

SynShop Prototyping

Presented by Charley Jones, PMP aka Dataman





SynShop Prototyping

Charley Jones, PMP Dataman



Database Admin for Clark County
I develop apps that store and retrieve
data like time sheets, customer
statements, and training requests.
Because once its in a database, it's
easier to track.



SynShop
Prototyping

Charley Jones, PMP



Graduate New England Institute of
Technology, Electronics Engineering.
Over 15 projects published in the
public domain.



SynShop
Prototyping

Pololu Robotics
An amazing local resource

**Word class robotics and component
supply right here in Las Vegas.**

Ryan?



SynShop
Prototyping

Tonight

Prototyping

Rapidly taking an idea from thought to proof of concept.



SynShop
Prototyping

SynShop The Las Vegas Hacker Space

We are like minded individuals that
freely share our knowledge and
experience.



SynShop

Prototyping

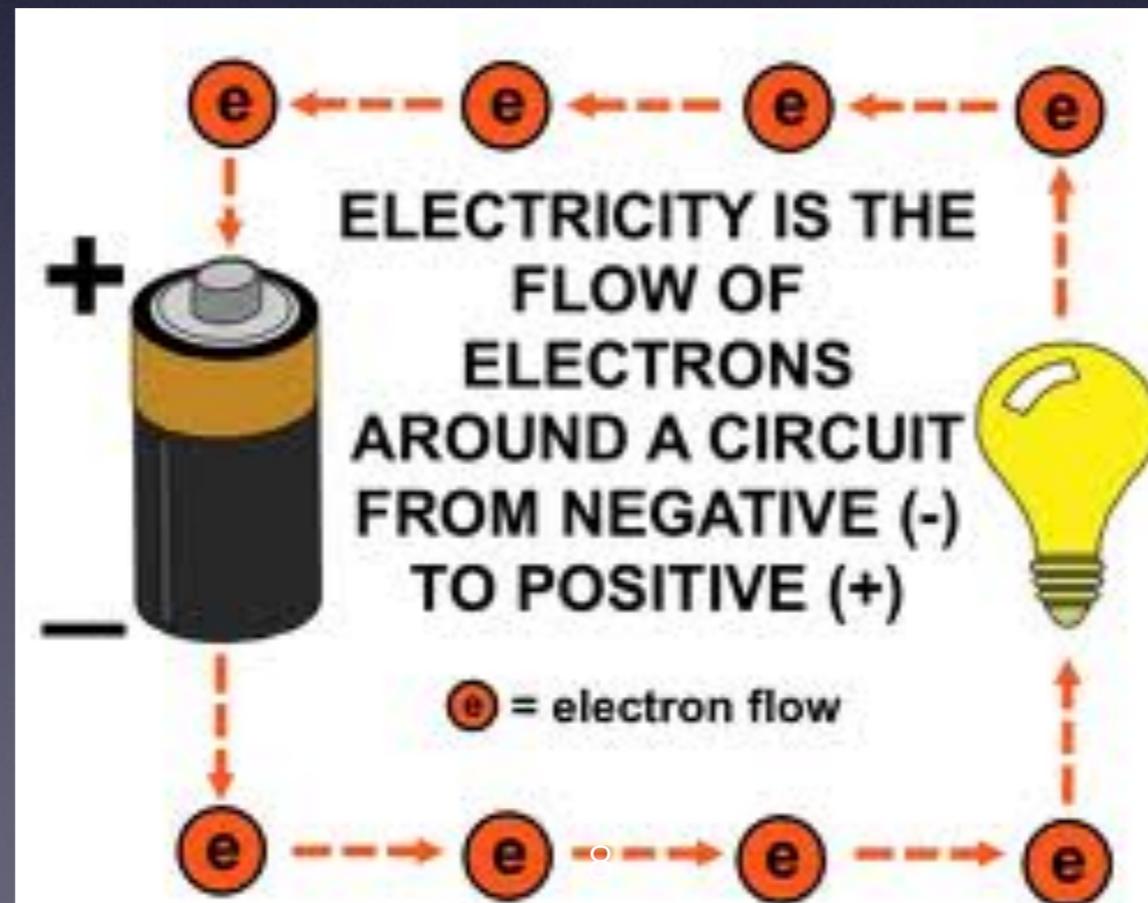
Let's start with the basics

Basic Electronics



SynShop Prototyping

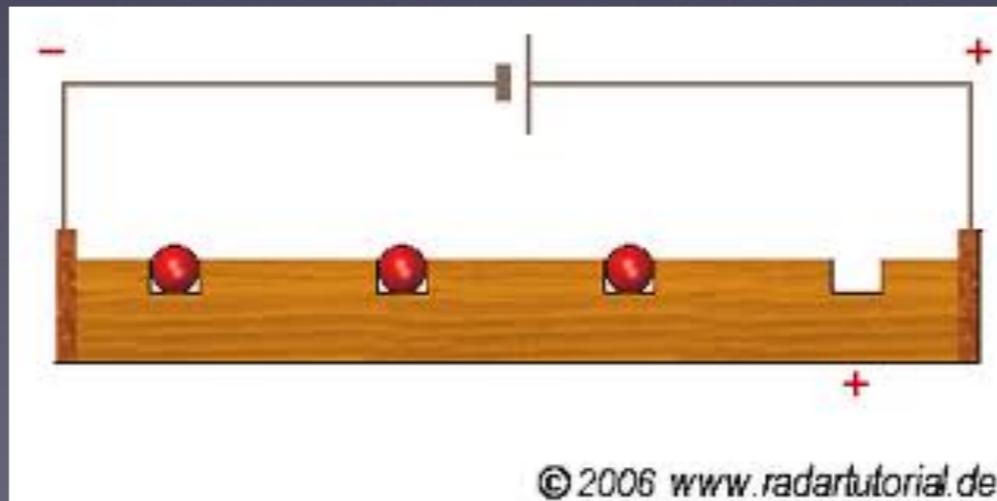
It is widely held that Electrons flow from negative to positive





SynShop
Prototyping

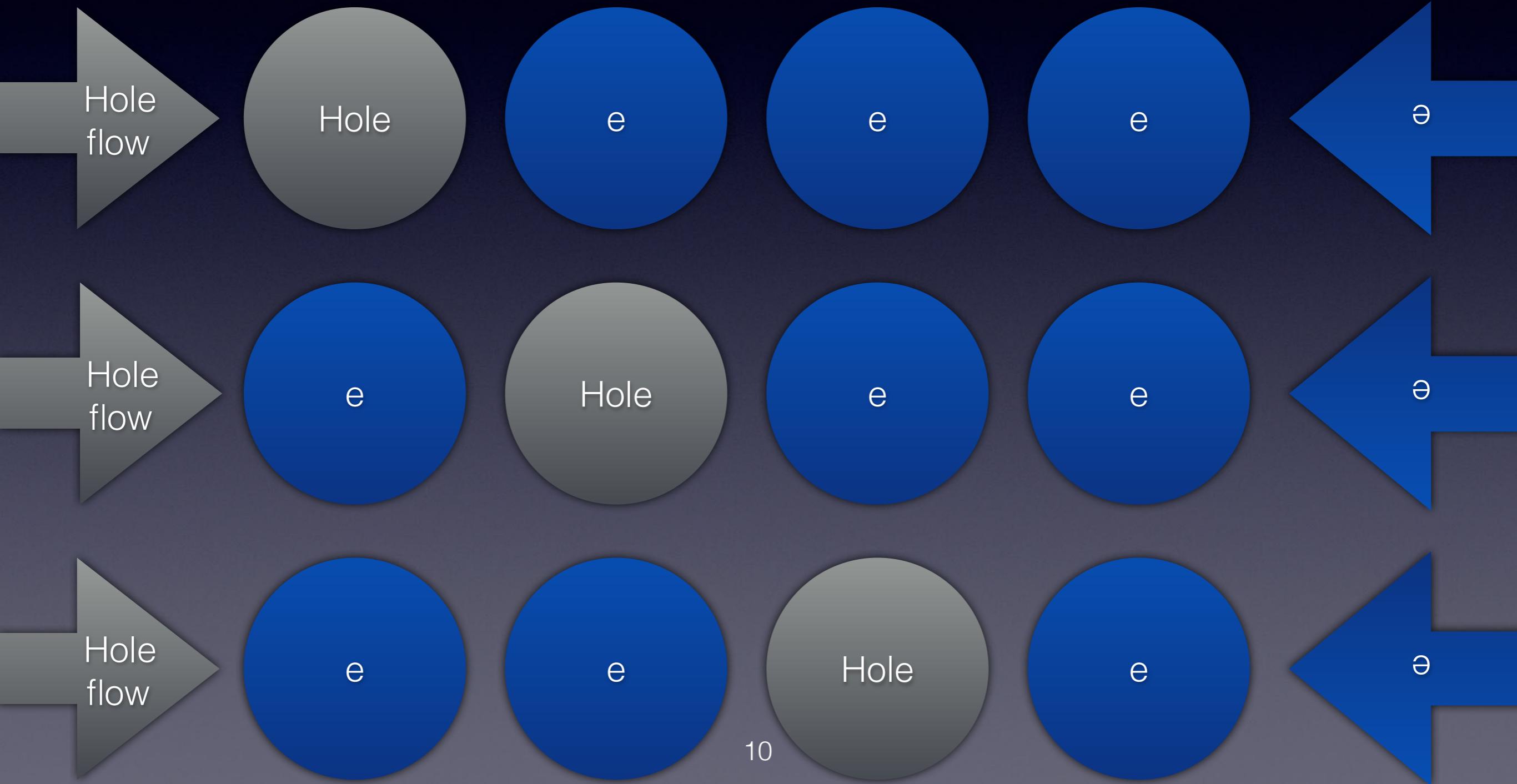
**Physicists and engineers study hole flow, that is, the space vacated by an electron as it moves through a circuit.
Positive to Negative.**





SynShop Prototyping

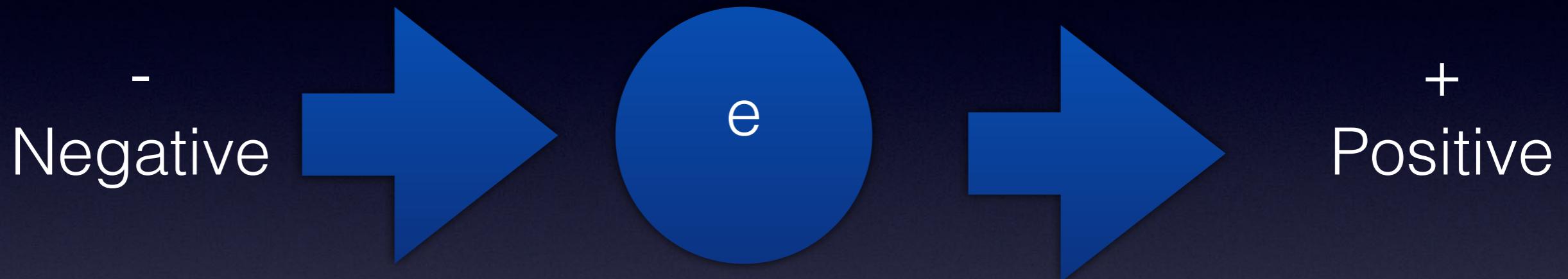
Hole flow



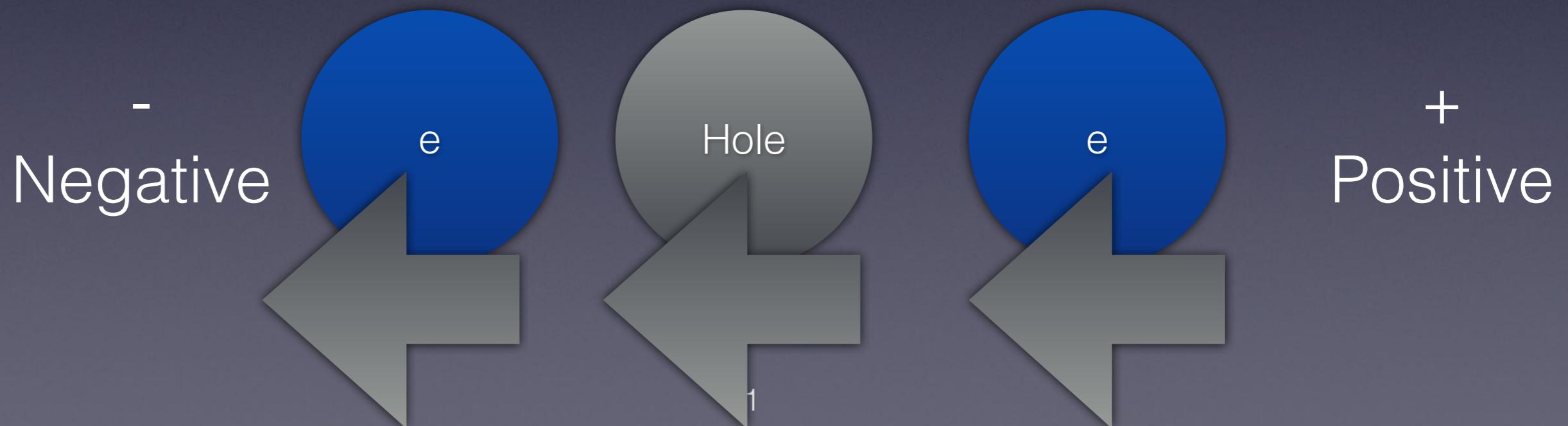


SynShop
Prototyping

Electron flow, negative to positive



Hole flow, positive to negative





SynShop
Prototyping

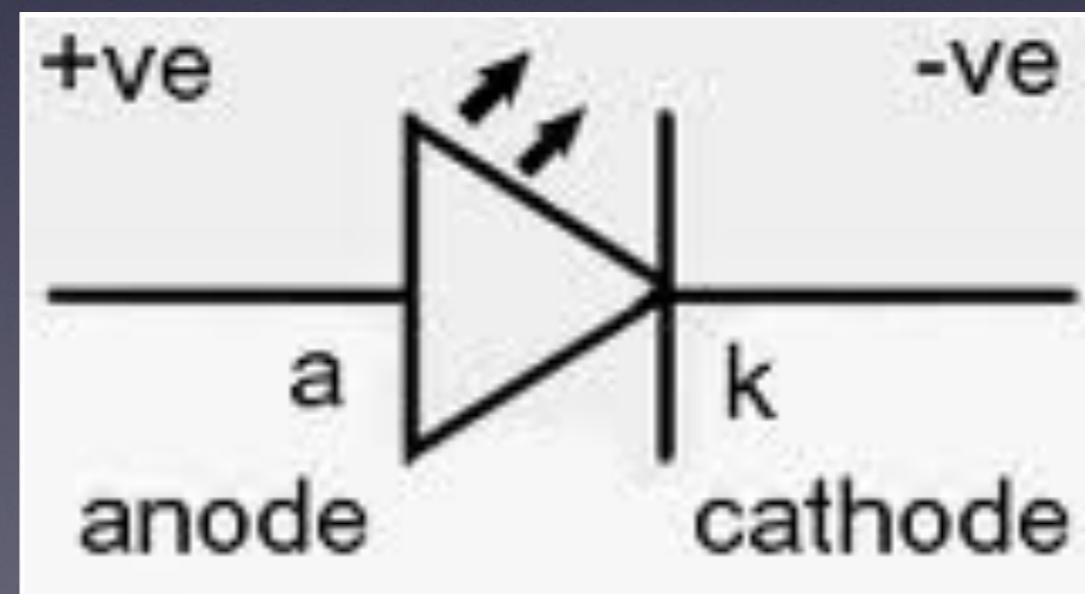
**Positive to Negative
Negative to Positive
Who cares?**



SynShop Prototyping

**Engineers got to design the symbols that we use. So, arrows typically point to negative.
(hole flow)**

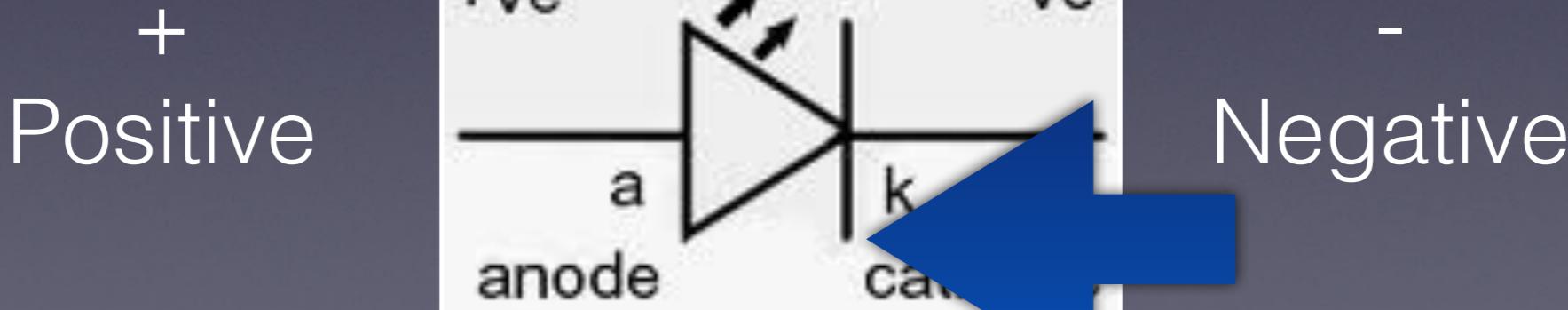
+
Positive





SynShop Prototyping

So just remember
You're a salmon
Swimming up river...





SynShop
Prototyping

Voltage

How badly electrons want to move.

1,000v is stronger than 10v.

A fire hydrant has a potential to move water.





SynShop Prototyping

Current

How quickly electrons are moving.
Amps... Like mph...
Water moving through a firehose.

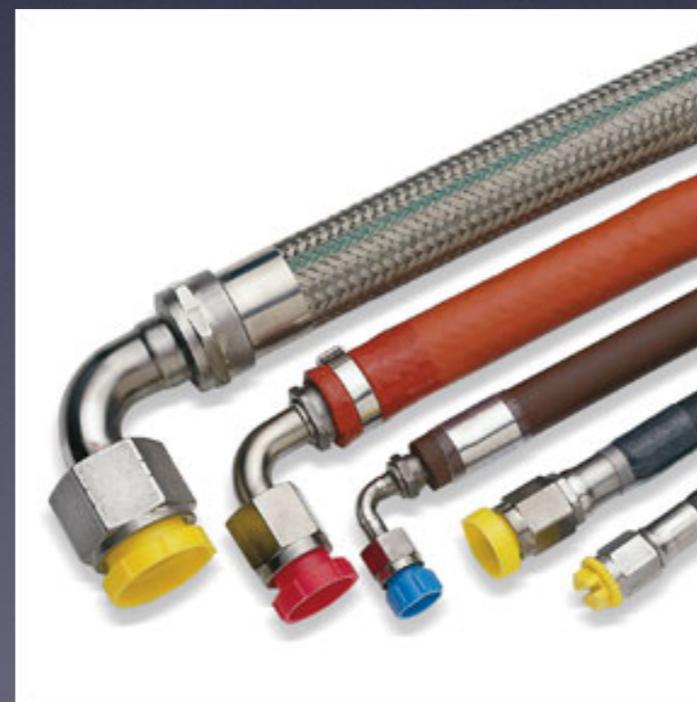




SynShop
Prototyping

Resistance

How much current is allowed to flow. Ohms. A bigger hose allows more water. A smaller hose is more resistive to flow.





SynShop Prototyping

**There is a direct correlation
between voltage, current, and resistance.
It's predictable.
Ohms law.**

$$V=IR$$

$$R=V/I$$

$$I=V/R$$

**So in a 6v circuit with 1k resistance
 $I = 6v / 1000 \text{ ohms}$
There must be 0.167 amps
167 millamps**



SynShop
Prototyping

Mega x 1 Million
Kilo x 1 Thousand
Milli / Thousand
Micro / Million
Nano / Billion

1k ohm = 1,000 ohms

1milli volt = 0.001 volts



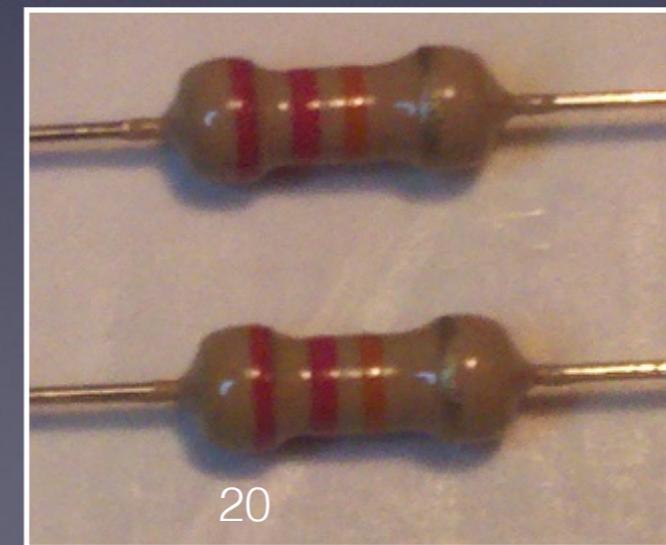
SynShop
Prototyping

Resistor

Most common electrical part.

Resists current.

**The higher the value,
the higher the resistance**

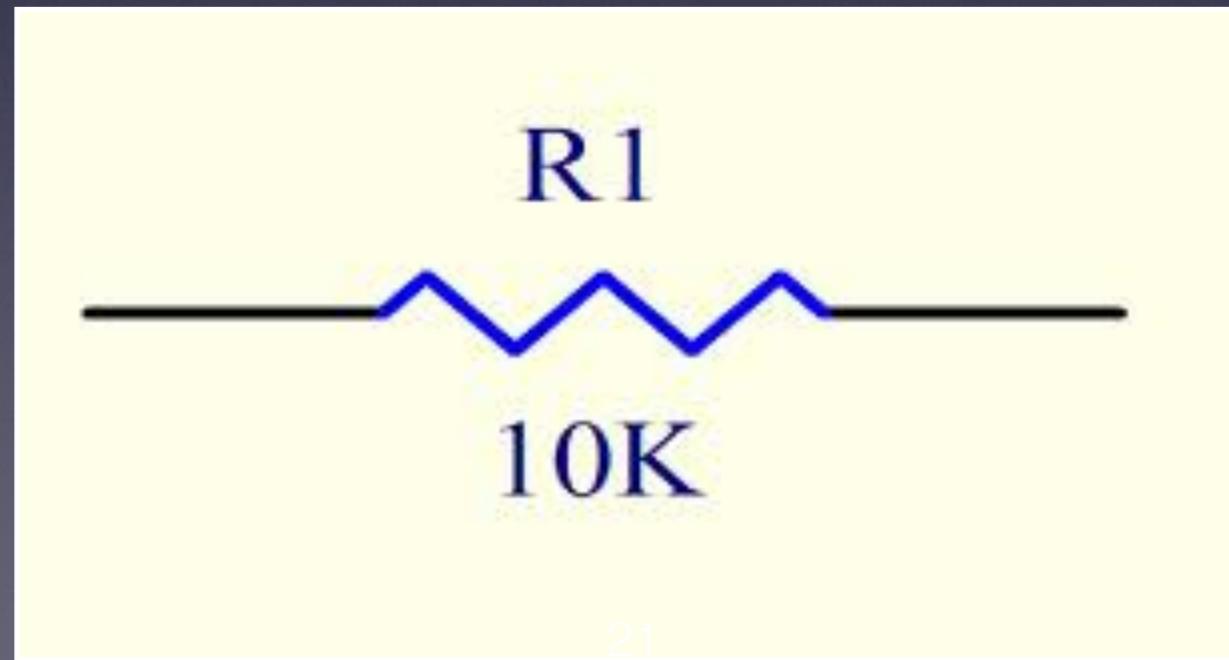




SynShop
Prototyping

Resistor

On a schematic they look like this





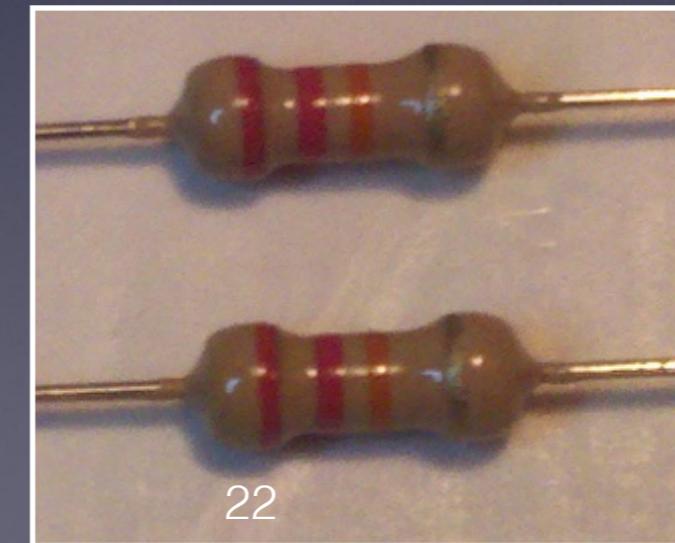
SynShop
Prototyping

Resistor
Measured in ohms. Ω
Color determines value.

100 Ω



22k Ω



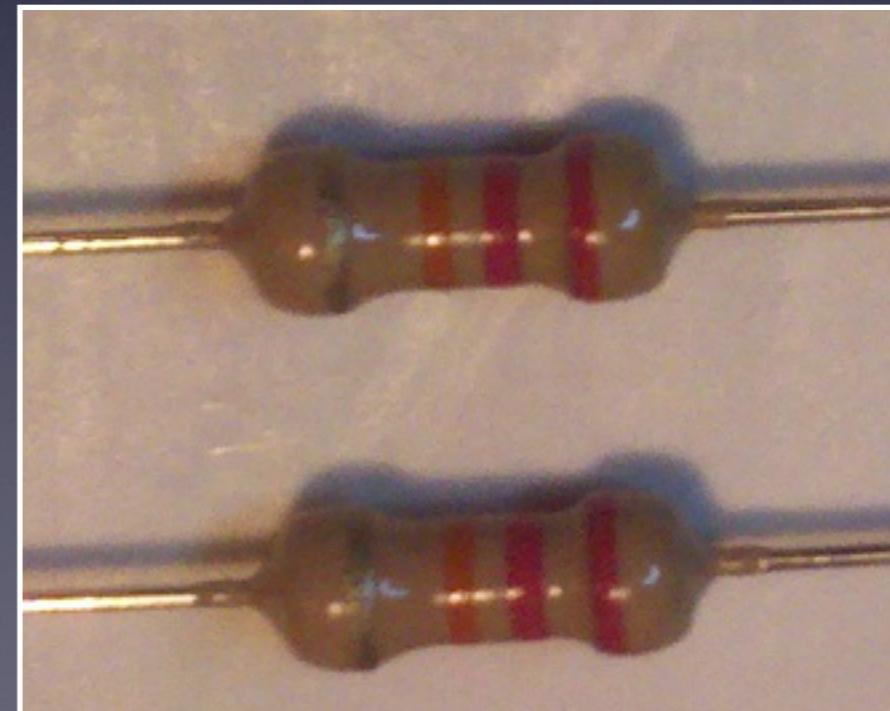
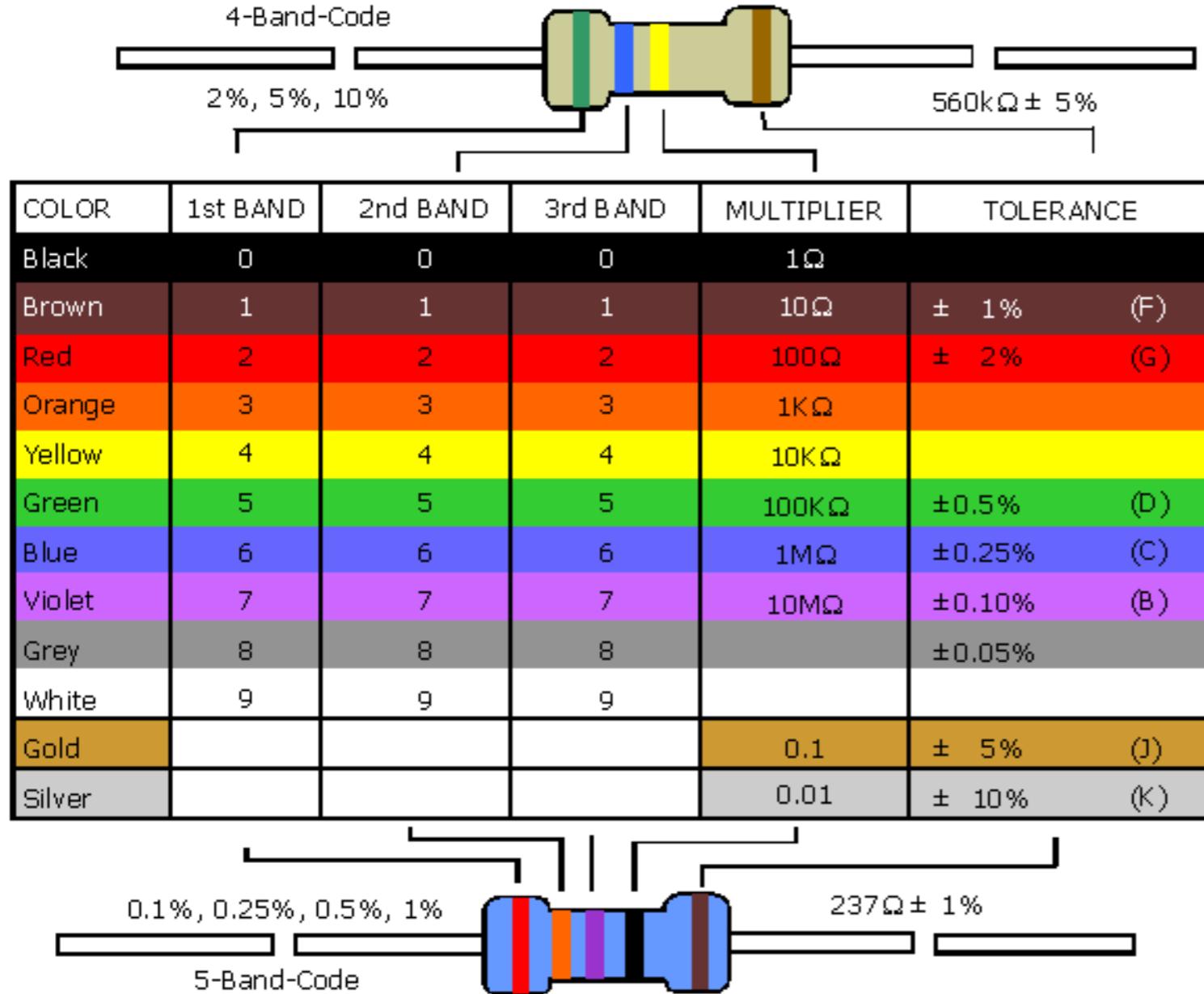
330k Ω





SynShop Prototyping

How to read a resistor



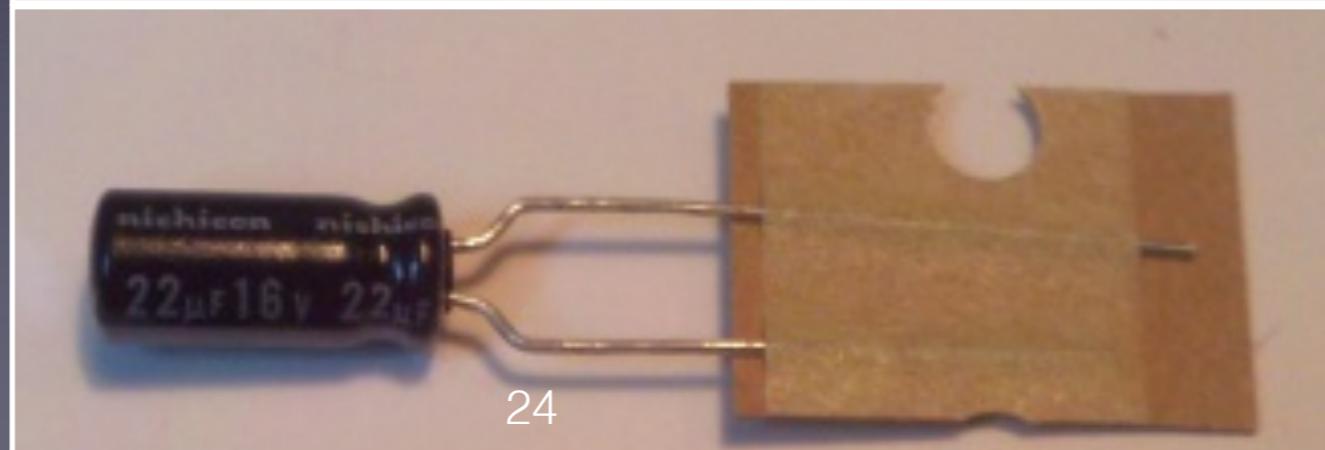


SynShop
Prototyping

Capacitors

Think of capacitors as tiny batteries.

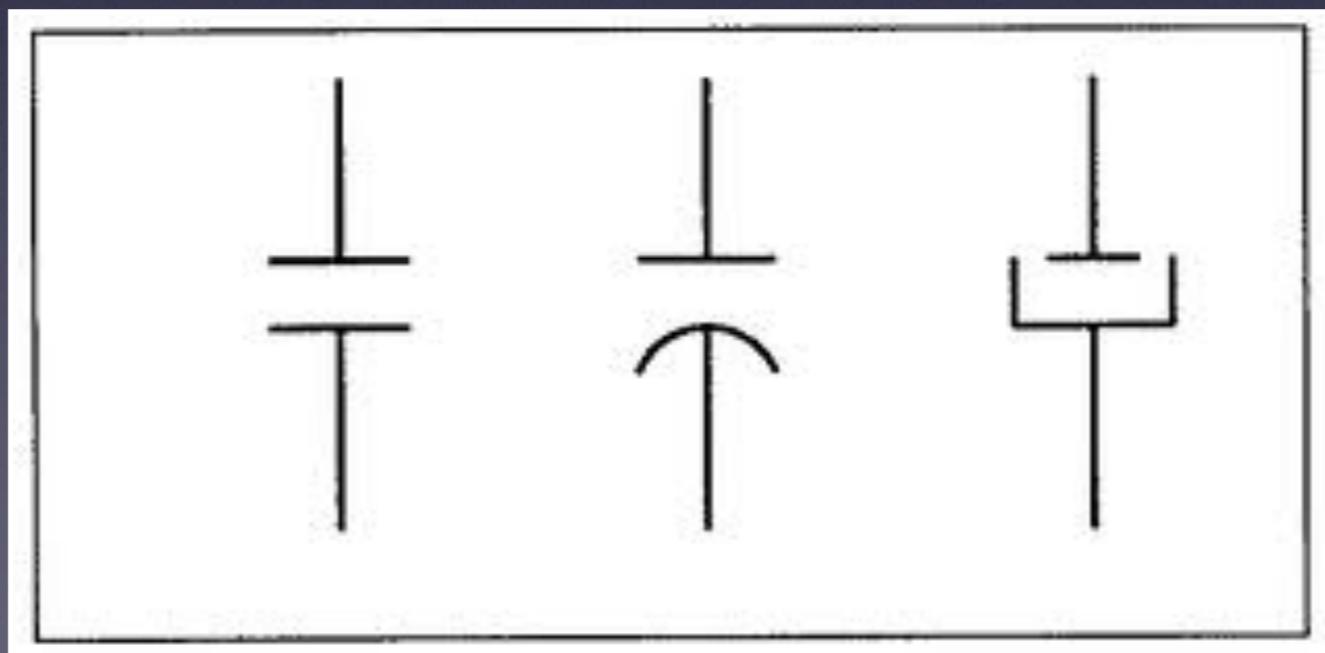
They resist changes in voltage.





SynShop
Prototyping

Capacitors
Schematic symbols.
Measured in farads, f.
uf, microfarads are common





SynShop
Prototyping

Capacitors

Values are typically written on the side. Values are in Farads. Typically micro farads, uf.





SynShop
Prototyping

Capacitors

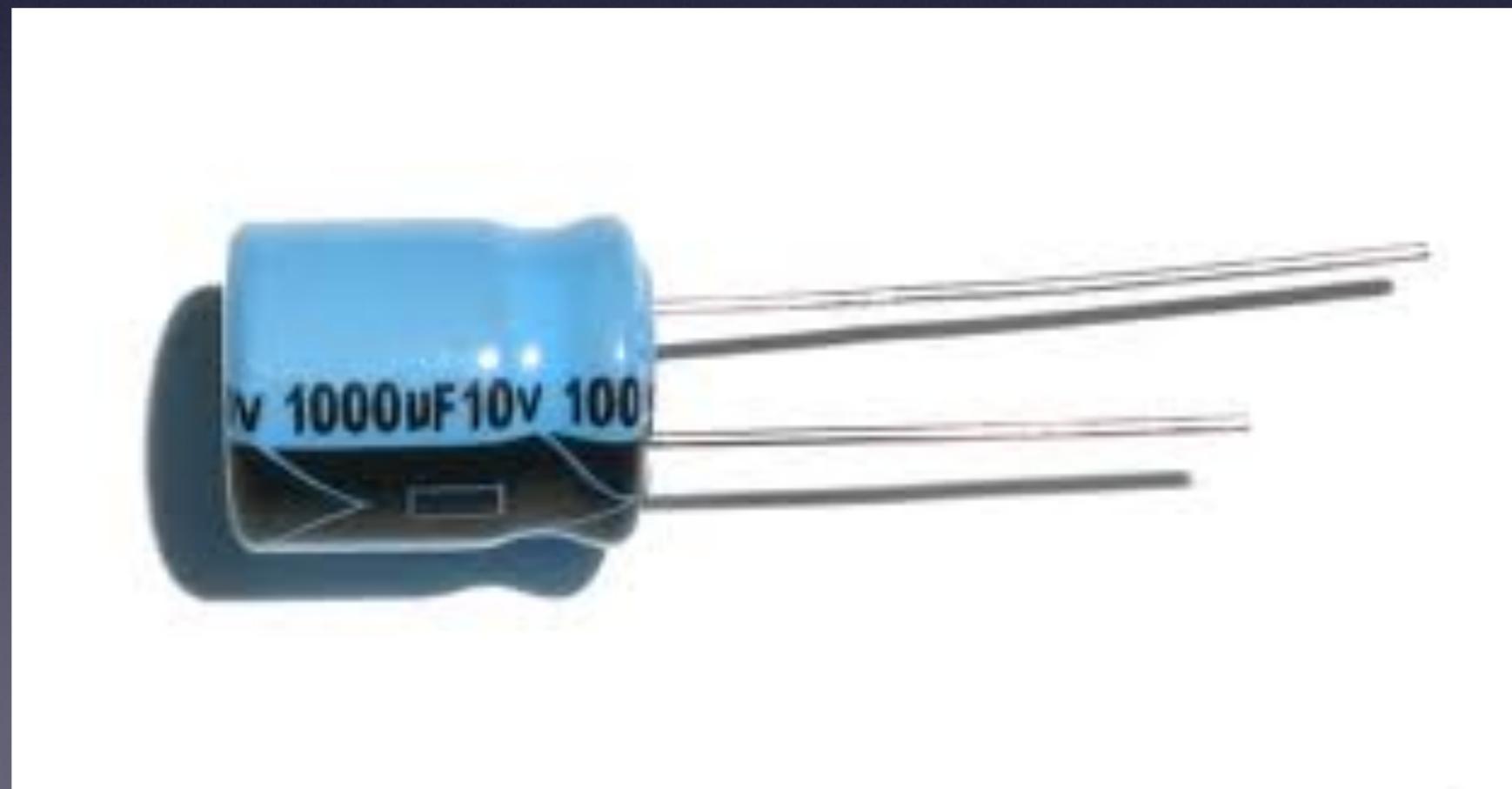
**Electrolytic capacitors must be inserted correctly into the circuit.
Else they go pop!**





SynShop
Prototyping

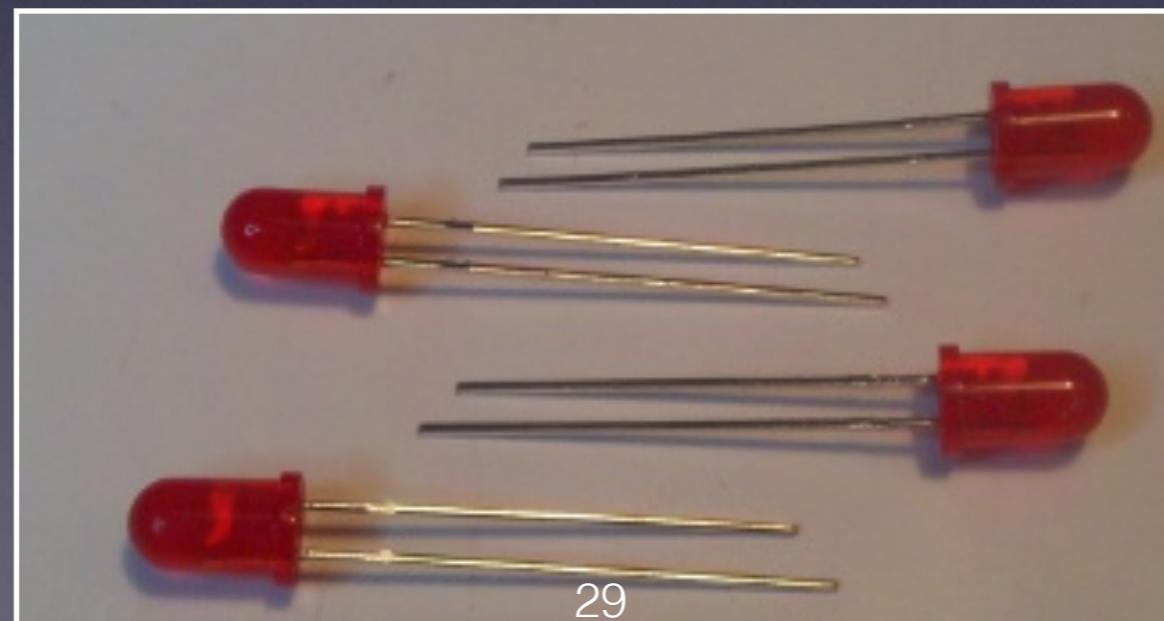
Capacitors
Long lead is positive,
Short lead is negative





SynShop
Prototyping

LEDs
Light Emitting Diode
Only allows current flow in one direction.



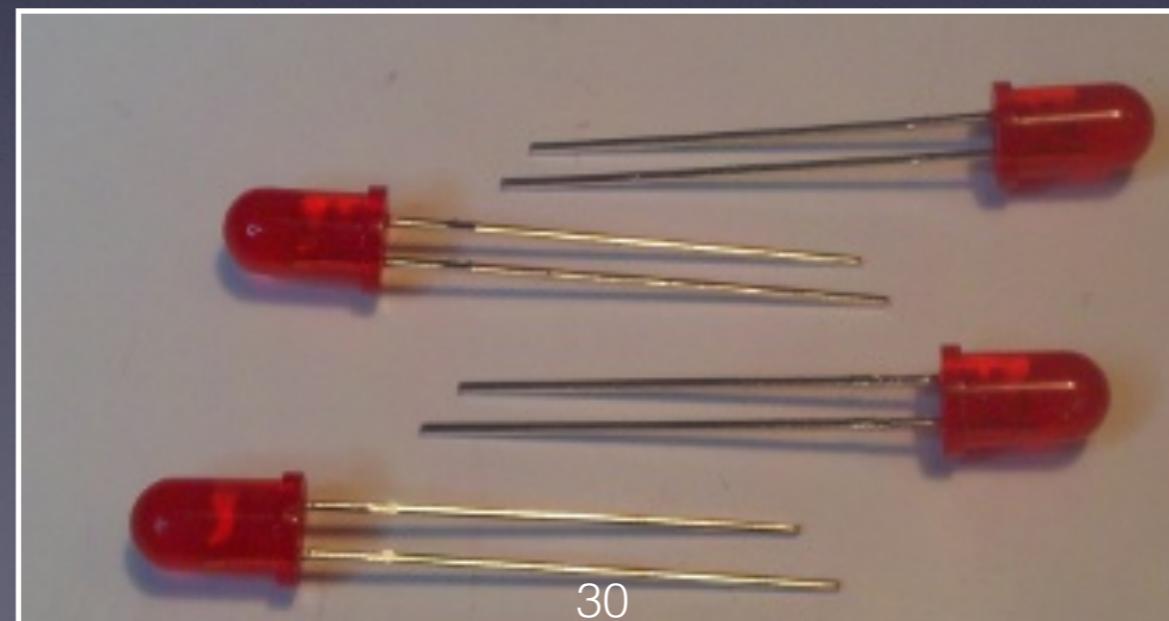


SynShop
Prototyping

LEDs

Also polarized, like electrolytics.

Long leg is positive,
Short leg negative, flat spot.

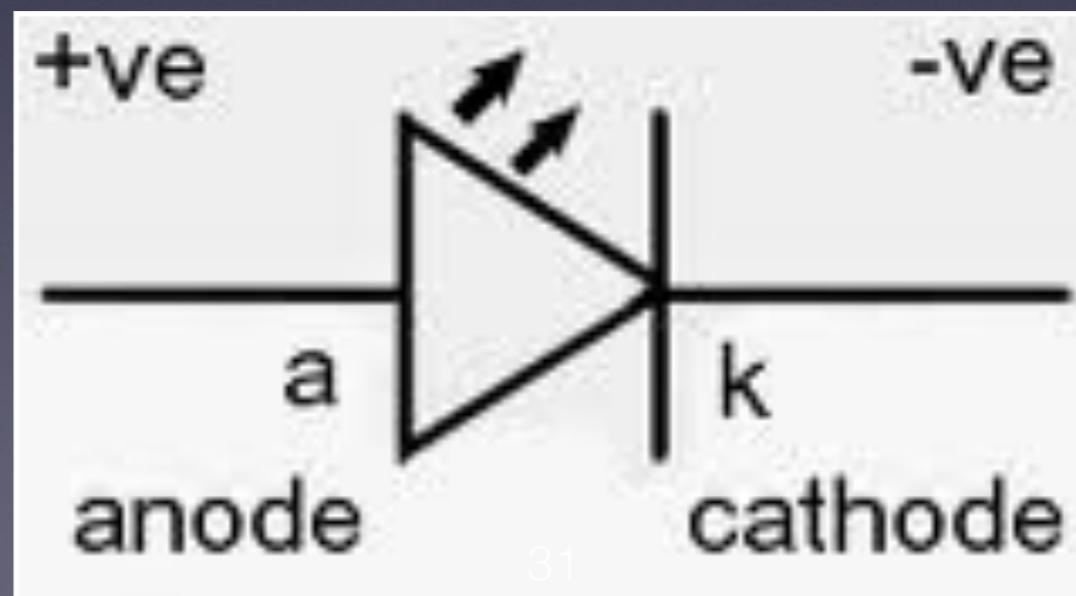




SynShop
Prototyping

LEDs

If you put them in backwards,
They may pop,
But will not light.

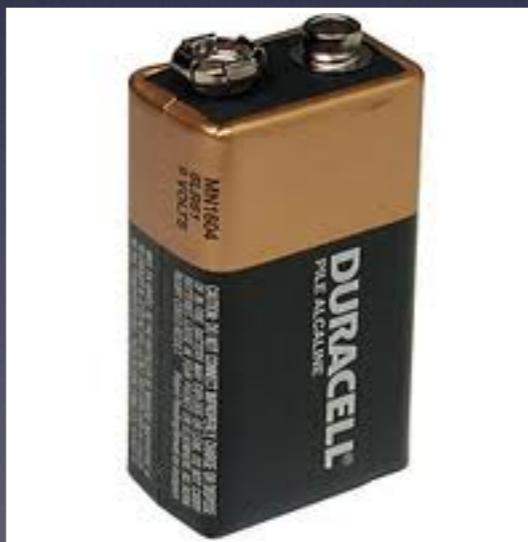




SynShop
Prototyping

Battery

**Red + is positive.
Black - is negative.**



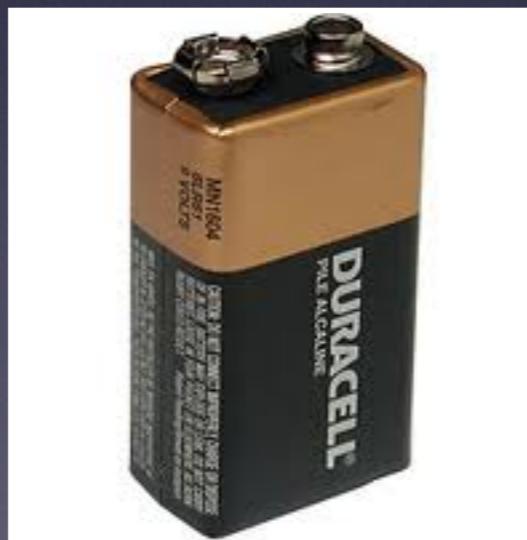
© Solarbotics Ltd. www.solarbotics.com



SynShop
Prototyping

Battery

The battery clip is designed in such a way that red and black are connected correctly.



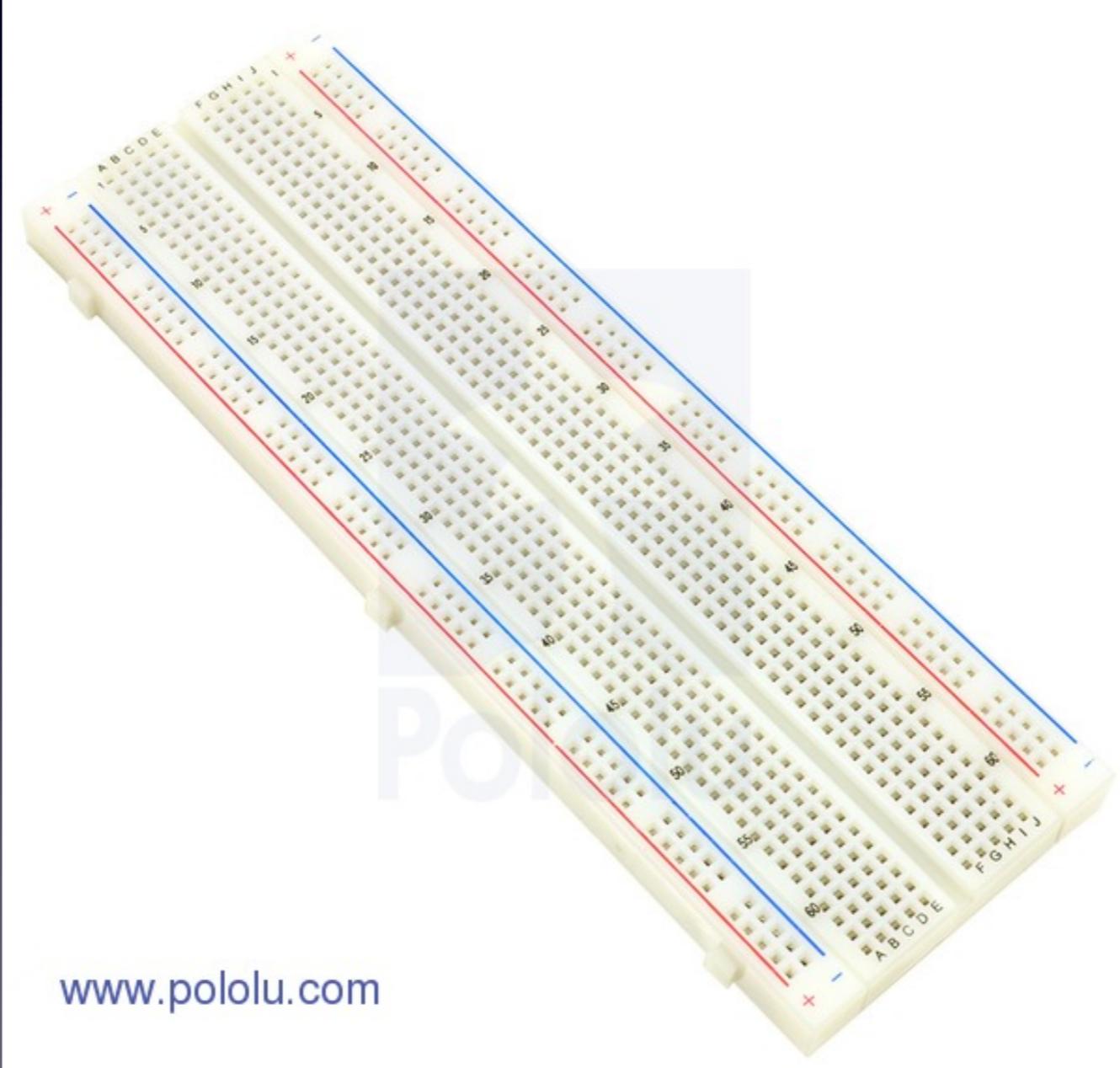
© Solarbotics Ltd. WWW.SOLARBOTICS.COM



SynShop
Prototyping

Breadboard

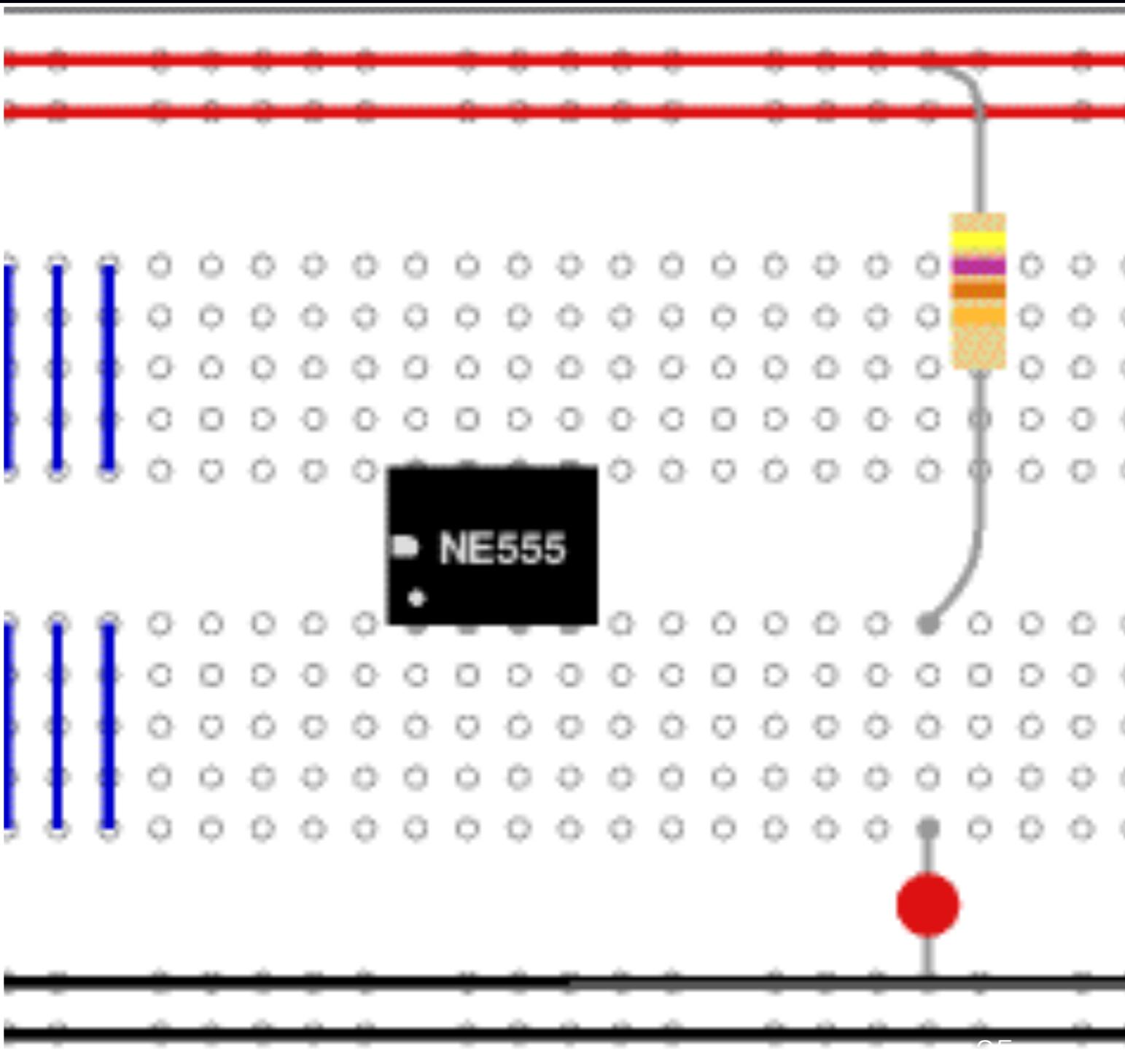
#1 Electronics Prototyping Tool





SynShop
Prototyping

Breadboard



Top and bottom rails are connected horizontally

Rows are connected vertically, not across the center gap.

In this example the led lights because power flows from negative rail, through led, through resistor, to positive.



So far we've looked at:

Battery (provides voltage)

Resistors (resist current)

Capacitor (resist voltage change)

LEDs (they light up)

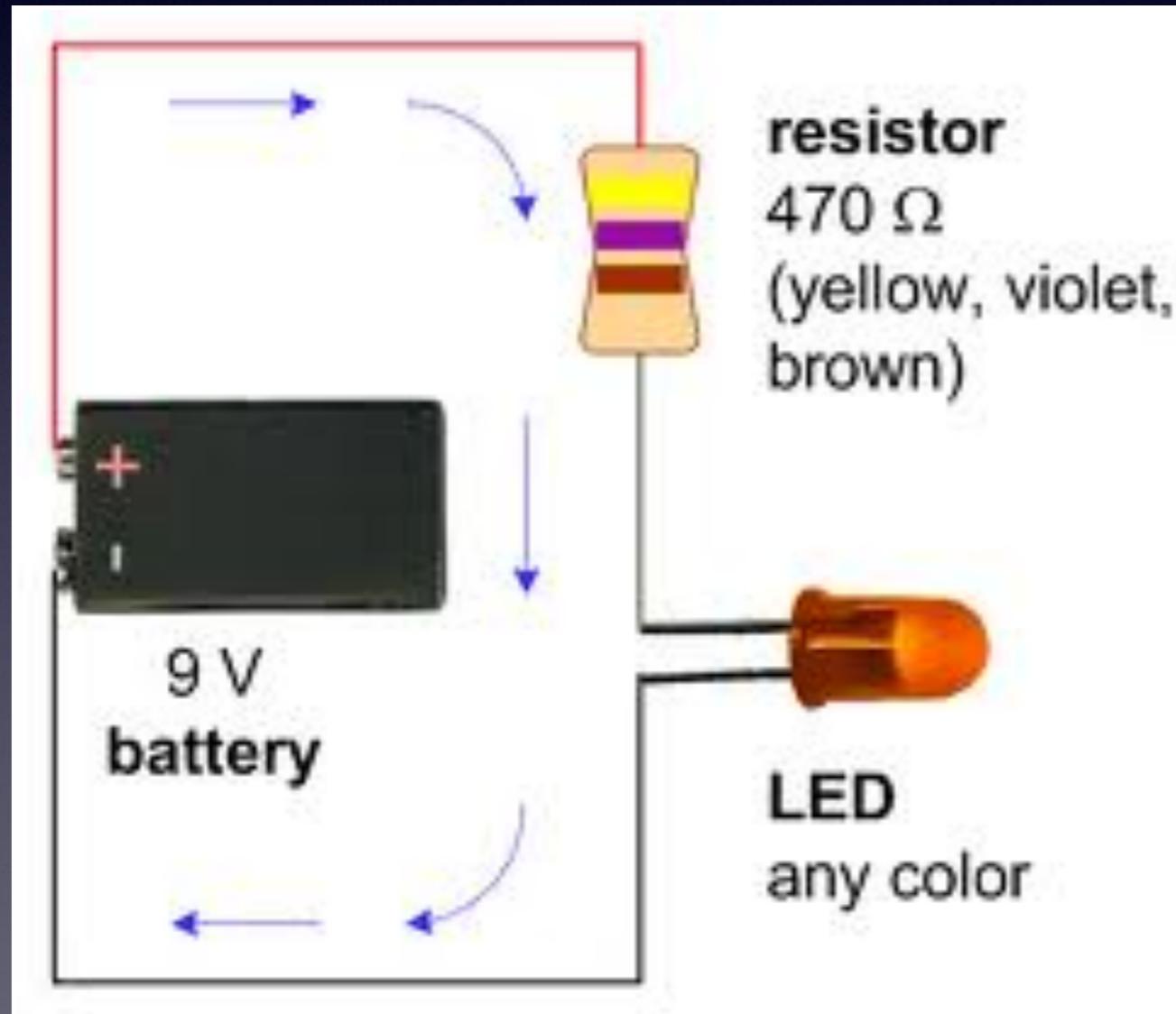
Breadboard (simple place to build)



SynShop

Prototyping

That brings us to the first build



I'm Alive
Simple Breadboard
Setup and status.

See, the engineers
snuck in hole flow
again.

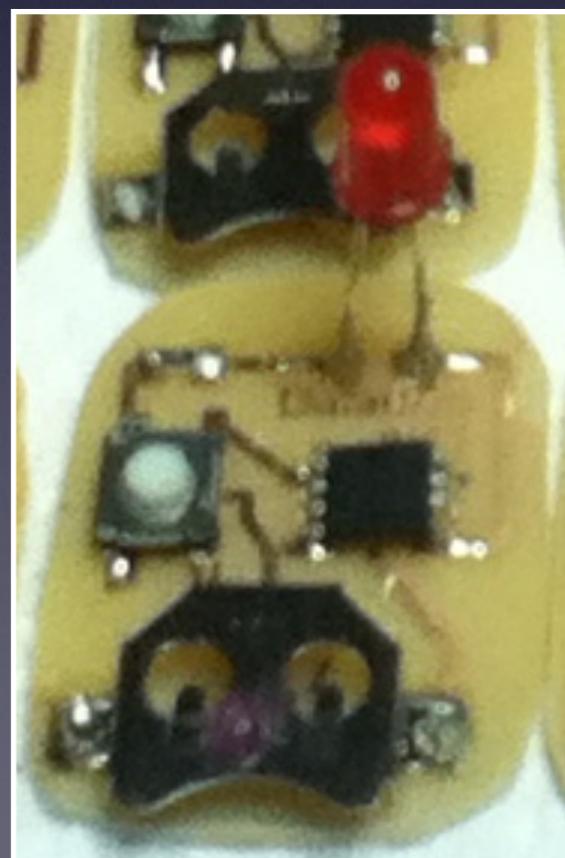


SynShop
Prototyping

SynShop Guinea Pig

You have been recruited as a guinea pig for the Buildup Timer.

Click at start of step.
Perform step.
Click at end of step.

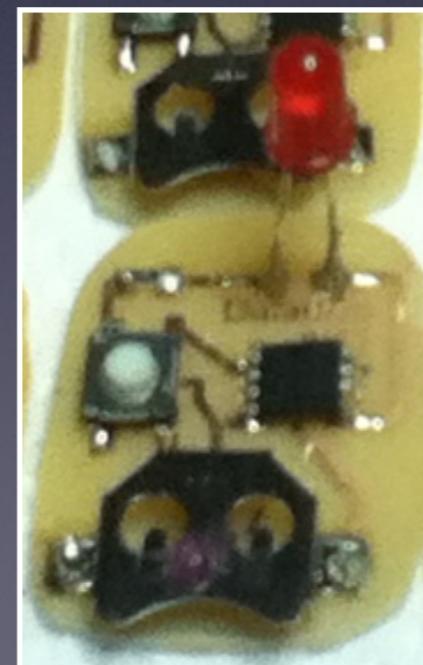




SynShop
Prototyping

SynShop Guinea Pig

Builder Timer blinks faster each minute. Let's us know who's having trouble. It's not a race!





SynShop Prototyping

I'm Alive Build

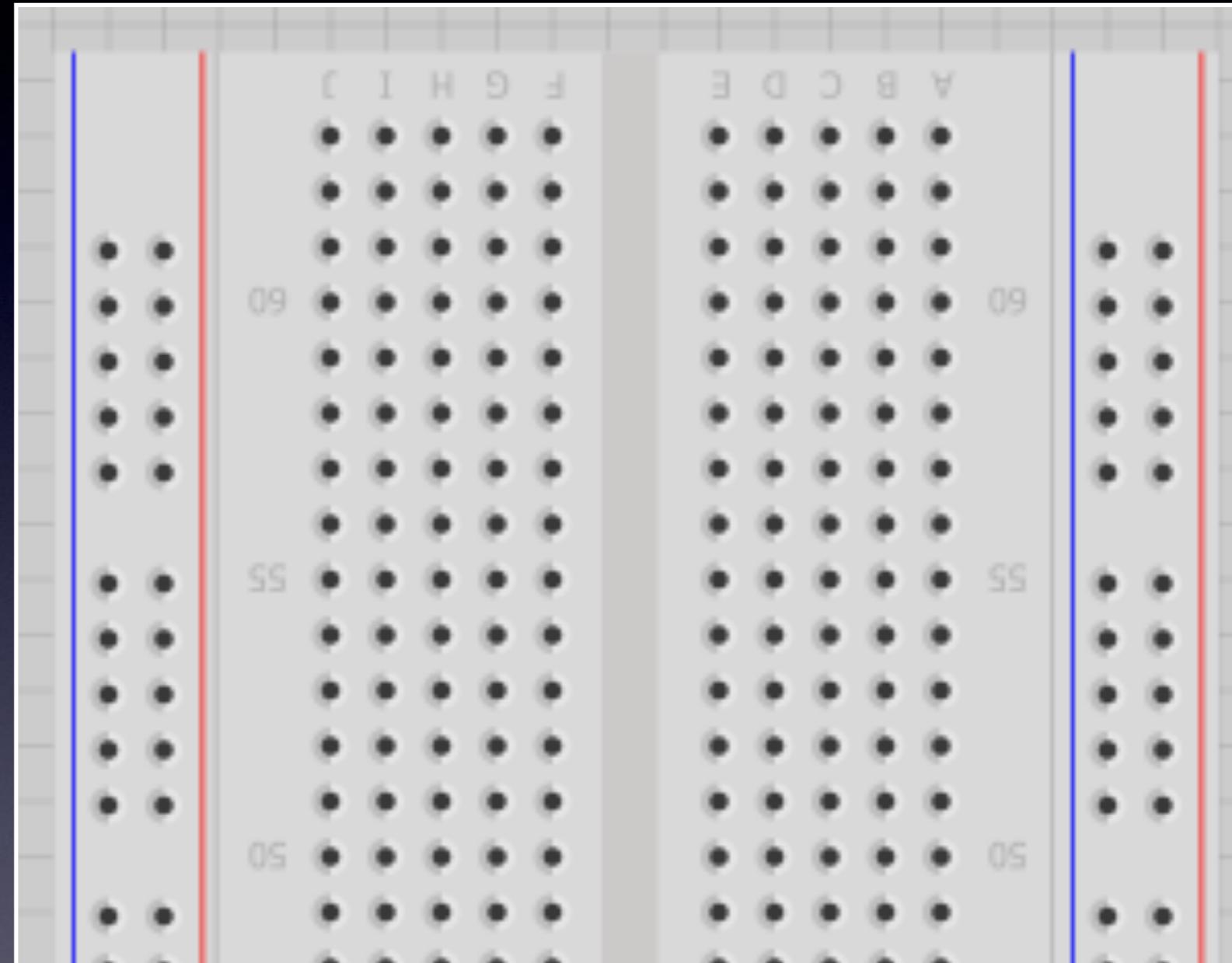


SynShop

Prototyping

Step 1

Orientate
board with
high
numbers
at the top.



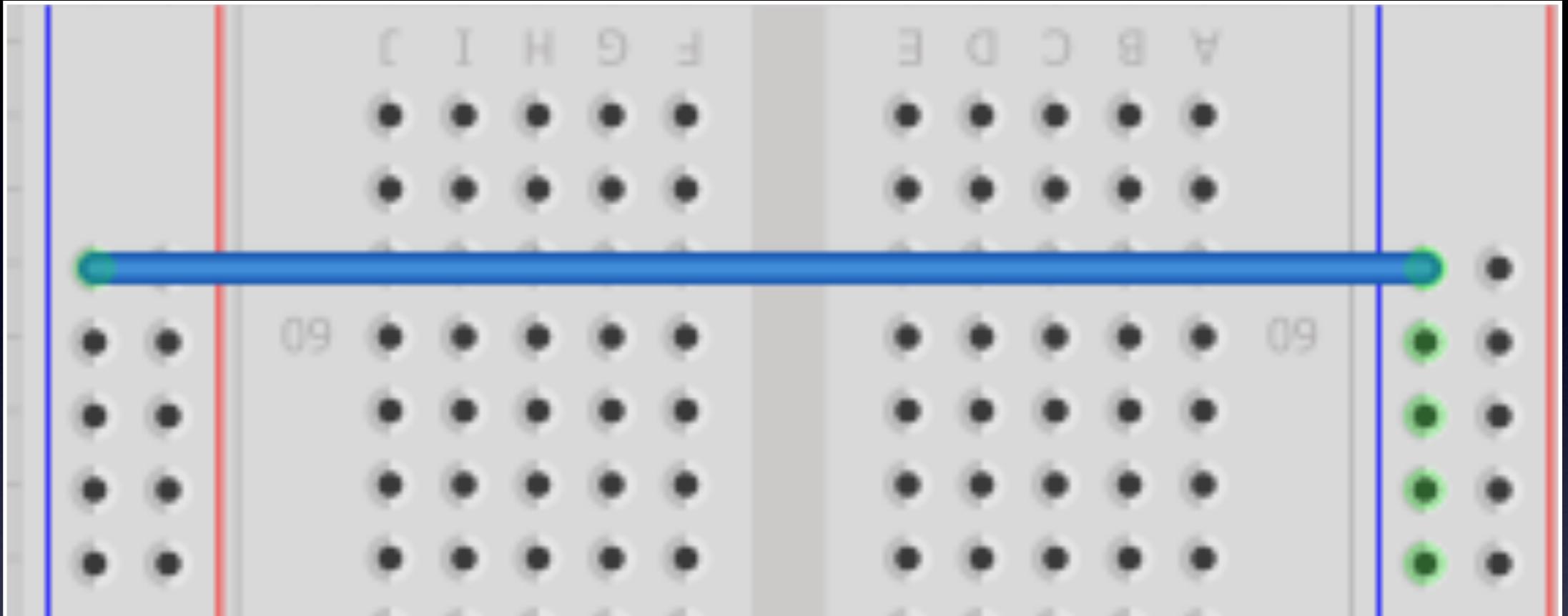


SynShop

Prototyping

Step 2

Tie the
two
negative
rails (blue)
together.



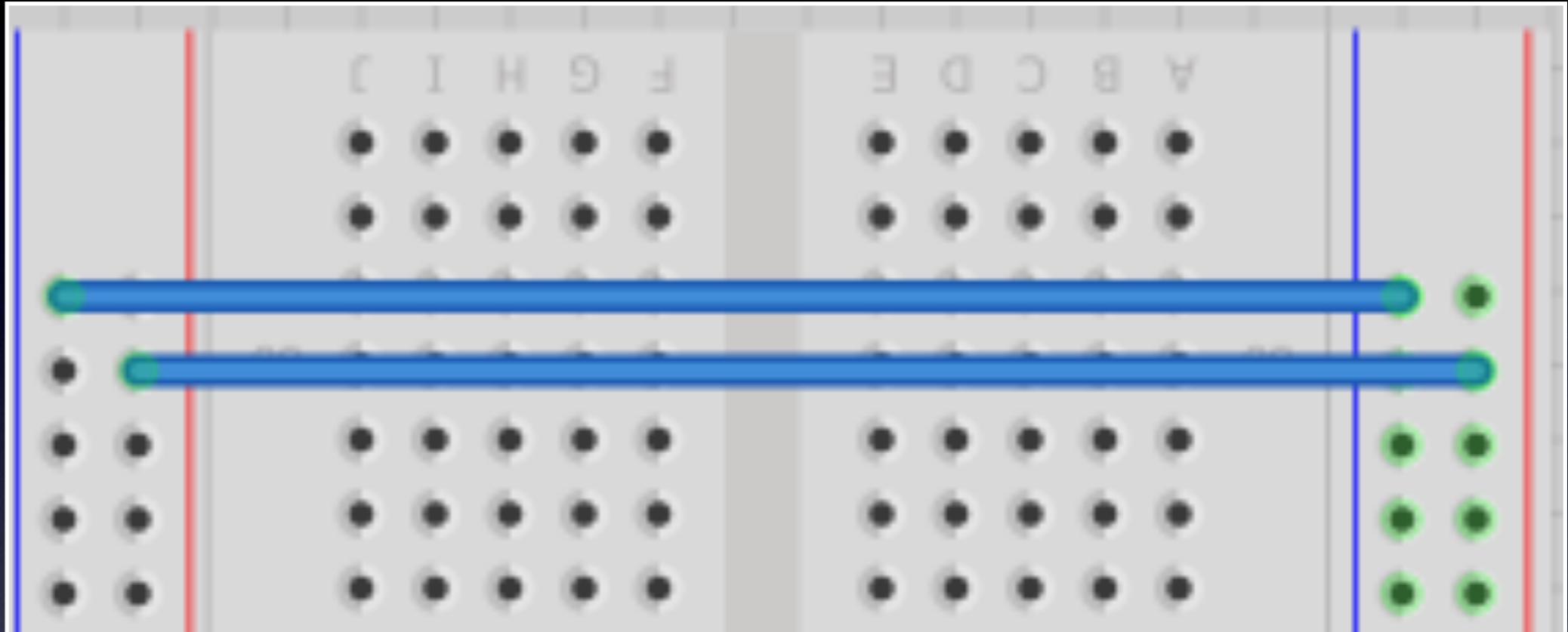


SynShop

Prototyping

Step 3

Tie the
two
positive
rails (red)
together.



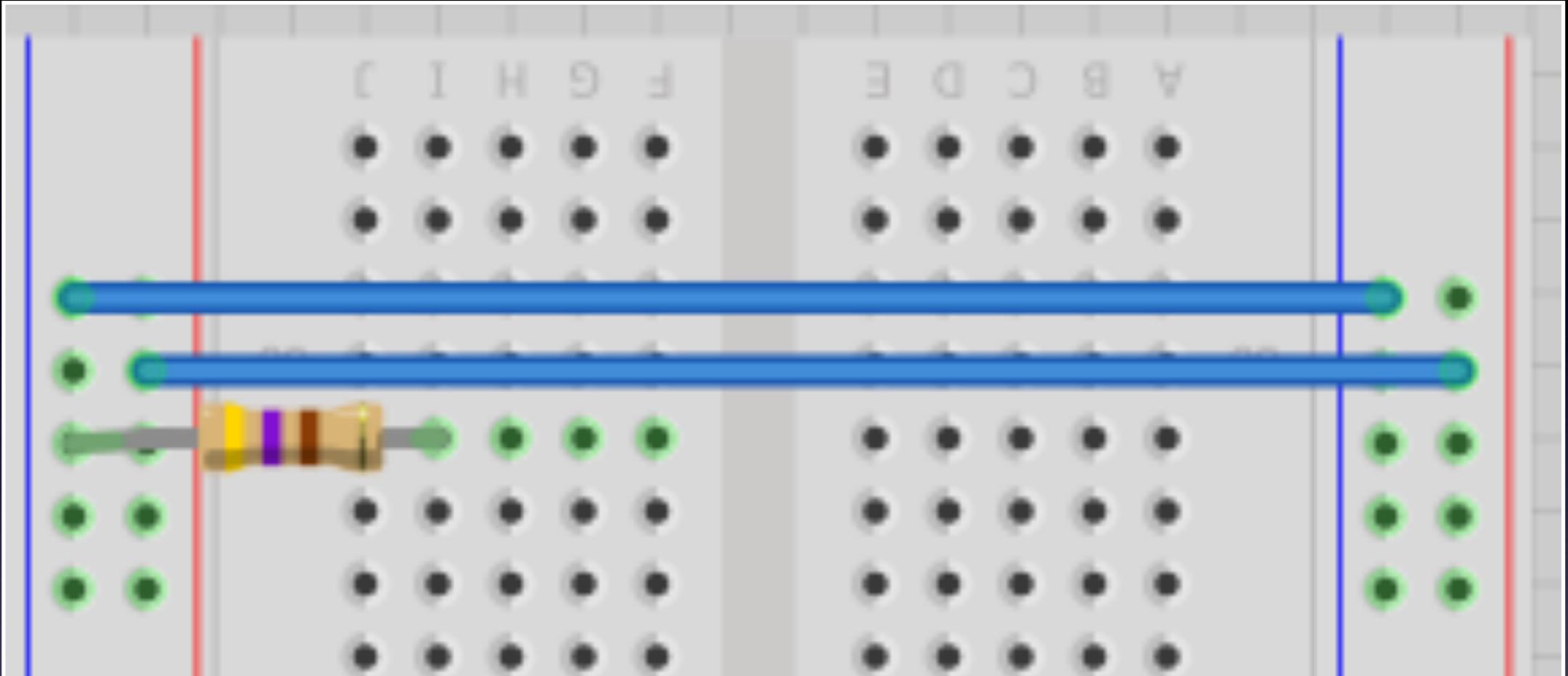


SynShop

Prototyping

Step 4

Insert 470 ohm resistor from NR (negative rail) to row 59 as shown.





SynShop

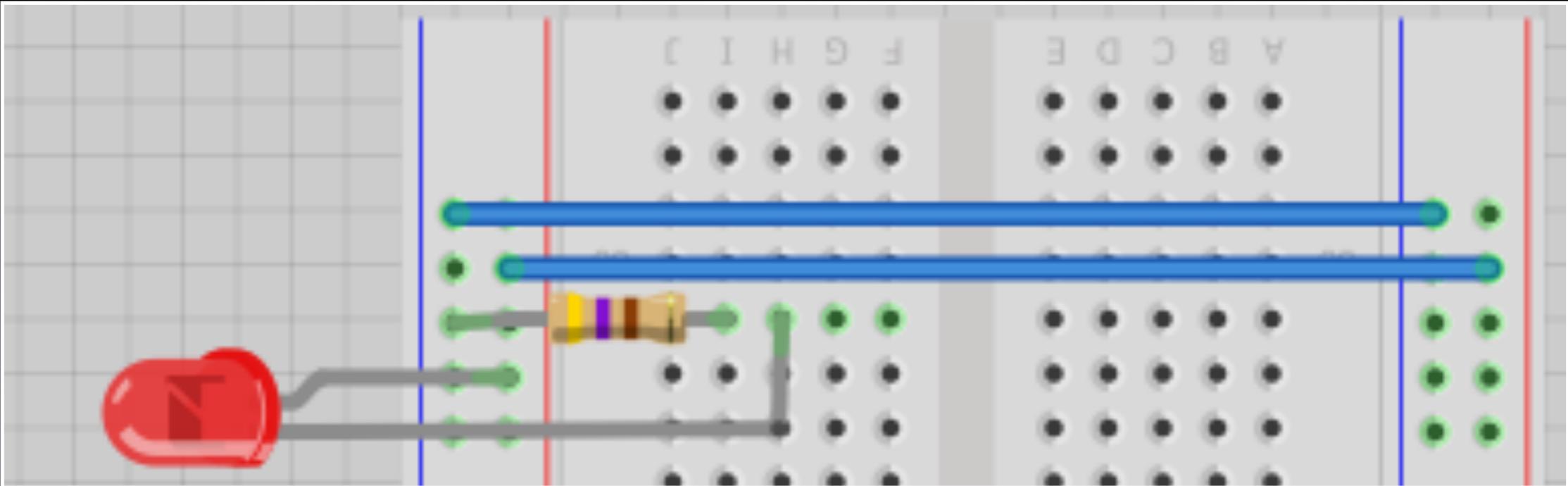
Prototyping

Step 5

Insert LED

**Long leg
into PR
(positive
rail)**

**Short leg
into row
59.**

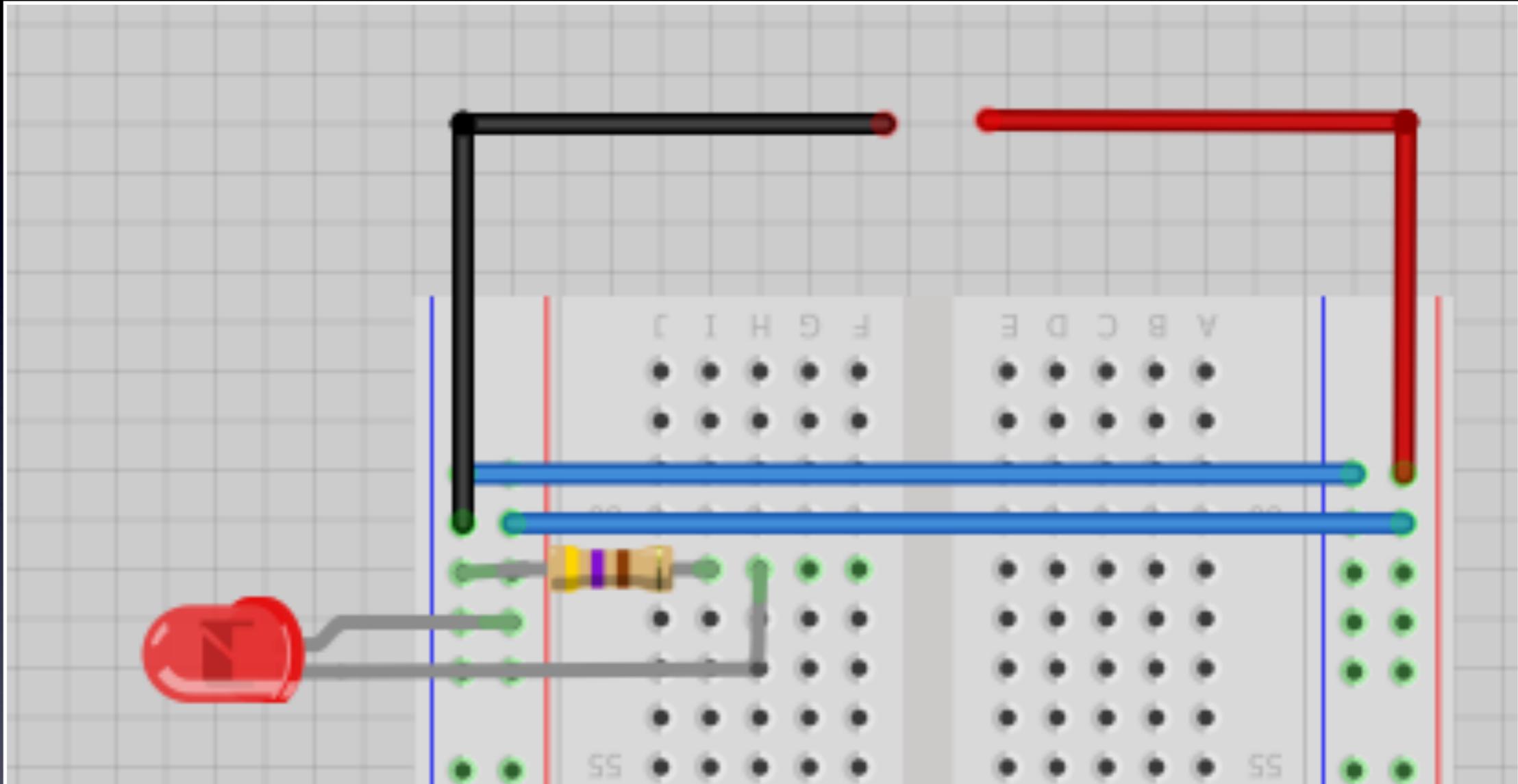




SynShop

Prototyping

Step 6
Attach
battery
clip black
wire to
NR.
Attach
battery
clip red
wire to
PR.
Attach
battery,
LED
should
light.





SynShop Prototyping

**Tying rails together is
common when using breadboard,
But not required.**



SynShop
Prototyping

Disconnect Battery

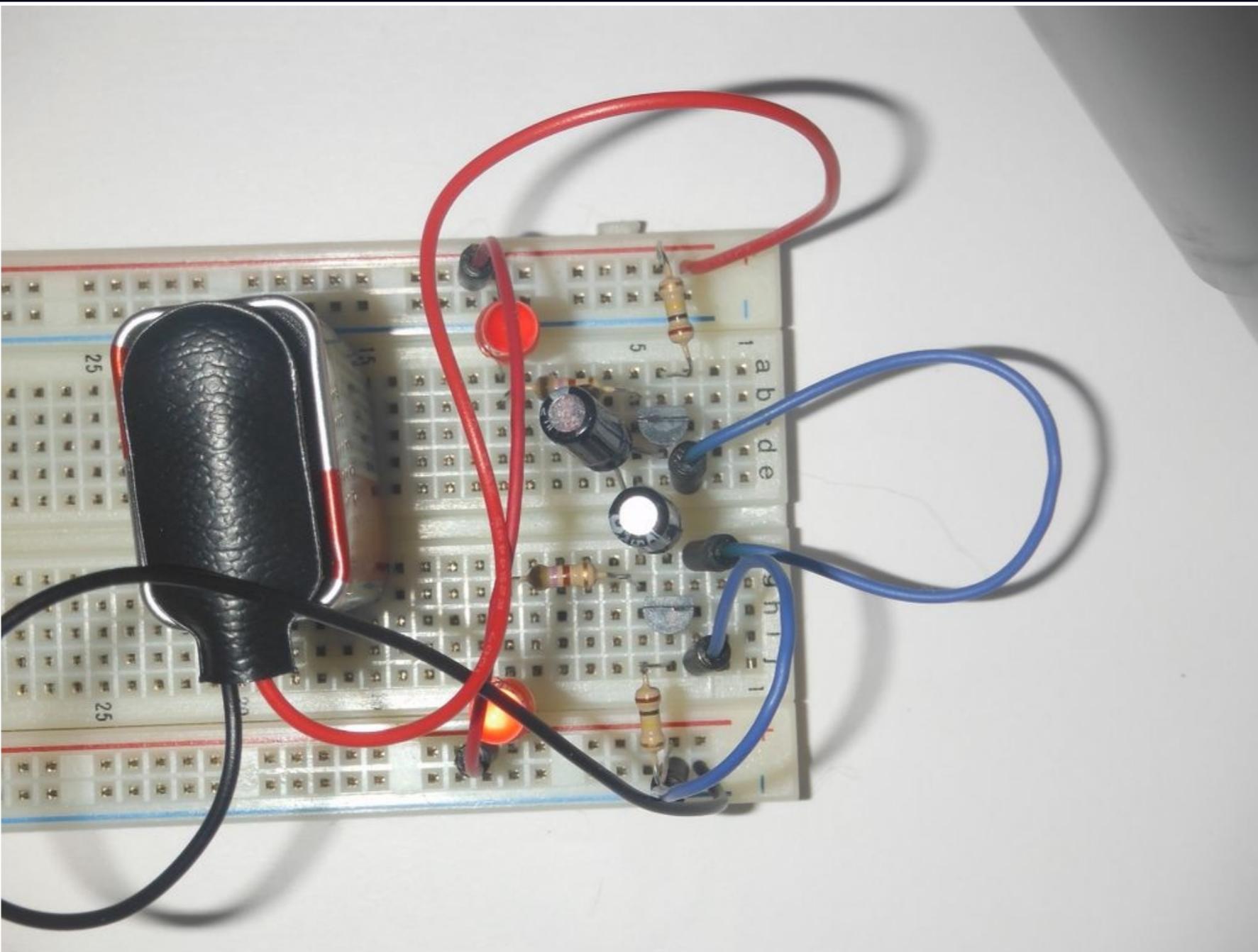
**Never work with circuit powered on.
May destroy parts.
Worse, you may get zapped.**





SynShop
Prototyping

Next build, STOP and GO





SynShop Prototyping

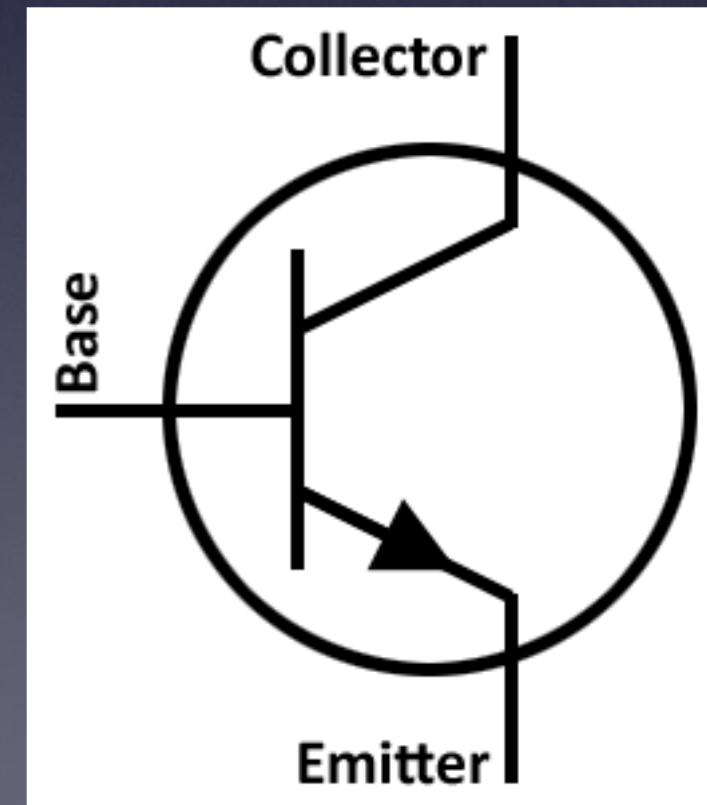
In the next build we are placing 10 components and two jumpers.

One of those components is new, the Transistor. And theres a new concept, the RC Time constant.



Transistor

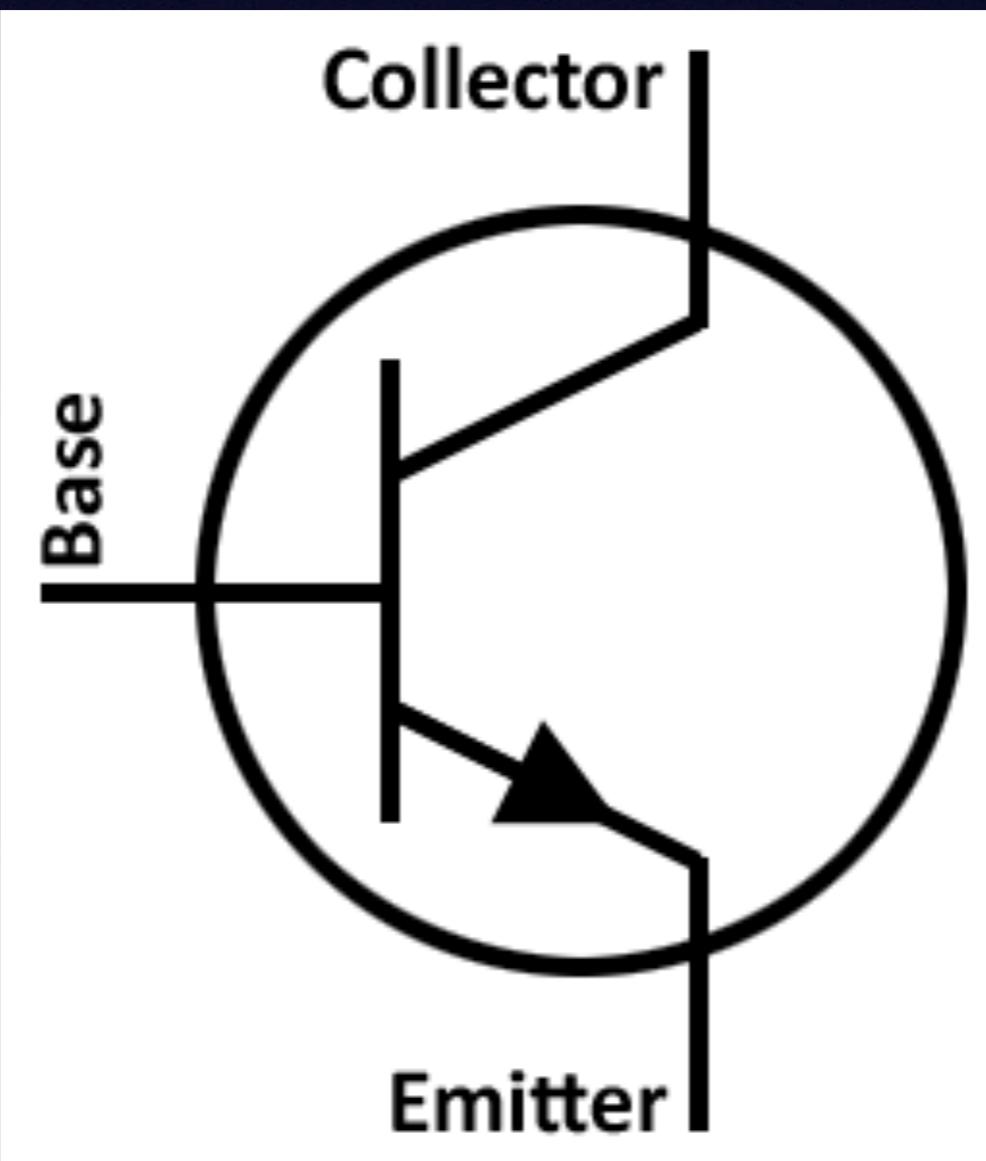
A transistor is simply an electronic switch. When a sufficient voltage is placed at the BASE, current is allowed to flow.





SynShop
Prototyping

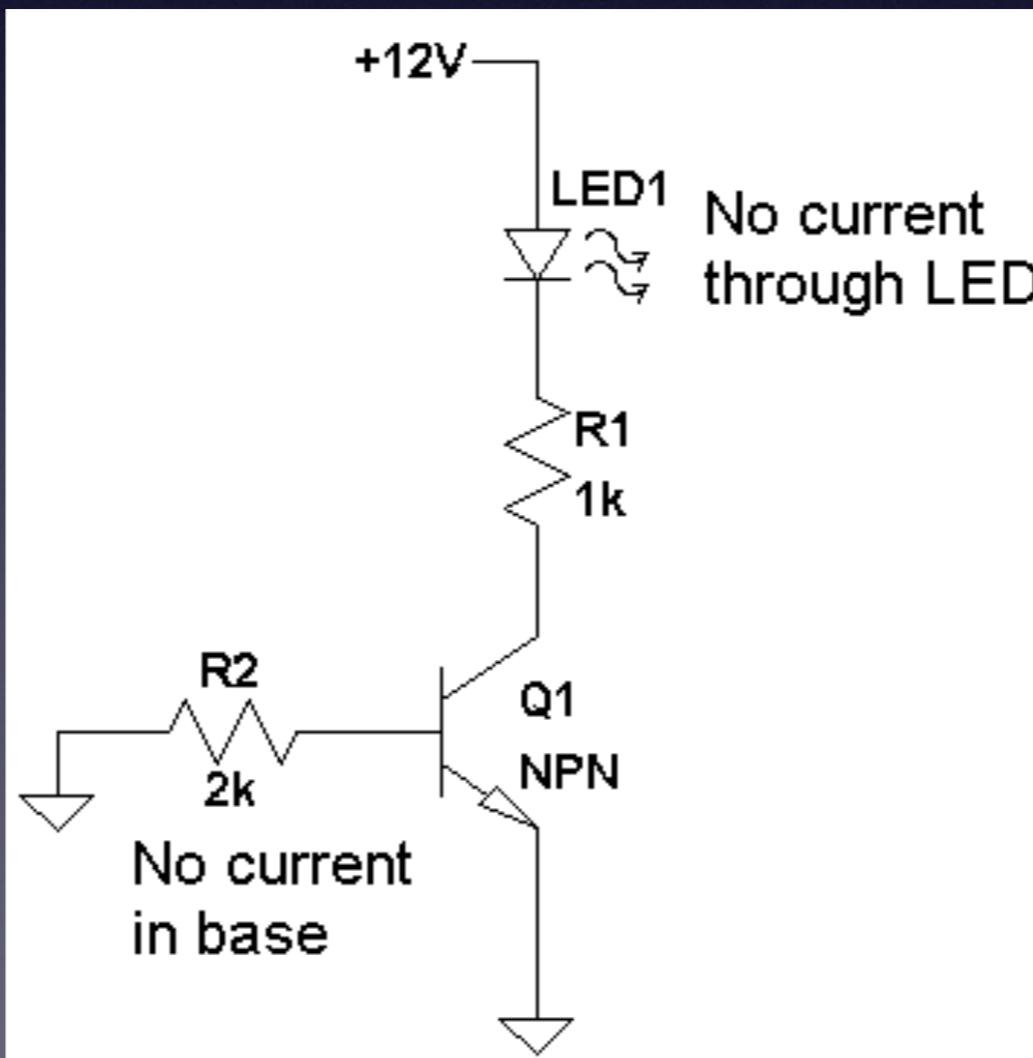
There are 3 leads on a transistor.
Collector, Base, Emitter.





SynShop Prototyping

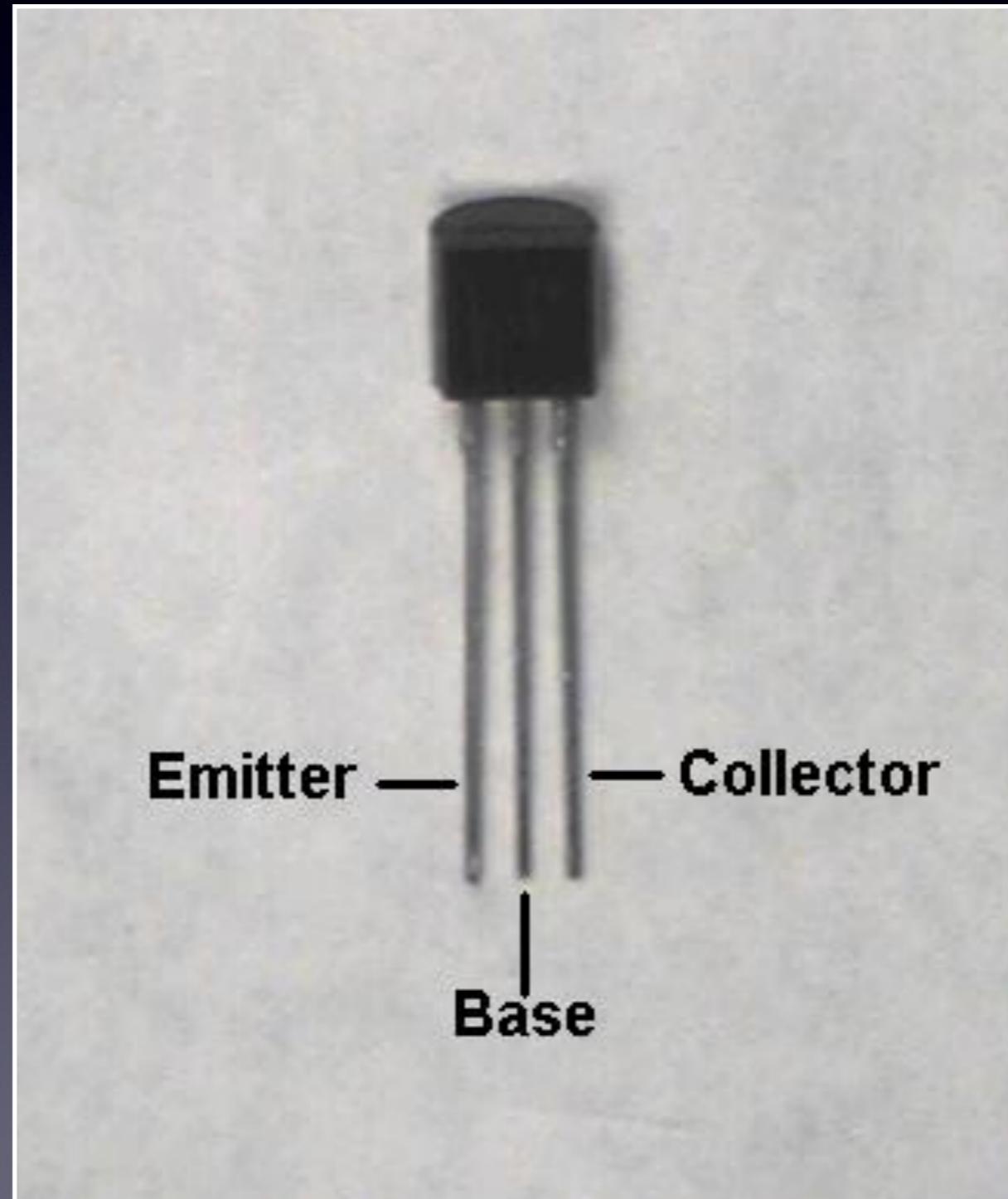
A sufficient voltage at the base lets current flow between the collector and emitter.





SynShop
Prototyping

Common pinout...





RC Time Constant

A resistor and capacitor in series
will charge at a known rate...

RC seconds = R ohms x C farads

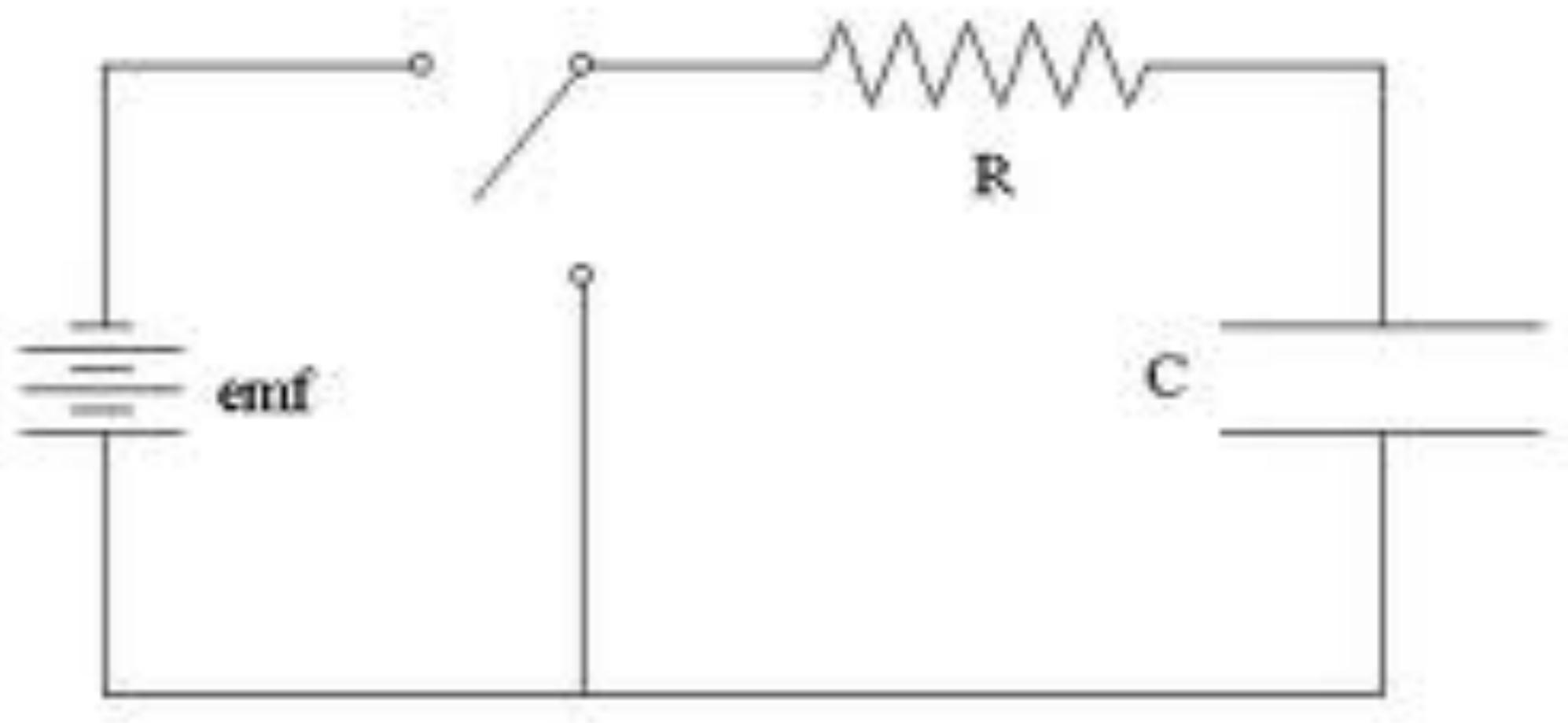
RC = 100k ohms x 10u farads

RC = 100,000 ohms x 0.000,010f

RC = 1 second



SynShop Prototyping





SynShop
Prototyping

**Stop and Go
Build**

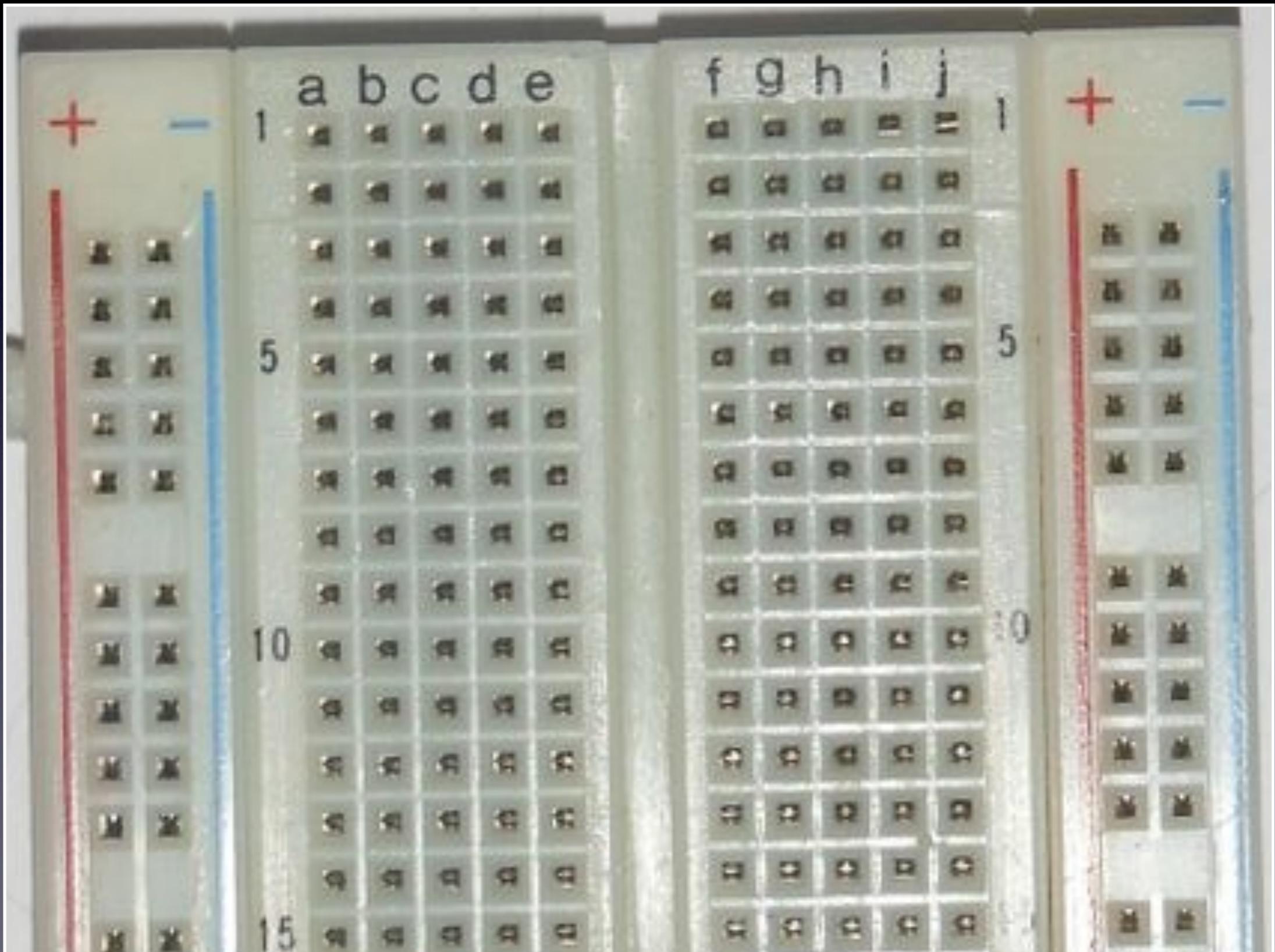


SynShop

Prototyping

Step 1

Orientate
board with
low
numbers
at the top.





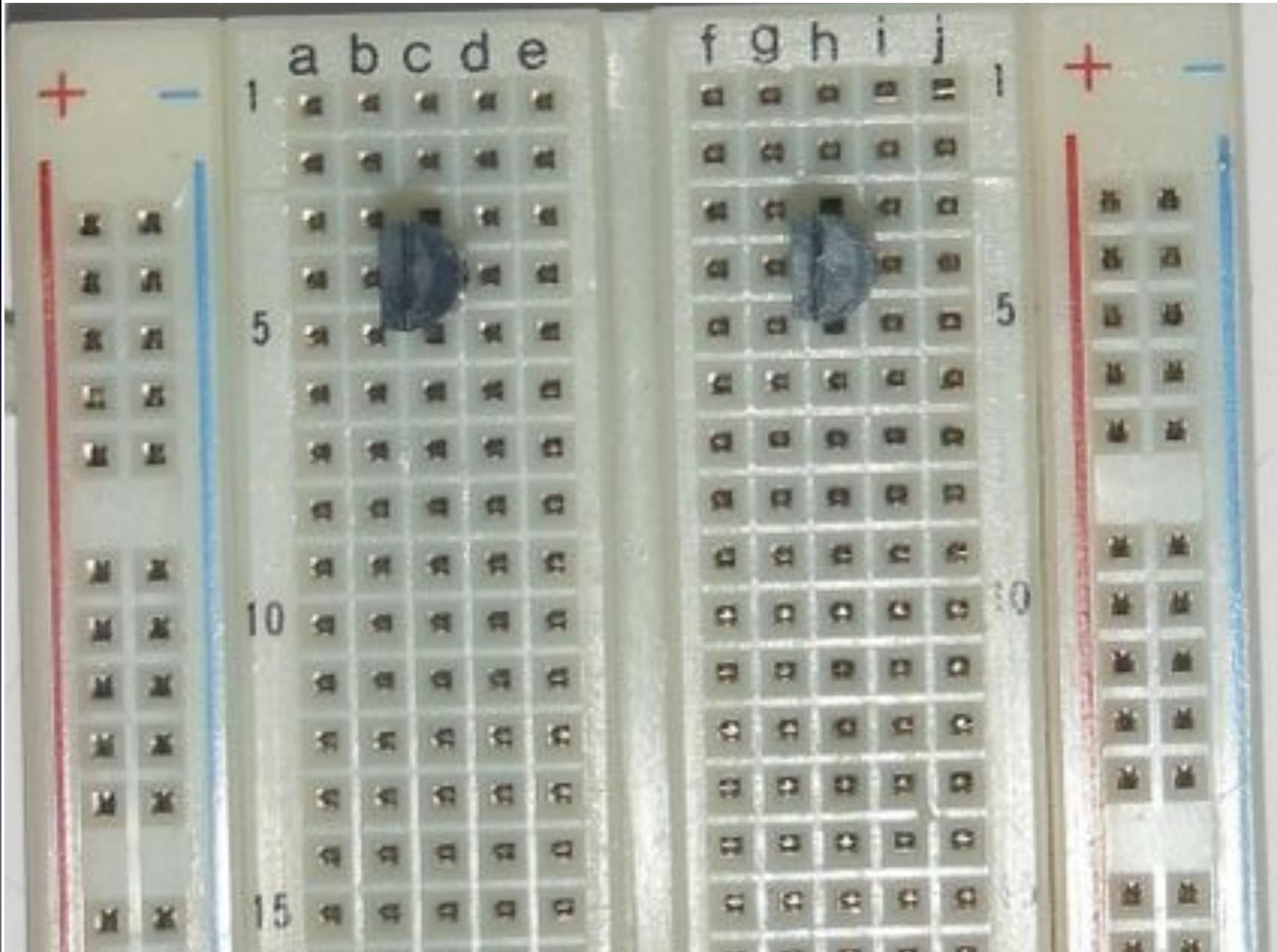
SynShop

Prototyping

Step 2

Place two
transistor,
flat side
facing left.

C3-C5
H3-H5





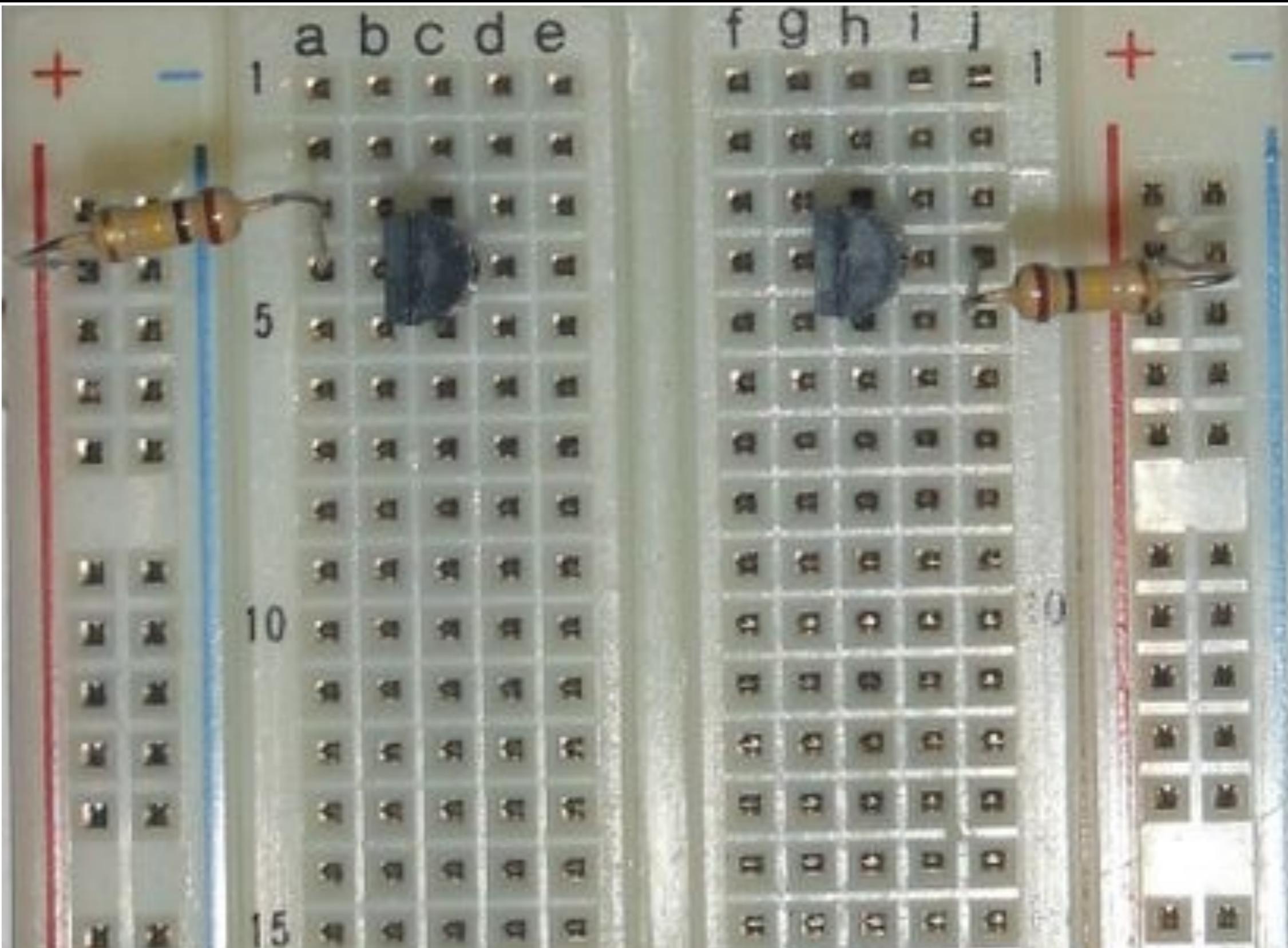
SynShop

Prototyping

Step 3

Place 100k
resistors
from base
to positive
rail.

A4-PR
J4-PR





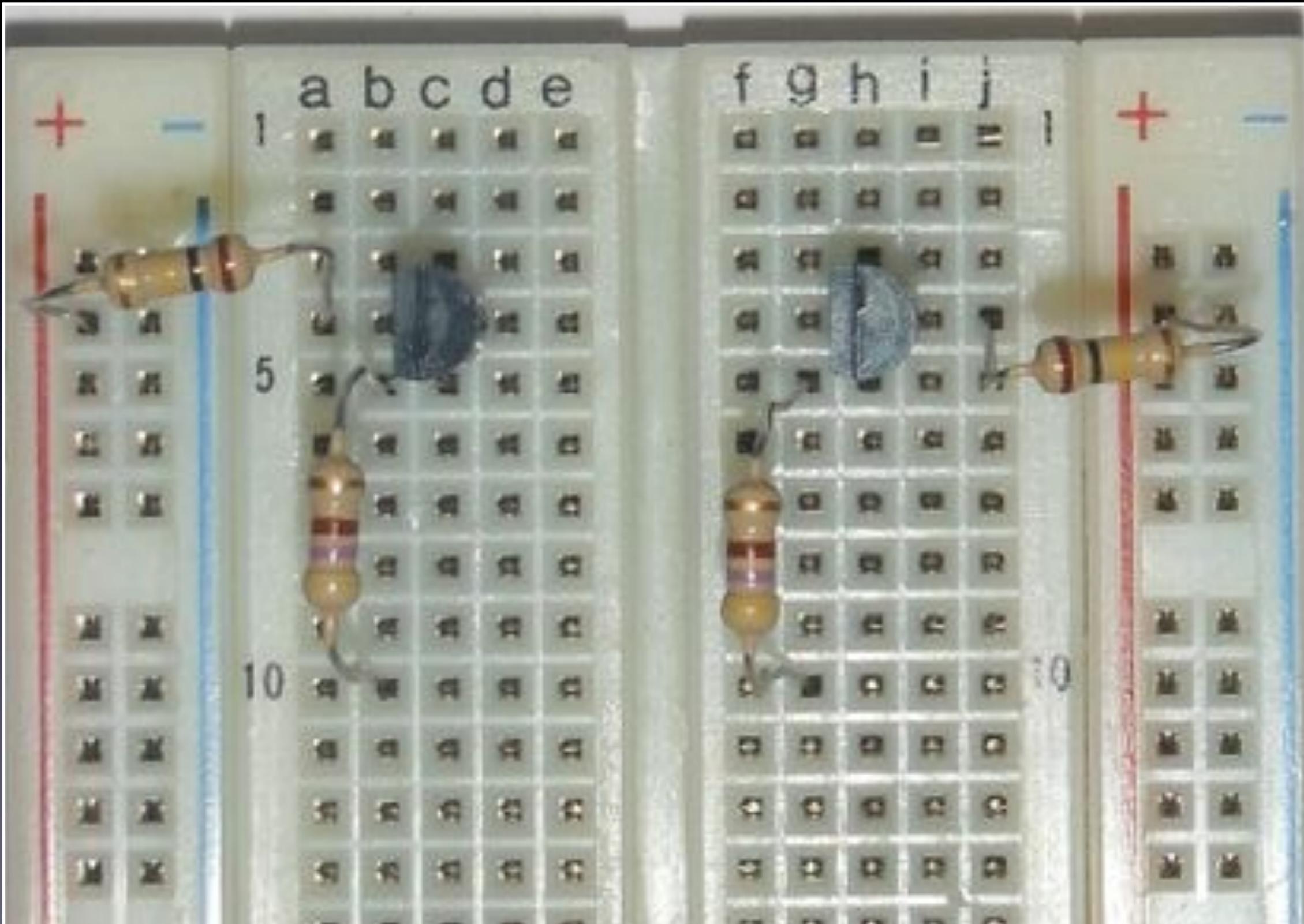
SynShop

Prototyping

Step 4

Place 470 ohm resistors from collector to row 10.

B5-B10
J5-J10





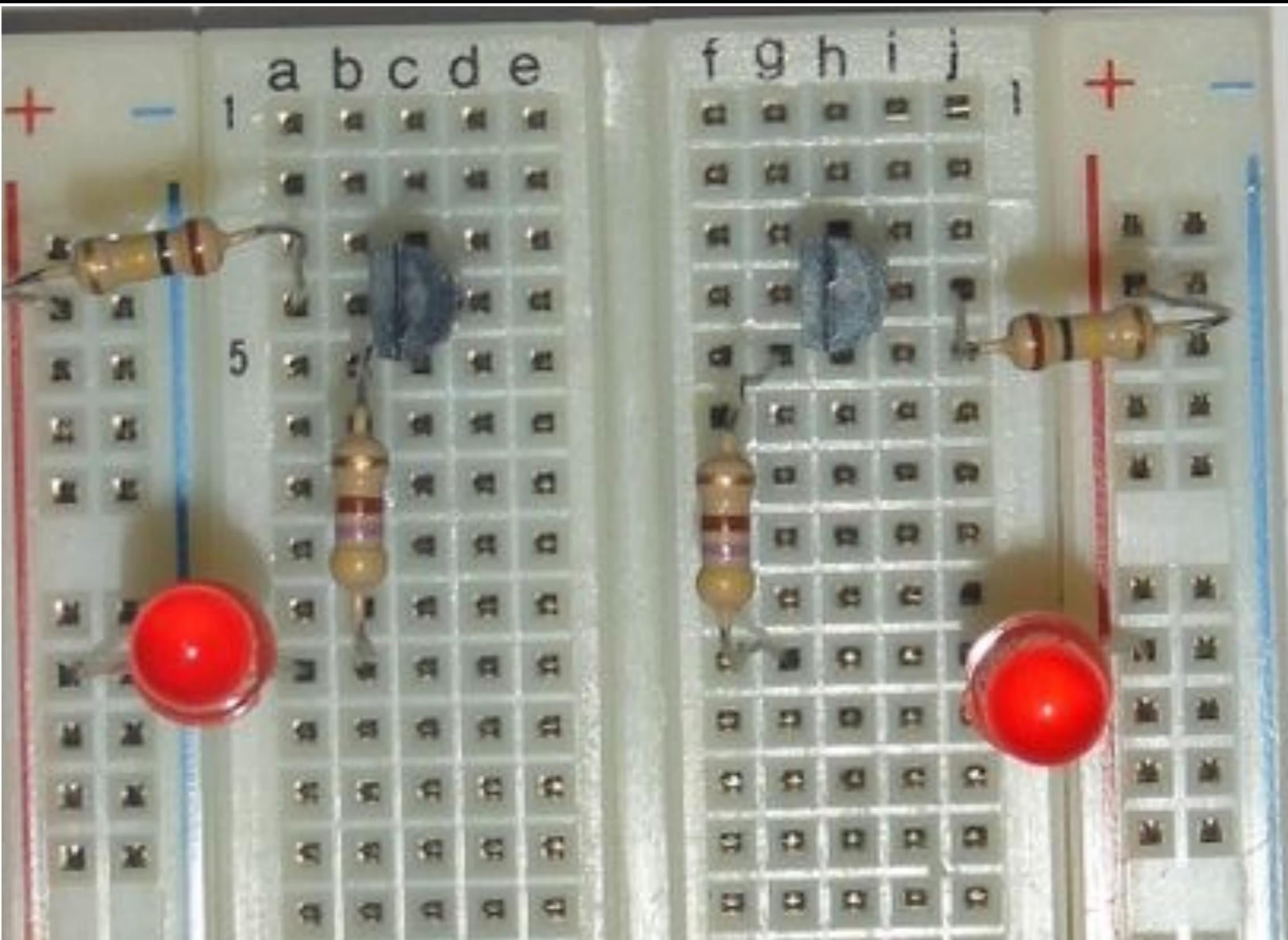
SynShop

Prototyping

Step 5

Place two
LEDs,
long leg in
Positive
Rail, short
leg on row
10.

PR+ A10-
PR+ J10-





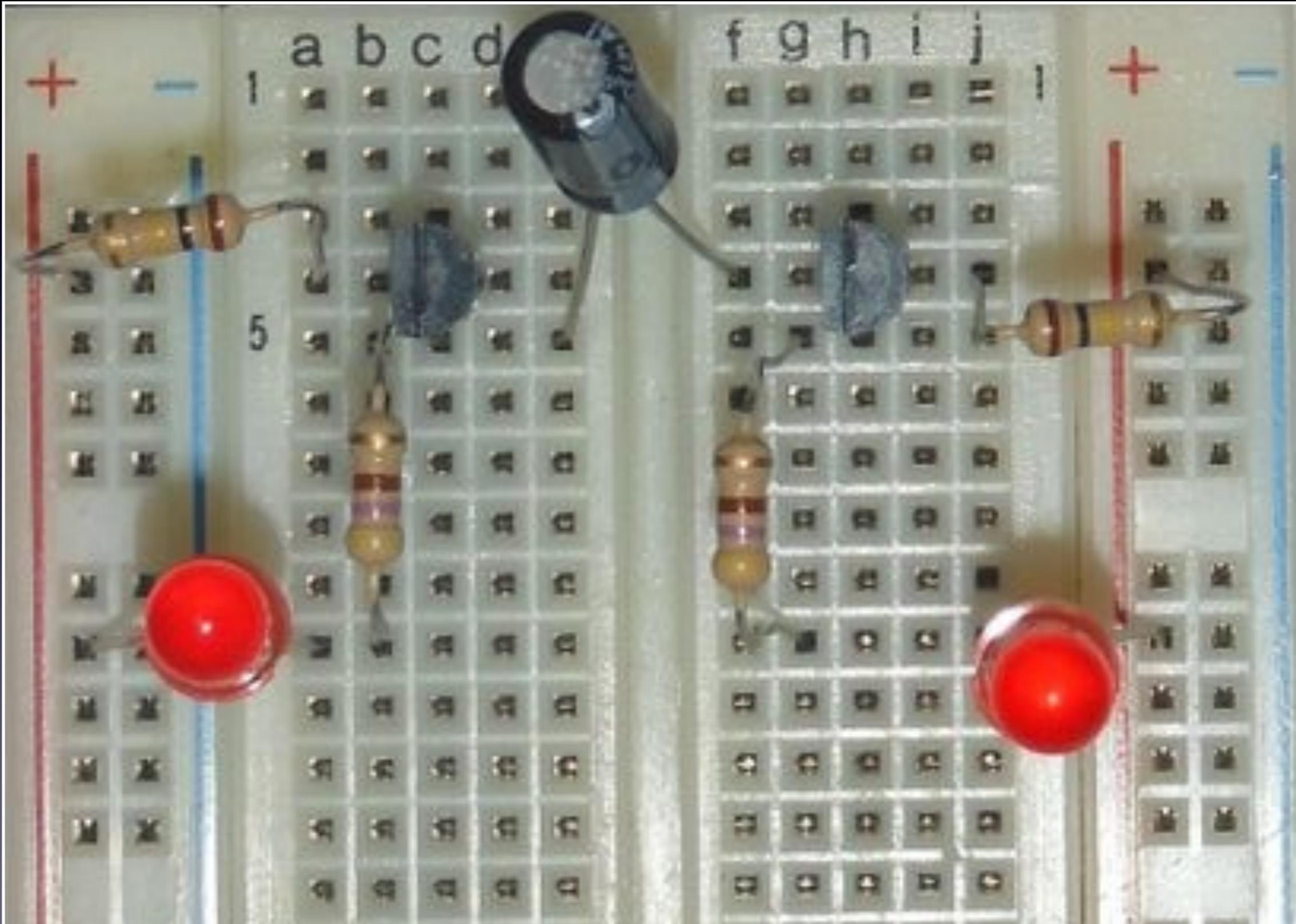
SynShop

Prototyping

Step 6

Place 10uf capacitor,
long leg
emitter, to
opposite
transistor
base short
leg.

E5+ F4-





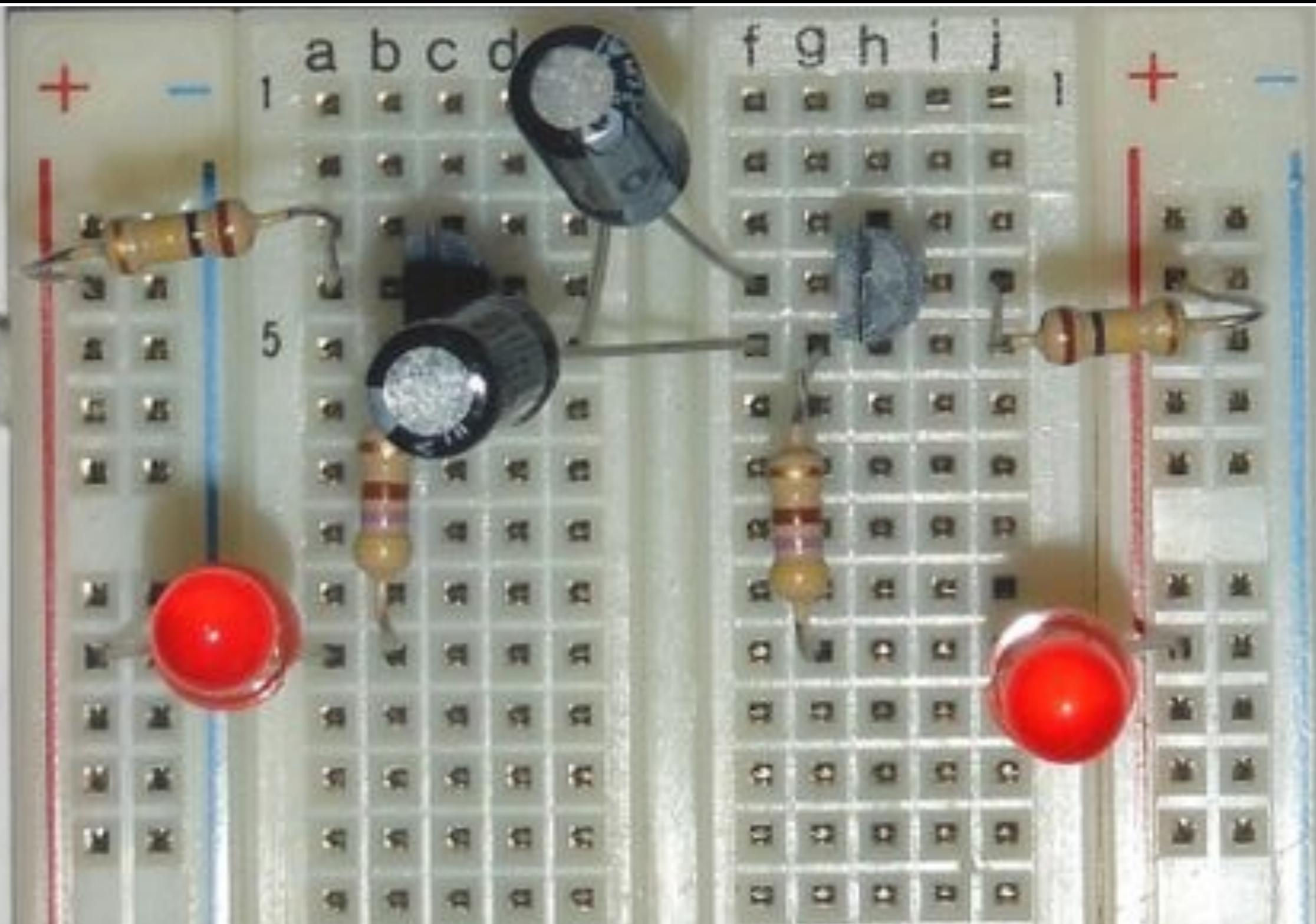
SynShop

Prototyping

Step 7

Place 10uf capacitor, long leg emitter, to opposite transistor base short leg.

F4+ D4-





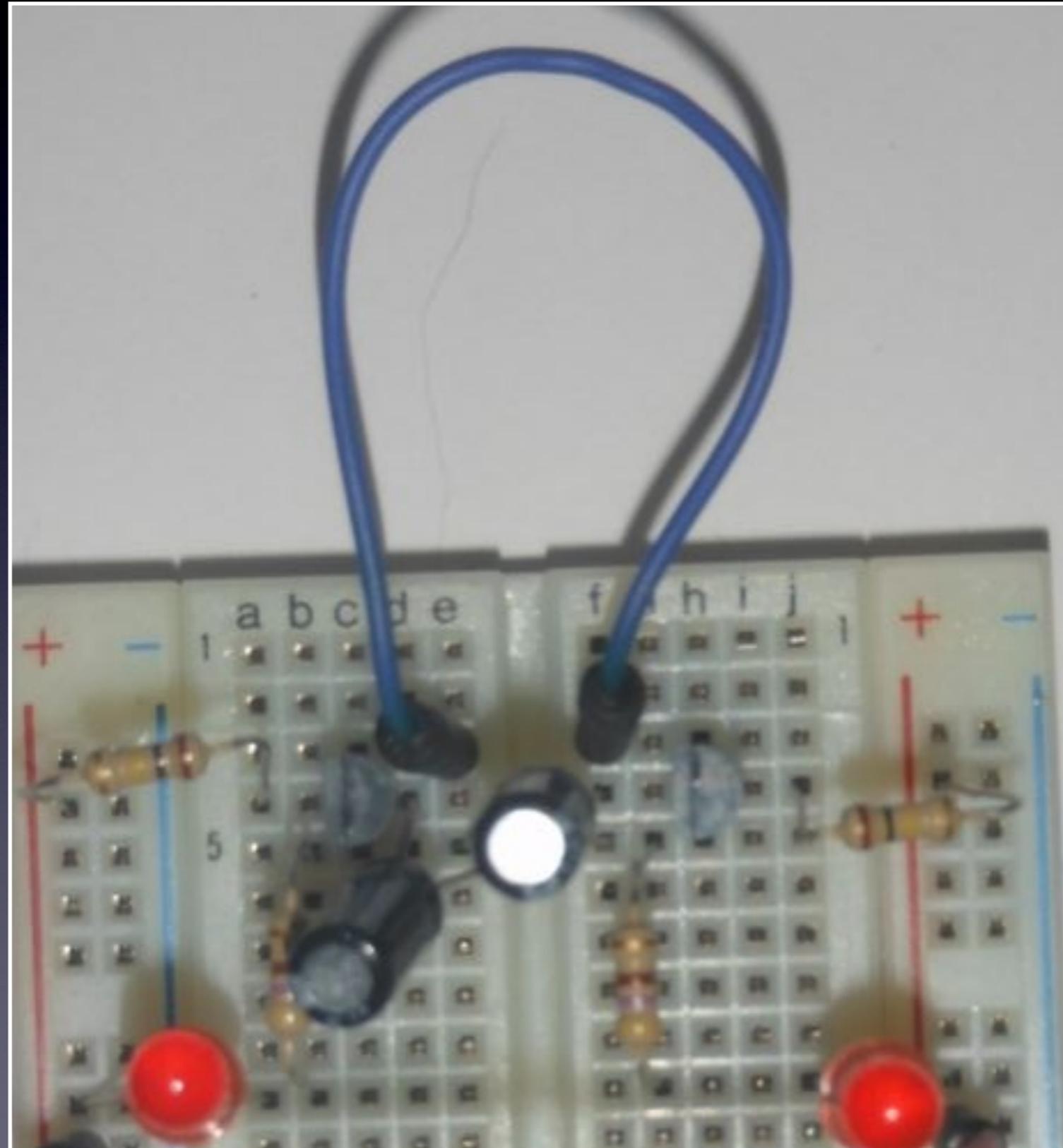
SynShop

Prototyping

Step 8

Place a
jumper to
connect
both
emitters.

E3-F3





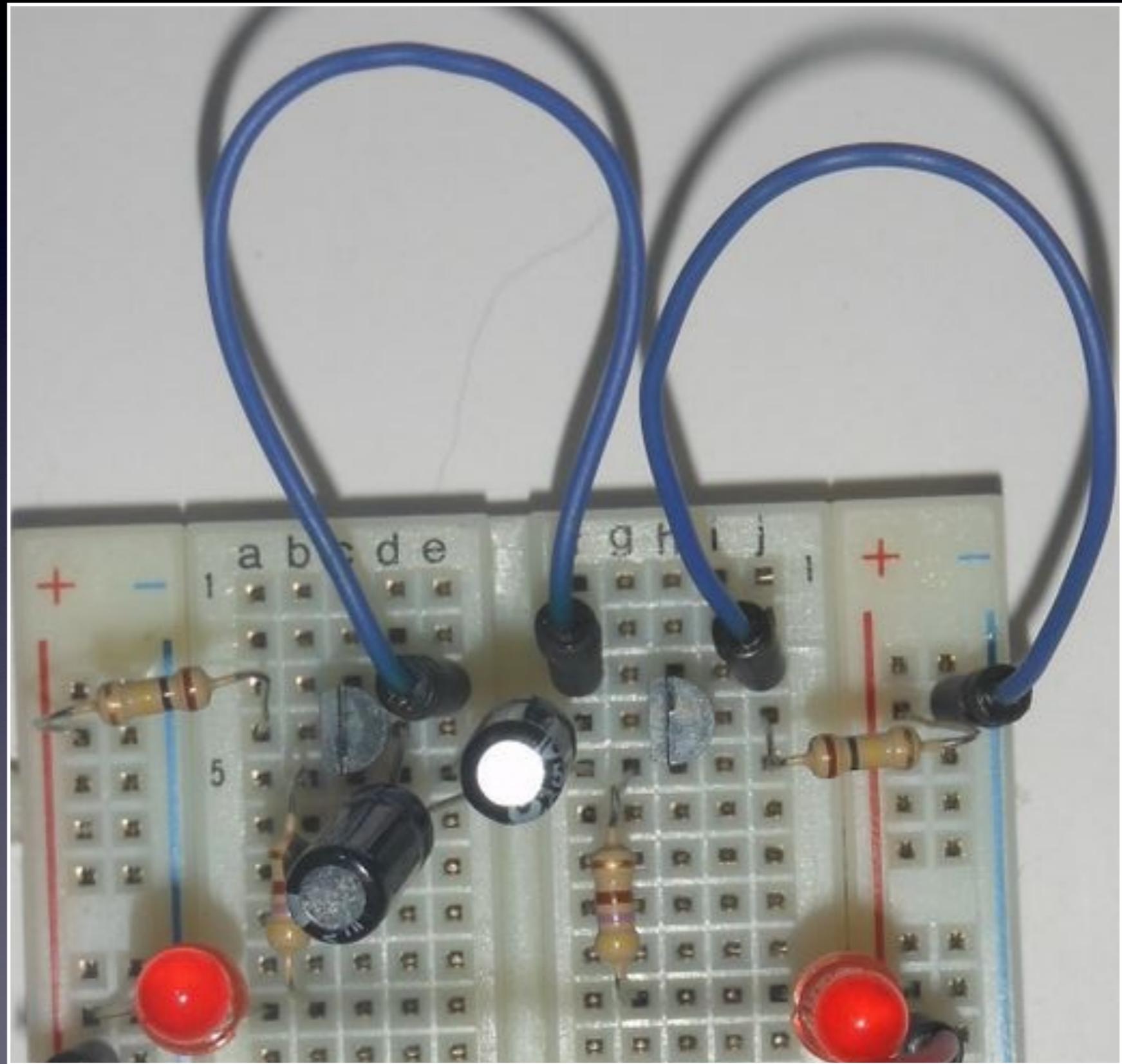
SynShop

Prototyping

Step 9

**Connect
emitters to
ground.**

J3-NR





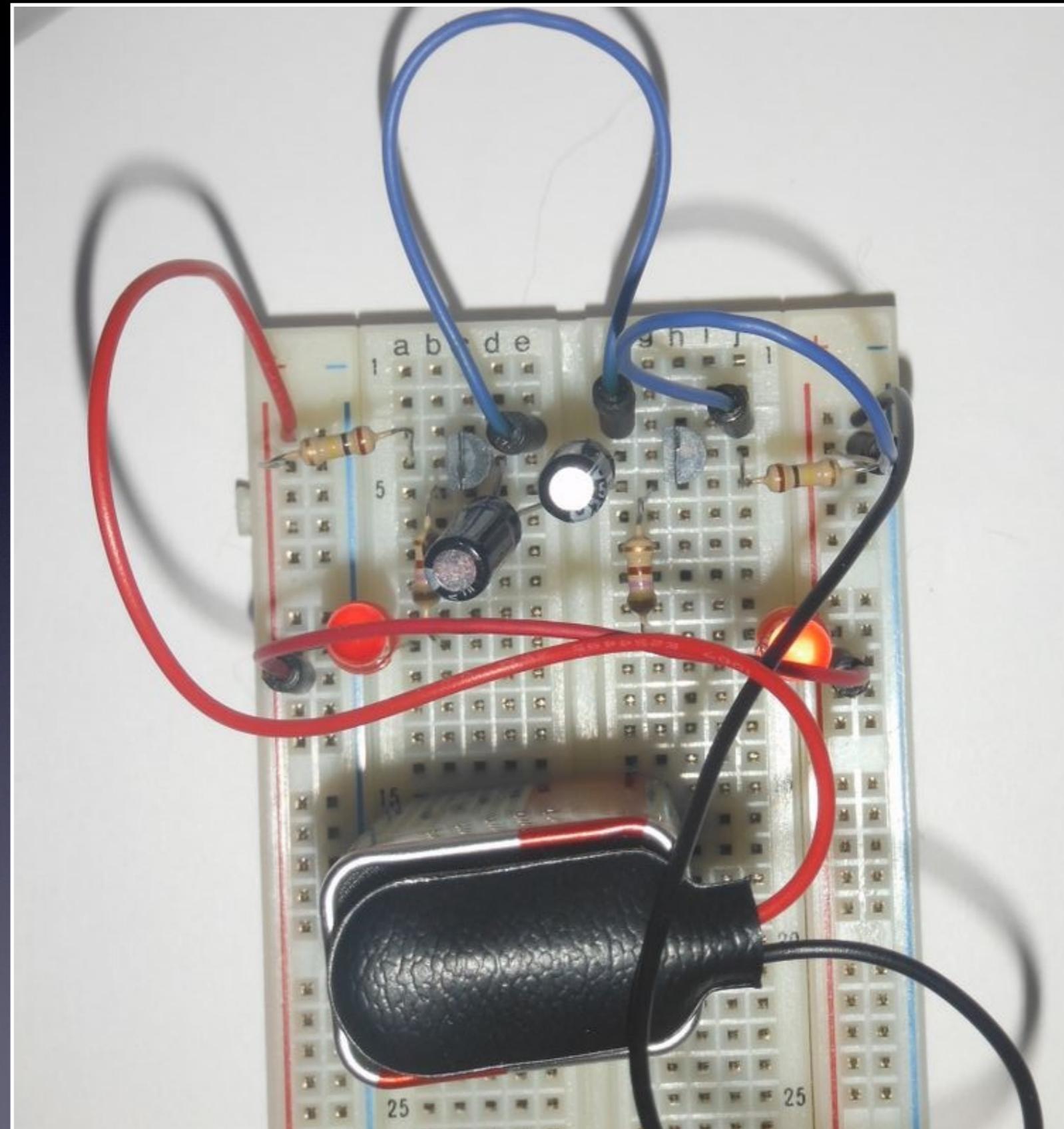
SynShop

Prototyping

Step 10

**Reconnect
battery.**

**Should be
blinking.**





SynShop
Prototyping

Disconnect Battery

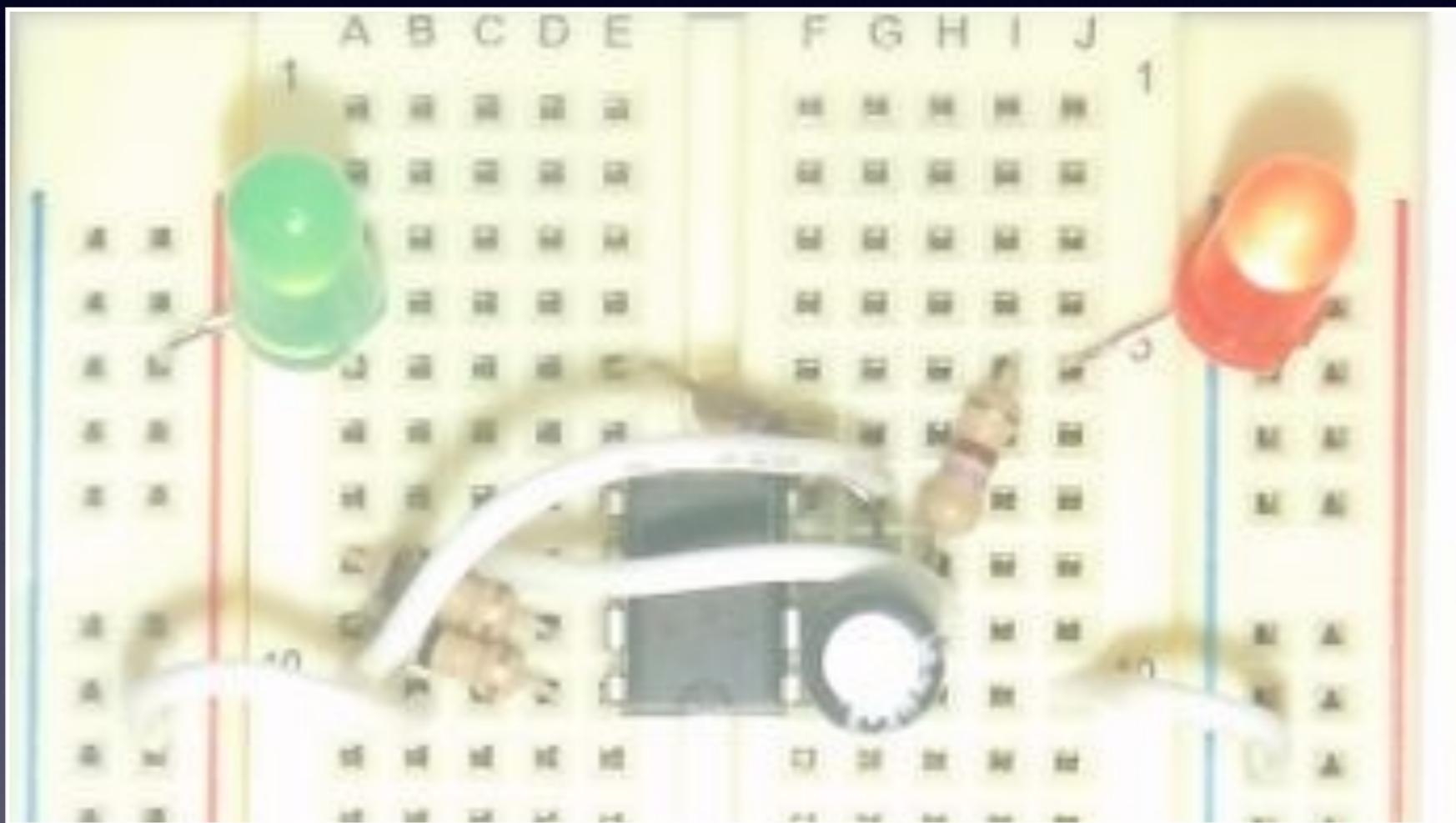
**Never work with circuit powered on.
May destroy parts.
Worse, you may get zapped.**





SynShop
Prototyping

Next build, STOP and GO 555





SynShop Prototyping

In the next build we are placing 2 less components.

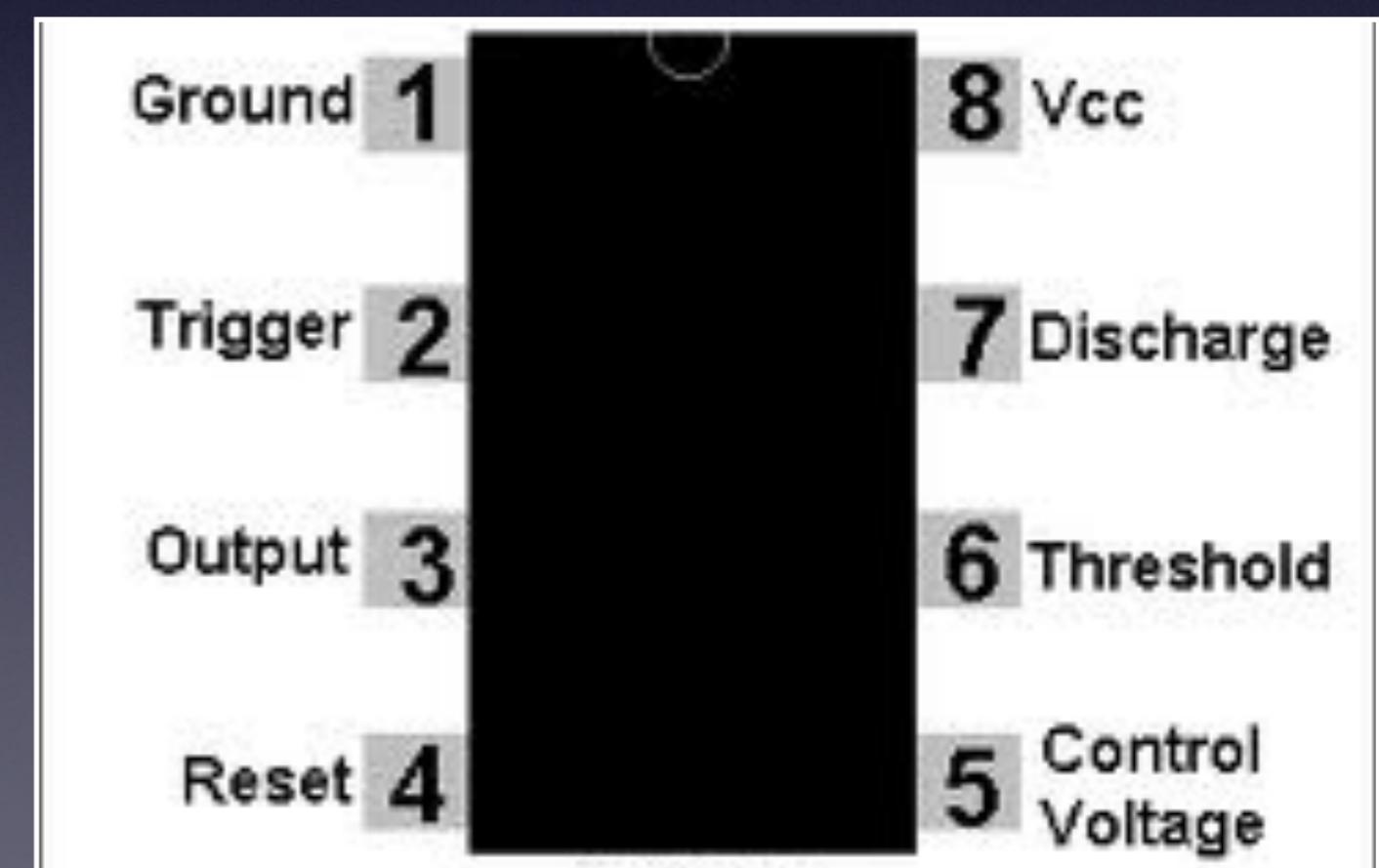
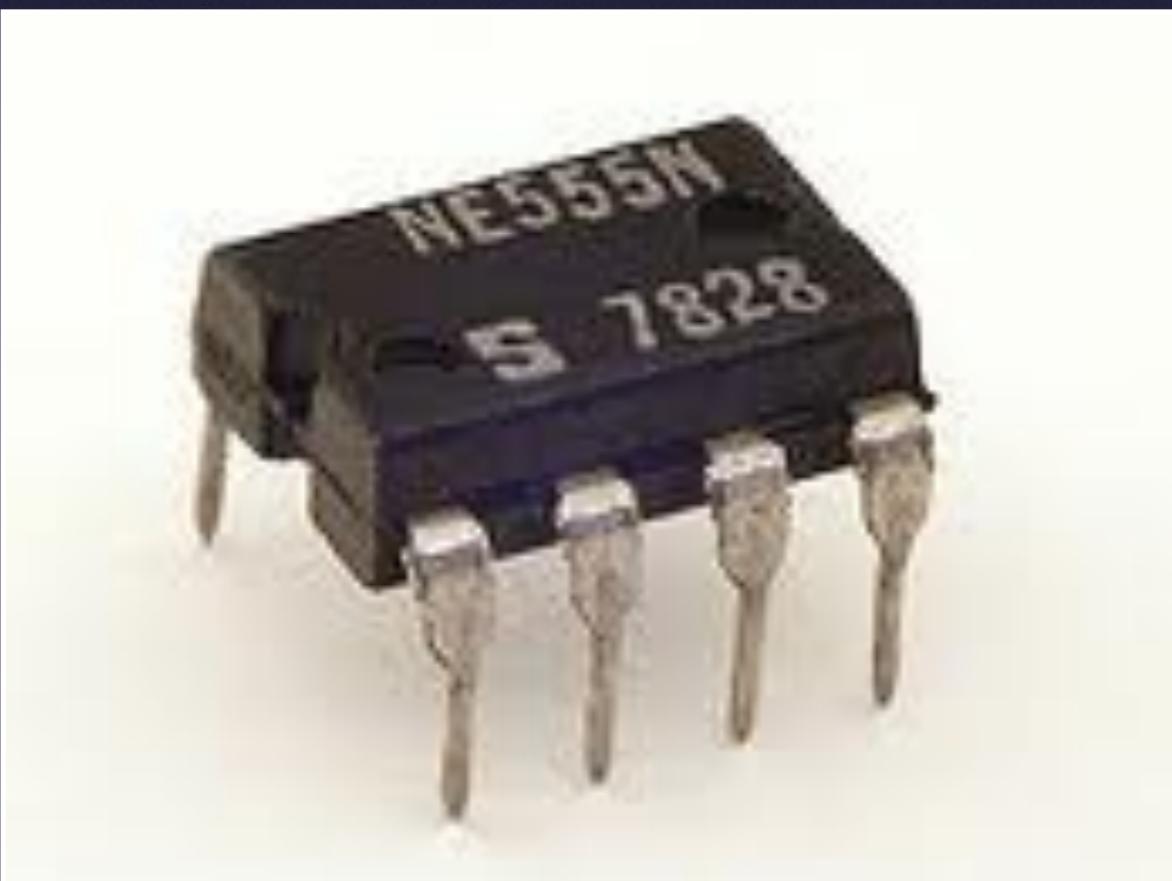
**One of those components is new,
the Integrated Circuit, IC.**



SynShop Prototyping

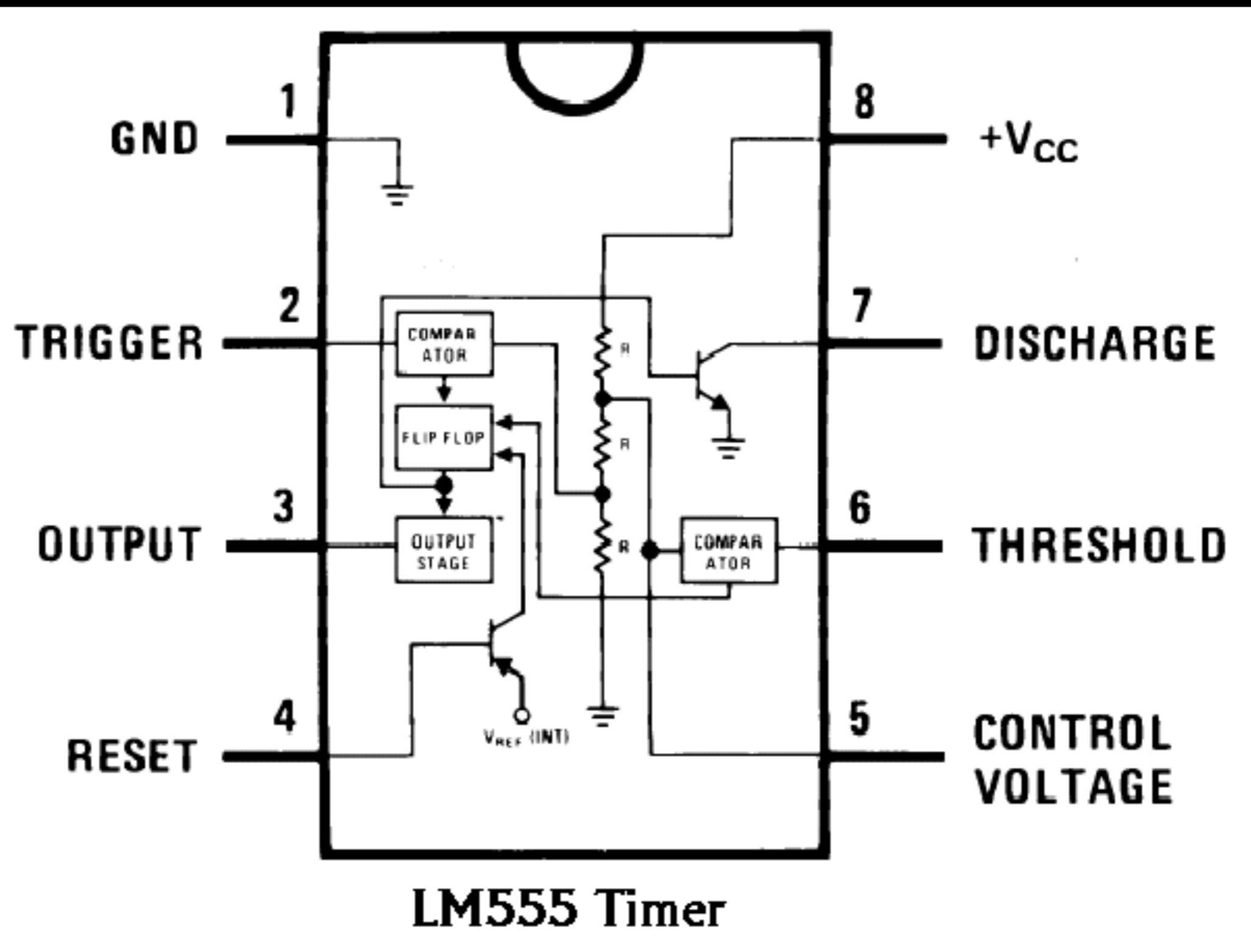
IC

Notch typically goes to the left.
Pin 1 is lower left.





SynShop Prototyping

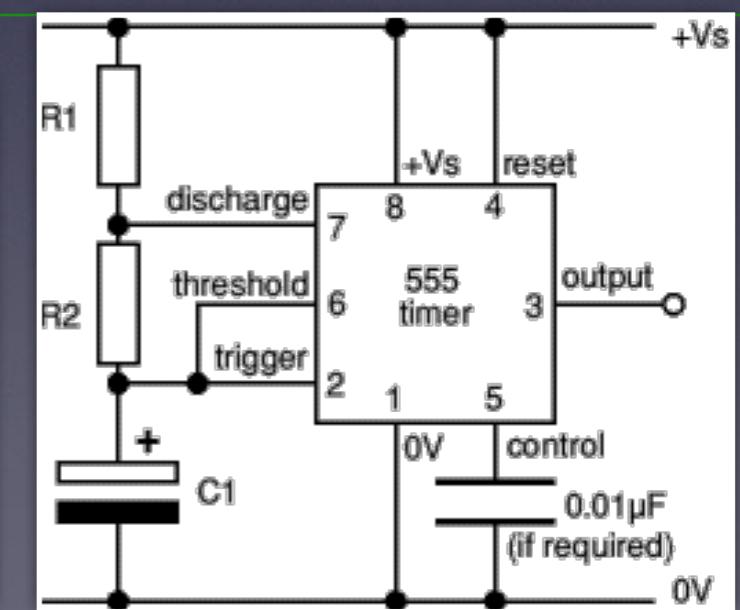
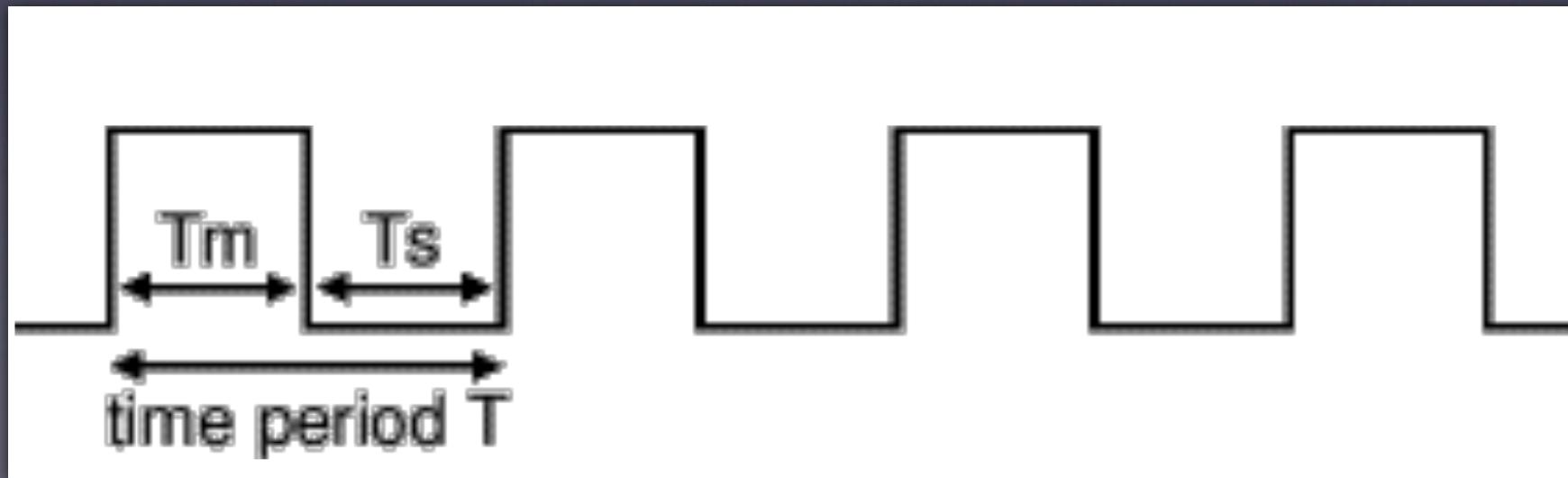




SynShop Prototyping

But why this chip? What does it do?

In our circuit, the timer controls the on and off time of the LEDs.





SynShop
Prototyping

Stop and Go 555 Build

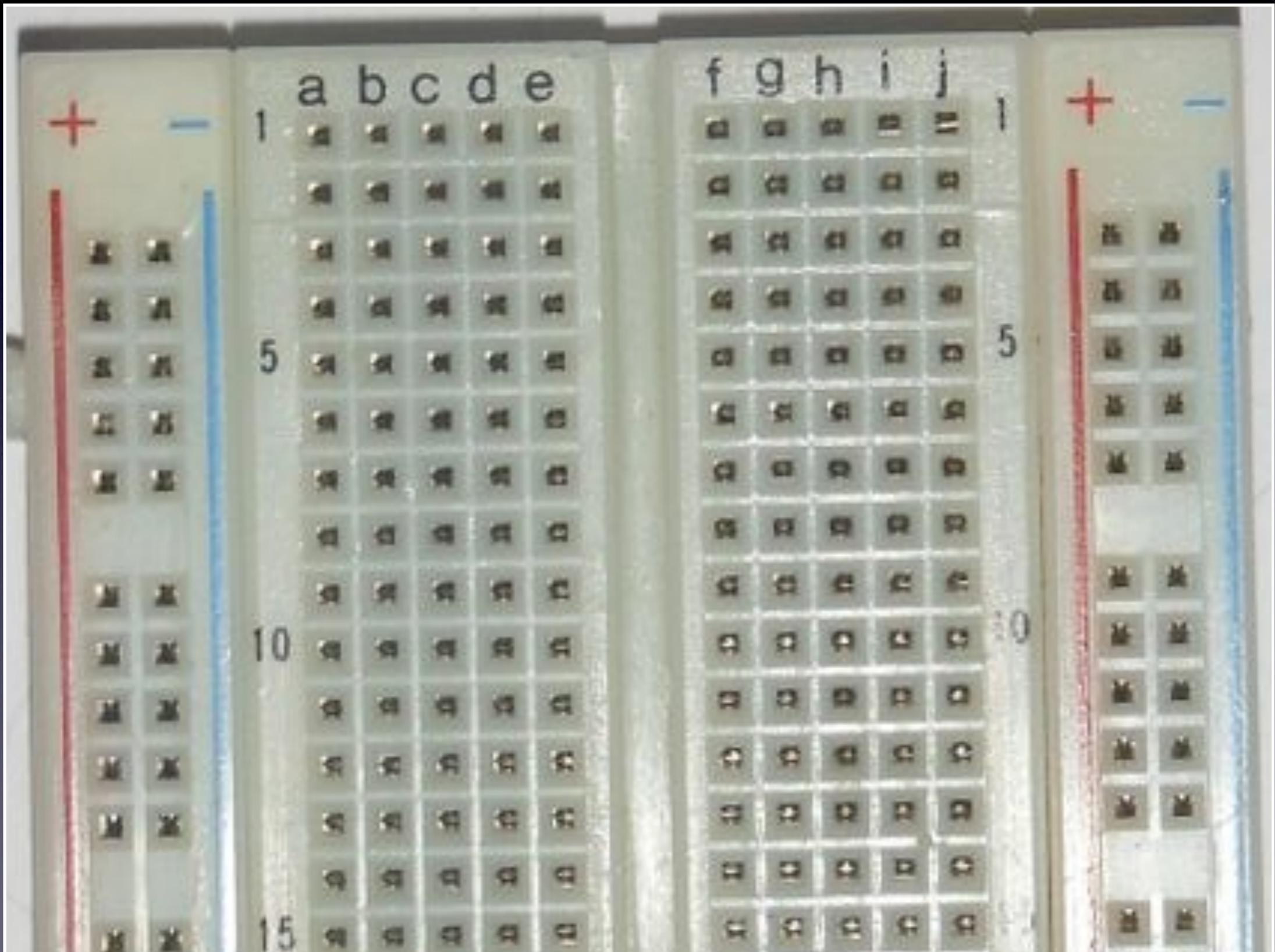


SynShop

Prototyping

Step 1

Orientate
board with
low
numbers
at the top.





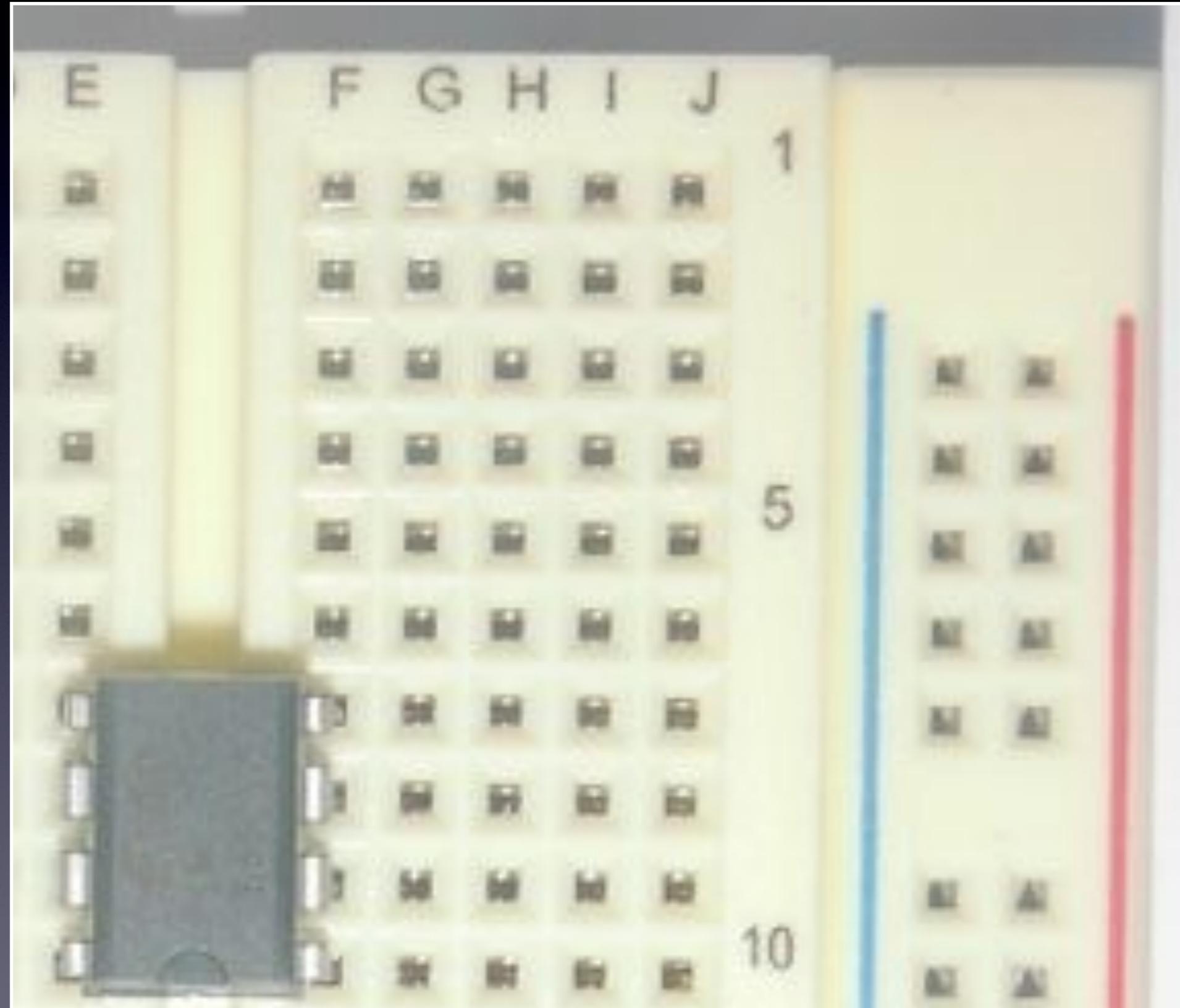
SynShop

Prototyping

Step 2

Place IC
with pin 1
at F10.

E7-F10





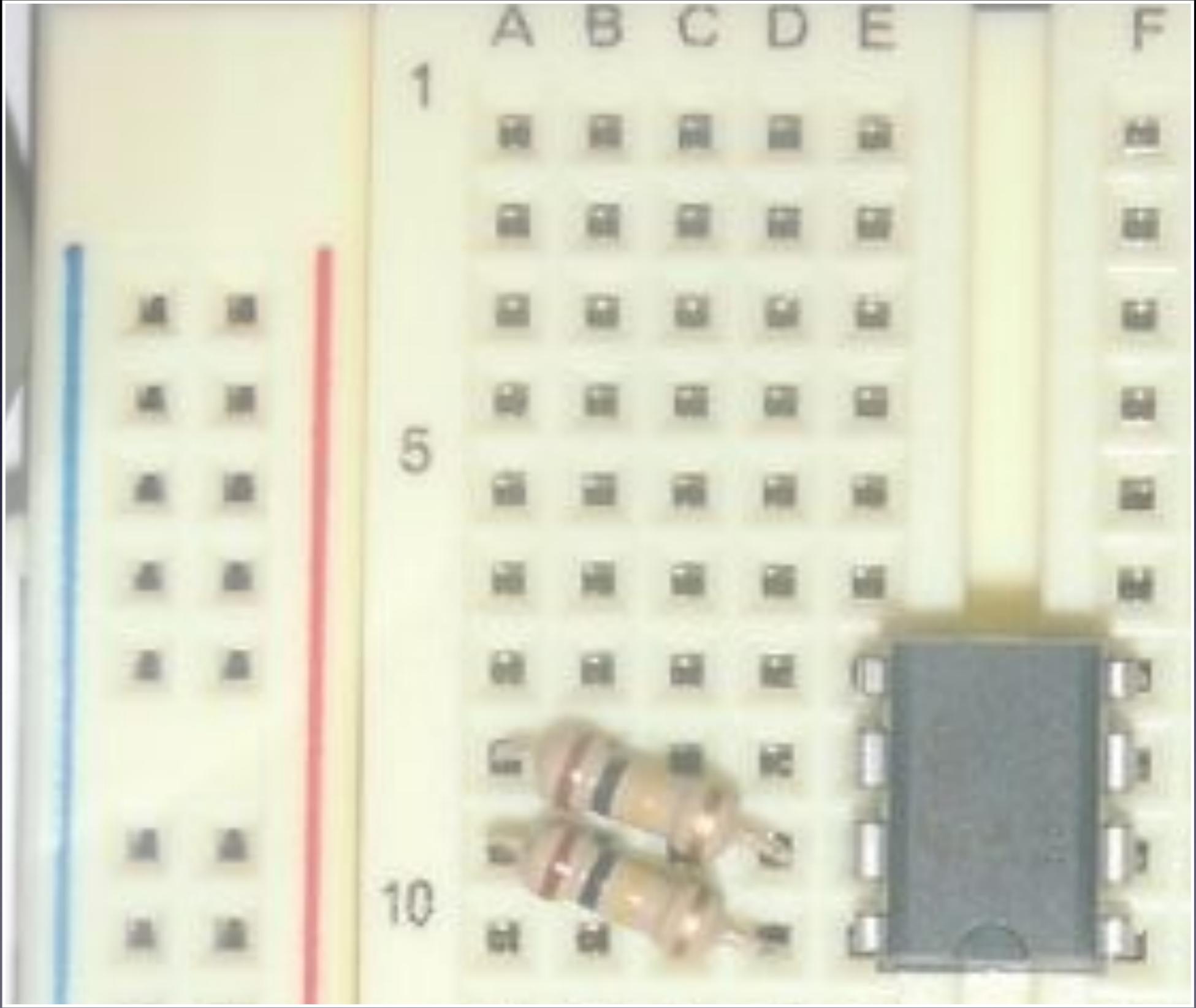
SynShop

Prototyping

Step 3

Place 100k
resistors
from pins
8-7, and
pins 7-6.

A9-D10
A8-D9





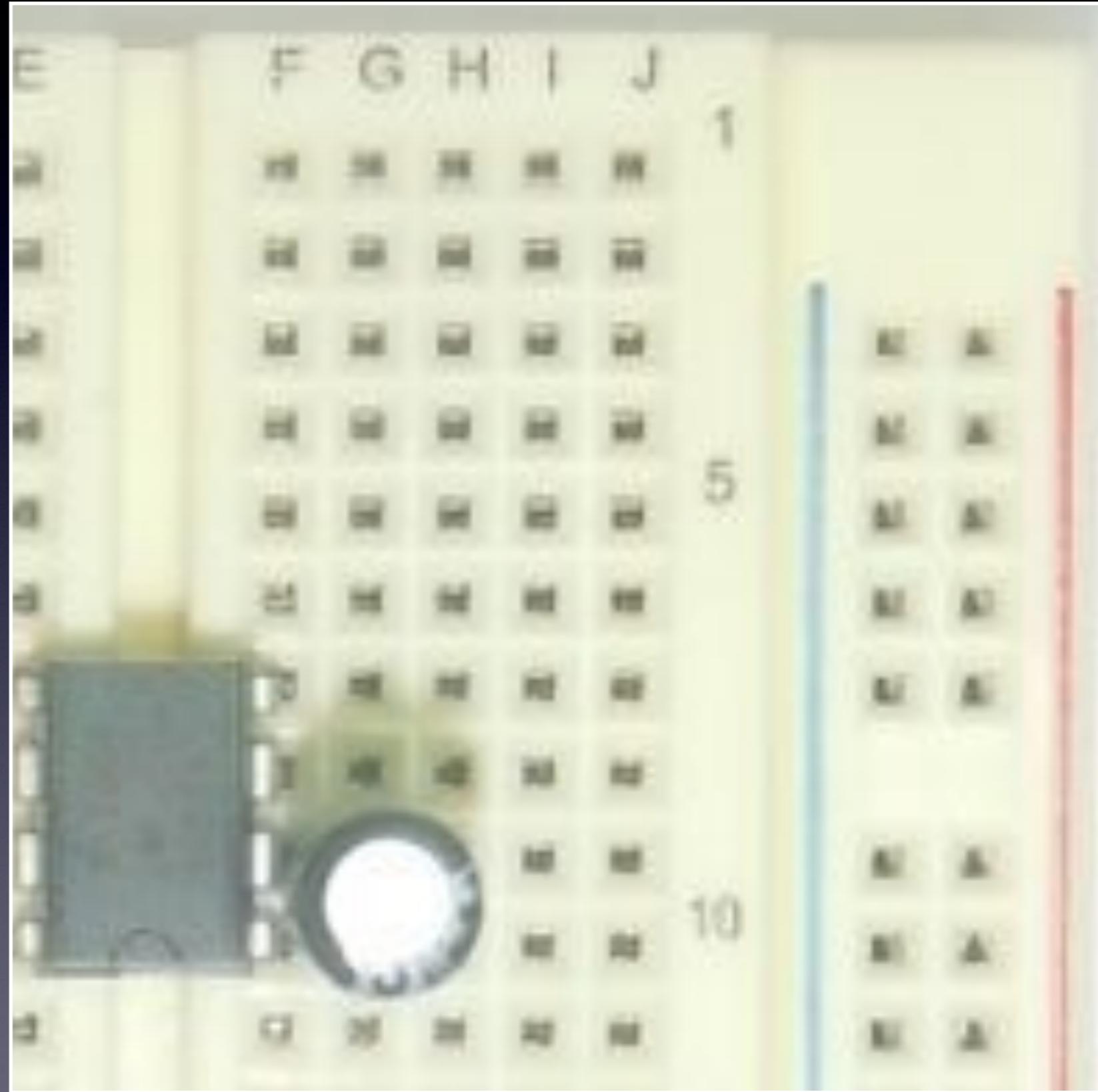
SynShop

Prototyping

Step 4

Place
capacitor
long leg at
pin 2,
short leg
at pin 1.

G9+ G10-



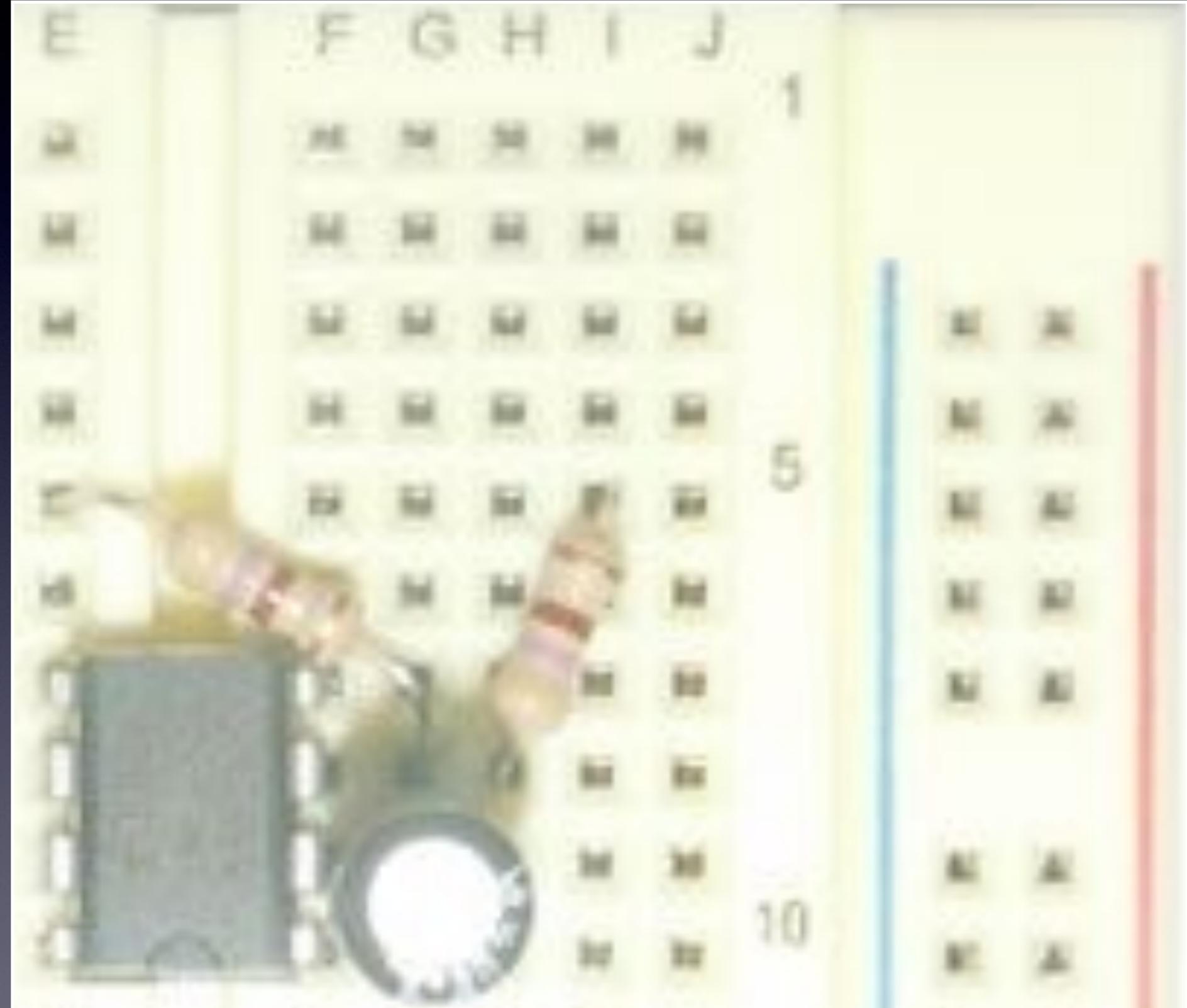


SynShop Prototyping

Step 5

Place 470 ohm resistors from pin 3 to row 5.

E5-G8
I5-H8





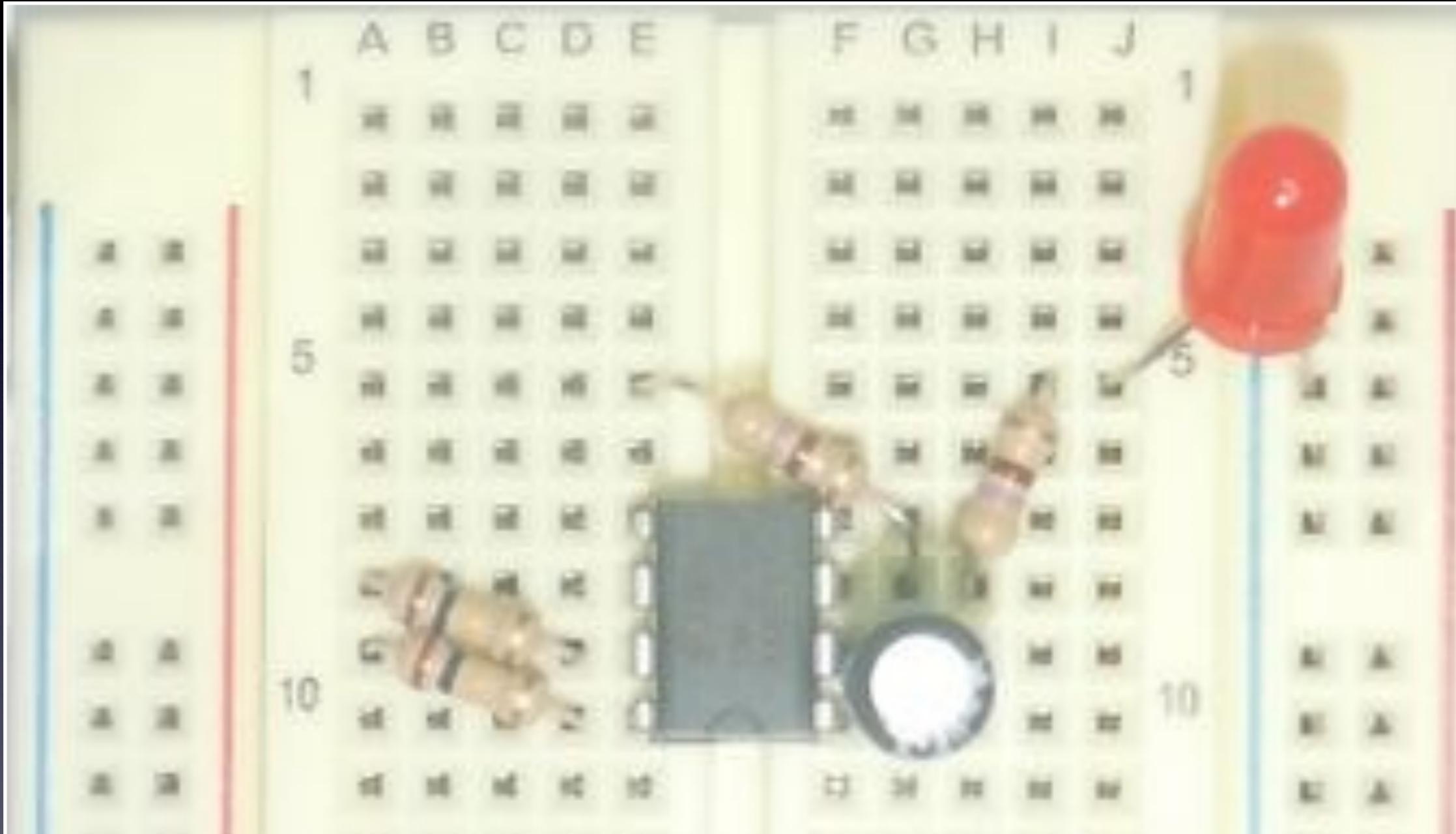
SynShop

Prototyping

Step 6

**Place LED
from row
10 long
leg to
Ground
Rail short
leg.**

J5+ GR-





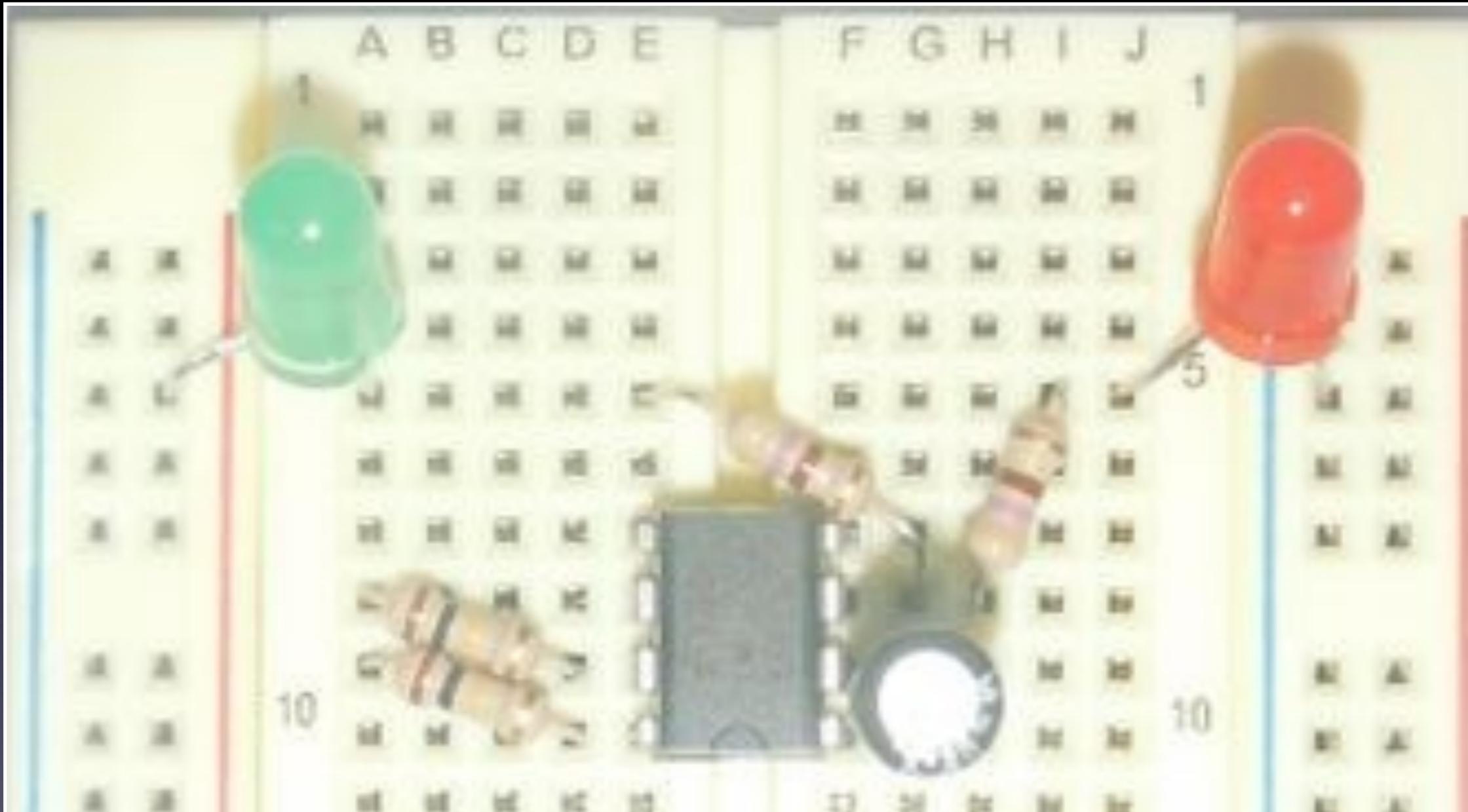
SynShop

Prototyping

Step 7

Place
green LED
from row
10 short
leg to
positive
rail long
leg.

A5- PR+





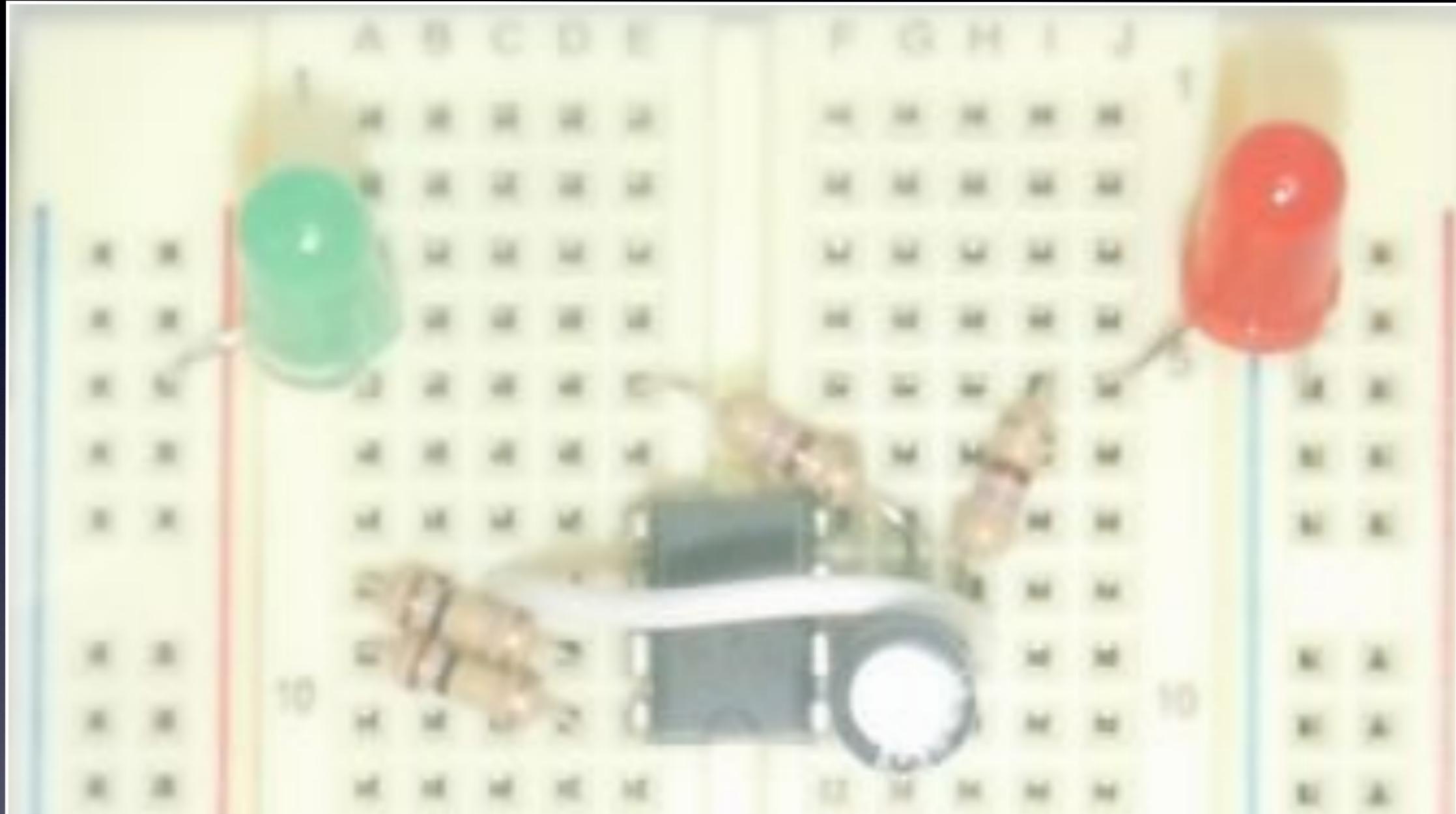
SynShop

Prototyping

Step 8

**Jumper
pin 6 to
pin 2.**

C8-H9





SynShop

Prototyping

Step 9

**Jumper
pin 8 to
pin 4.**

A10-G7





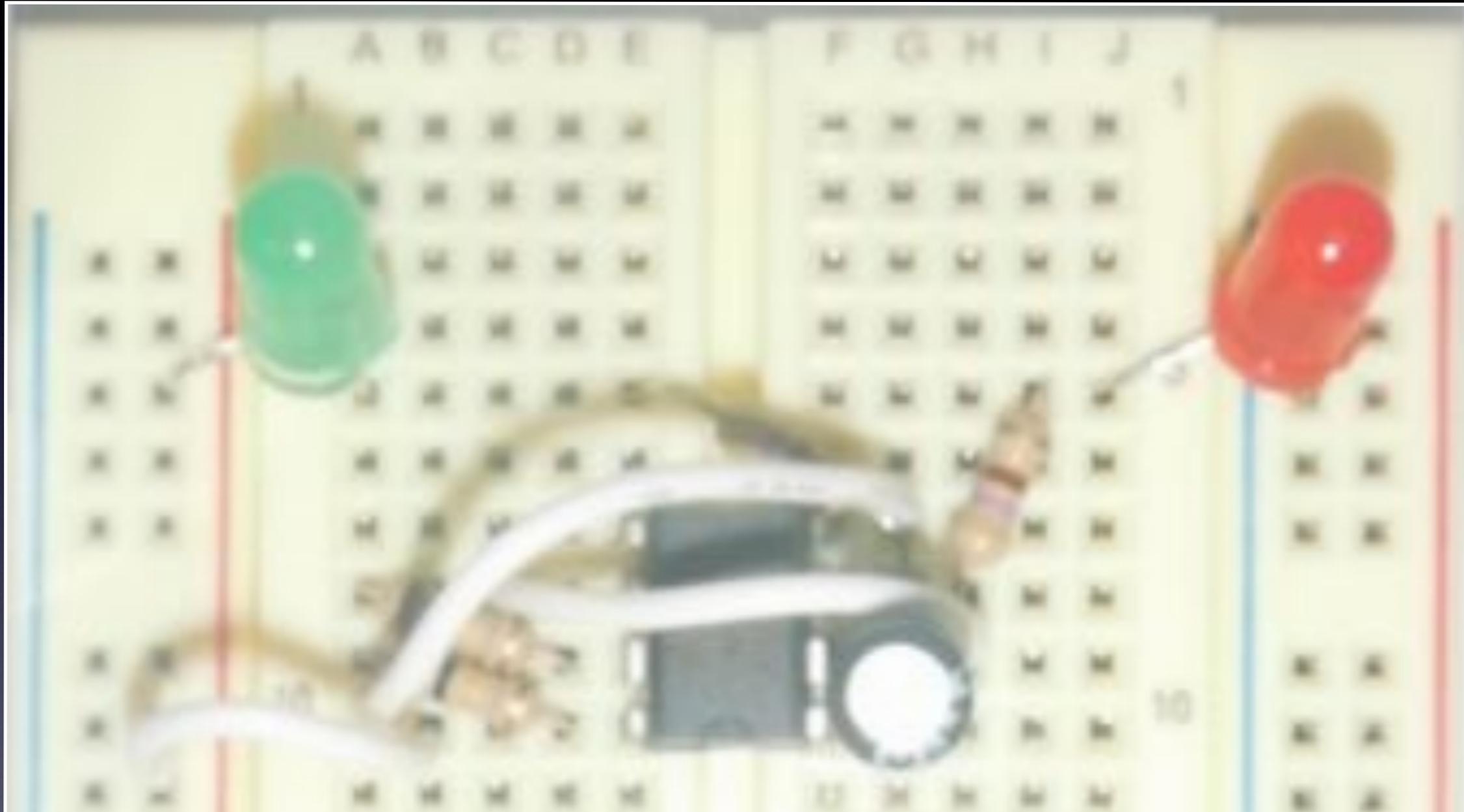
SynShop

Prototyping

Step 10

**Jumper
pin 8 to
positive
rail.**

B10-PR





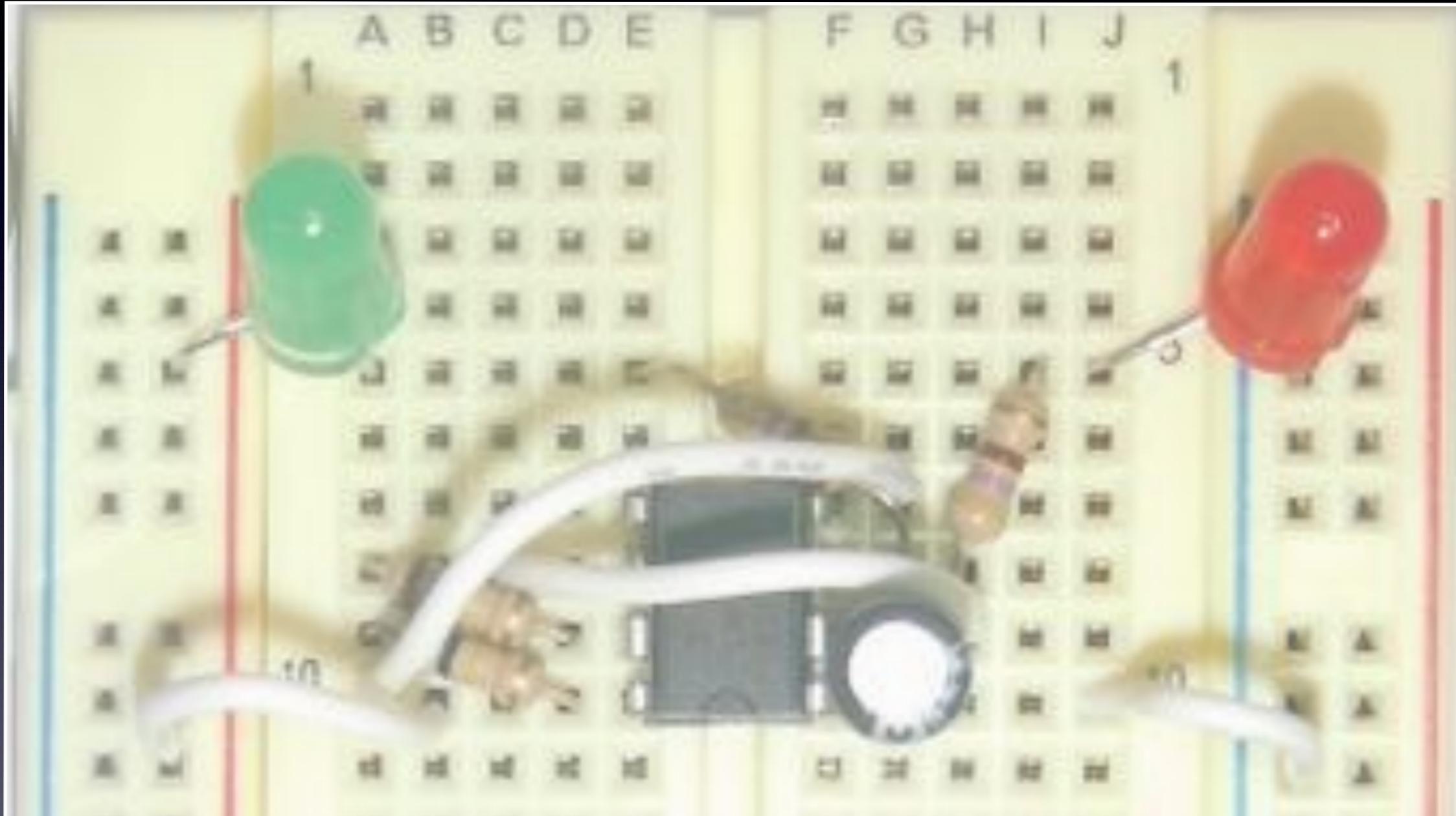
SynShop

Prototyping

Step 11

**Jumper
pin 1 to
pin
negative
rail.**

J10-NR





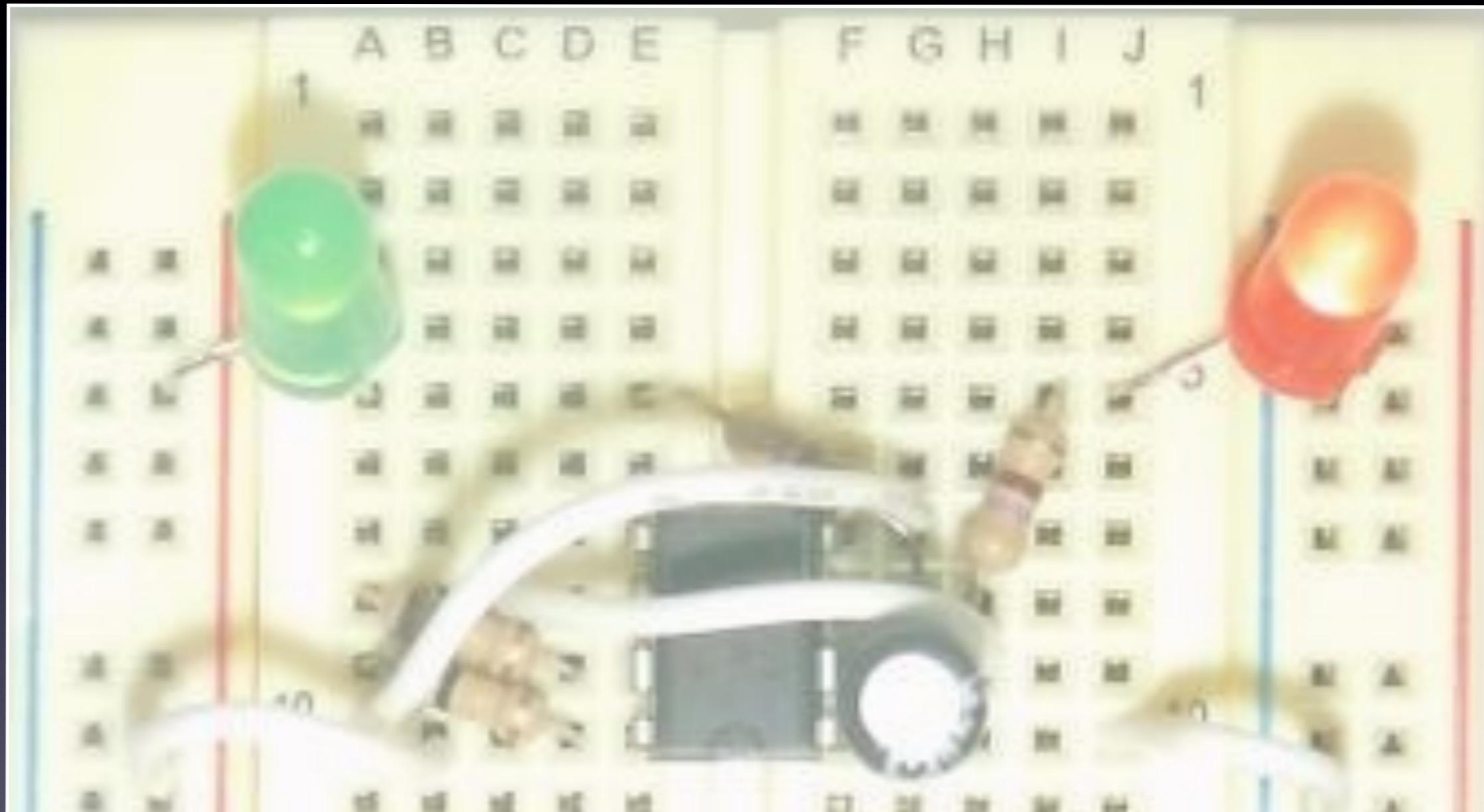
SynShop

Prototyping

Step 12

**Connect
battery.**

**Should
start
blinking.**





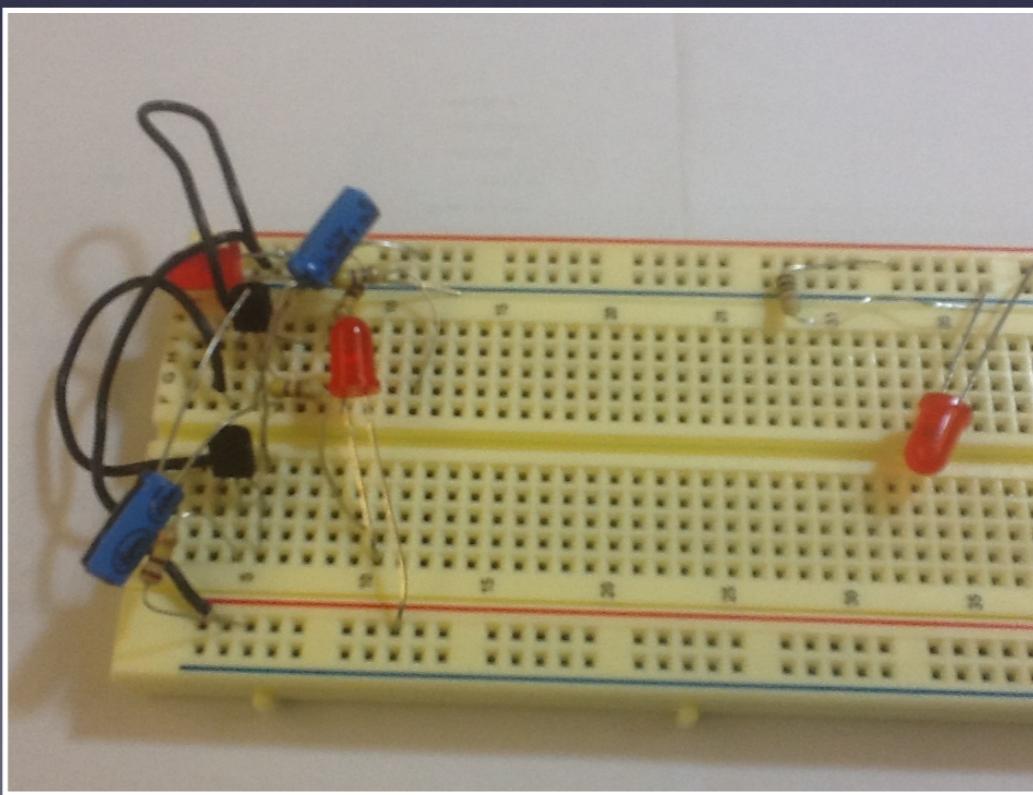
SynShop Prototyping

Going farther...



SynShop
Prototyping

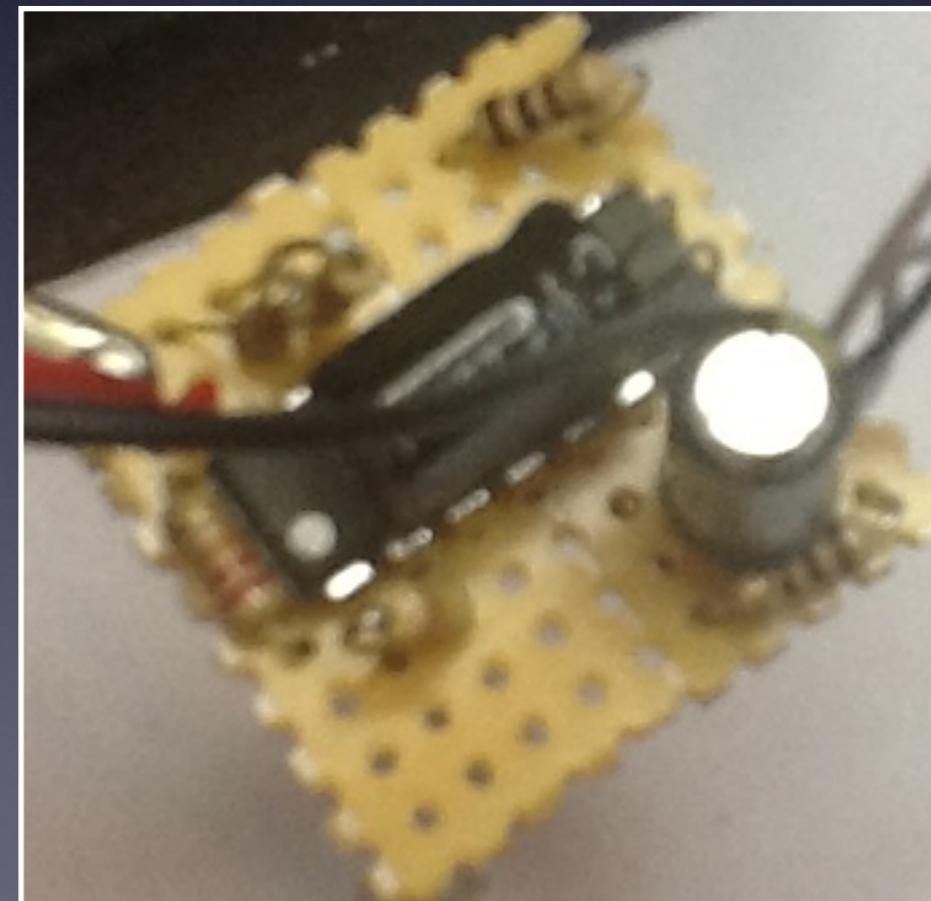
Breadboards are great for fast builds, but not very permanent. Parts can easily get smushed or fall out.





SynShop
Prototyping

Protoboard is simply a preprinted Printed Circuit Board (Pcb) that we use like a breadboard.





SynShop

Prototyping

**Except that we solder the stuff in.
Typically messy due to the number
of connections we have to make.**



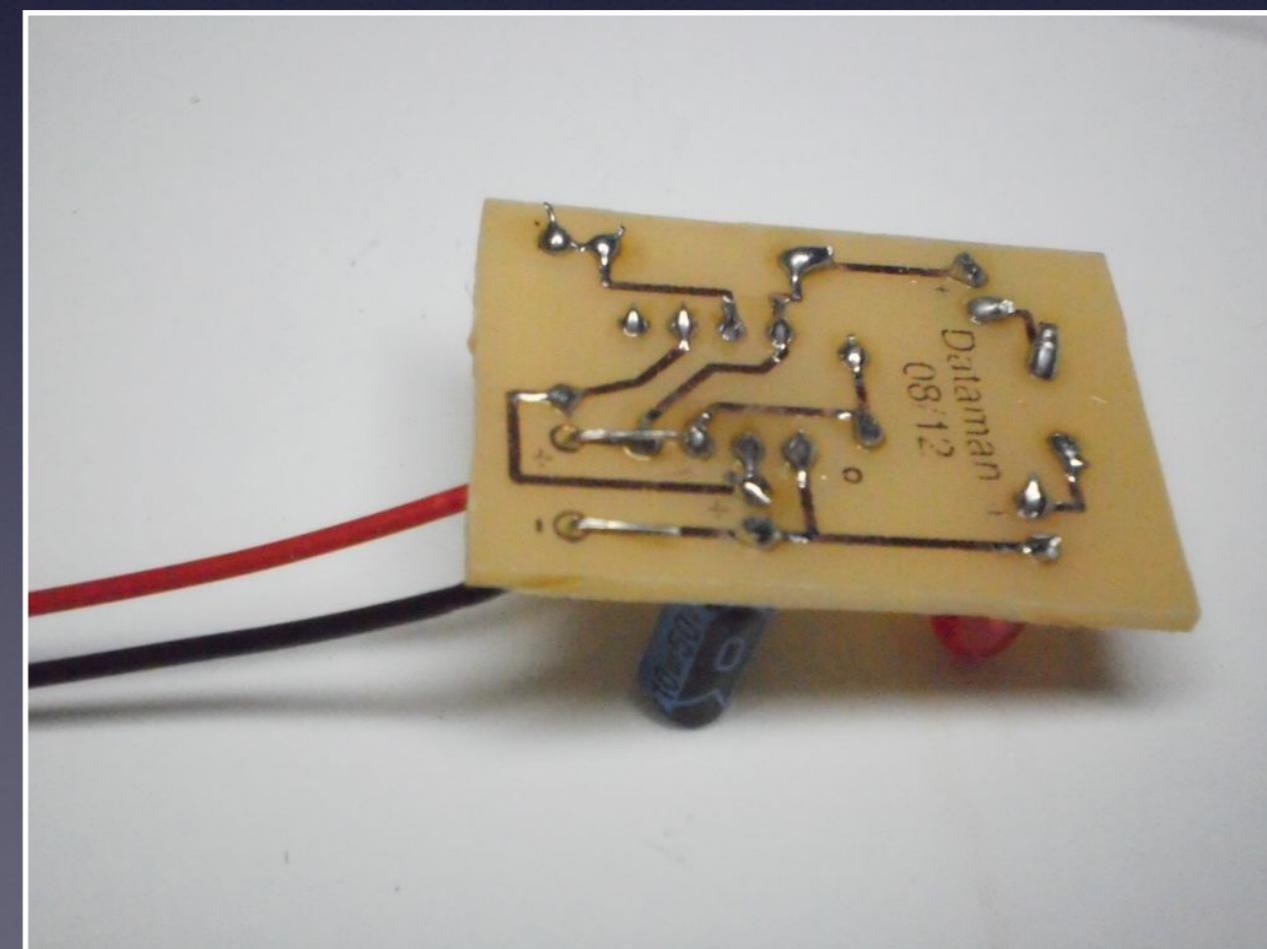


SynShop Prototyping

Printed circuits boards (pcb) are customized designed to out circuit and make all the connections.



91

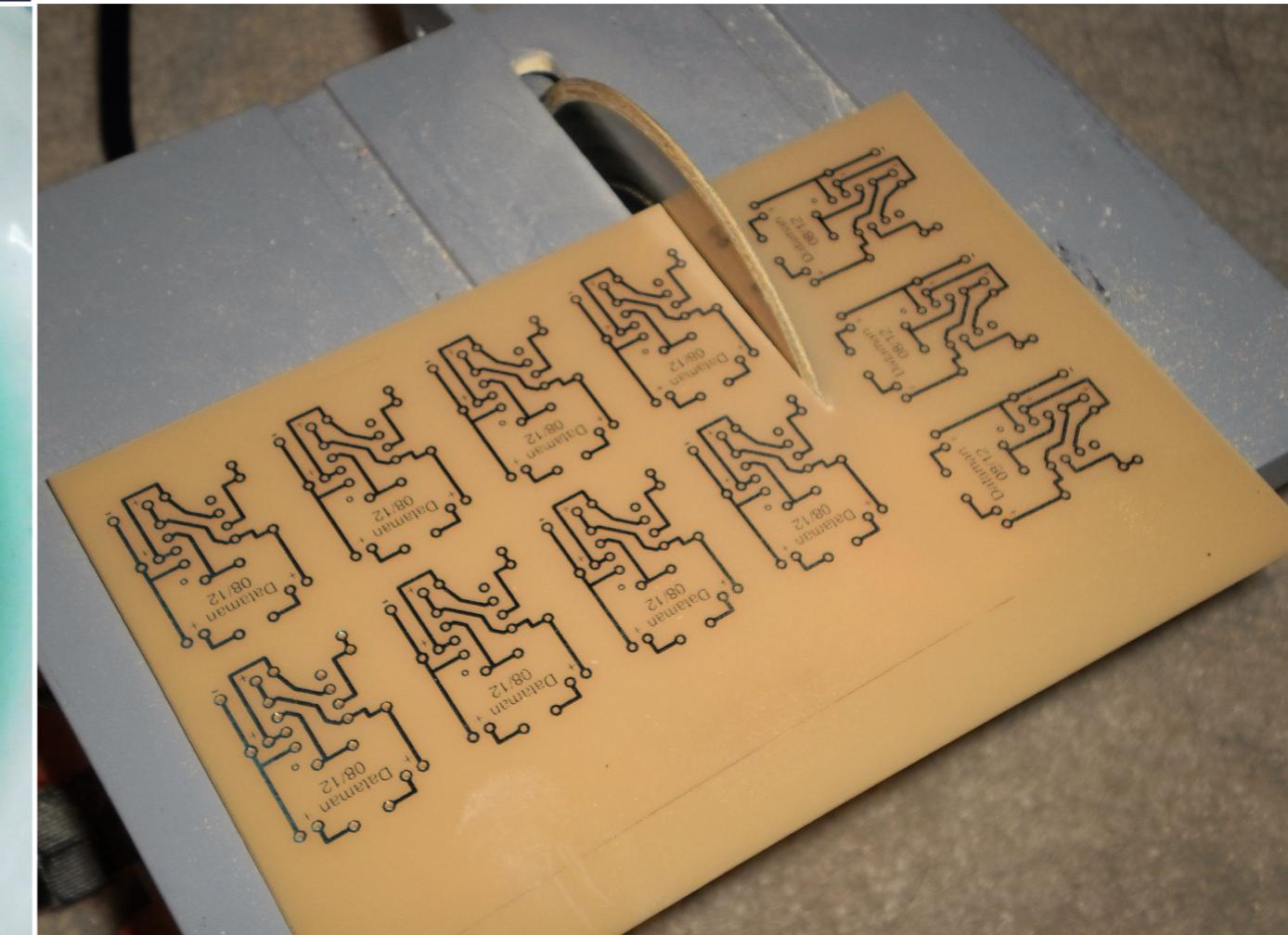
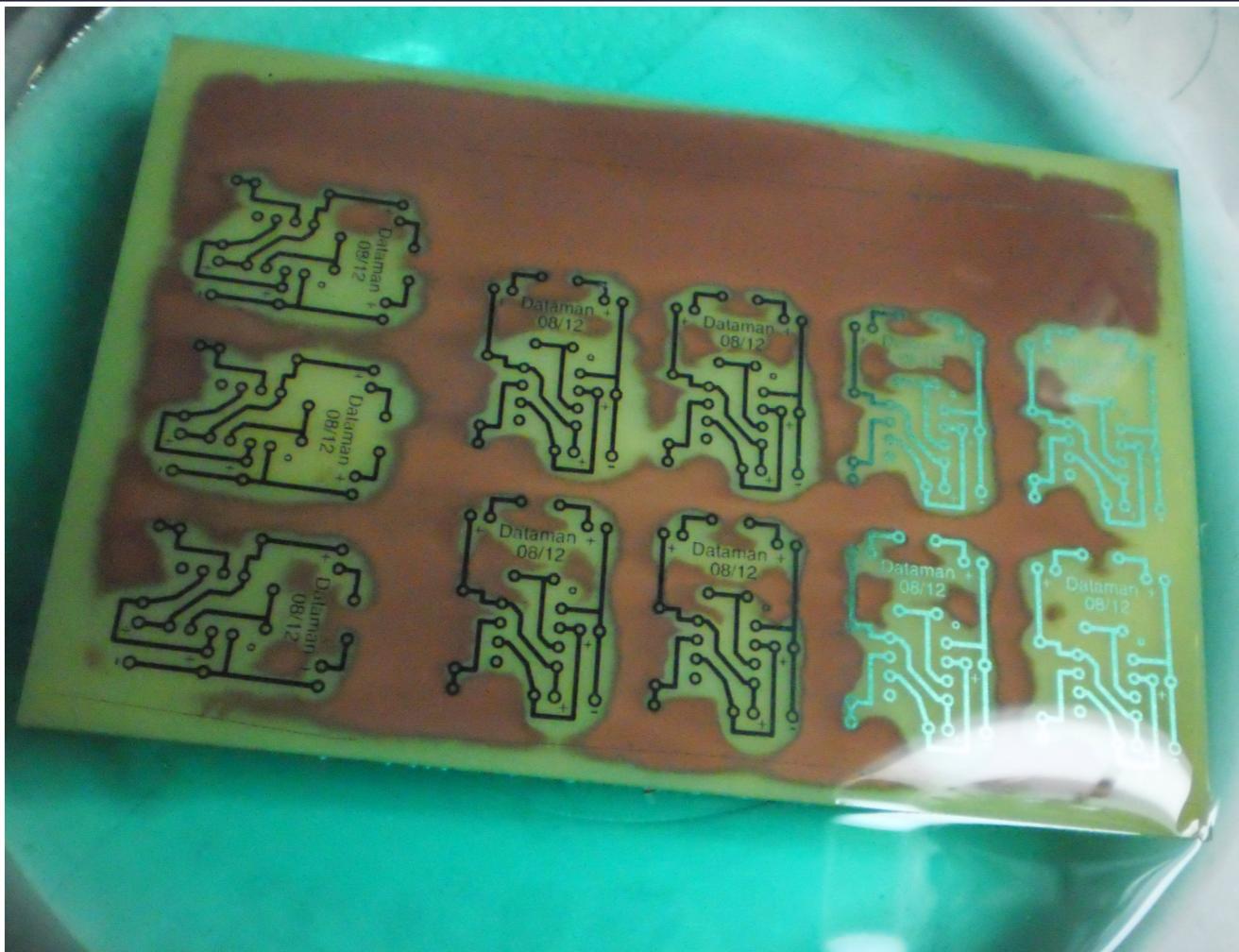




SynShop

Prototyping

You can even
make your own PCBs.





SynShop
Prototyping

We cover both
protoboards and PCBs
in the next class:

Soldering Buildup.



SynShop Prototyping

And that's the class.



SynShop
Prototyping

And that's 3 full circuits!

**Take home the parts!
Build this over and over.**



SynShop Prototyping



There was no cost for this class, but I did have out of pocket expenses. (\$2.50/kit)
Please leave a couple bucks in the tip jar if possible. Anything above cost goes to Synshop.



SynShop Prototyping

This entire course is published
github.com/dataman/PrototypeBuildup

Or simply go to
github.com/dataman





SynShop Prototyping



Thank You!