12 Ways to Blink an LED

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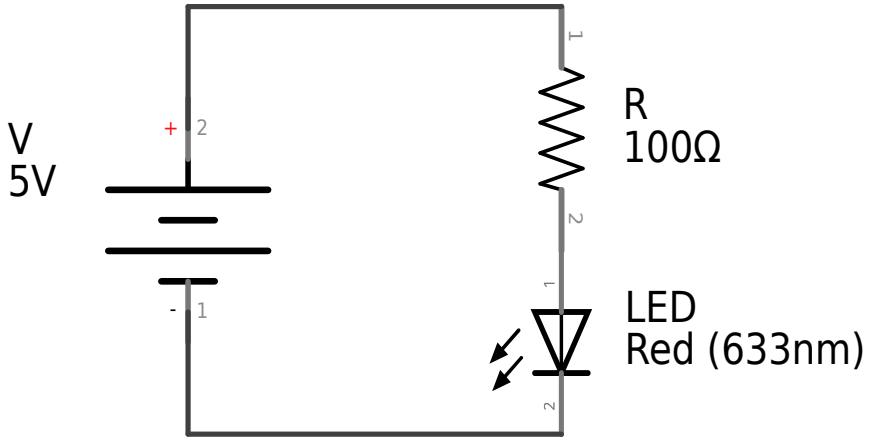
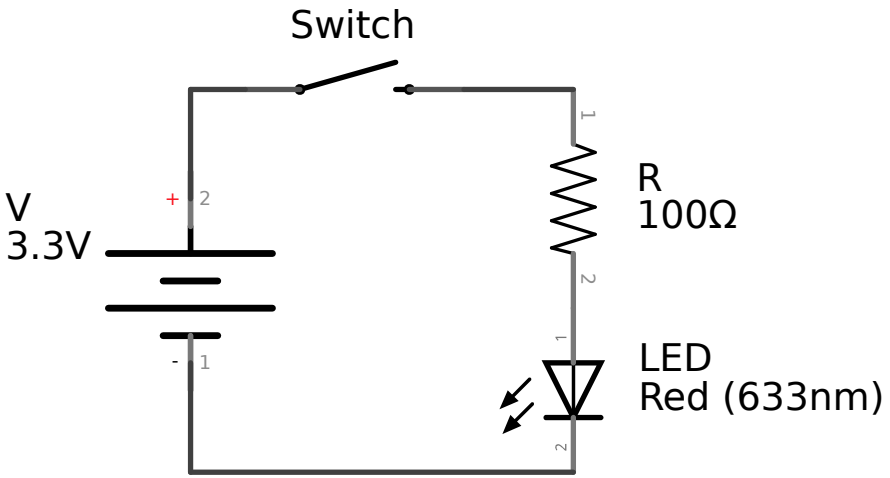
LED basic circuit

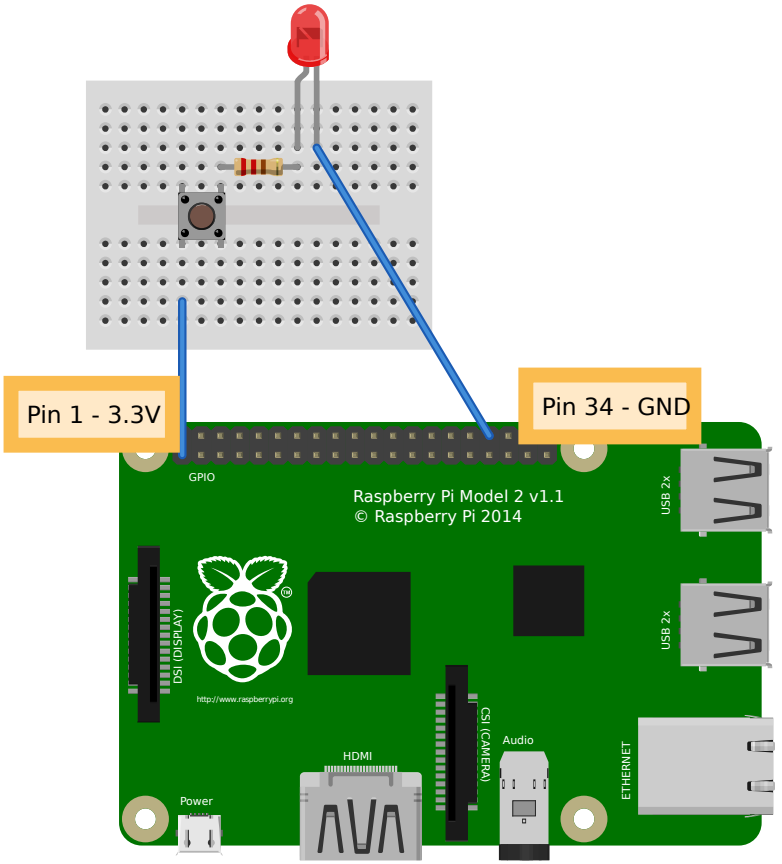


- Need to limit current (no magic smoke)
- $V = V_{LED} + V_R$
- $V_R = IR$ (Ohm's Law)
- $V = V_{LED} + IR \Rightarrow R = (V - V_{LED})/I$
- LED: $V_{LED} \sim 2.5V$

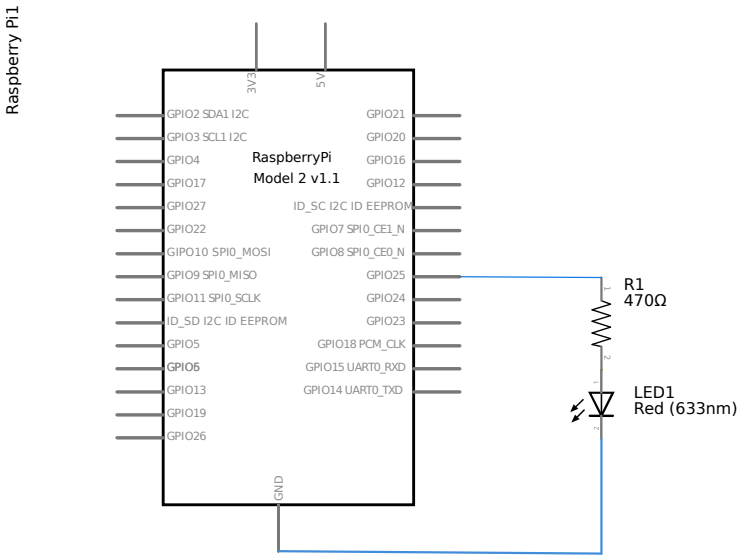
- Raspberry Pi: 3.3V, 16mA
- $R = (3.3 - 2.5)/0.016 = 50$ ohms
- Arduino: 5V, 40mA
- $R = (5 - 2.5)/0.040 = 62.5$ ohms
- Bigger is safer

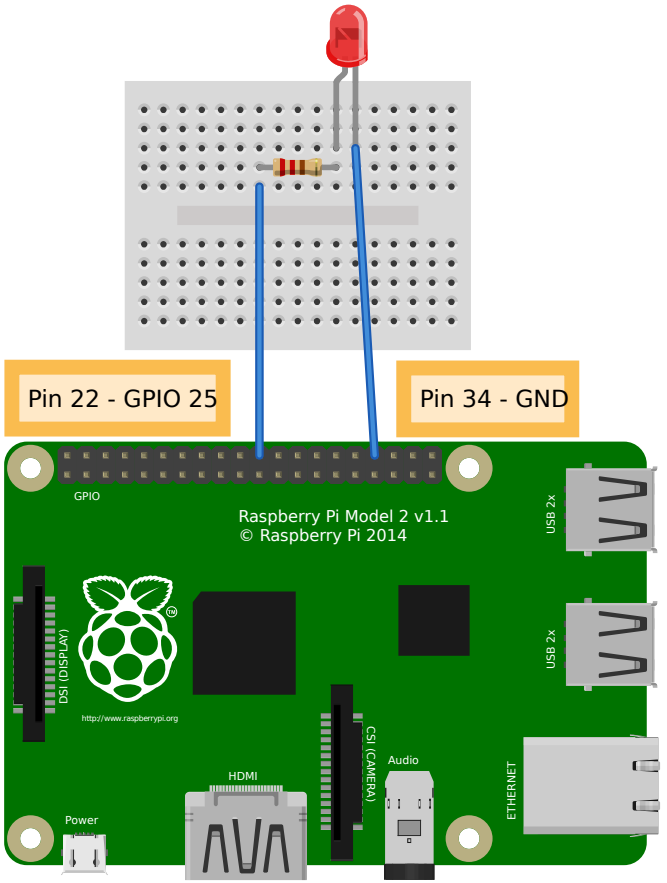
Blink LED with pushbutton





Blink LED with Pi





- Create a file named BlinkRaspberryPi.py with Python code:

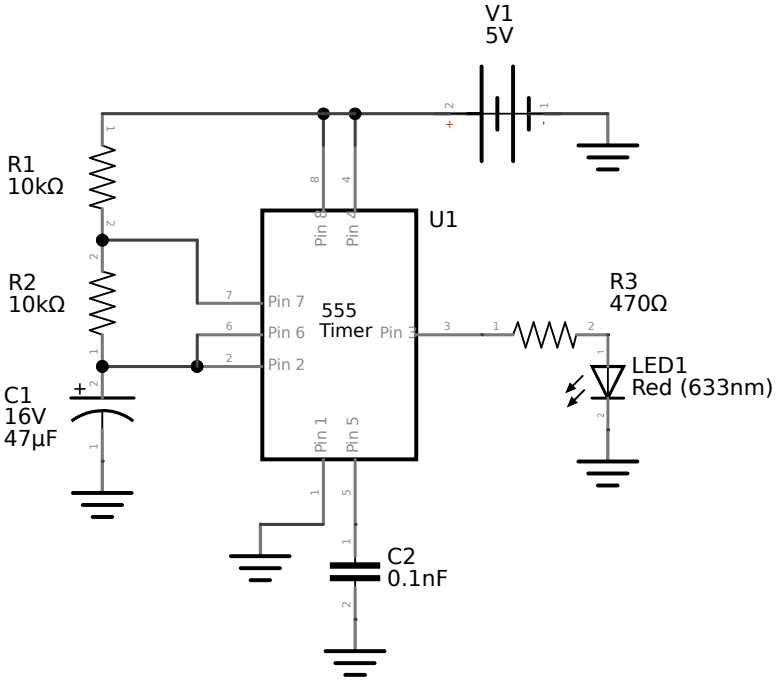
```
import RPi.GPIO as GPIO
import time

GPIO.setmode(GPIO.BCM)
GPIO.setup(25, GPIO.OUT)

while True:
    GPIO.output(25, GPIO.HIGH)
    time.sleep(1)
    GPIO.output(25, GPIO.LOW)
    time.sleep(1)
```

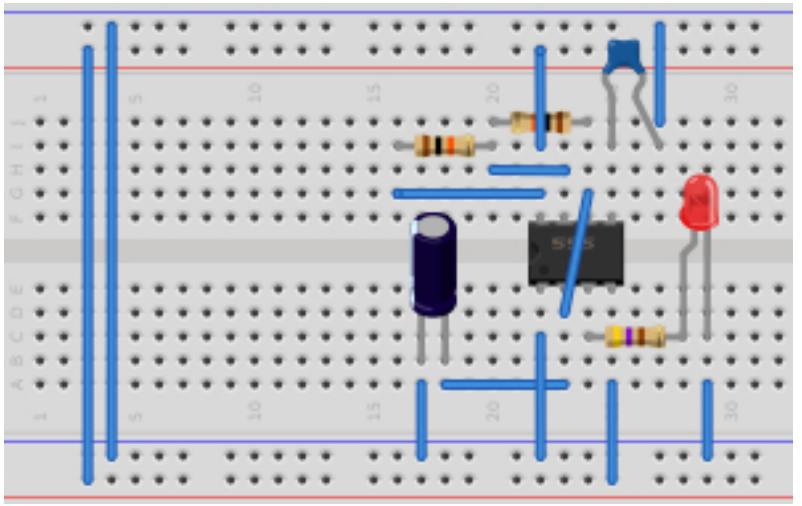
- Ensure you have the Python libraries for accessing GPIO pins installed:

```
$ sudo apt-get install python-rpi.gpio python3-rpi.gpio
```

- Run it: `python BlinkRaspberryPi.py`
- What does script do?
- Raspberry Pi has digital outputs only (HIGH, LOW)

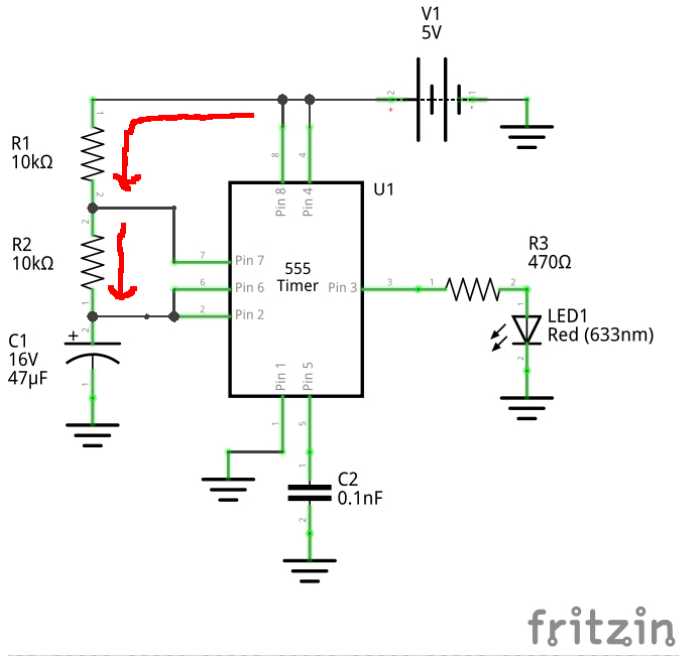
555 Astable Multivibrator

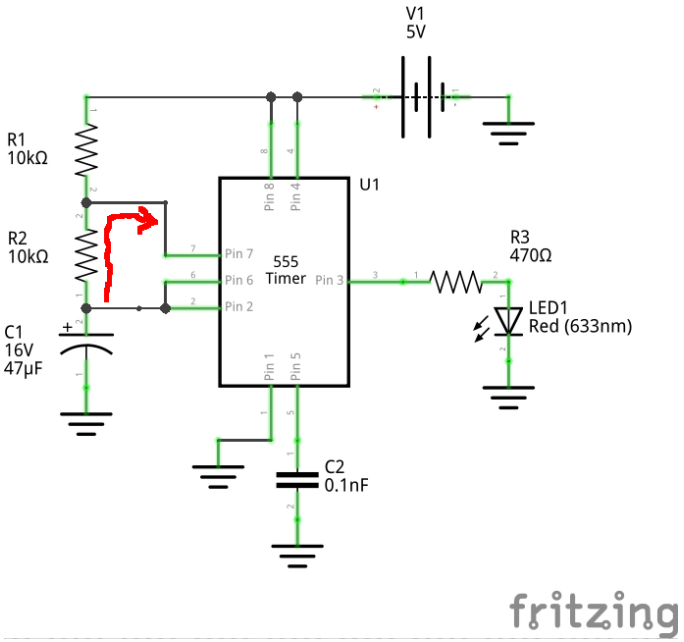




- Connect 5V from Pi to red rail, ground to blue rail
- Dot on IC is pin 1, C1 has +/-
- Timing is determined by how quickly capacitor C1 charges/discharges

How the 555 circuit works





- Charging (left): Capacitor C1 charges through R1 and R2
- When capacitor voltage reaches 2/3 V1, pin 7 connects to ground
- Discharging (right): Capacitor C1 discharges through R2
- When capacitor drops to 1/3 V1, pin 7 disconnects from ground
- Water analogy: voltage like pressure, current like flow rate
- Capacitor like bucket, resistor like hose restriction
- Bigger capacitor or bigger resistor means longer time
- Time constant for charging = (R1+R2)*C1
- Time constant for discharging= R2*C1

Arduino

- https://www.arduino.cc/ , Download, “Linux ARM (experimental)”
- `$ cd ~/Downloads`
- `$ tar Jxf arduino-1.6.*-linuxarm.tar.xz`
- `$ cd arduino-1.6.*-linuxarm`
- `$ ./install.sh`
- `$ ./install.sh`
- Start the Arduino IDE, set Board and Port
- Open the Blink example, compile and upload
- If using Nano, use built in LED on pin 13
- If not Nano, wire LED and resistor to a pin, change program to suit.

ATtiny

- Attiny 45 is a tiny Arduino (6 I/O pins, 4kb memory)
- Use Arduino IDE to set up:
  - Open `File→Preferences`
  - Go to “Additional Boards Manager URL”
  - `https://raw.githubusercontent.com/damellis/attiny/ide-1.6.x-boards-manager/package_damellis_attiny_index.json`
  - Click OK
  - Open `Tools→Board→Boards Manager`
  - Scroll to the bottom to “attiny”
  - Click once, Install button will appear, click it
  - Should see “INSTALLED” next to “attiny” when complete
  - Should now have two ATtiny options in `Tools→Board` menu:
    - ATtiny 25/45/85
    - ATtiny 24/44/84

Set up Arduino as ATtiny programmer

- Load sketch `File→Examples→11.ArduinoISP→ArduinoISP`
- Upload to Arduino.
- Go to `Tools→Board` and select "ATtiny 25/45/85".
- Go to `Tools→Processor` and select "ATtiny 45".
- Go to `Tools→Clock` and select "Internal 1MHz".
- Go to `Tools→Programmer` and select "Arduino as ISP".

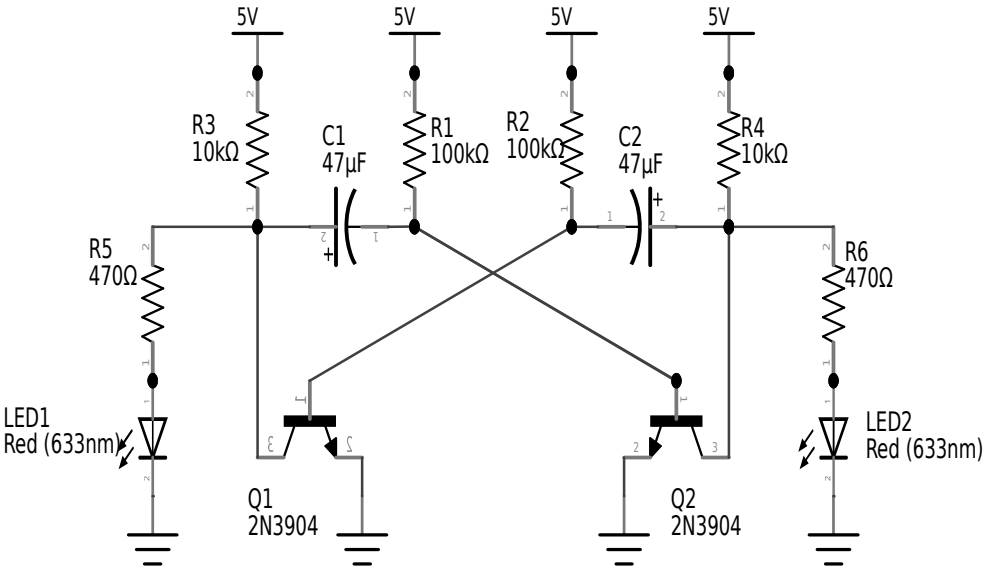
Connect Attiny to Arduino, upload sketch

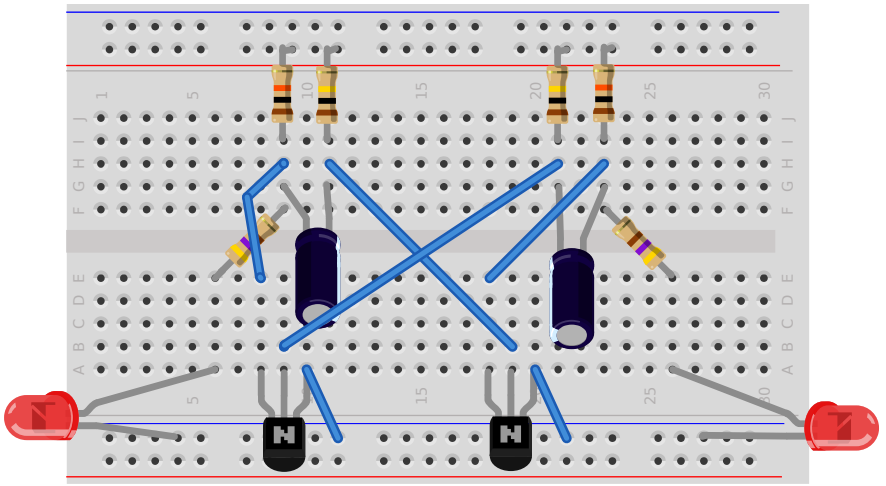
- Wire up ATtiny to Arduino with jumpers (see below).
- If Nano, put 47uF capacitor between RST (+) and GND (-).
- Wire an LED and resistor to pin 5 (logical pin 0).
- Load the Blink sketch from Examples (or from GitHub).
- Modify to use pin 0 instead of 13.
- Upload, LED blinks.

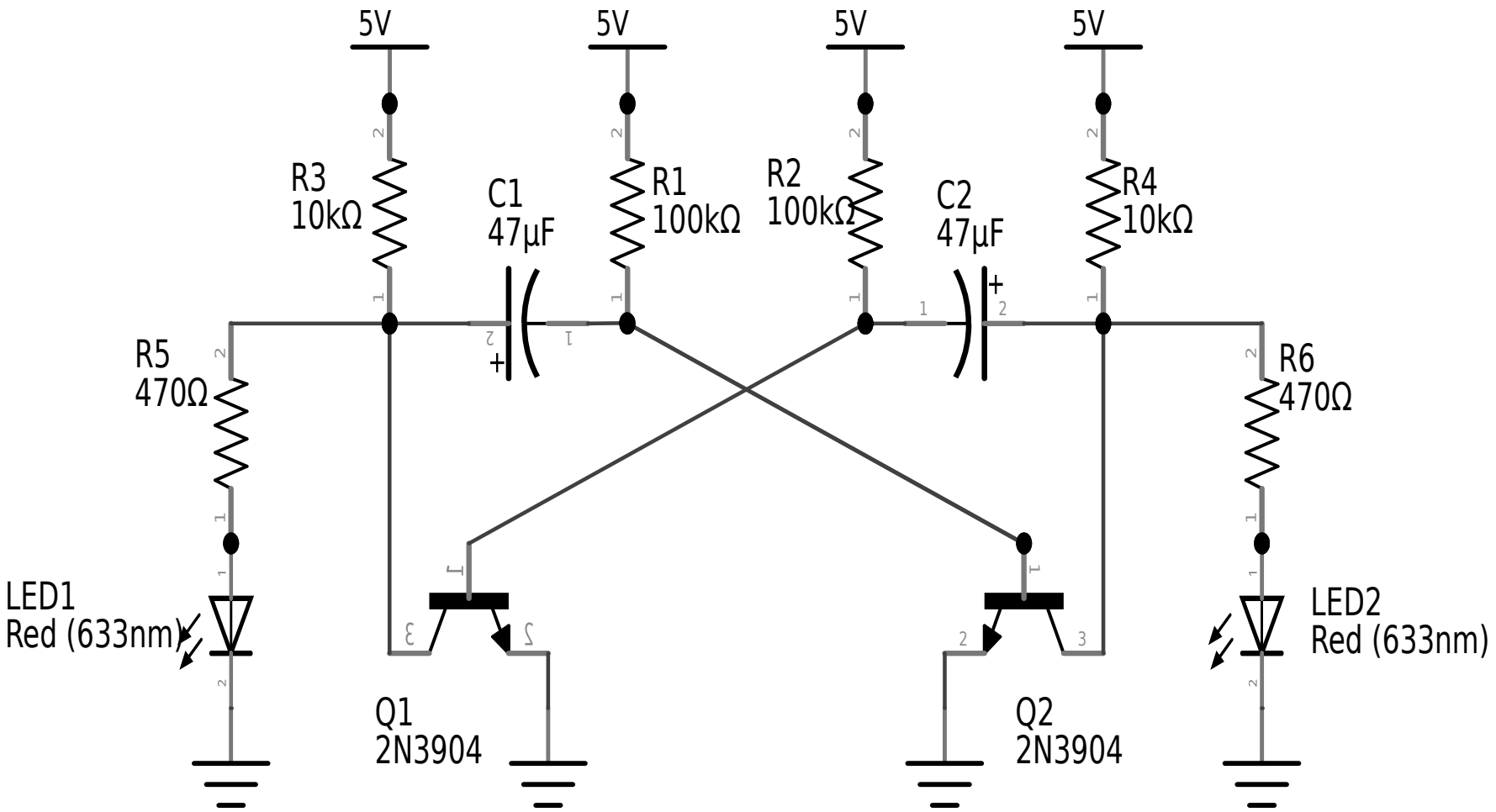
Pin name	Attiny pin	Nano	Uno
RST	1	D10	10
GND	4	GND	GND
MOSI	5	D11	11
MISO	6	D12	12
SCK	7	D13	13
VCC	8	5V	5V

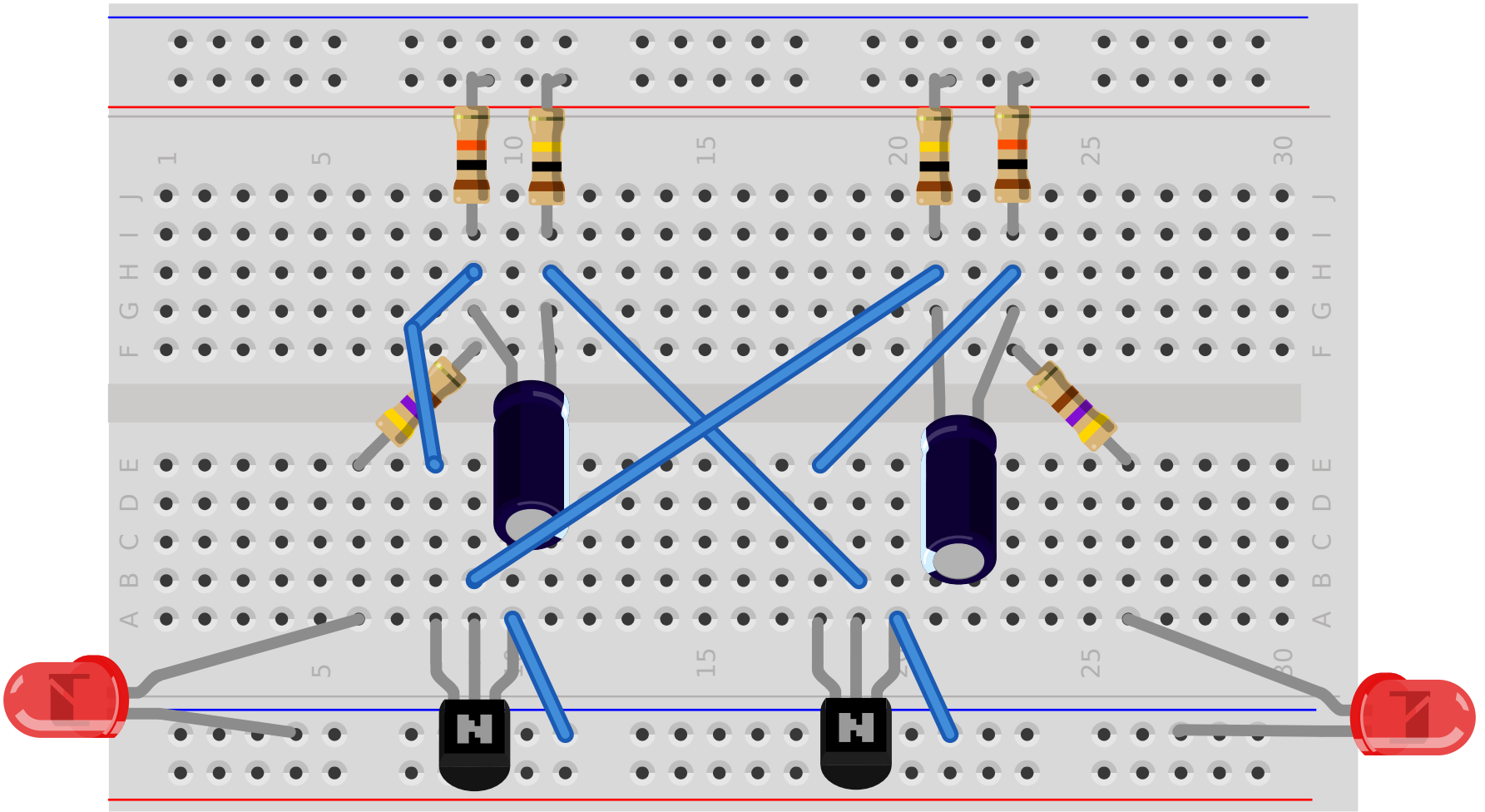
Transistor Astable Multivibrator

- Similar to the 555 astable multivibrator but with super simple transistor
- Timing similar to 555: R1*C1 and R2*C2
- Note: transistors as switches – useful for Raspberry Pi pins, too



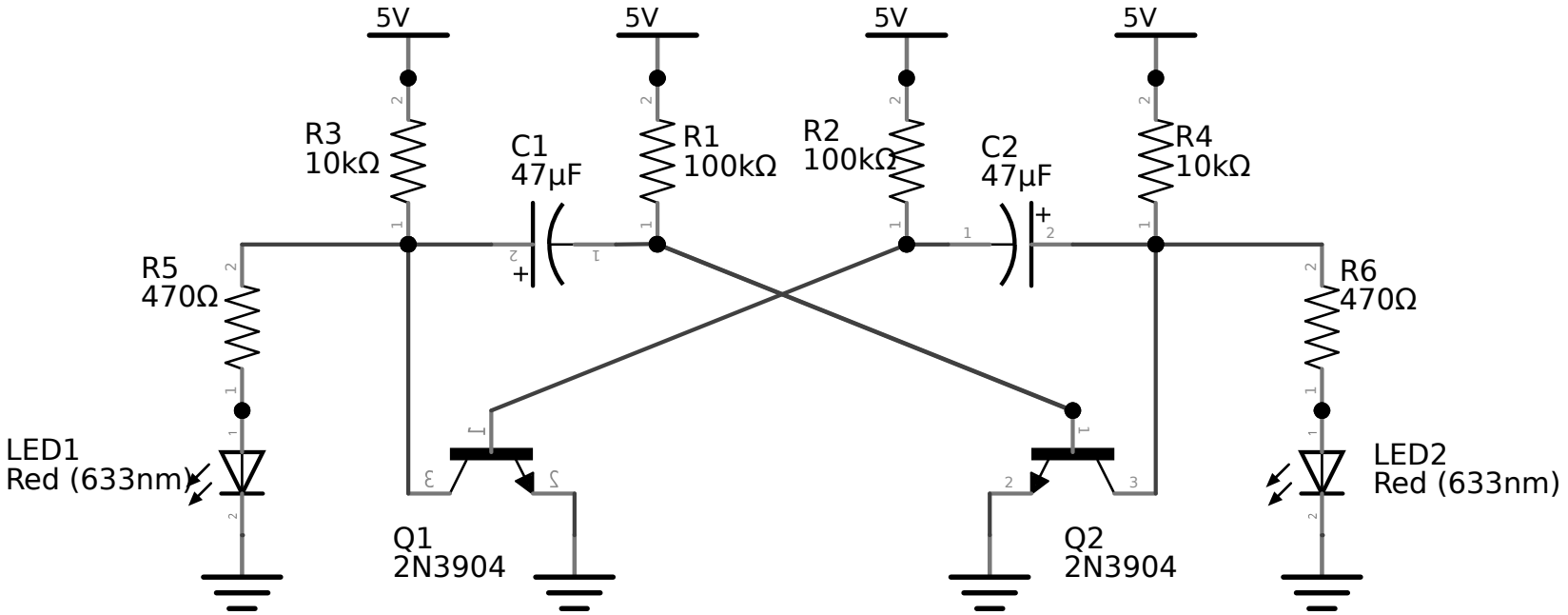



5V
5V
5V
5V
R3
10kΩ
C1
47µF
R1
100kΩ
R2
100kΩ
C2
47µF
R4
10kΩ
R5
470Ω
R6
470Ω
LED1
Red (633nm)
LED2
Red (633nm)
Q1
2N3904
Q2
2N3904


1
5
10
15
20
25
30
A B C D E
F G H I J

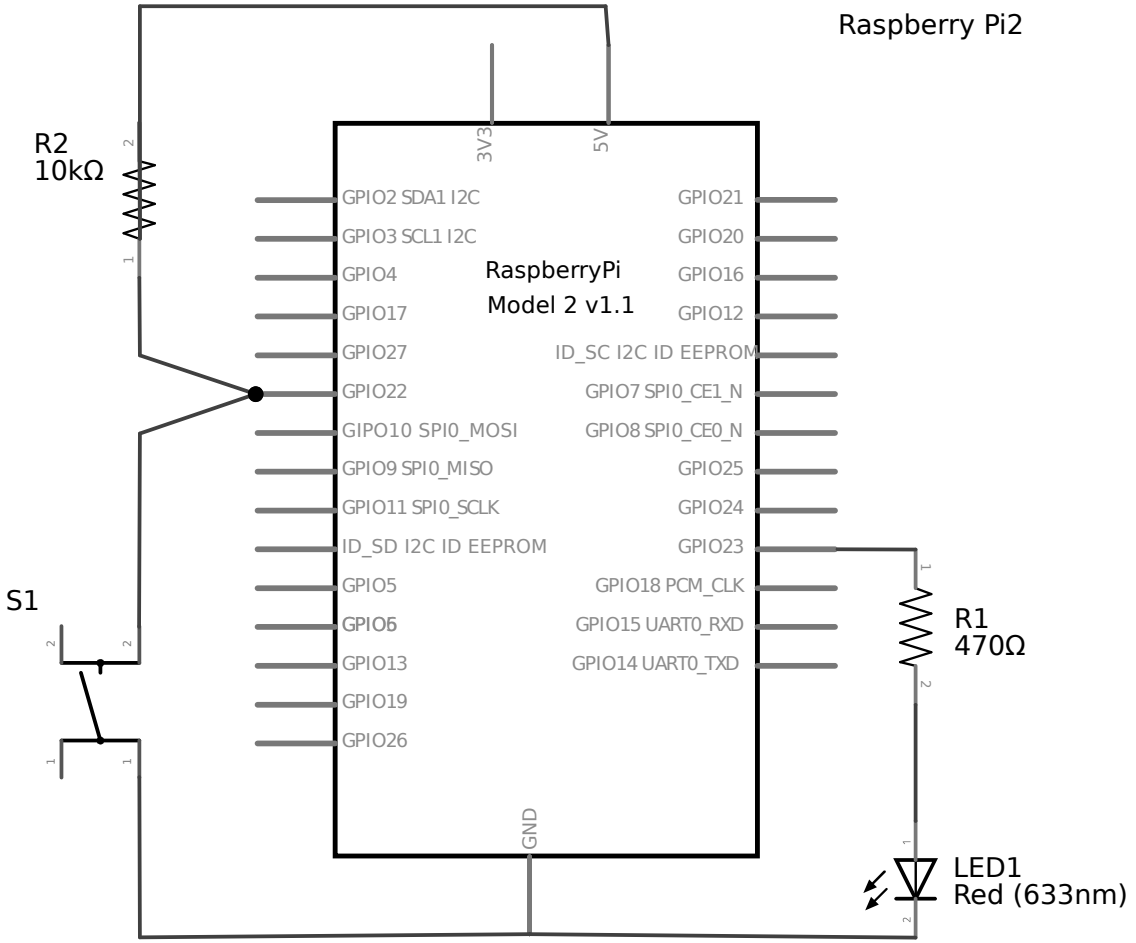
How It Works (briefly)

- Transistors Q1 and Q2 are switches (rather than amplifiers)
- Timing determined by R1*C1 and R2*C2
- If C1 discharged, C2 charged, then Q1 on, Q2 off
- C1 charges until it turns on Q2
- Voltage on C2 drops, which turns off Q1



Pi as Intermediary

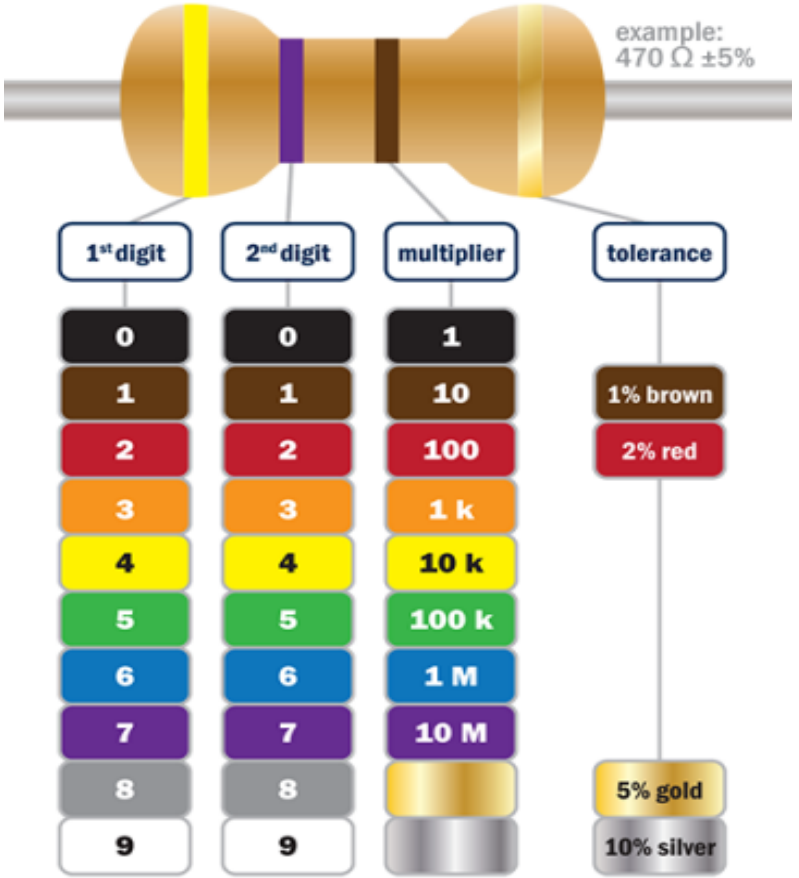
- Pushbutton press turns LED on, release turns LED off



RpiReadWrite.py (on GitHub)

```
import RPi.GPIO as GPIO
import time

BUTTON = 22
LED = 23

GPIO.setmode(GPIO.BCM)
GPIO.setup(BUTTON, GPIO.IN)
GPIO.setup(LED, GPIO.OUT)

try:
    while True:
        inputValue = GPIO.input(BUTTON)
        if (GPIO.LOW == inputValue):
            GPIO.output(LED, GPIO.HIGH)
        else:
            GPIO.output(LED, GPIO.LOW)
        time.sleep(2)
except KeyboardInterrupt:
    GPIO.cleanup()
```

Reference



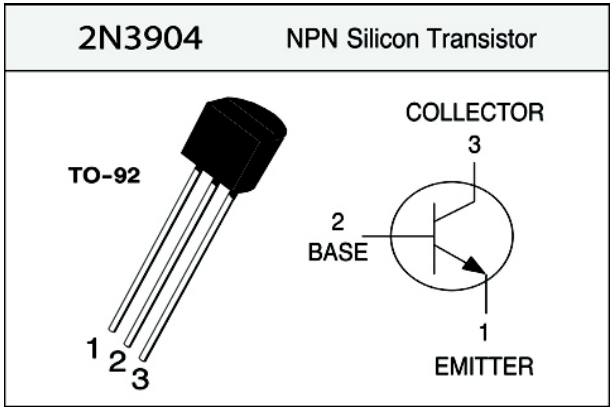
Raspberry Pi 3 GPIO Header

Pin#	NAME	NAME	Pin#
01	3.3v DC Power	DC Power 5v	02
03	GPIO02 (SDA1 , I²C)	DC Power 5v	04
05	GPIO03 (SCL1 , I²C)	Ground	06
07	GPIO04 (GPIO_GCLK)	(TXD0) GPIO14	08
09	Ground	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	Ground	14
15	GPIO22 (GPIO_GEN3)	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	Ground	20
21	GPIO09 (SPI_MISO)	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	(SPI_CE0_N) GPIO08	24
25	Ground	(SPI_CE1_N) GPIO07	26
27	ID_SD (I²C ID EEPROM)	(I²C ID EEPROM) ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

Rev. 2
29/02/2016

www.element14.com/RaspberryPi

Components


2N3904
NPN Silicon Transistor
TO-92
1 2 3
COLLECTOR
3
2
BASE
1
EMITTER