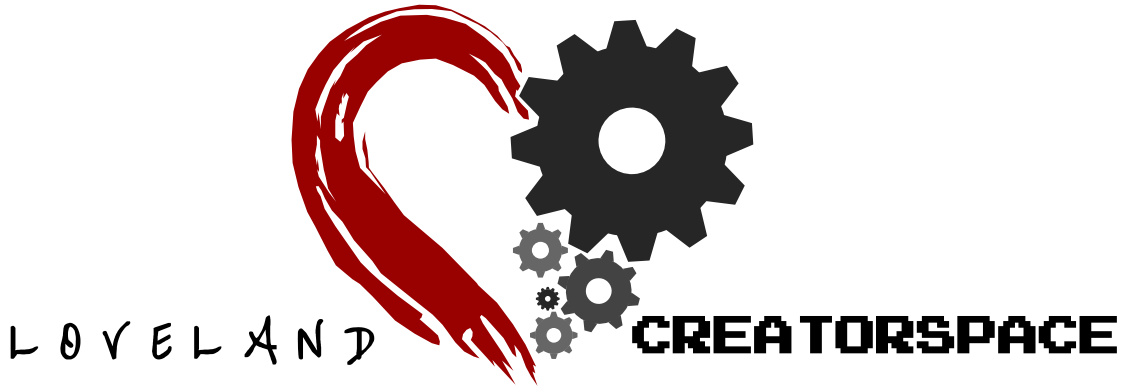
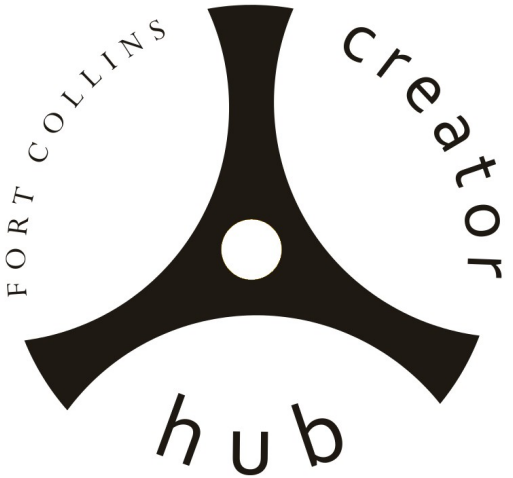
Building Oscillating Circuits
(multivibrators)
Using Transistors





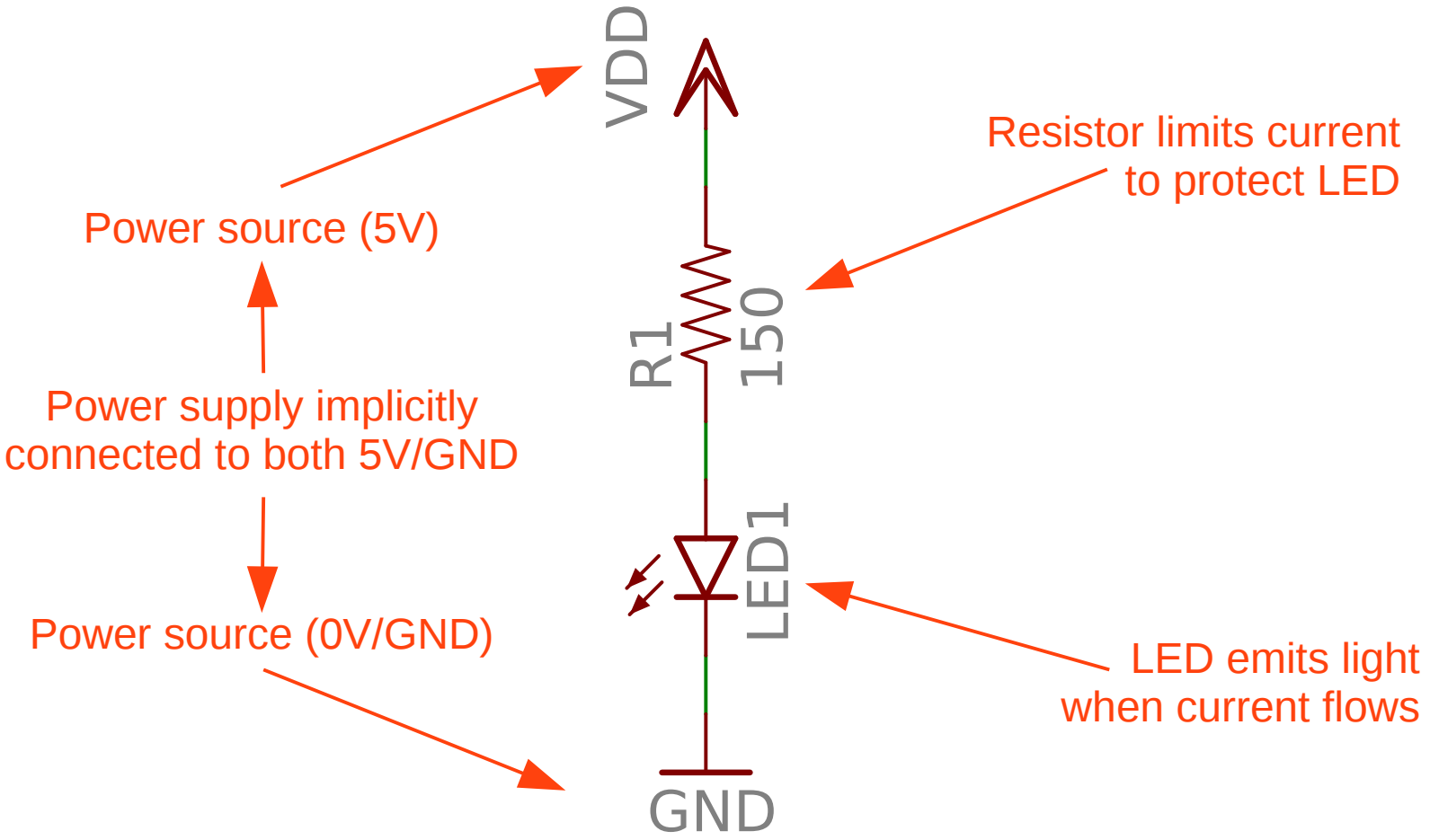
Introduction

- What is a multivibrator?
- Different types (bistable, monostable, bistable)
- Walk through of the circuits
- Build the circuits

What's a multivibrator?

- Circuit that has two states, and changes (vibrates, oscillates) between them
- Bistable – Stable in both states (Bi: 2)
  - Moves between states only when forced externally
- Monostable – Stable in just one state (Mono: 1)
  - Moves from state A to B by external force
  - Moves from state B to A after a time delay
- Astable – Stable in neither state (A: Not)
  - Autonomously oscillates between the states

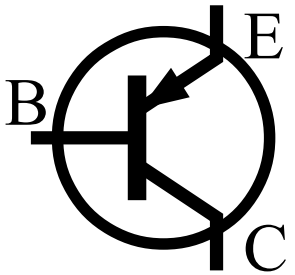
LED Circuit



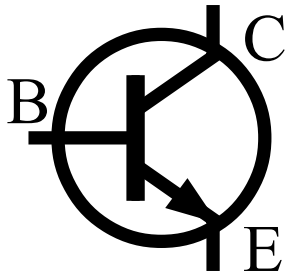
(Bipolar) Transistors

- A transistor can be a switch,
  or electronically controlled variable resistor
- Transistors generally have 3 pins
- For Bipolar transistors, these are named:
  - Collector
  - Base
  - Emitter
- Base voltage controls whether (how much) the Collector and Emitter are connected

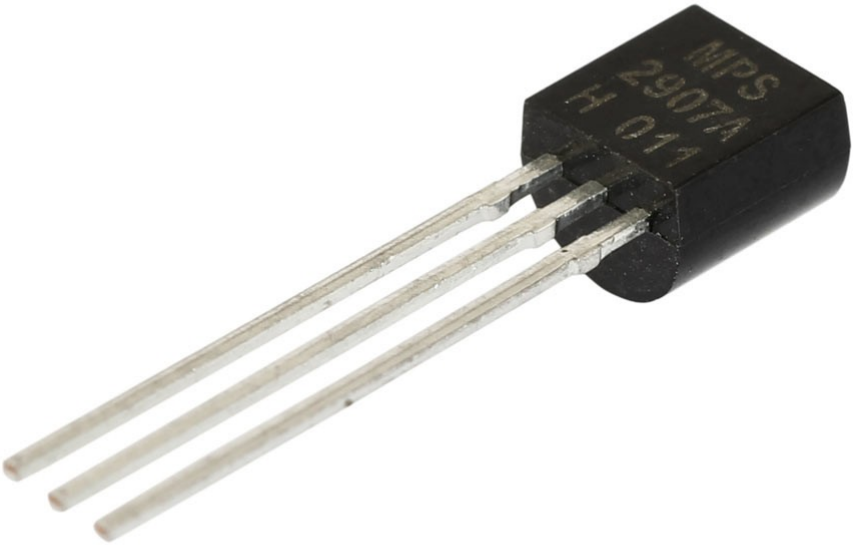
Transistor – Pictures and Symbols



PNP
(**P**ointing i**N** **P**roudly)



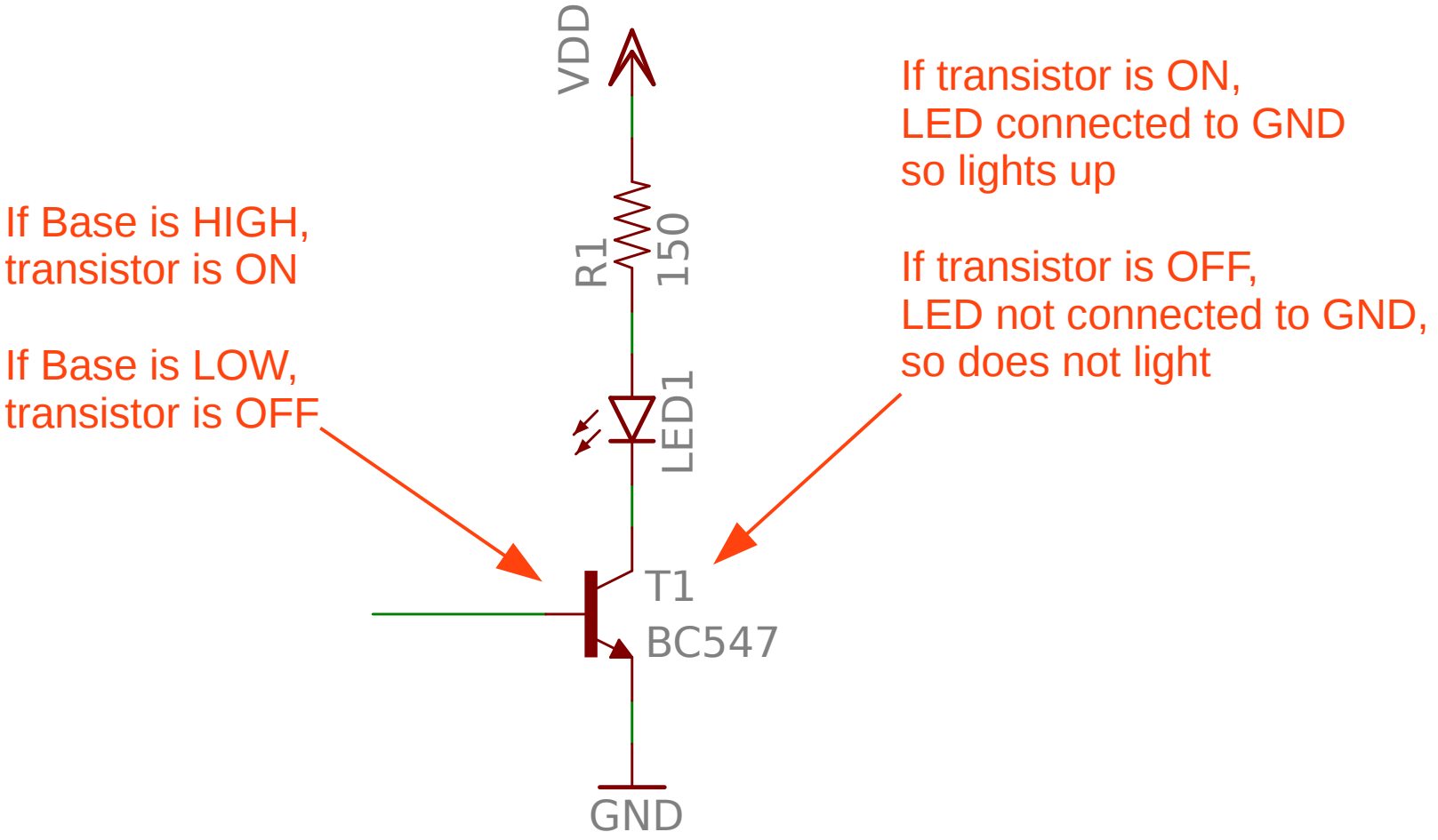
NPN
(**N**ot **P**ointing i**N**)



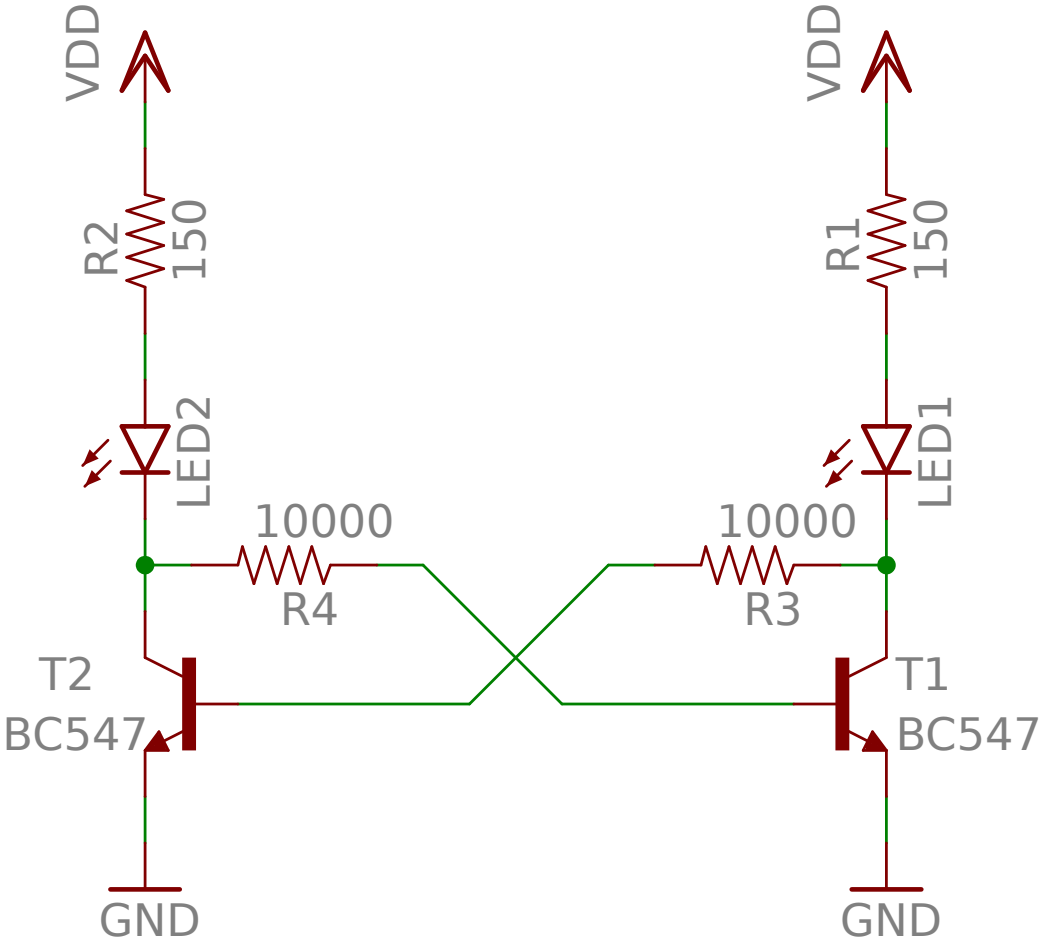
Transistors - Operation

- Base-Emitter current determines
  Collector-Emitter current
- Transistors often characterized as amplifying current:
  The more Base current flows,
  the more Collector-Emitter current can flow.
- A Base voltage is required
  to cause a Base current to flow
- NPN: Turns on when Base is high (cf. Emitter)
- PNP: Turns on when Base is low (cf. Emitter)

Transistor Circuit

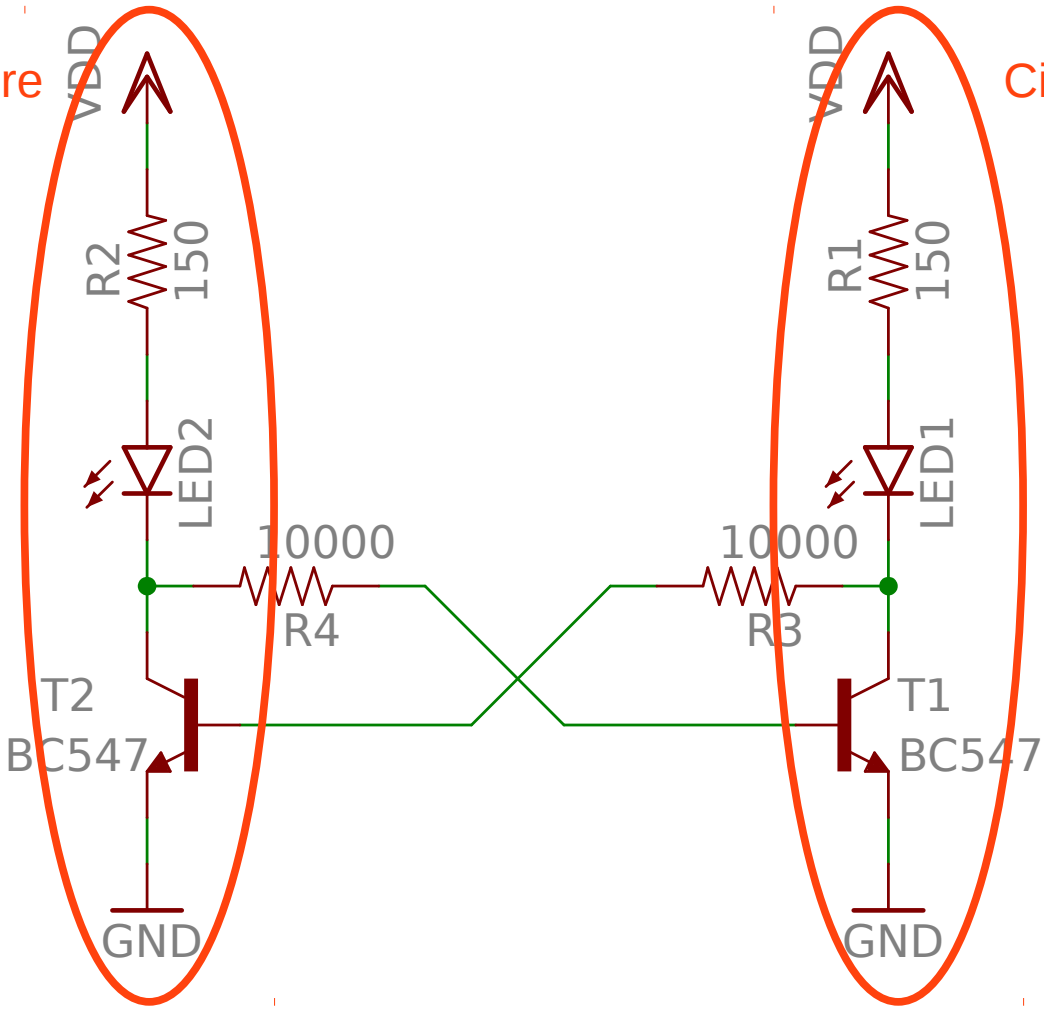


Bistable Circuit



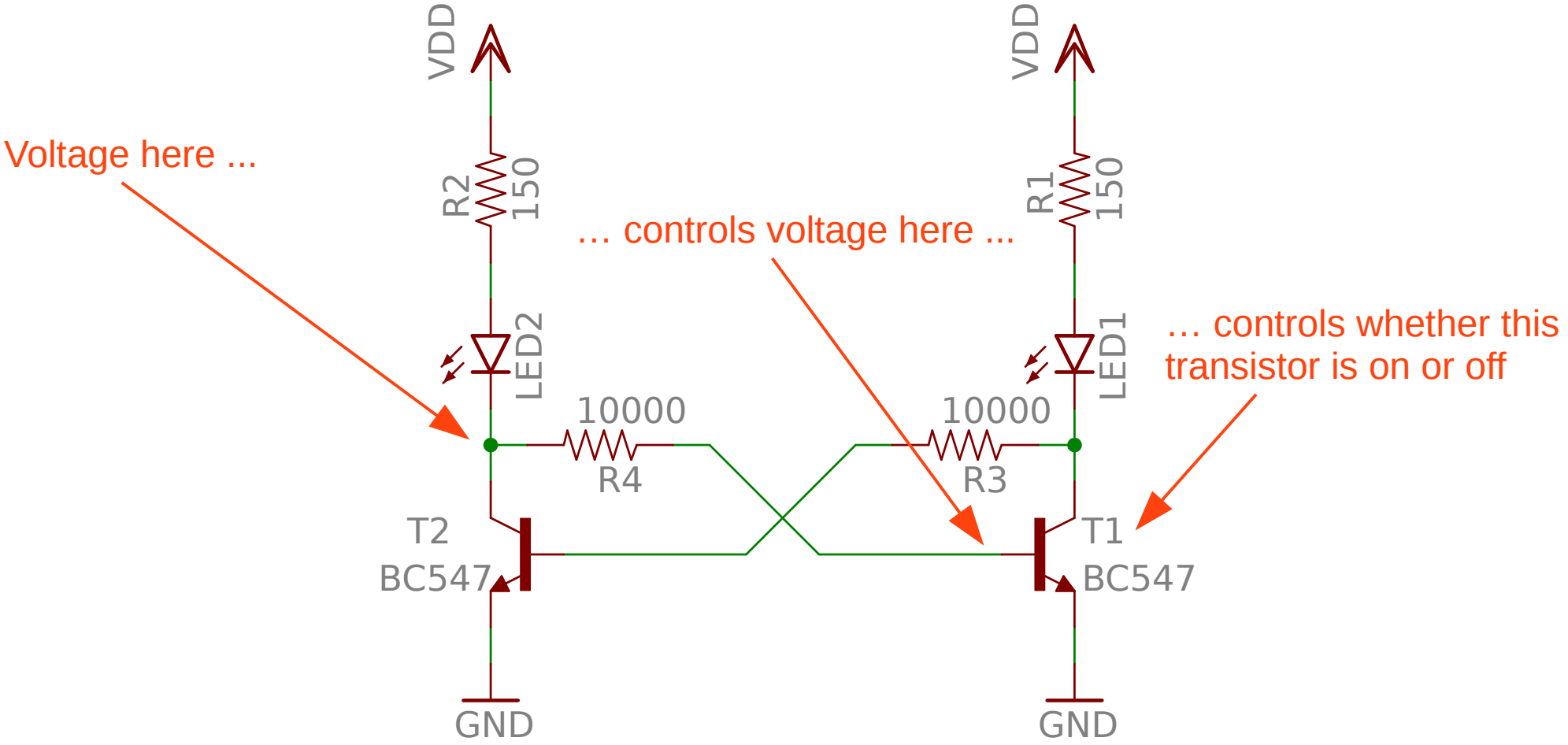
Bistable Circuit

Circuit from before

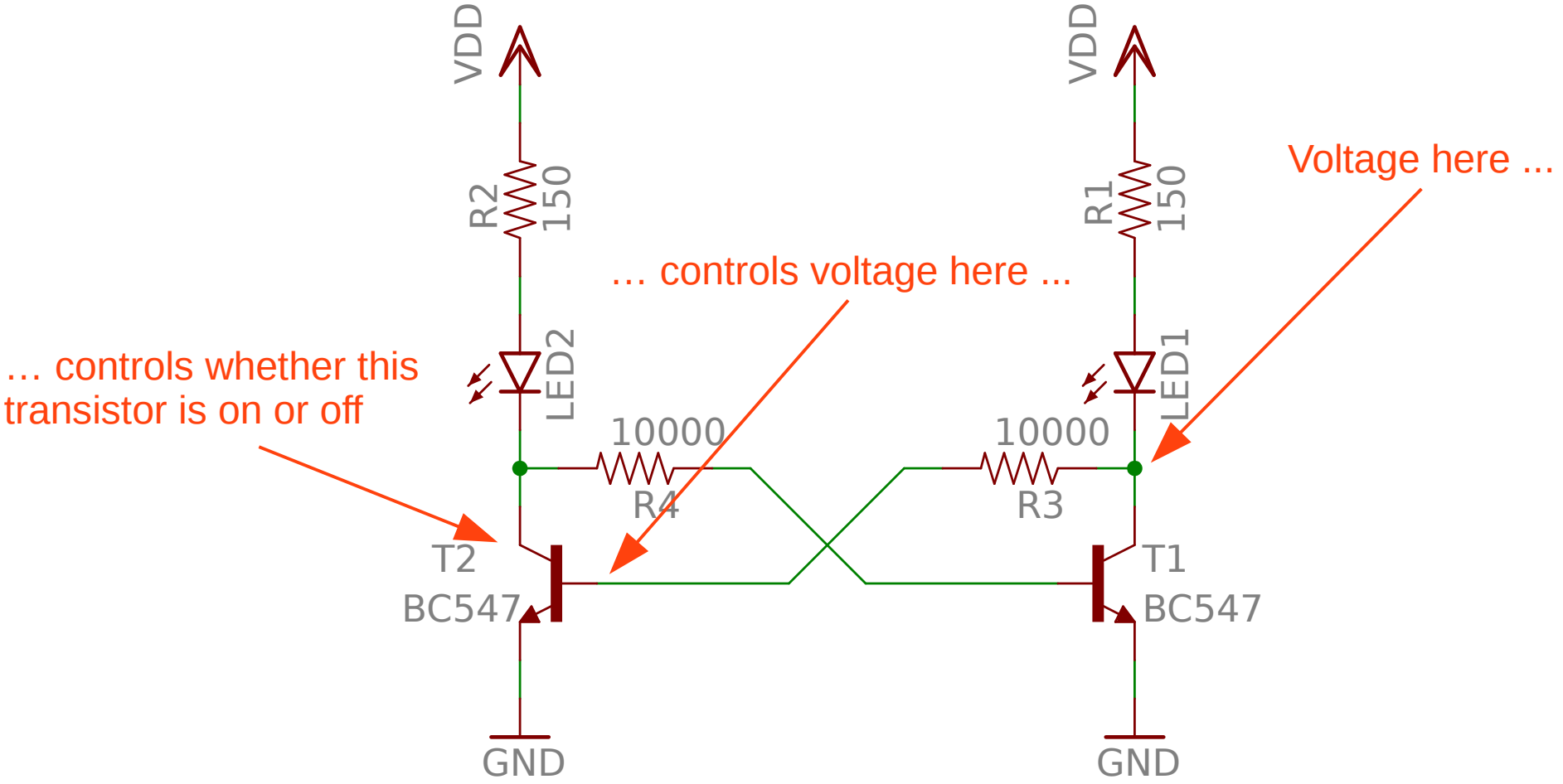


Circuit from before

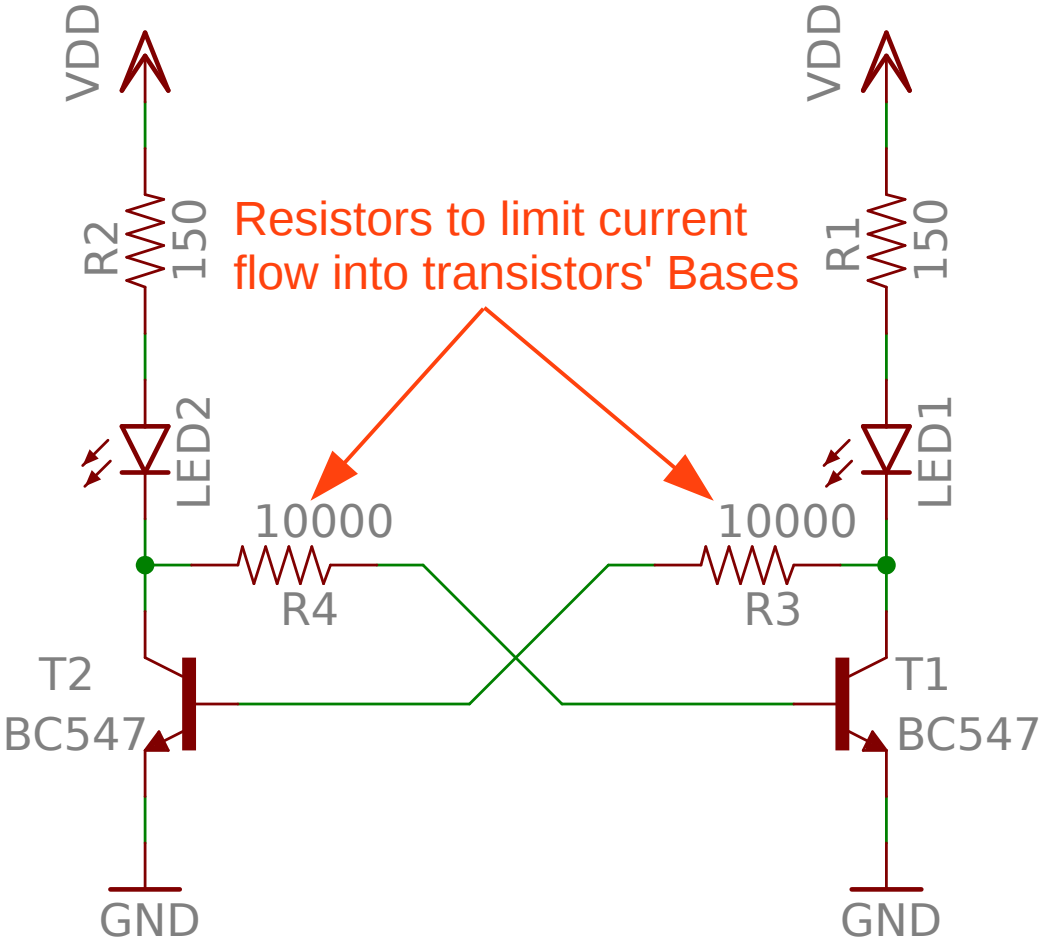
Bistable Circuit



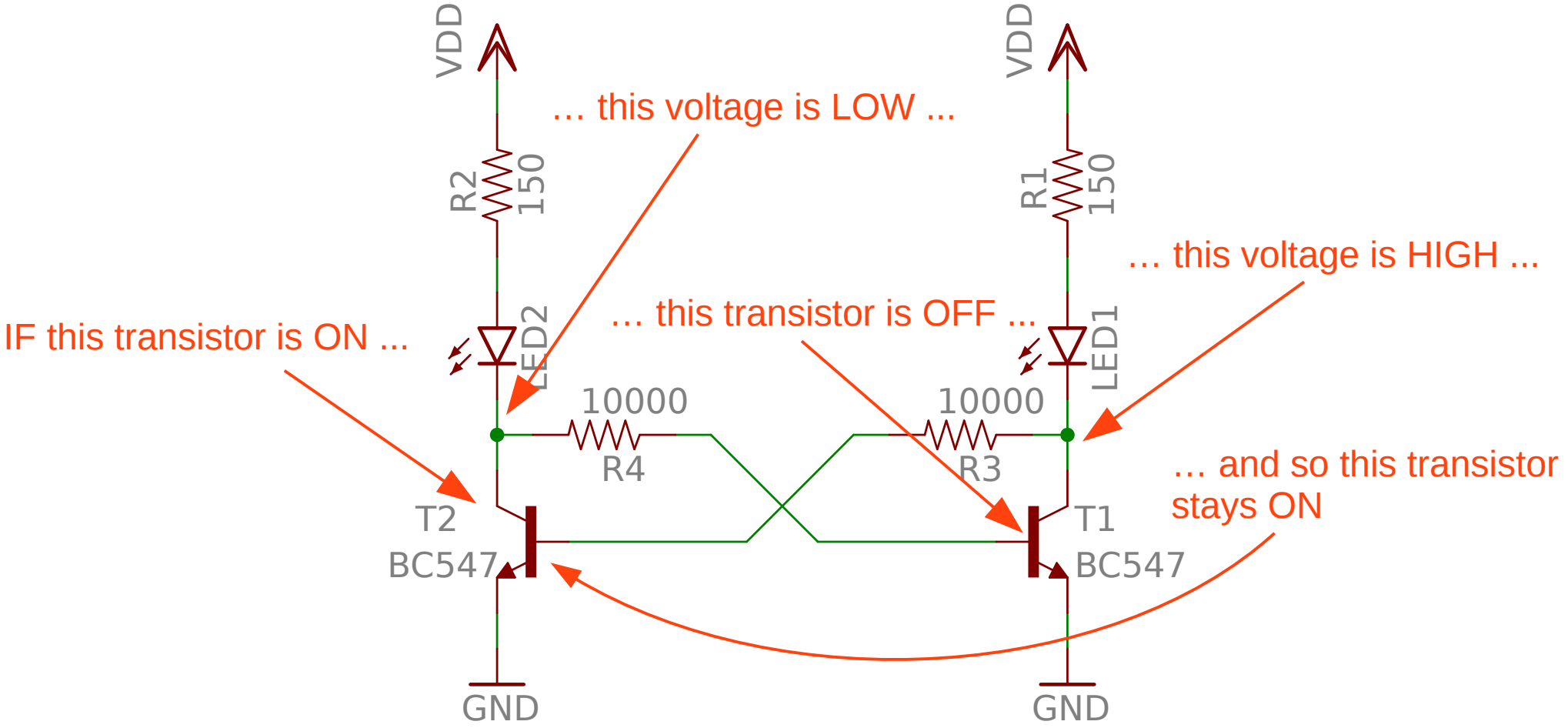
Bistable Circuit



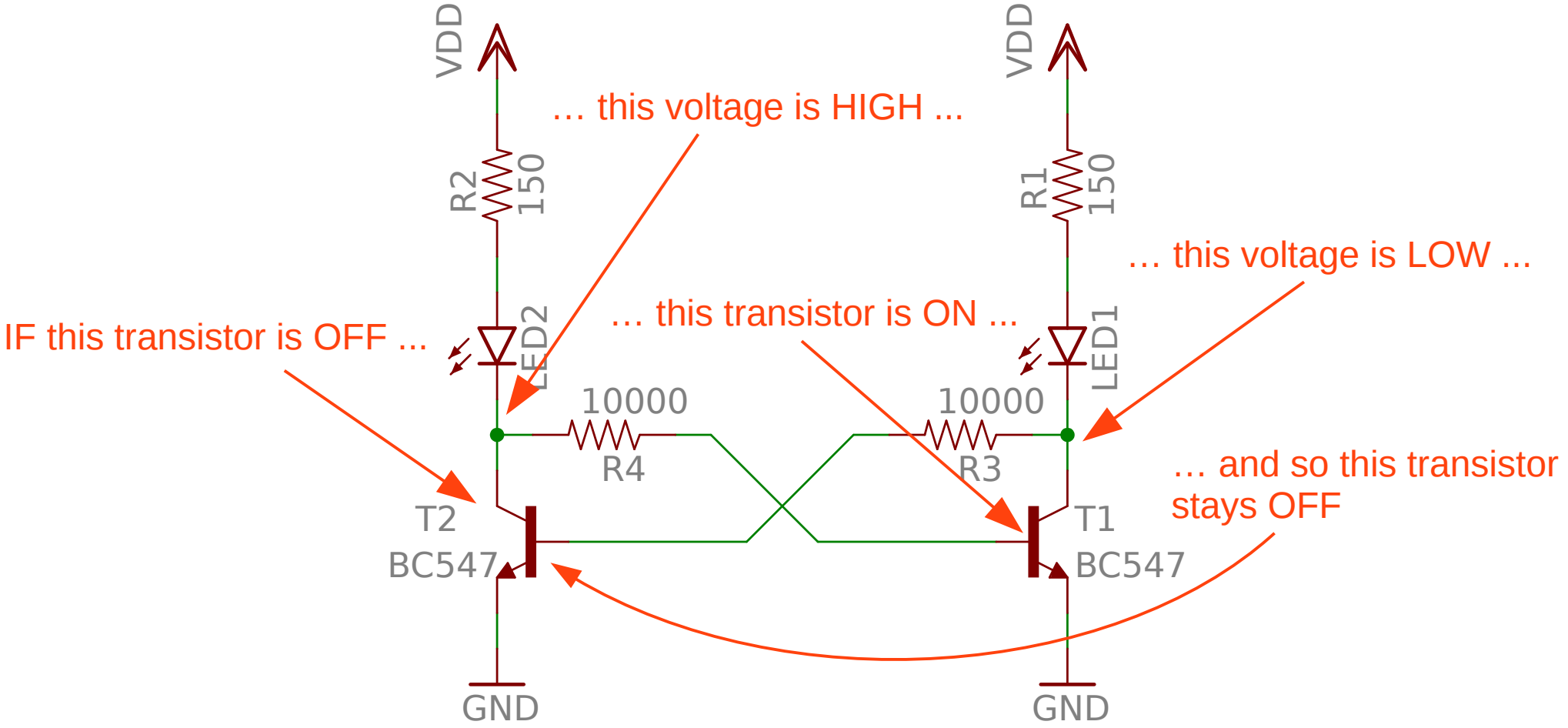
Bistable Circuit



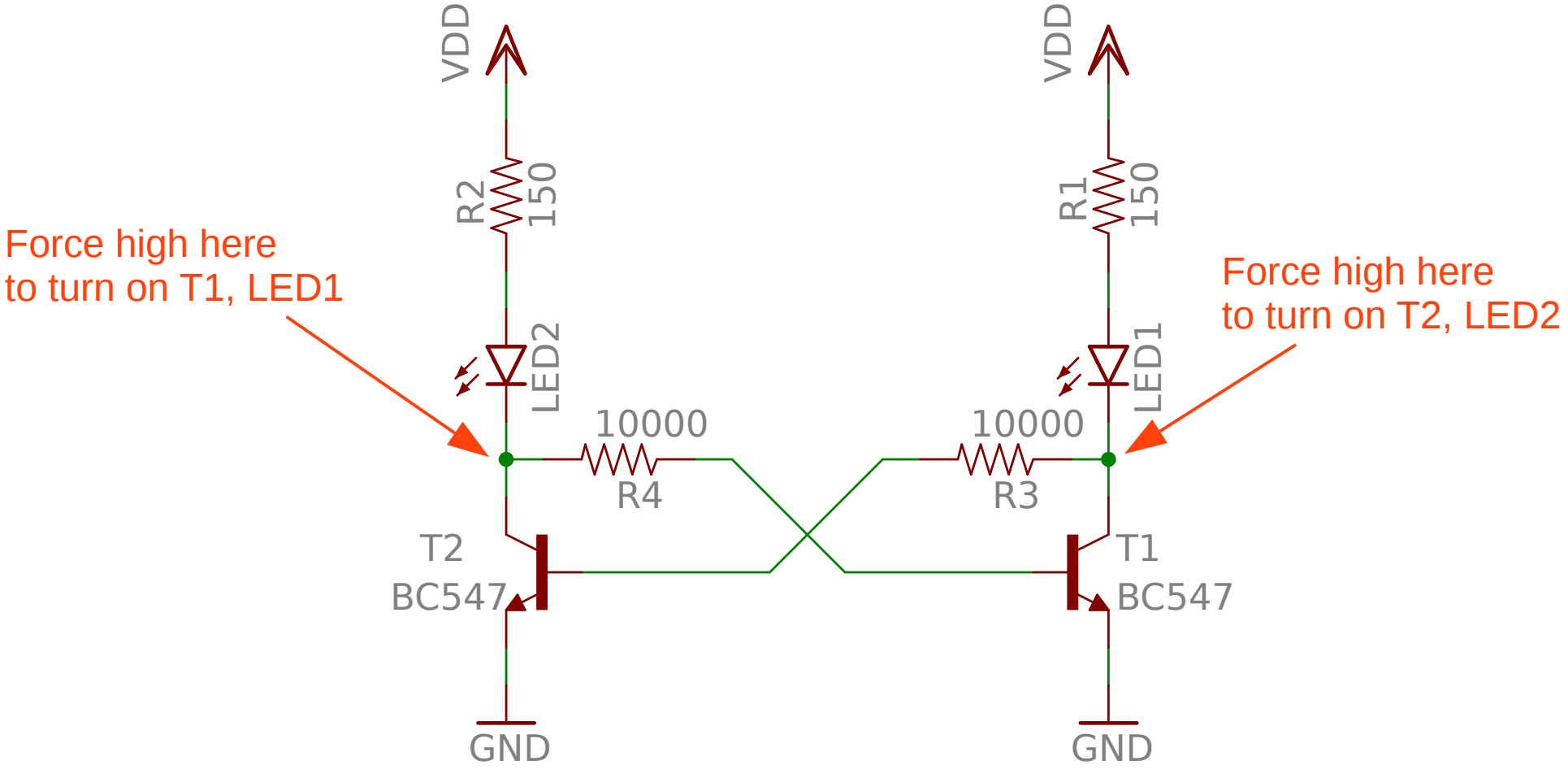
Bistable Circuit



Bistable Circuit



Bistable Circuit



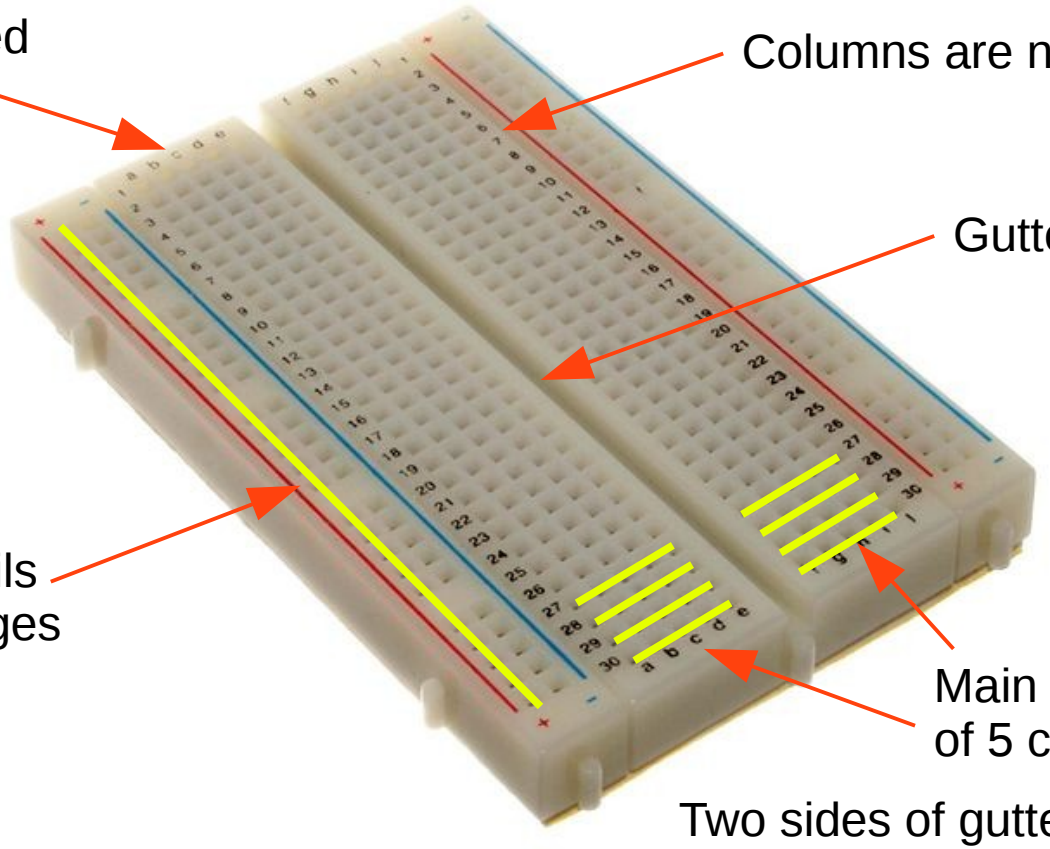
Bistable Animation

http://www.falstad.com/circuit/e-multivib-bi.html

Let's Build The Circuit!

Breadboards

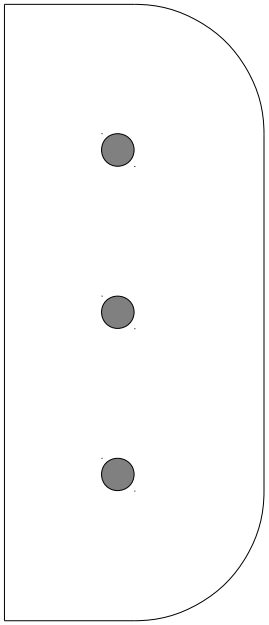
- Used for quick circuit prototyping
- Holes to plug components' wires into
- Internal wires connect some of the holes



Placing components

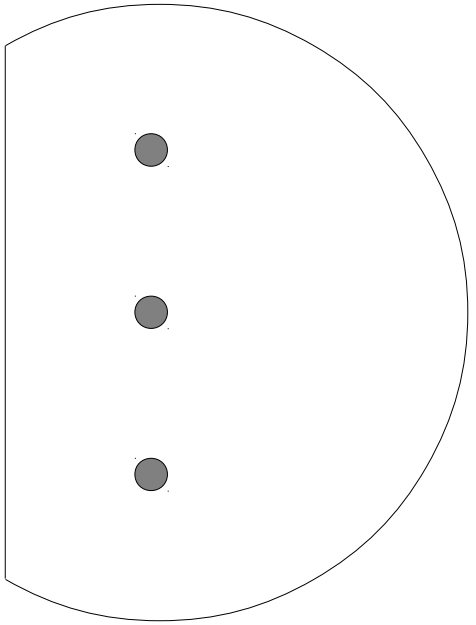
- Polarity
  - Some components don't work backwards
- Don't bend pins
  - Slight angling OK, no need for kinks
- Don't burn out LEDs
  - By connecting to power with no resistor
- Don't connect power until circuit is complete

Transistor Packages



E-line package

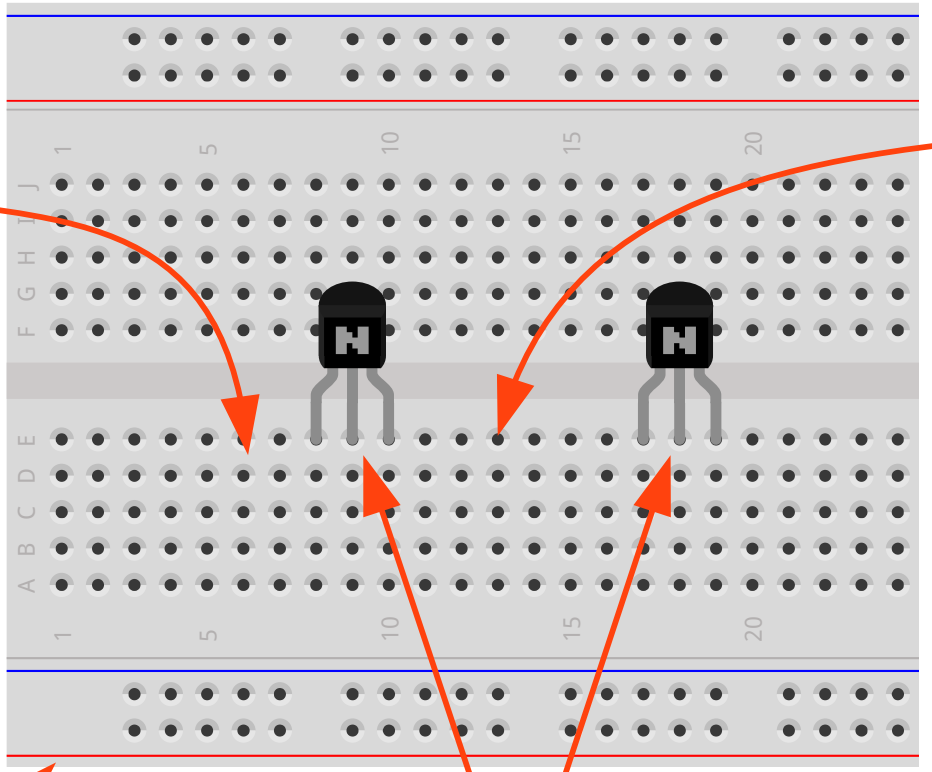
Kit contains:
ZVP2110A (we won't use this)



TO-92 package

Kit contains:
BC547 (use this; has pink dot on back)
BS170 (we won't use this)

Bistable – Step 1



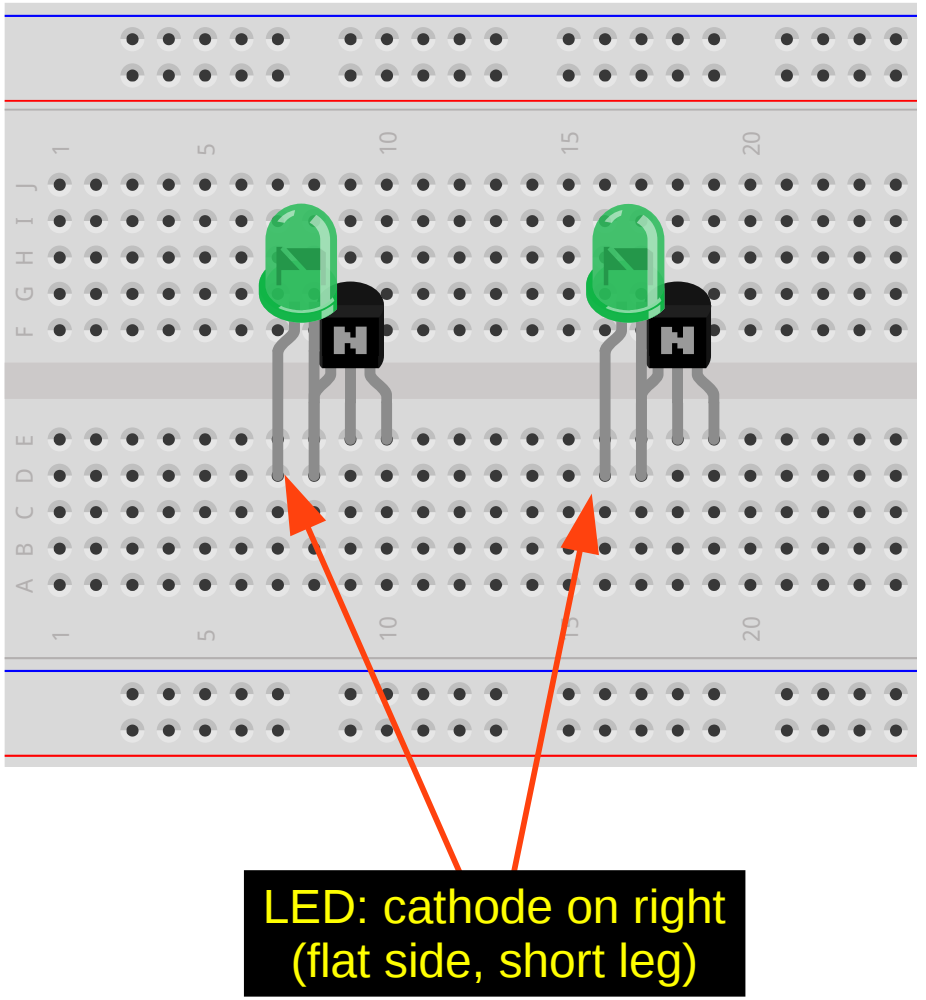
At least 3 hole gap horizontally to edge

6 hole gap horizontally

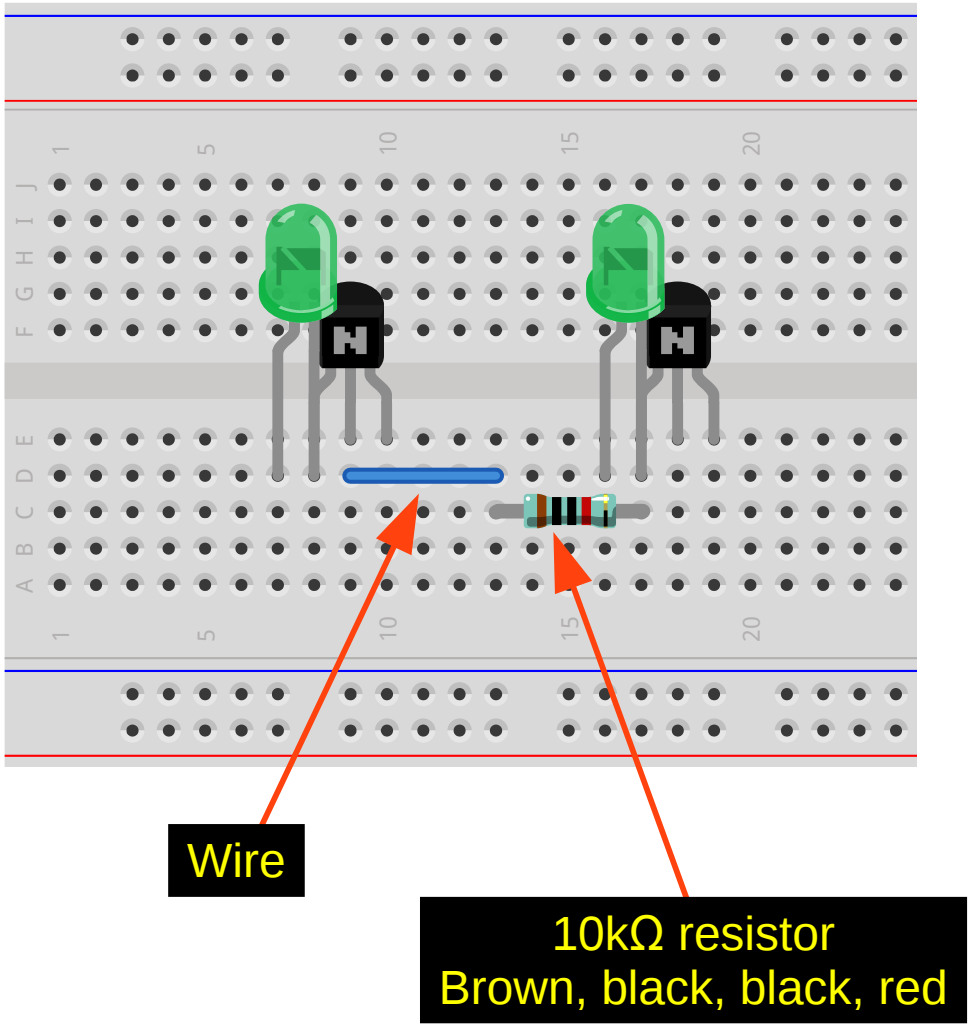
Red line nearest you

BC547 (pink dot)
Flat side towards you

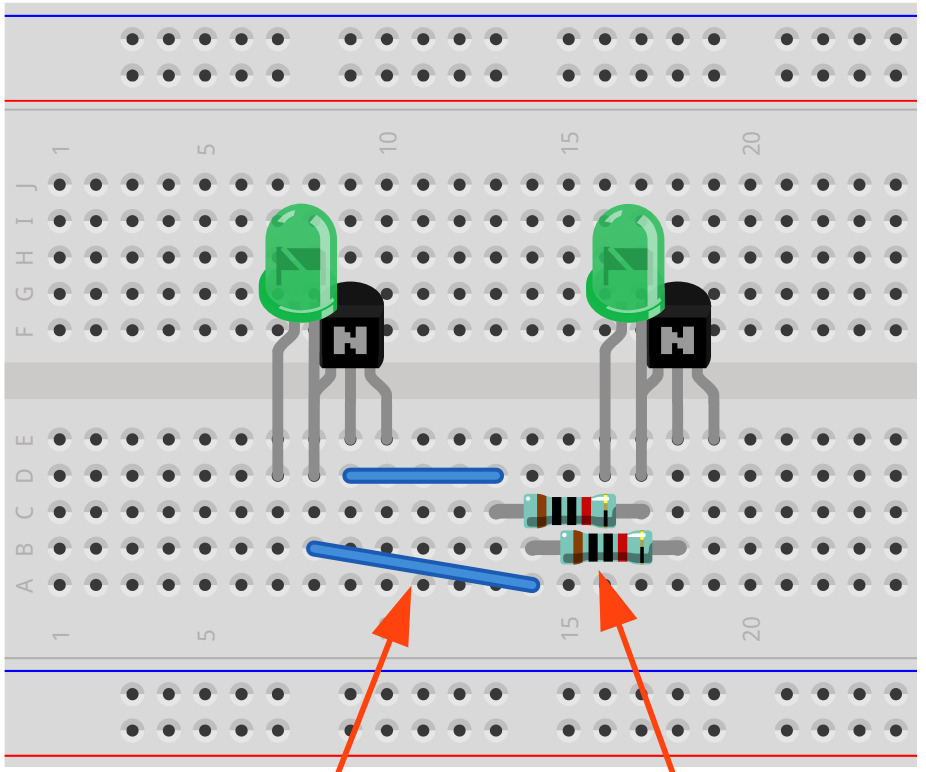
Bistable – Step 2



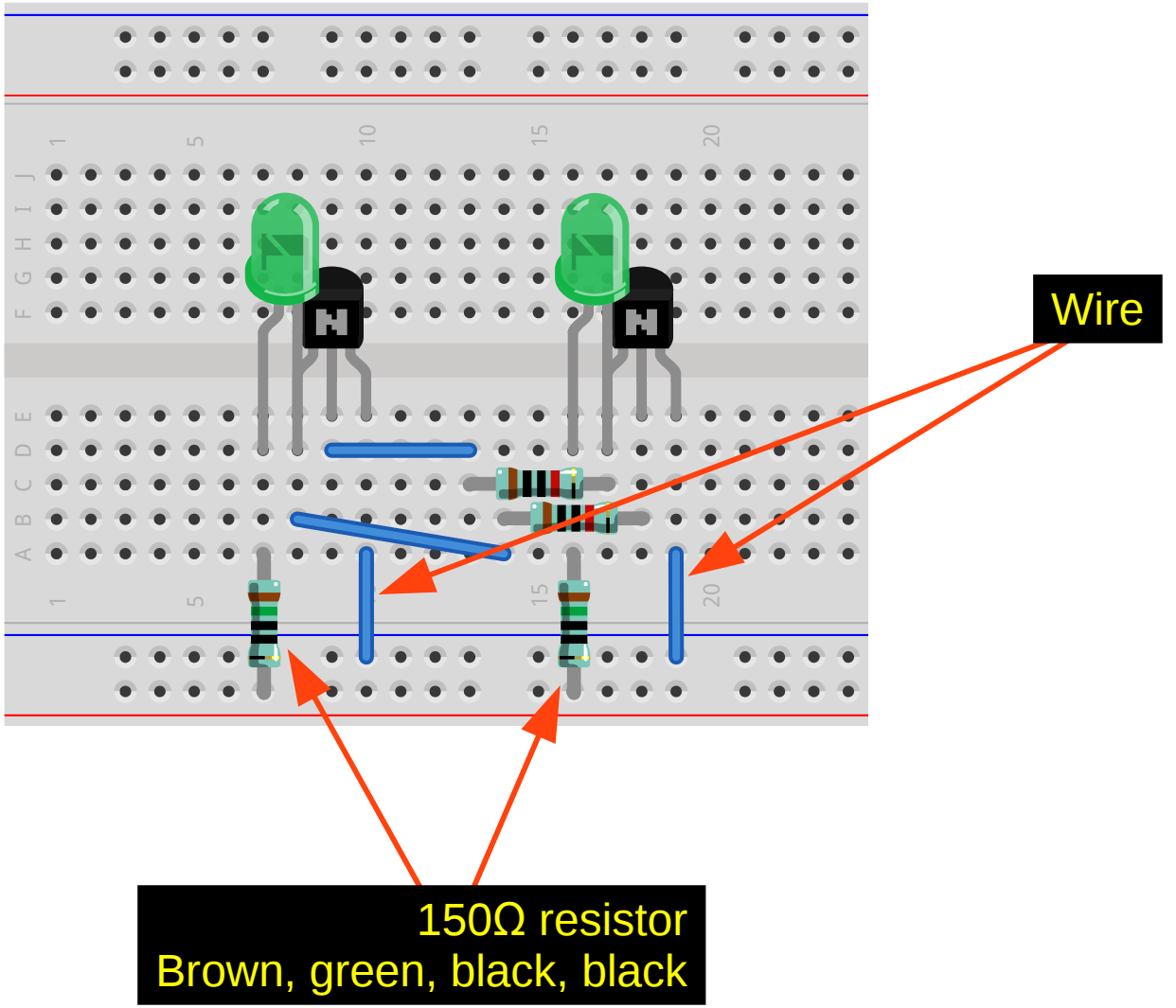
Bistable – Step 3



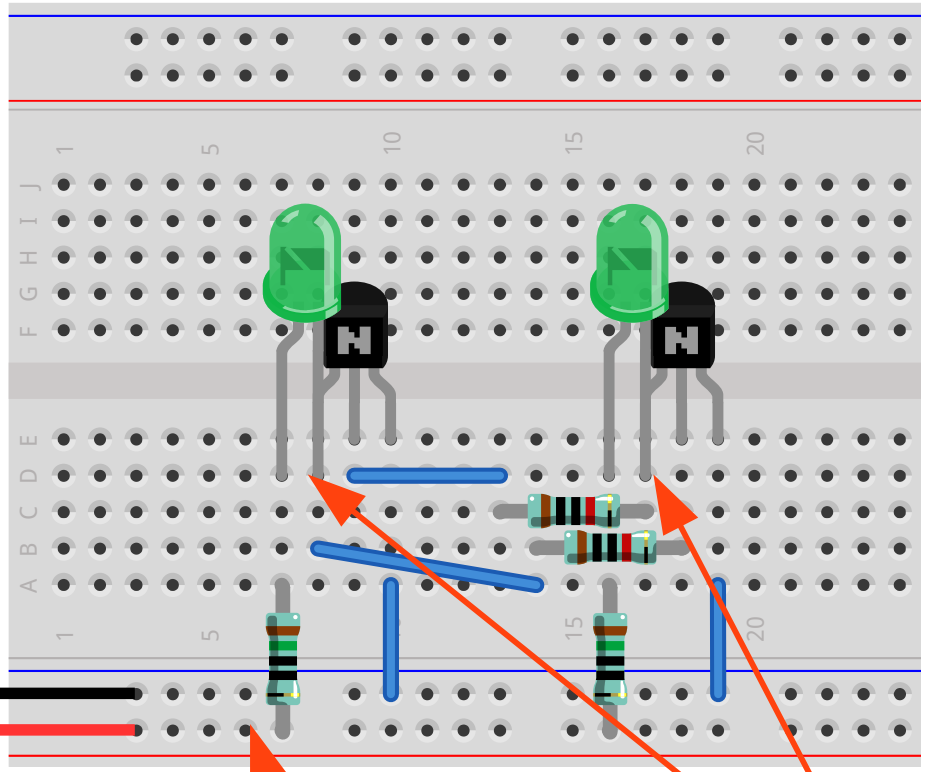
Bistable – Step 4



Bistable – Final



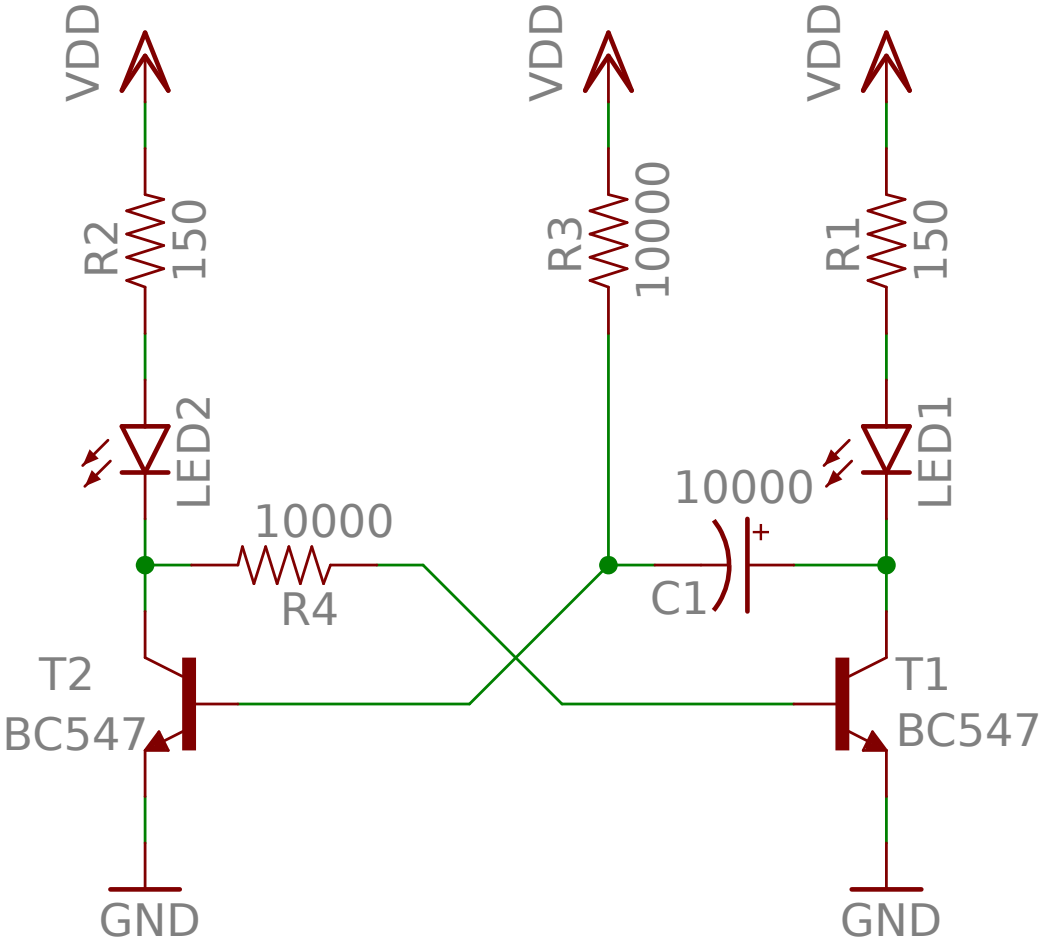
Bistable – Test



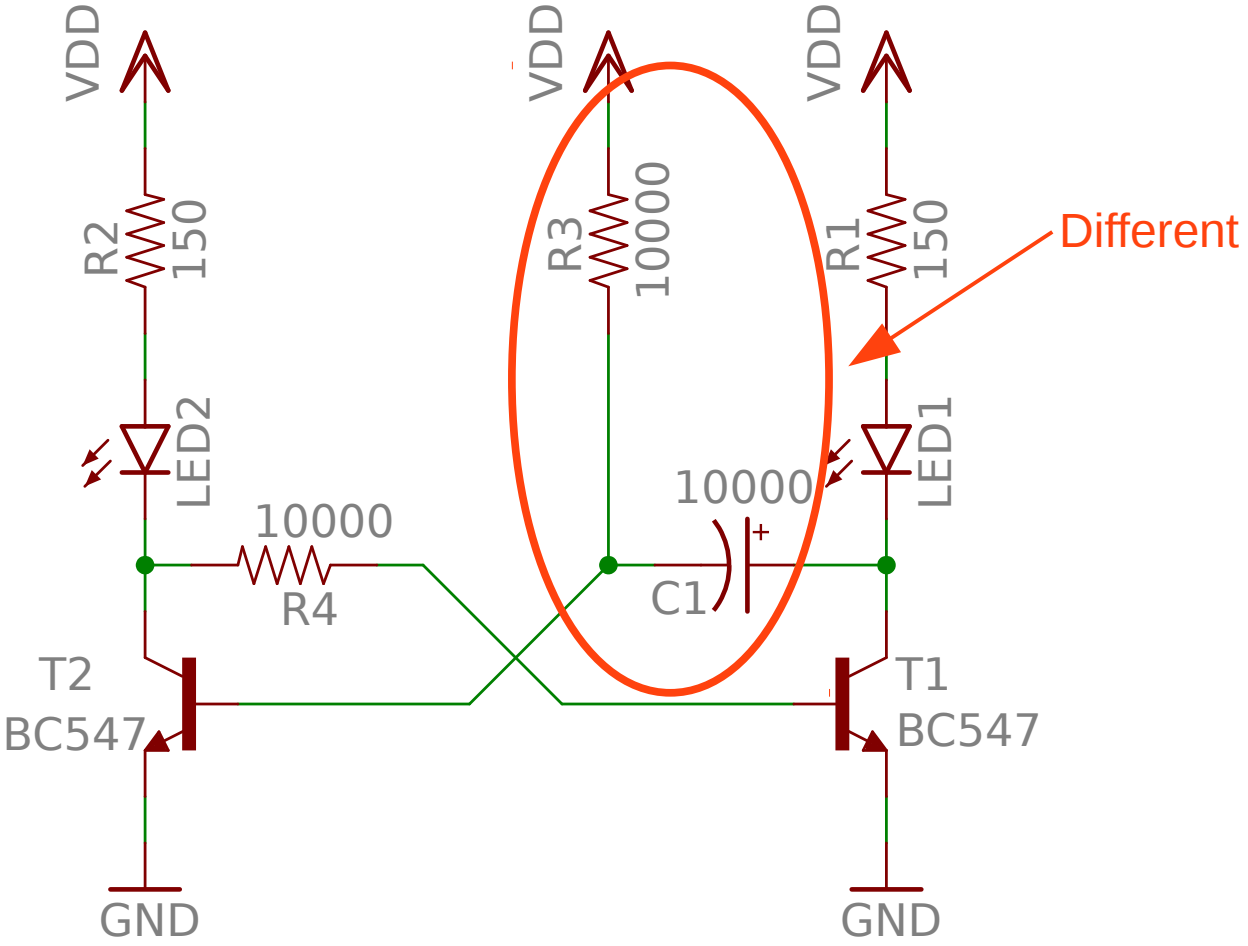
Apply power
Match heat-shrink colors

Touch wire from POWER … to either LED's right pin
One pin at a time

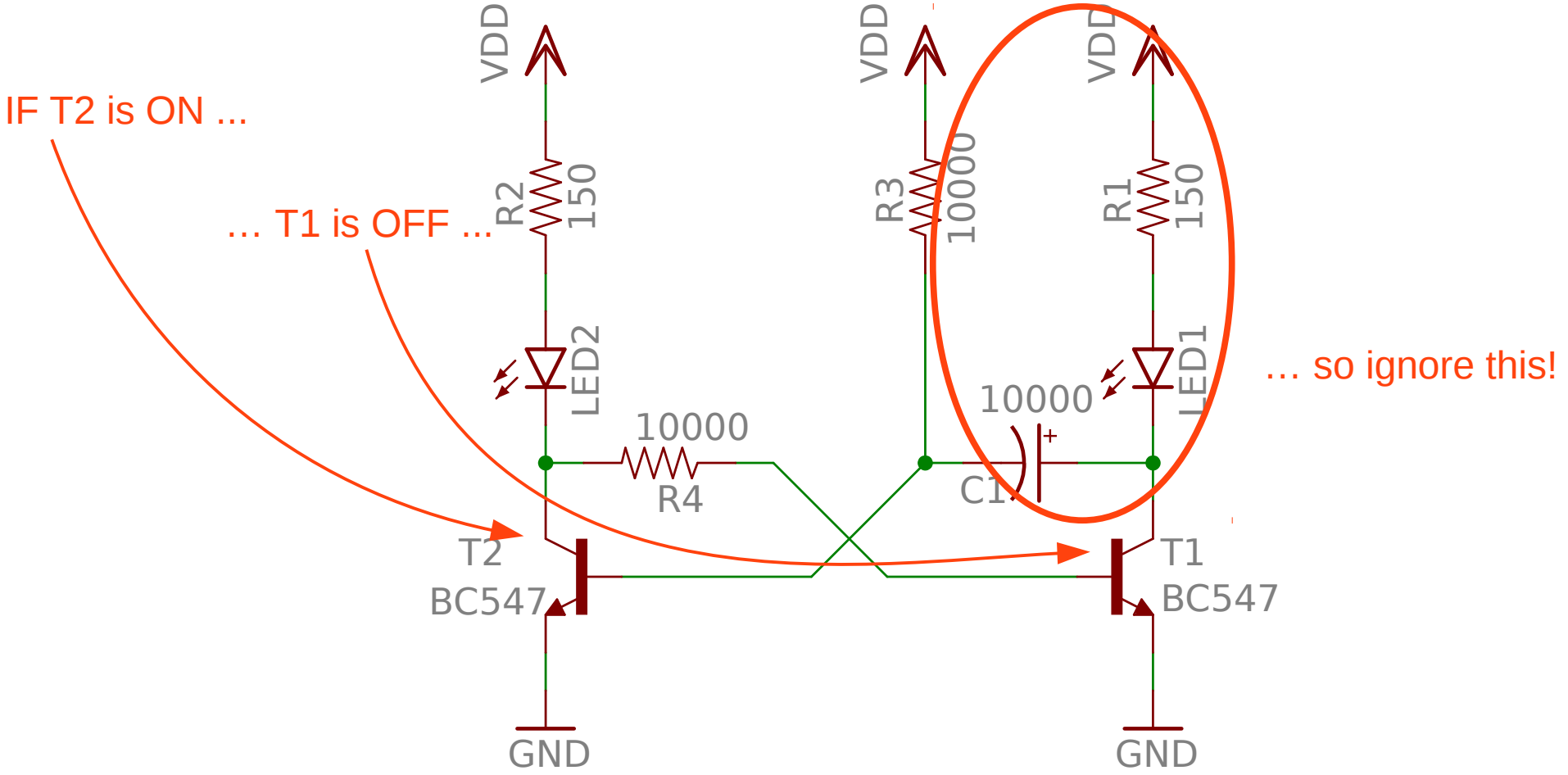
Monostable Circuit



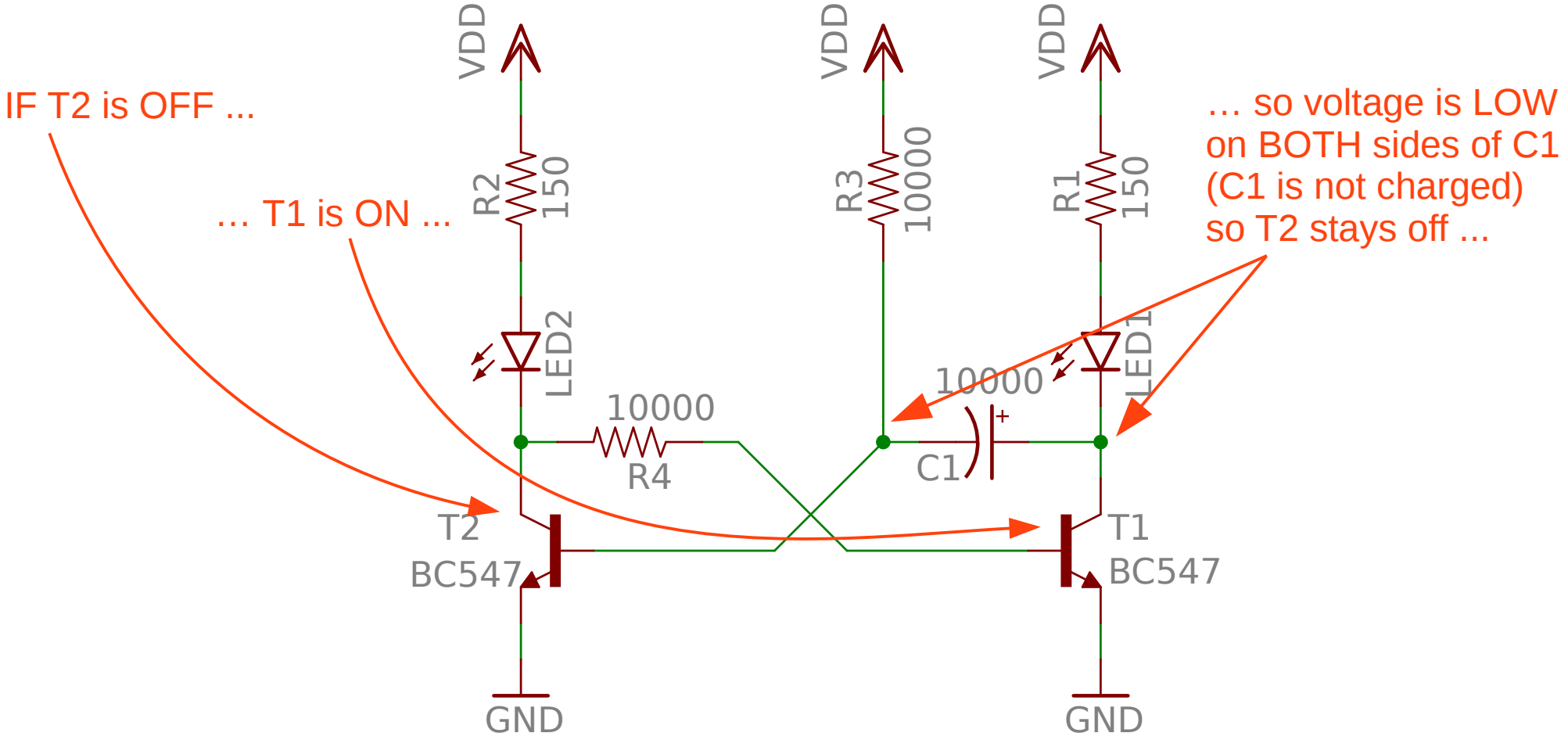
Monostable Circuit



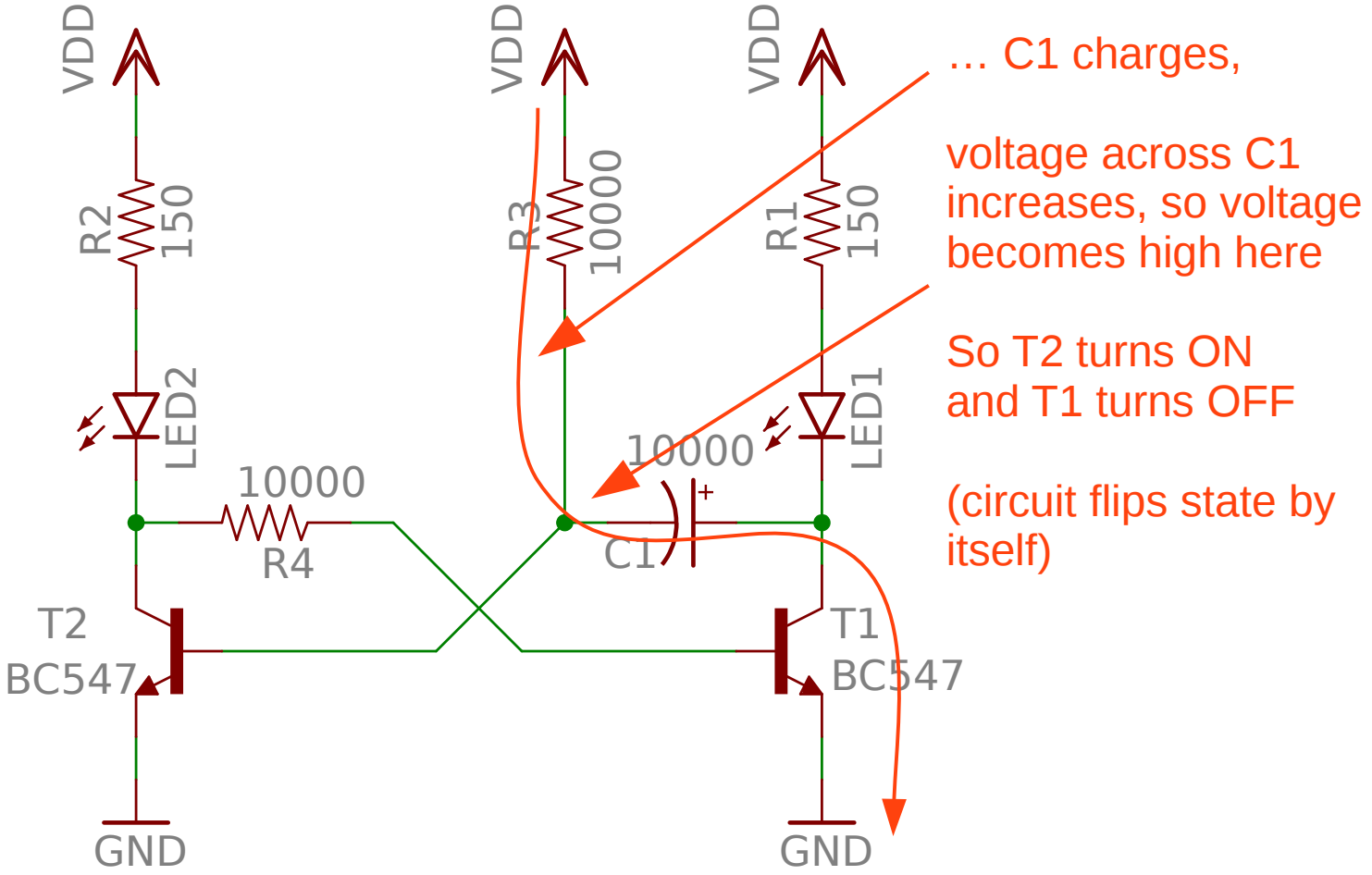
Monostable Circuit – Stable State



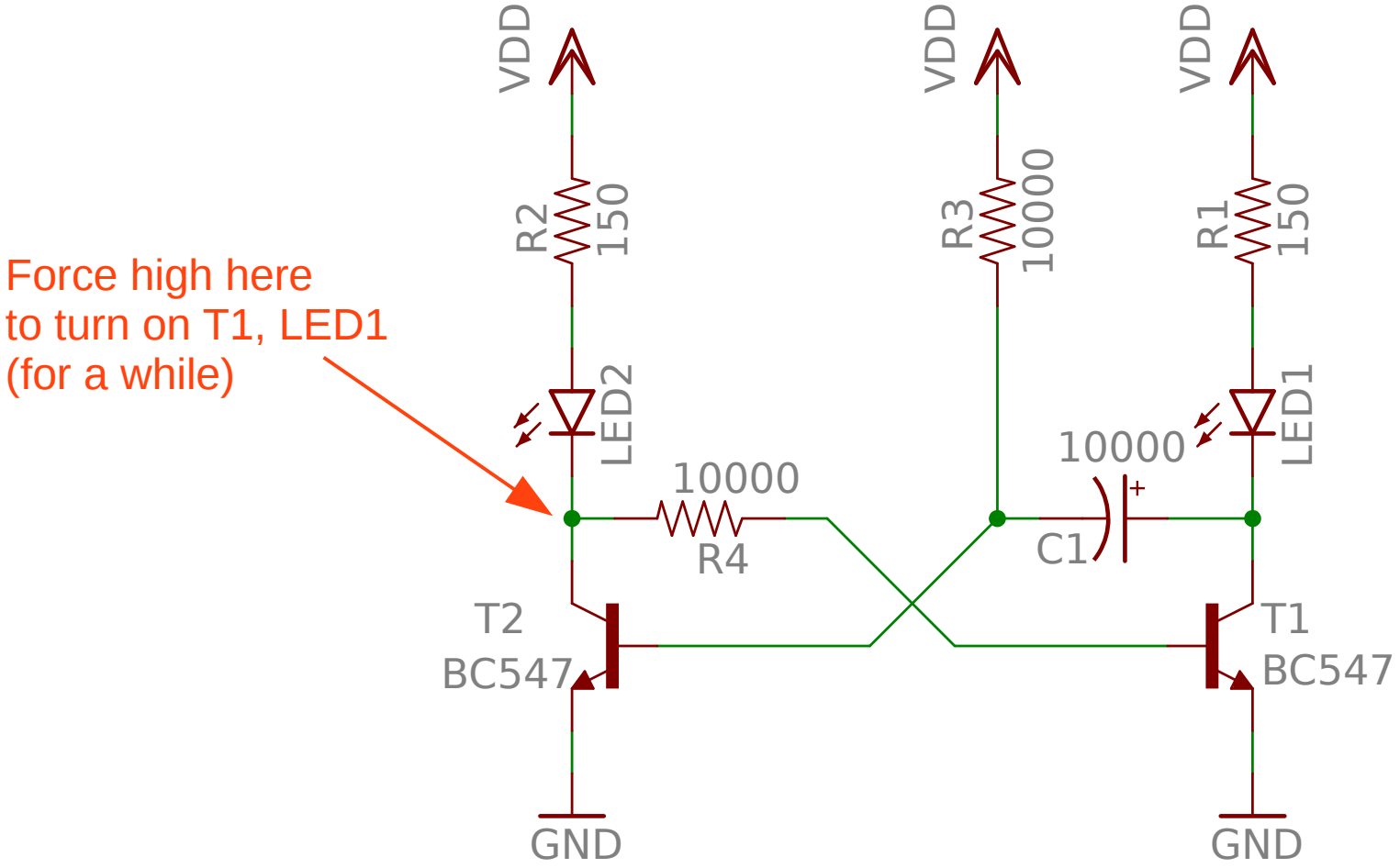
Monostable Circuit – Unstable State



Monostable Circuit – Unstable State



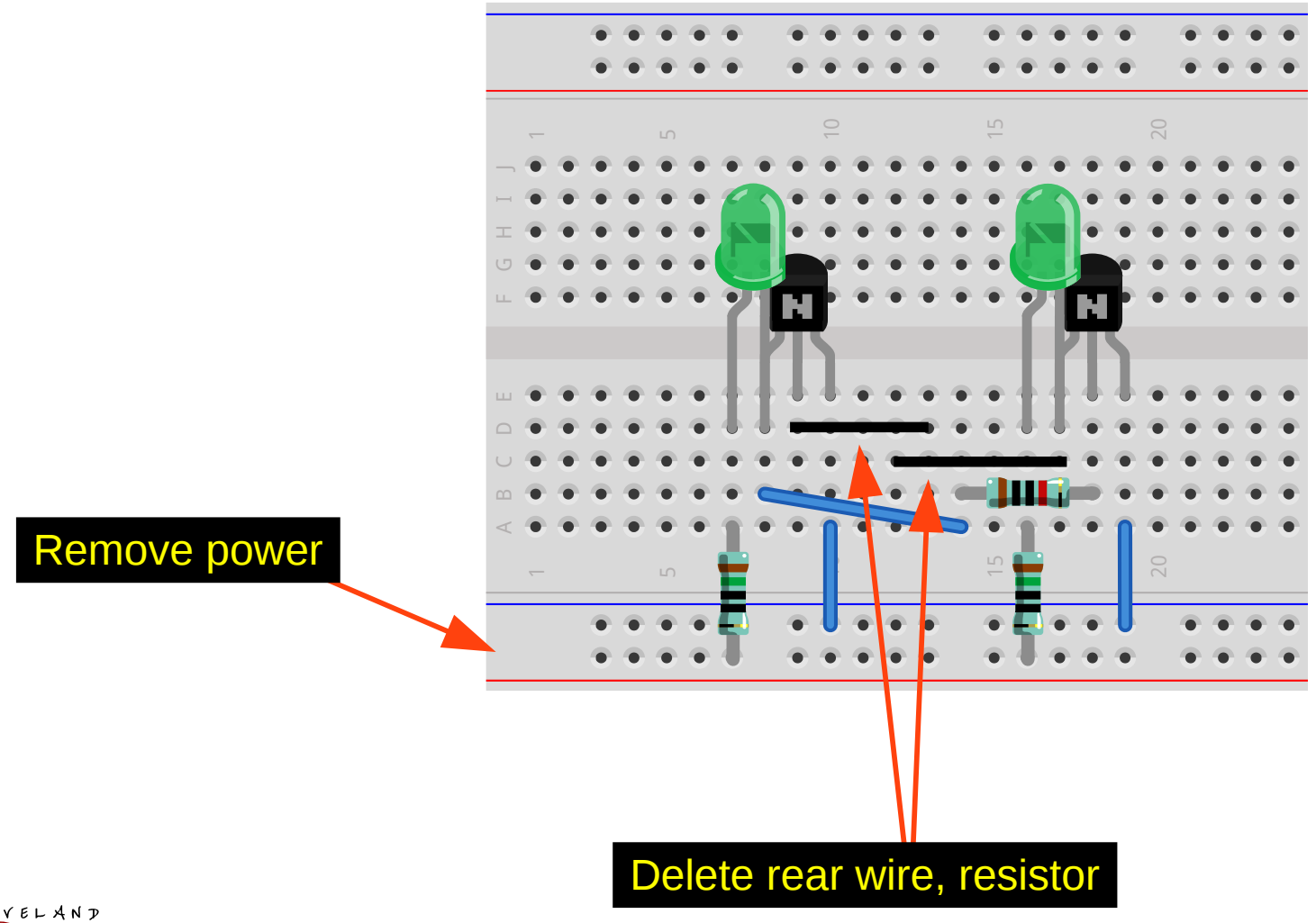
Monostable Circuit – Unstable State



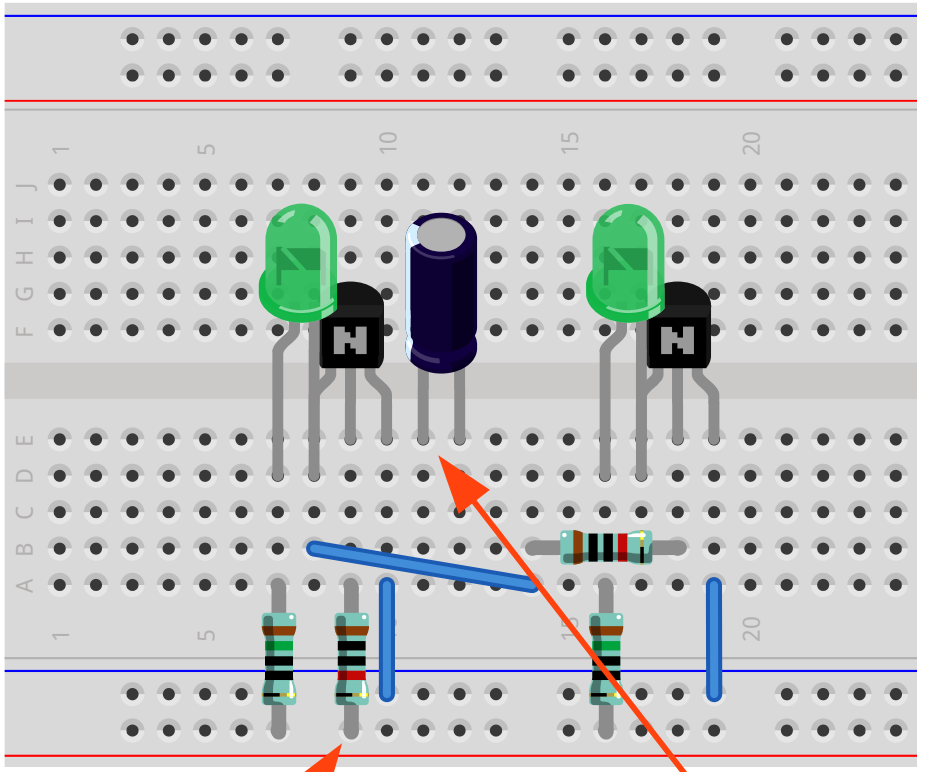
Monostable Animation

http://www.falstad.com/circuit/e-multivib-mono.html

Monostable – Step 1



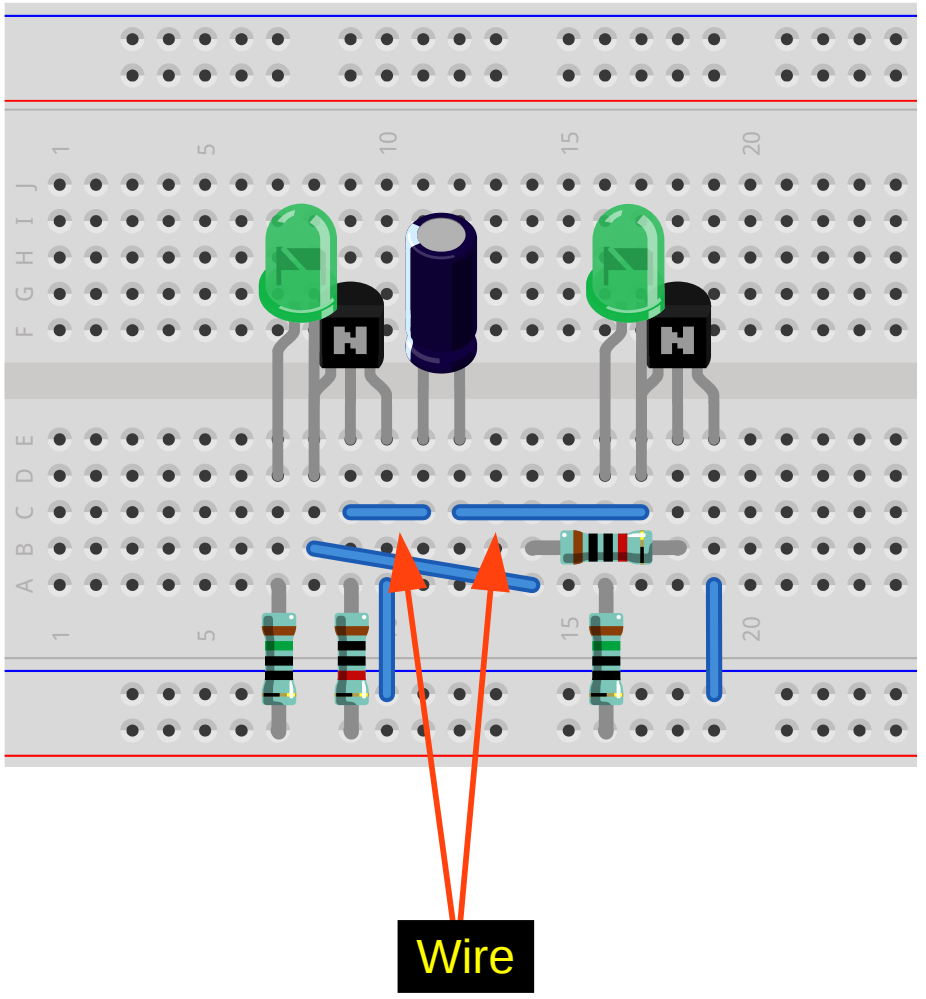
Monostable – Step 2



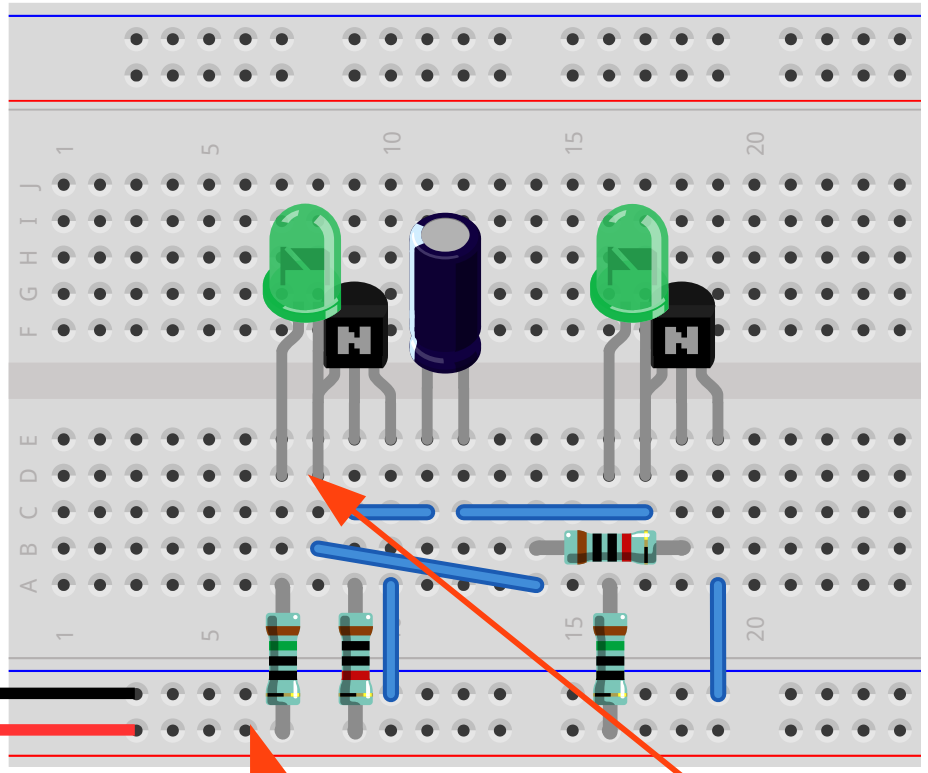
10kΩ resistor
Brown, black, black, red

10µF capacitor
Negative pin (stripe) on left

Monostable – Final



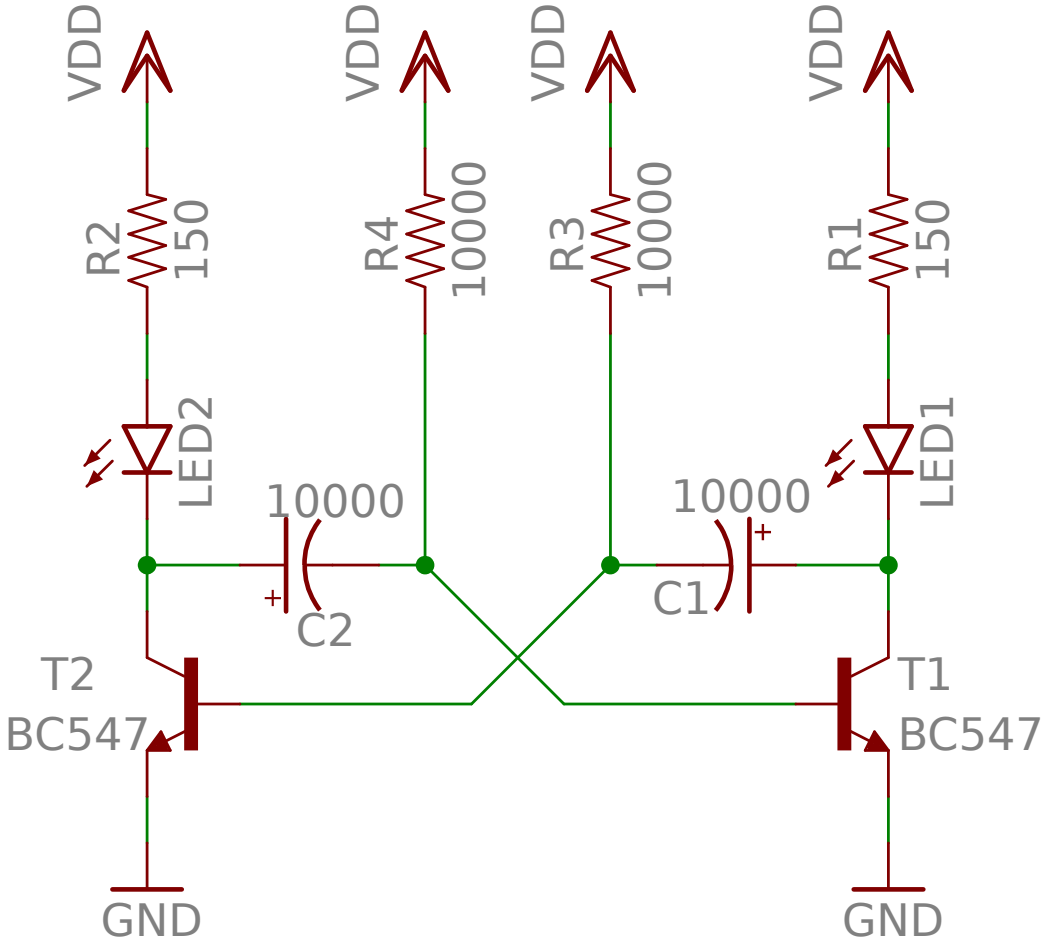
Monostable – Test



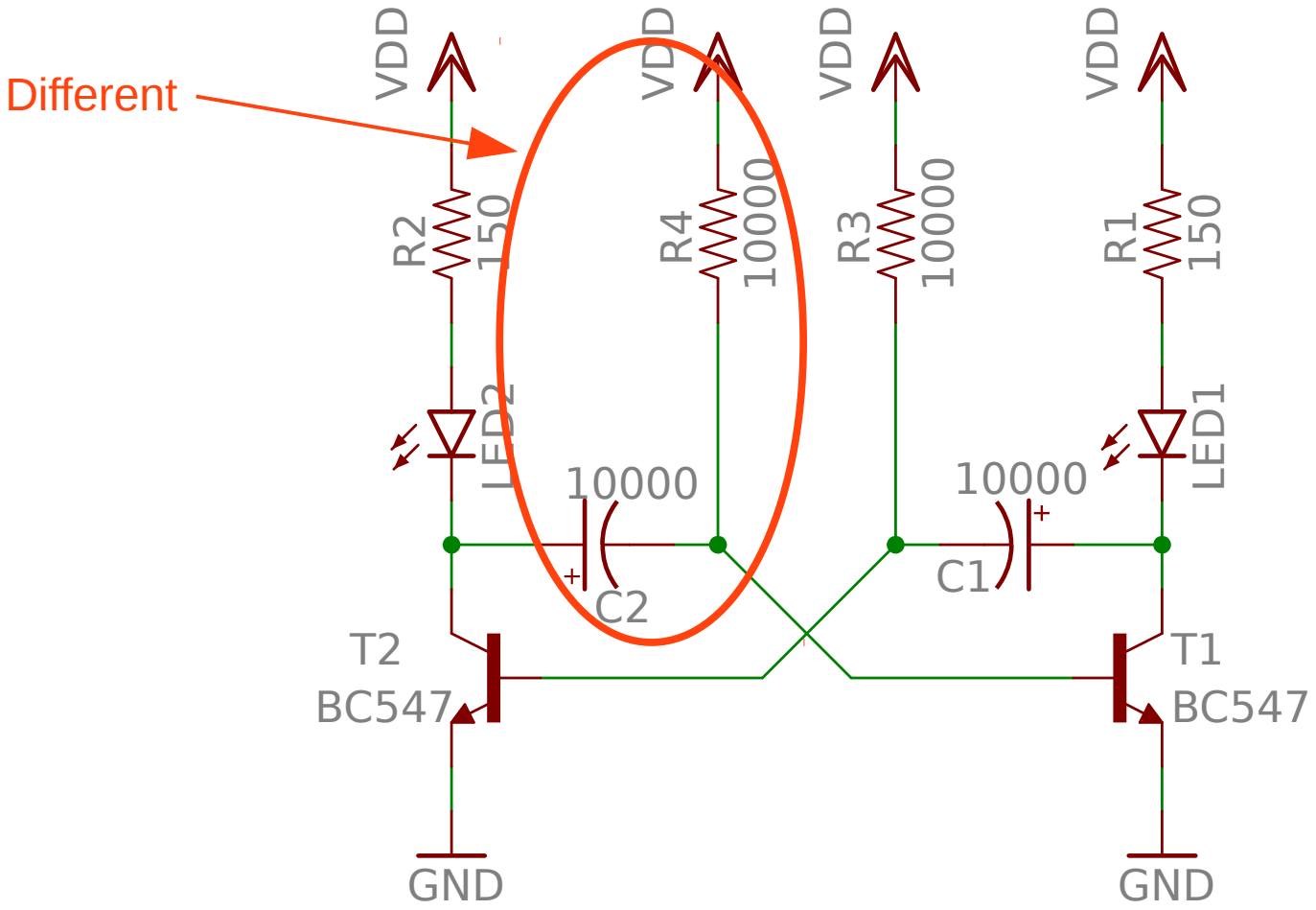
Apply power
Match heat-shrink colors

Touch wire from POWER … to left LED's right pin
Wait for LEDs to change automatically

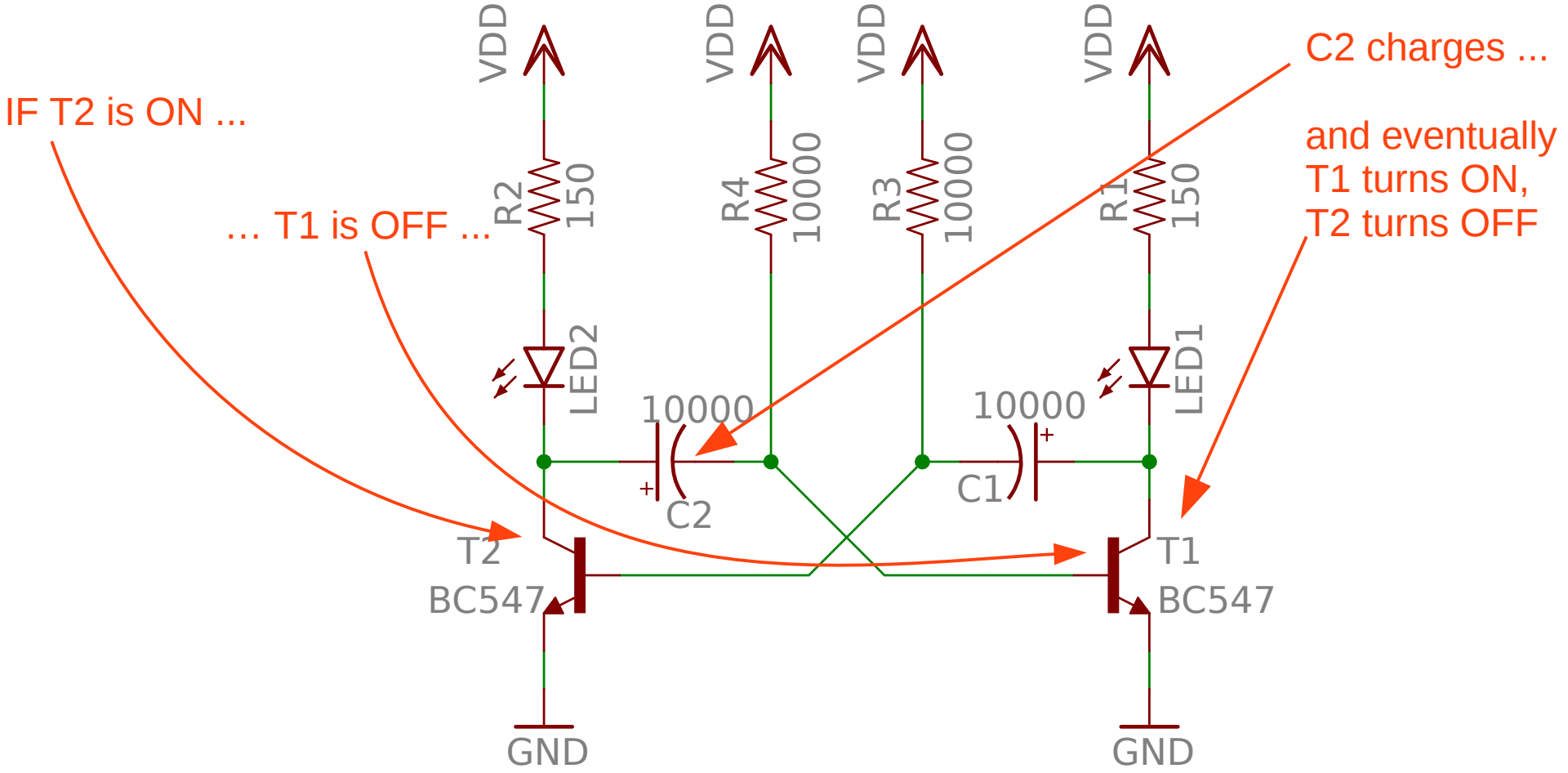
Astable Circuit



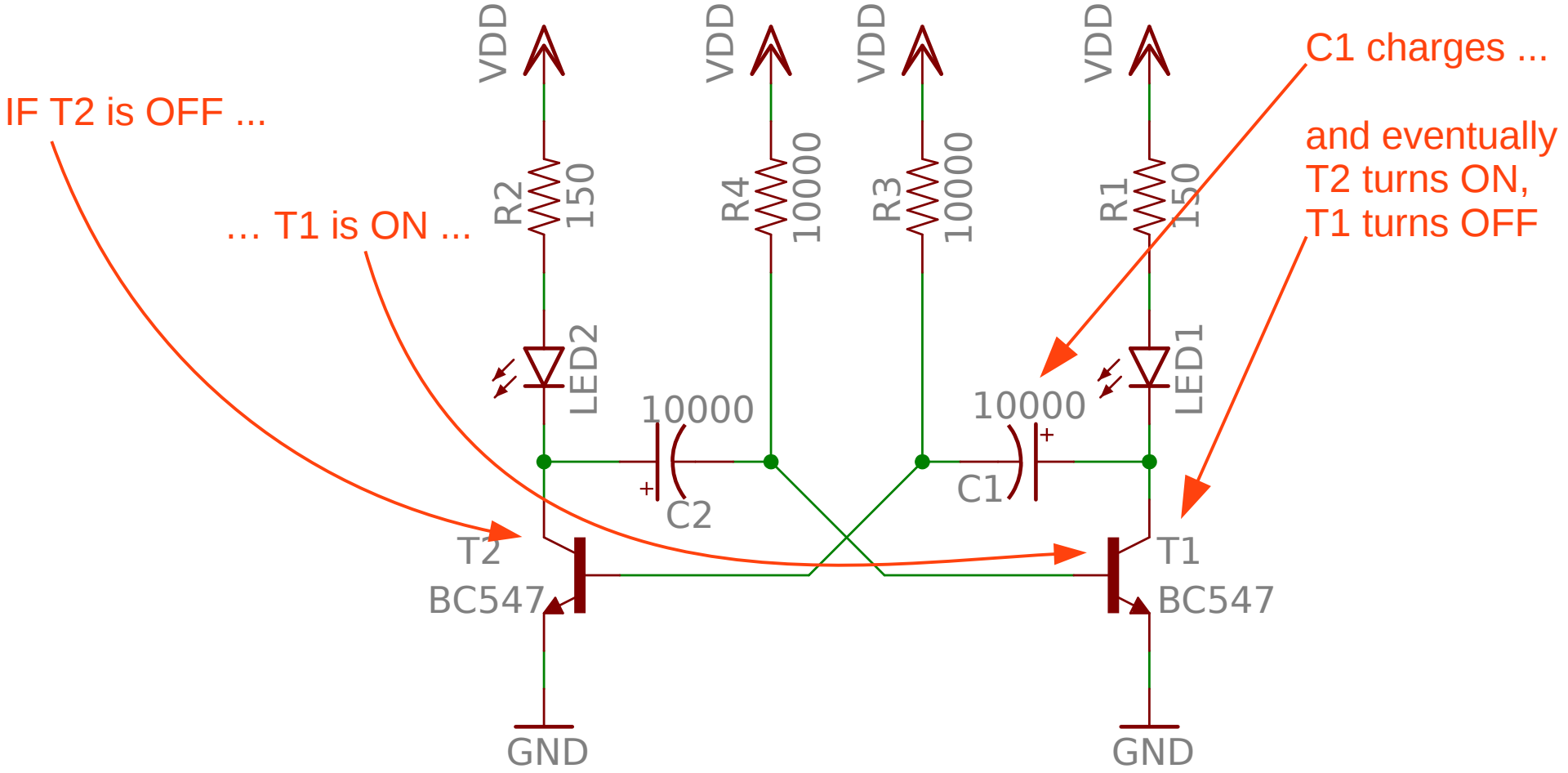
Astable Circuit



Astable Circuit – Unstable state 1



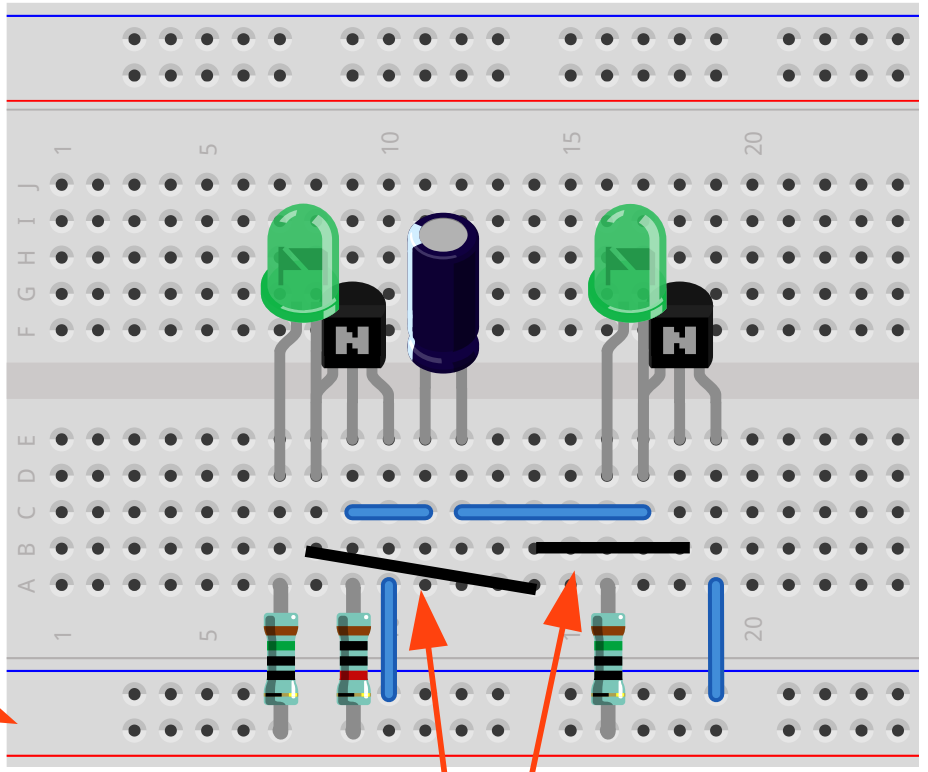
Astable Circuit – Unstable state 2



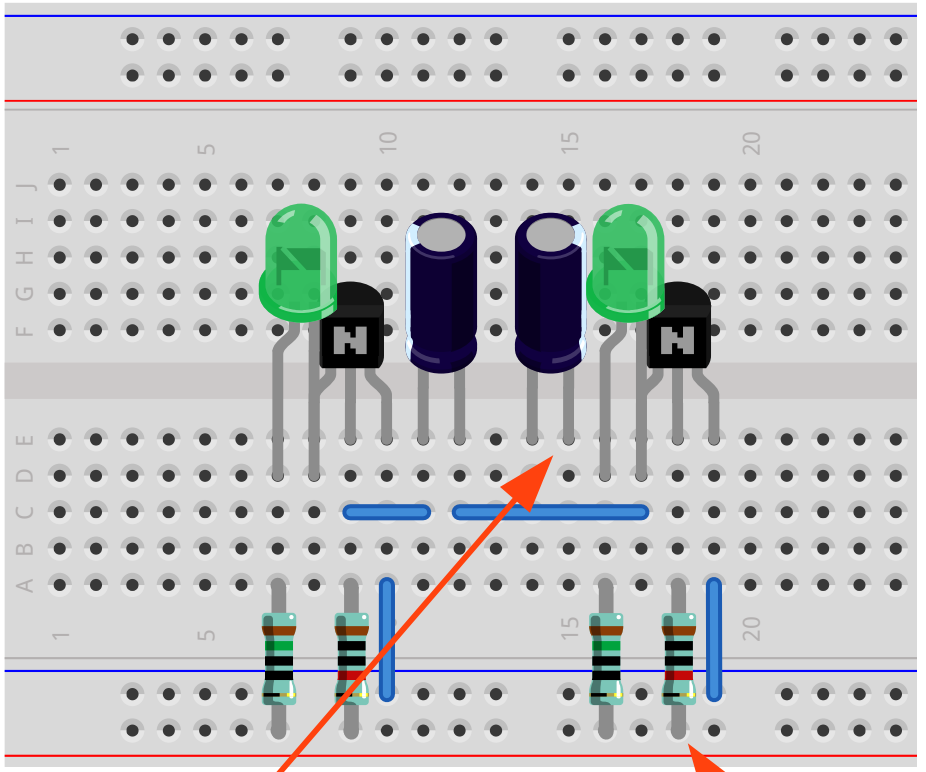
Astable Animation

http://www.falstad.com/circuit/e-multivib-a.html

Astable – Step 1



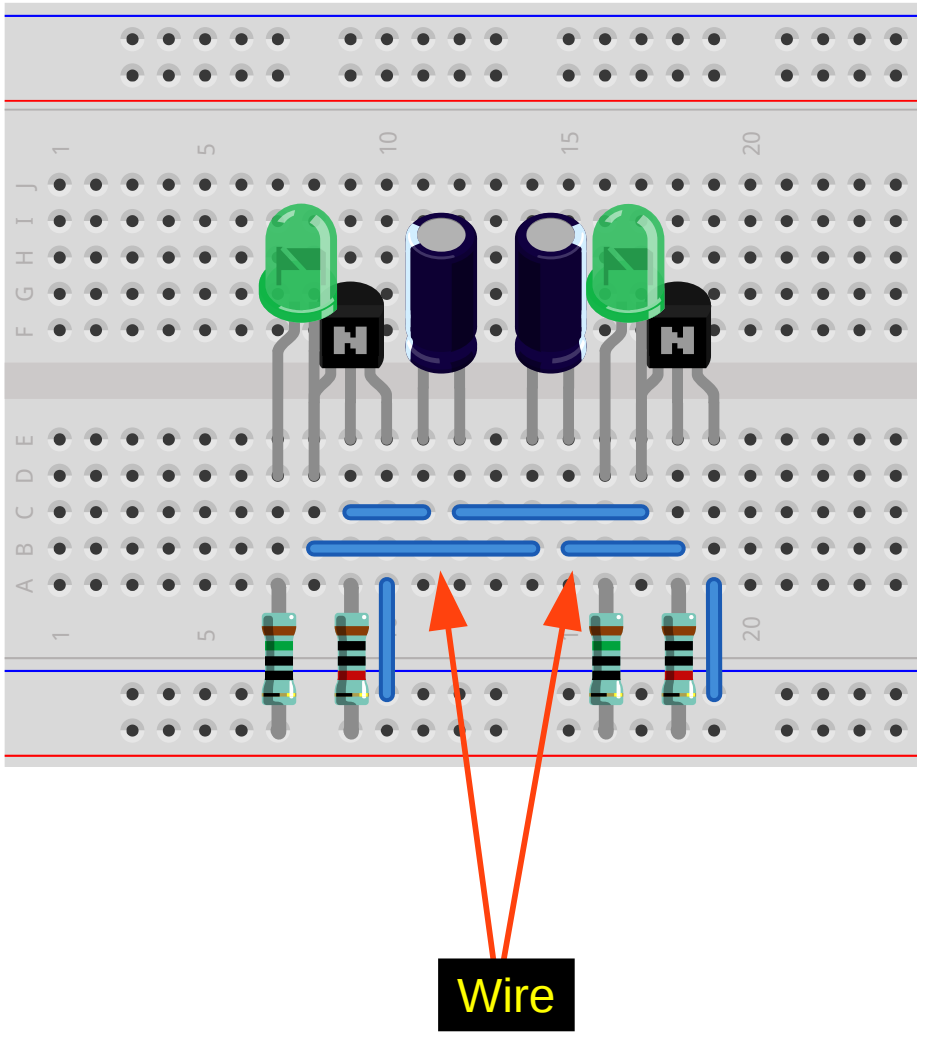
Astable – Step 2



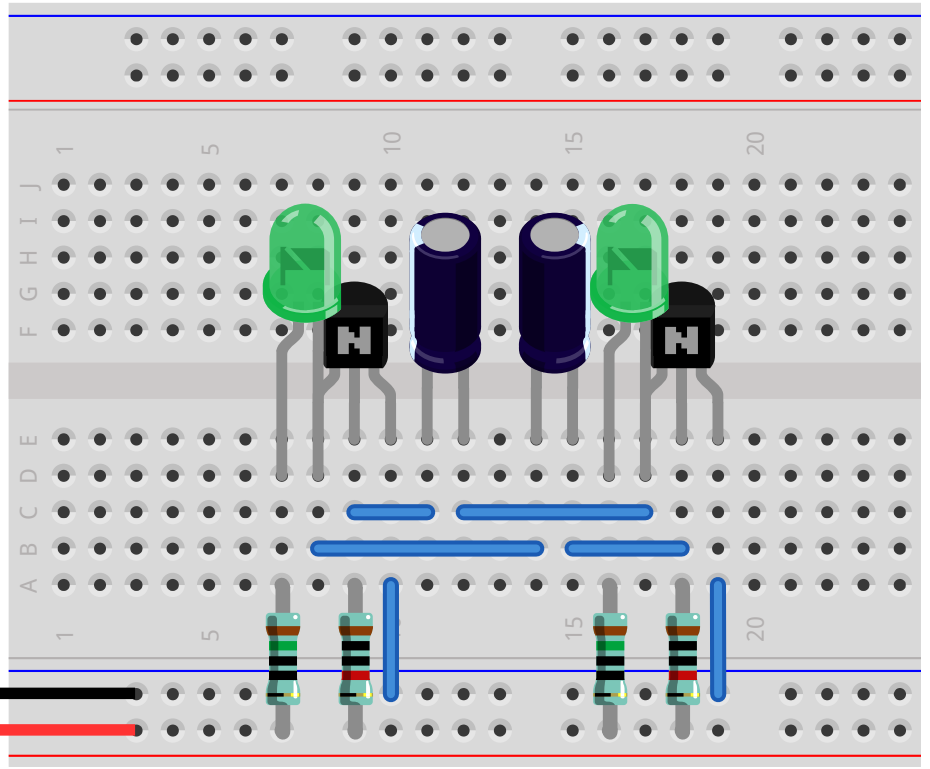
10µF capacitor
Negative pin (stripe) on right

10kΩ resistor
Brown, black, black, red

Astable – Final



Astable – Test



Apply power
Match heat-shrink colors

Observe circuit switching back and forth between two states automatically

Questions

(and congratulations for
getting through nearly 50 slides!)