



# 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** (1<sup>st</sup> and biggest hardware accelerator)

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

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

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Patreon: [mitchaltman](https://www.patreon.com/mitchaltman)

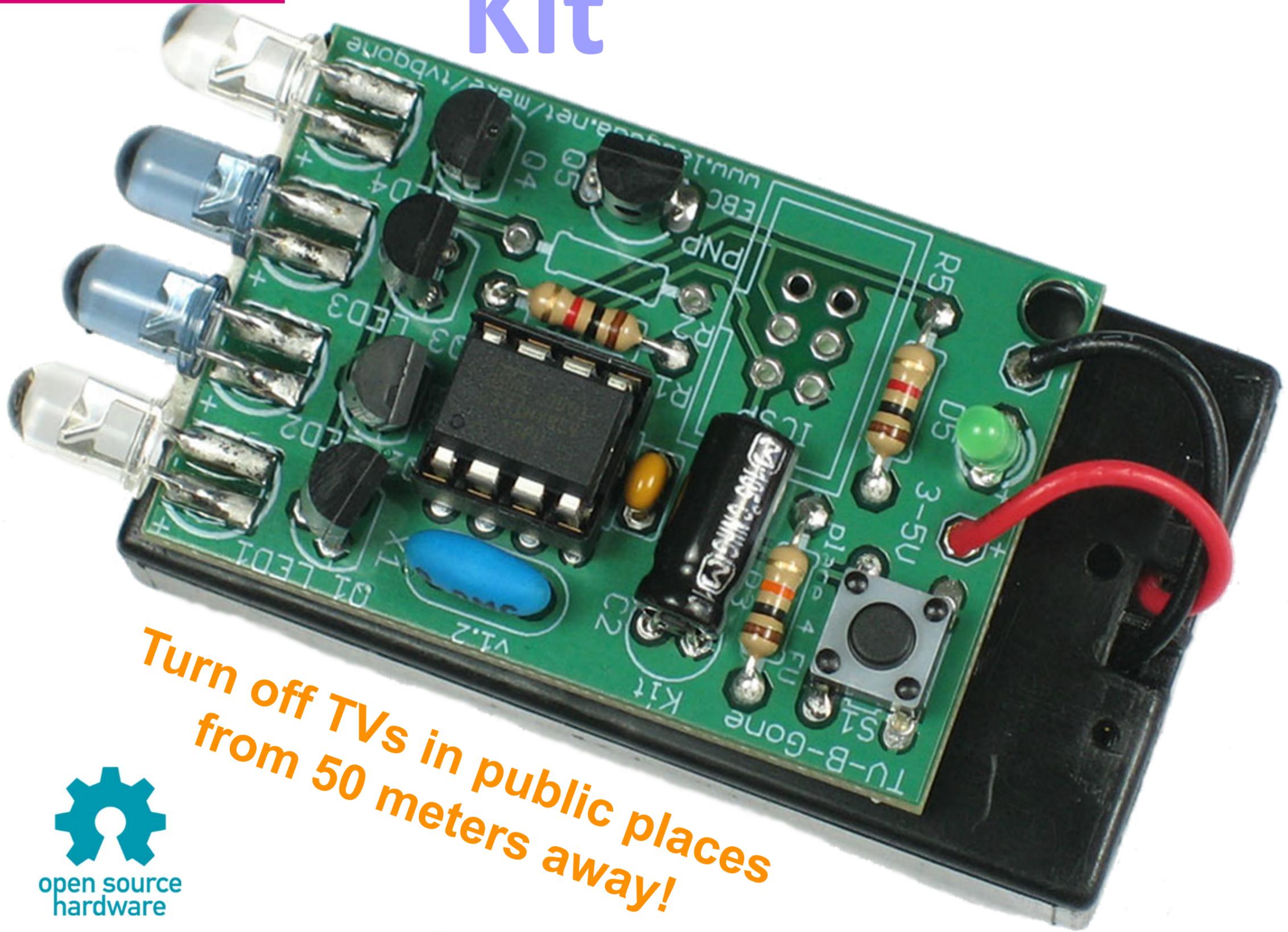


# Syllabus

- 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



# Kit



Turn off TVs in public places  
from 50 meters away!



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CORNFIELD ELECTRONICS

**TV B GONE®**



HIGH POWER UNIVERSAL REMOTE CONTROL

Just Point & Click...  
**TURN ANY TV**  
On or Off! **AMAZING!**

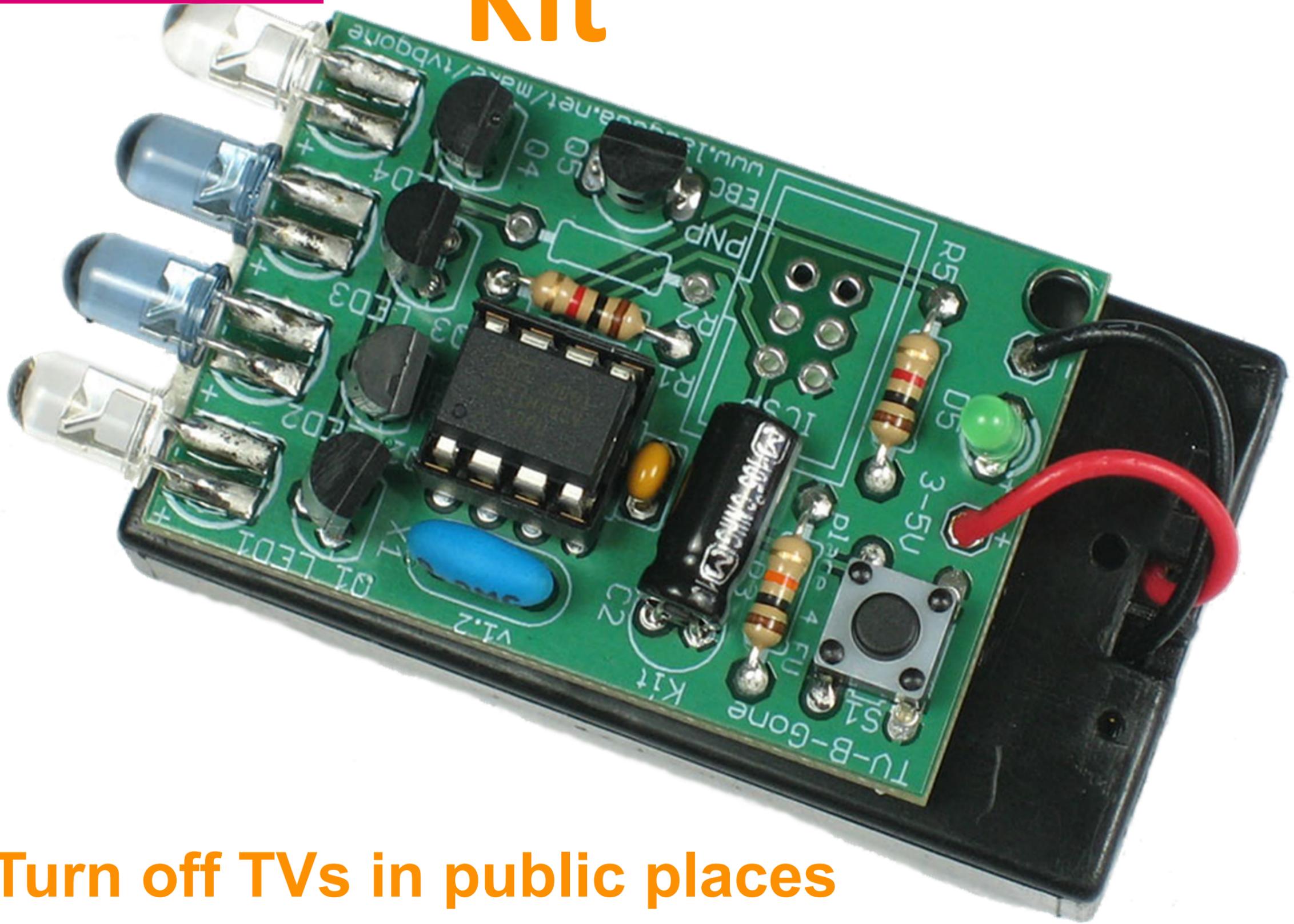
A black universal remote control with a silver keychain, positioned in the center. It is surrounded by a bright, radiating light effect of yellow and blue lines. The background features two black and white faces with wide-eyed, surprised expressions.

*TV-B-Gone*  
*Just a remote control,*  
*but only one button:*  
*OFF!*





# Kit



Turn off TVs in public places from 50 meters away!



# Kit: in a jacket



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



# Kit: in a hat





# Kit: Sonic Screwdriver



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



Takes about 60 seconds



About 150 IR "OFF" codes (one per blink)

TV-B-Gone universal remote control

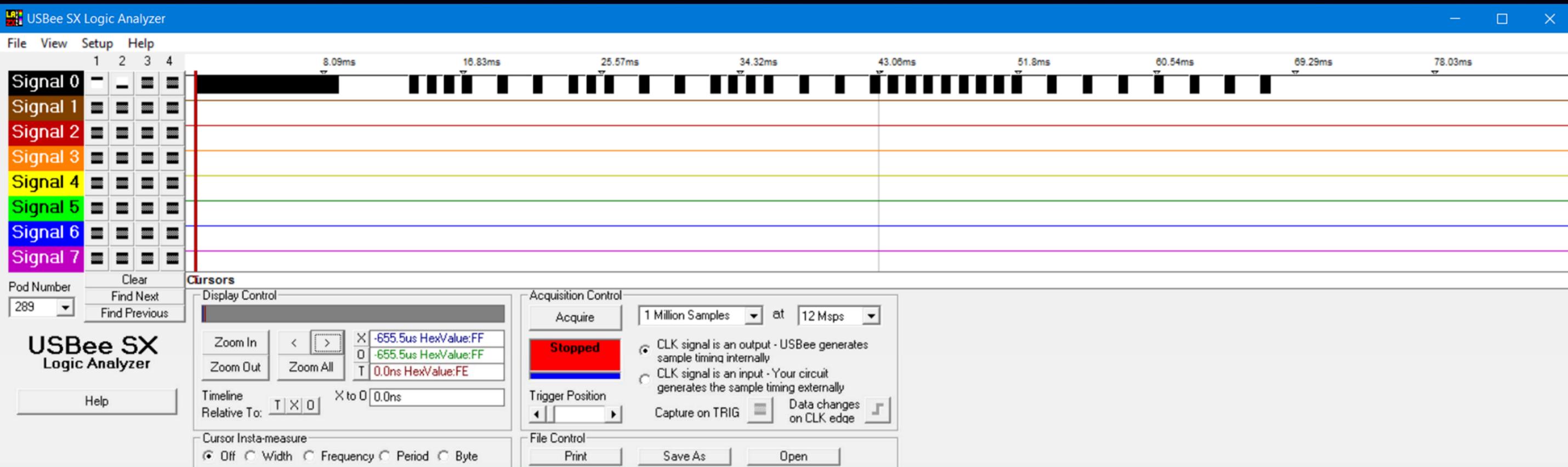
# IR Remote control codes



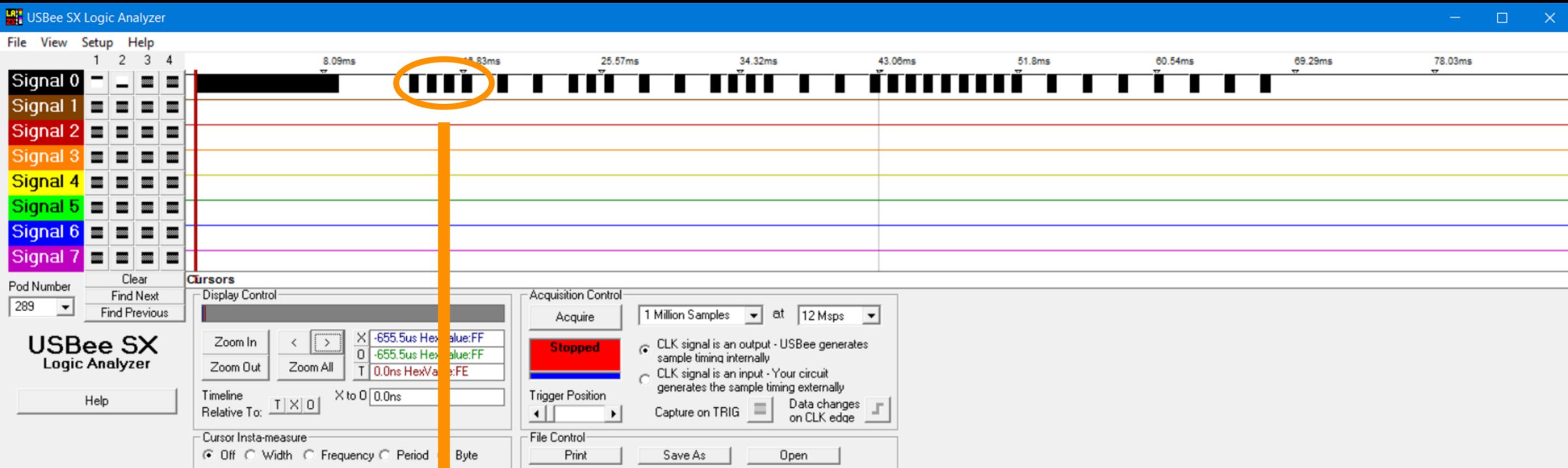
Allen Hall

NEC TV remote control

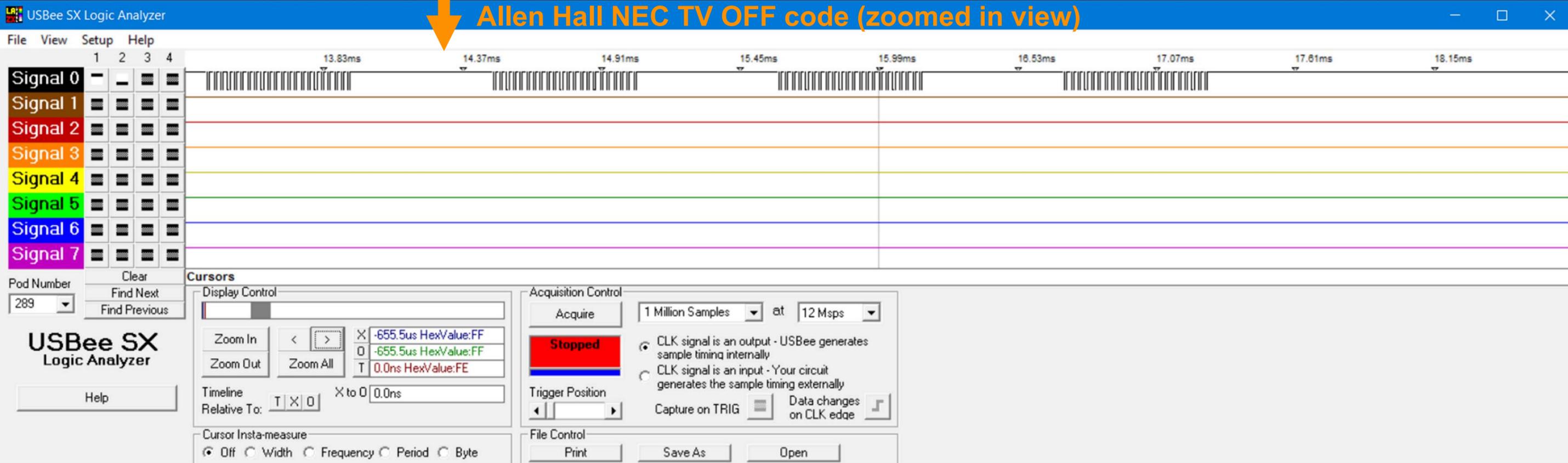
# Allen Hall NEC TV OFF code



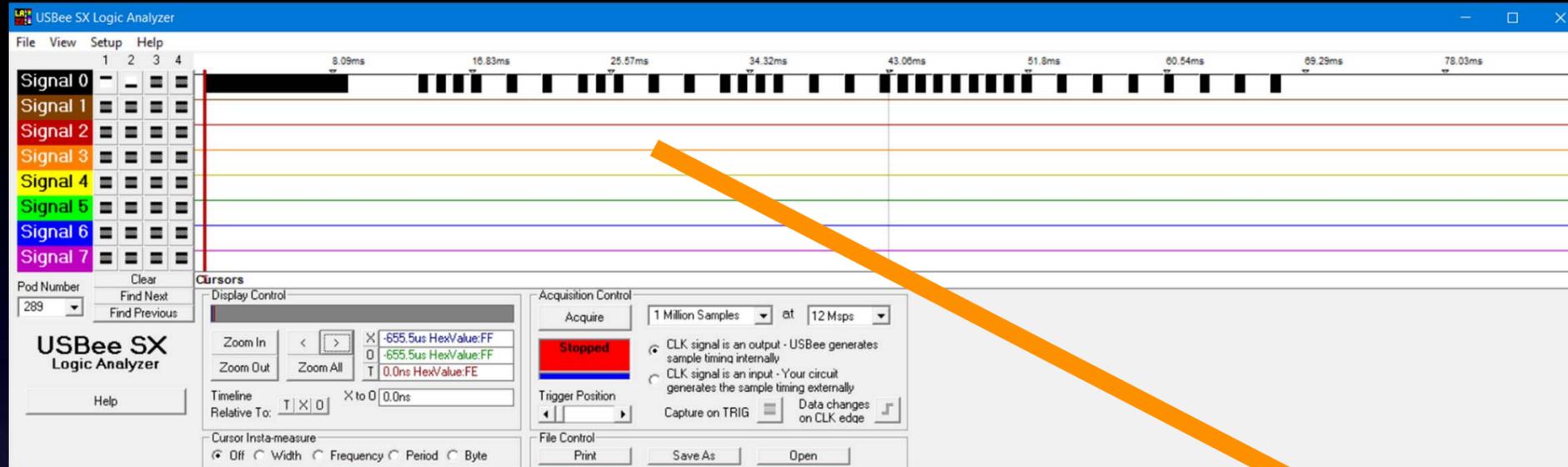
# Allen Hall NEC TV OFF code



Allen Hall NEC TV OFF code (zoomed in view)

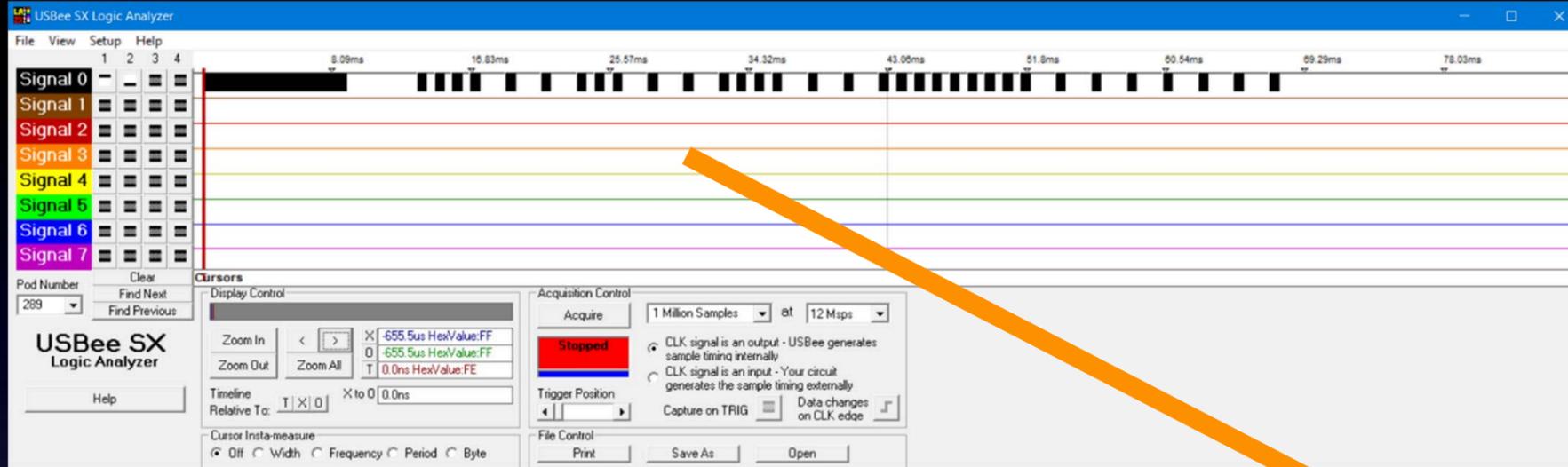


# Allen Hall NEC TV OFF code



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

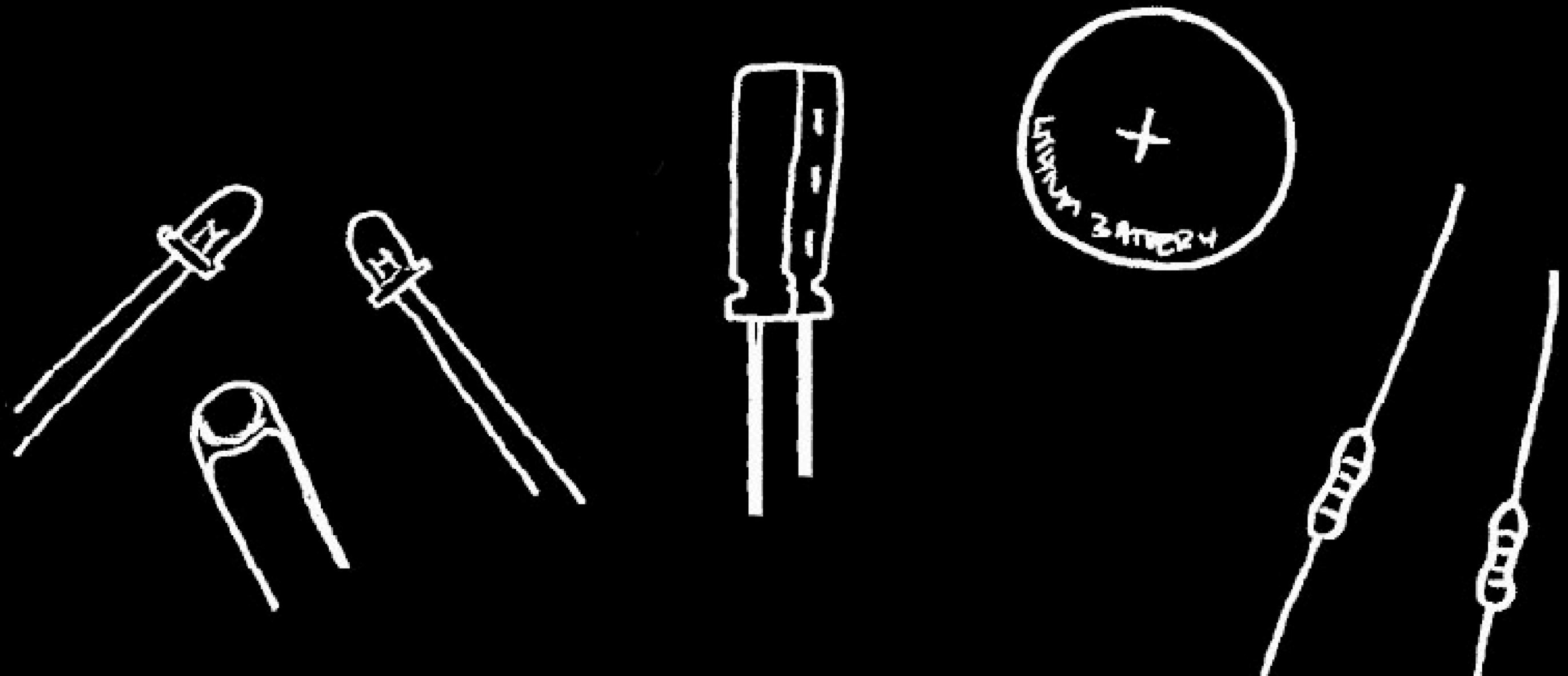
# Allen Hall NEC TV OFF code



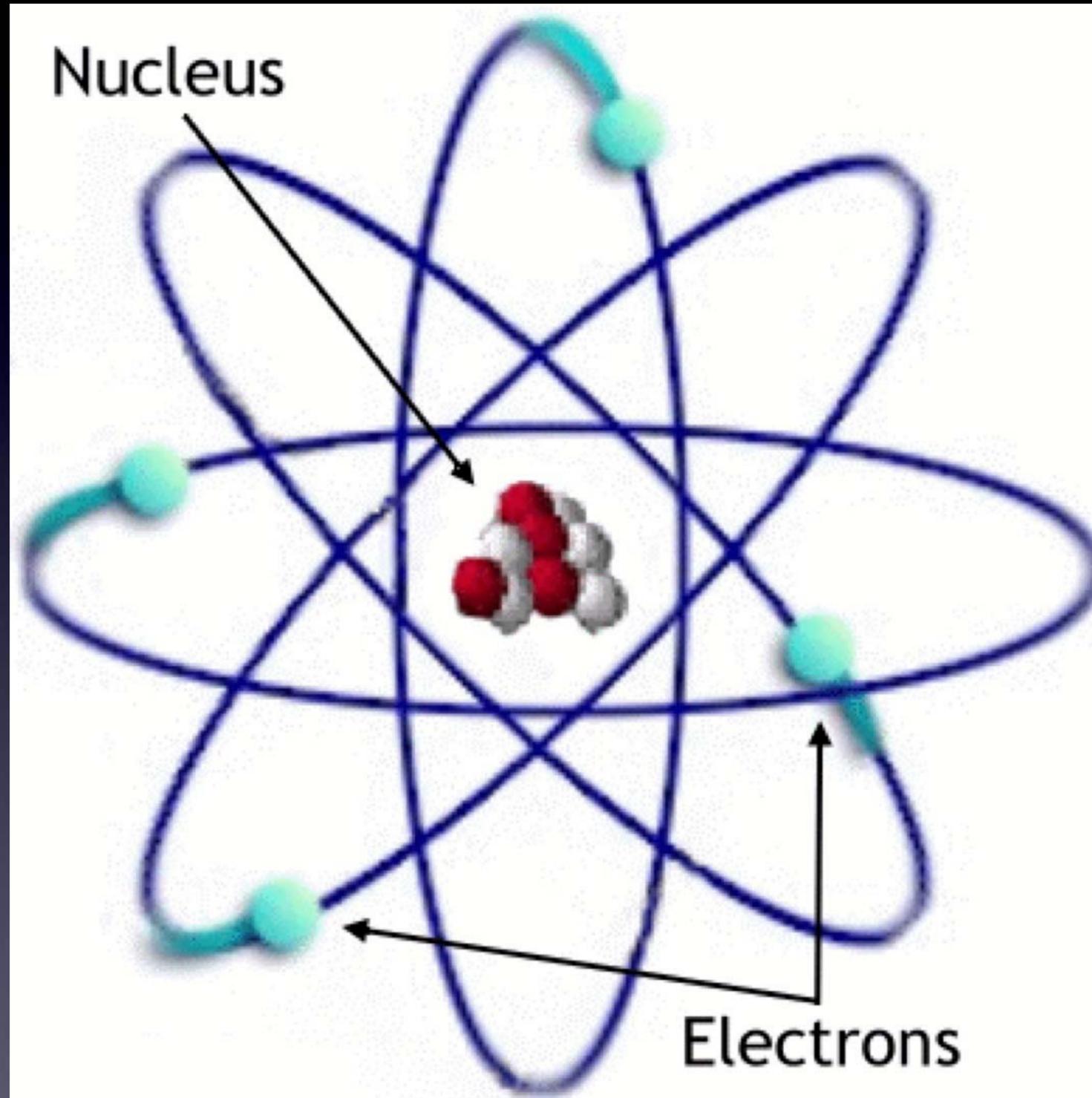
pair #	on-time	off-time	index
1	8,920 usec	4,450 usec	0
2	560 usec	560 usec	1
3	560 usec	560 usec	1
4	560 usec	560 usec	1
5	560 usec	1,680 usec	2
6	560 usec	1,680 usec	2
7	560 usec	1,680 usec	2
8	560 usec	560 usec	1
9	560 usec	560 usec	1
10	560 usec	1,680 usec	2
11	560 usec	1,680 usec	2
12	560 usec	1,680 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*

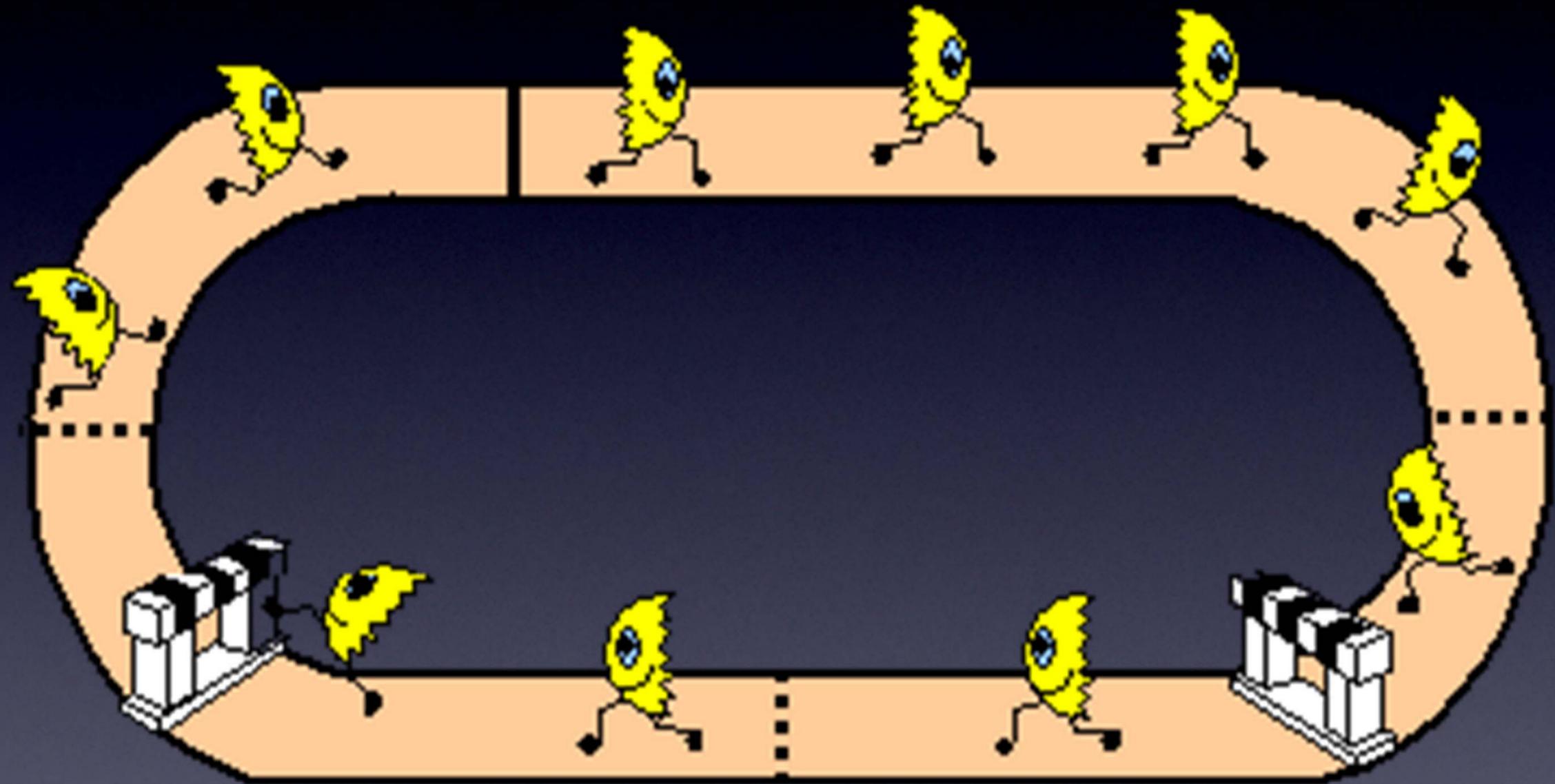


# A Little About Electronics



Electrons

# A Little About Electronics



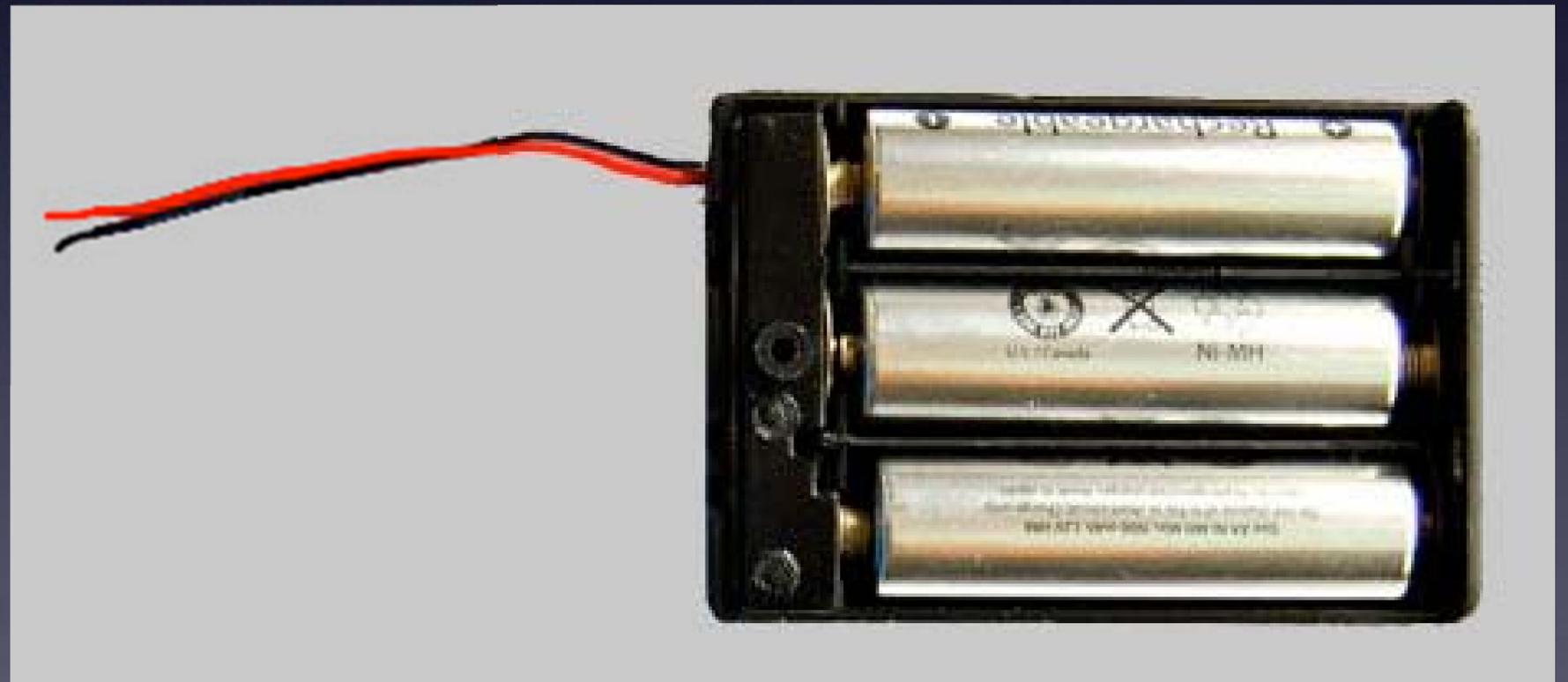
Circuit = Electrons going in complete circle = Magic!

# A Little About Electronics



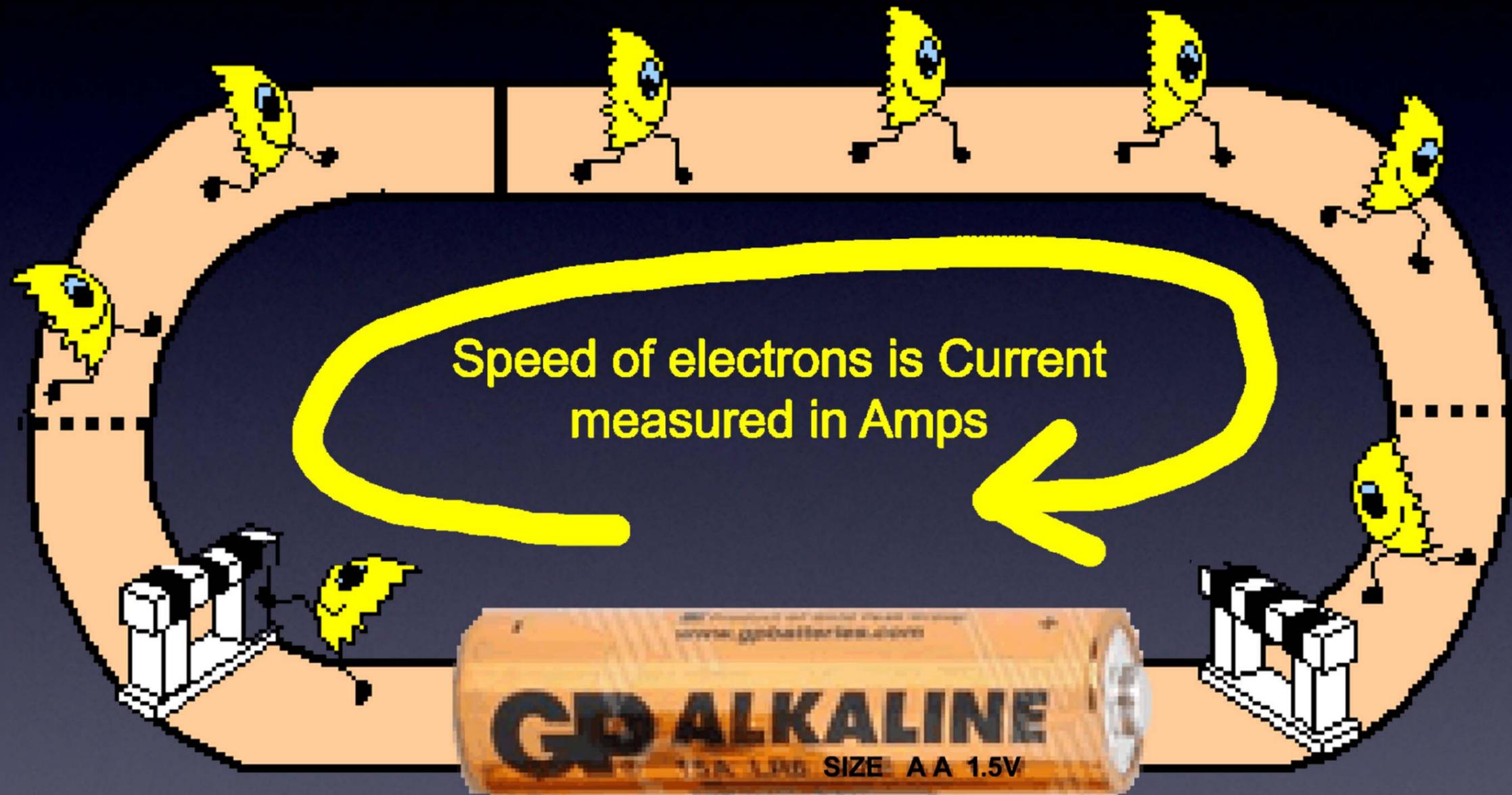
## Power Supplies

# Everything You Need to Know About Electronics



Voltage / **Volts**

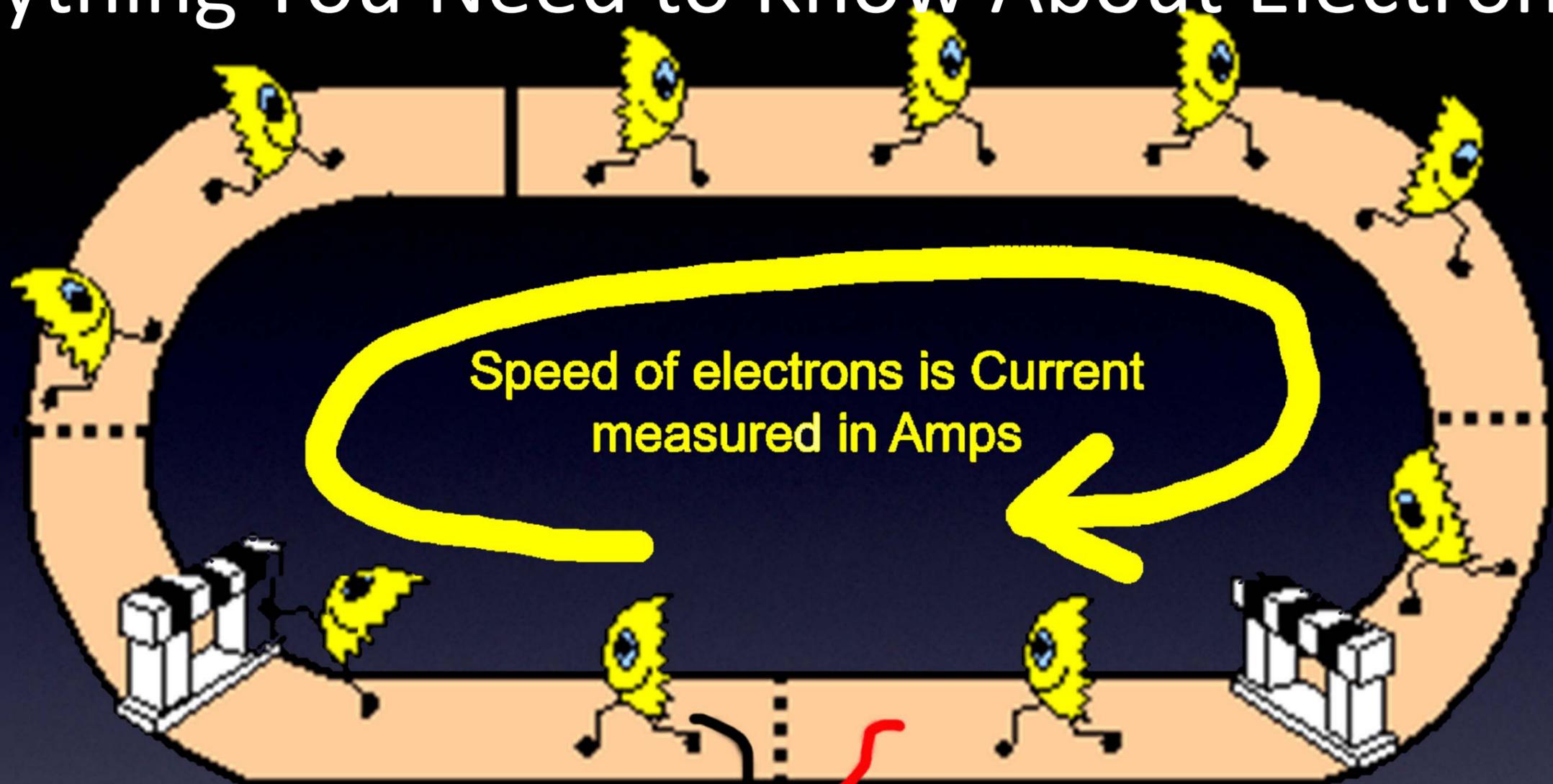
# Everything You Need to Know About Electronics



Electrons pushed with 1.5V.  
So, they move!

Current / **Amps**

# Everything You Need to Know About Electronics



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

Current / **Amps**

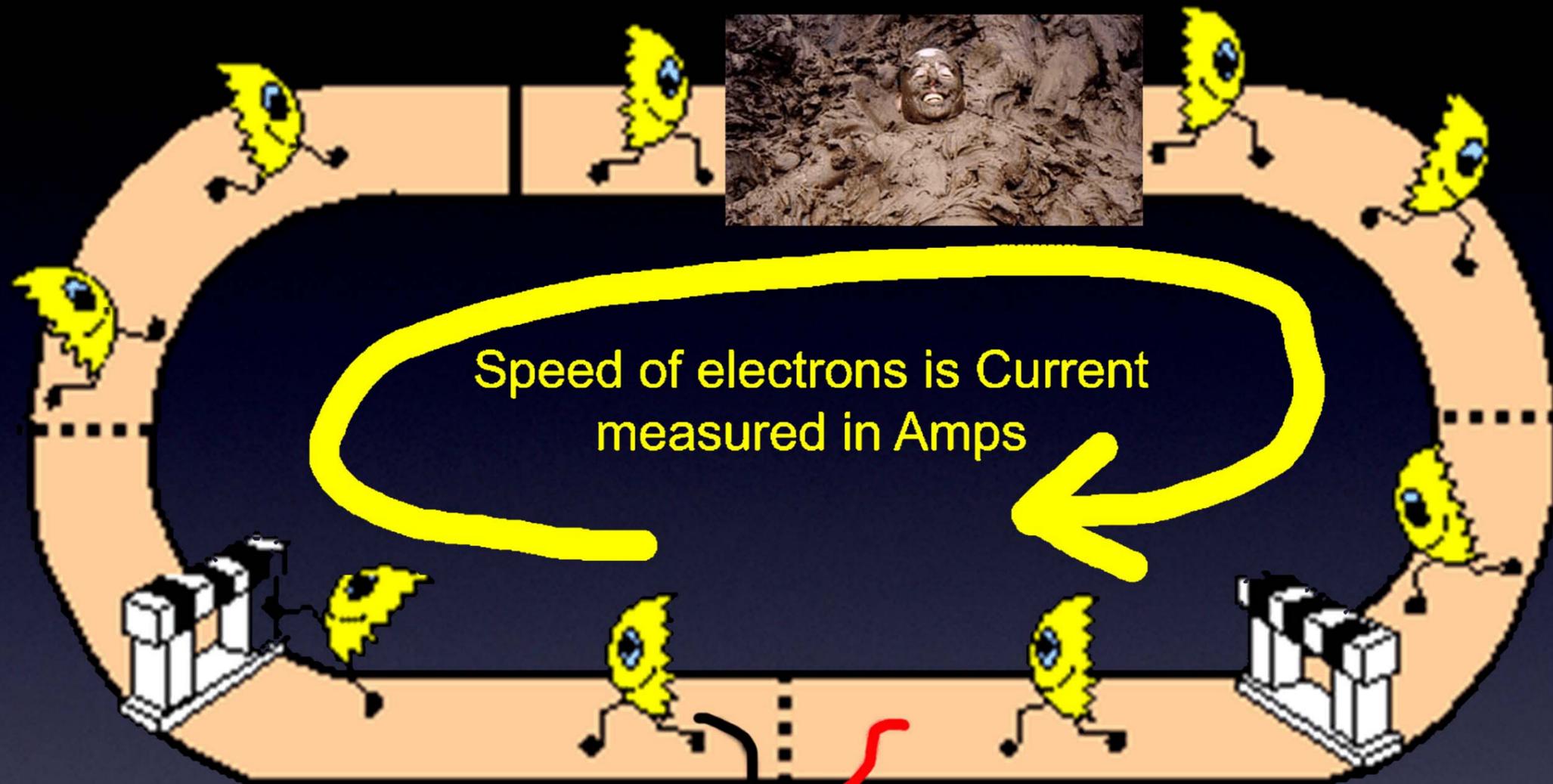
# Everything You Need to Know About Electronics

**Too much energy?**

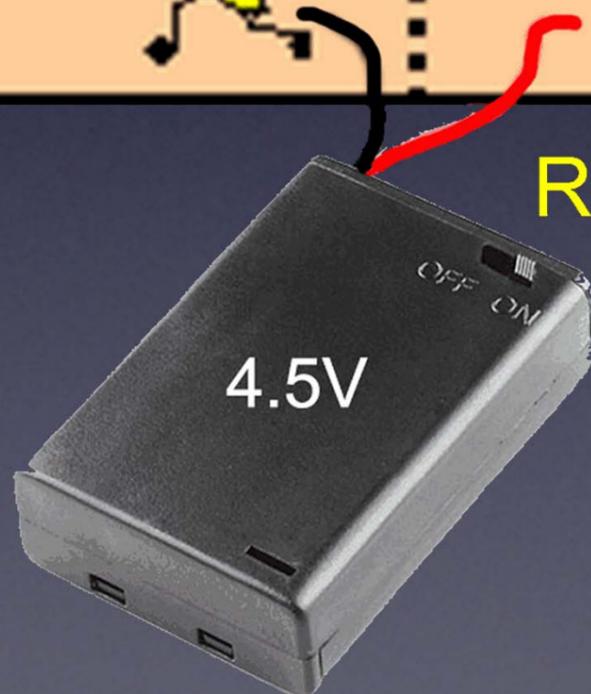
**Lots of energy!**

Current / **Amps**

# Everything You Need to Know About Electronics



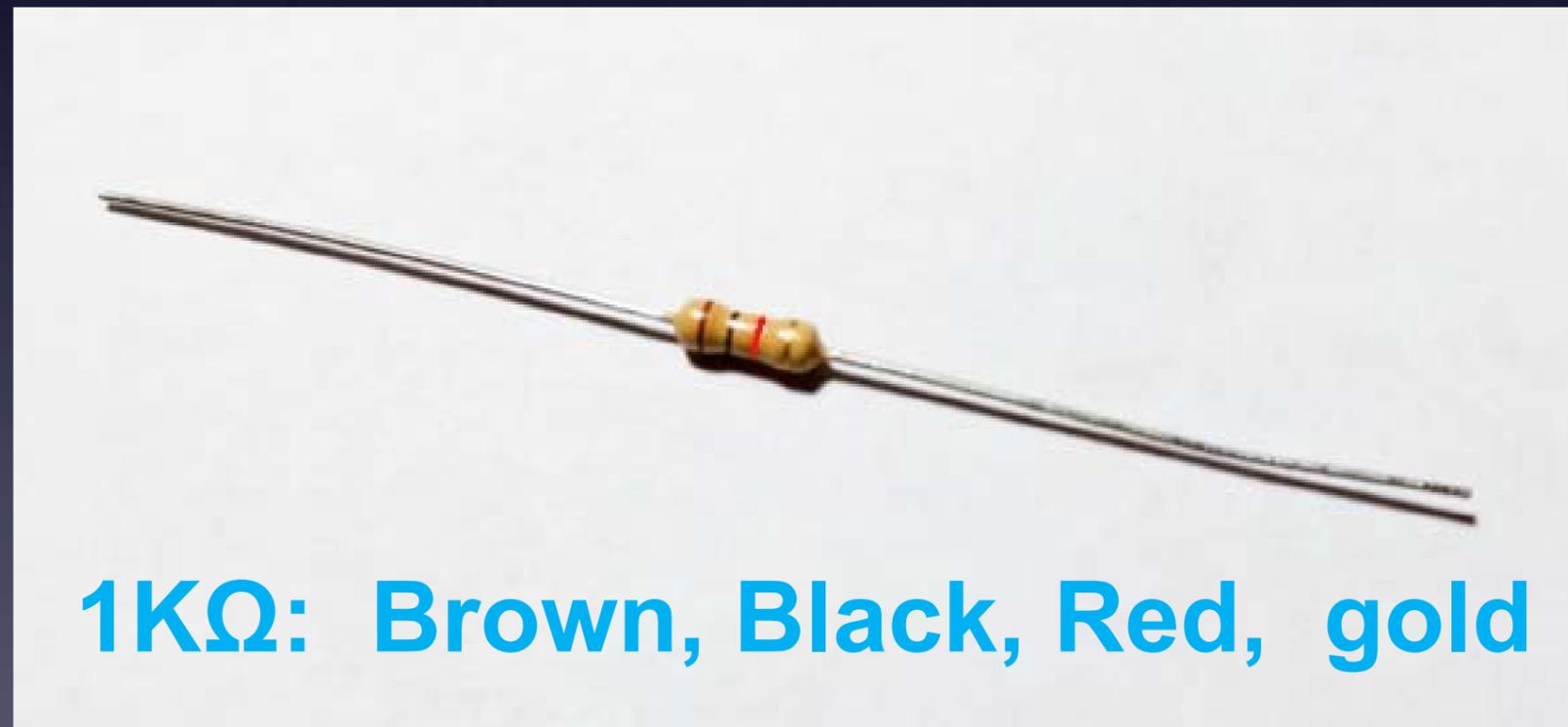
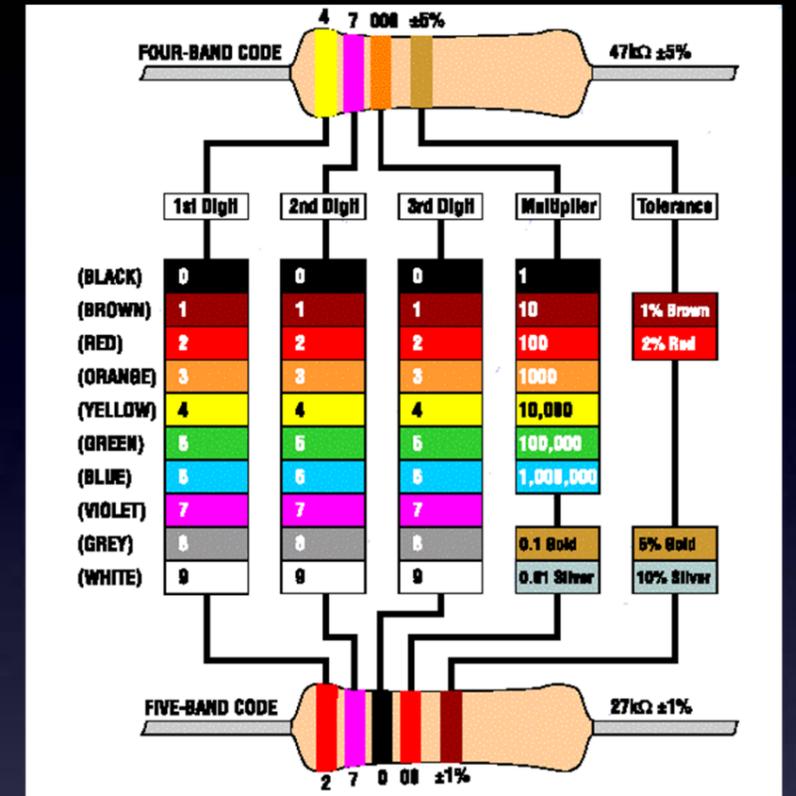
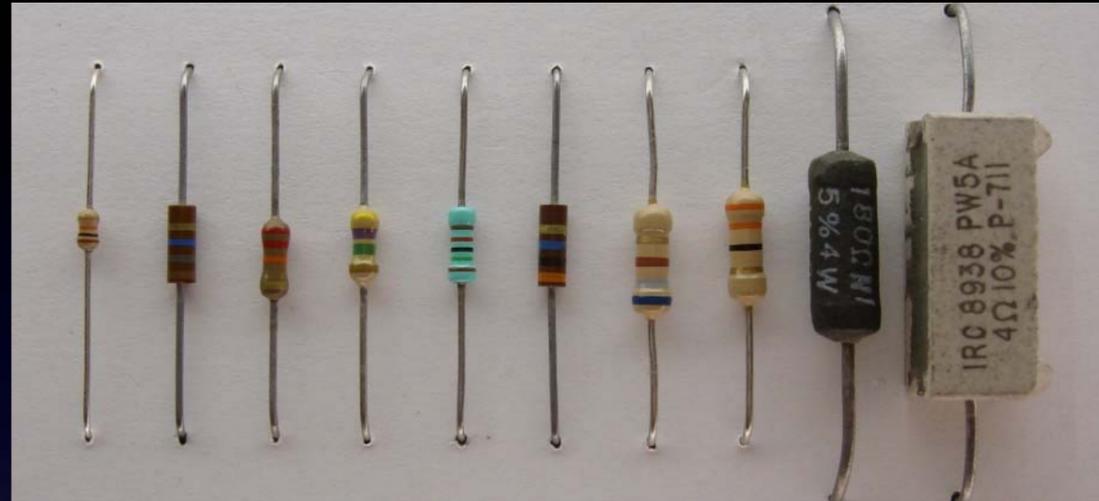
Resistance in the electrons' path slows them down, which means less current (less Amps).



Resistance / **Ohms**



# What You Need to Know About Electronics



**1KΩ: Brown, Black, Red, gold**

Resistor / **Ohms**

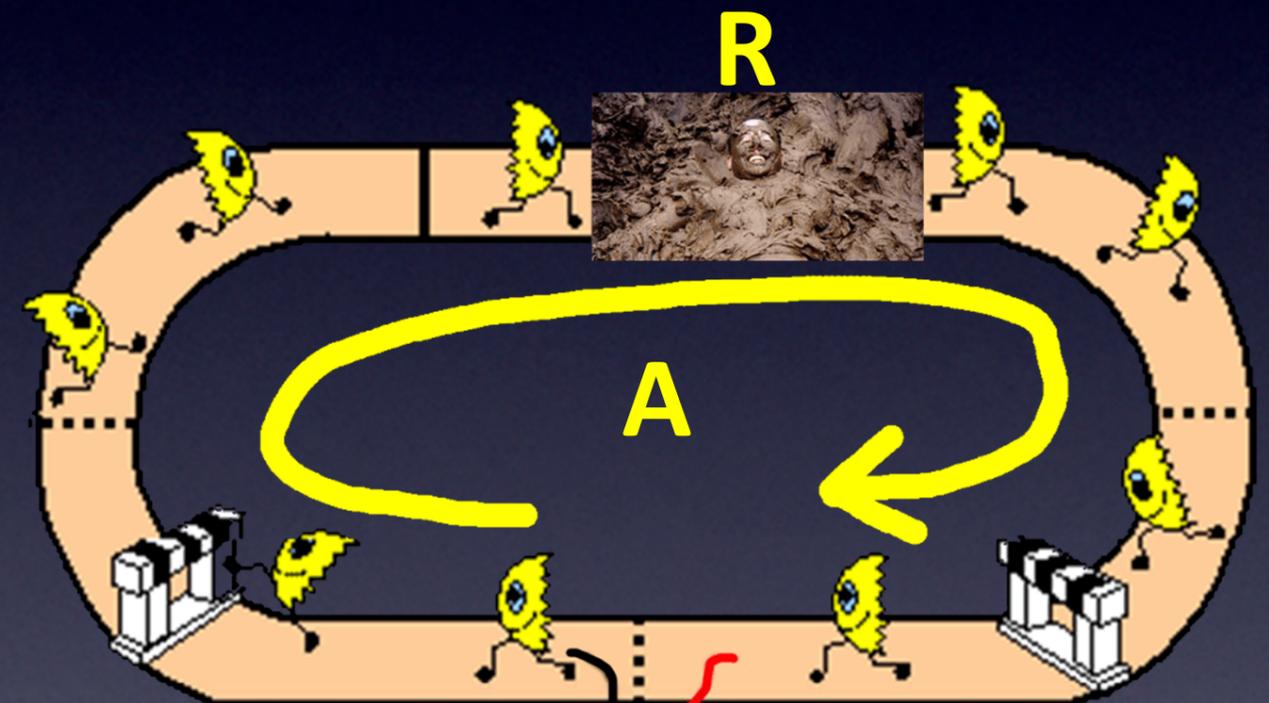
# A Little About Electronics

## Ohm's Law

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

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

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



$$\mathbf{V} \text{olts} = \mathbf{A} \text{mps} \times \mathbf{R}$$

(Ohms)

# A Little About Electronics

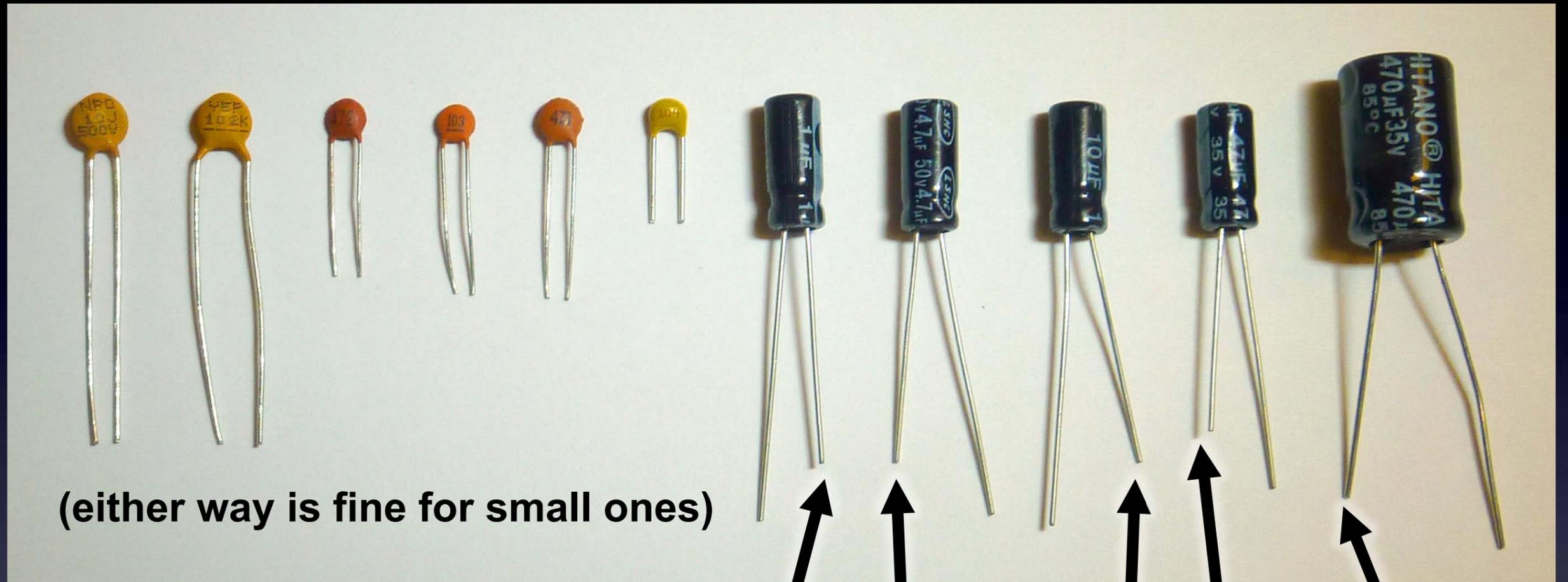


# What happens?

*polarity*

Power Supply – it matters how you connect it!

# A Little About Electronics



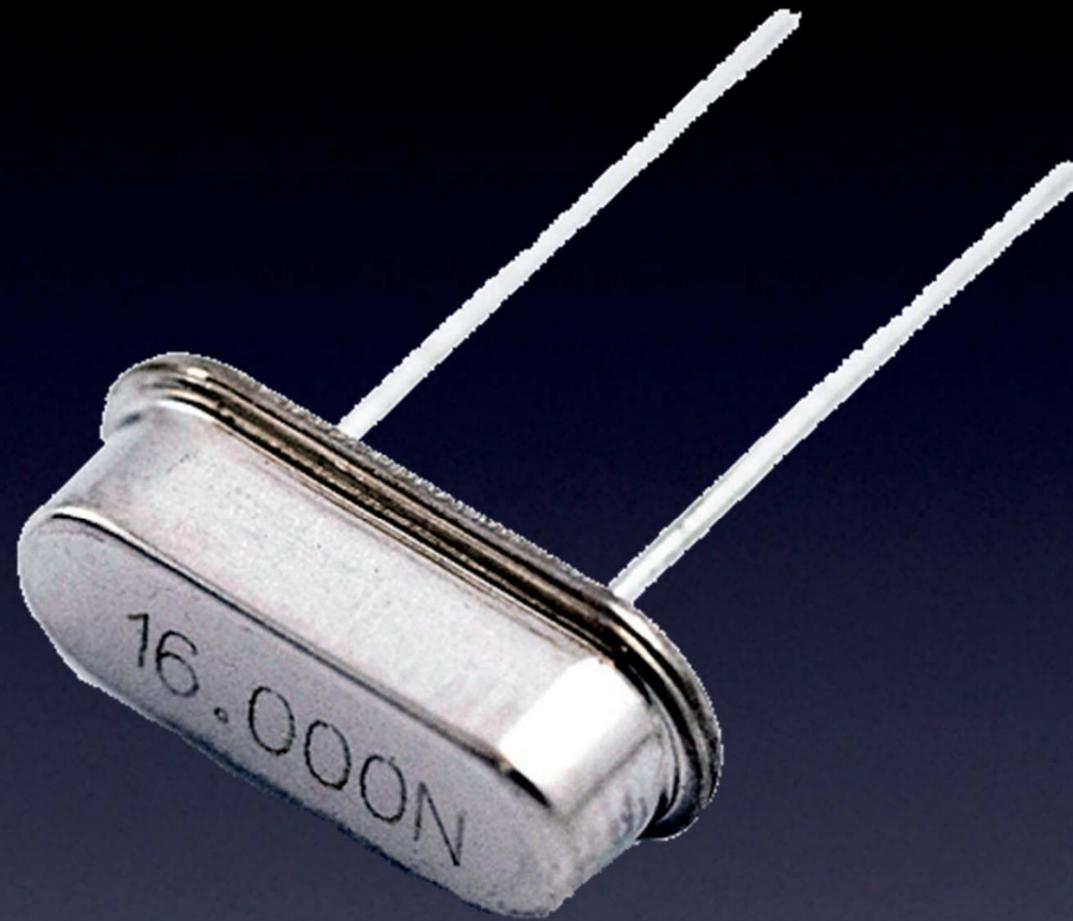
(either way is fine for small ones)

**Short wire is Minus / Negative**

Little buckets for electrons

Capacitor / Farads

# A Little About Electronics

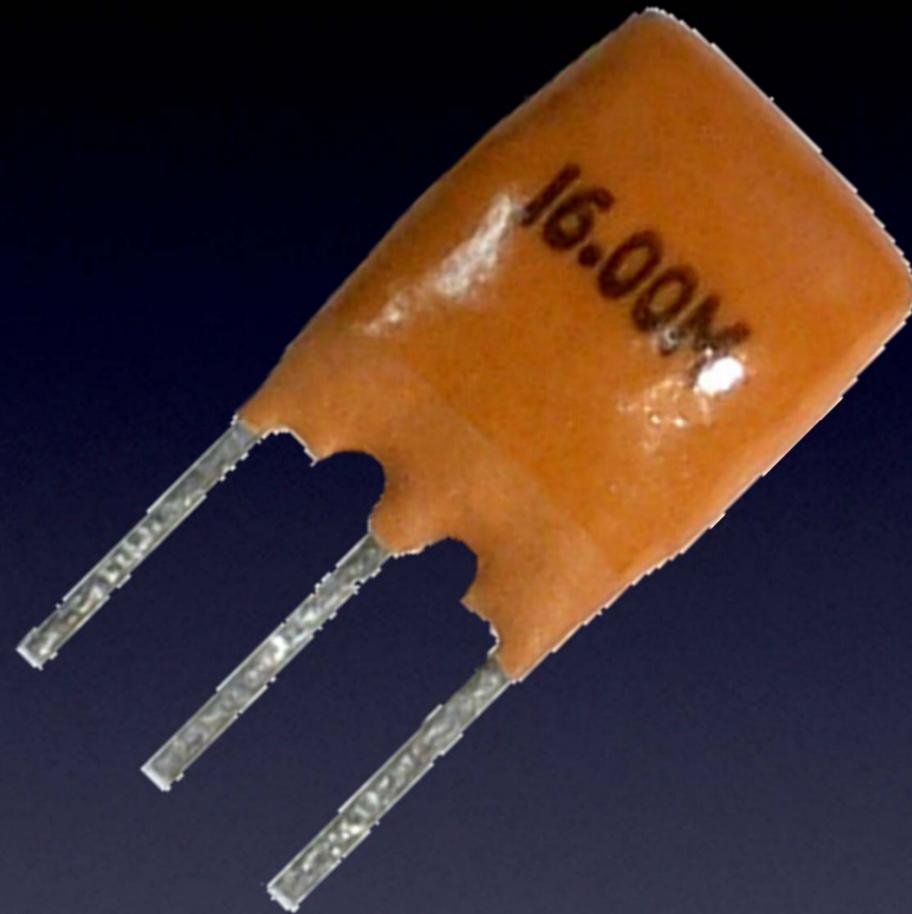


A precision cut piece of quartz crystal

For precise timing

Crystal / Hertz

# A Little About Electronics

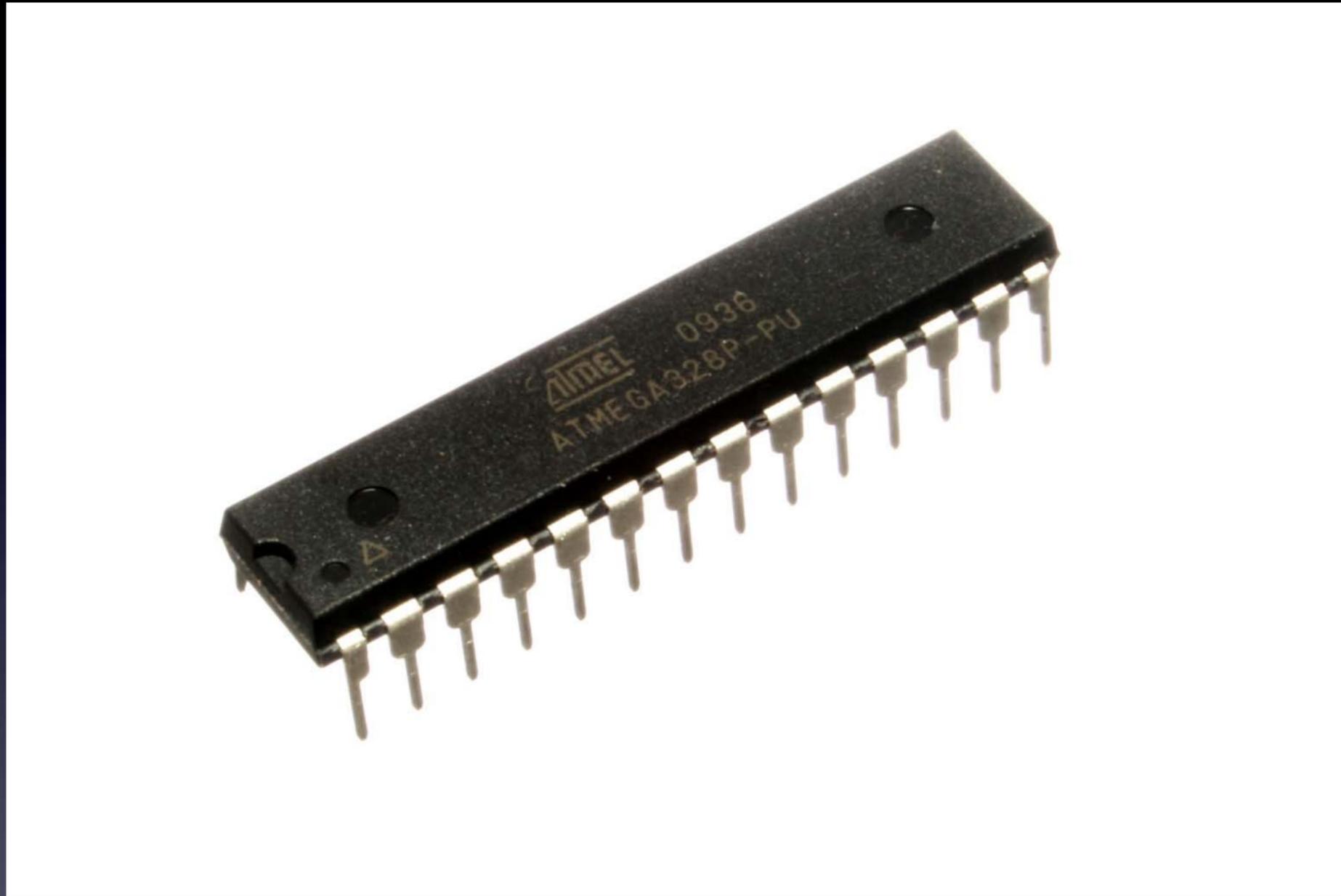


**A bunch of resistors and capacitors**

**For precise timing (but less than a crystal)**

**Ceramic Resonator / Hertz**

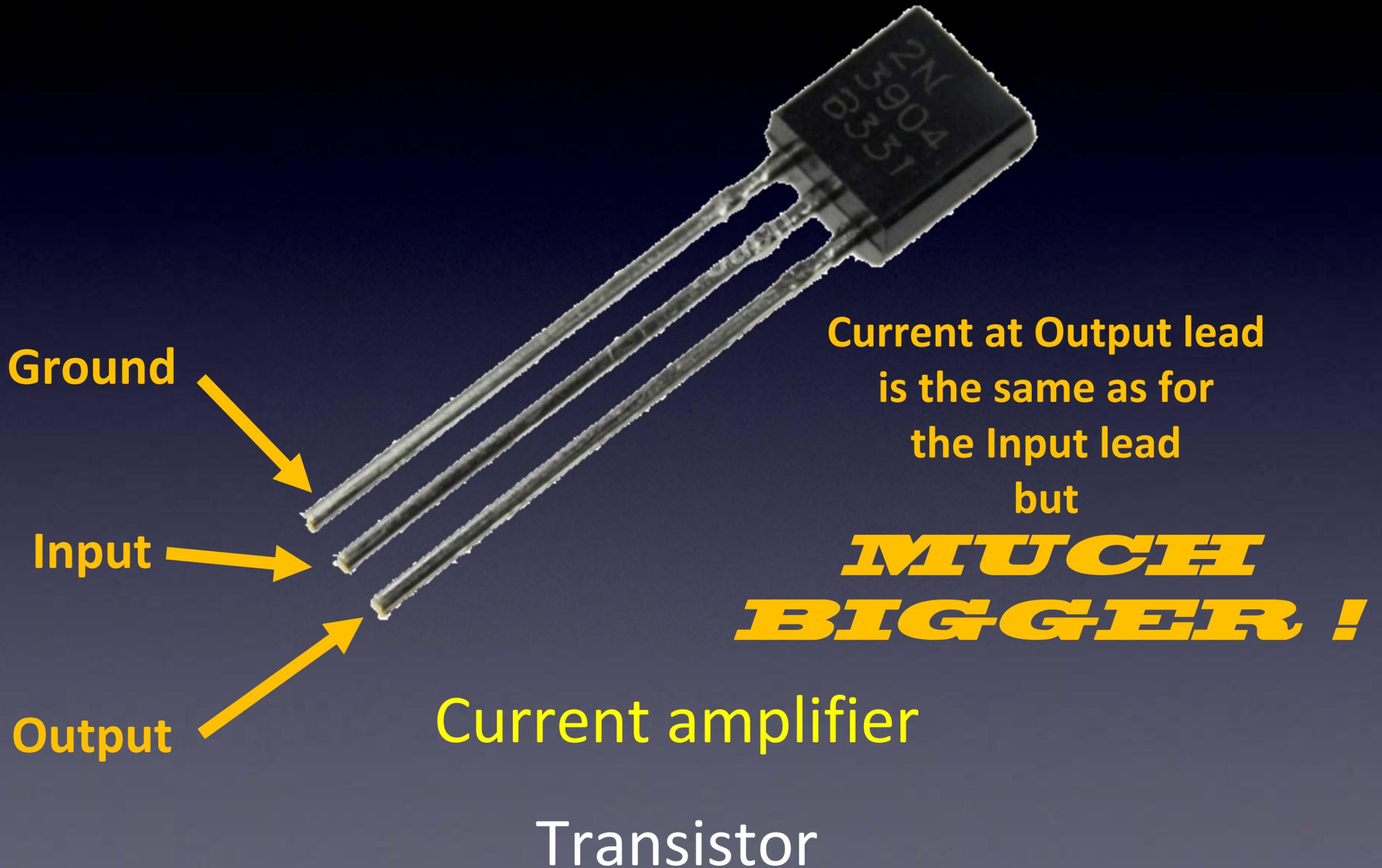
# A Little About Electronics



A complete computer on a chip

Microcontroller

# A Little About Electronics



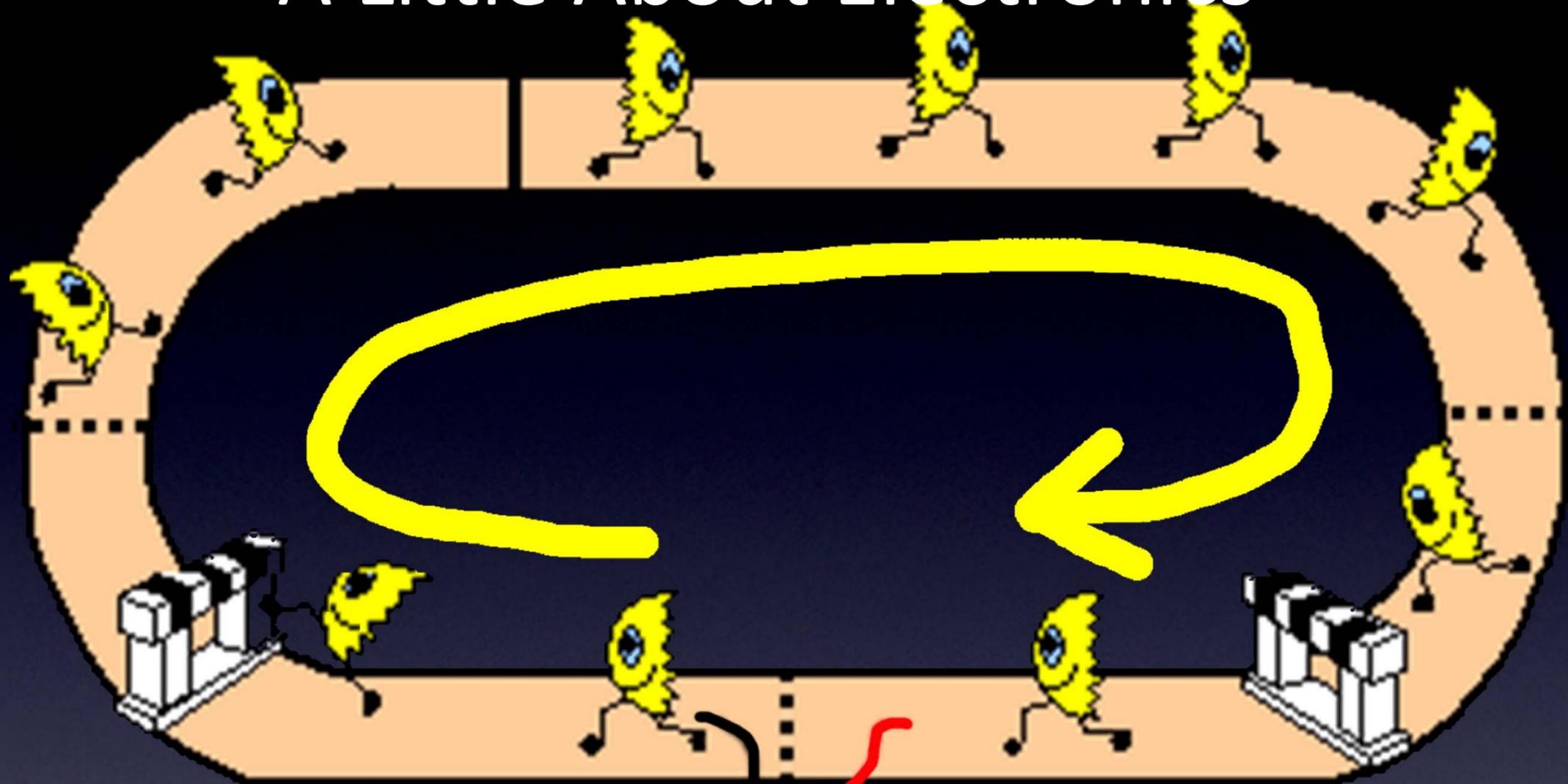
LED



Plus / Positive (+)

Minus / Negative (-)

# A Little About Electronics



**Black Wire = “-”**

**Red Wire = “+”**



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

# A Little About Electronics



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

**Black wire:**  
**Minus, Negative,**  
**0V,**  
**Ground (GND)**

Power Supply – it matters how you connect it!

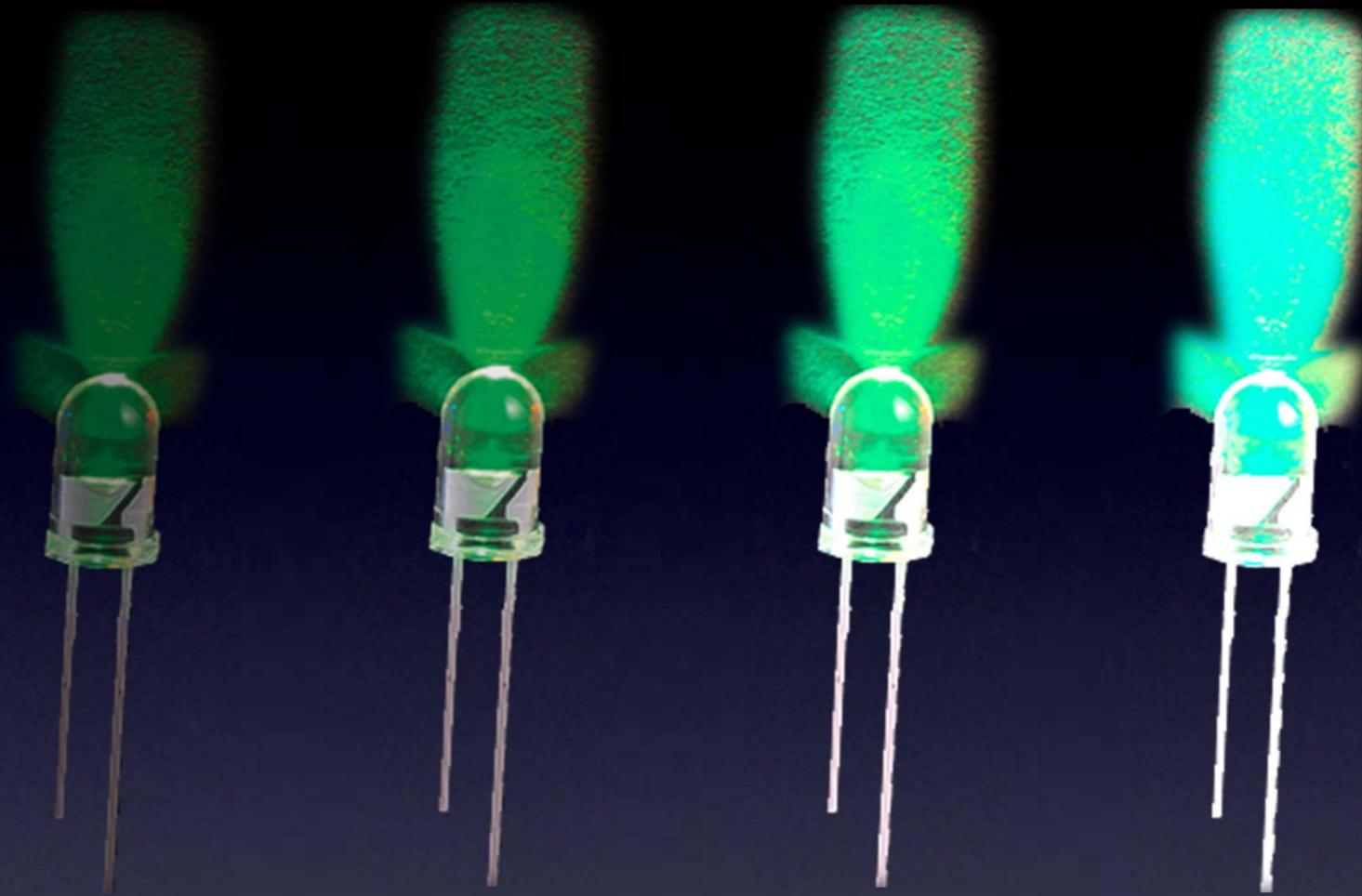
# A Little About Electronics



Lots of different colored LEDs!

LED

# A Little About Electronics



More current  $\rightarrow$  More brightness! (until...)

LED

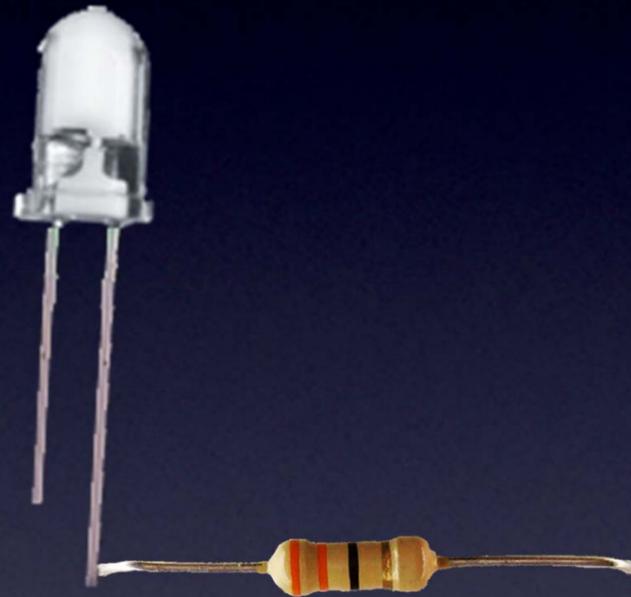
# A Little About Electronics



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

LED

# A Little About Electronics

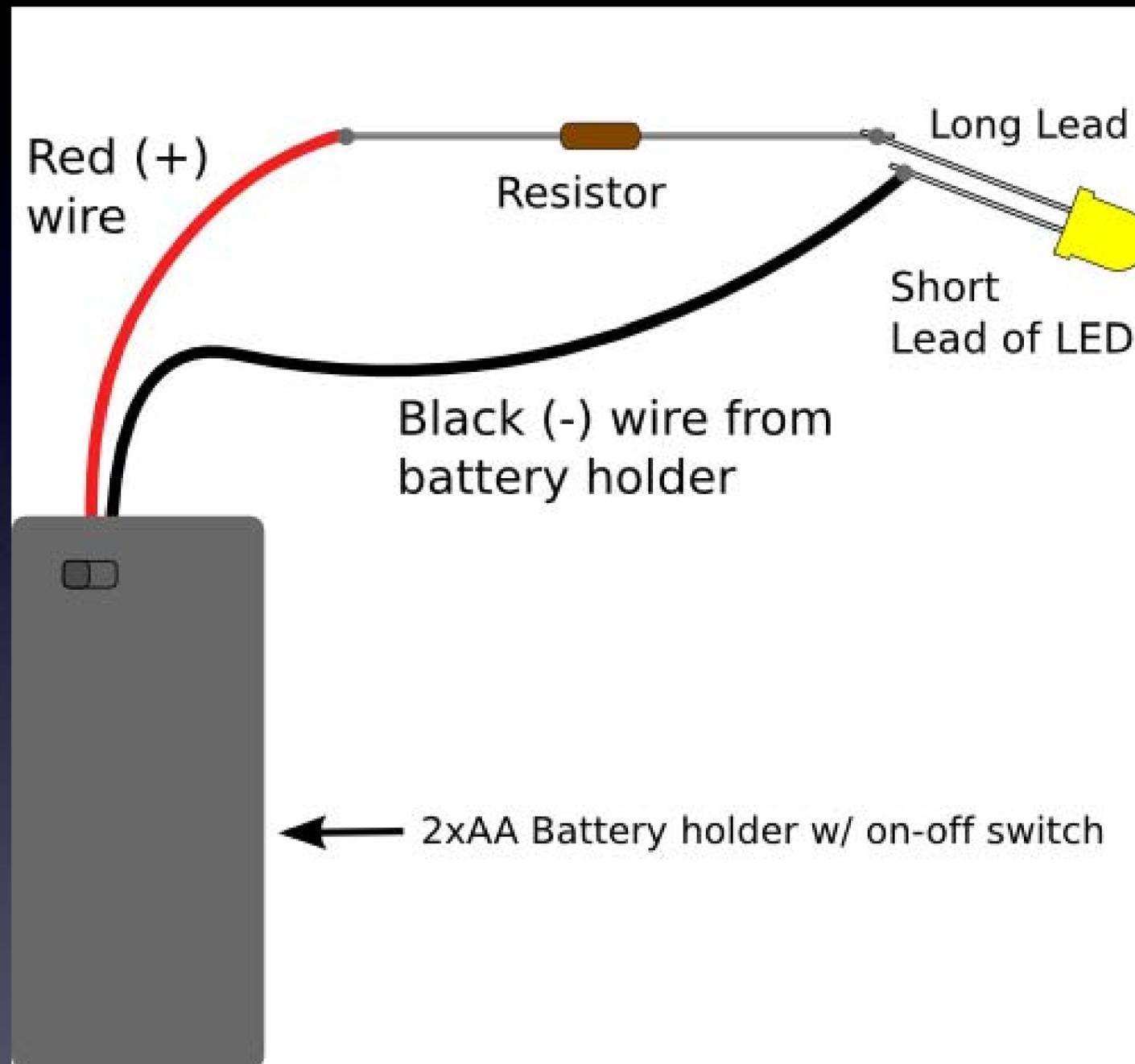


*(with a resistor  
so no magic smoke goes away)*

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

LED

# A Little About Electronics



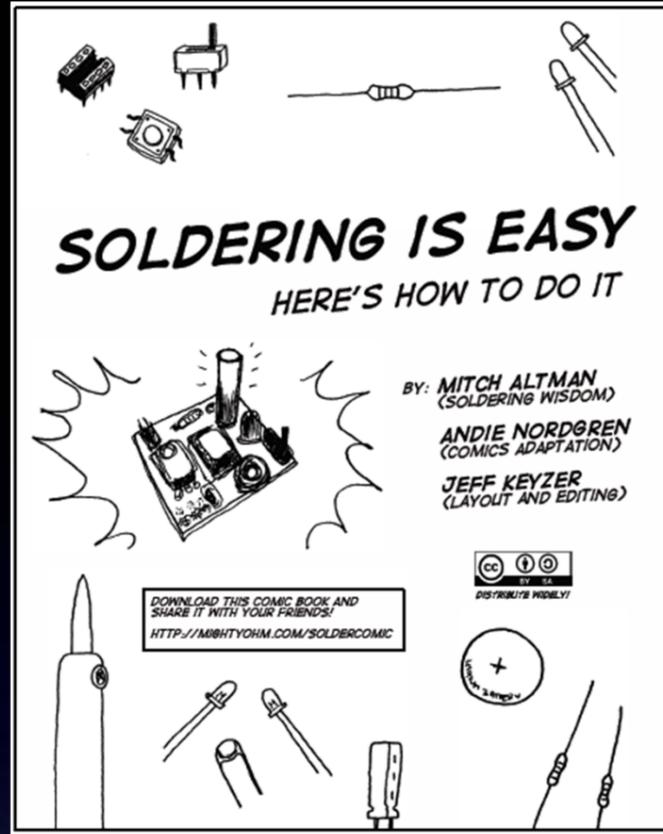
Making an LED light up

(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.)

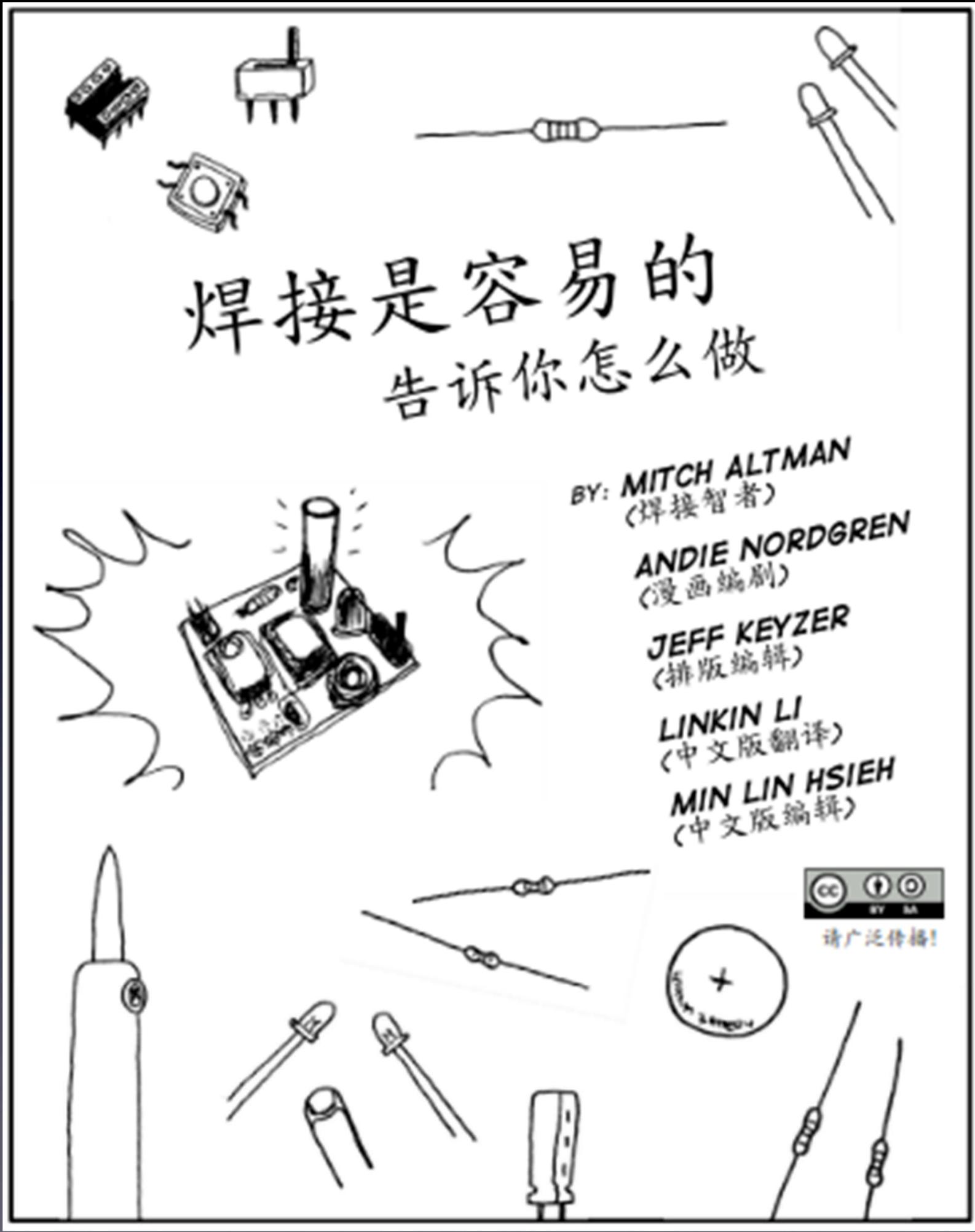
download for free at:  
<http://mightyohm.com/soldercomic>

# Learn To Solder



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

# Learn To Solder



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

# Learn To Solder

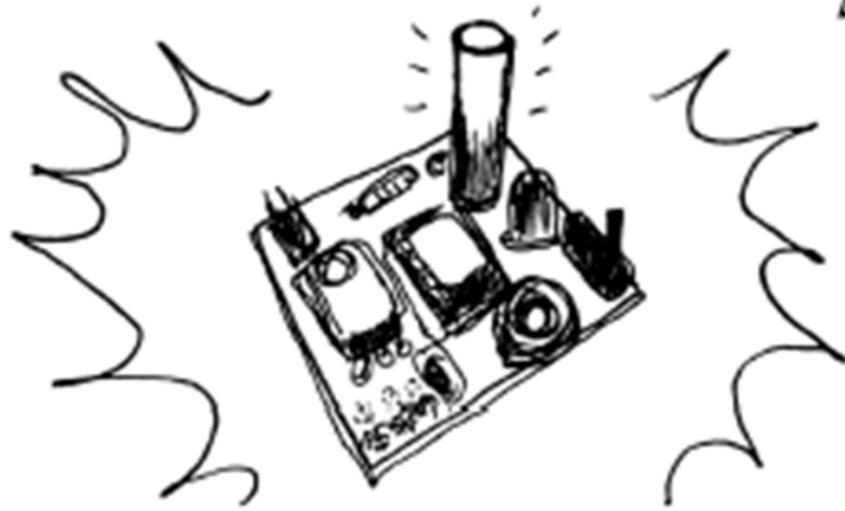
## ***SOLDER C'EST FACILE*** ***VOICI COMMENT FAIRE***

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

***ANDIE NORDGREN***  
(ADAPTATION BD)

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

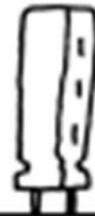
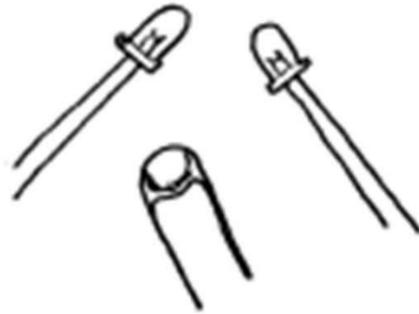
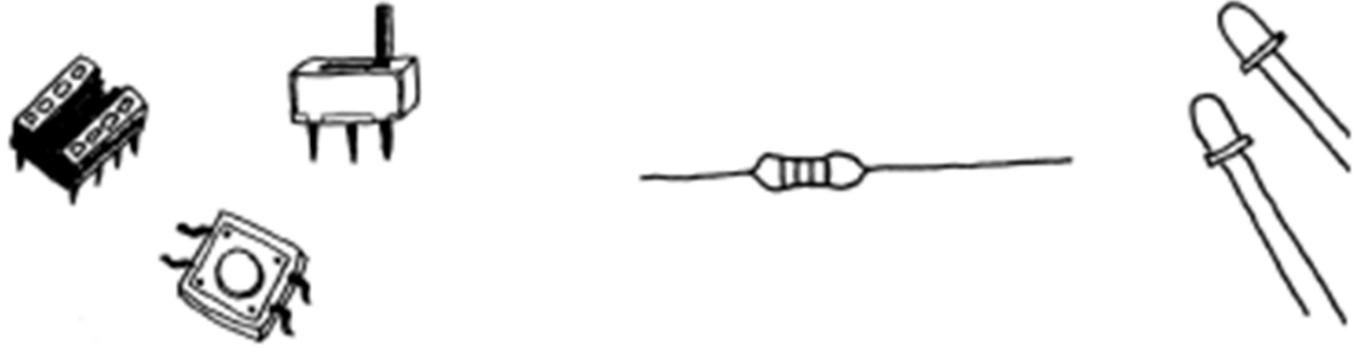
***SNOOTLAB***  
(TRADUCTION FR.)



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



A DIFFUSER LARGEMENT !



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

# Learn To Solder



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

# Learn To Solder



# 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!

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

# Parts

**NOTE: No R4**  
**NOTE: R2 remains blank**

PCB

Battery Pack

Double-sided tape  
(to attach PCB  
to  
Battery Pack)

(colors are NOT important)  
LED1, LED2, LED3, LED4

D5

Q1, Q2, Q3, Q4 – 2N2222A

Q5  
2N2907

**NOTE: only use for EU:**  
R3 (10K) **Brown, Black, Orange, Gold**

R1, R5 (1K) **Brown, Black, Red, Gold**

C2

C1

X1

IC1

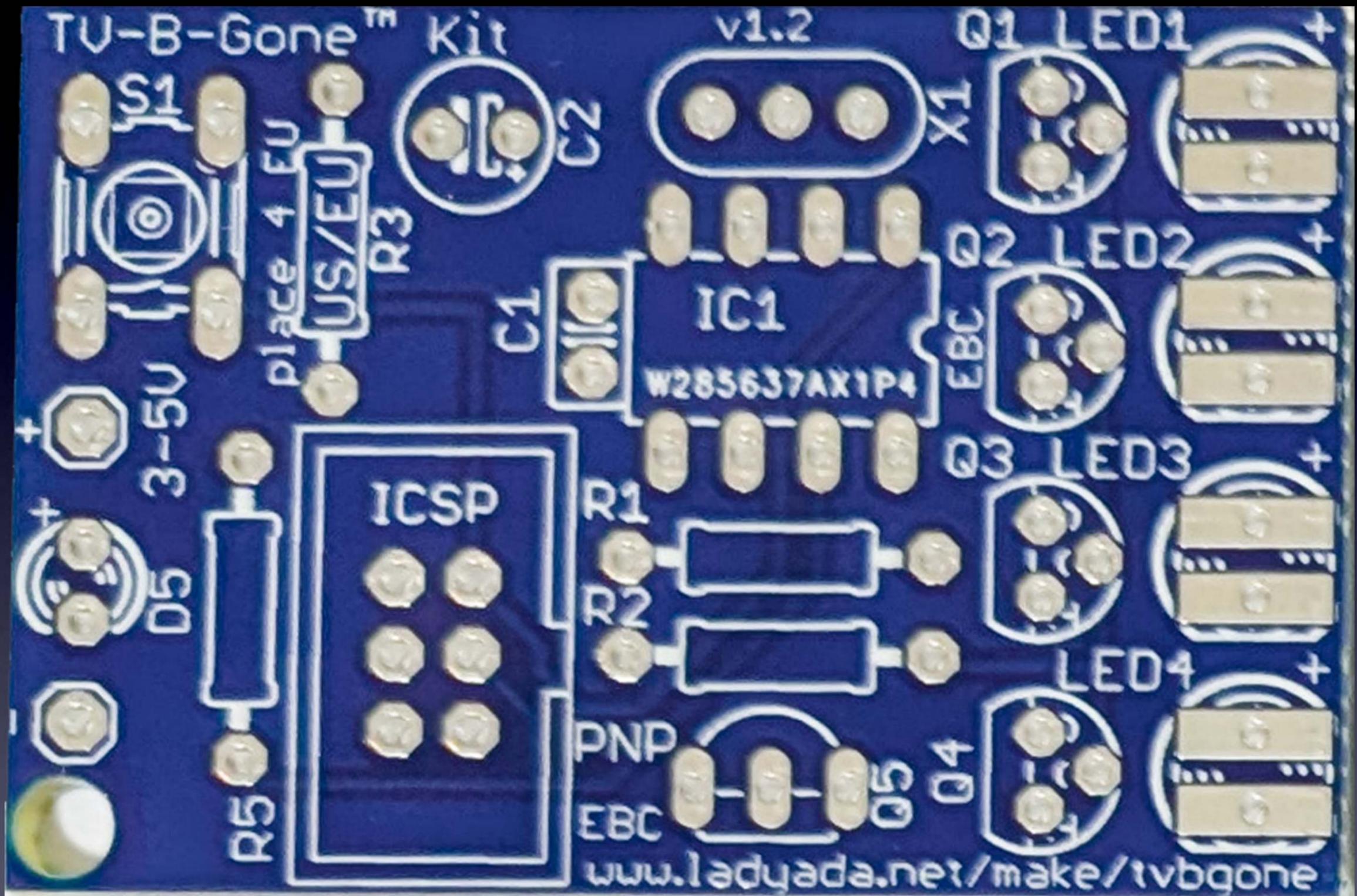
S1

ATtiny85V chip

Socket (note polarity)

(not included)

All of the parts



The board we'll solder the parts to



Note:  
Since we will use  
**Lead-Free** solder  
it is 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

**R3**

NOTE:

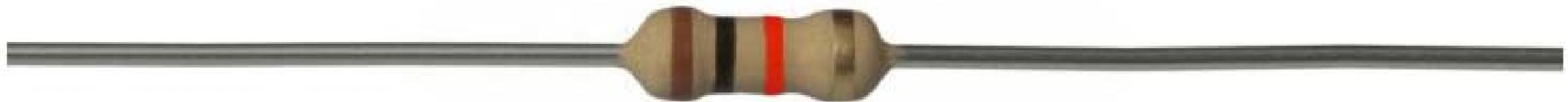
R3 is only used for EU

**Brown, Black, Orange**

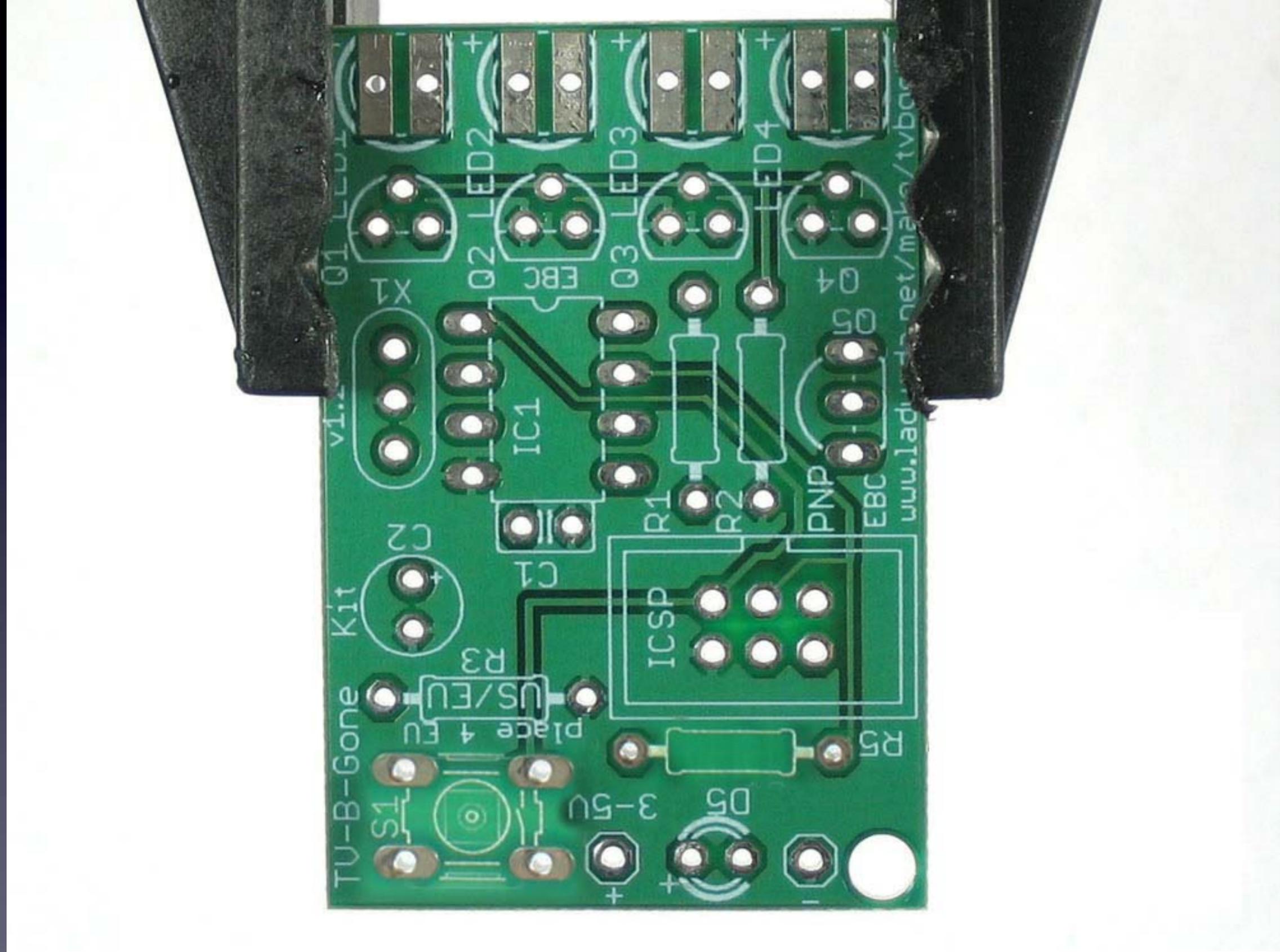
**R1 & R5**

**Brown, Black, Red**

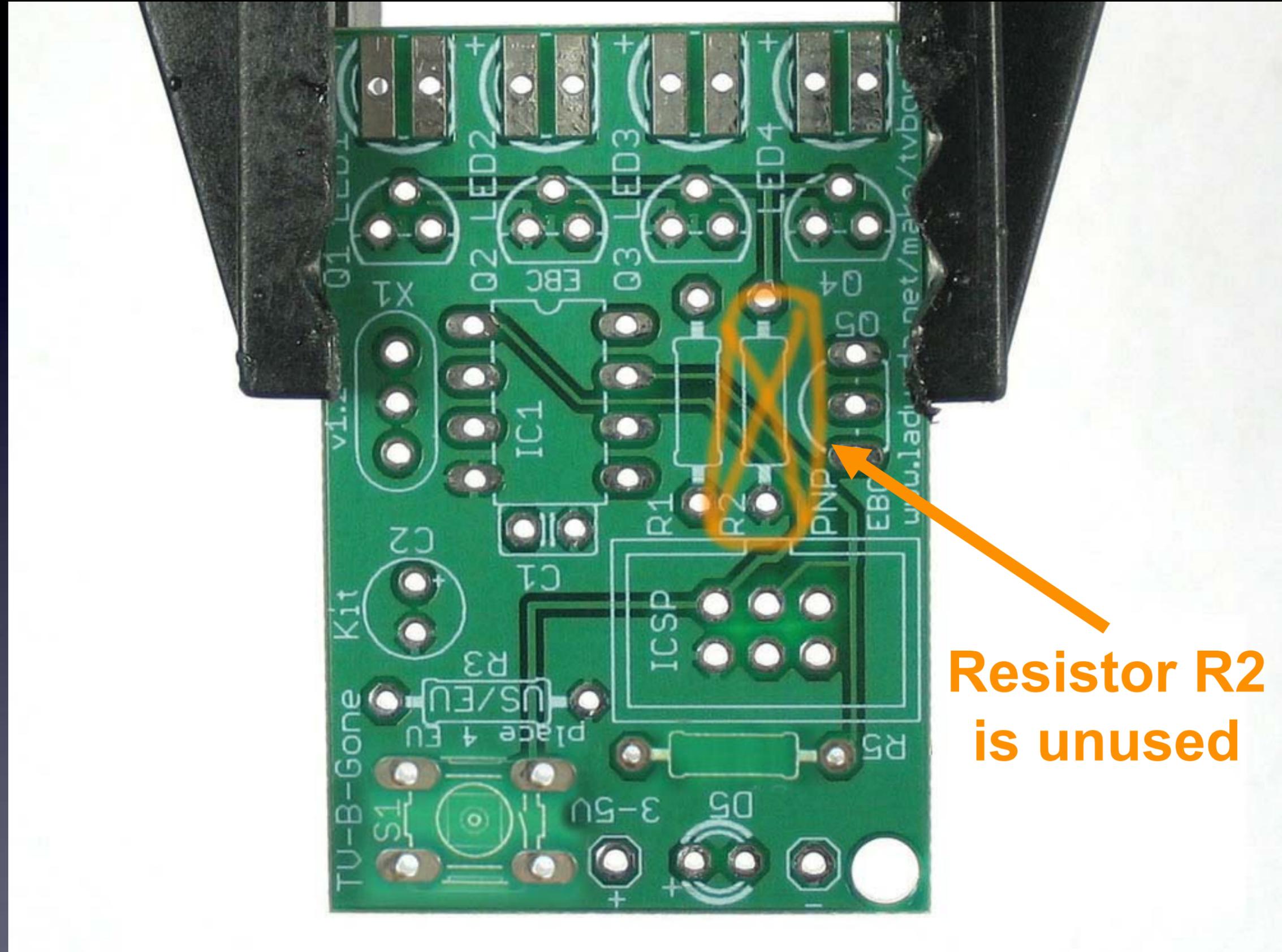
# Look at the shape of these parts



**See the same shapes on the PCB**



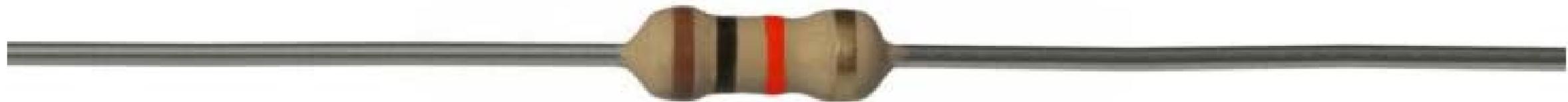
**Do NOT put anything in R2**



**Resistor R2  
is unused**

# We will start with Resistors R1 & R5

**R1 & R5**



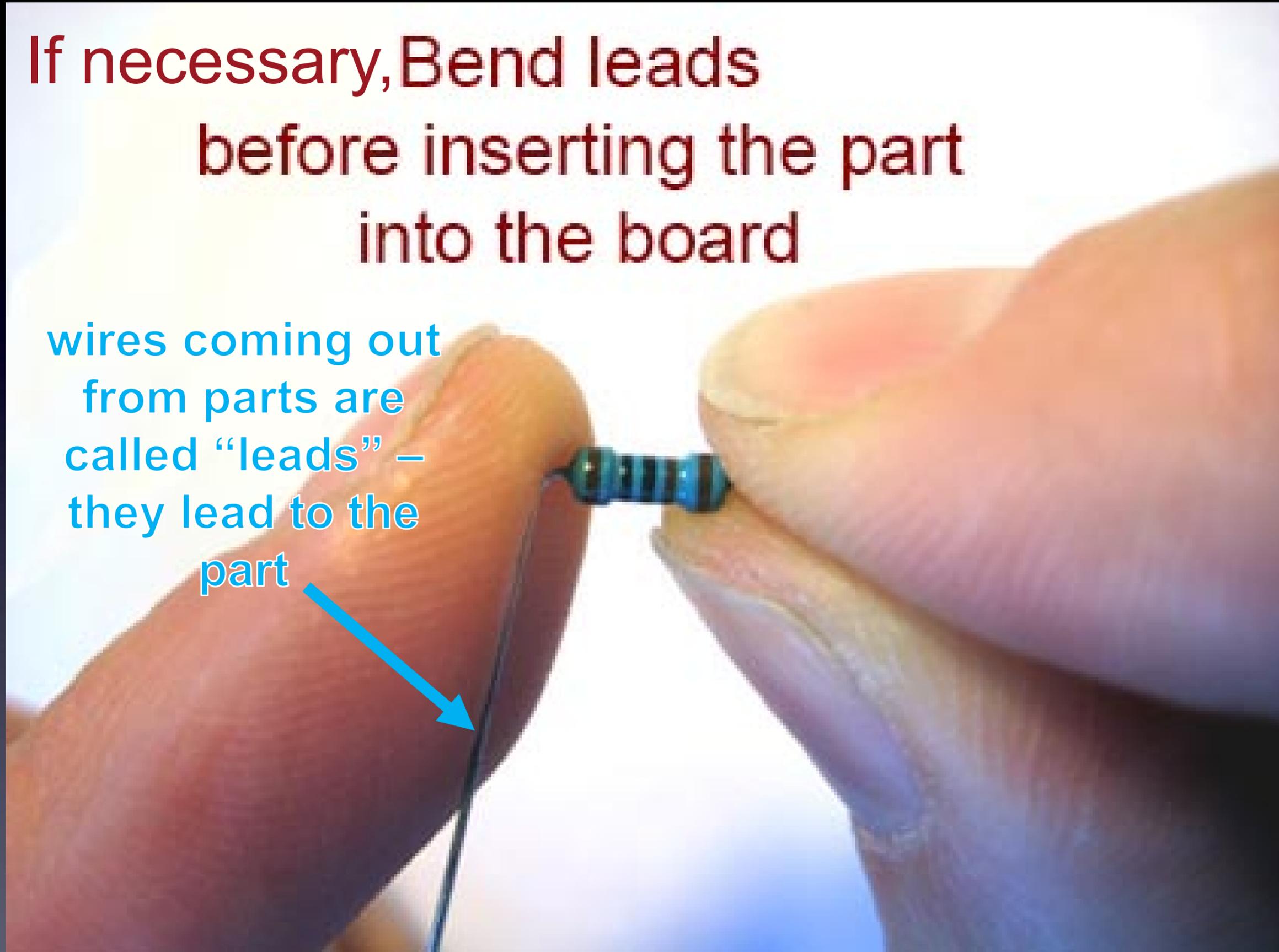
**1K Ohm: Brown, Black, Red**

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

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

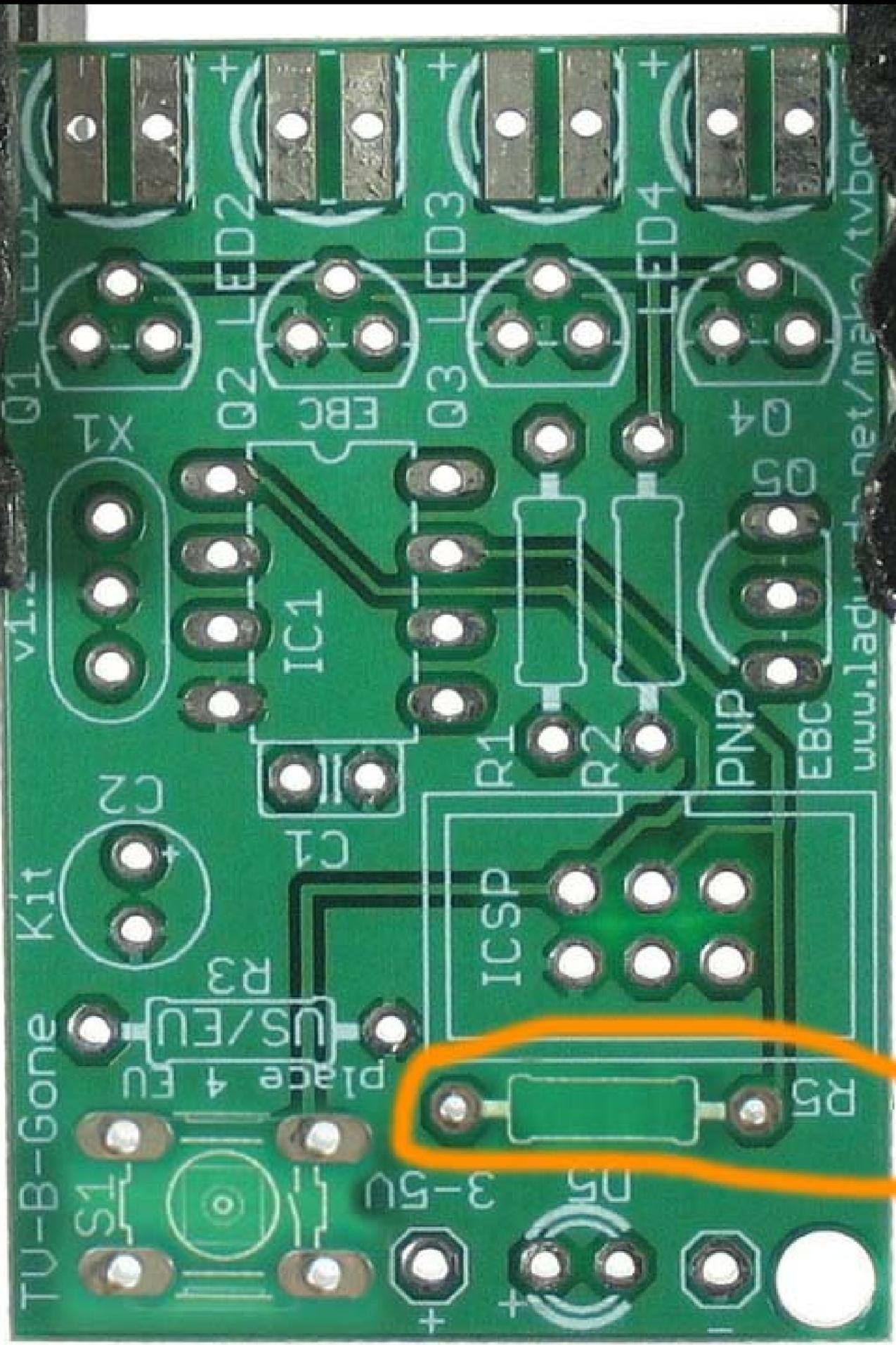
If necessary, Bend leads  
before inserting the part  
into the board

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





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

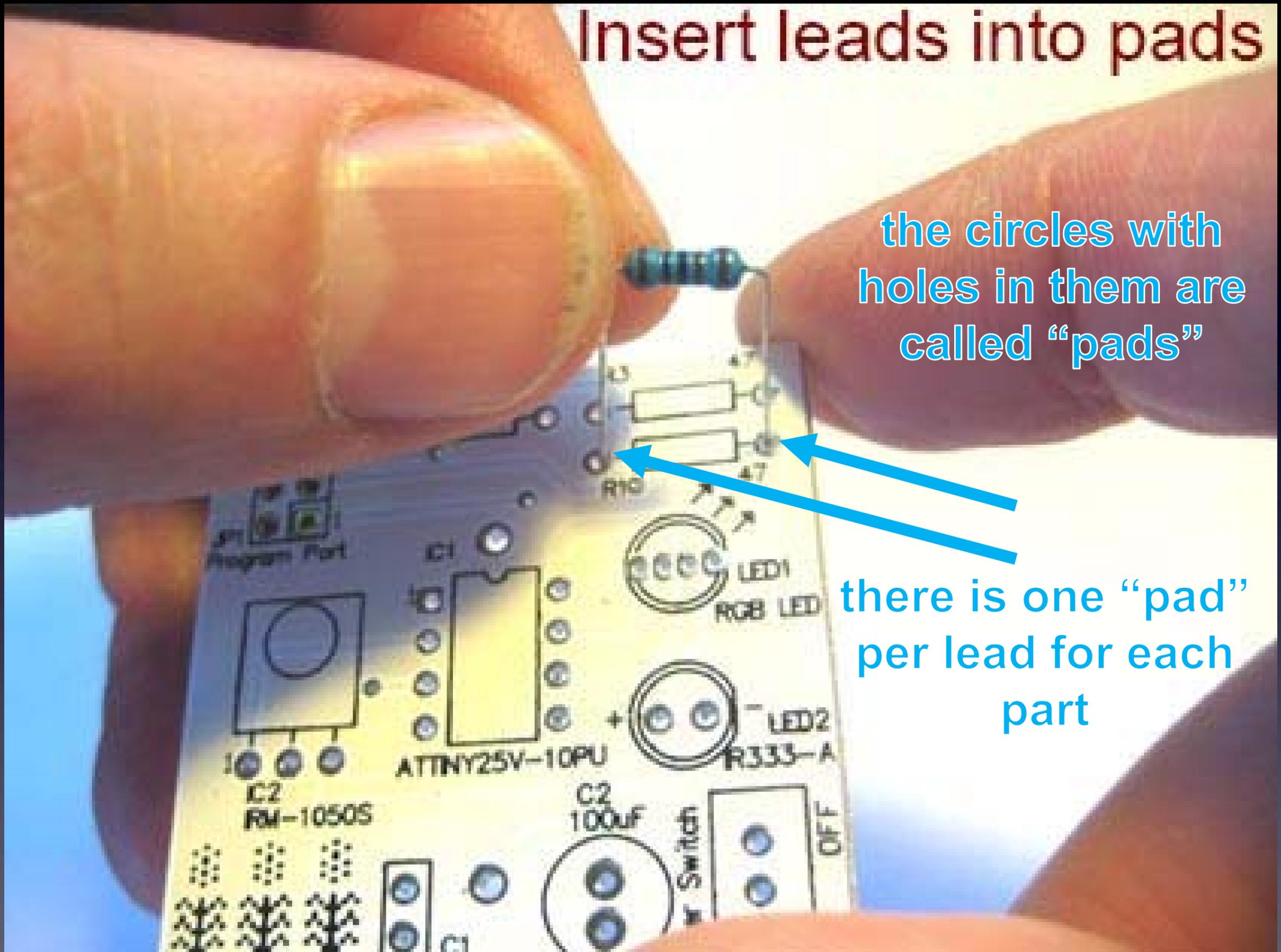


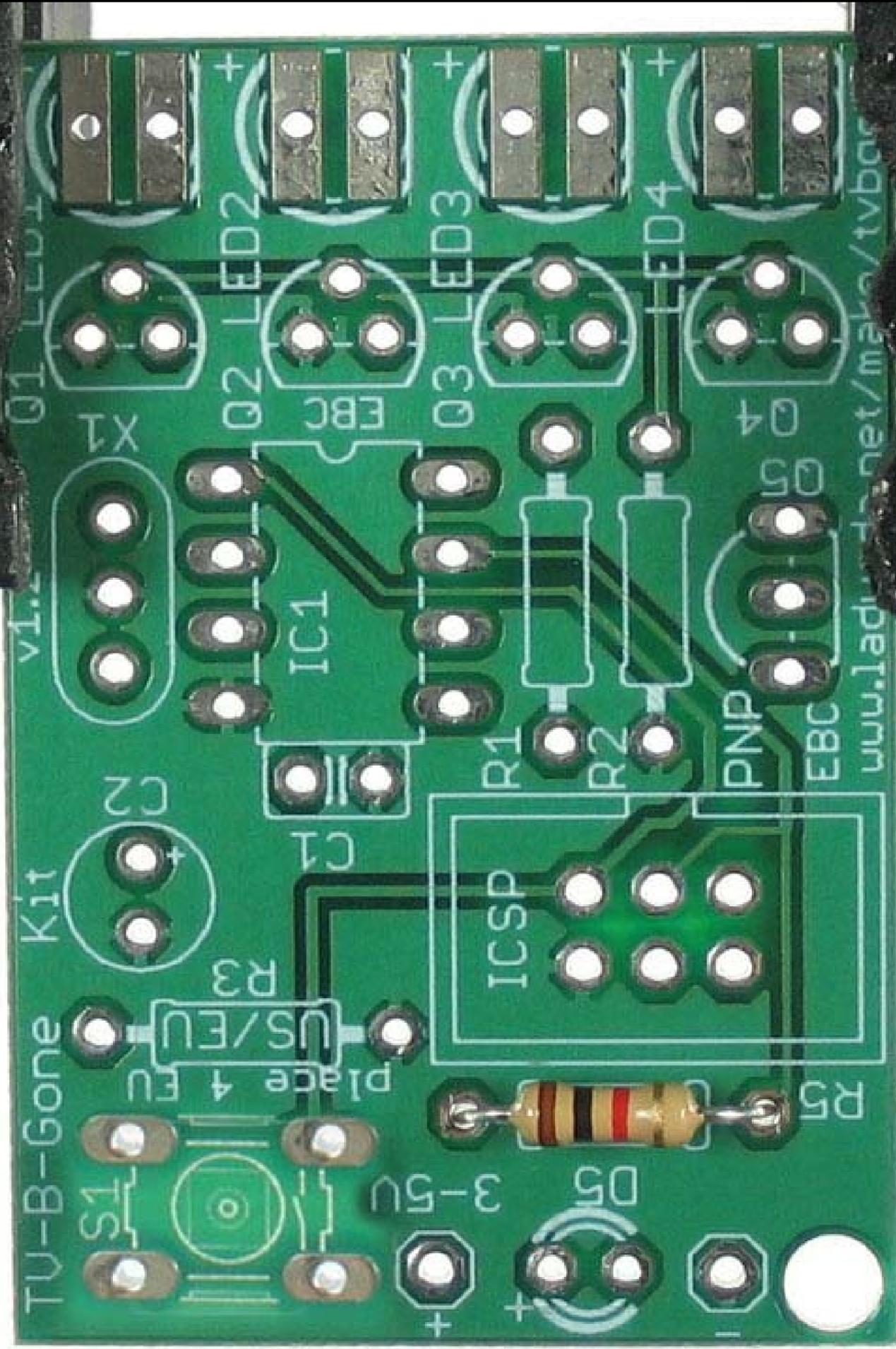
**Resistor R5**

Insert leads into pads

the circles with holes in them are called "pads"

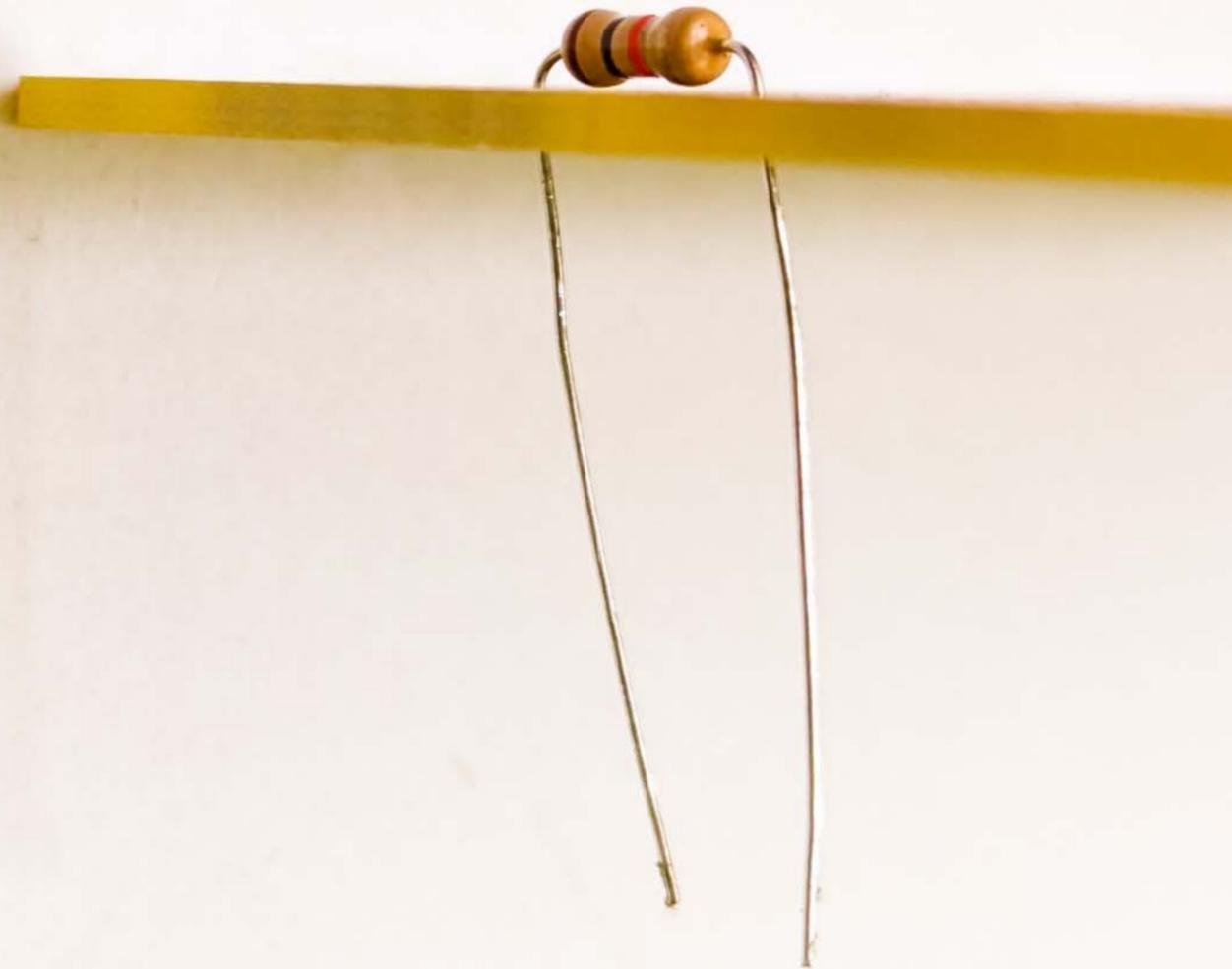
there is one "pad" per lead for each part





**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 iron

(Like a pencil – held from underneath)

**Important**

# The best kind of solder for DIY electronics:

*(Sn – Tin / Pb – Lead)*

**63/37 rosin core,**

**0.031" (0.8mm) diameter (or smaller)**

*(60/40 is also good)*

**Note:**

**Most**

***Lead-Free* solder**

**has poisonous fumes!**

**This is what we will use:**

**A good kind of solder for DIY electronics:**

*This is the only good **Lead-Free** solder I have found!*  
*(after years of searching)*



**Kester**  
**K100LD Rosin**  
*(not "No Clean")*  
**0.031" diameter (0.8mm)**

**This is what we will use:**

# A good kind of solder for DIY electronics:

*This is the only good **Lead-Free** solder I have found!*  
(after years of searching)



Kester **K100LD Rosin** Solder  
0.031" diameter (0.8mm)

## Note:

Since we will use **Lead-Free** solder  
it is *helpful*  
to also have  
*flux paste* in a syringe  
*And Isopropyl Alcohol*



**AMTECH NC-559-ASM**



**99%**

# Another good kind of solder for DIY electronics:

*This is another good **Lead-Free** solder I have found!*



**Duratool  
D01685 Rosin**

**0.7mm diameter**

*(as good as the  
Kester K100LD Rosin)*

# 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)

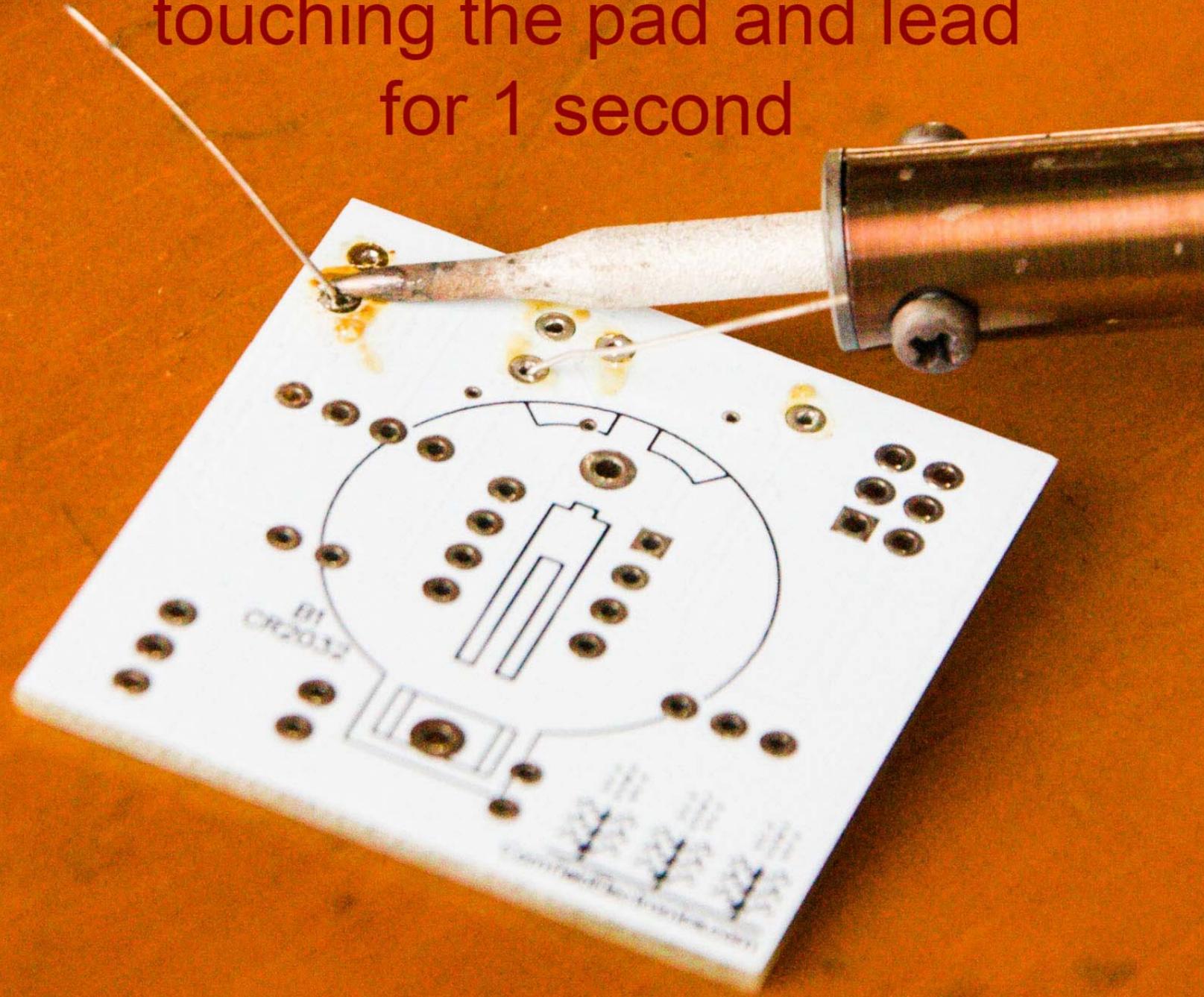
Bang (lightly) 3 times,

Swipe, Rotate, Swipe (on the sponge):

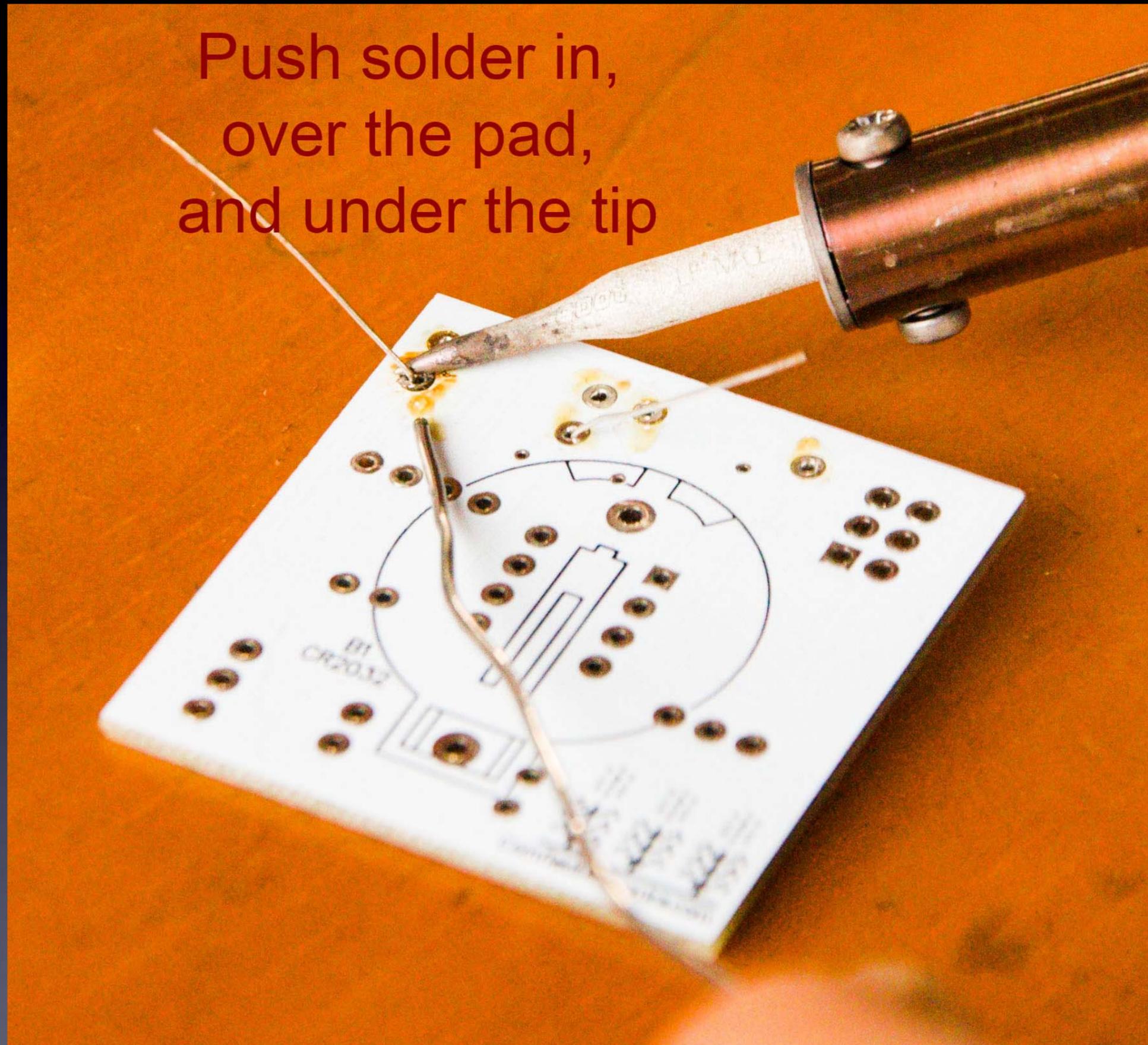
*Keep the tip shiny silver!*

knock solder off the tip

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



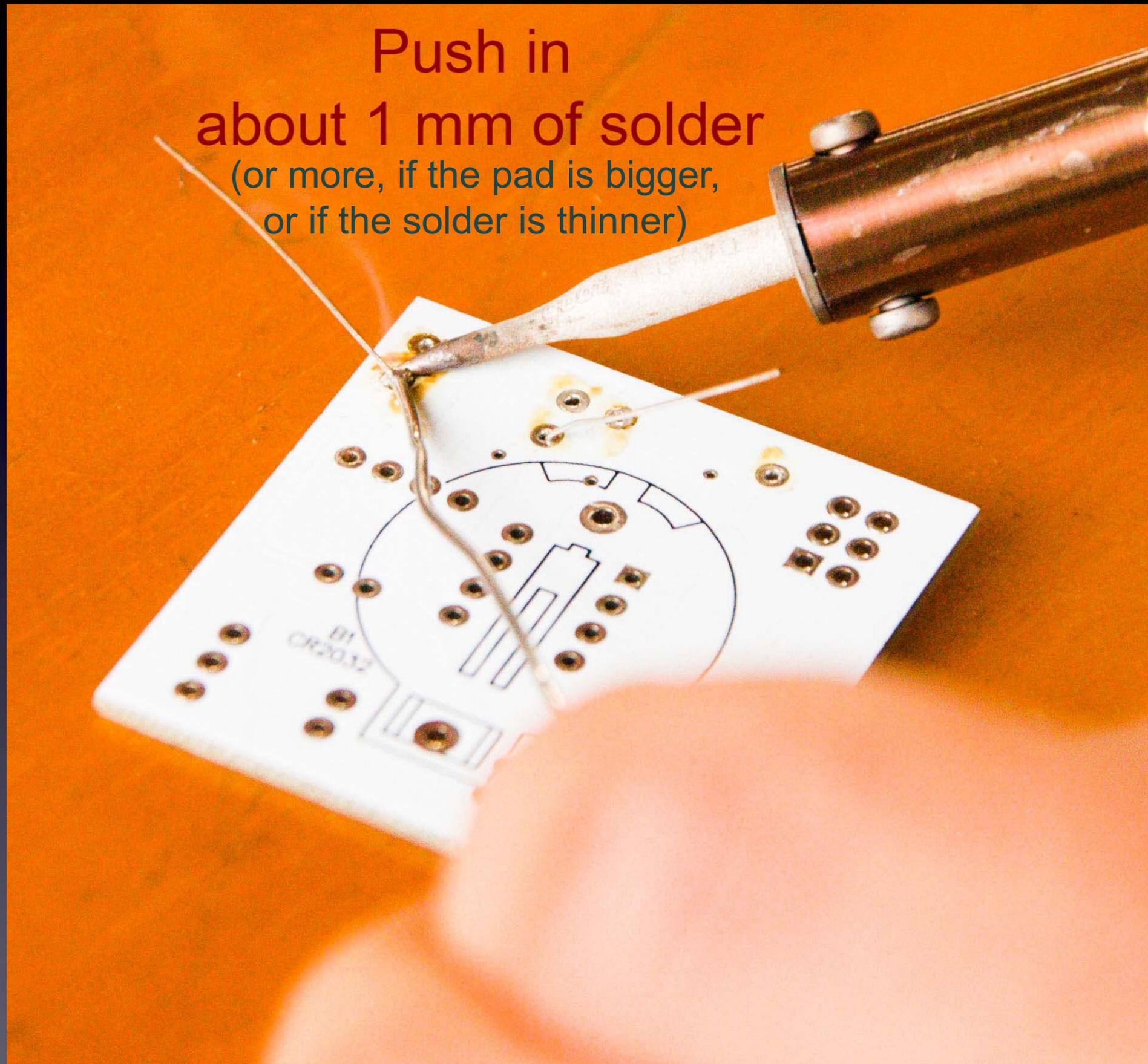
Do this quickly (slowly doesn't work well) – solder in & out in about 1 second



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

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



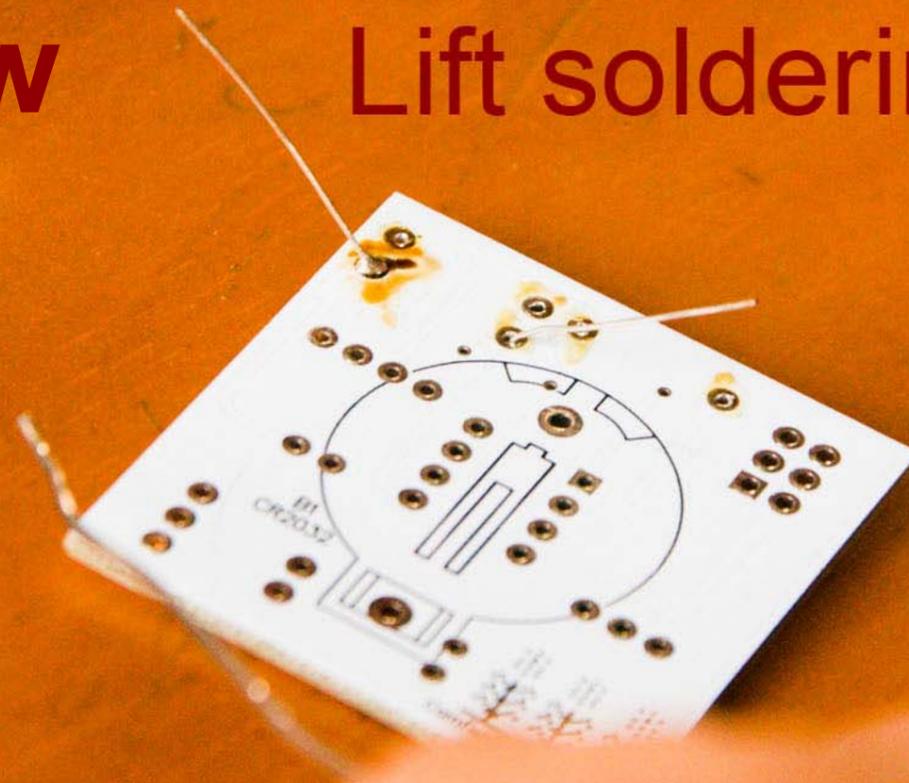
Pull solder away,  
***But*** keep holding soldering iron down  
for 1 more second !!

Secret #2:

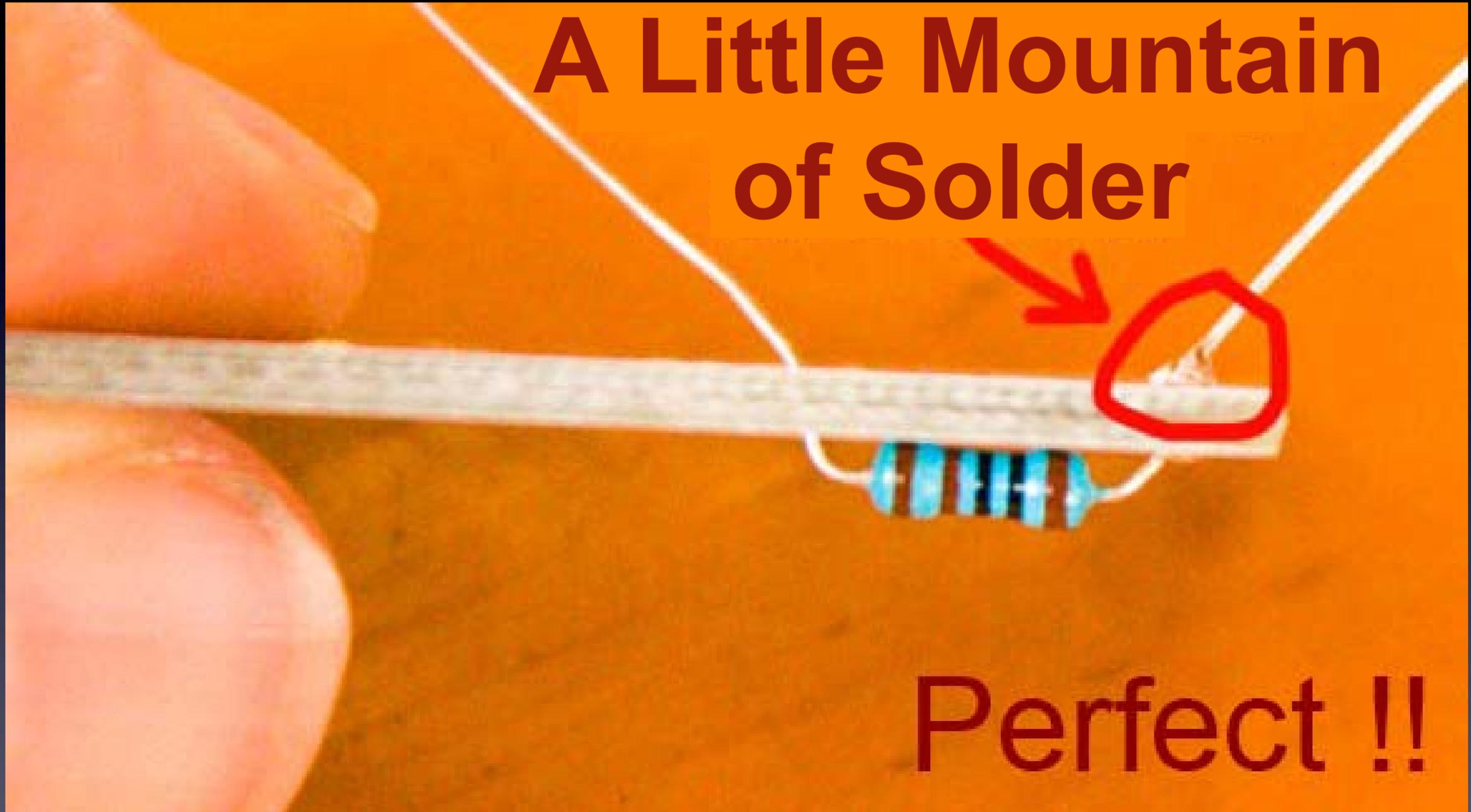
Keep hot tip down  
1 second  
for solder to flow !!

**Now**

**Lift soldering iron**



**A Little Mountain  
of Solder**



**Perfect !!**

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)



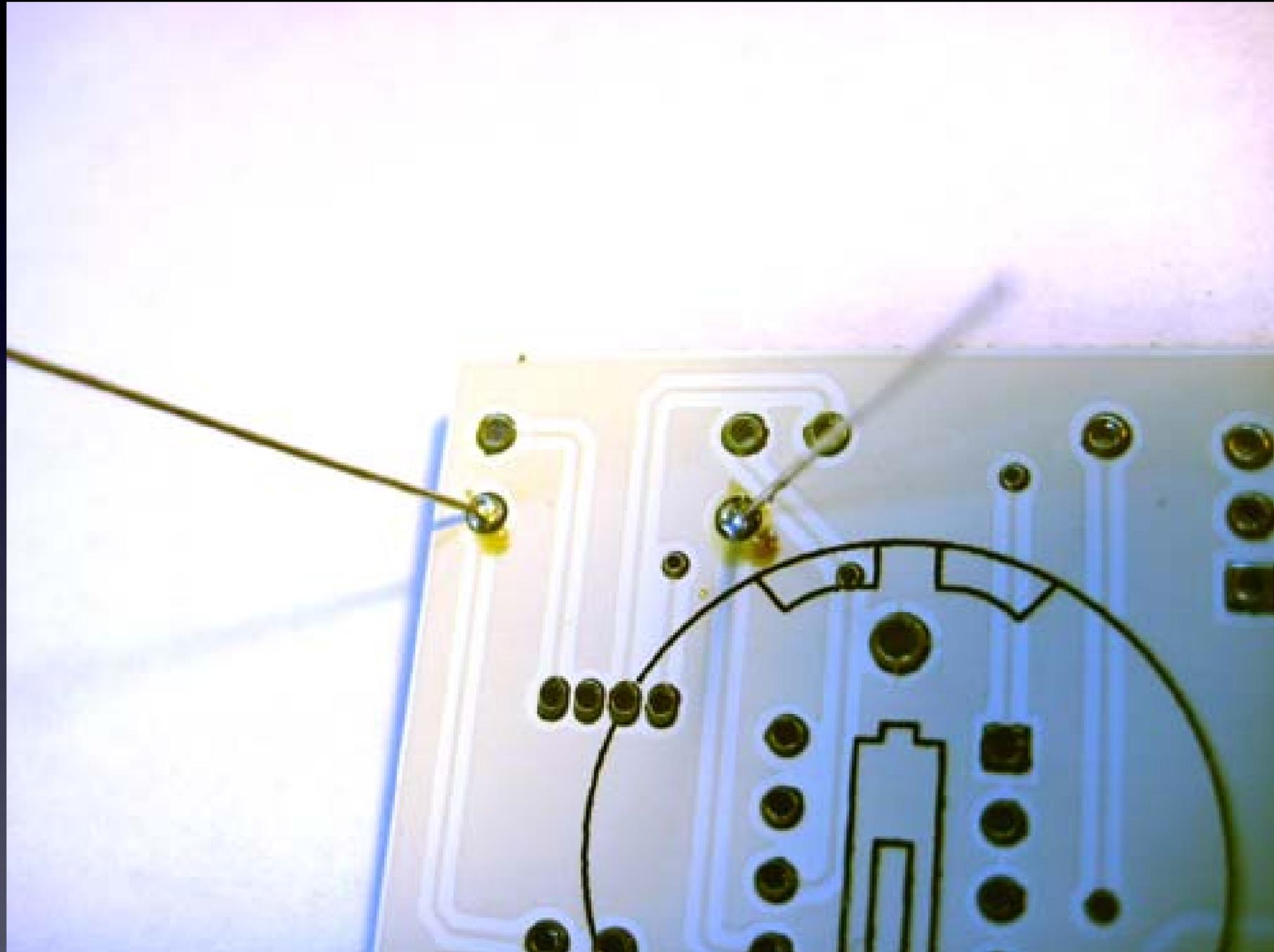
***WAIT !***

**The Rhythm !**  
and speed (about 1 second per step)



**Lift** Tip

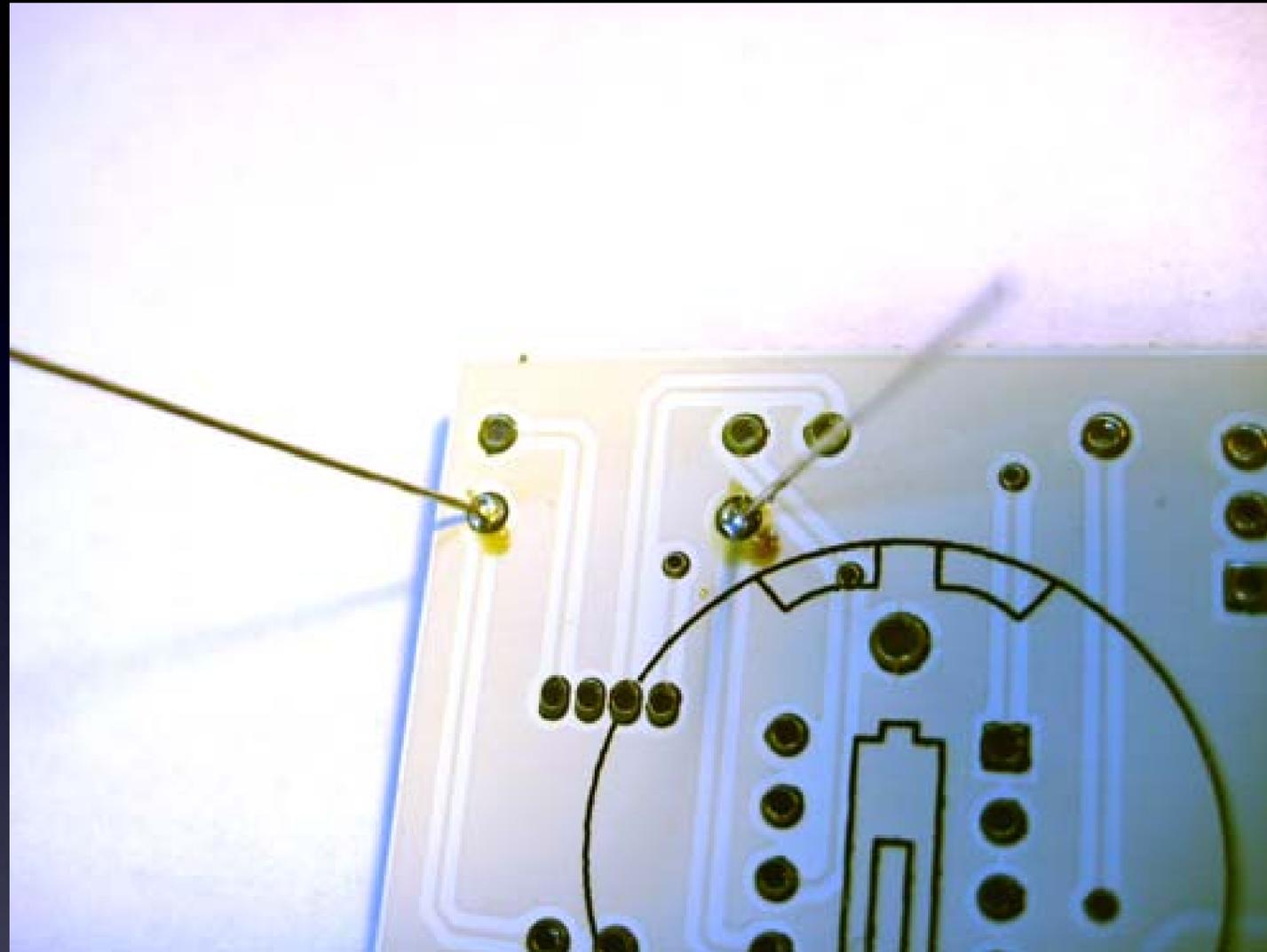
Solder all of the leads of the part to the board



For this part, there are two leads

Here you can see two good solder connections

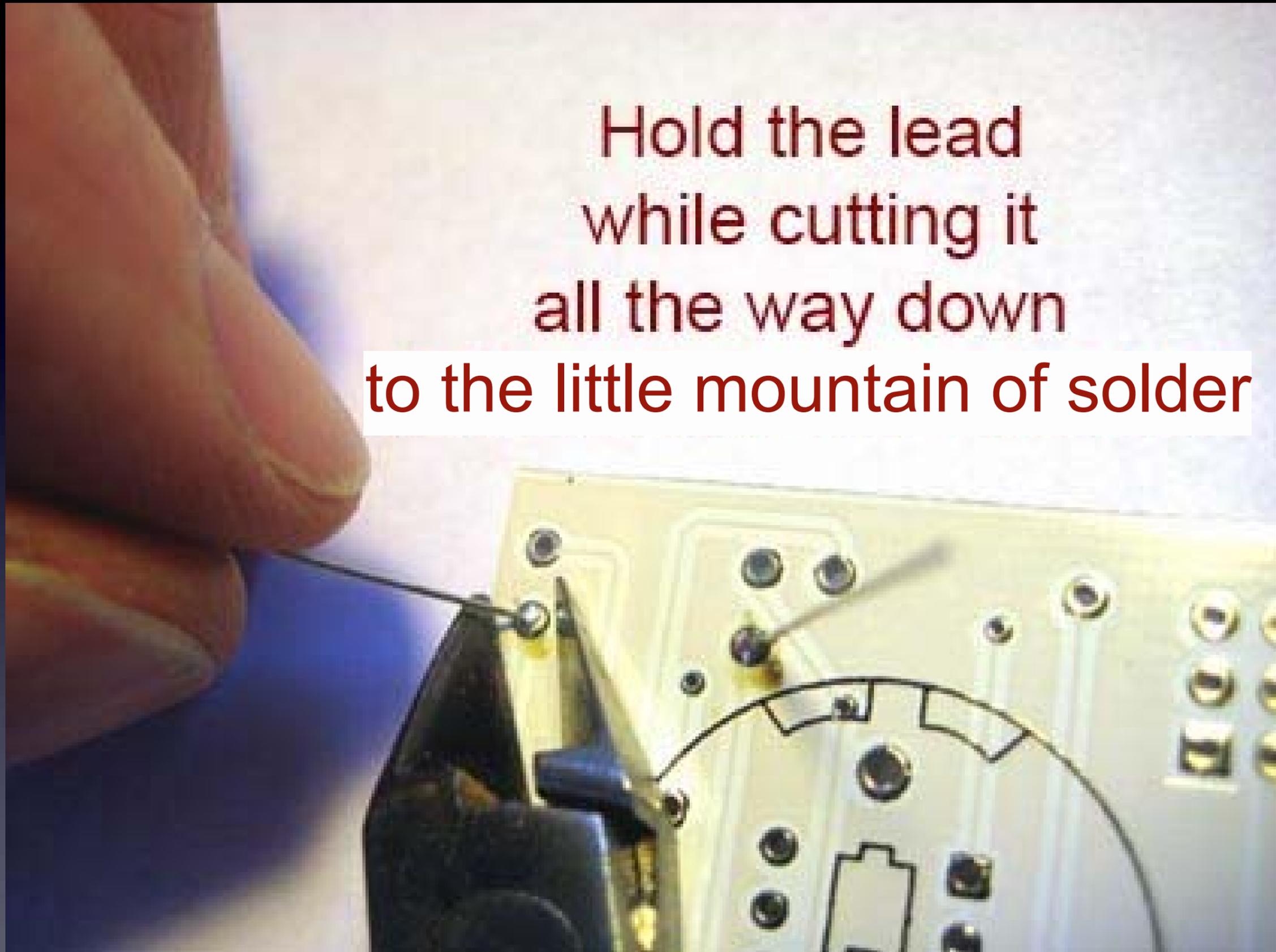
# Two good solder connections



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

## Now cut the leads short

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



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

# Safety Tip #3:

Hold or cover the lead !

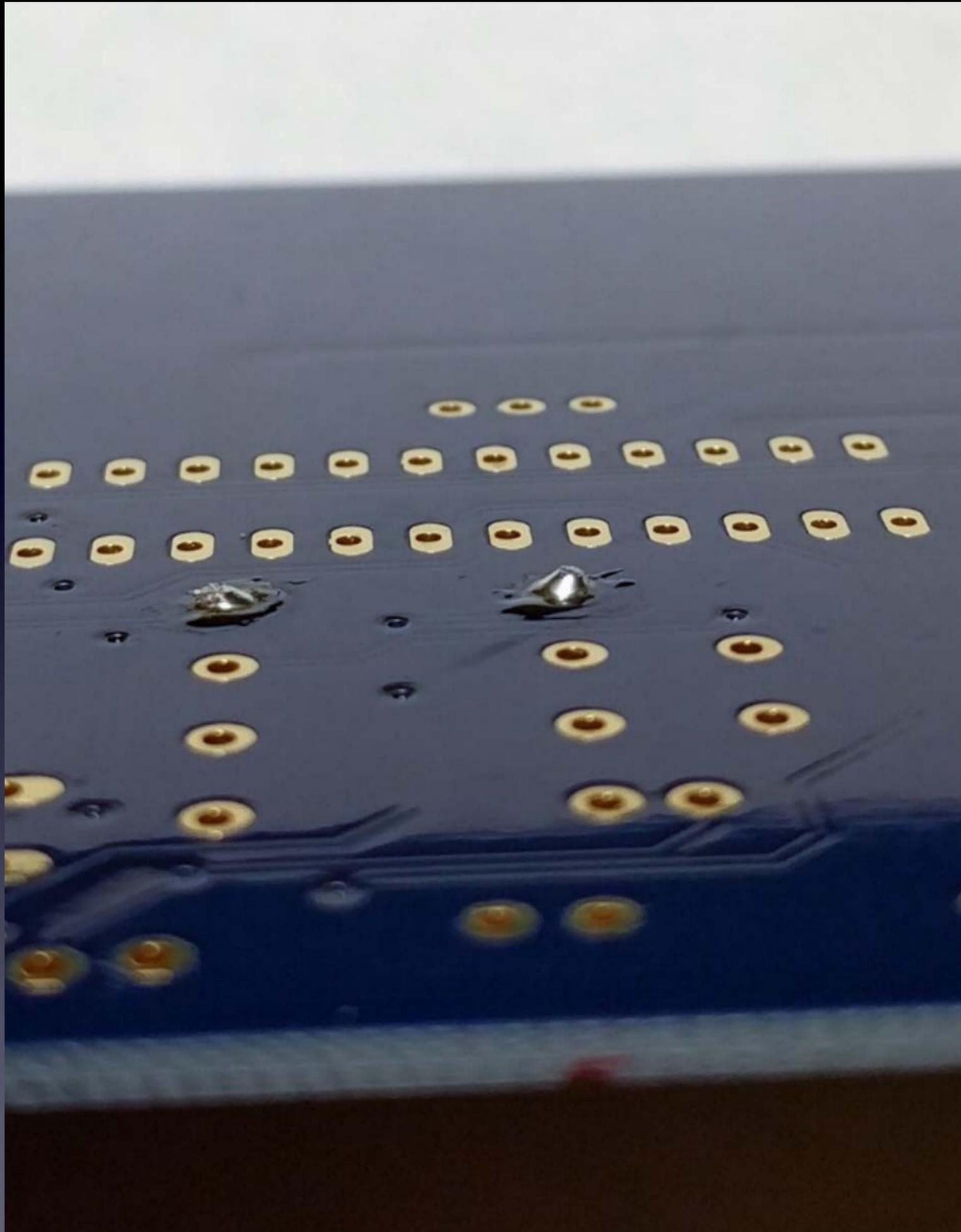
(or it will fly into your eye!)

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



All done !

No wires sticking out



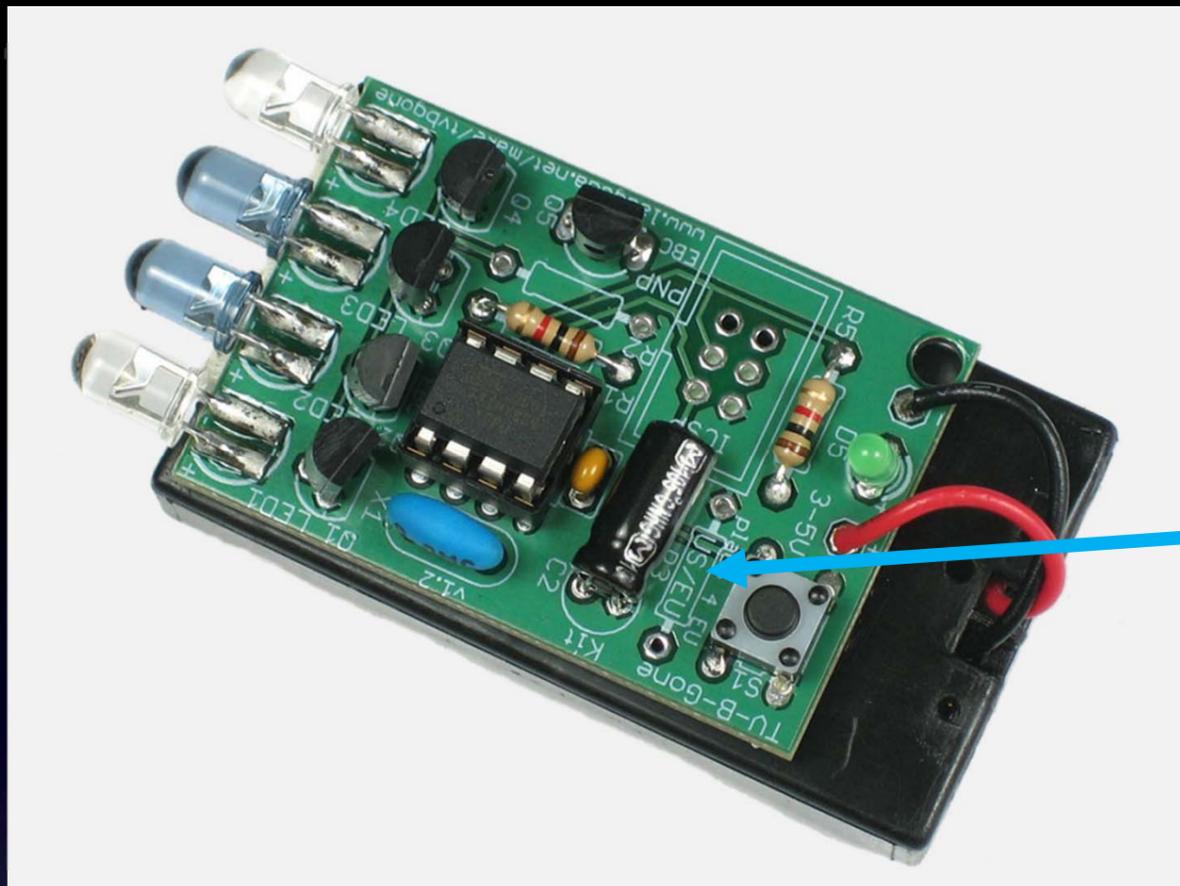
# A closer look at good solder connections

## Notice that:

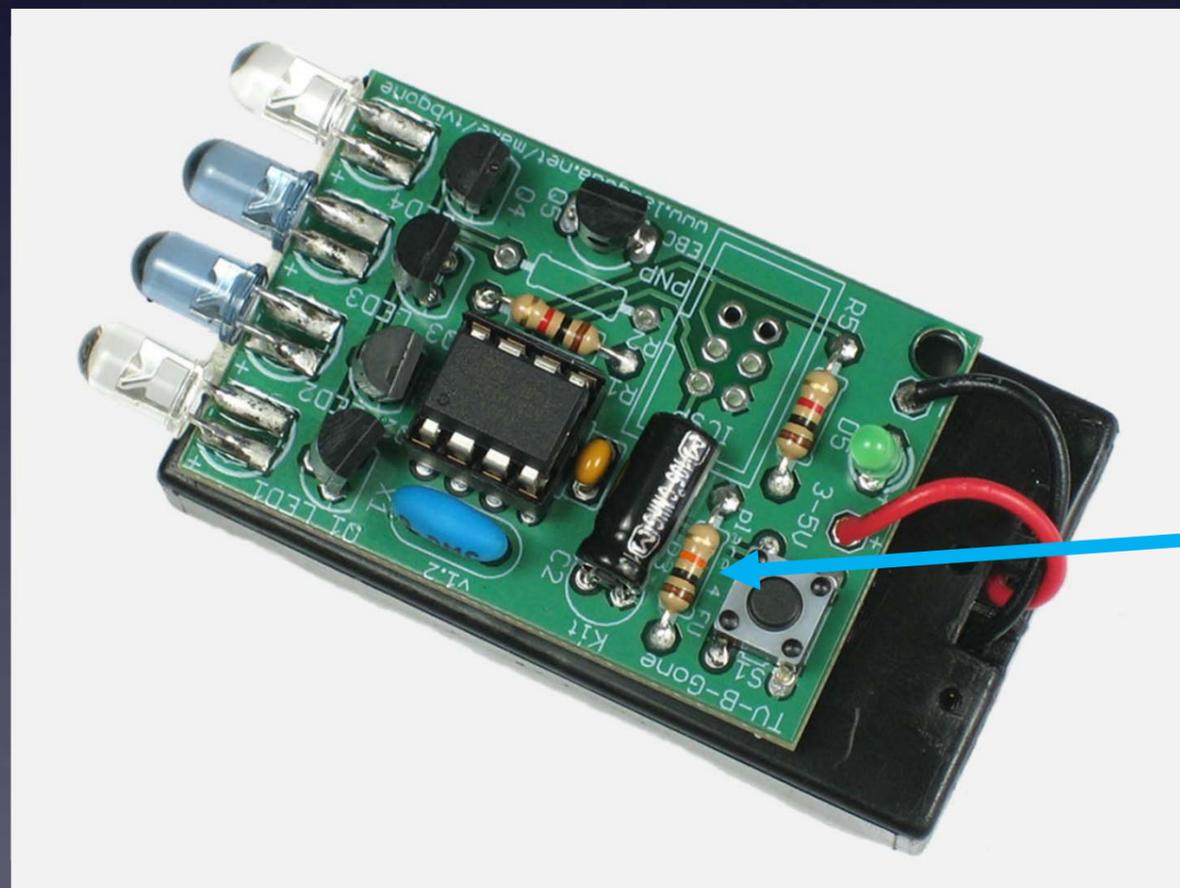
- Each connection is a small mountain (not flat)
- You cannot see any pad (they're totally covered with solder)
- You cannot see the holes (they're totally covered with solder)
- No connections to other pads

One part at a time

Till all the parts are soldered



**NA** (R3 not soldered)



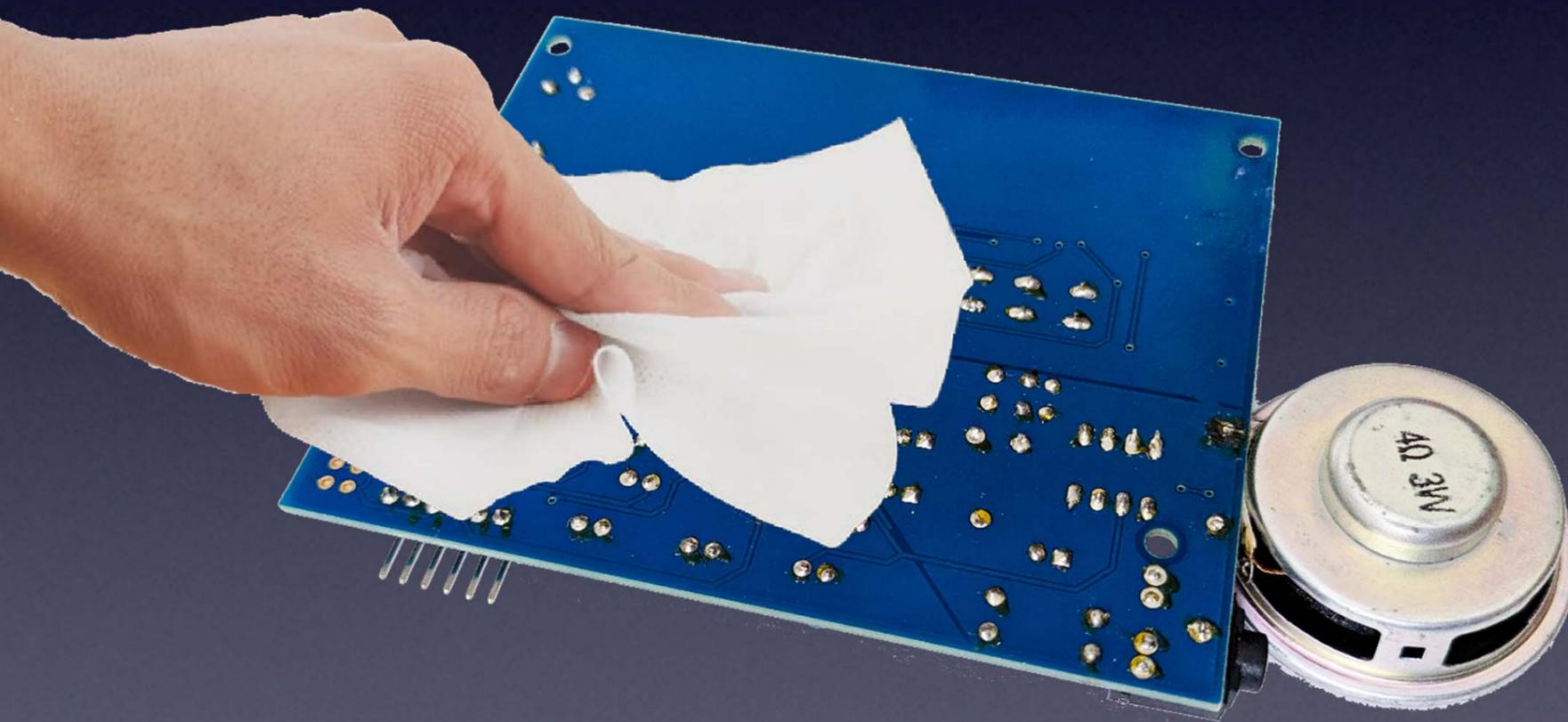
**EU** (R3 soldered in)

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

If you used any *flux paste* for *re-working problems*



The bottom of the PCB will be sticky from the flux



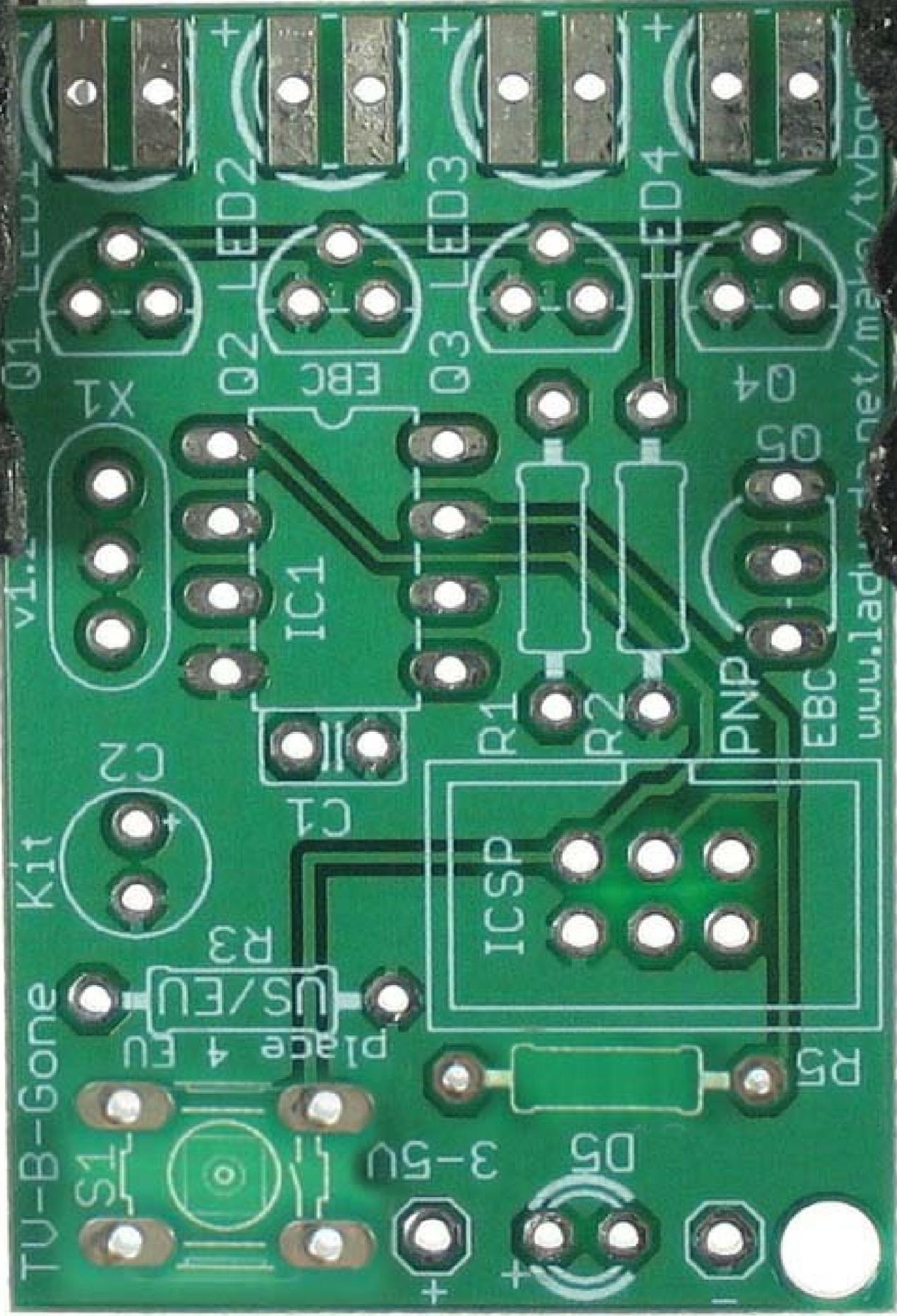
You can clean it with a cloth wet with *Isopropyl Alcohol*

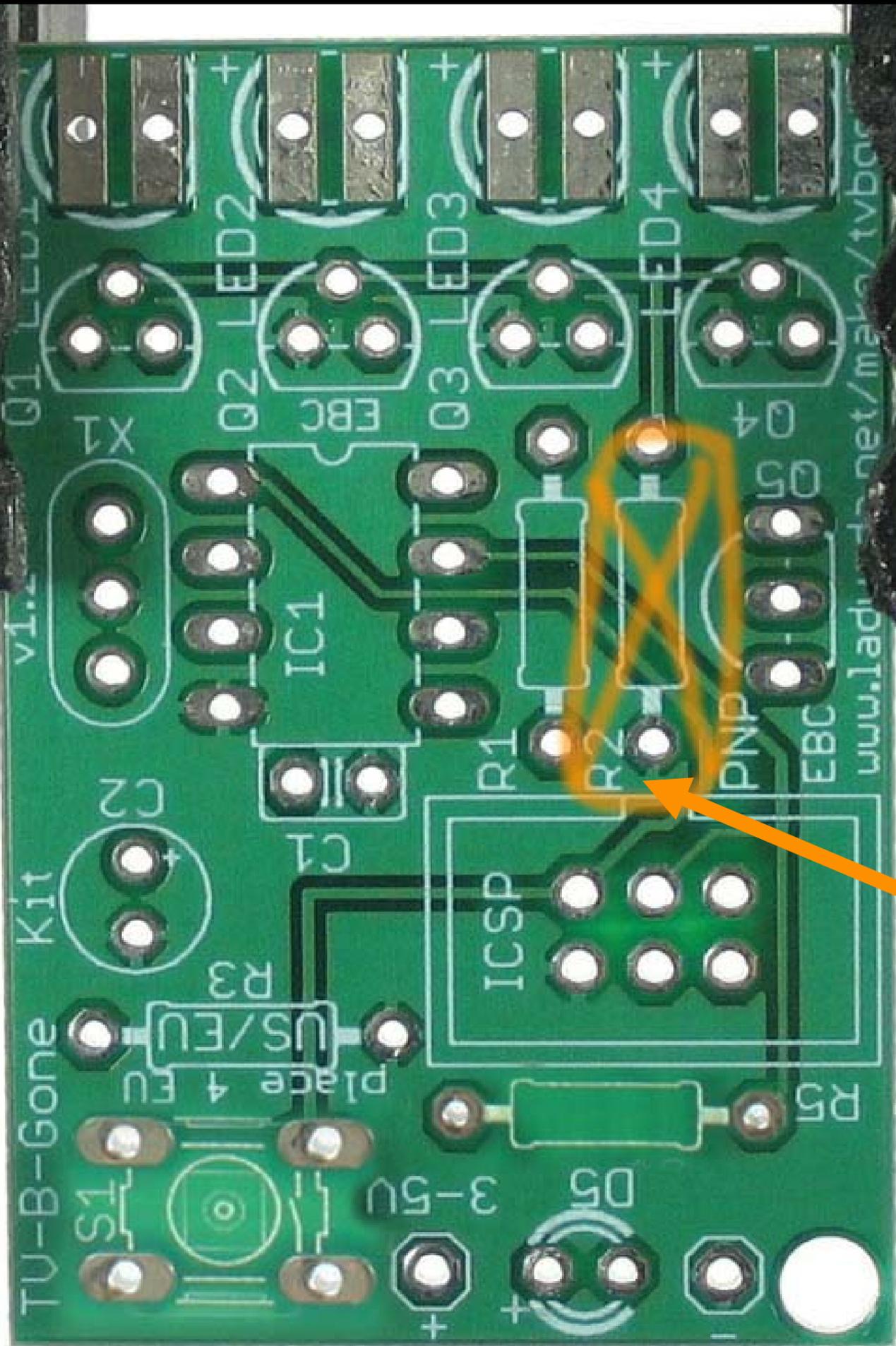
Then test with batteries,

And it works!

(Or you start debugging.)

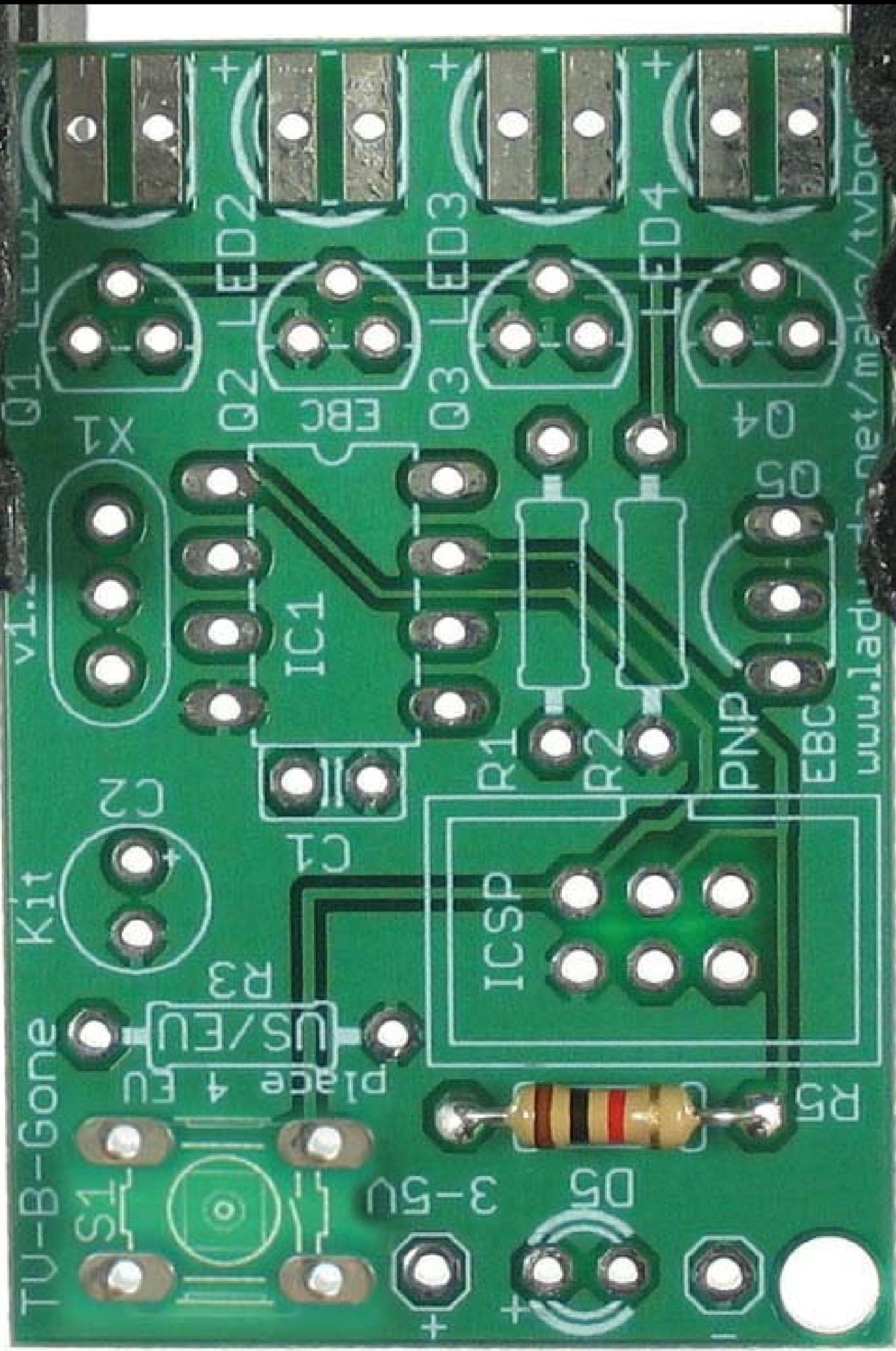
Let's start!



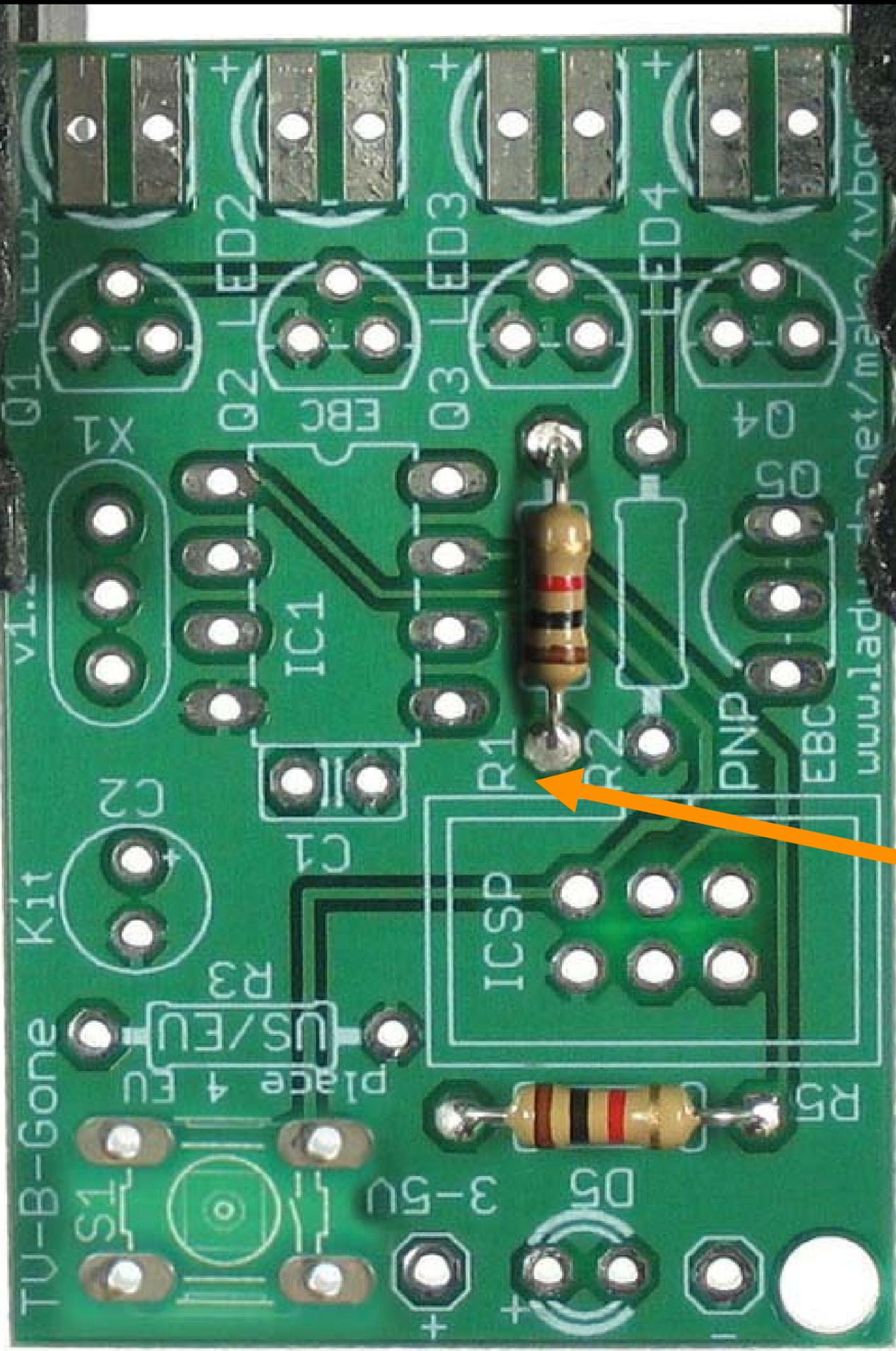


**Remember:**

**Resistor R2  
is unused**



**Resistor R5**



**R1**  
**same as R5**

# Resistor R3 is ONLY for Europe

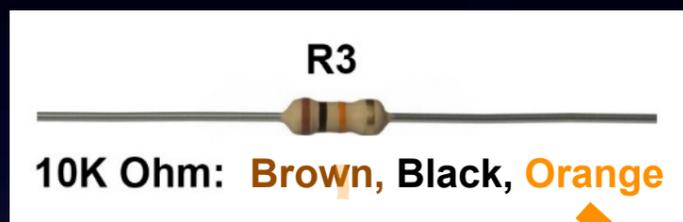
R3



10K Ohm: **Brown, Black, Orange**

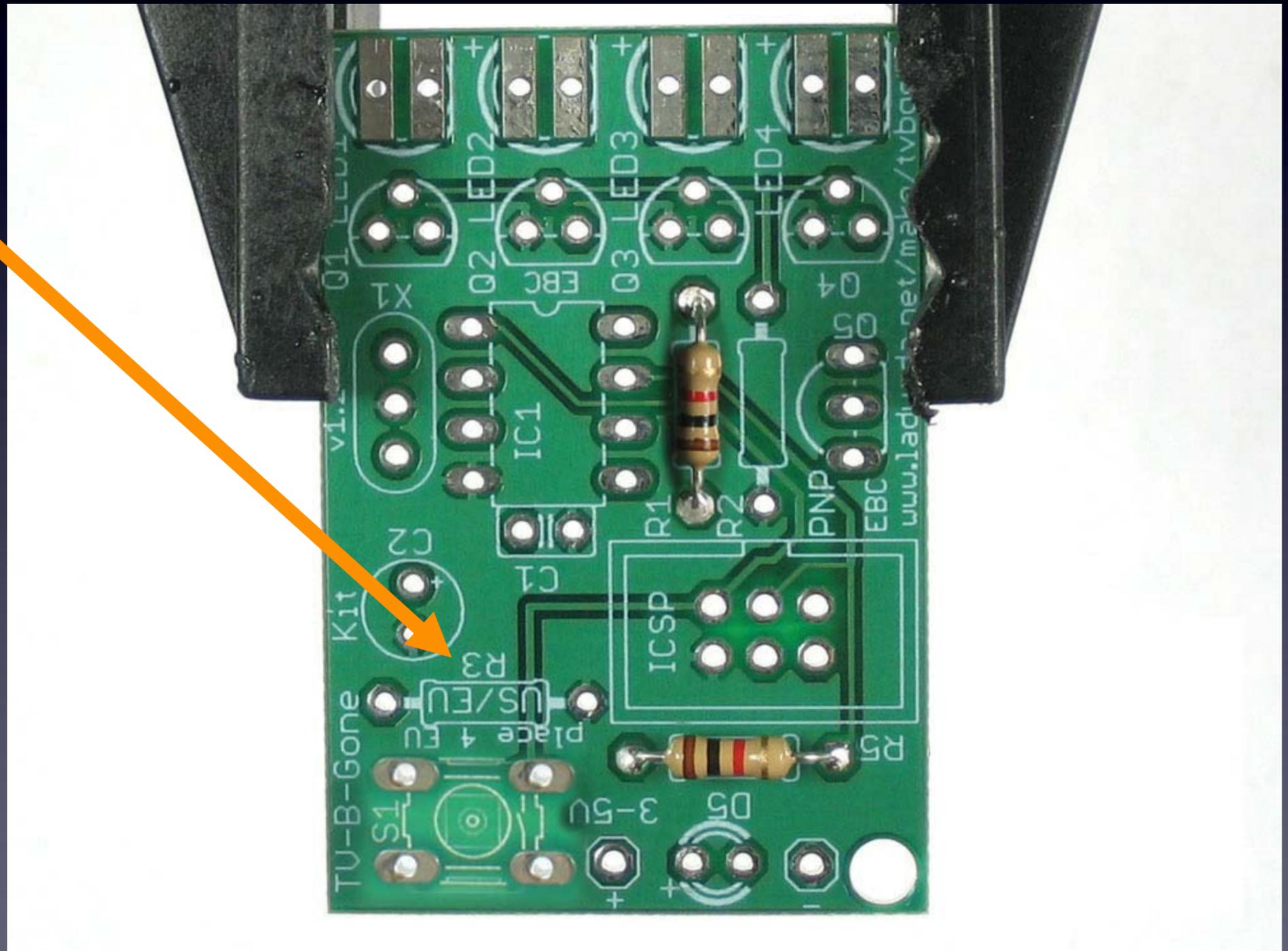
NOTE: Do NOT use the ~~[ Brown, Black, Red ]~~ resistor !

# Resistor R3 is ONLY for Europe



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

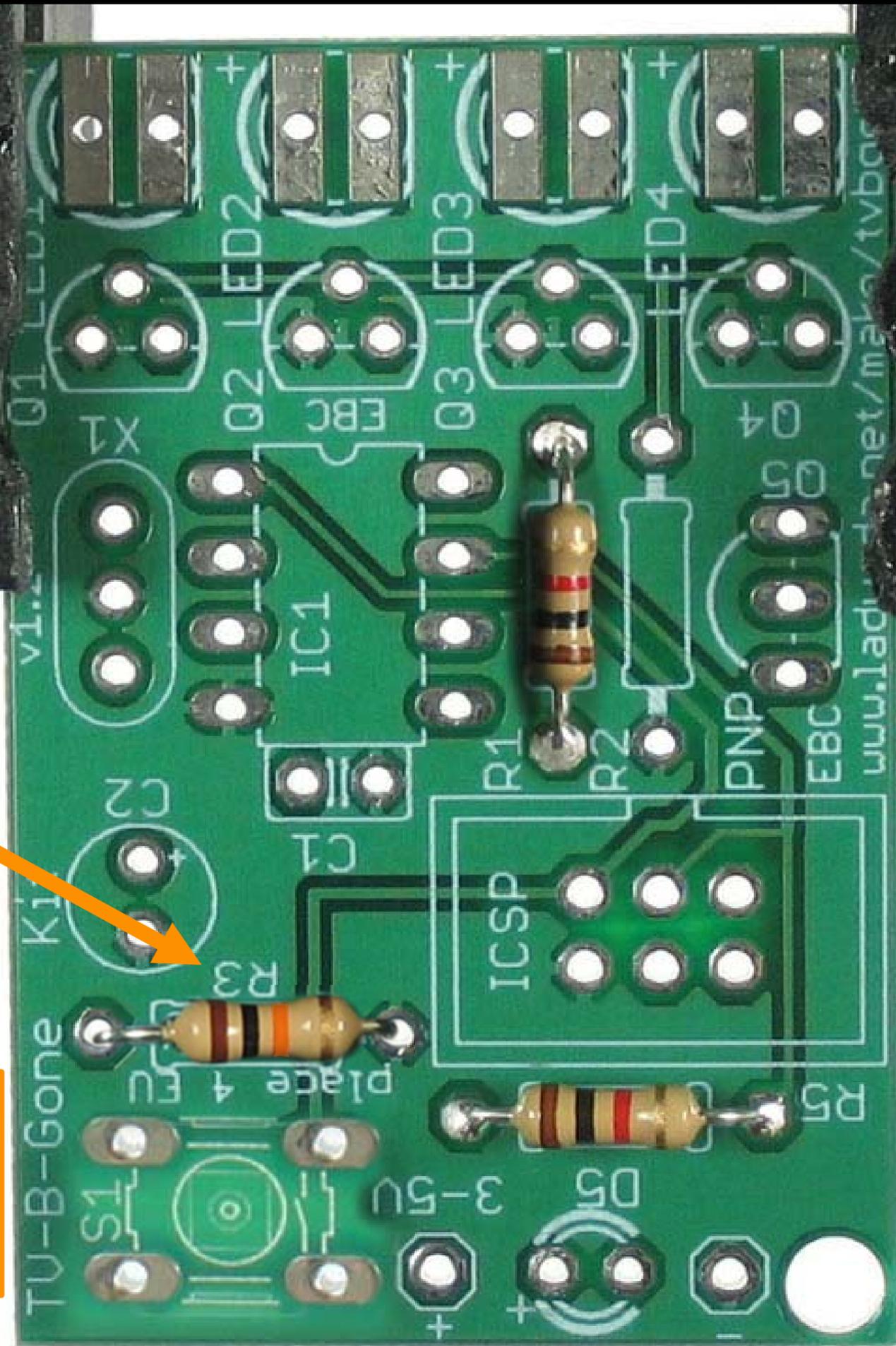
**For North  
America:**  
**no R3**  
(also for Asia and  
South America)

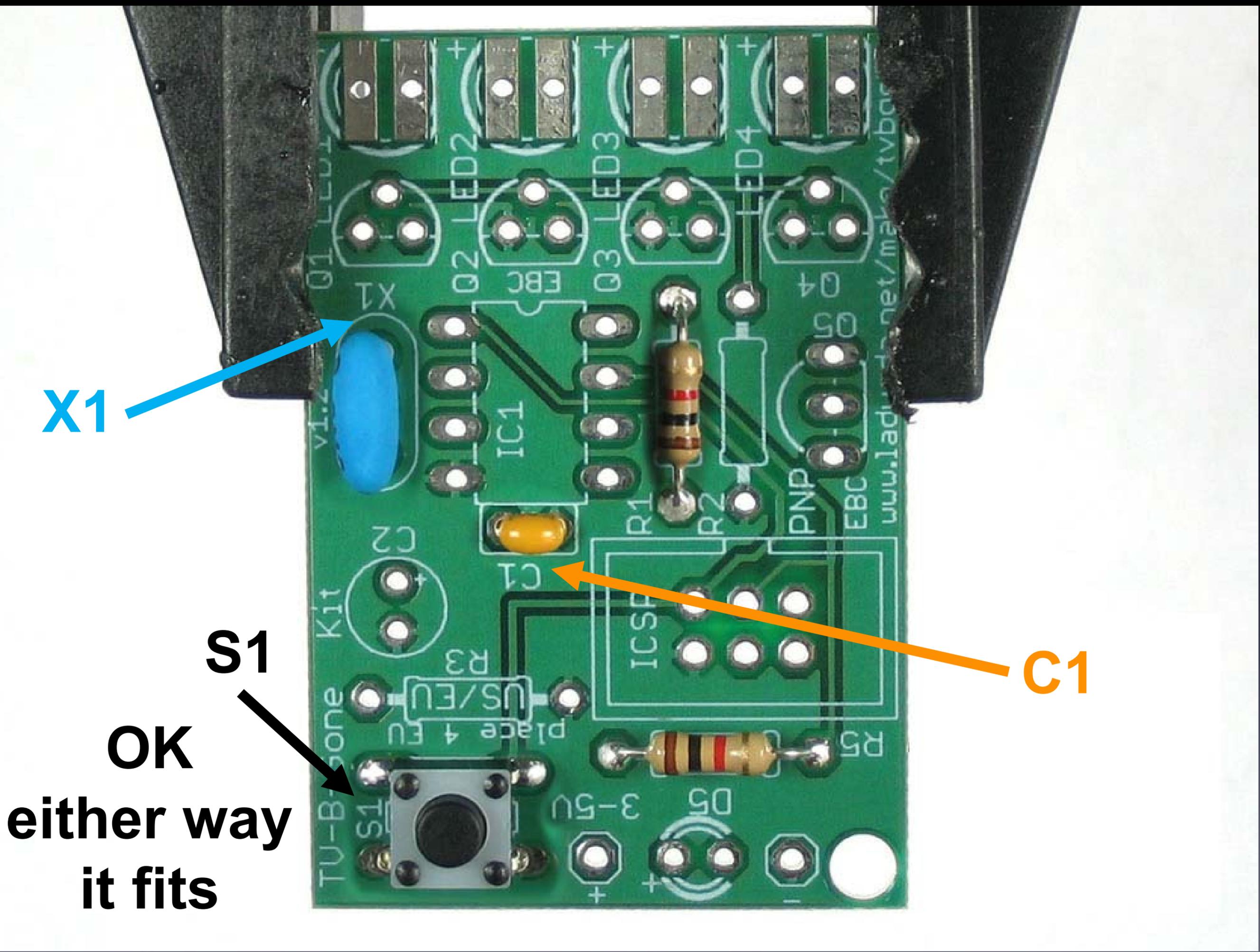


**R3**

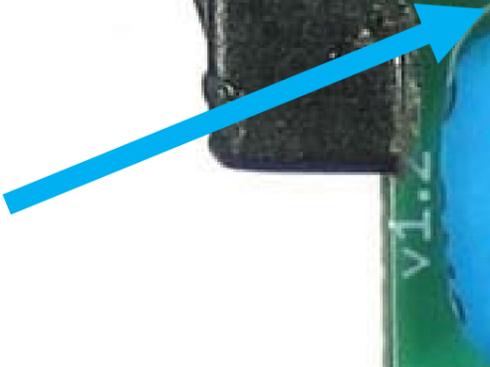
**ONLY for  
Europe**

**For NA  
don't solder in  
R3**

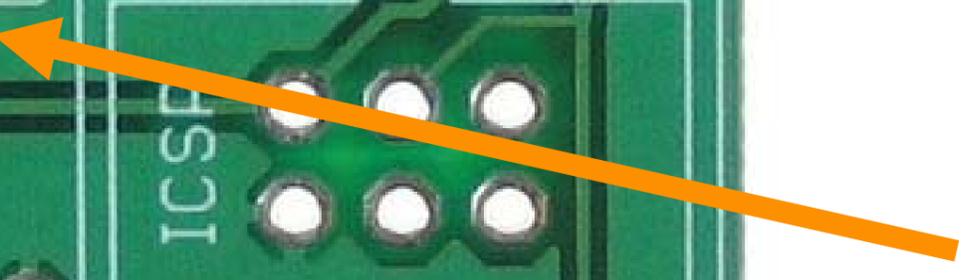




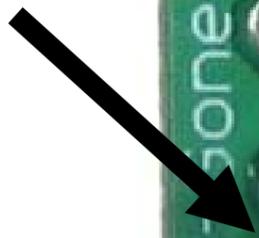
X1



C1



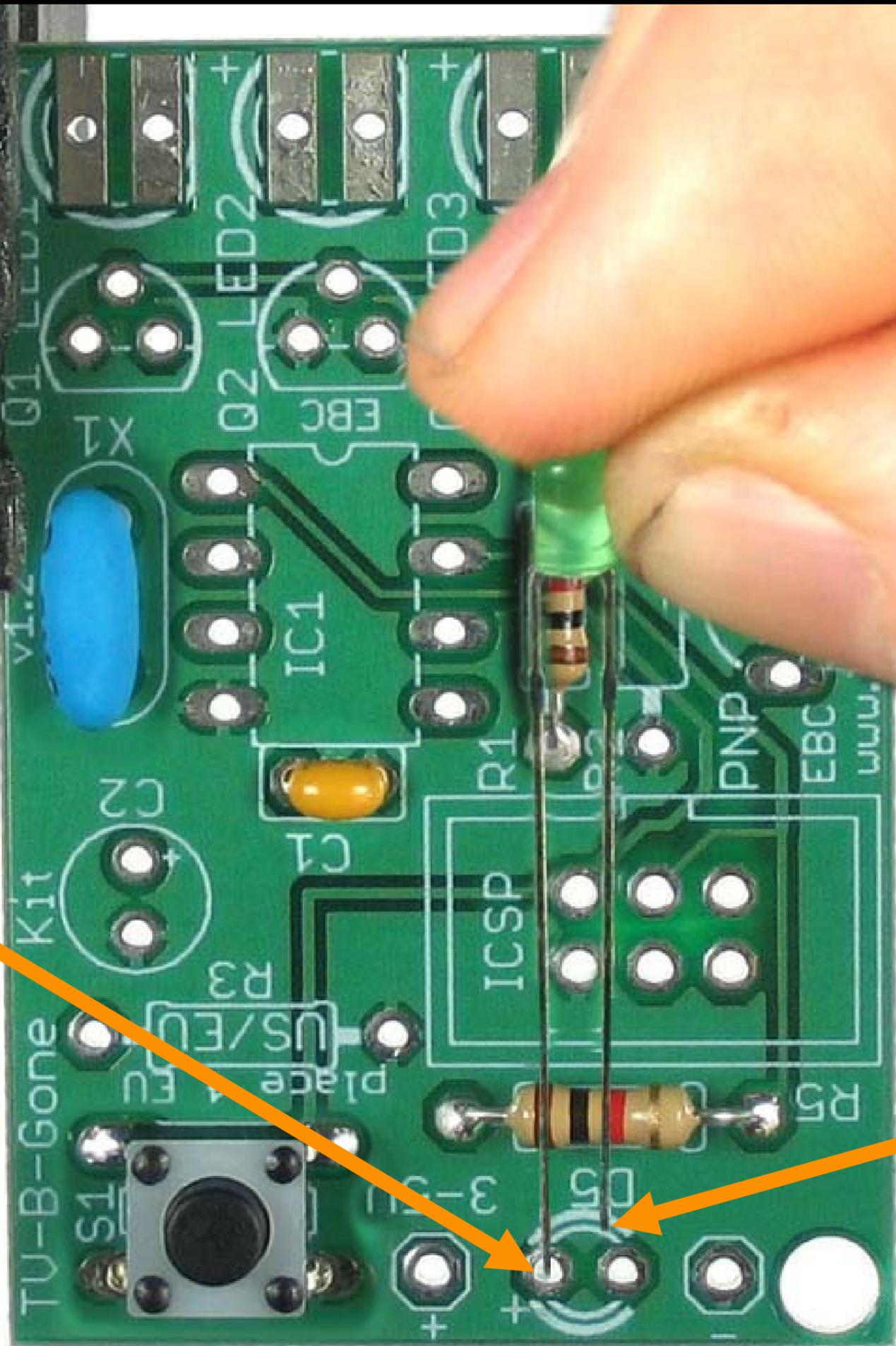
S1

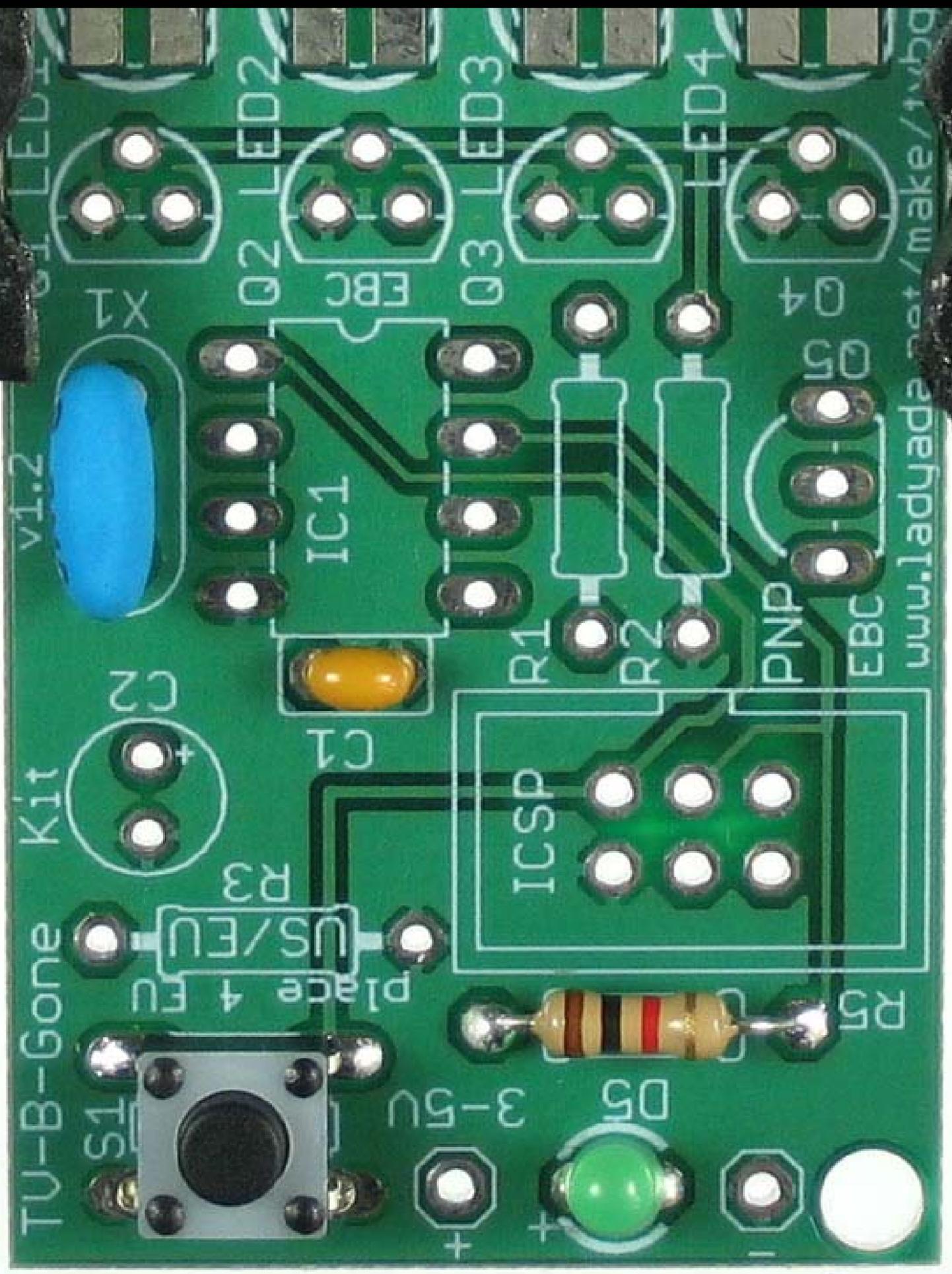


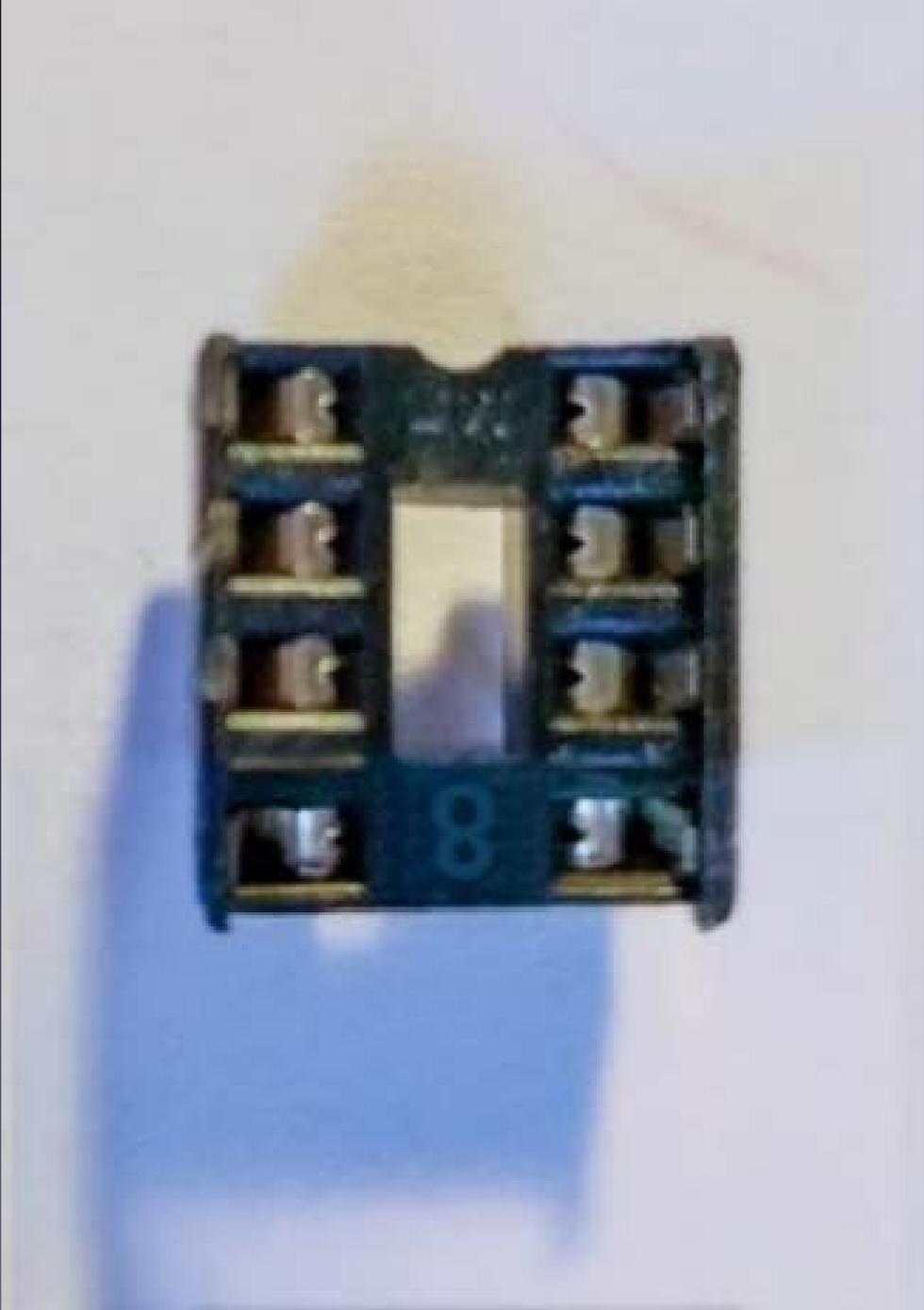
OK  
either way  
it fits

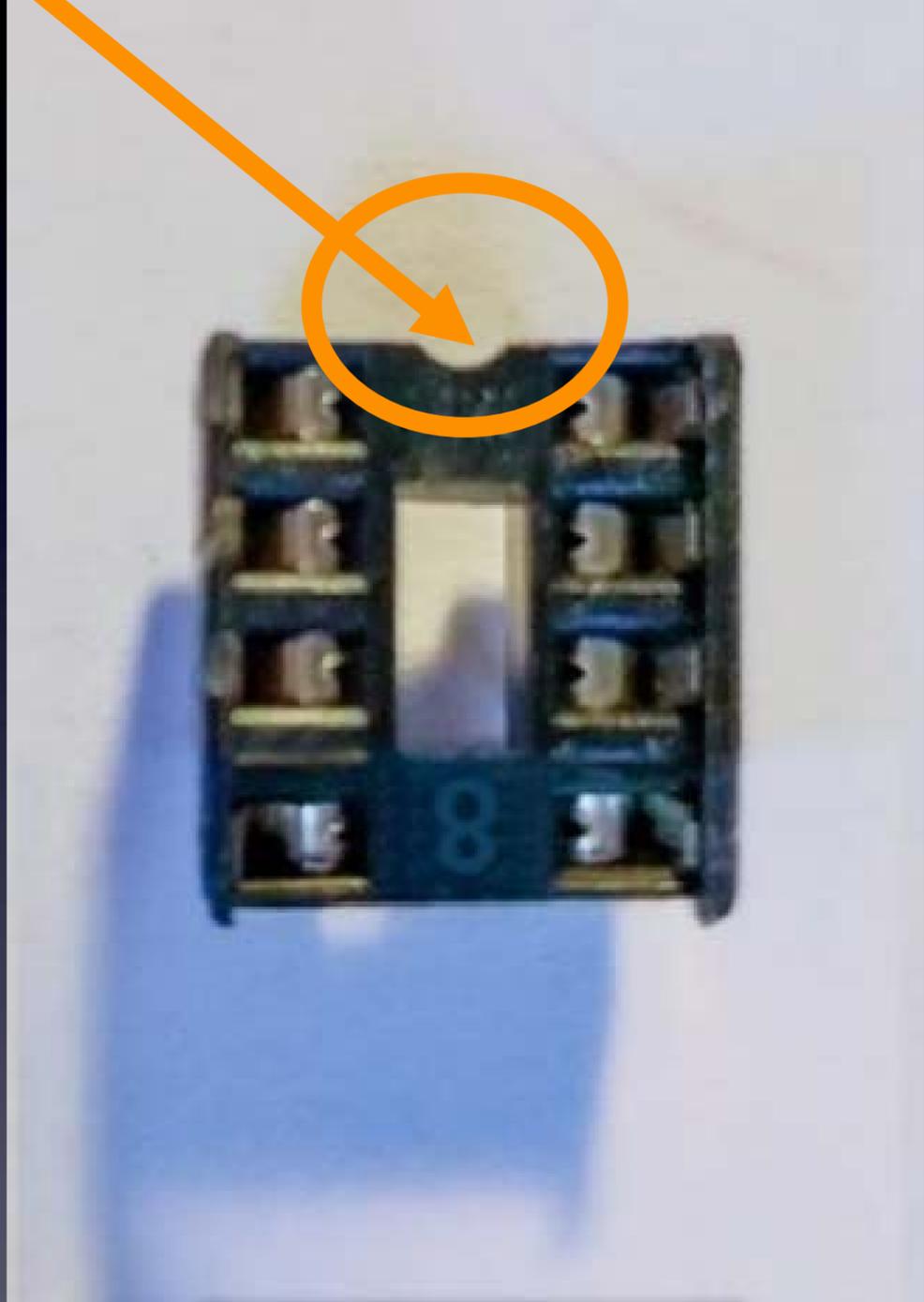
**D5**  
**Long lead**

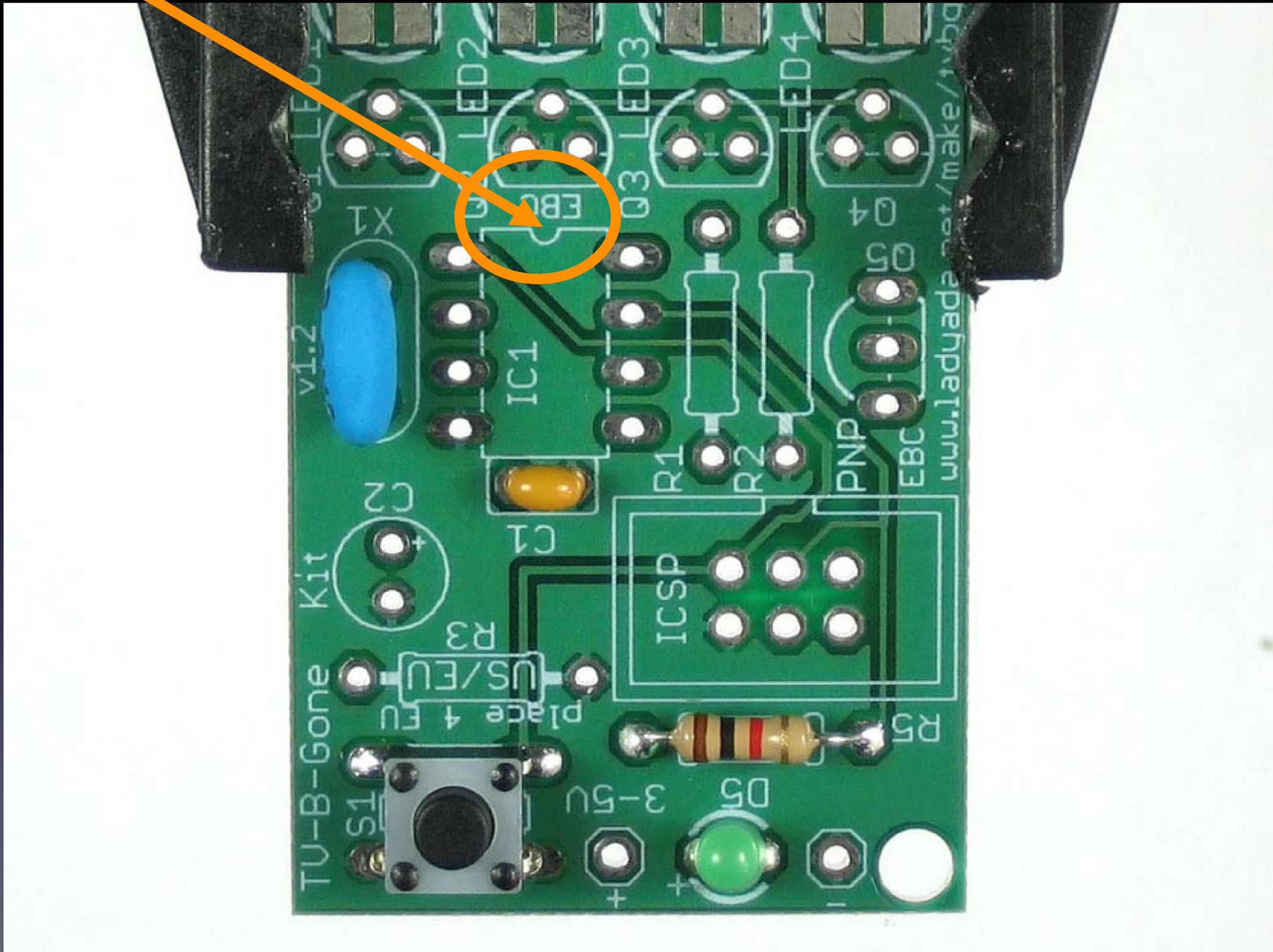
**Short lead**





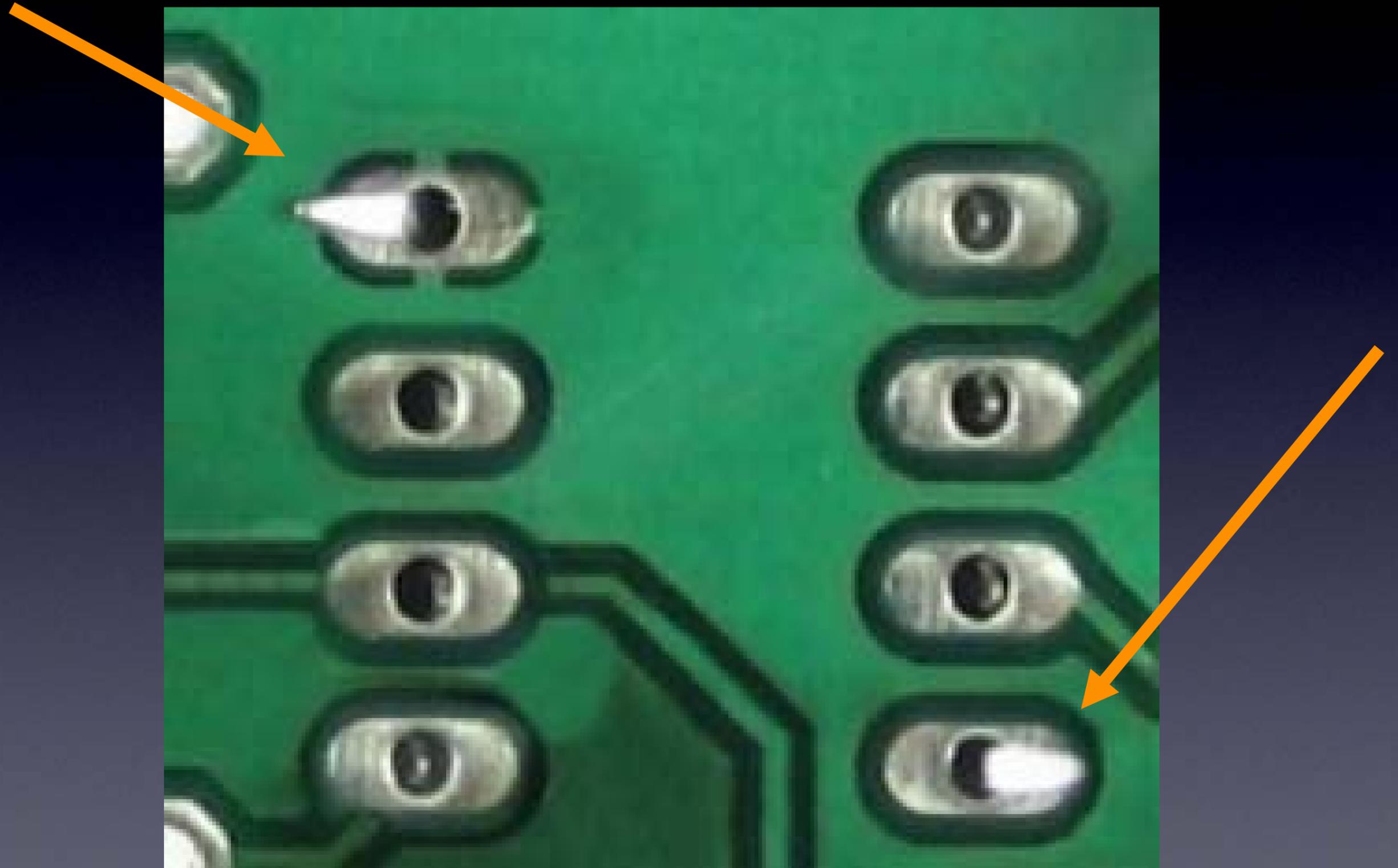








**Bend pins on 2 opposite corners**

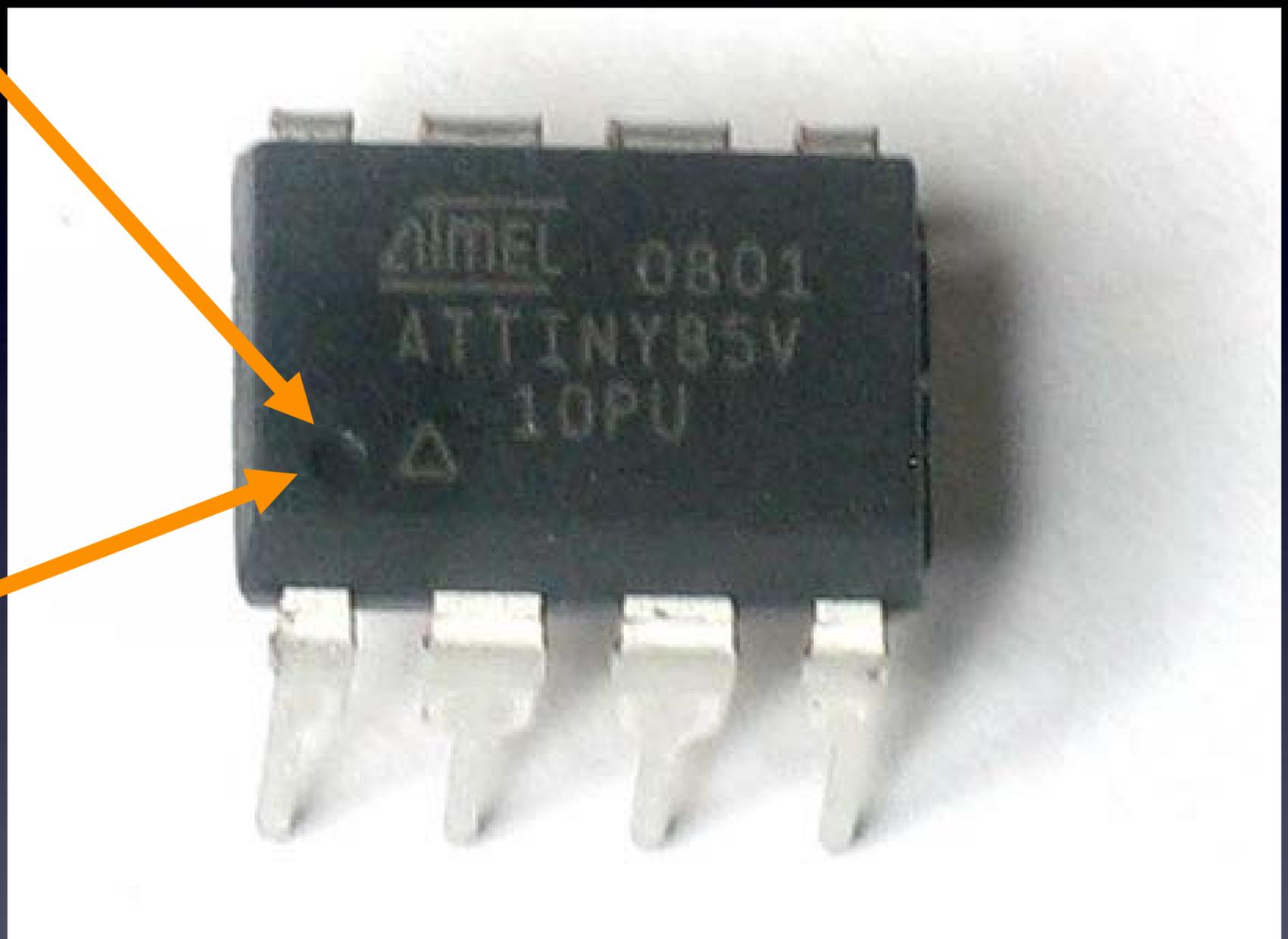


**so socket won't fall out while soldering**

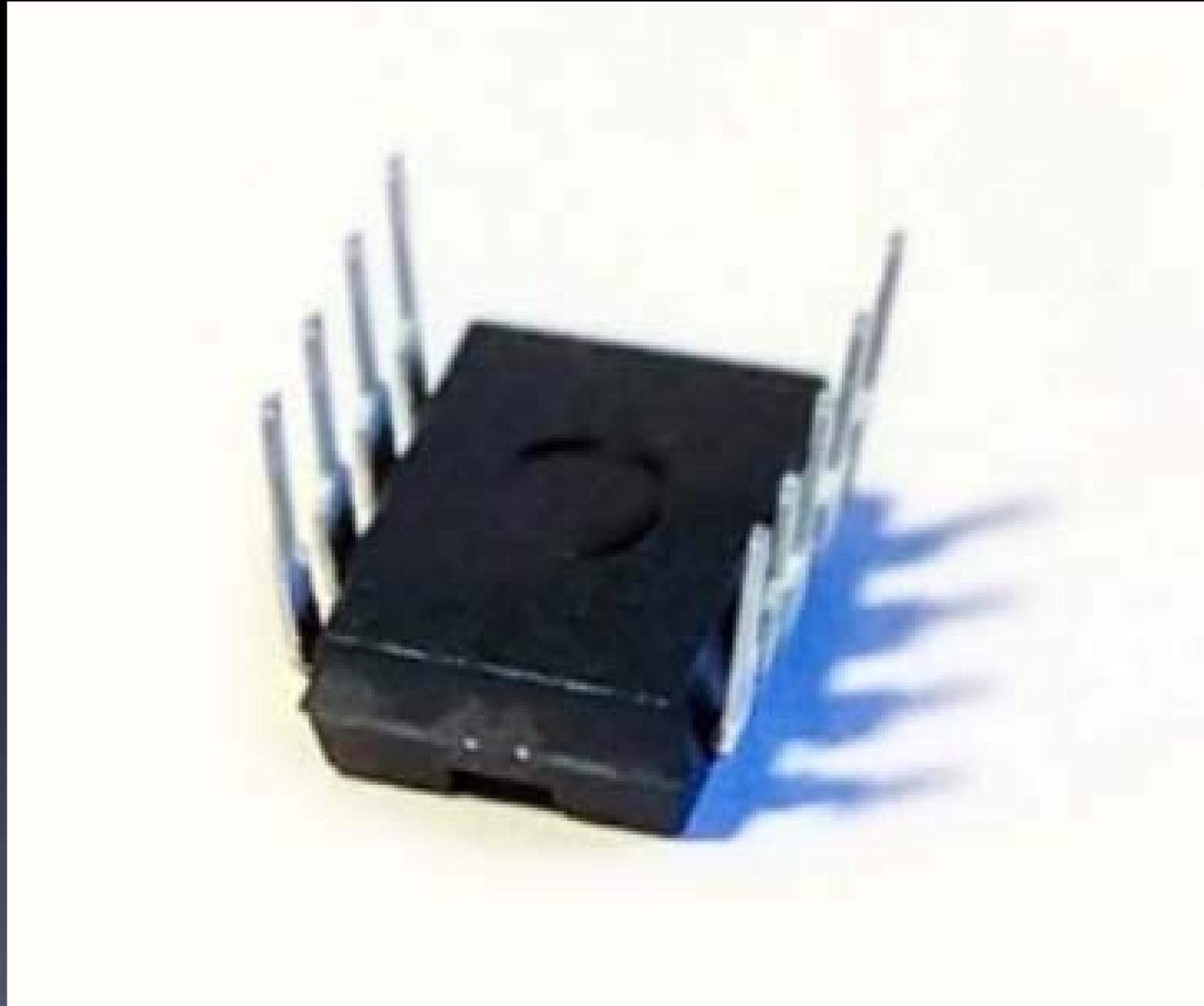
**Pin 1**

**IC1**

**Indented  
black dot**

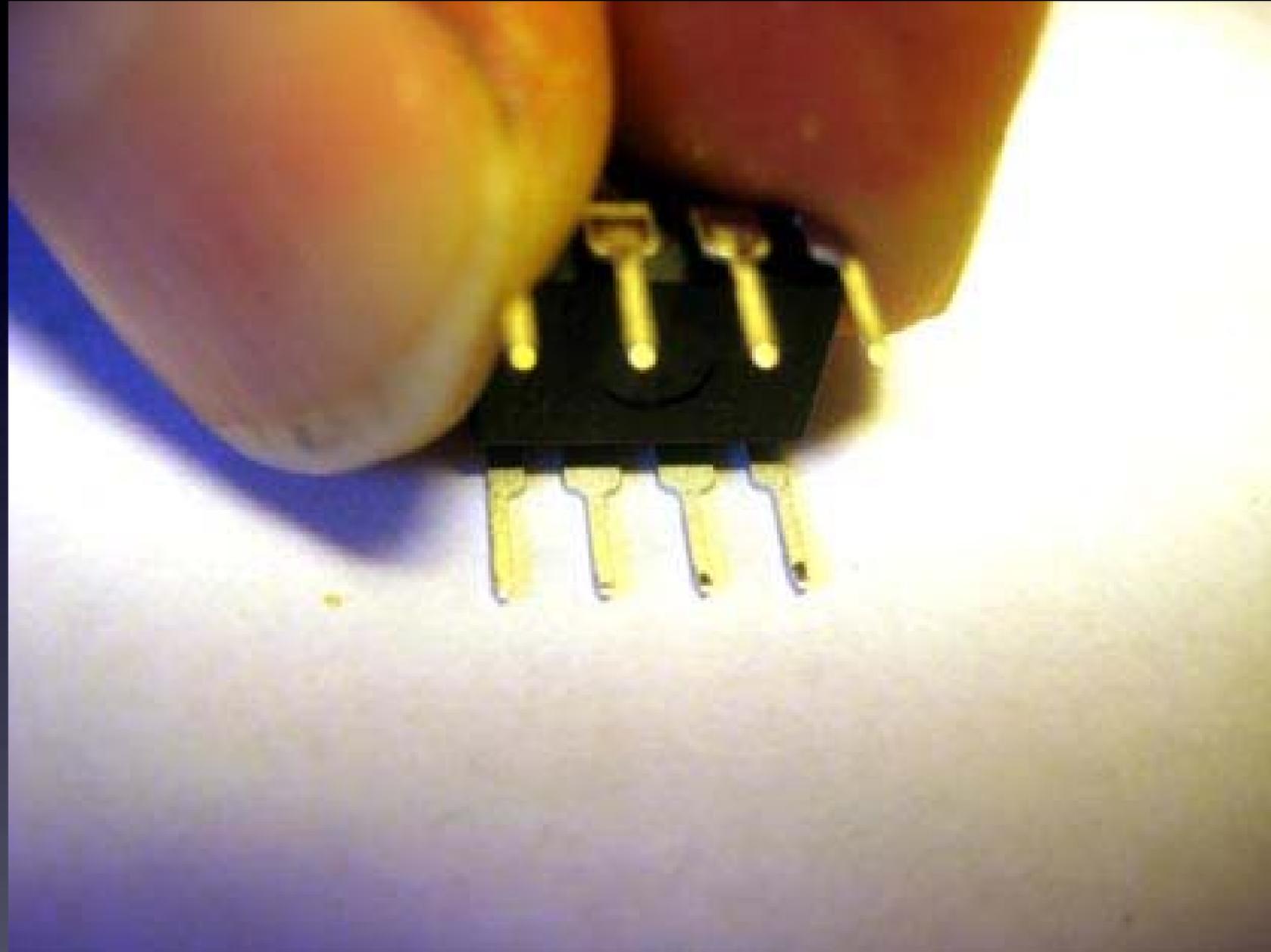


**IC1**



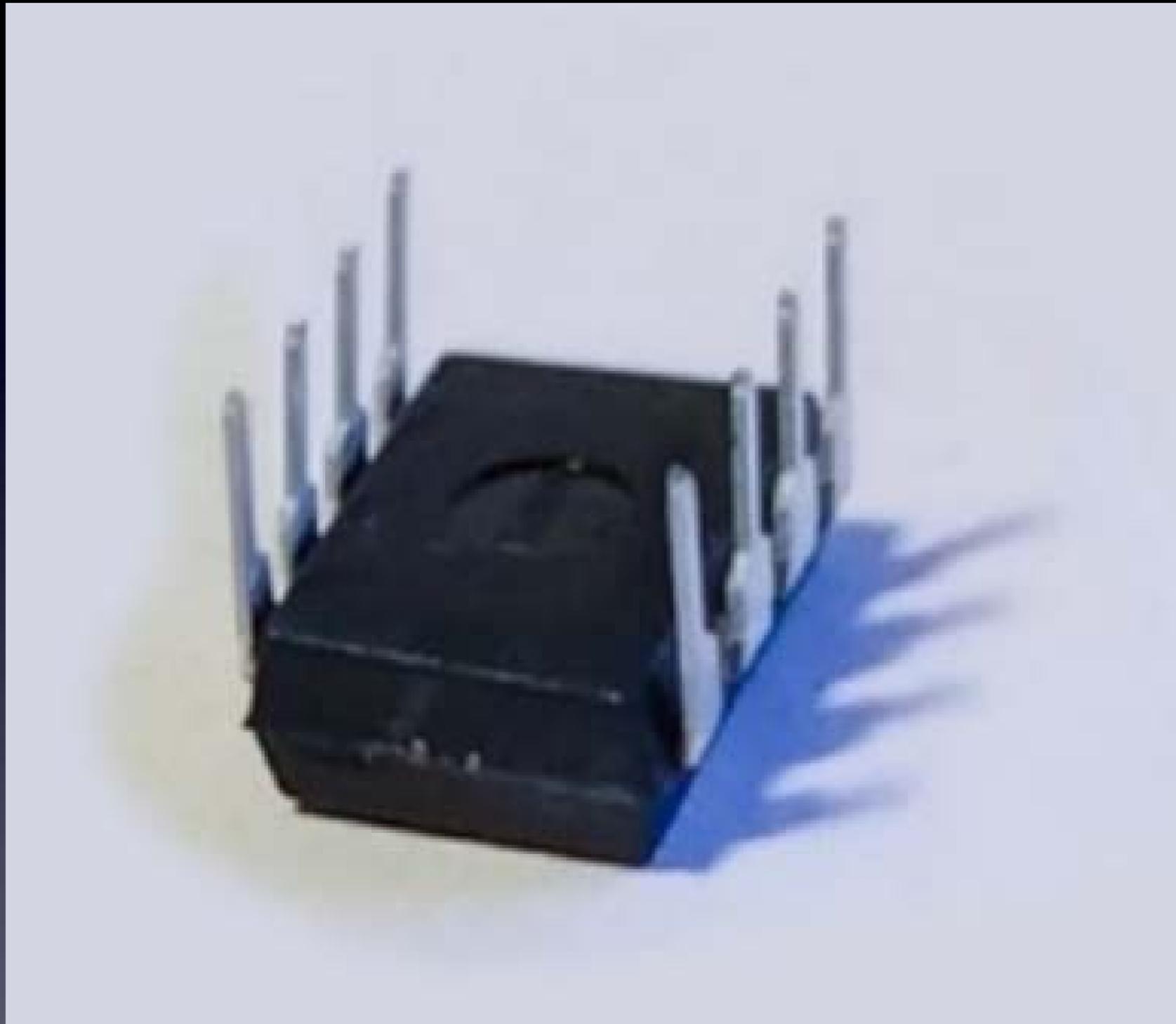
**When chips are new,  
their pins are bent out.**

**IC1**



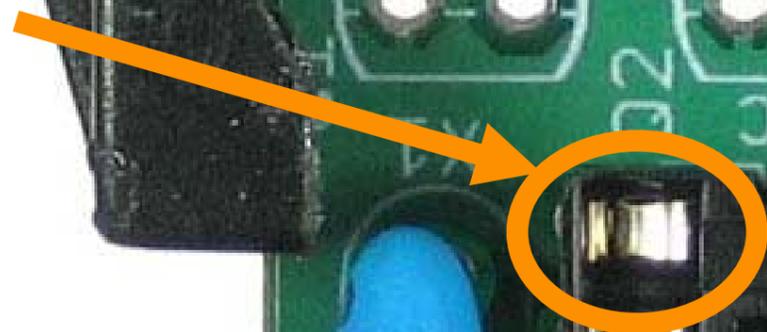
**We need the pins bent straight and parallel.  
Use your work table to (gently) bend the leads.**

**IC1**

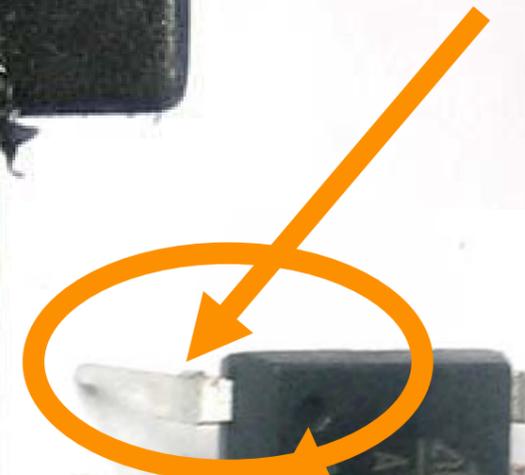


**Gently bend leads so they're straight and parallel**

**Pin 1**



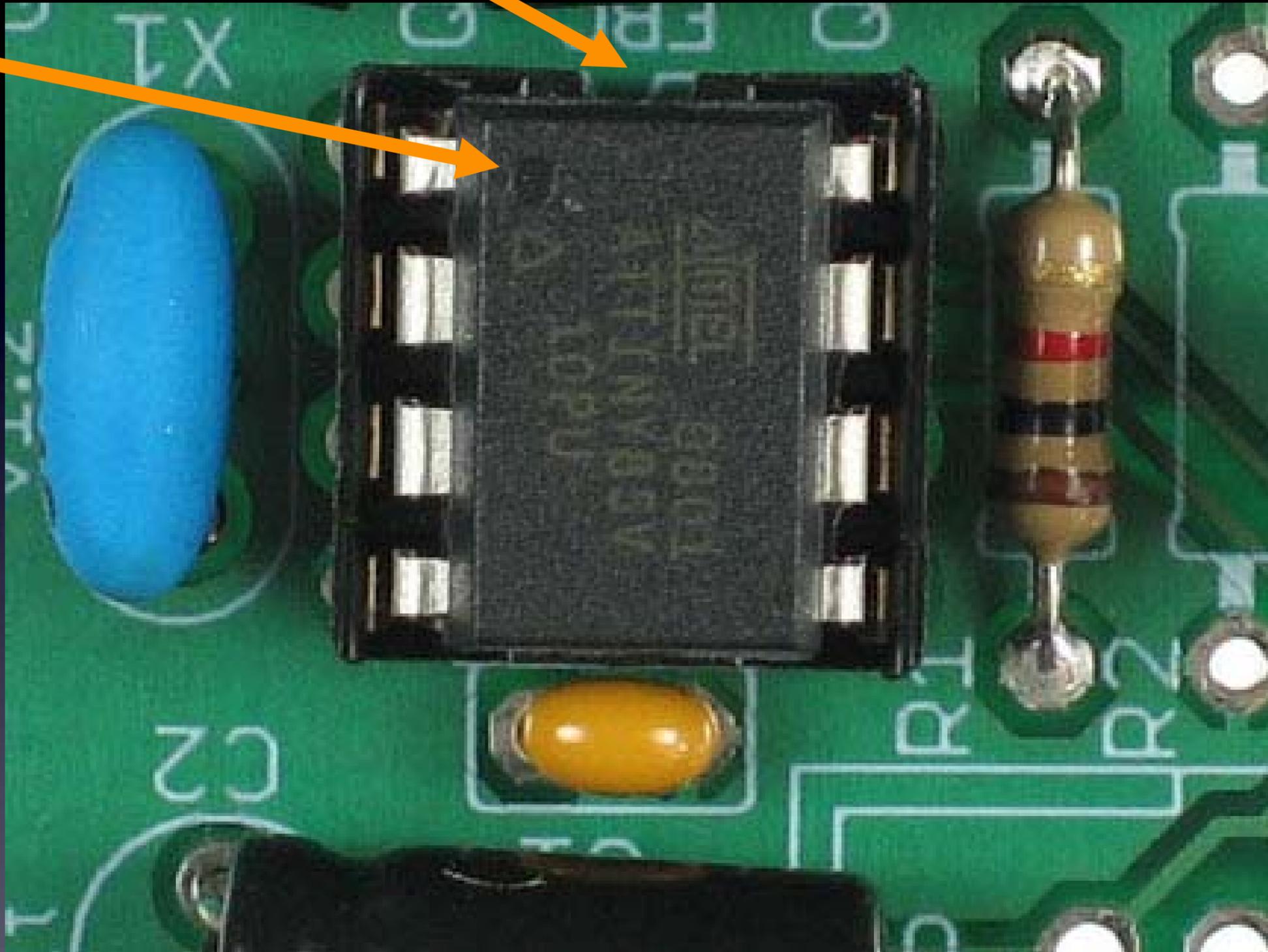
**Pin 1**



**Indented  
black dot**

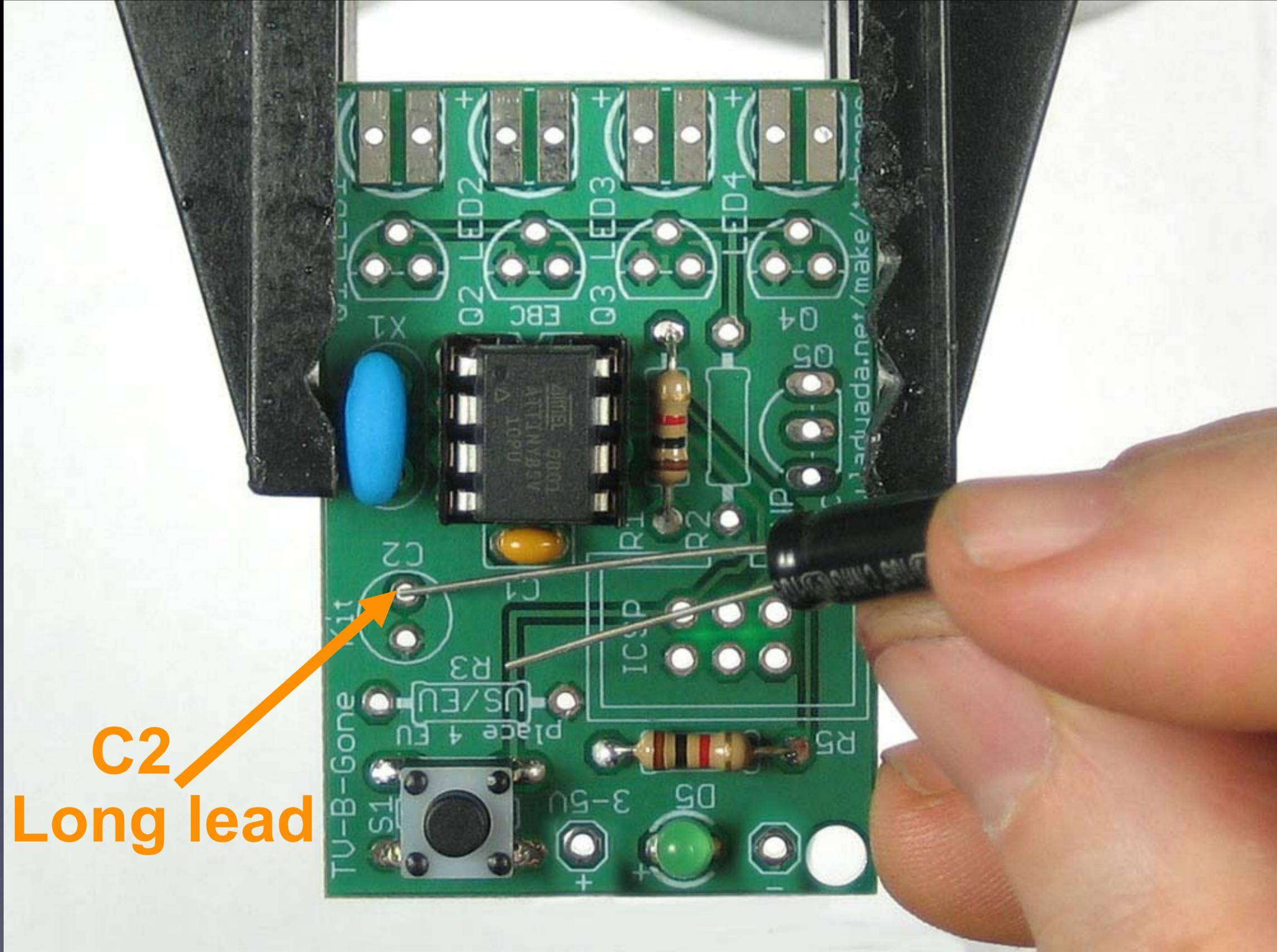


**Make sure all 8 pins  
are in place,  
and push it into its socket.**



**Proper orientation**

**C2**  
**Long lead**



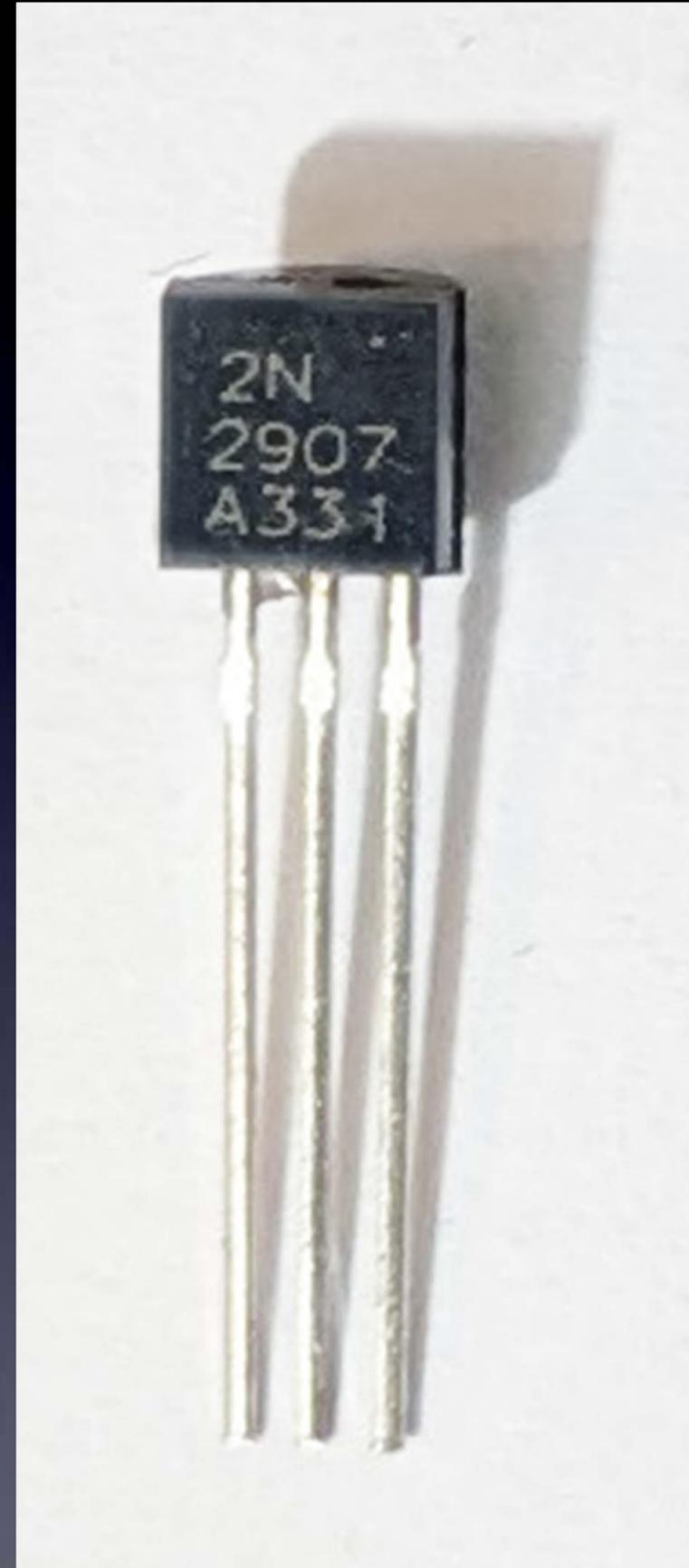
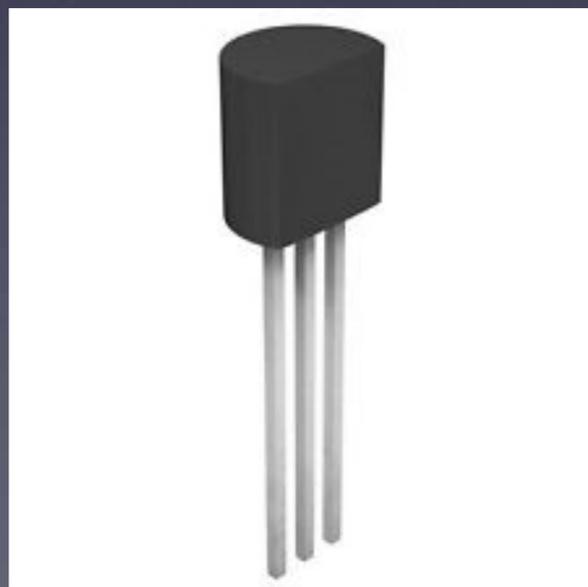


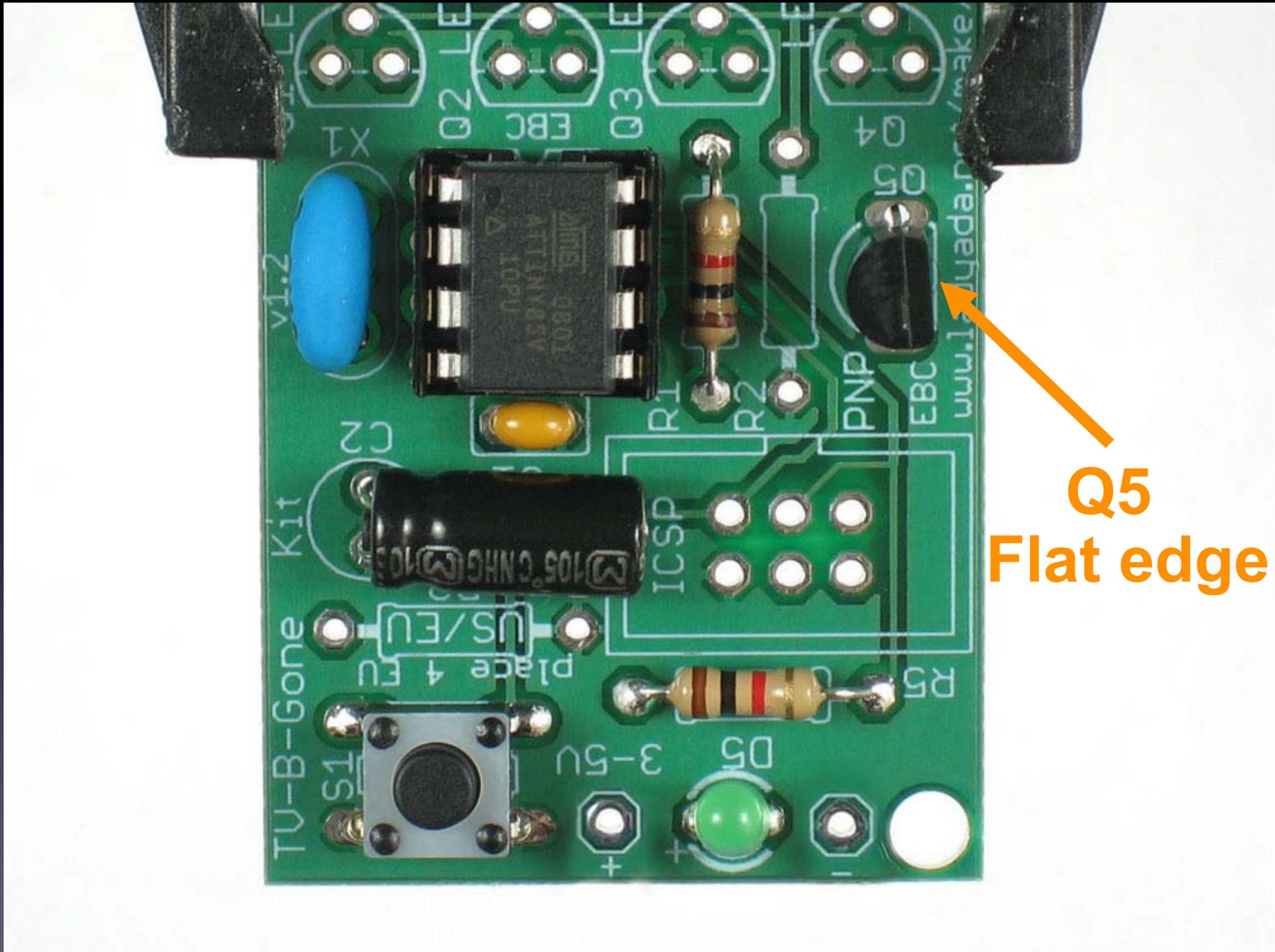
**Q5**

**2N2907**

**(the one that  
is not  
taped to others)**

Look at this shape:





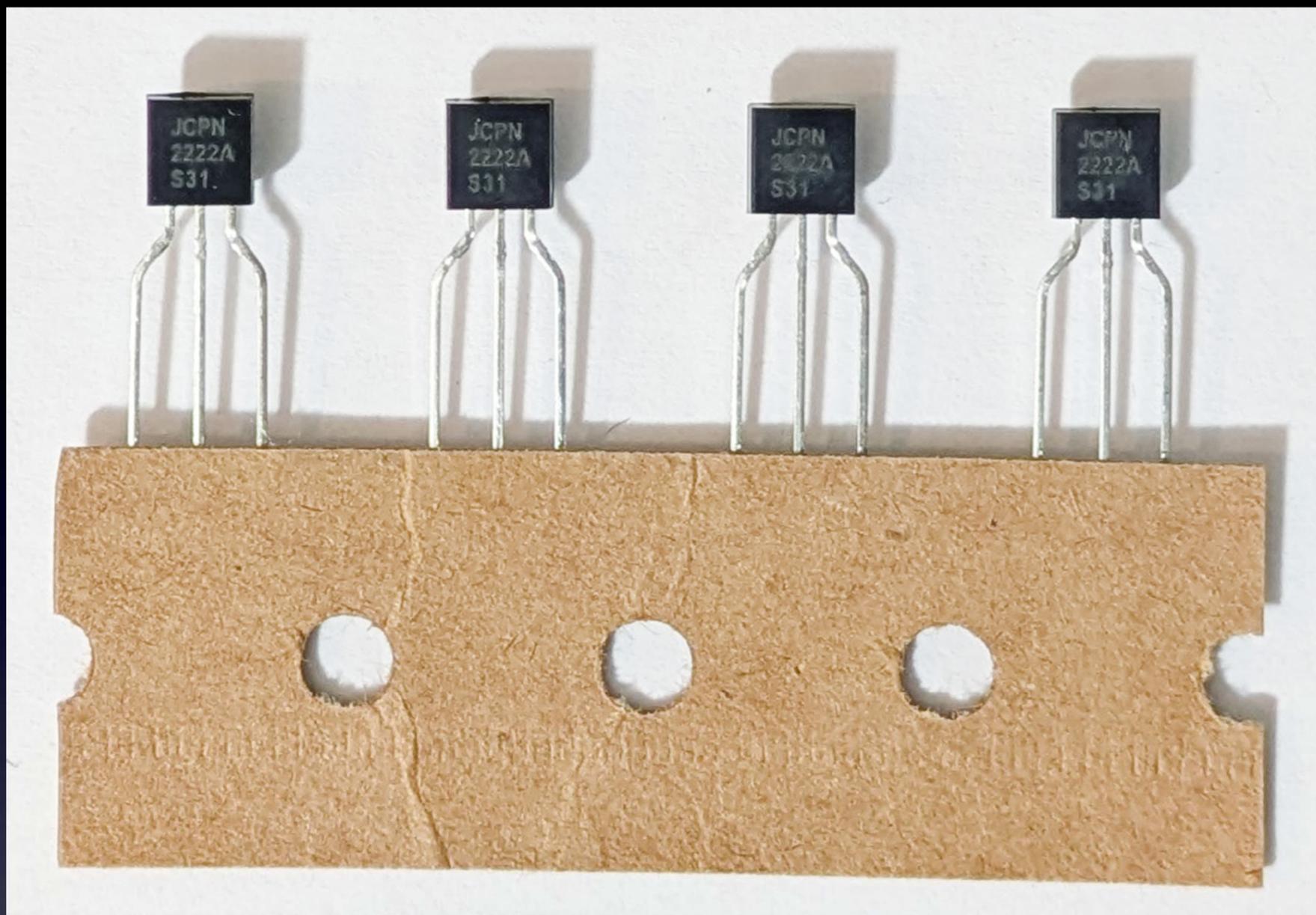
**Q5  
Flat edge**

**DO NOT push transistors all the way into the board**

**DO NOT push transistors all the way into the board**



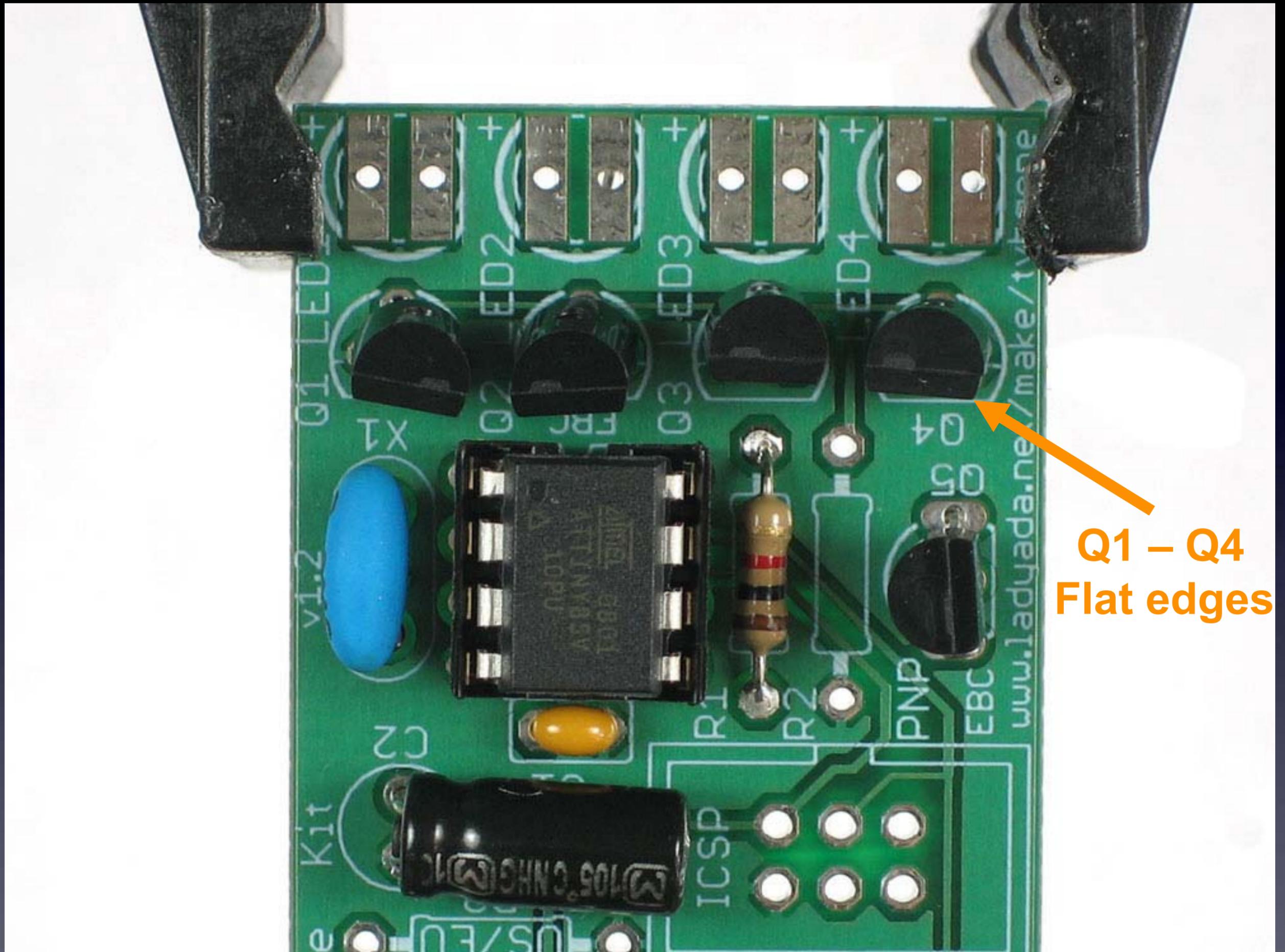
**Only push till it is a little hard to push more**



**Q1, Q2, Q3, Q4**

**2N2222**

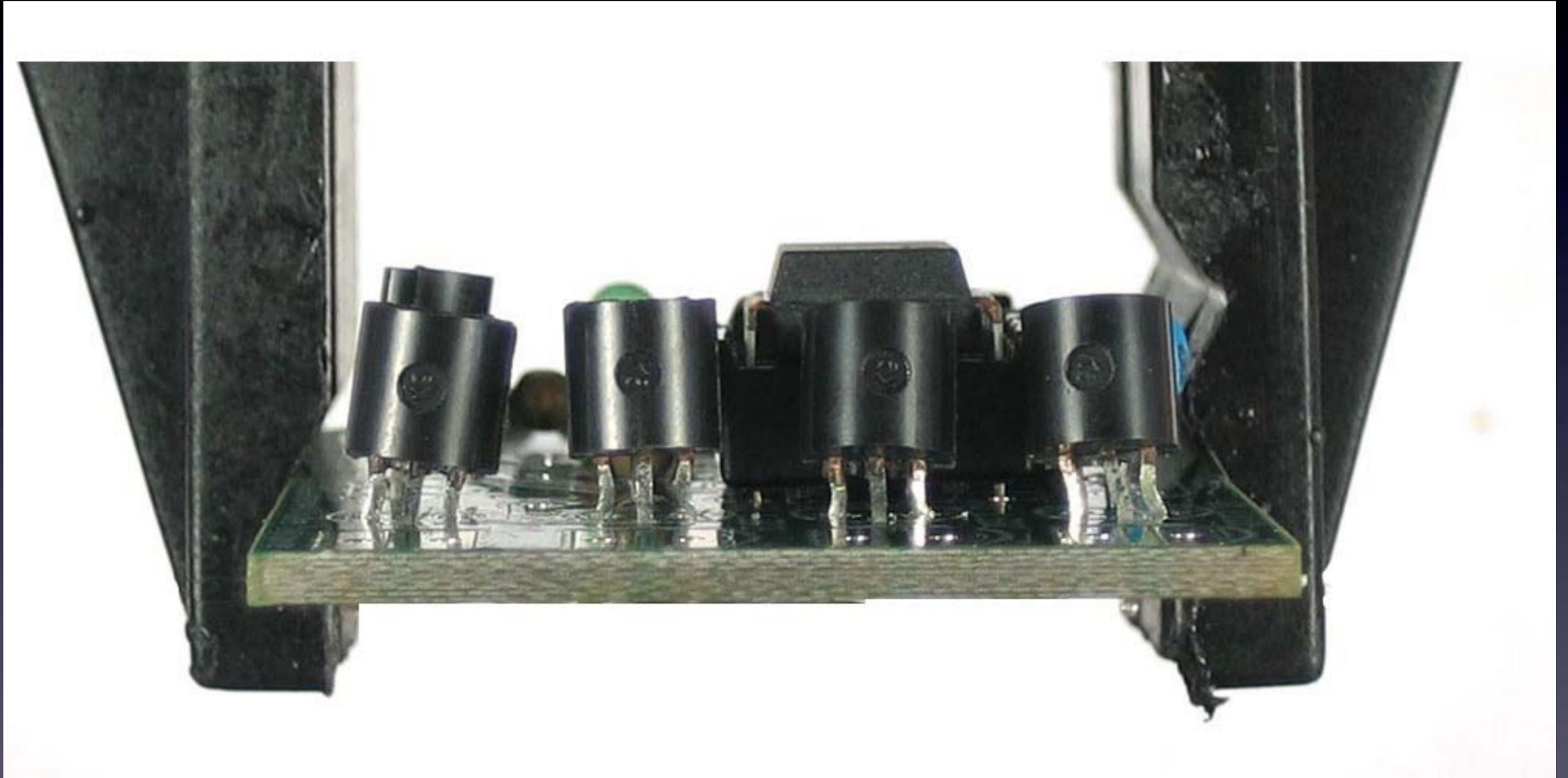
**(taped together)**



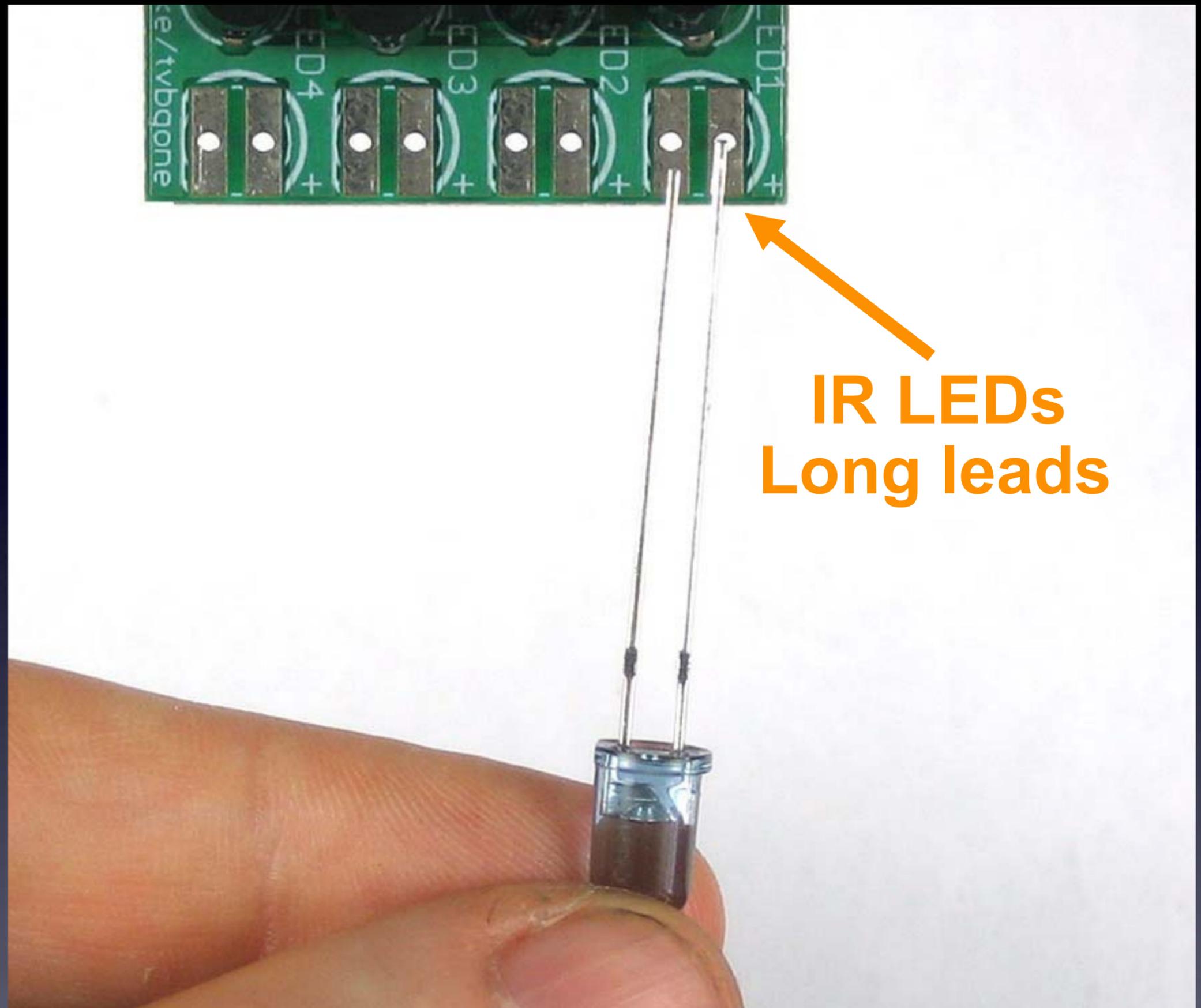
**Q1 – Q4  
Flat edges**

**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**

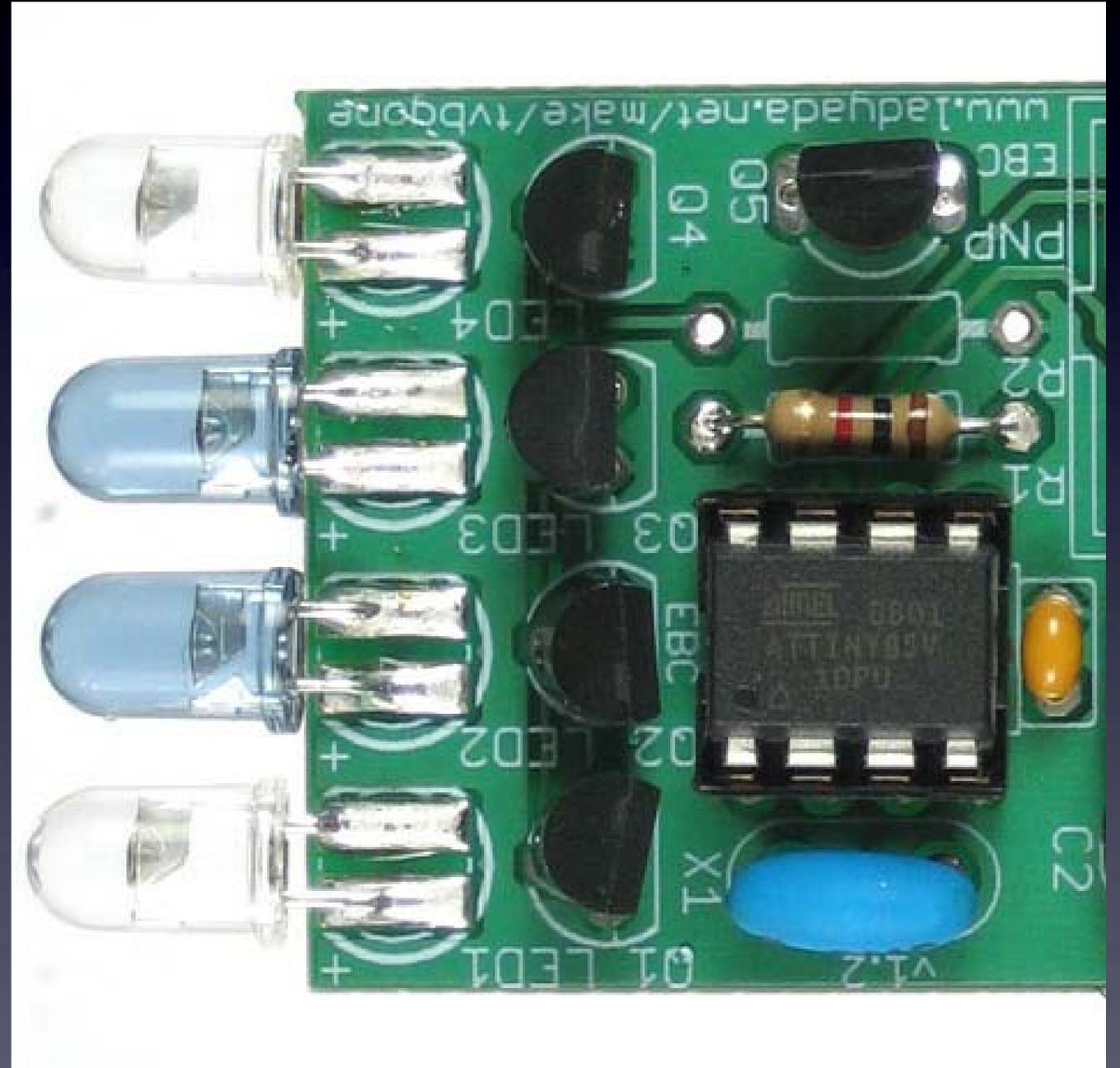


**DO NOT solder these yet!**

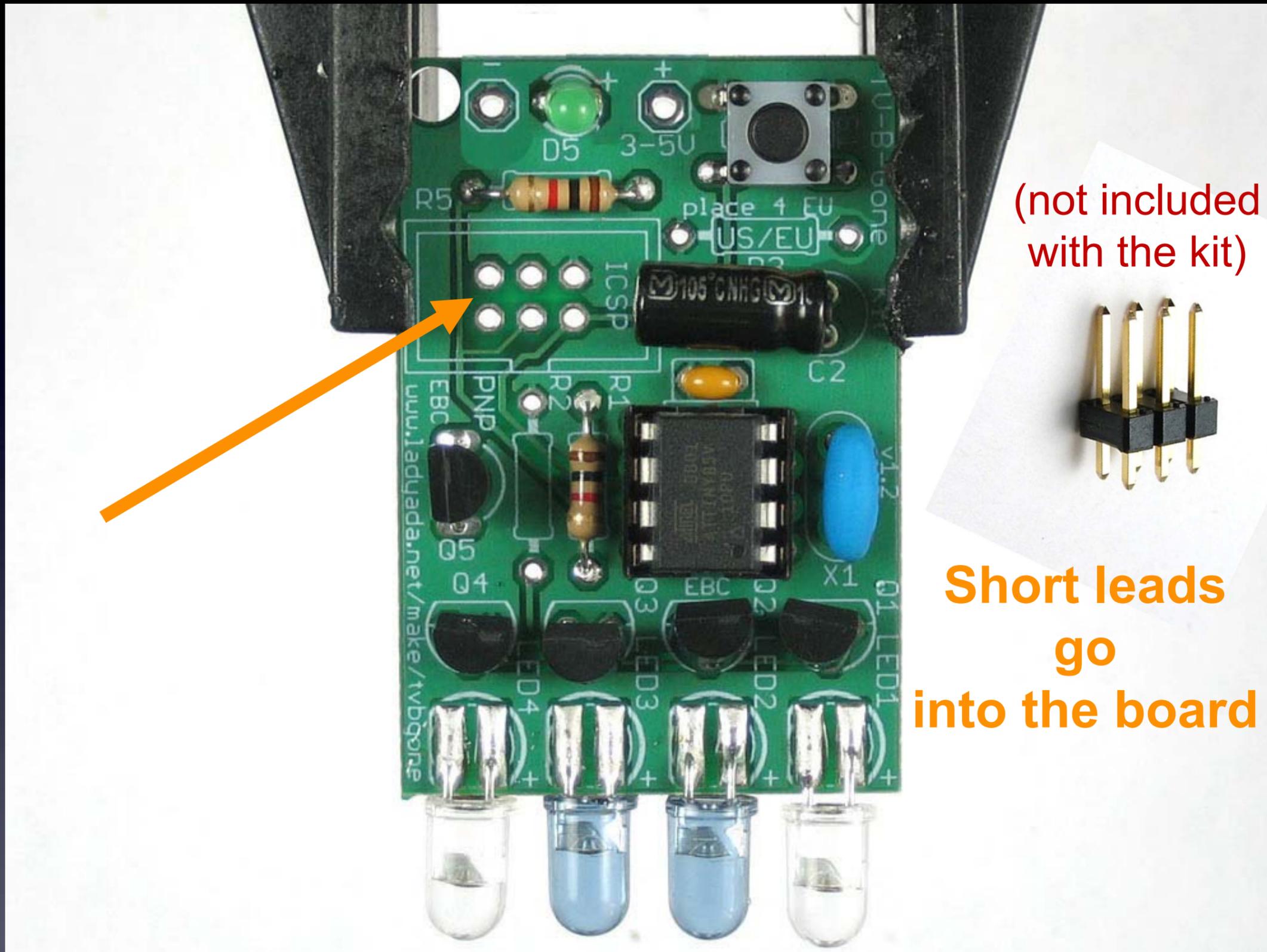
**You may want to bend the IR LEDs over, like this:**



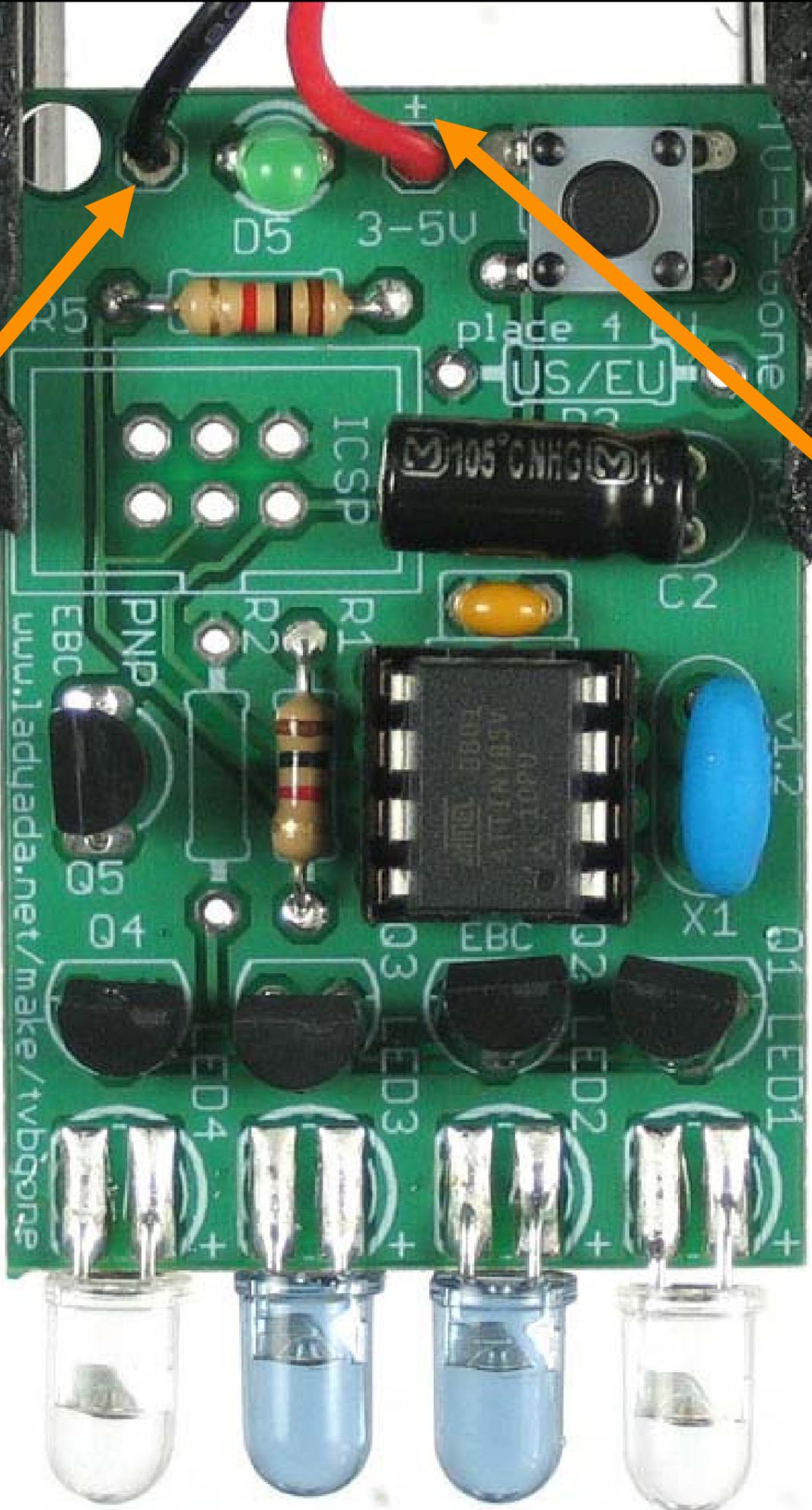
**The color of these LEDs is unimportant**



**(The ordering of these LEDs is unimportant)**



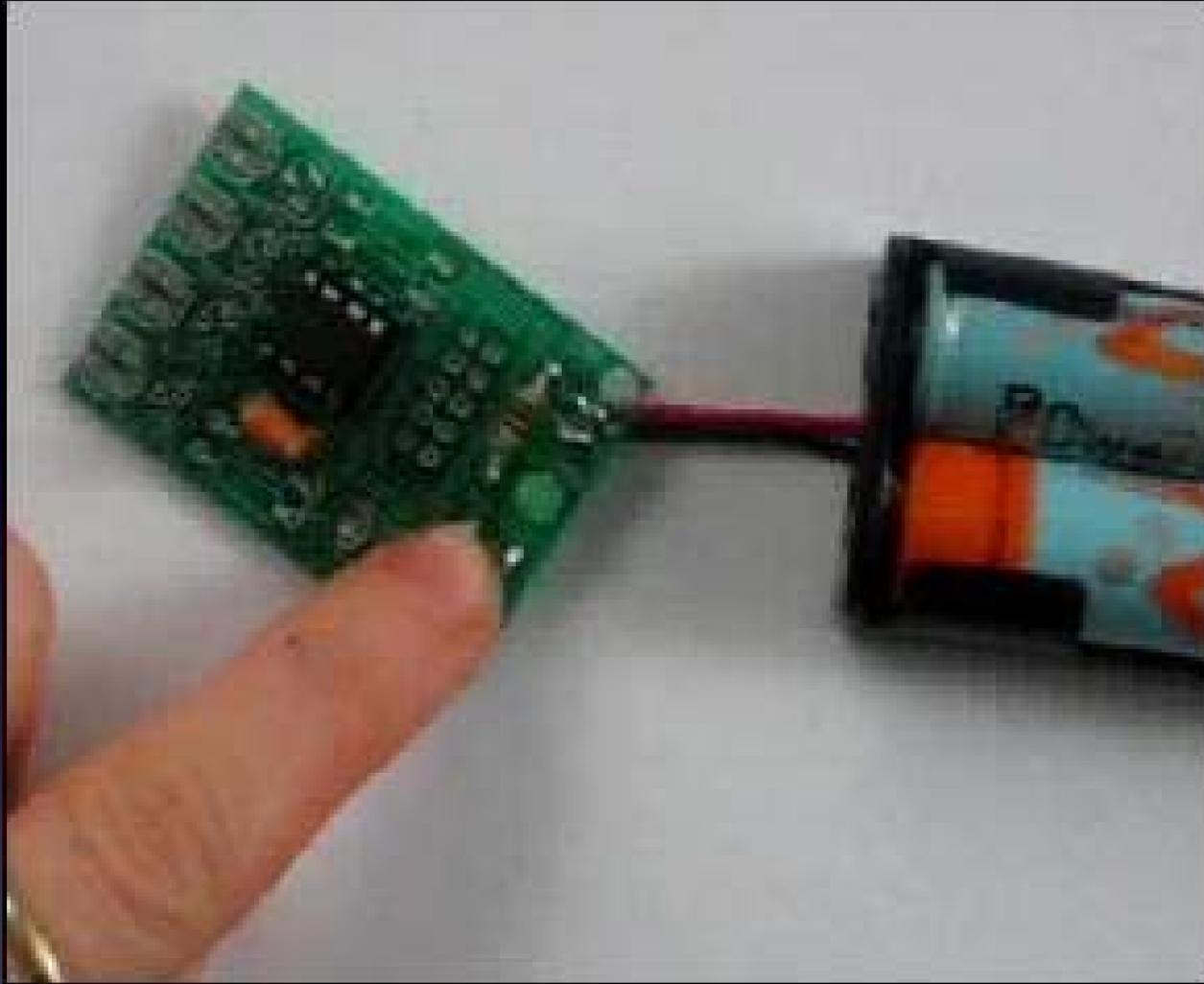
**Optional: ICSP header  
(for re-programming the microcontroller)**



**Black wire  
of battery pack  
“-”**

**Red wire  
of battery pack  
“+”**

# Test 1

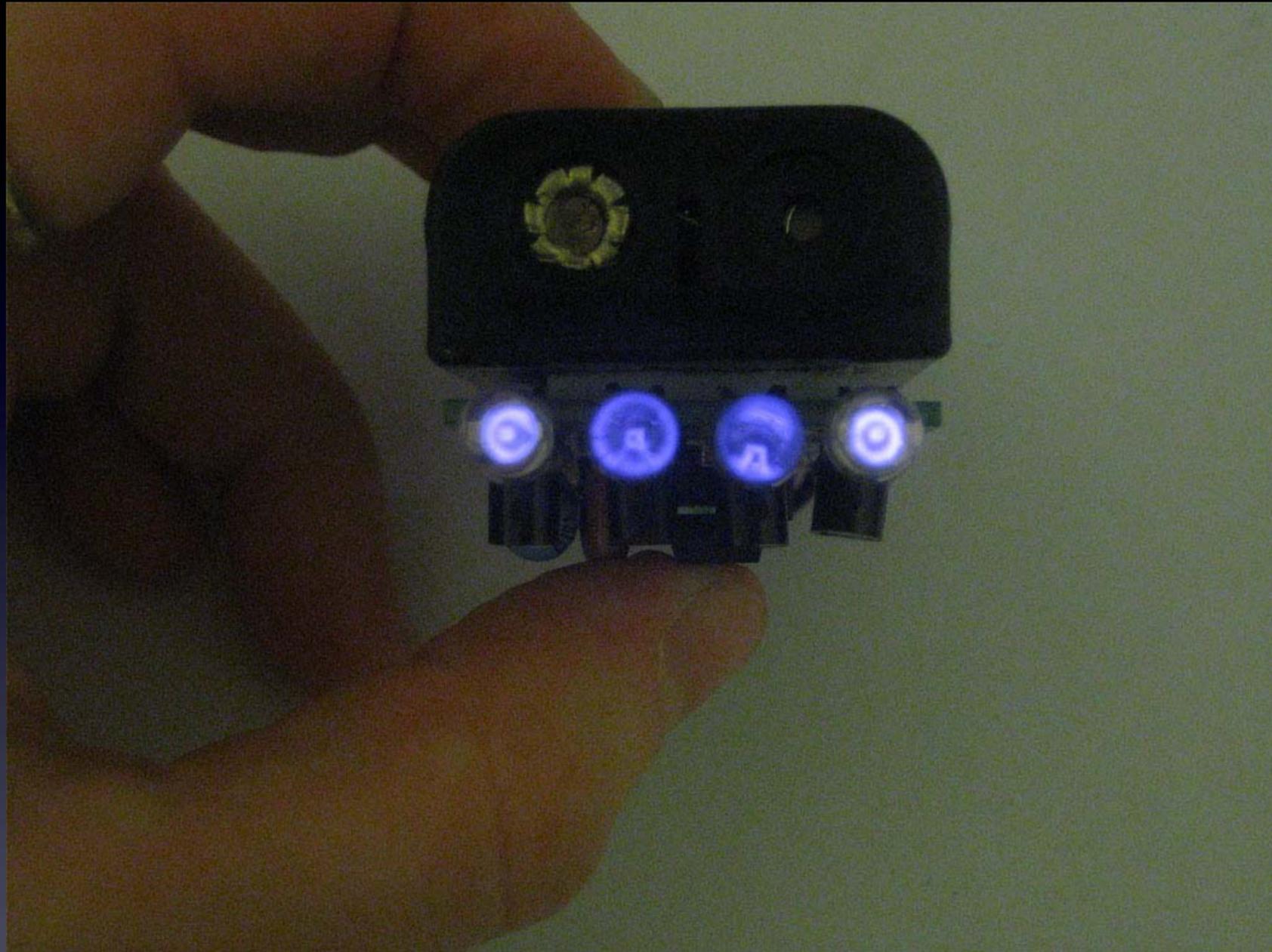


**IMPORTANT:  
Use Alkaline  
AA batteries**

other kinds of AA batteries  
will not work

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

# Test 2



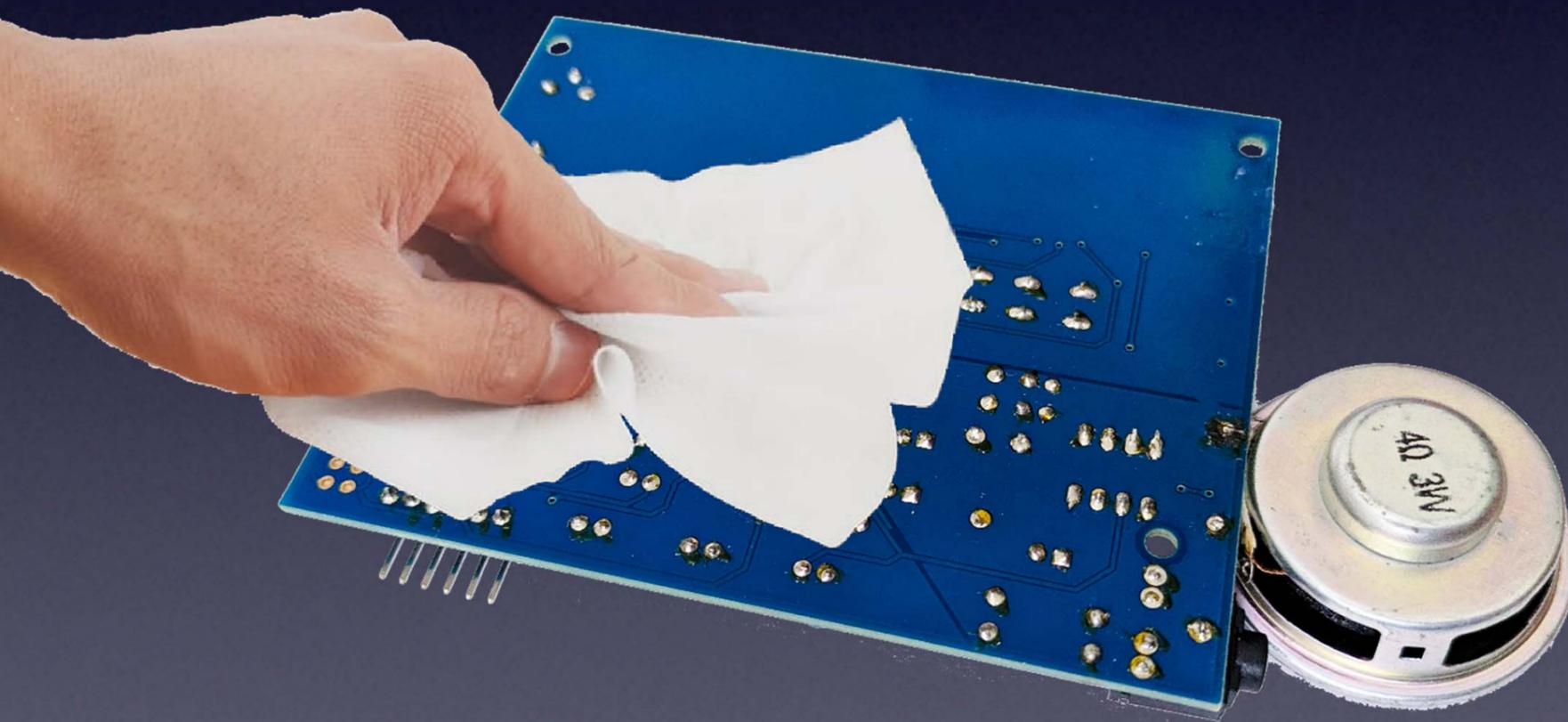
**All IR LEDs blink**

(using your phone's front-facing camera)

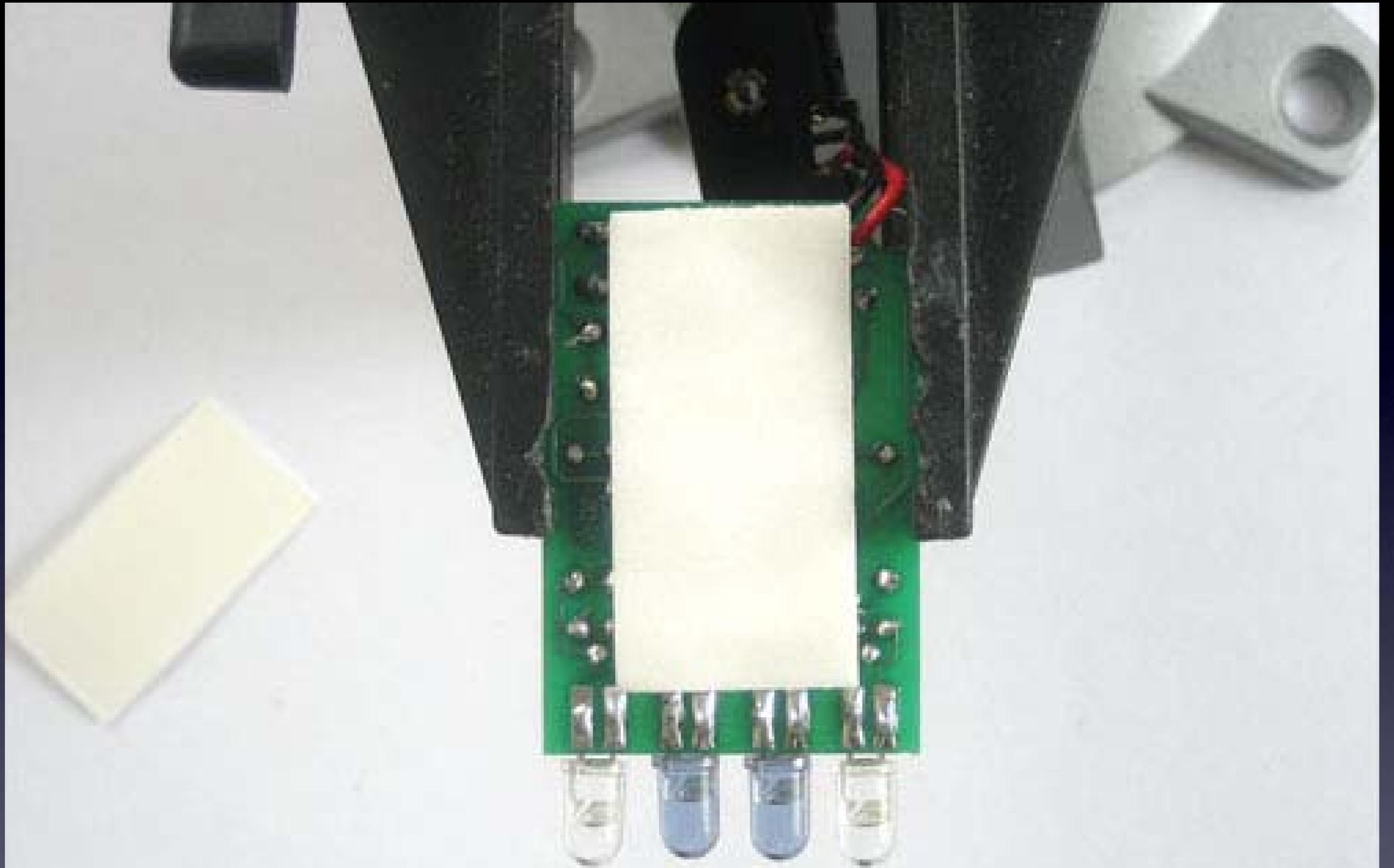
If you used any *flux paste* for *re-working problems*



The bottom of the PCB will be sticky from the flux

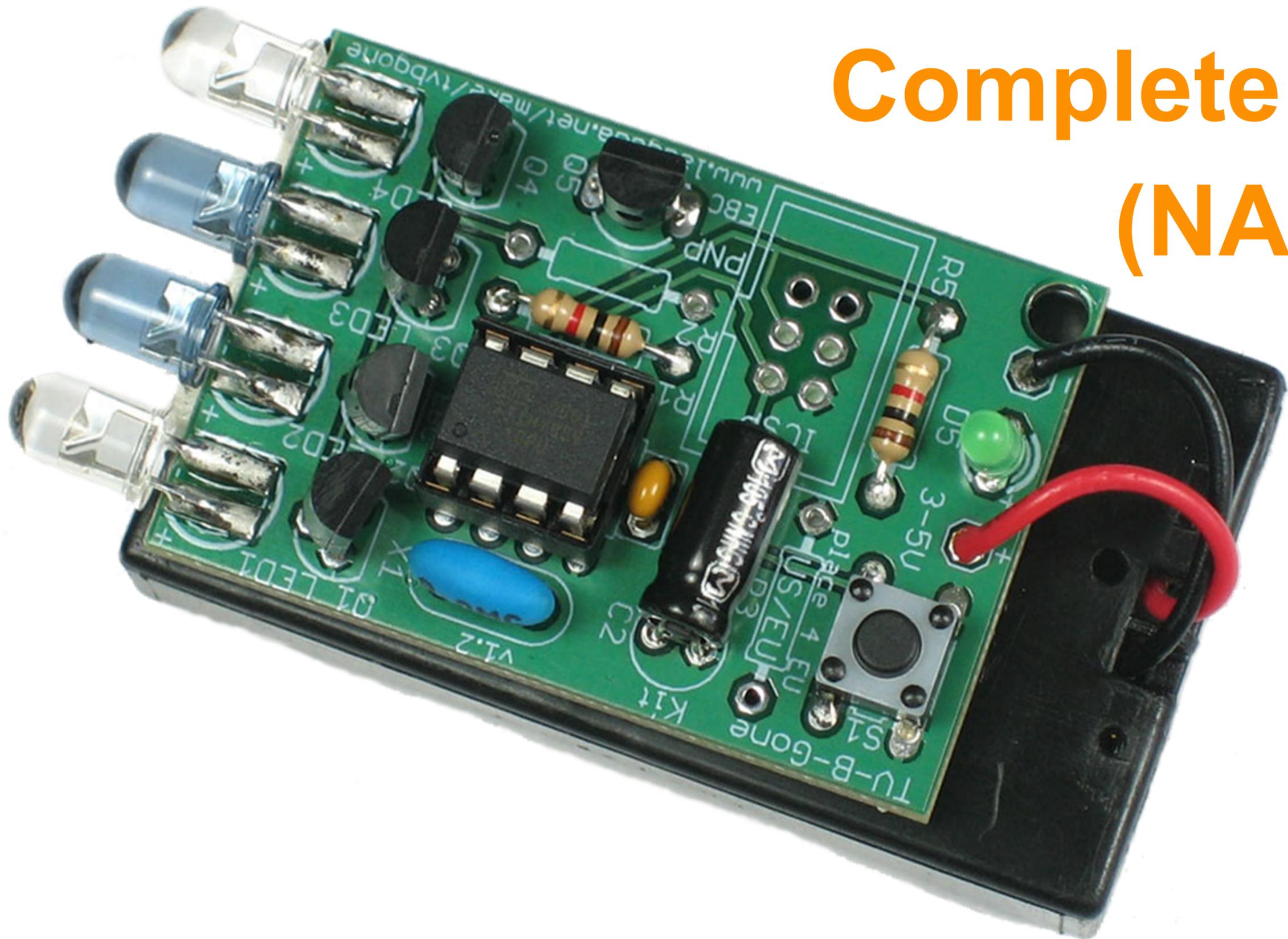


You can clean it with a cloth wet with *Isopropyl Alcohol*

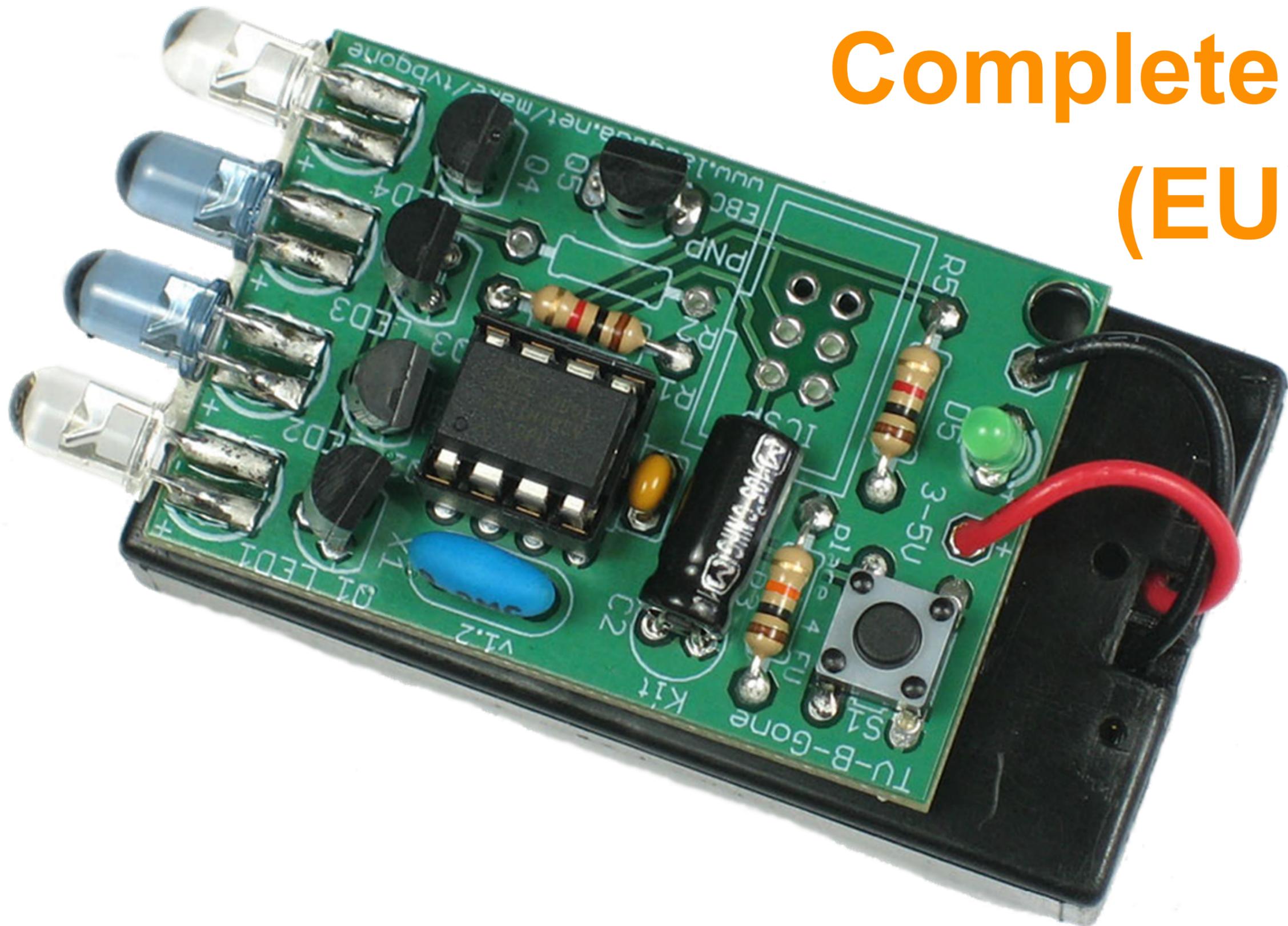


**You can use the double-sided tape to connect the PCB to the battery pack**

Complete!  
(NA)



Complete!  
(EU)



**TV B GONE®**

**Turn off TVs!!**



**Make the world a better place**

Please Remember:

to

**Wash your hands**

after soldering



# 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** (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)  
 facebook: [maltman23](https://www.facebook.com/maltman23)  
 flickr: [maltman23](https://www.flickr.com/photos/maltman23/)  
 WeChat: [mitchaltman](https://www.wechat.com/mitchaltman)  
 Fediverse: [@maltman23@mastodon.social](https://maltman23@mastodon.social)  
 Patreon: [mitchaltman](https://www.patreon.com/mitchaltman)

