make it!

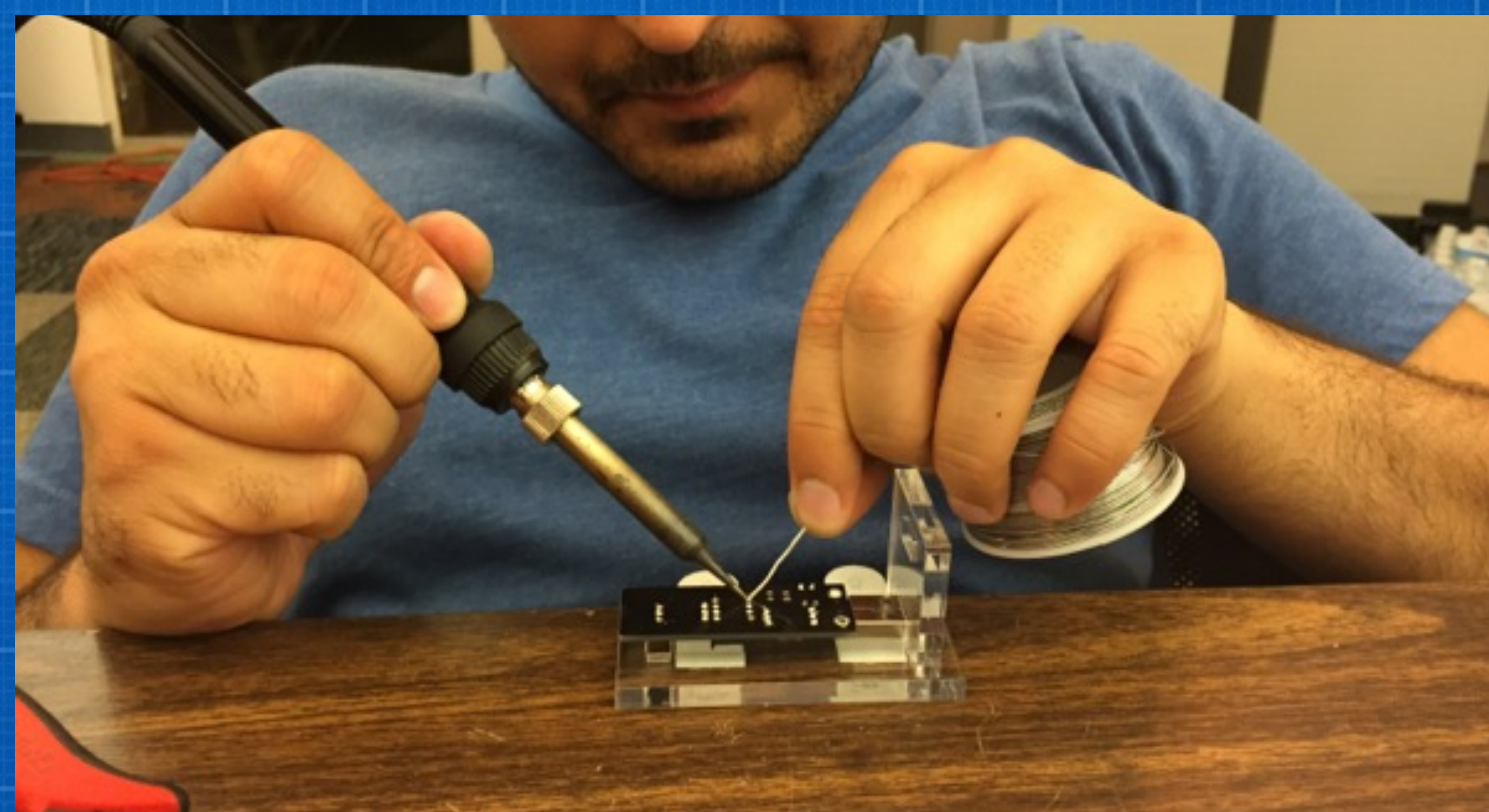
WHERE SOFTWARE MEETS HARDWARE

May 19, 2015

Introduction

- *"The Internet is rapidly transforming from a simple network of humans with computers into the backbone of a new industrial society of networked machines that connect with each other to get things done. And nowhere is this revolution more apparent than in consumer hardware."*

The C1 Blinky

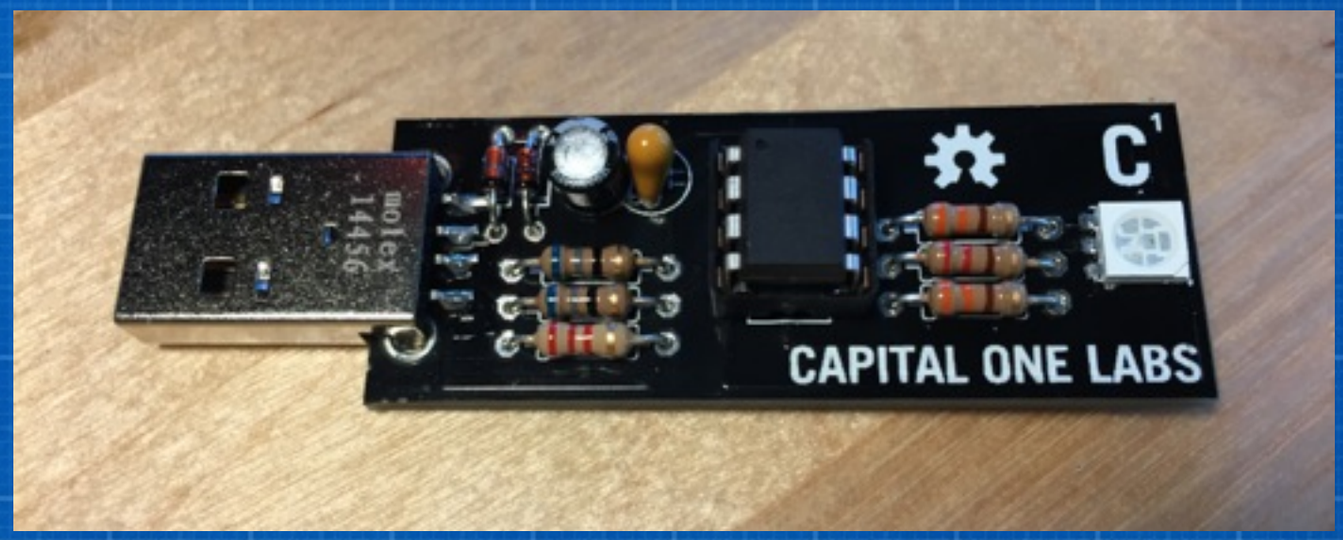


CAPITAL ONE LABS

make it!

Goals

- Develop a greater appreciation for the marriage between software and hardware.
- Build a working IoT device:
  - The C1 Labs Blinky!
  - A USB-connected, RGB LED that you can control from anywhere!



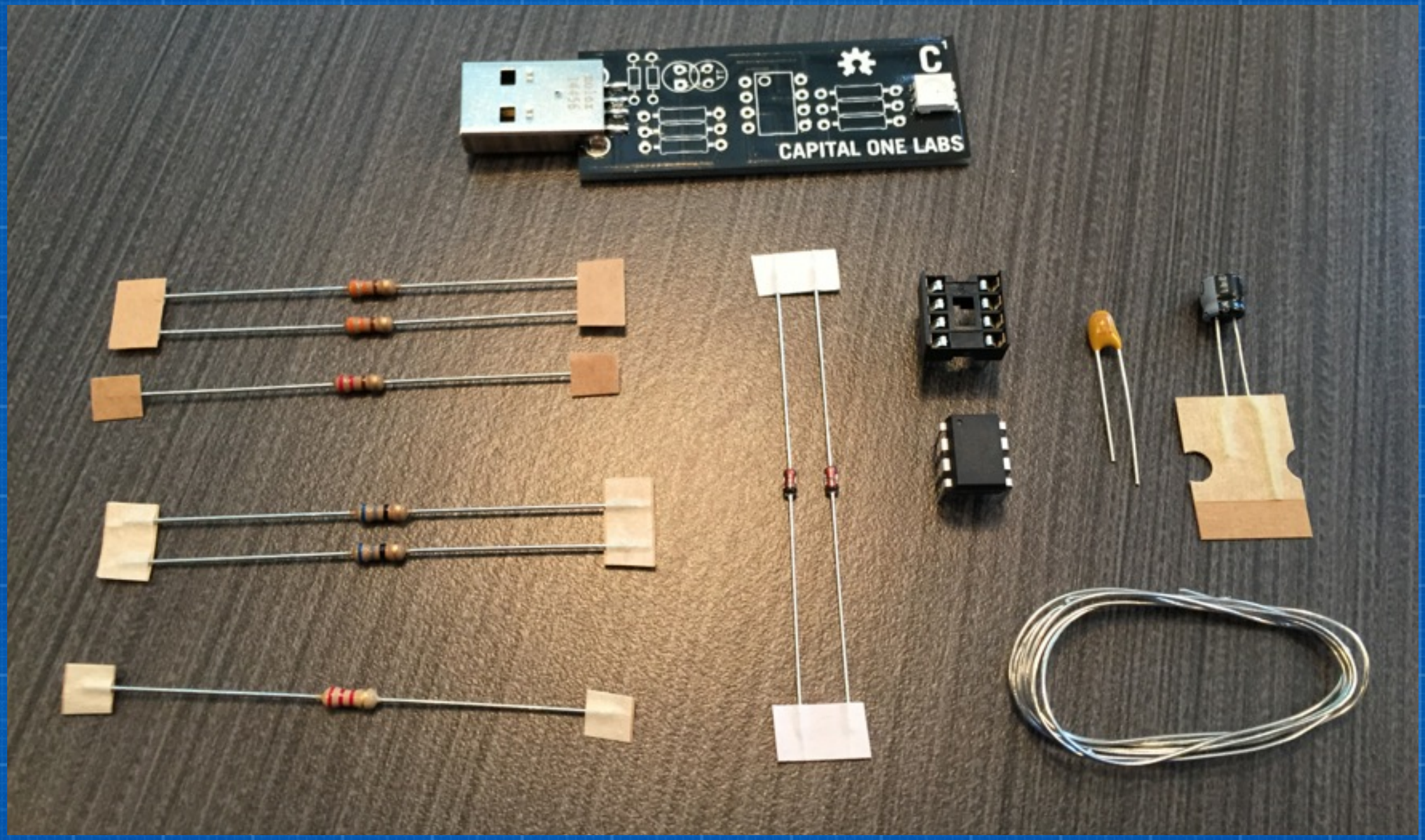
C1 CAPITAL ONE LABS make it!

Agenda

- What We'll Do Today:
  - Some Basic Electronics
  - Some Soldering
  - Some Programming

C1 CAPITAL ONE LABS make it!

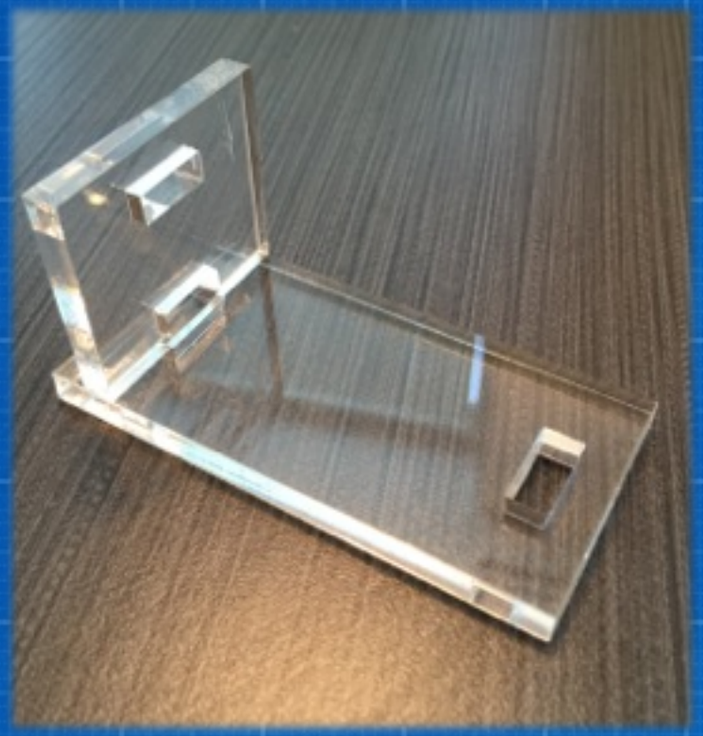
C1 Blinky Kit



C1 CAPITAL ONE LABS

make it!

Soldering Assist Kit



C1 CAPITAL ONE LABS make it!

Basic Electronics

- The USB Port
- Resistors
- Diodes
- LEDs
- Capacitors
- Integrated Circuits
- Putting It All Together
- The C1-Blinky USB RGB LED:
  - Circuit, PCB, and Completed Board

The USB Port

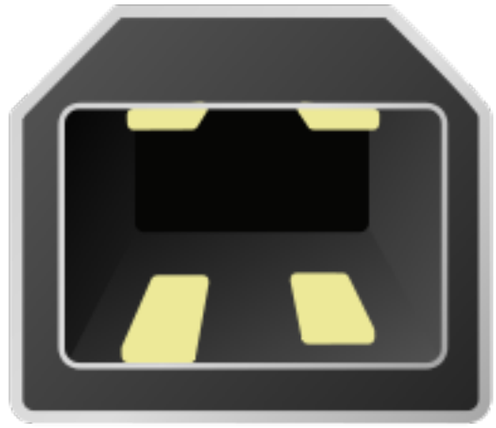
USB

Standard A

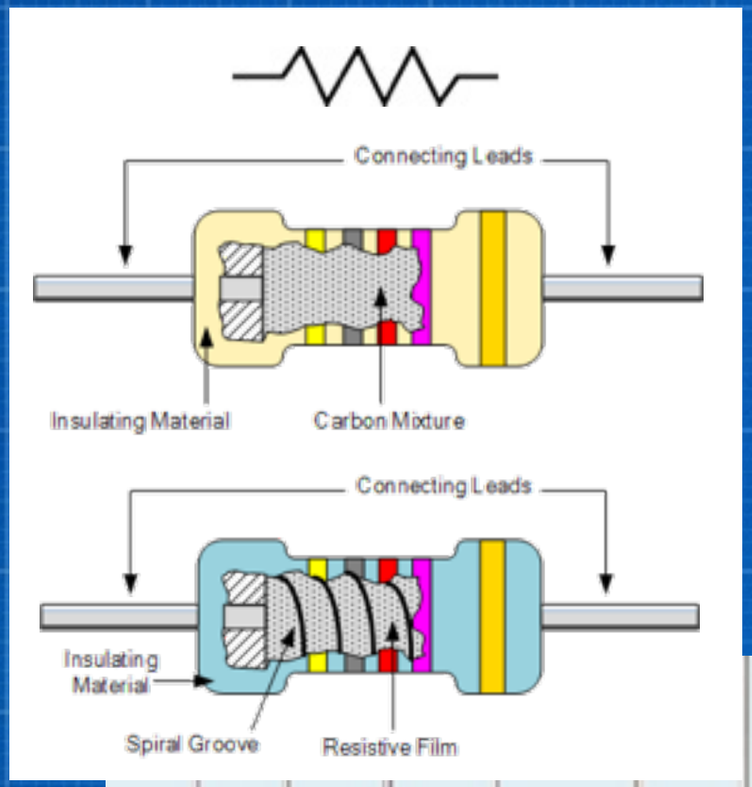
1	2	3	4
−	D+	D−	+

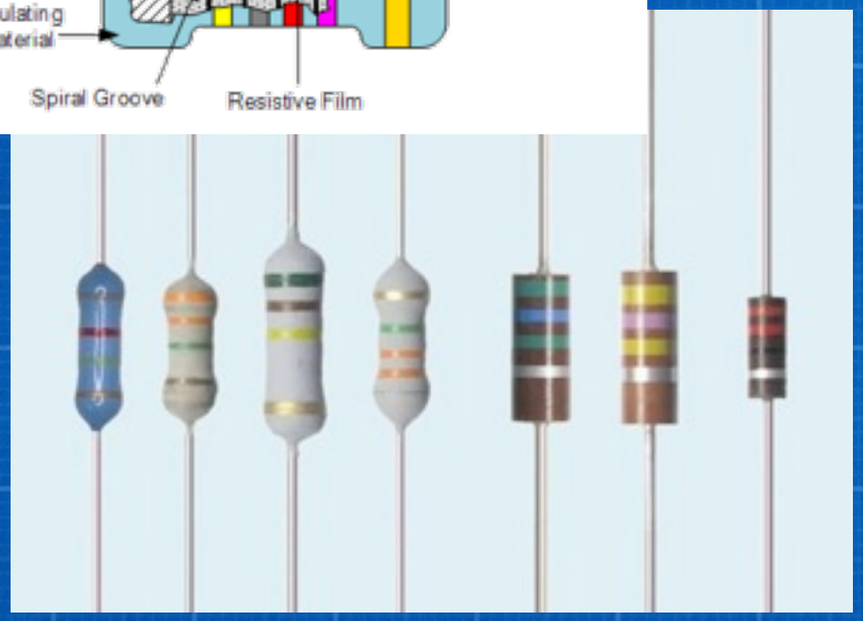
Standard B

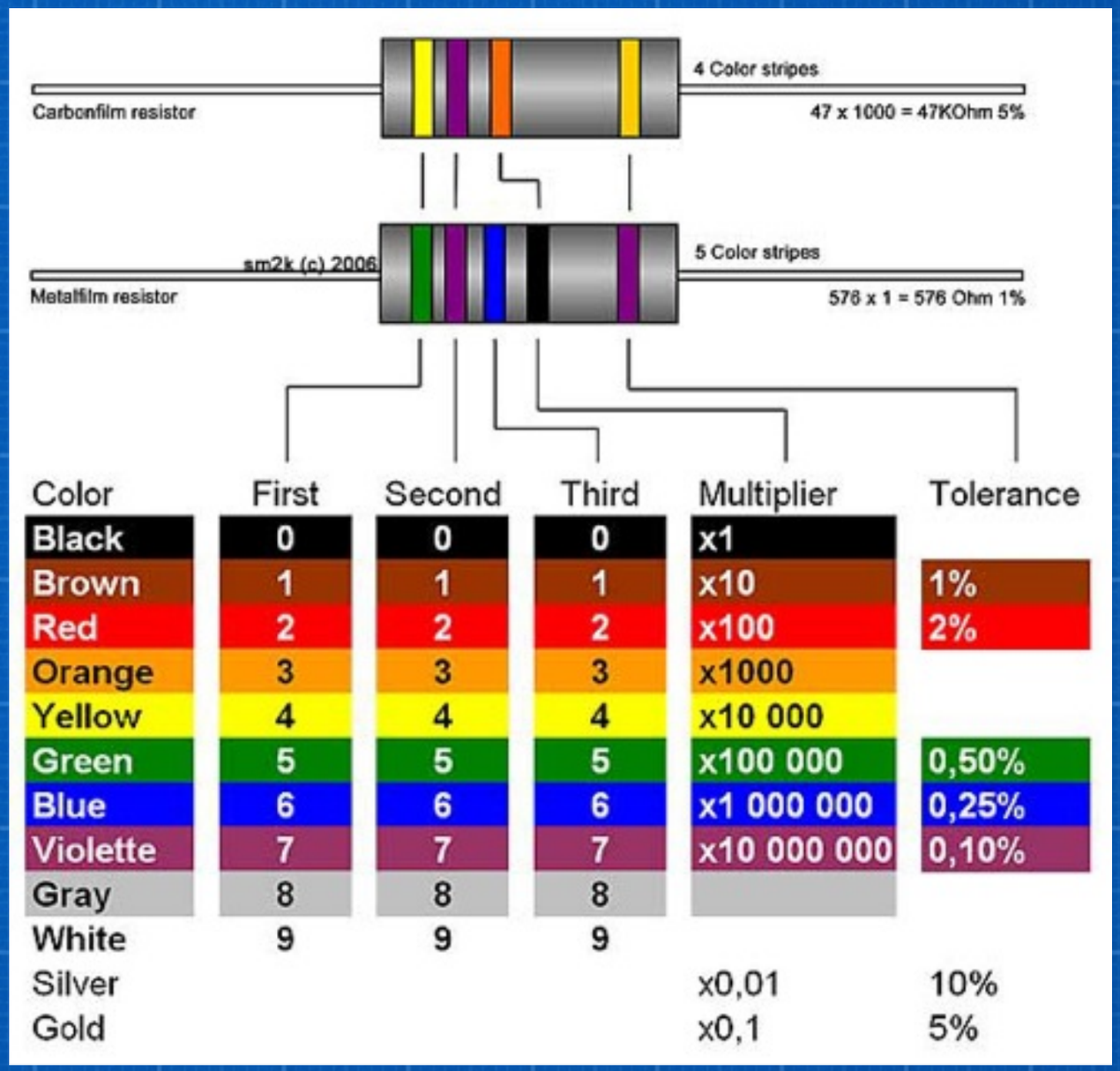
1	2	3	4
+	D−	D+	−



Basic Components: Resistors





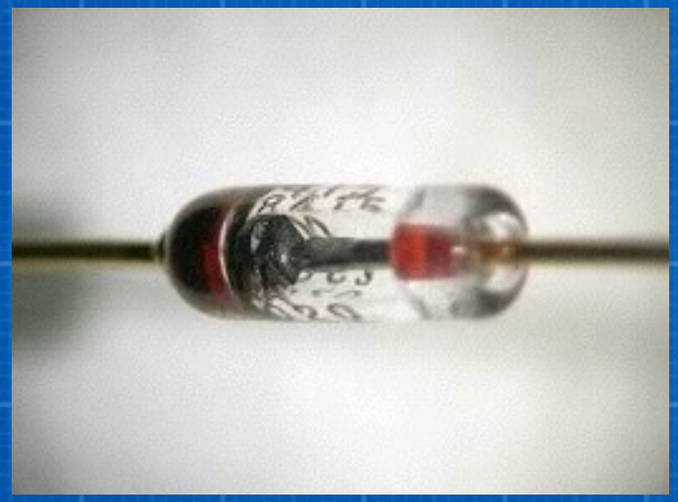


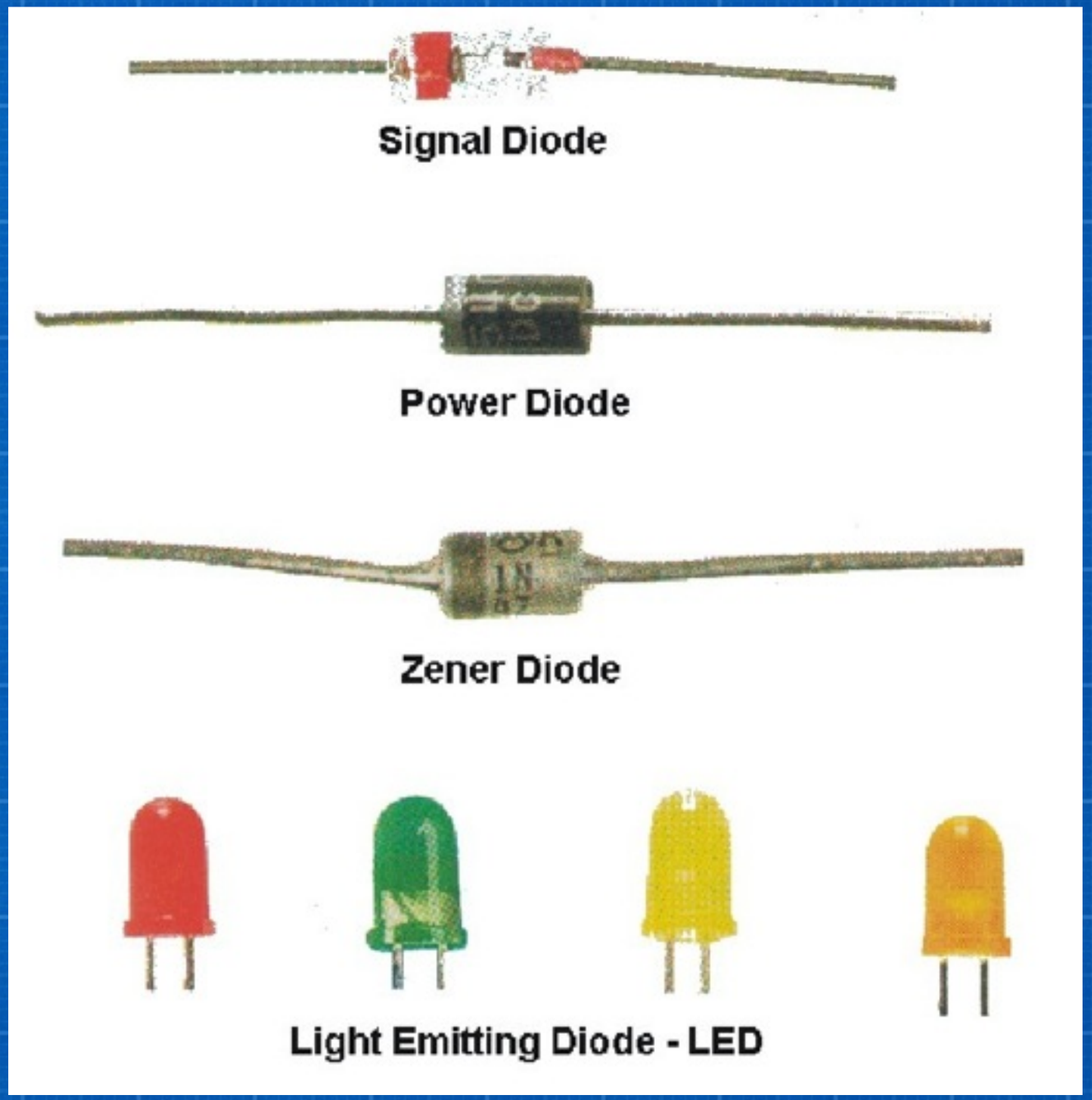
Color	First	Second	Third	Multiplier	Tolerance
Black	0	0	0	x1	
Brown	1	1	1	x10	1%
Red	2	2	2	x100	2%
Orange	3	3	3	x1000	
Yellow	4	4	4	x10 000	
Green	5	5	5	x100 000	0,50%
Blue	6	6	6	x1 000 000	0,25%
Violette	7	7	7	x10 000 000	0,10%
Gray	8	8	8		
White	9	9	9		
Silver				x0,01	10%
Gold				x0,1	5%

C1 CAPITAL ONE LABS

make it!

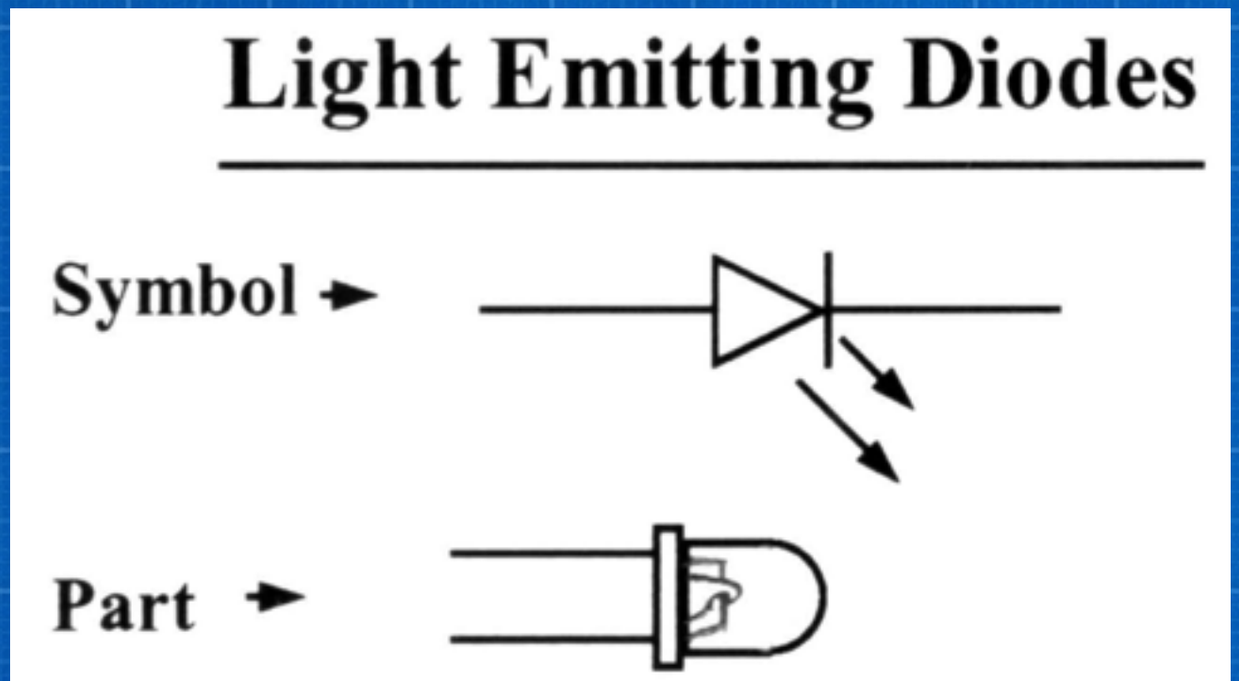
Basic Components: Diodes

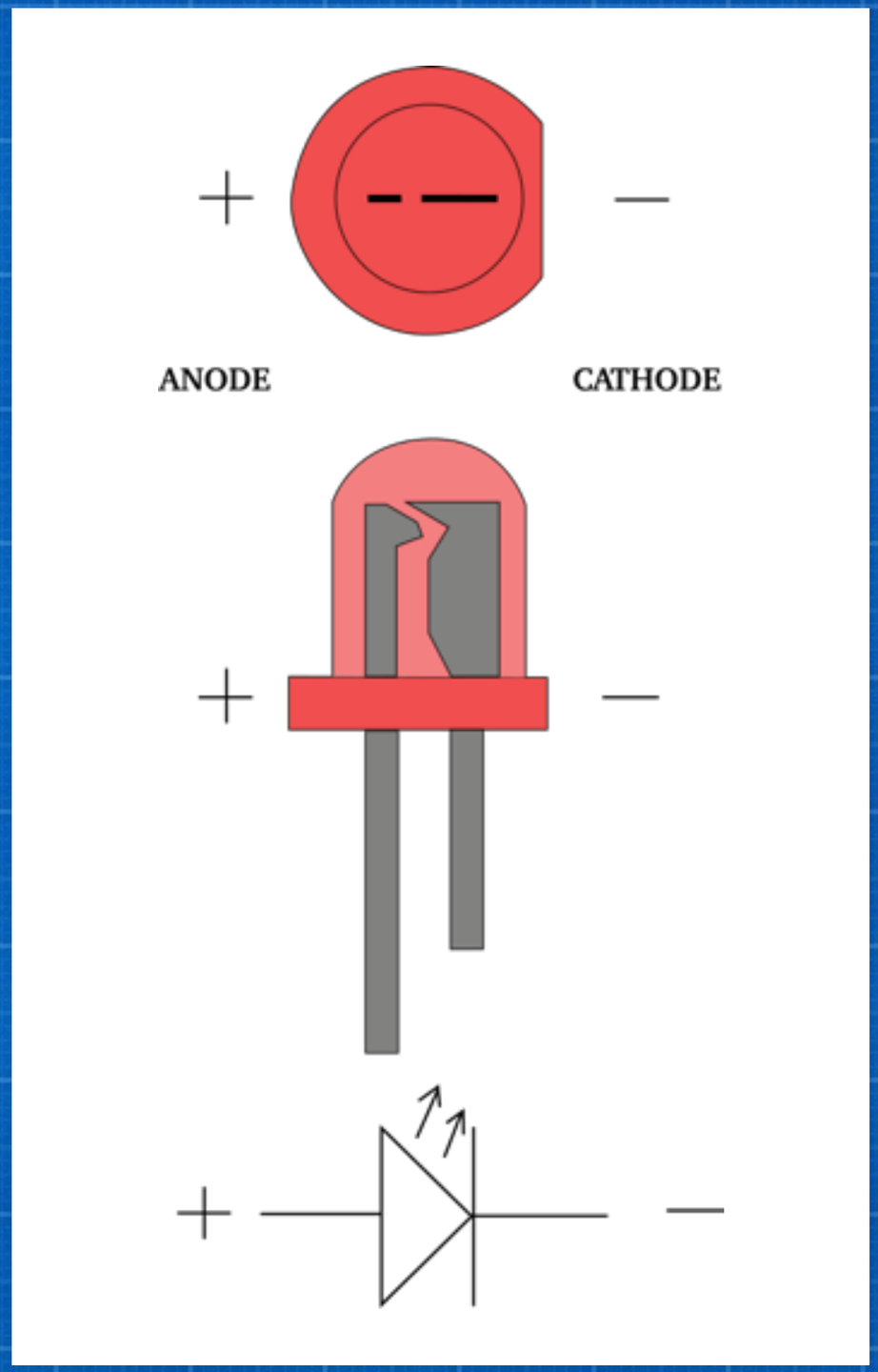




C1 CAPITAL ONE LABS make it!

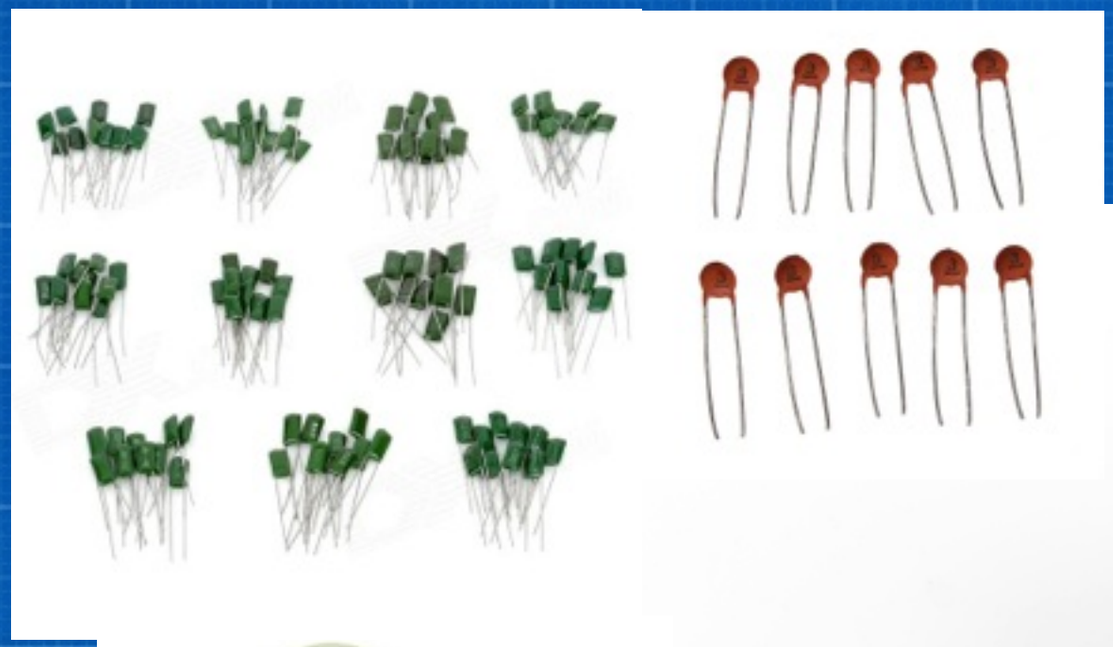
Basic Components:
Light Emitting Diodes (LEDs)

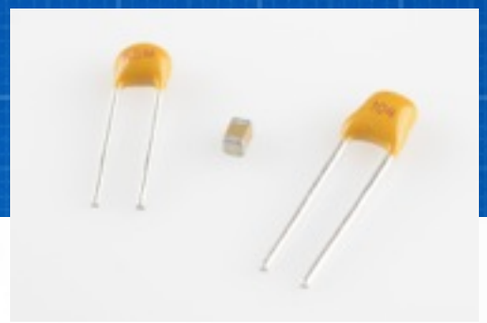




C1 CAPITAL ONE LABS make it!

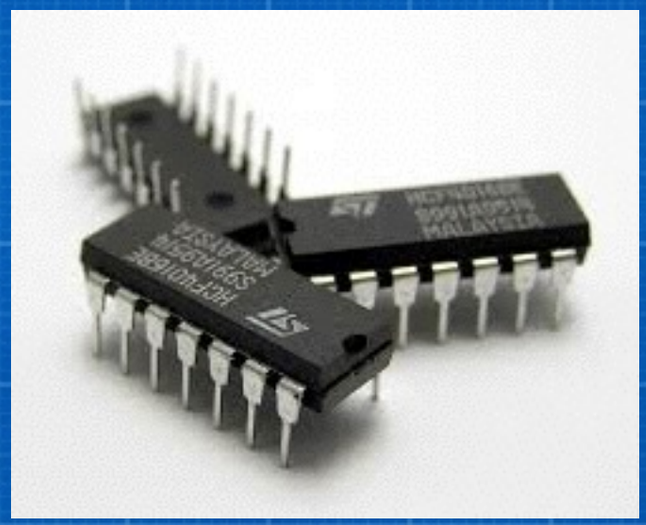
Basic Components: Capacitors

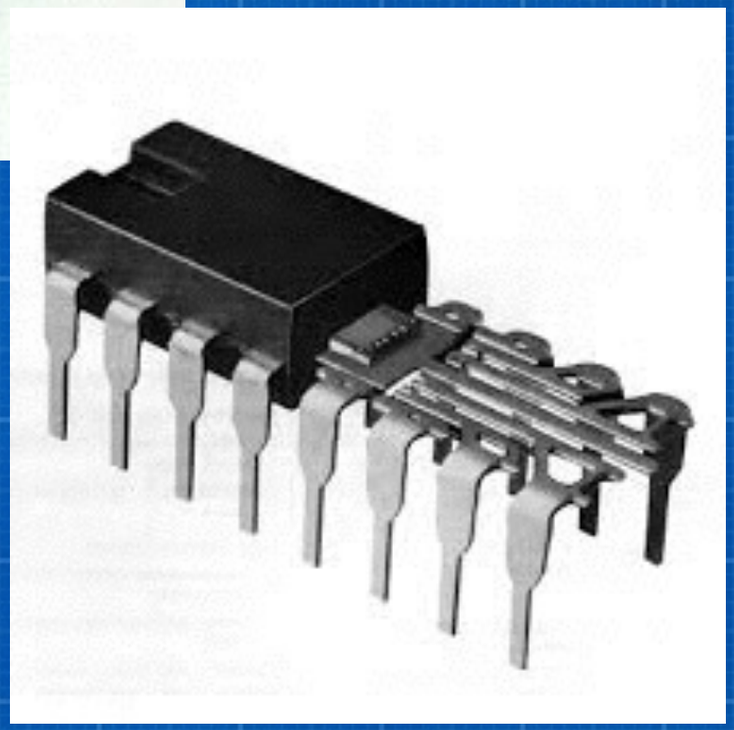




C¹ CAPITAL ONE LABS make it!

Basic Components: Integrated Circuits (ICs)

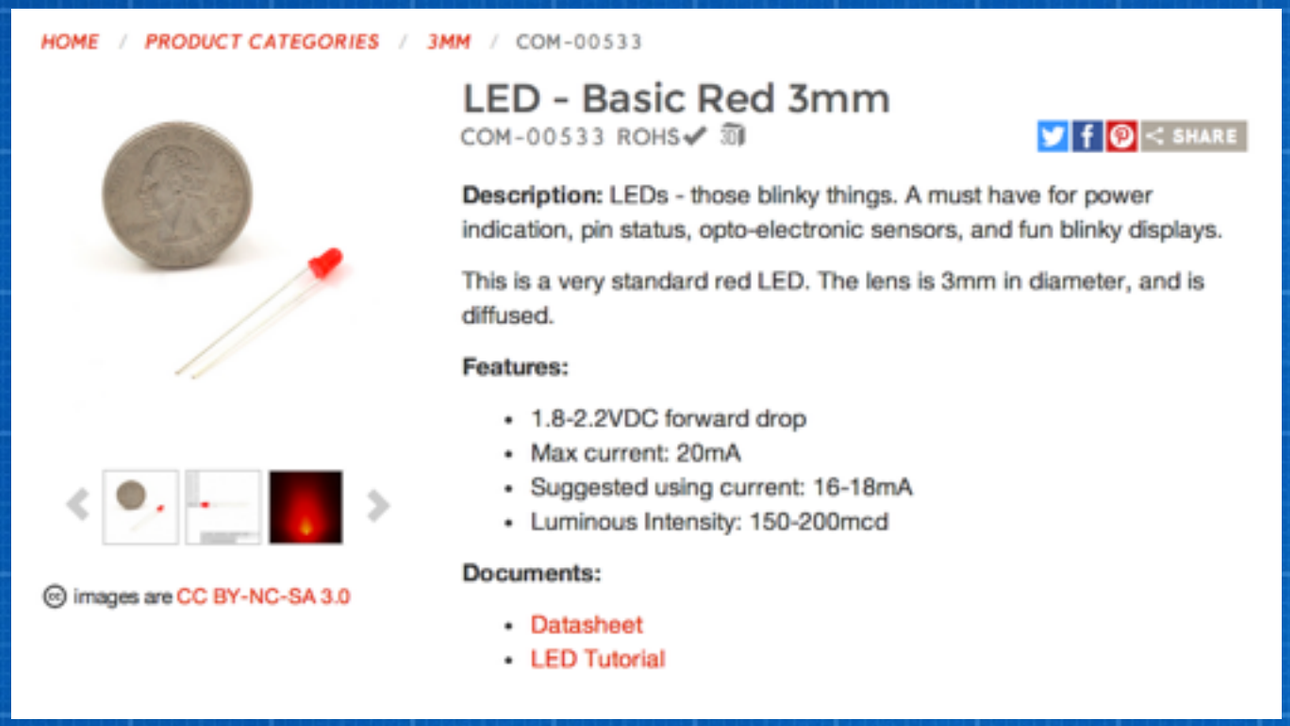


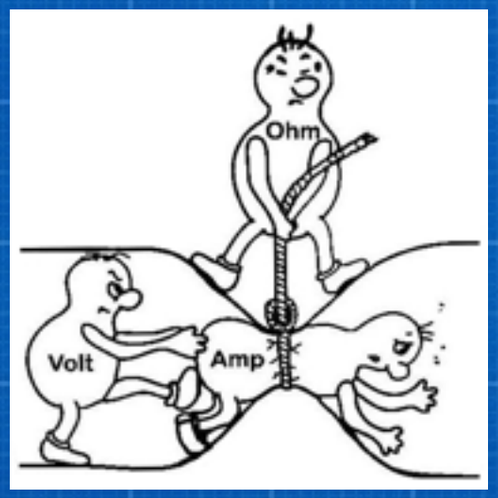


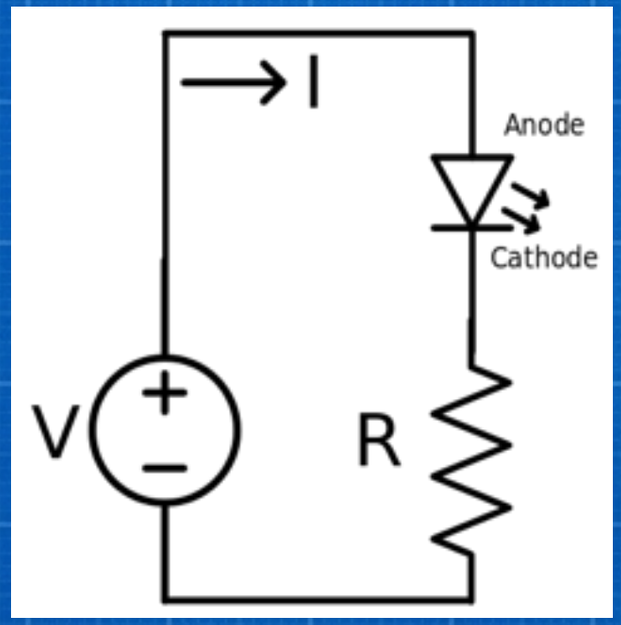
CAPITAL ONE LABS

make it!

Common Circuits: LED



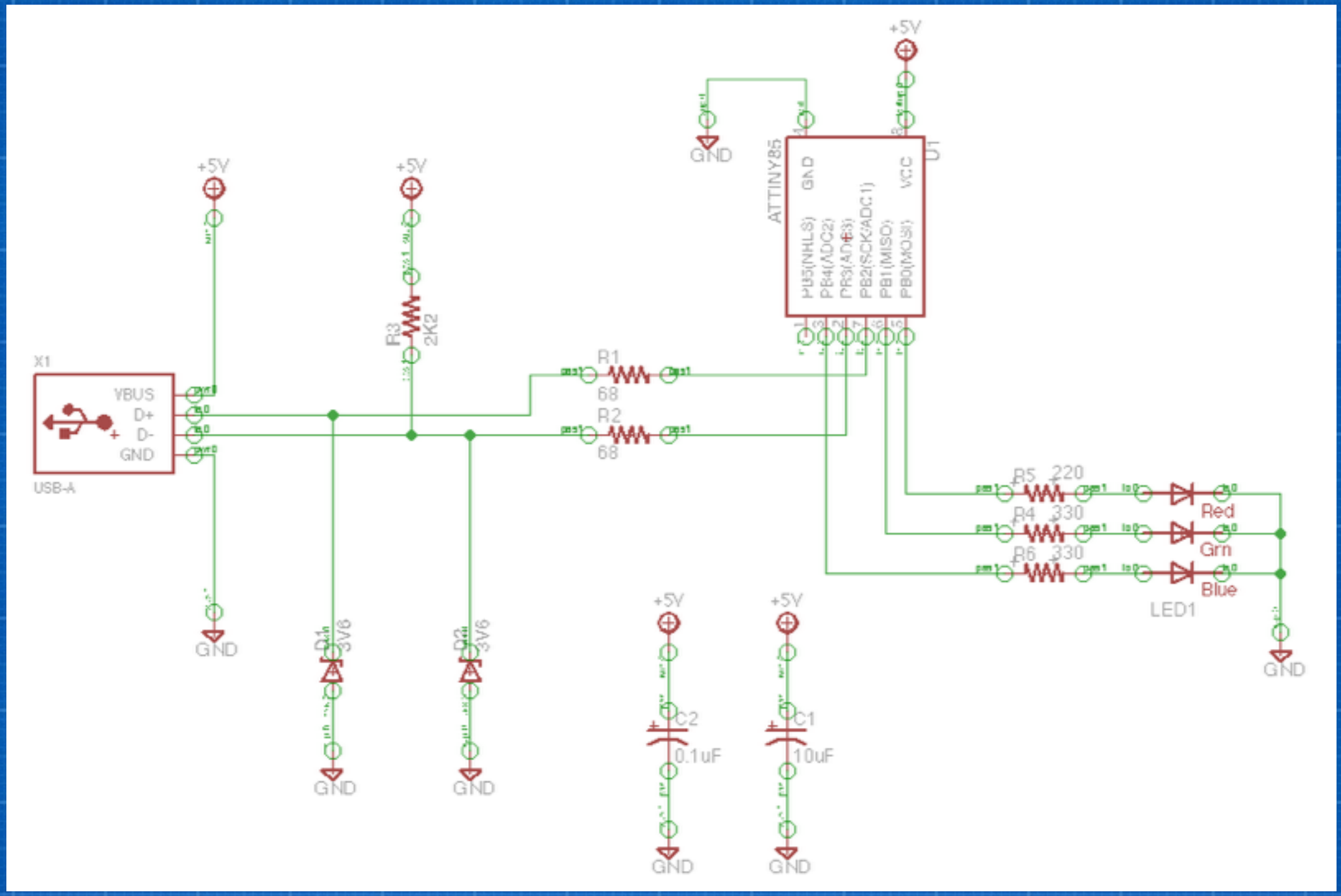




- Red LED
  - 16-18 mV
- 5 V SOURCE
  - minus 2 V drop
- V = C * R
- 3 = 0.020 * R
- R = 3 / 0.020
- R = 150 Ω
- Conventional Wisdom - use a 220-330 Ω resistor.

C1 CAPITAL ONE LABS make it!

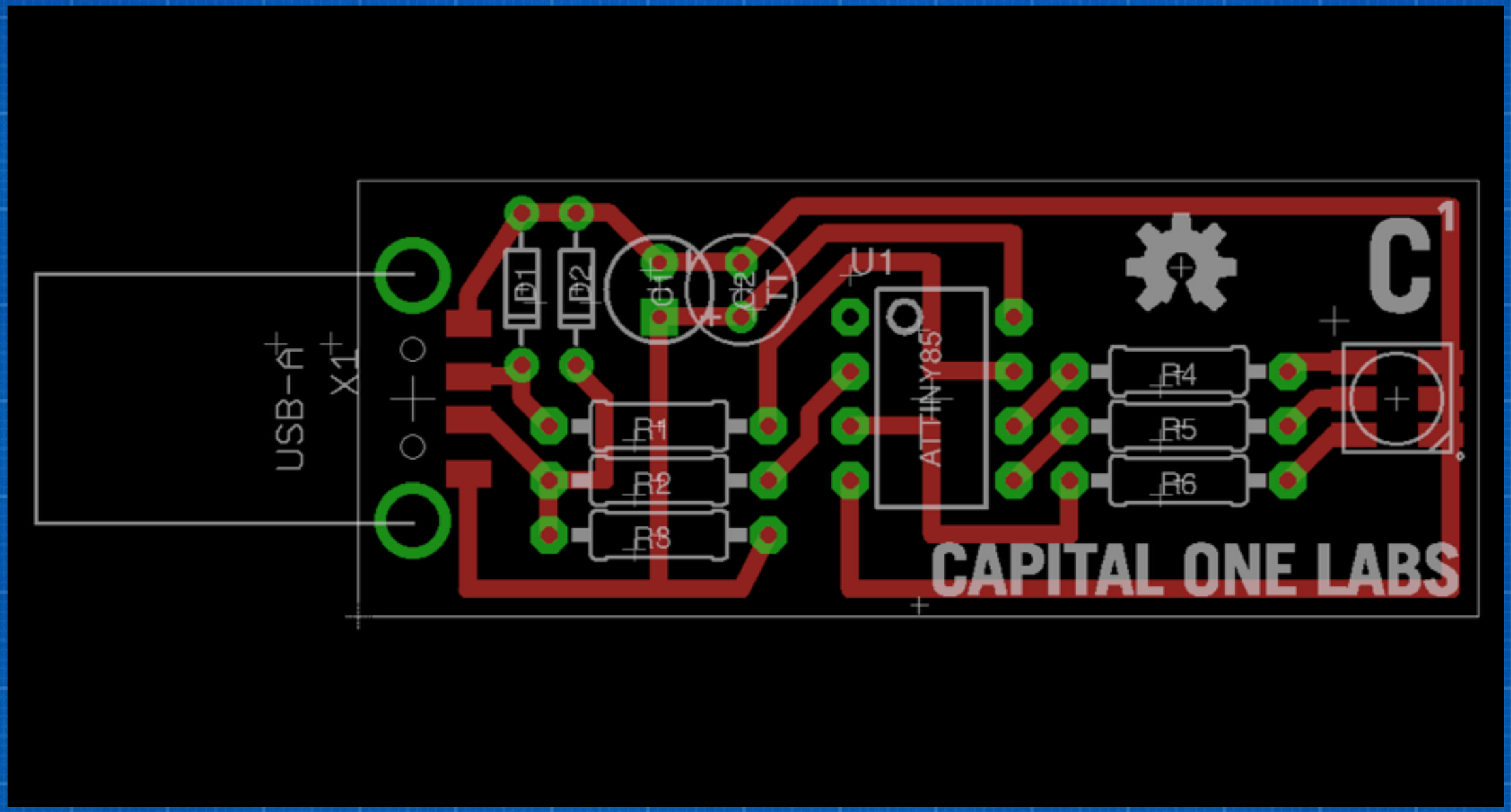
C1 Blinky Circuit



CAPITAL ONE LABS

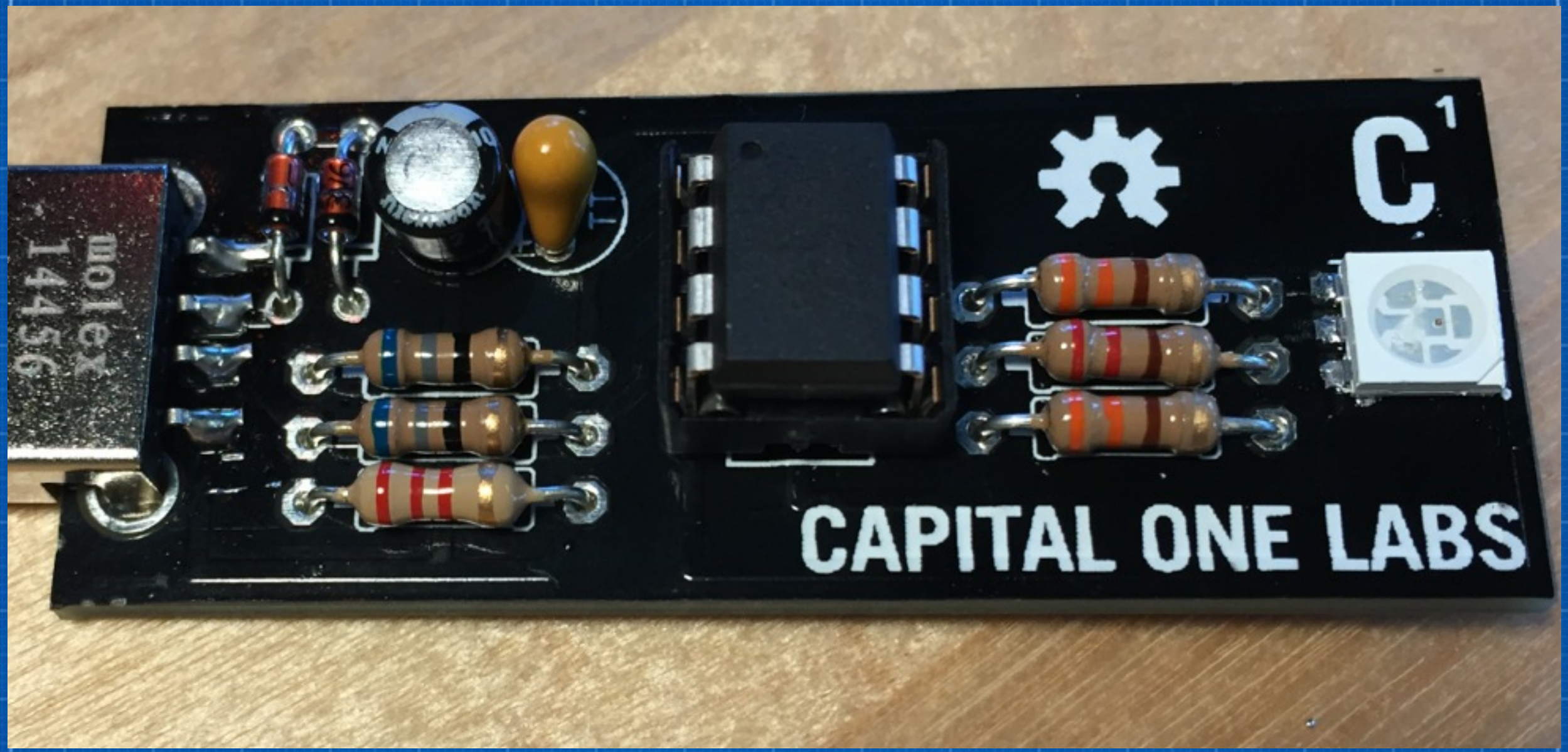
make it!

C1 Blinky PCB



C1 CAPITAL ONE LABS make it!

C1 Blinky
Completed Board



C1 CAPITAL ONE LABS make it!

Basic Soldering

- Plug in the soldering iron - it will take 2-3 minutes to heat up.
- Tin the tip - coat the entire tip in solder, then wipe it off on a piece of moist sponge.
- Add a small amount of solder to the tip right before you start to solder - the solder conducts heat better than the bare metal tip alone.
- Apply the iron to the pad you're trying to heat.
- Feed solder into to pad (NOT into the soldering iron).

C1 CAPITAL ONE LABS make it!

SAFETY

- Soldering Iron
  - Burns
  - Damage to Tables
  - Melting Plastic
  - Fire Hazard
- Leaded Solder
  - Don't Breathe the Fumes!!!

C1 CAPITAL ONE LABS make it!

PCB Assembly How-To

- Order:
  1. LED Resistors
  2. USB Resistors
  3. Diodes - Double Check Polarity!
  4. IC Socket (not the IC!)
  5. Capacitors - Double Check Polarity!

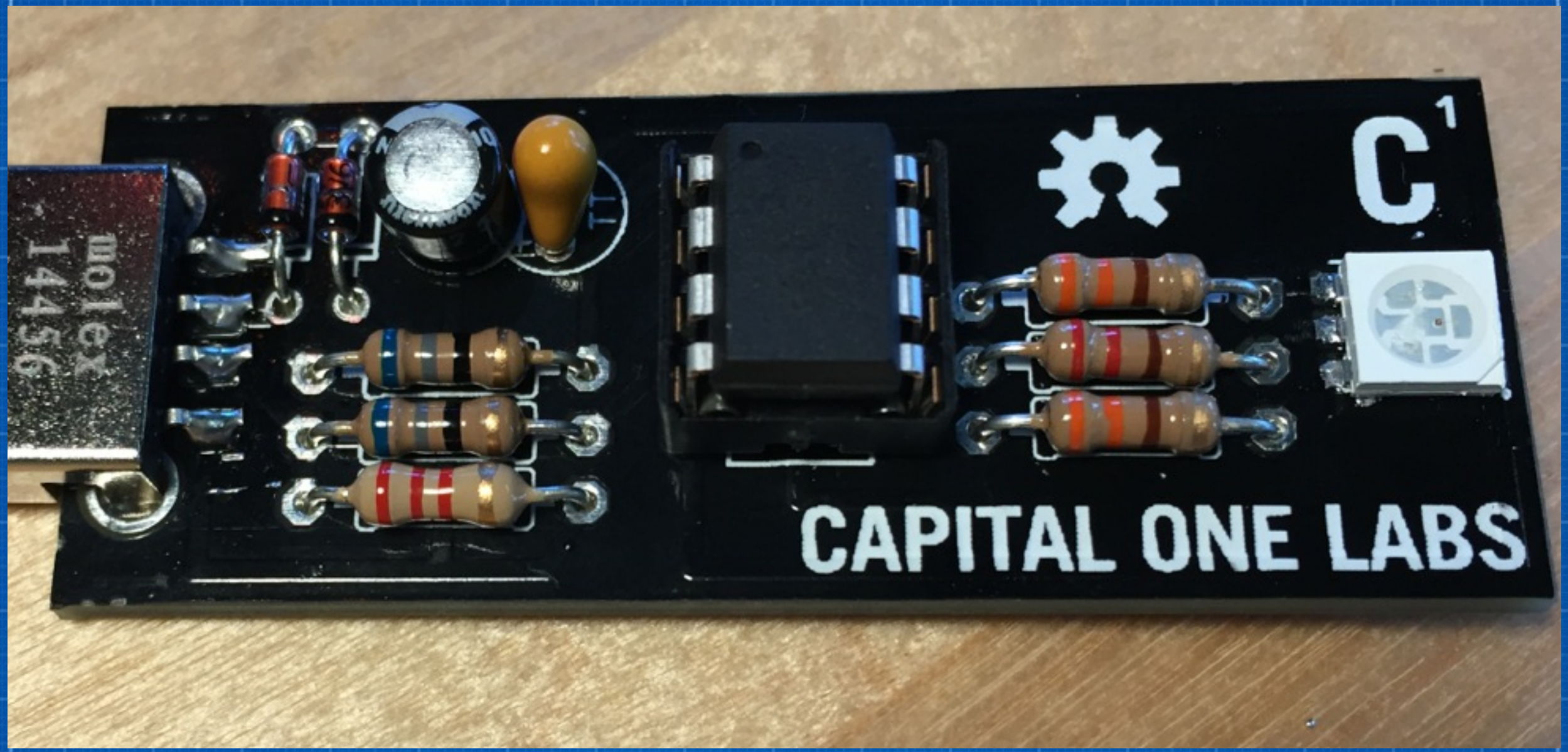
C1 CAPITAL ONE LABS make it!

PCB Assembly How-To

- Process:
  1. Bend leads using 3D-printed "C1 Bender Tool"
  2. Put leads through holes until flush with PCB
  3. Bend leads 45 degrees on the back-side to hold in place.
  4. Solder (remember, heat the pad, not the leads!)

C1 CAPITAL ONE LABS make it!

C1 Blinky
Completed Board



C1 CAPITAL ONE LABS make it!

C1 Blinky Programming

- In your Virtual Box image, the directory that contains the C1 Blinky software is:
    - ~/c1blinky
- There are two subdirectories: one that contains the firmware (already flashed onto your ATtiny85) and one that contains the command line program that sends color values to the USB port:
    - firmware
    - commandline

C1 CAPITAL ONE LABS

make it!

C1 Blinky Programming

- *Inside the commandline directory, the program that sends color values is set-led*
- *Usage:*
  - **`sudo ./set-led 255 0 0`**

C1 CAPITAL ONE LABS make it!

Using Your C1 Blinky

- How can you use your C1 Labs Blinky?
  - Indicator (financial health, weather, unread email, tweets, ANYTHING!)
  - Event Notifications

C1 CAPITAL ONE LABS make it!

Further C1 Blinky Development

- Network your C1 Blinky
- Write a library of functions:
  - Blink, Fade, Heartbeat, Rainbow, Status Index (Stoplight, Heat Map), Patterns, Morse Code, etc...
- IFTTT Rules for Event Processing
- Use it in a Hackathon!

C1 CAPITAL ONE LABS make it!

Acknowledgements

- Thanks to:
  - Saleem Sangi - Prototyping, circuit layout, homemade PCB developing, etching, and soldering.
  - Jared Alexander - Teaching Assistant
  - Colin MacDonald - Teaching Assistant
  - Kaylyn Gibilterra - Teaching Assistant
  - Amy Lifland - Early kit assembly and troubleshooting
  - Karla Escalante - Soldering kit assembly
  - Scott Harris (non-C1) - Nova Labs Member - inspiration for soldering holder, general assistance throughout the entire process.

C1 CAPITAL ONE LABS make it!

Acknowledgements

- Thanks to:
  - OrBlink - inspiration, initial firmware and command line software
  - BlinkStick - inspiration, initial BOM review of their firmware and software

C1 CAPITAL ONE LABS make it!