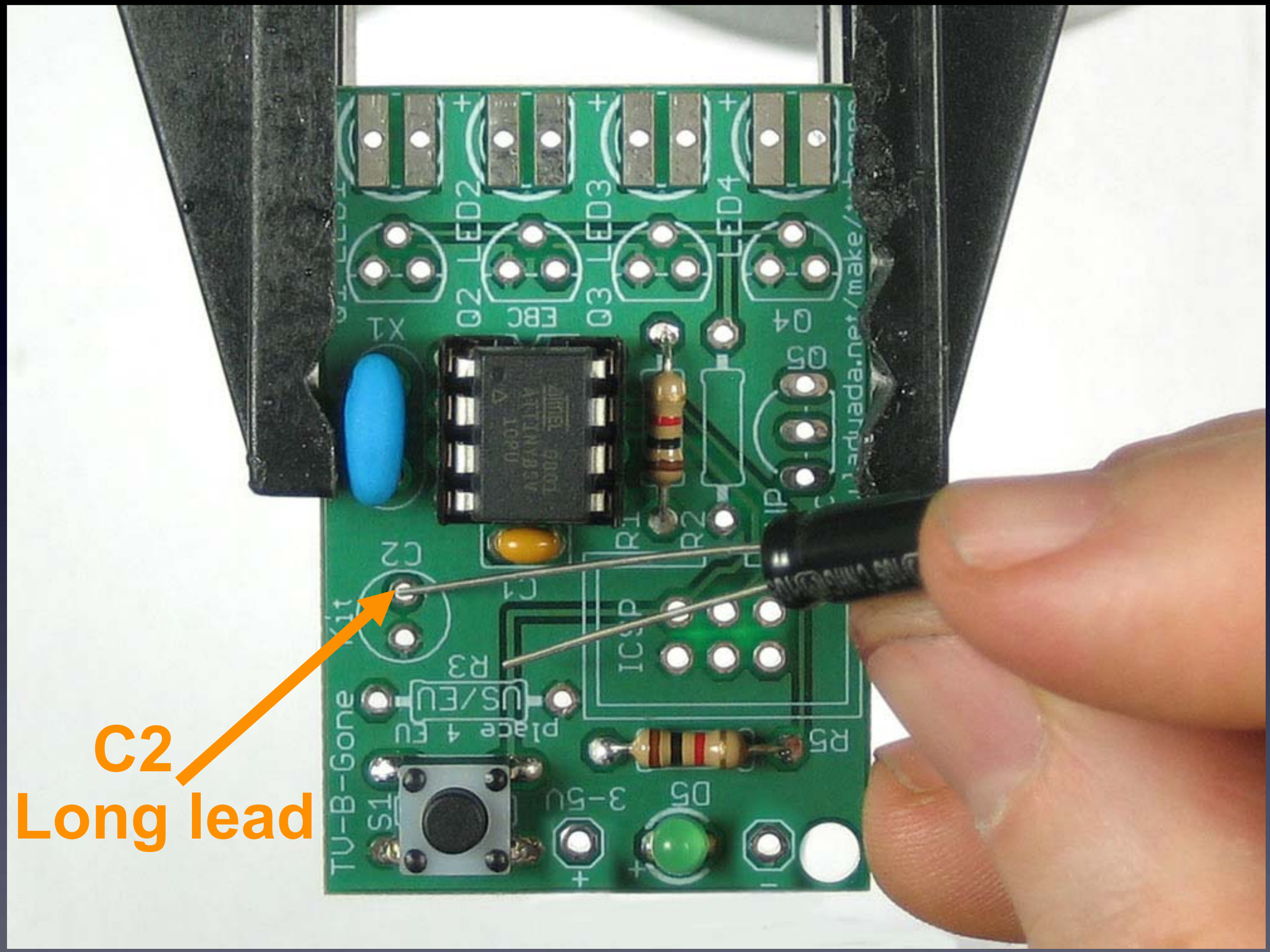
Pin 1

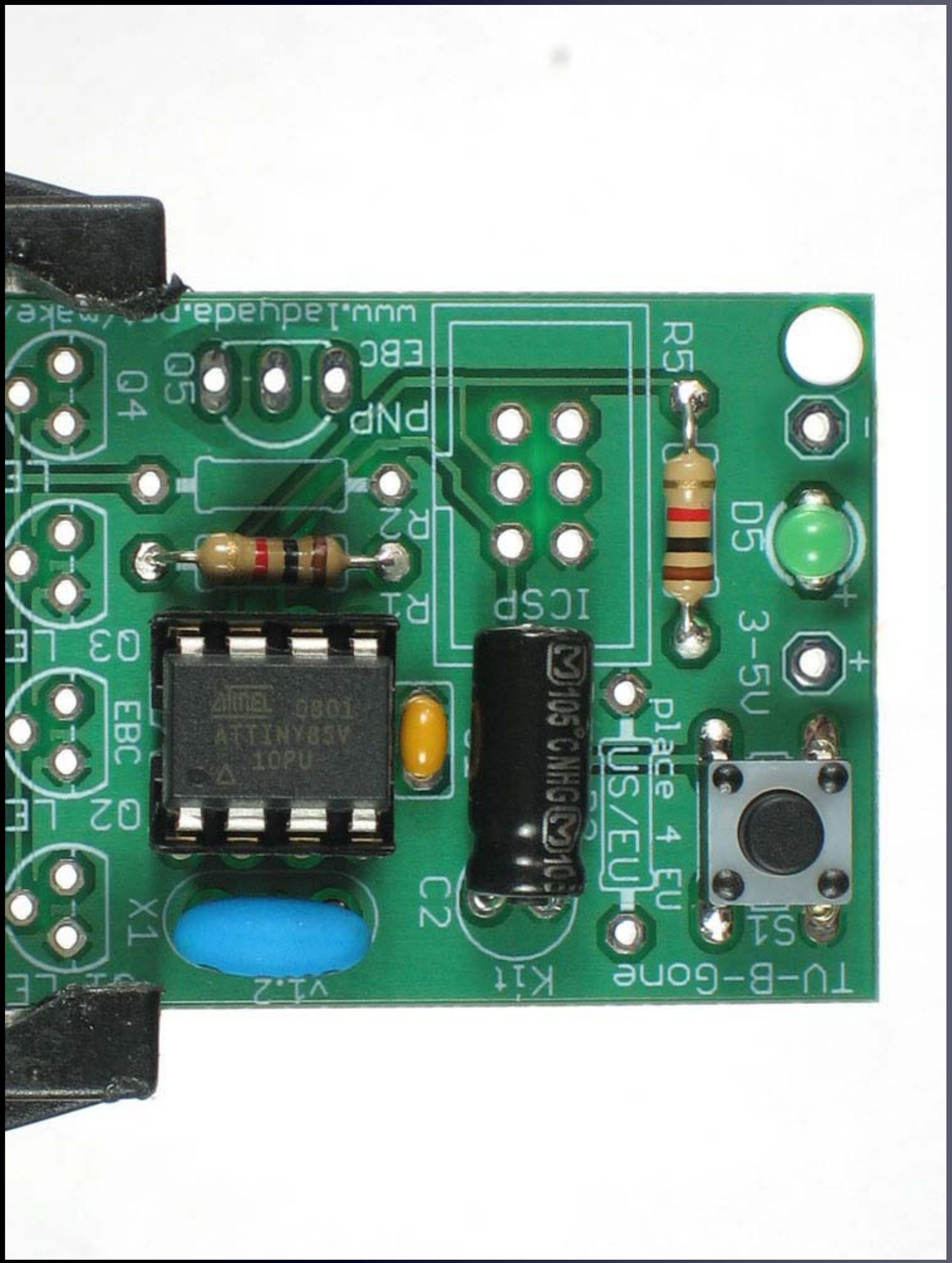
Indented
black dot

Make sure all 8 pins are in place, and push it into its socket.



Proper orientation


C2
Long lead

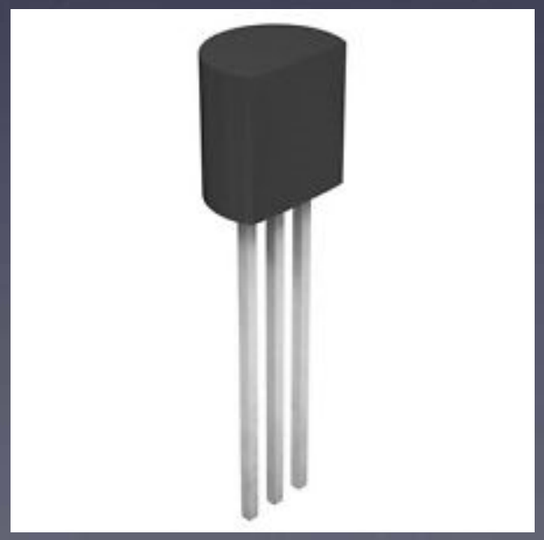

www.ladyada.net/make/
Q5
EBC
PNP
Q4
R5
R2
R1
ICSP
D5
3-5V
Q3
EBC
Q2
ATTINY85V
10PU
105°C NHG 10
Place 4 EU
US/EU
C2
X1
S1
v1.2
Kit
TV-B-Gone

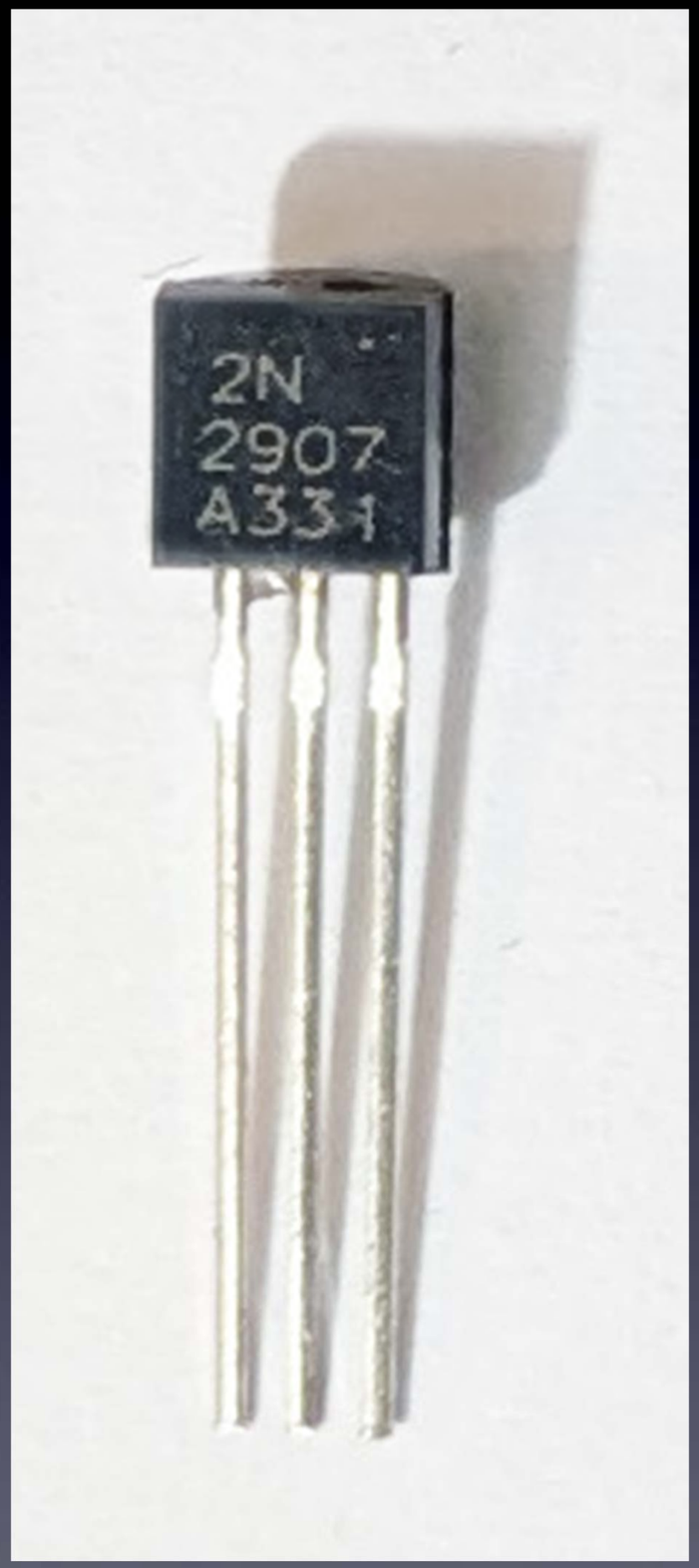
Q5

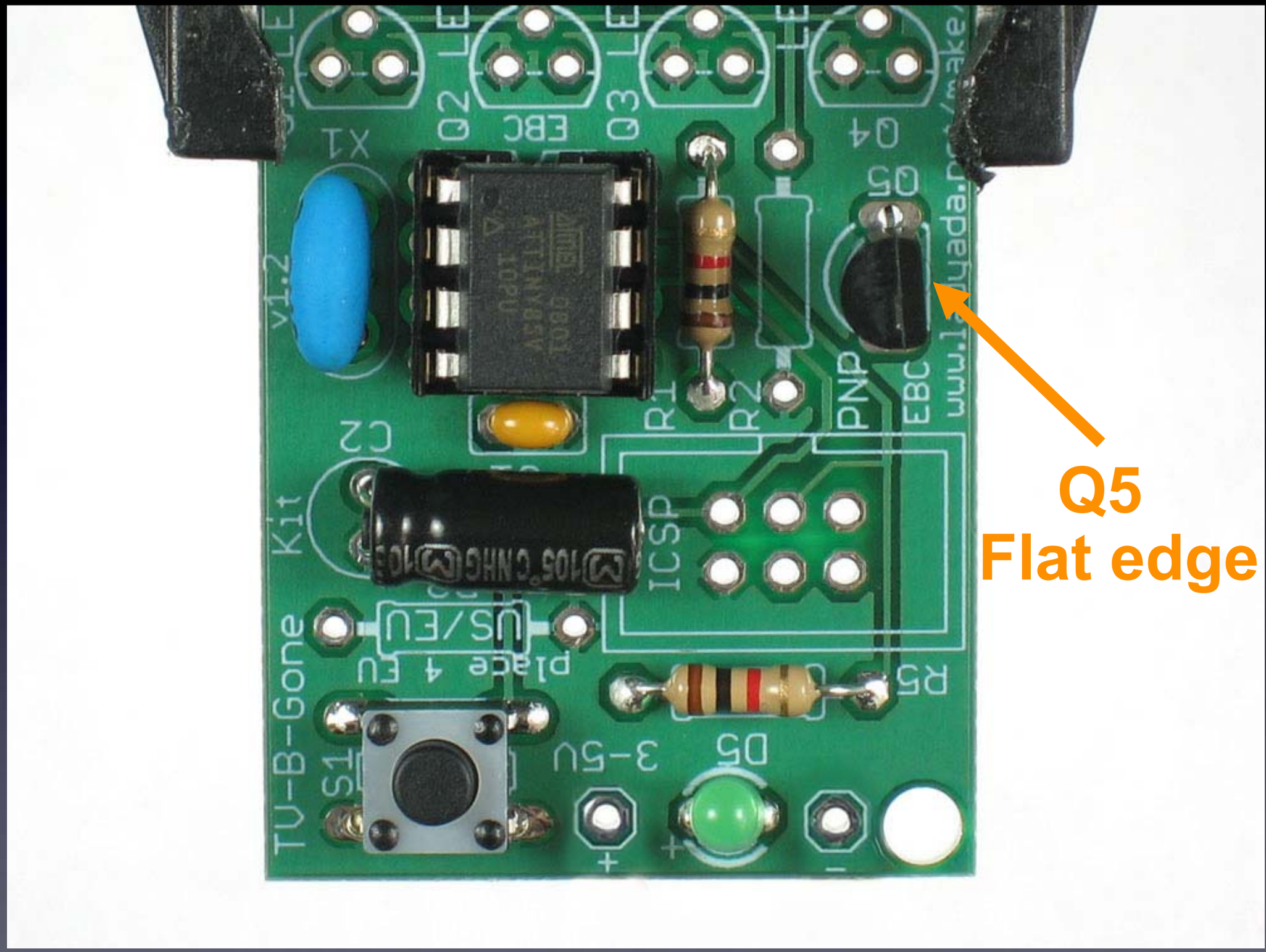
2N2907

(the one that is not taped to others)

Look at this shape:





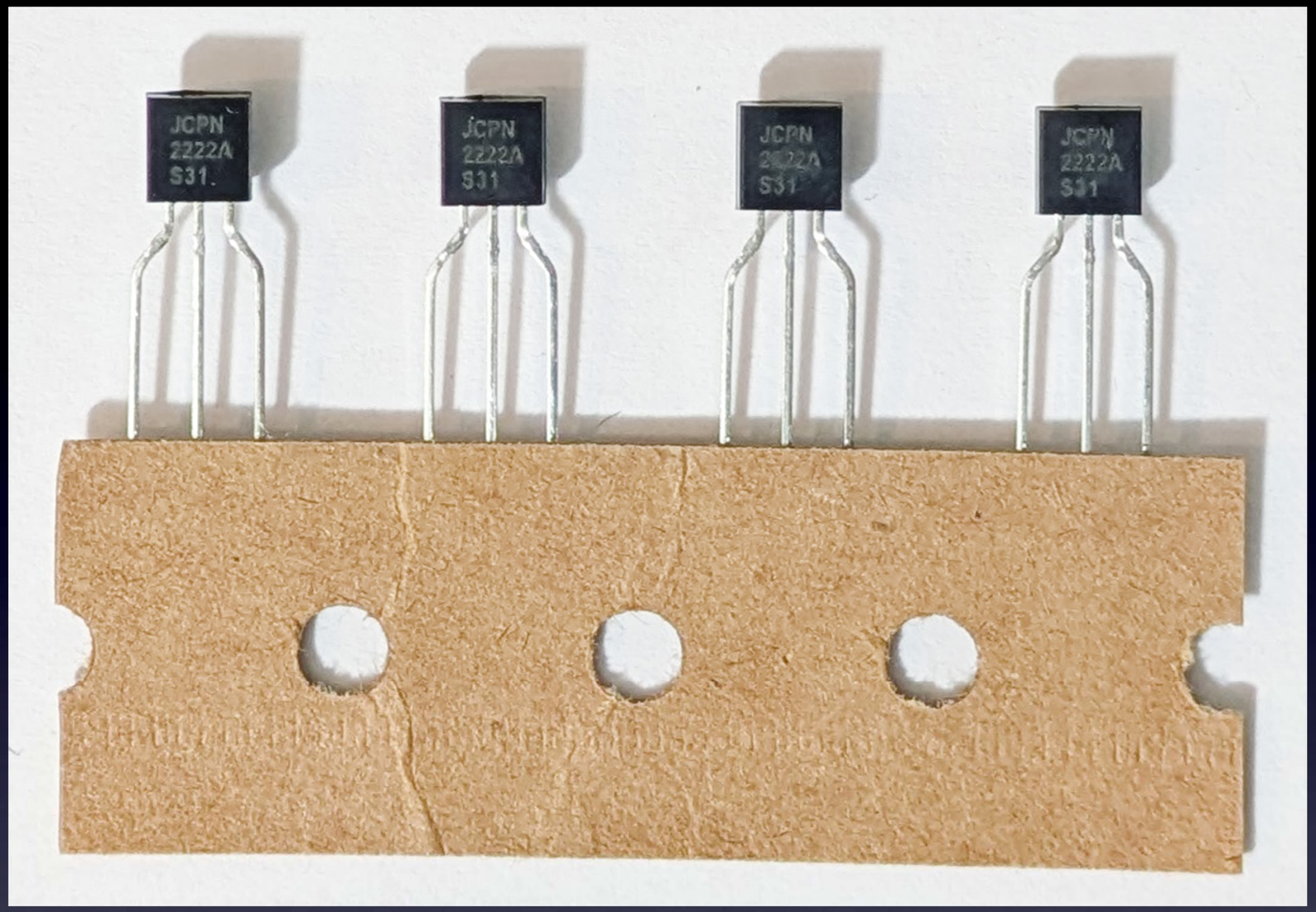


Q5
Flat edge

DO NOT push transistors all the way into the board

DO NOT push transistors all the way into the board

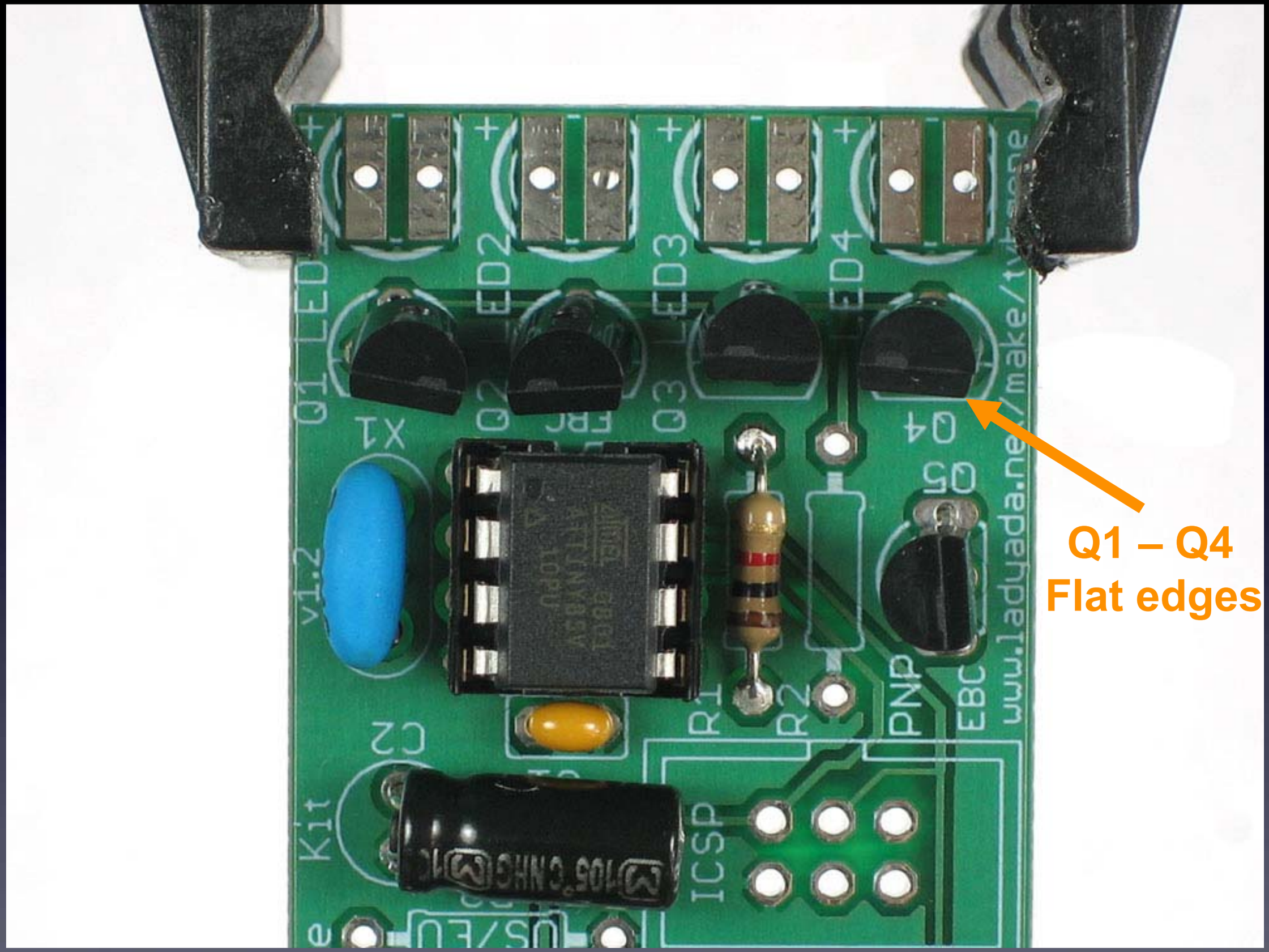
Only push till it is a little hard to push more



Q1, Q2, Q3, Q4

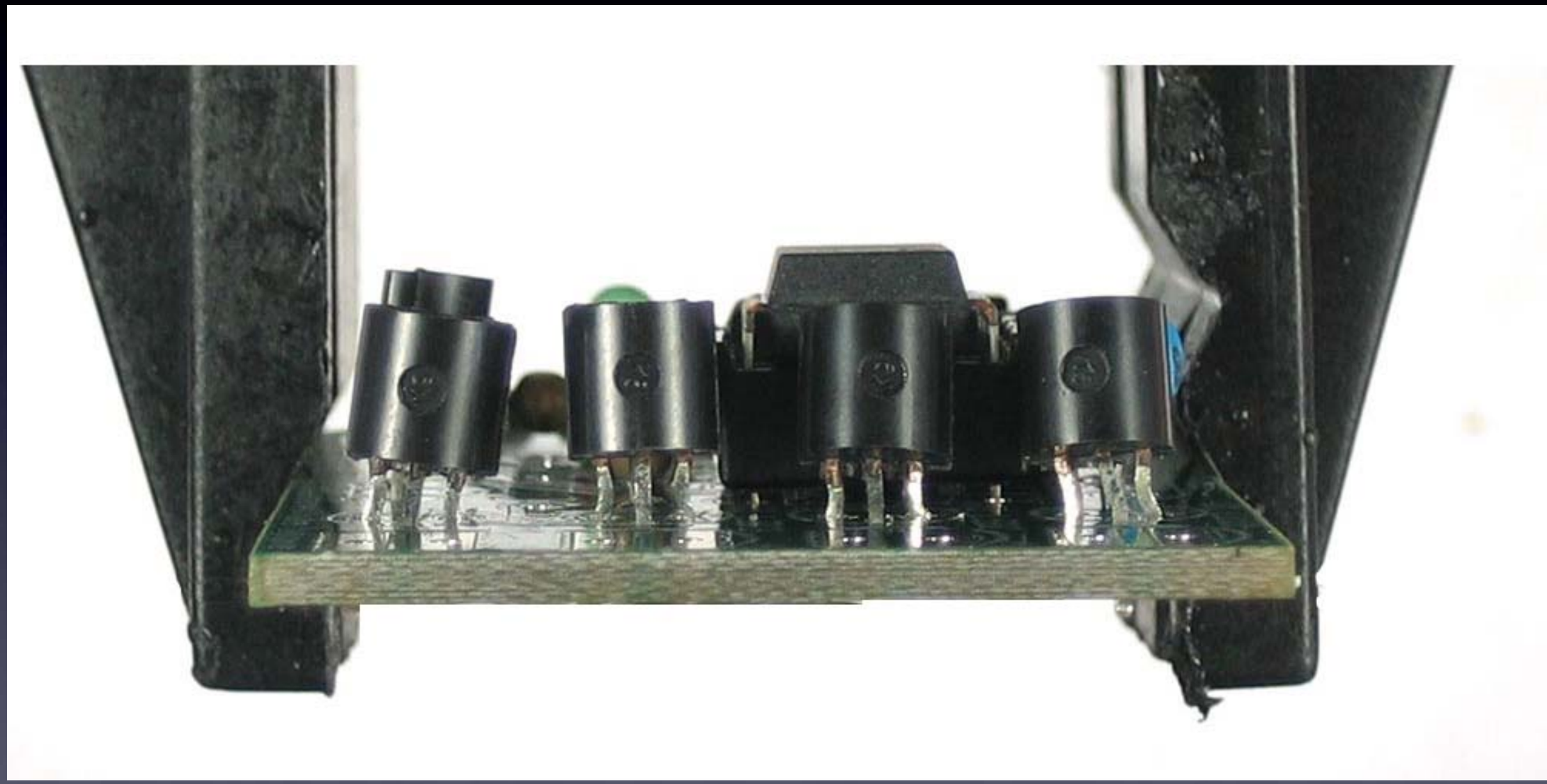
2N2222

(taped together)

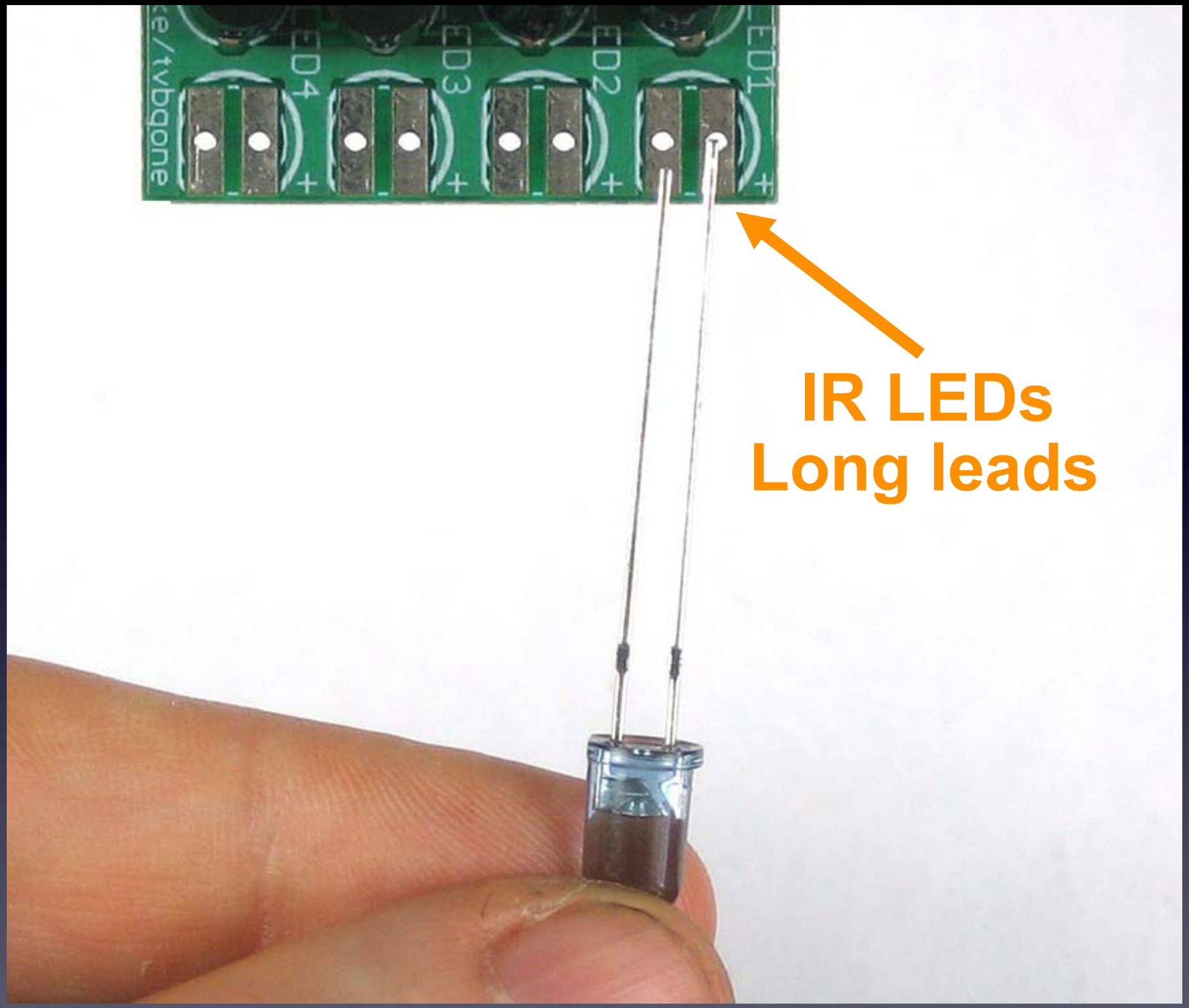


DO NOT push transistors all the way into the board

DO NOT push transistors all the way into the board



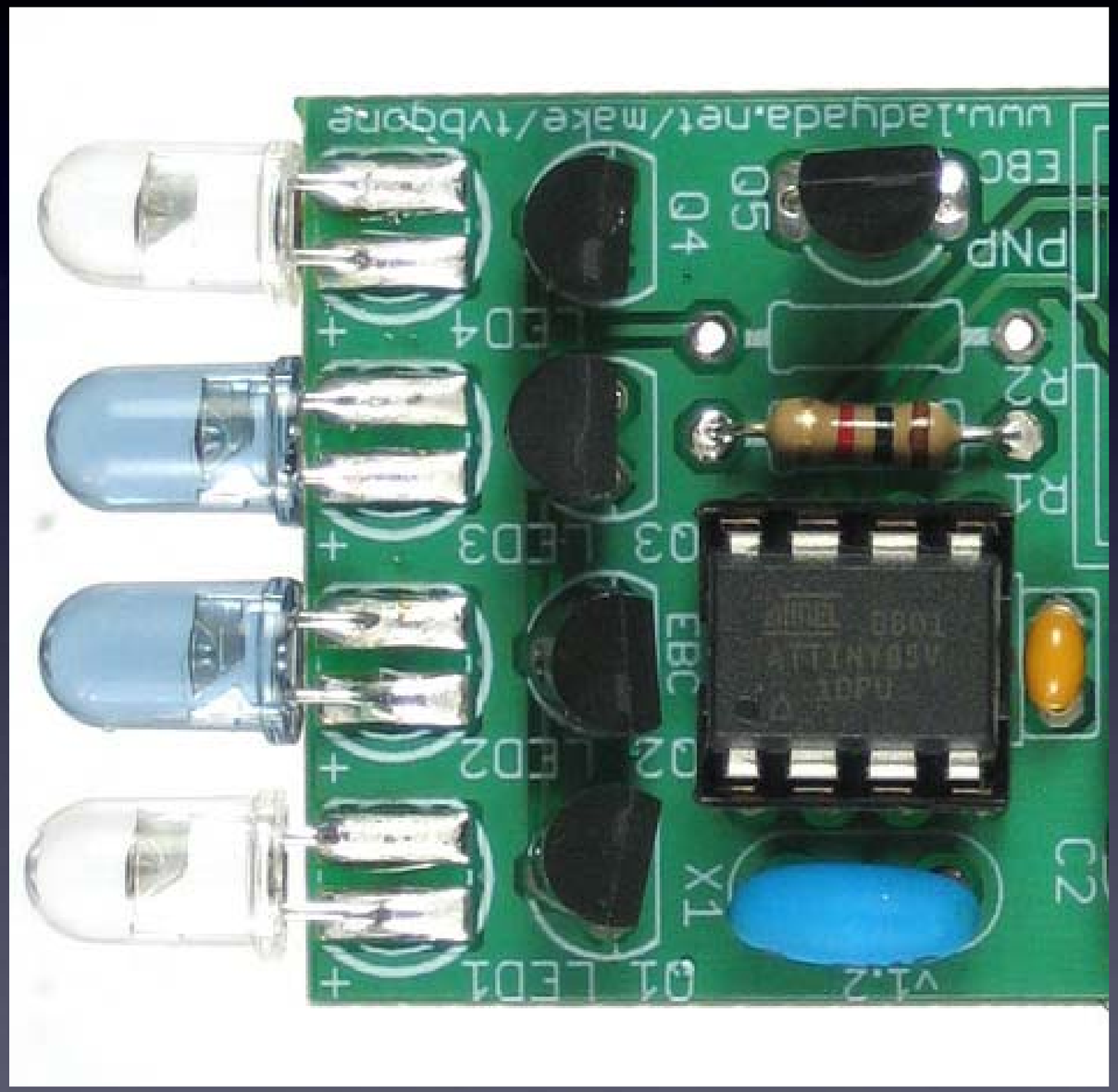
Only push till it is a little hard to push more



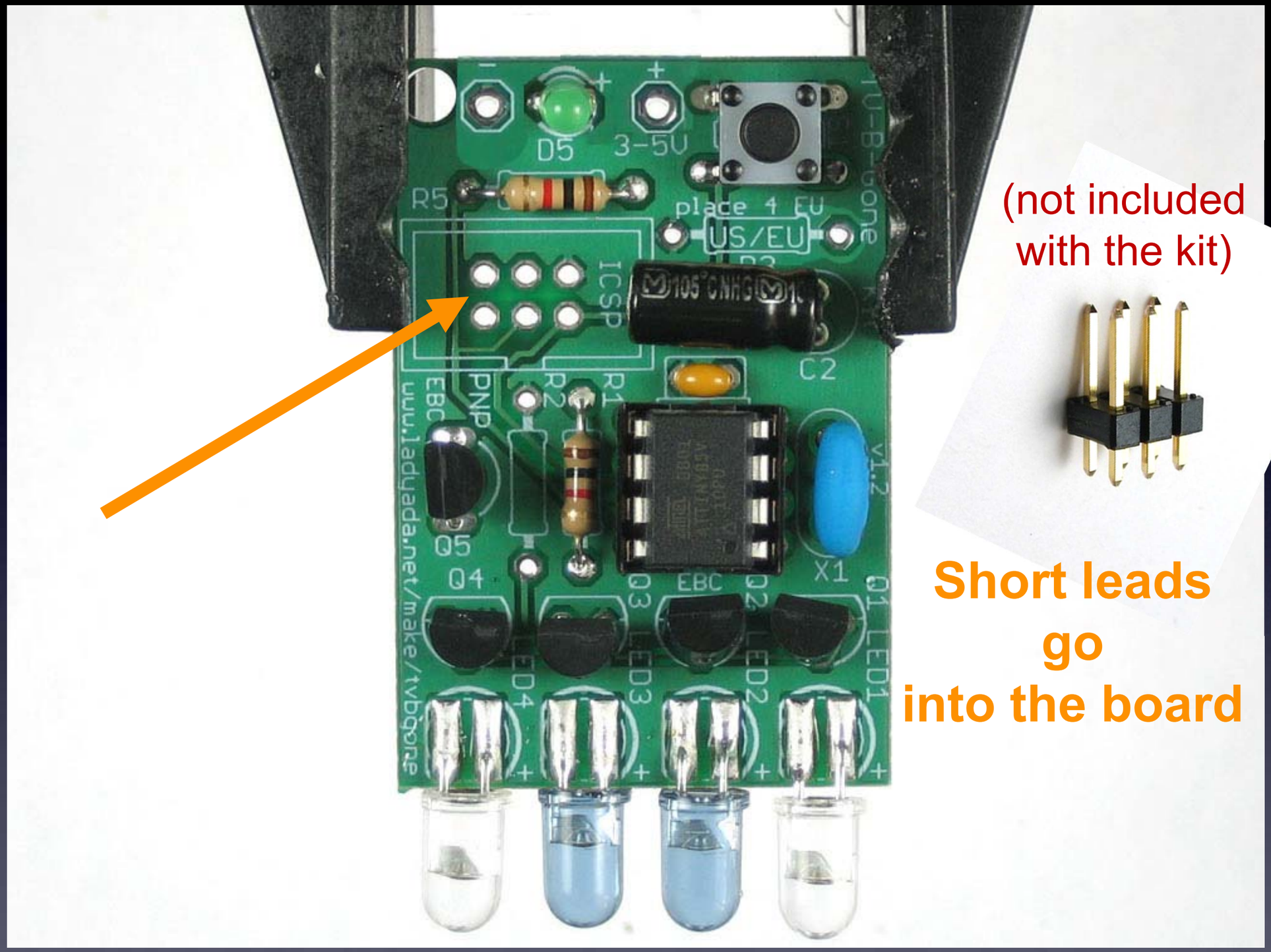
DO NOT solder these yet!

You may want to bend the IR LEDs over, like this:

The color of these LEDs is unimportant



(The ordering of these LEDs is unimportant)

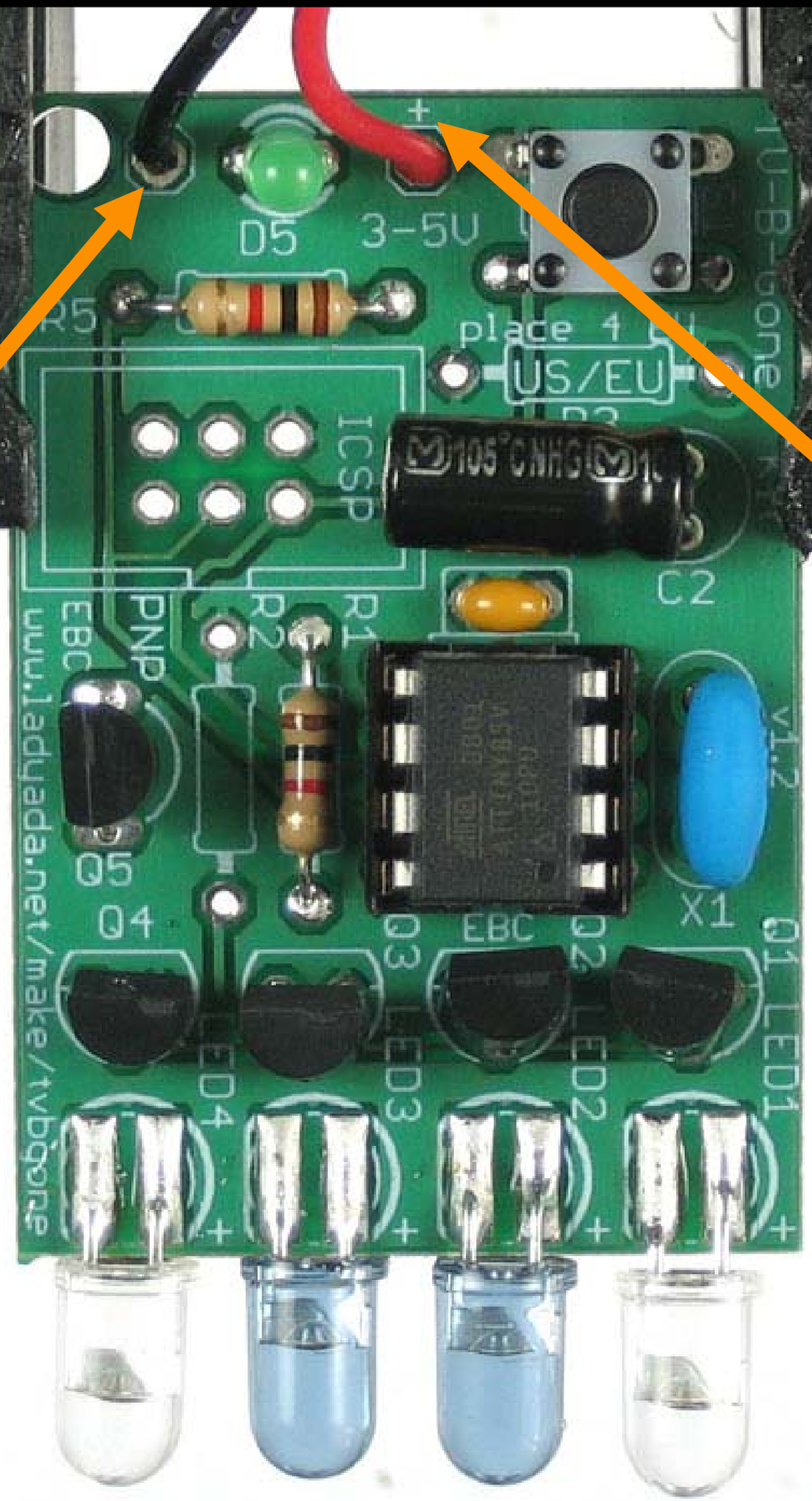


(not included with the kit)

Short leads go into the board

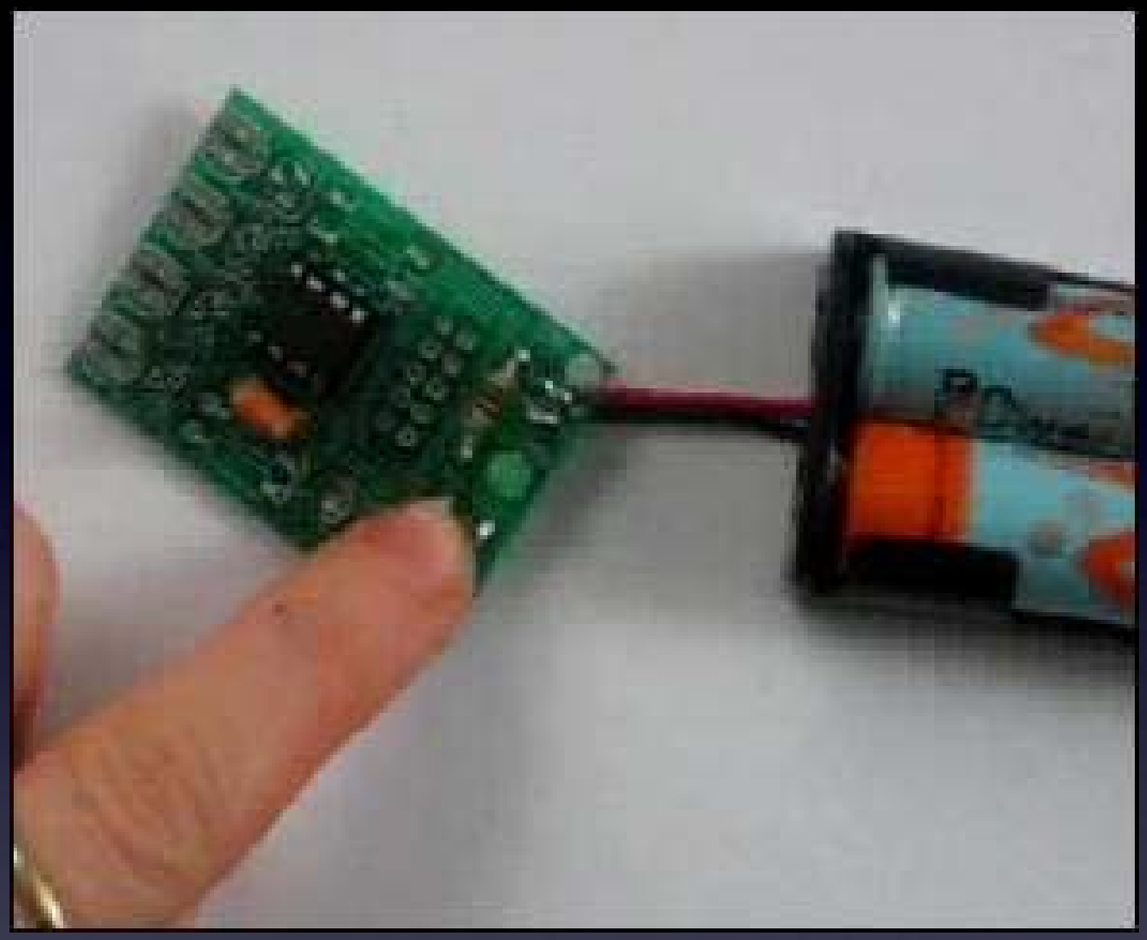
Optional: ICSP header (for re-programming the microcontroller)

Black wire of battery pack “-”



Red wire of battery pack “+”

Test 1

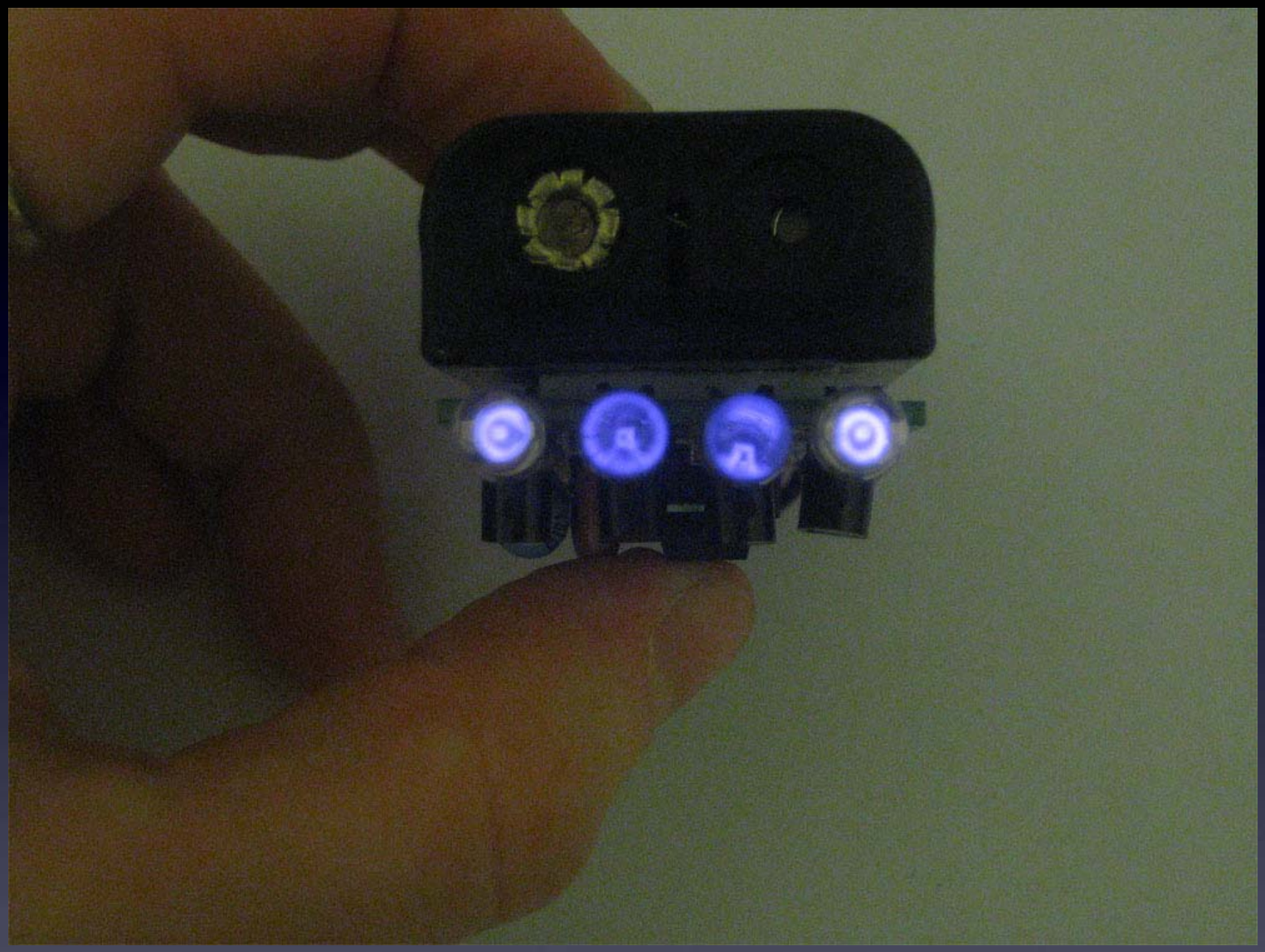


IMPORTANT:
Use Alkaline
AA batteries

other kinds of AA batteries
will not work

Green LED blinks
after inserting batteries
(and continues blinking for about 1 minute)

Test 2

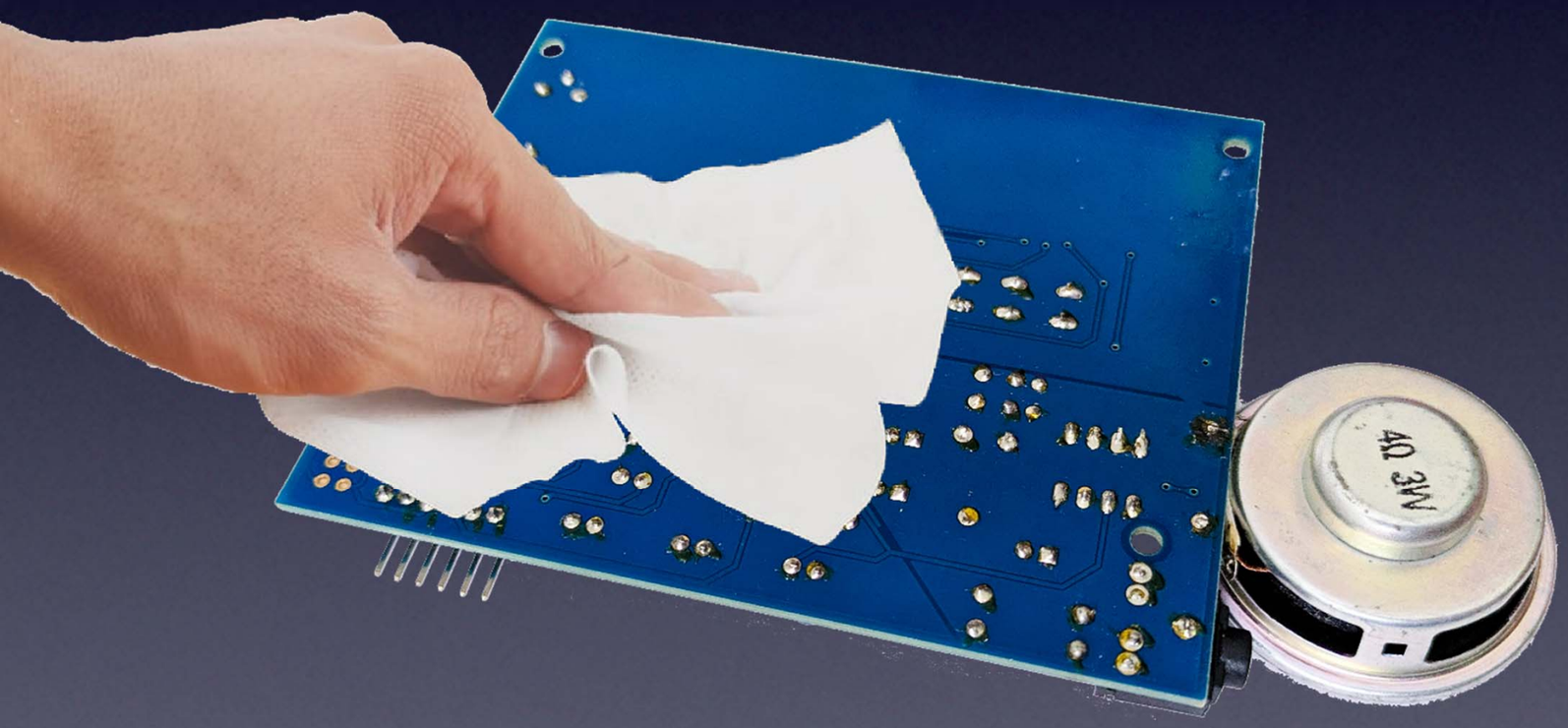


All IR LEDs blink

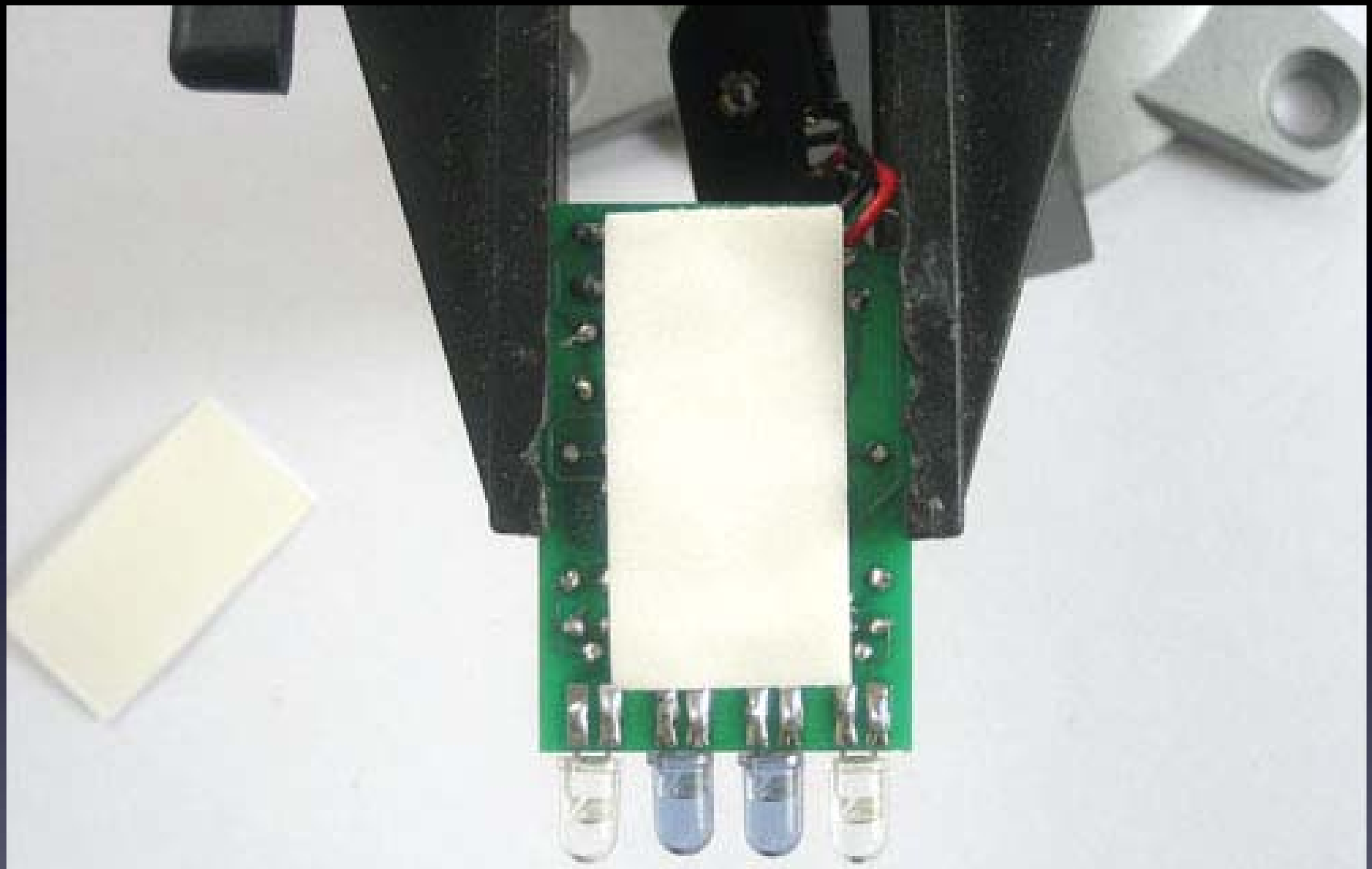
(using your phone’s front-facing camera)

Since we used *Lead-Free* solder
and
***flux paste* in a syringe**

<u>The bottom of the PCB will be sticky from the flux</u>



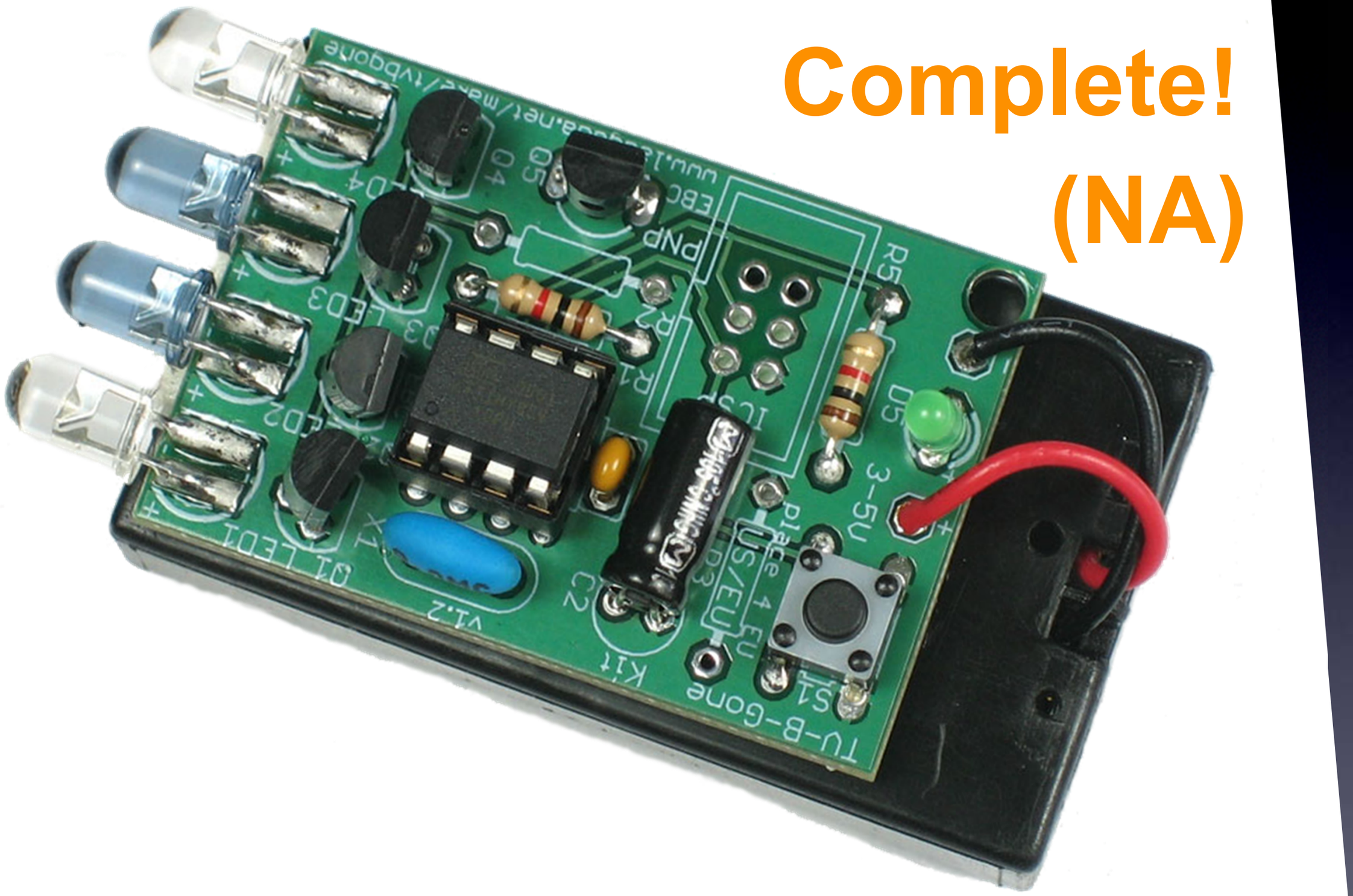
You can clean it with a cloth wet with Isopropyl Alcohol



You can use the double-sided tape
to connect the PCB to the battery pack

Complete!

(NA)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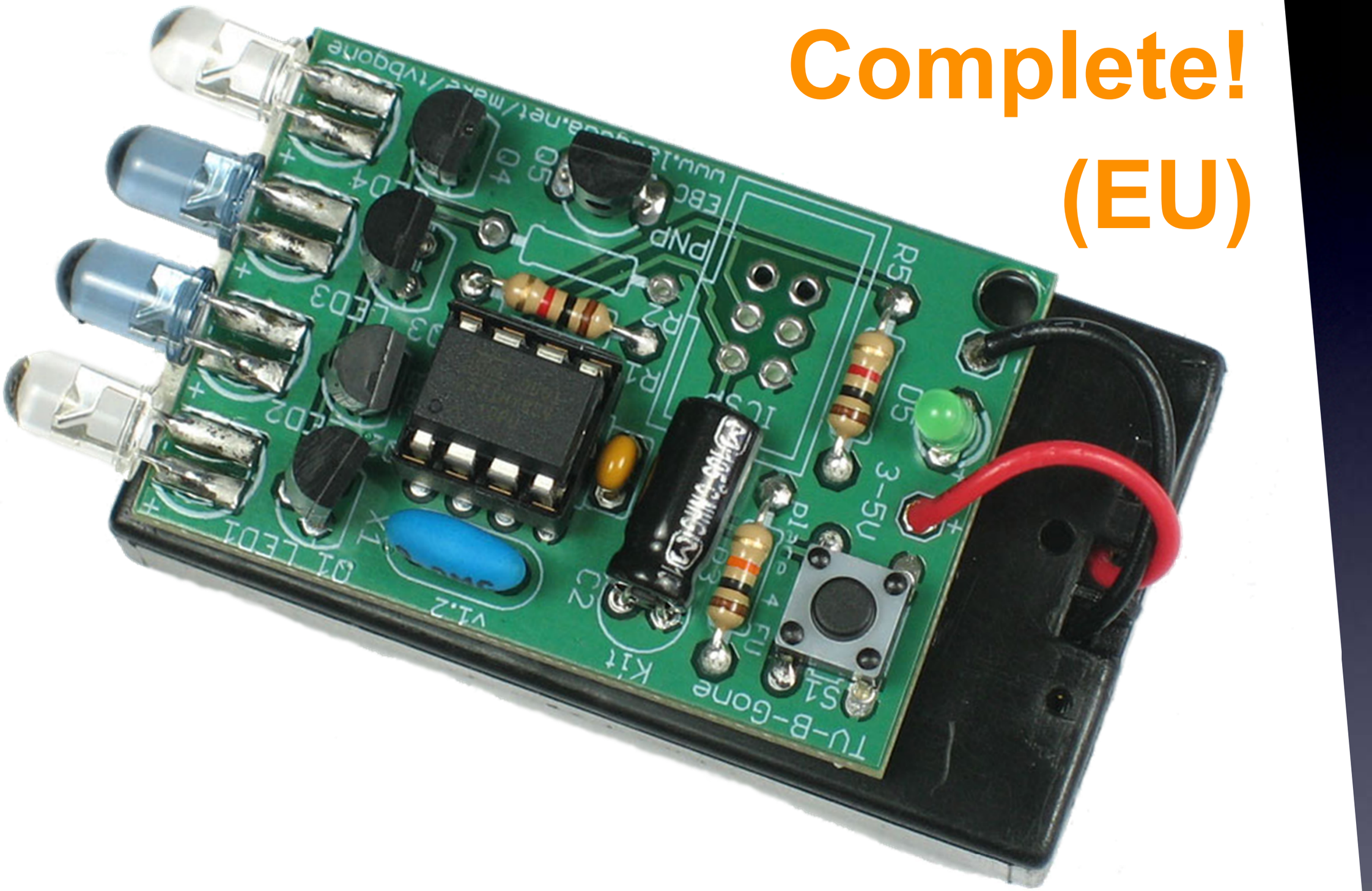
LED1
LED2
LED3
LED4
Q1
Q2
Q3
Q4
Q5
PNP
R2
R5
IC1
C2
K1
S1
TU-B-Gone
3-5V
V1.2

Complete!

(EU)


www.ladyada.net/make/tvbgone
PNP
LED1
LED2
LED3
LED4
LED5
R5
R2
R1
R3
R4
3-5V
V1.2
K1t
TV-B-Gone
S1

TV B GONE®

Turn off TVs!!

Make the world a better place

Please Remember:

to

Wash your hands

after soldering

2-Dec-2024

Make your own

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** (1st and biggest hardware accelerator)
Co-founder of **Noisebridge** (San Francisco hackerspace)
email: **mitch@CornfieldElectronics.com**
site: **www.CornfieldElectronics.com**
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flickr: **maltman23**
WeChat: **mitchaltman**
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