



University of Rome Tor Vergata
Bachelor science degree in Engineering Sciences

DESIGN AND REALIZATION OF A KINEMATIC INTERFACE FOR MUSIC SYNTHESIS: A LOW-COST OPTICAL BASED THEREMIN

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SUPERVISOR: PROF. CORRADO DI NATALE

CO-SUPERVISOR: ING. ALEXANDRO CATINI

THEREMIN

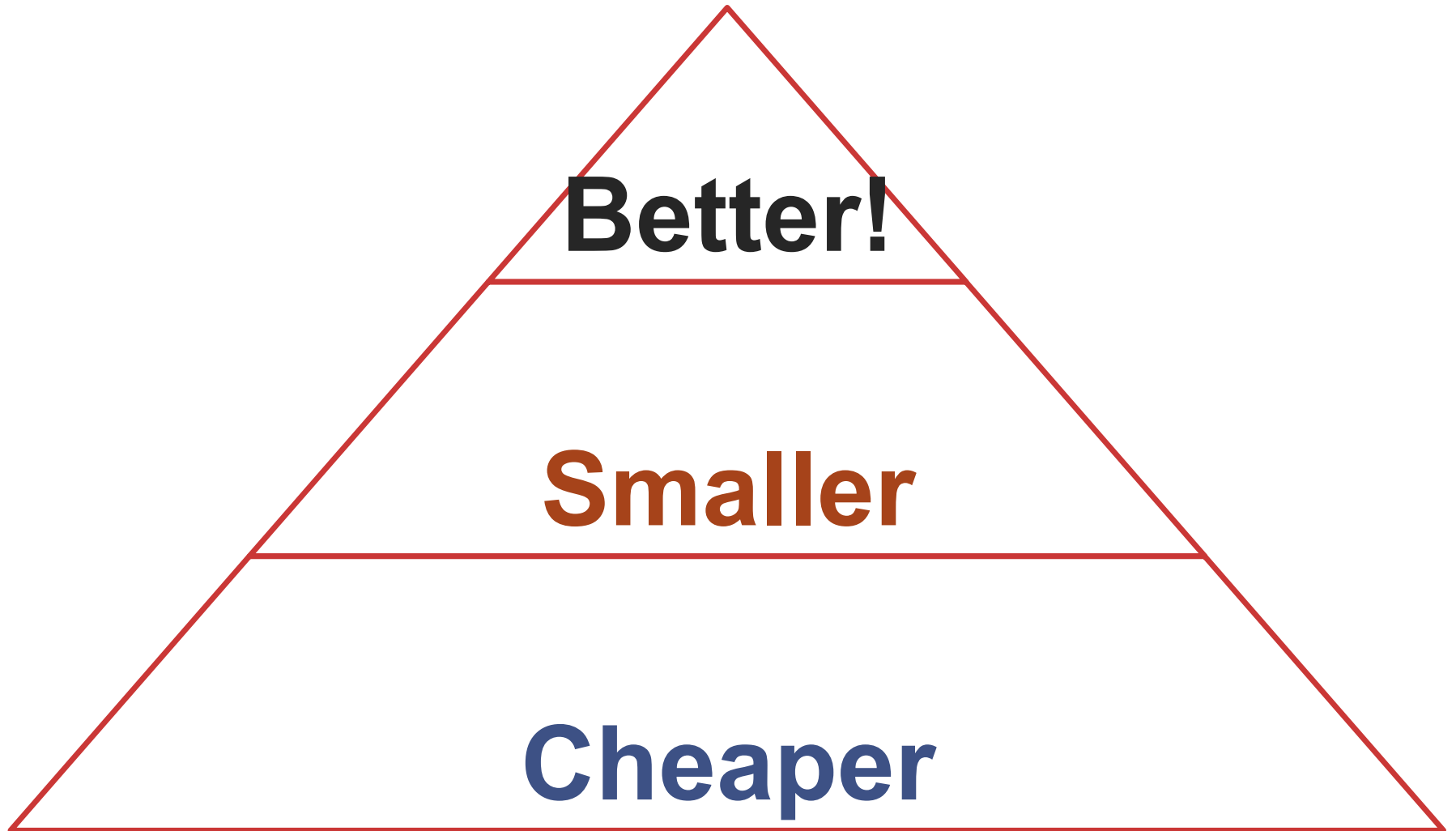
Invented in Russia in 1919

by Lev Sergeevič Termen (aka Léon Theremin)

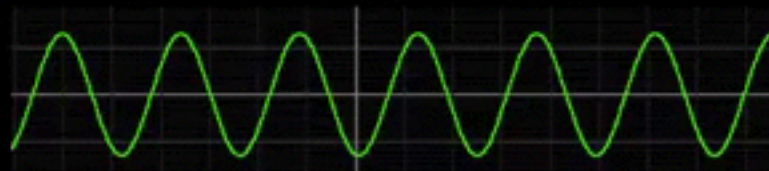
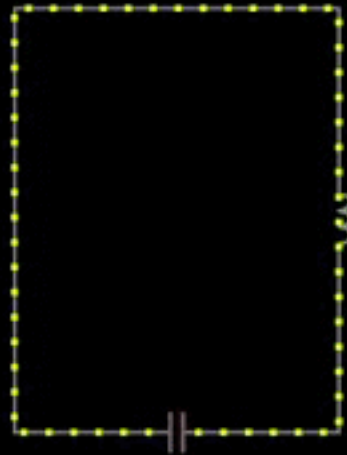


OUR PROJECT

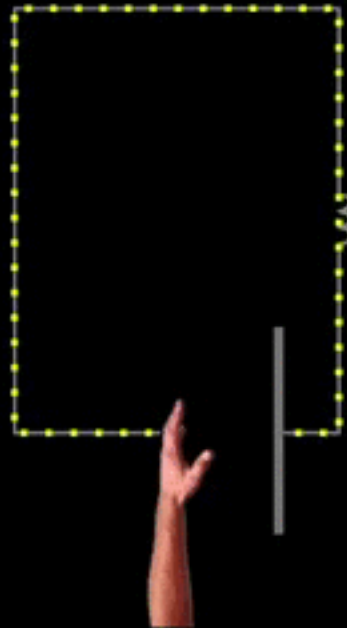
Build a low-cost Theremin replica using a completely different working principle.



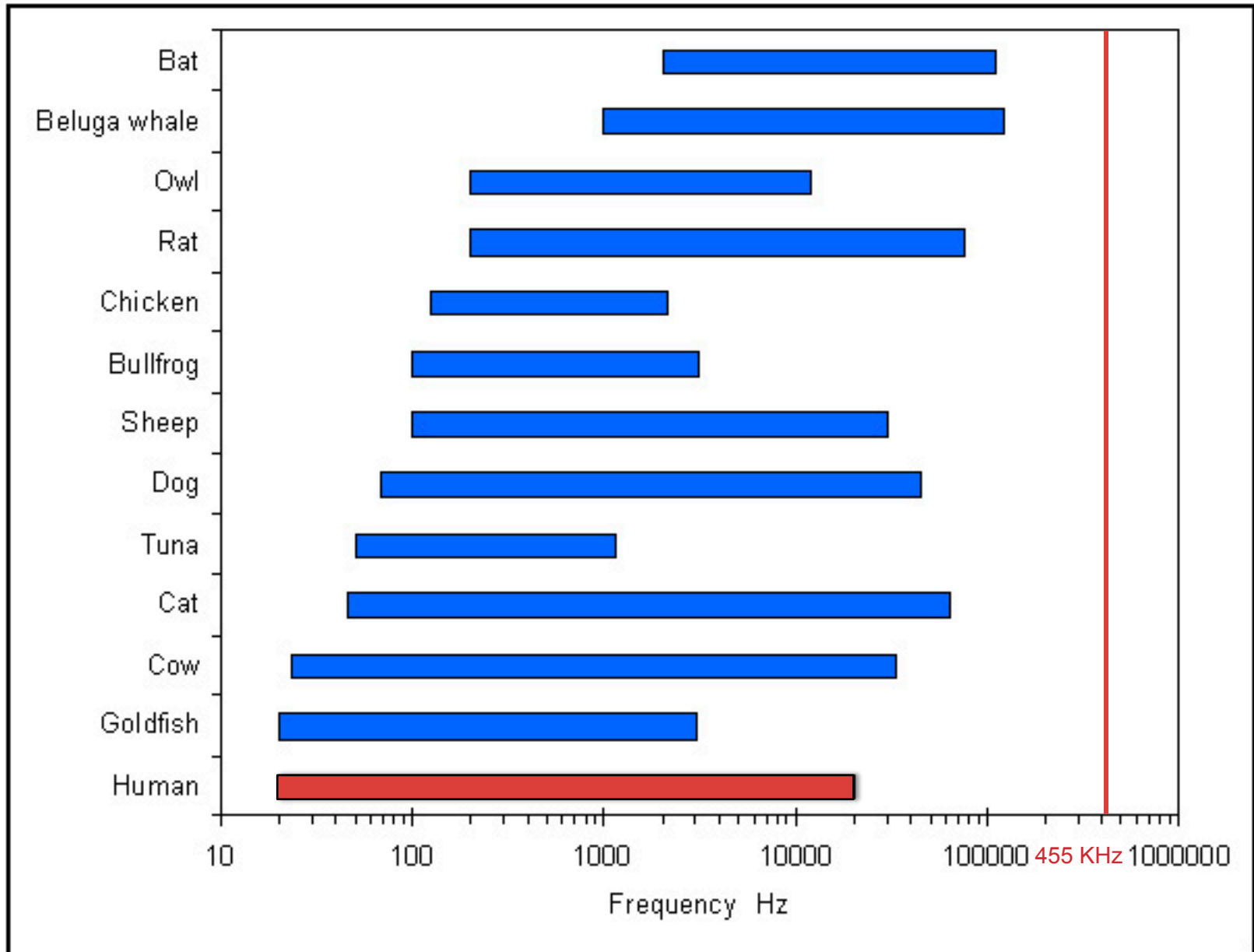
HOW A REAL THEREMIN WORKS? LC CIRCUIT SINE WAVE



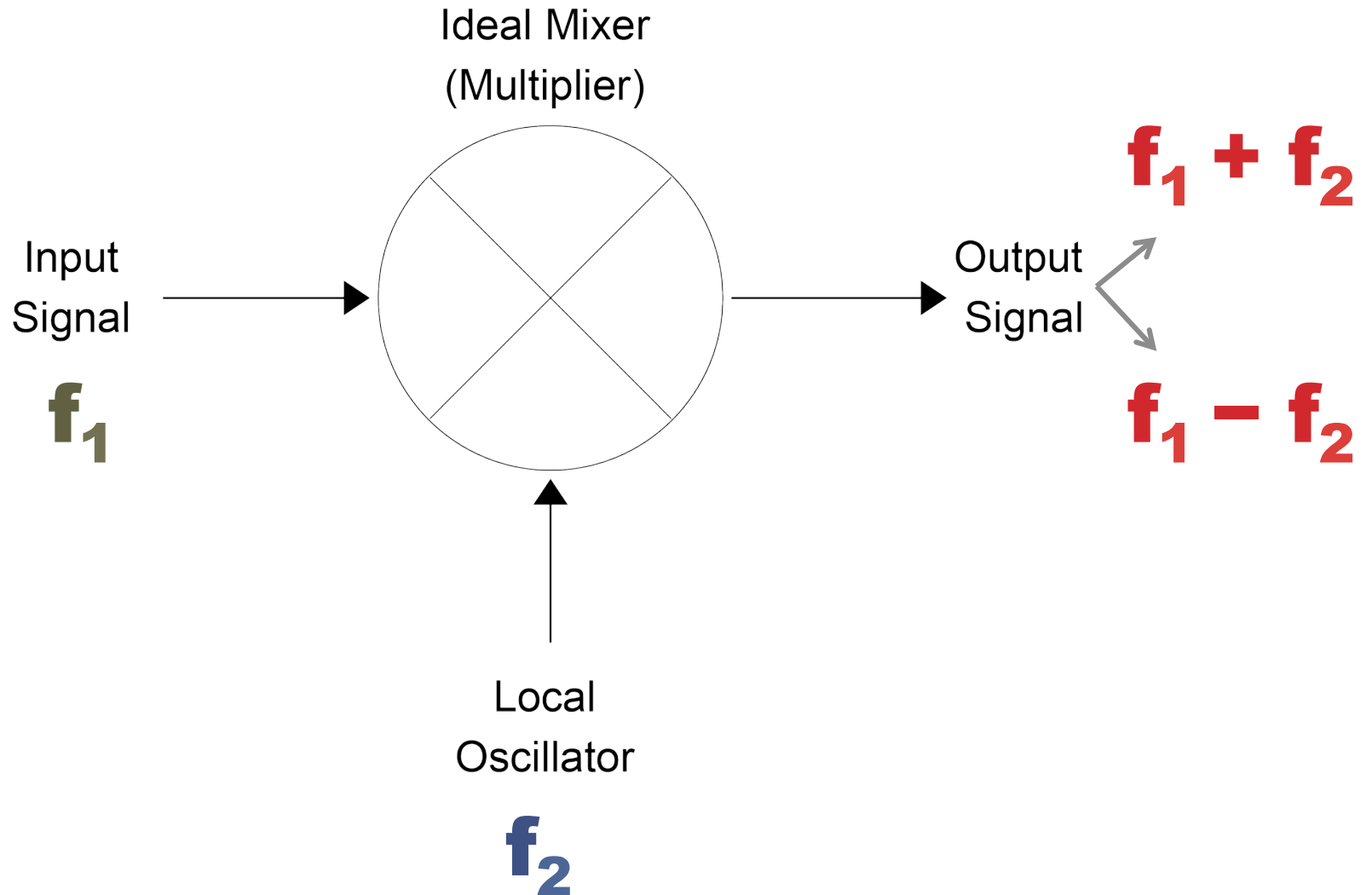
VARIABLE CAPACITOR USING HAND + ANTENNA AS PLATES



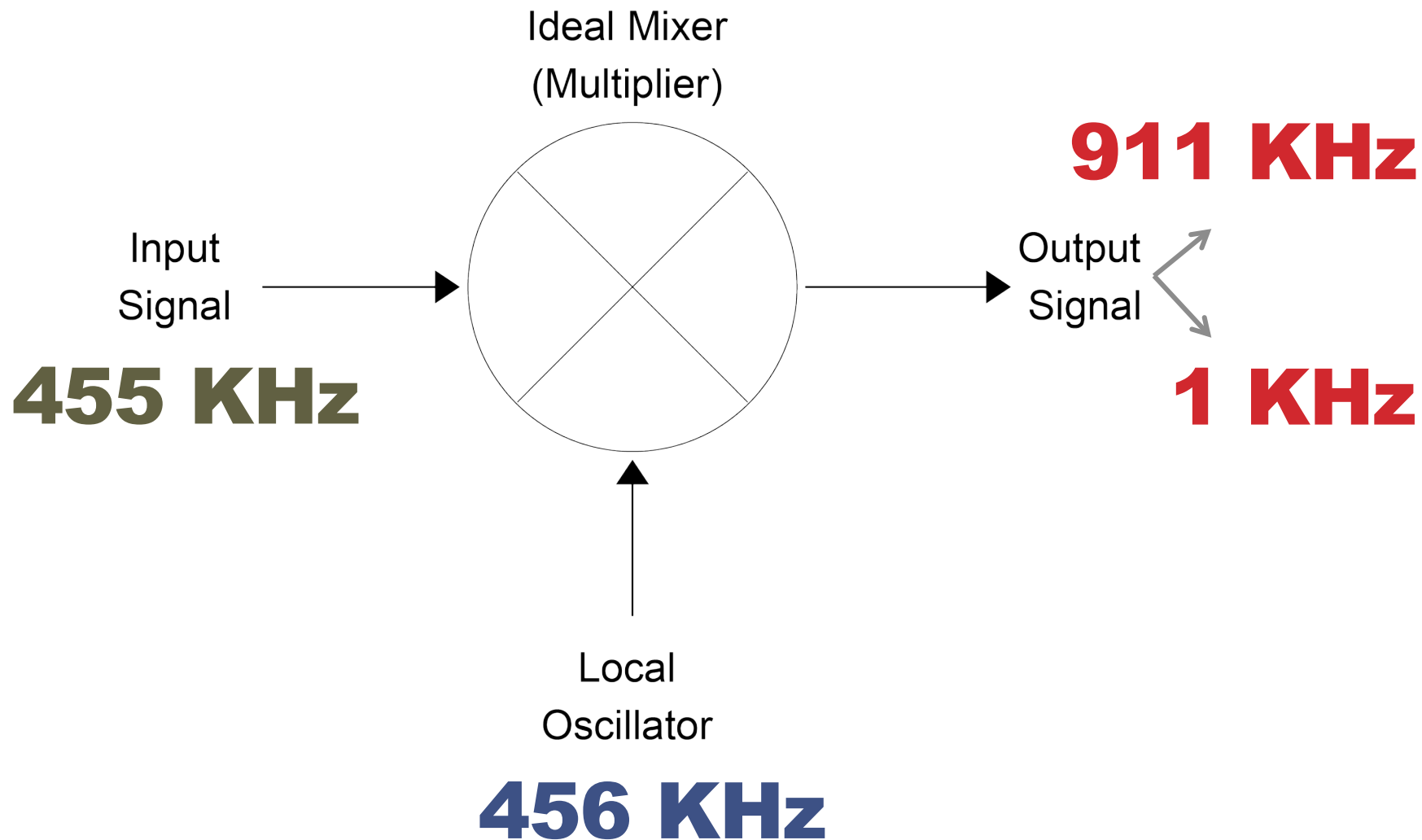
HEARING RANGES



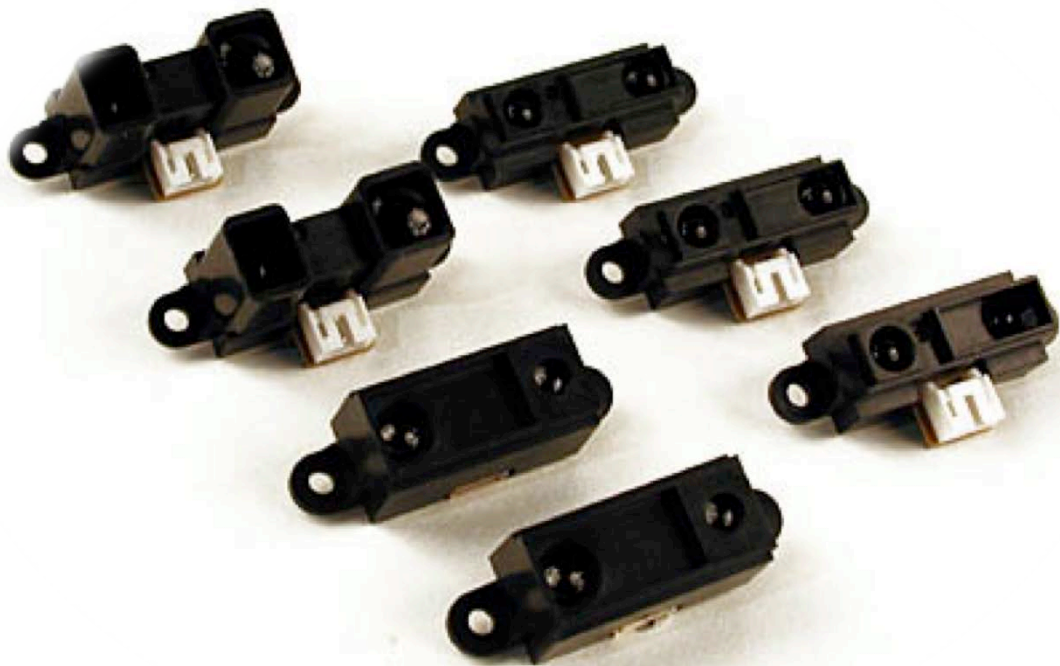
HETERODYNE



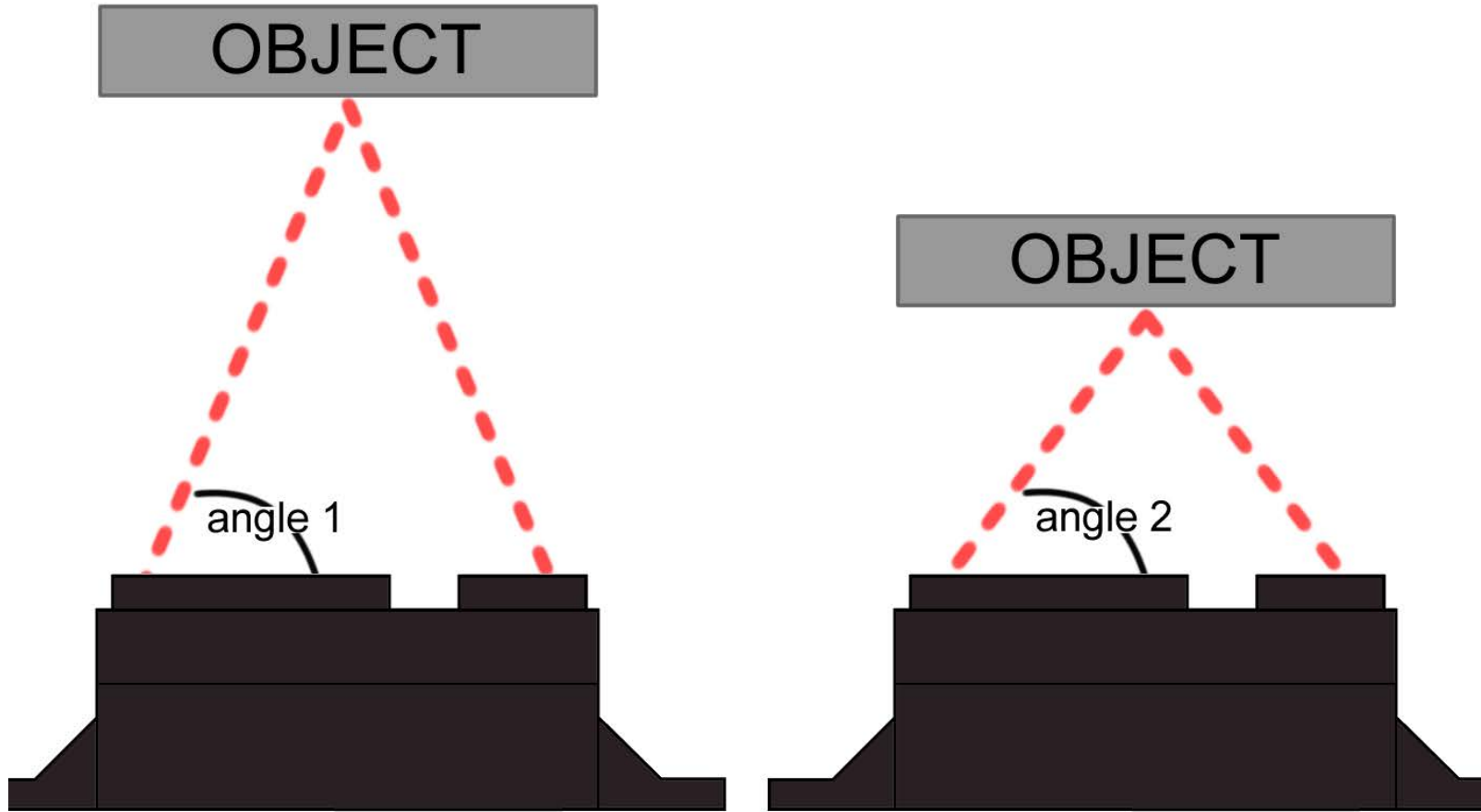
HETERODYNE



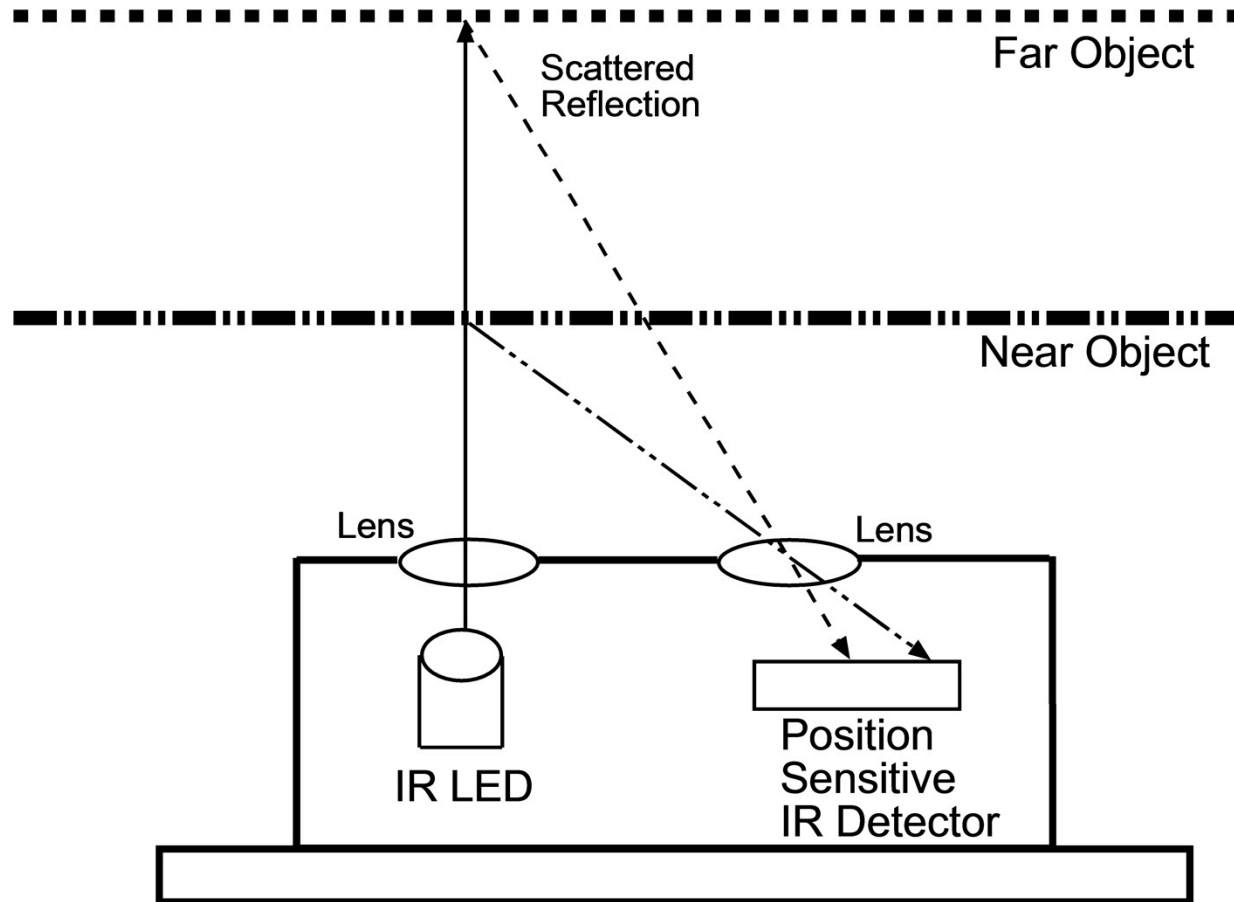
SHARP IR DISTANCE RANGE SENSORS



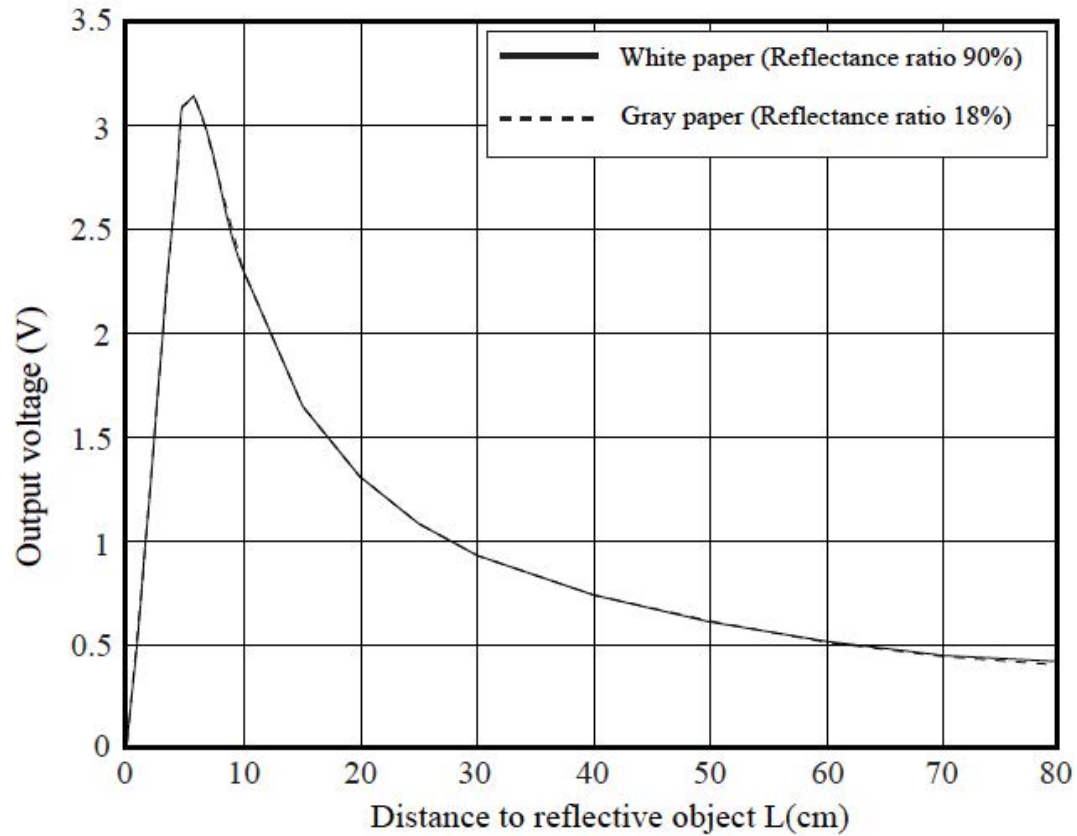
TRIANGULATION

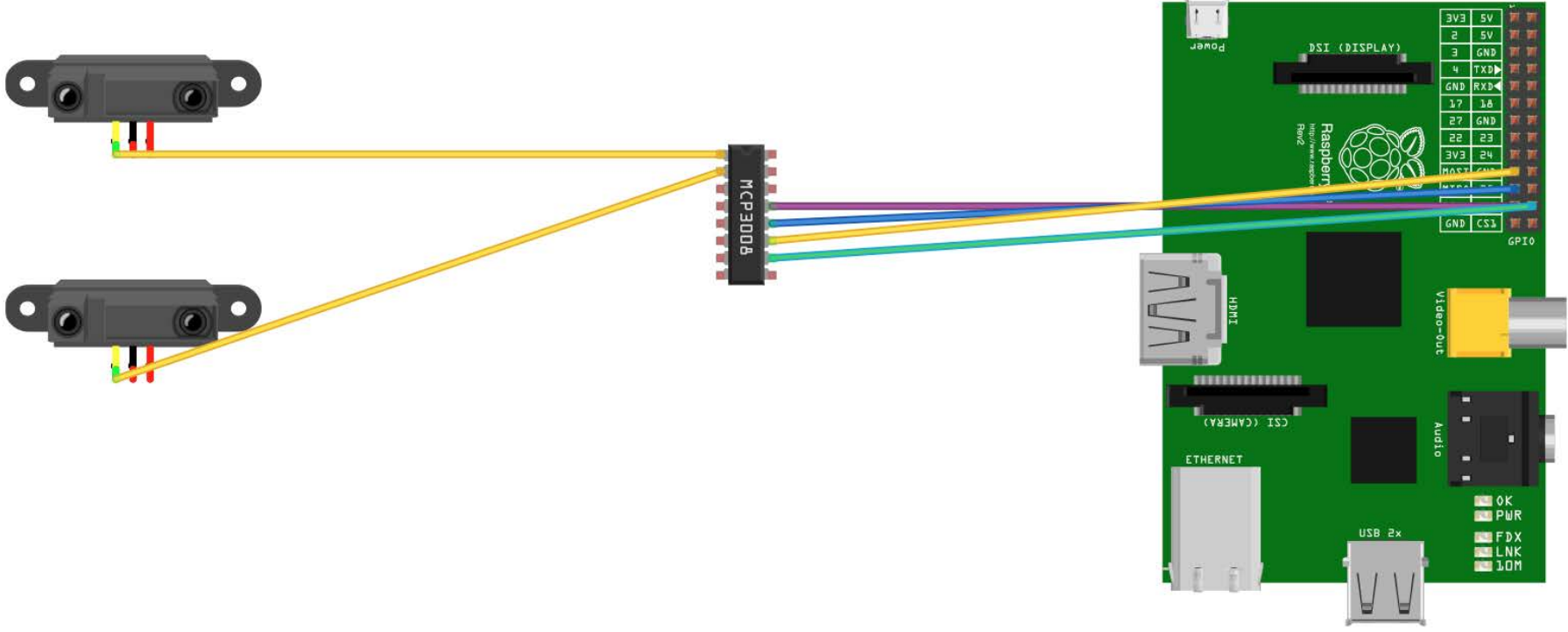


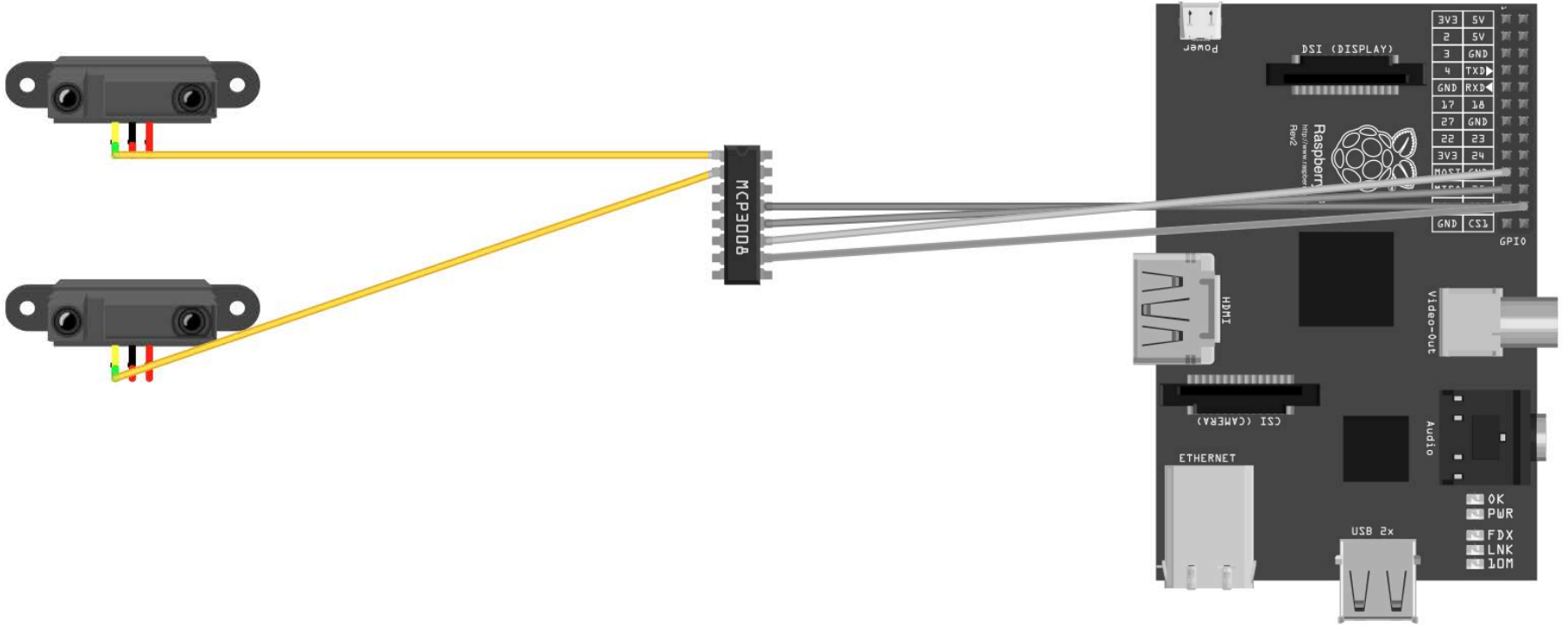
TRIANGULATION



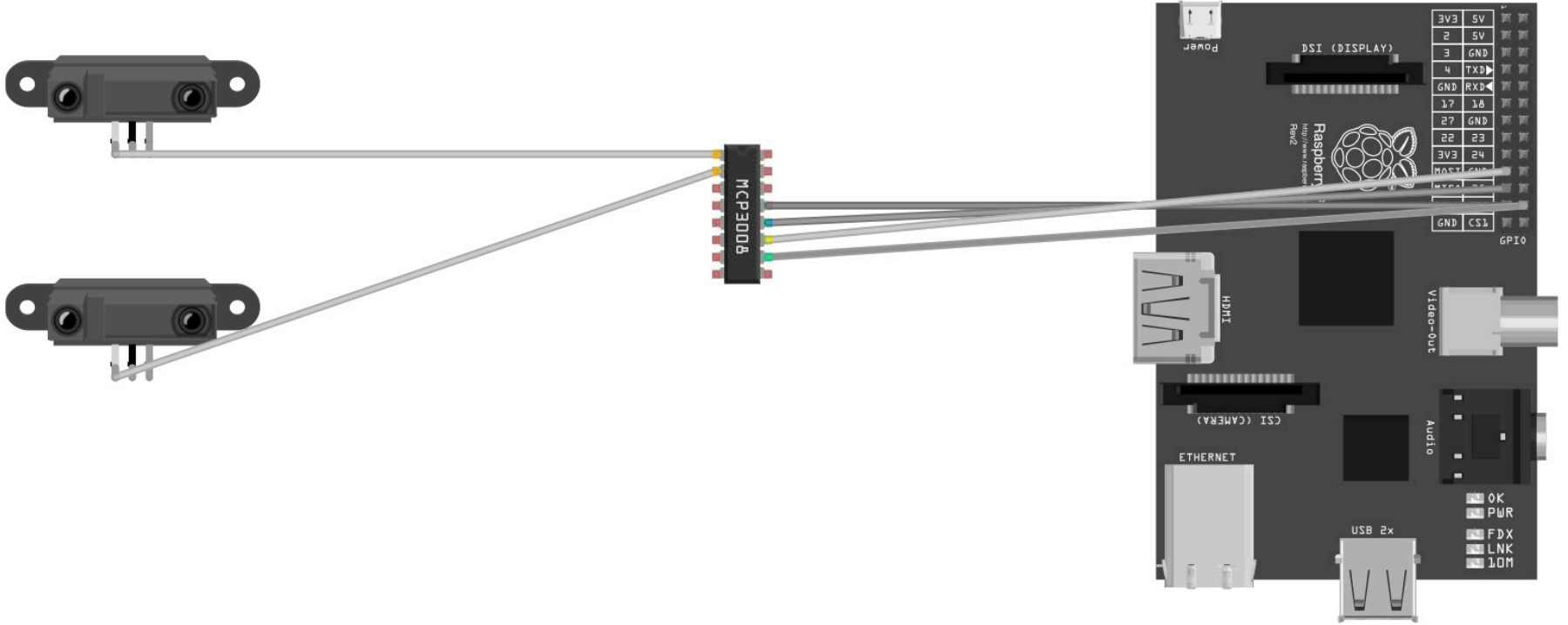
SHARP IR DISTANCE RANGE SENSORS



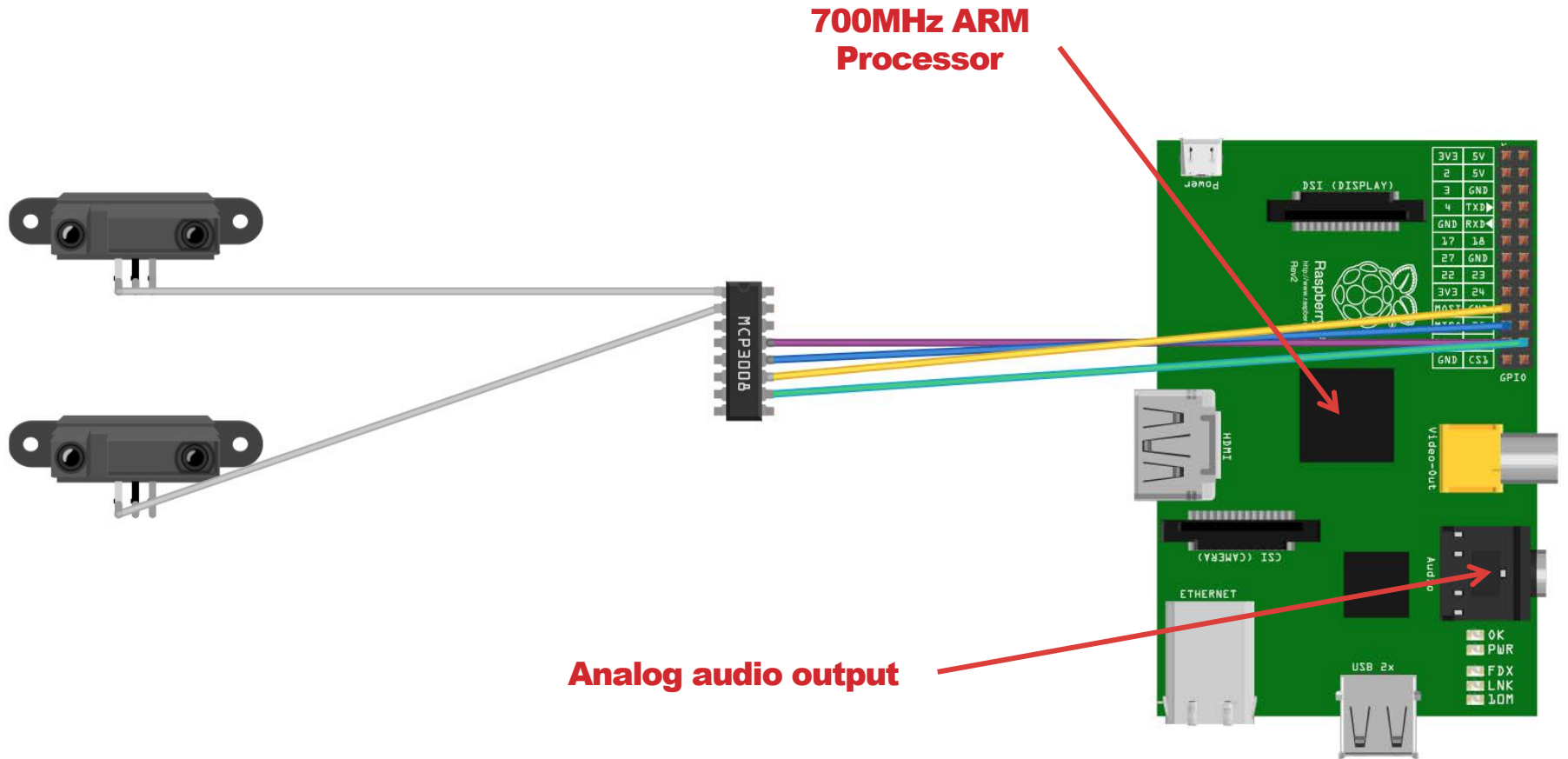




7€ each



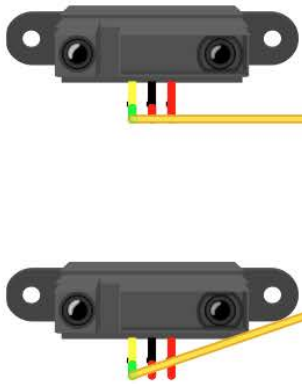
2€



**700MHz ARM
Processor**

Analog audio output

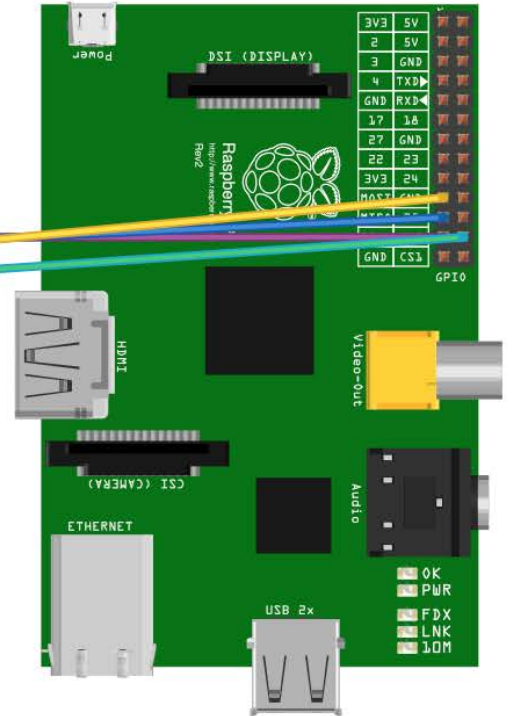
**starts from
20€**



7€ each



2€



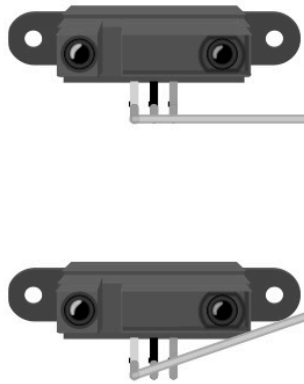
**starts from
20€**

MOOG ETHERWAVE THEREMIN

Starts from **370€**

Save up to **330€**

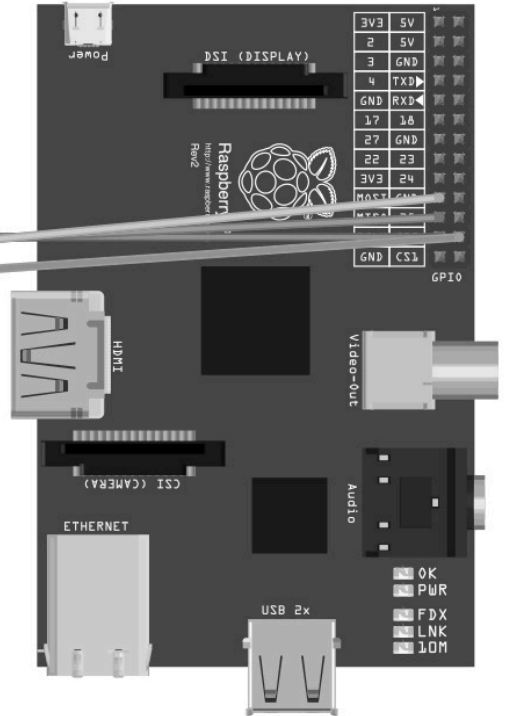




V_{out} (analog)

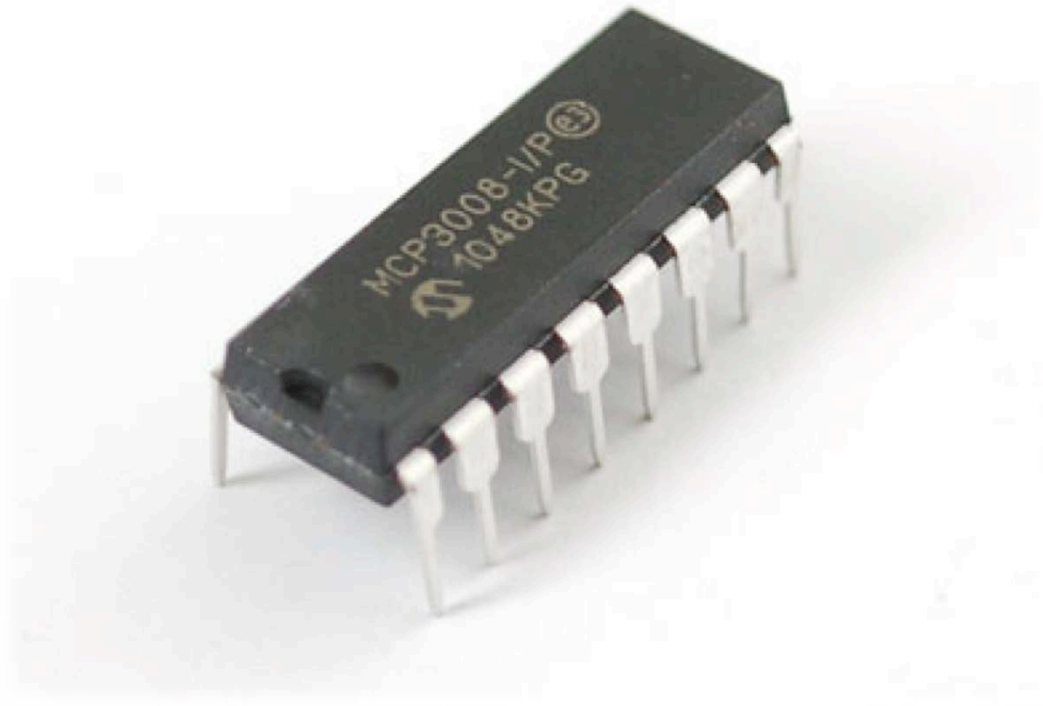


10bit digital signal



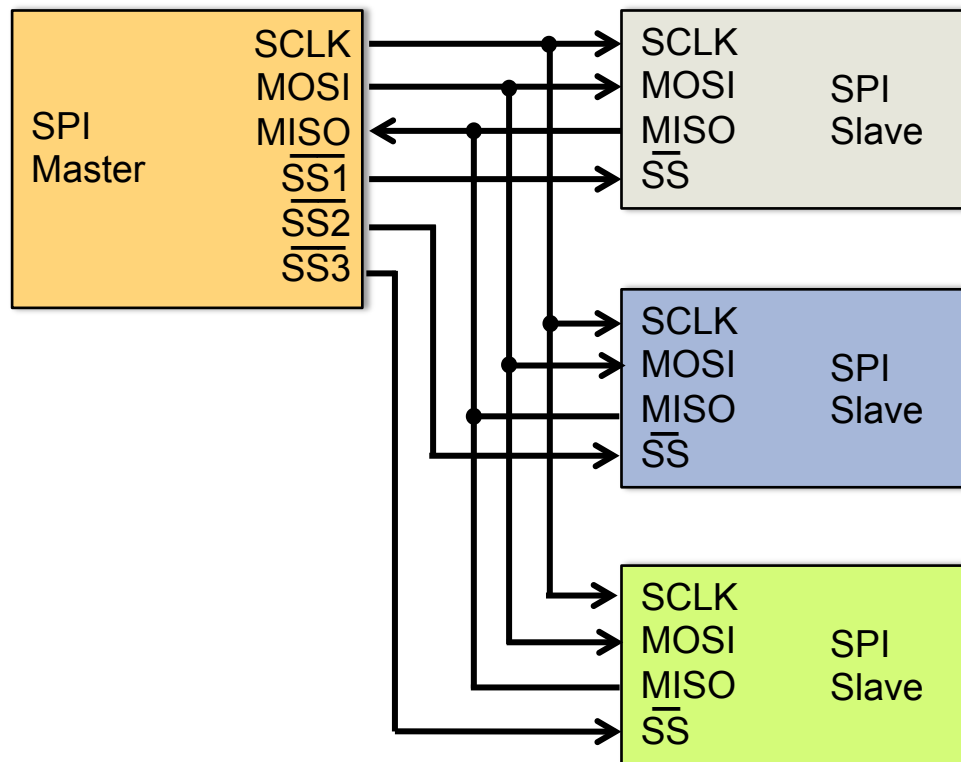
MCP3008

**8-channel, 10 bit ADC converter,
SPI interface, up to 200ksamples/second**



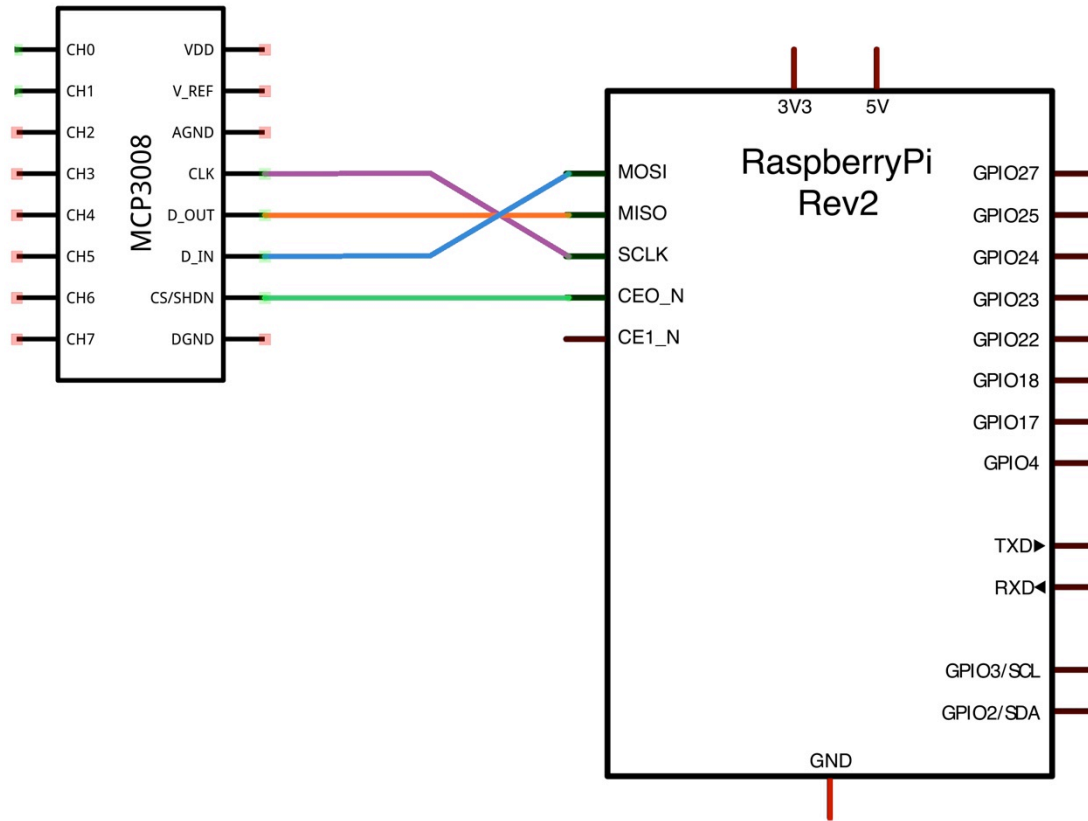
SPI

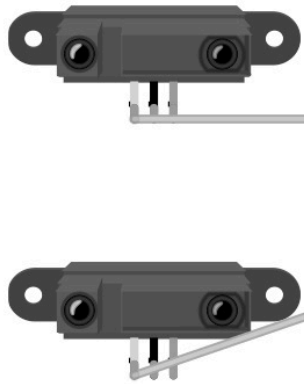
Serial Peripheral Interface communication bus



MCP3008 + RASPBERRY PI

Wiring Diagram





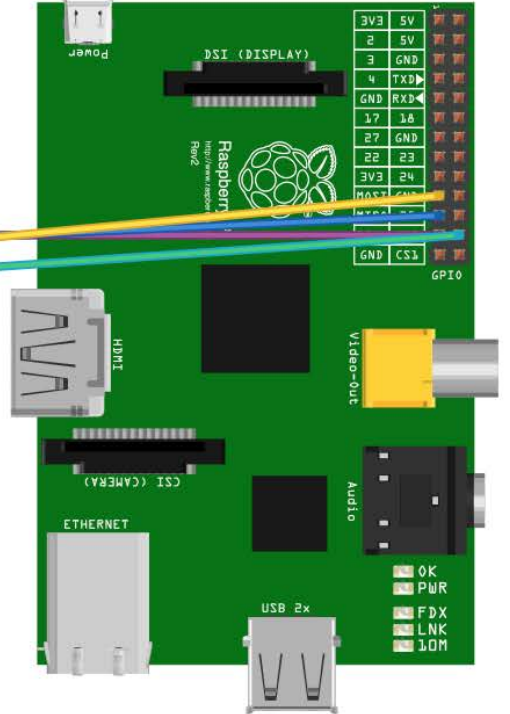
MCP3002



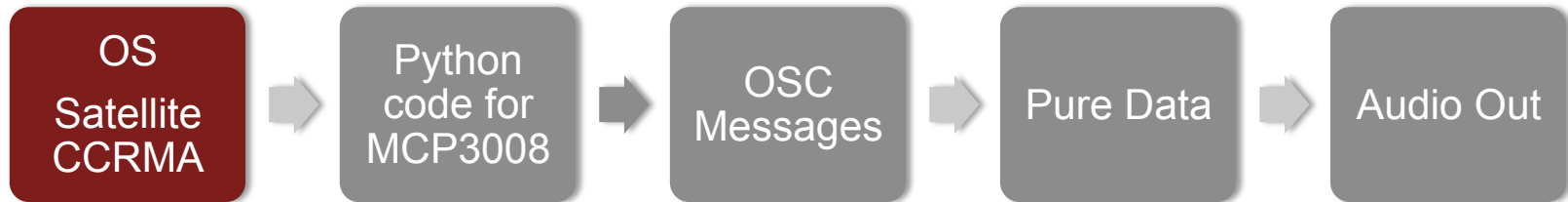
V_{out} (analog)



10bit digital signal



WHAT'S HAPPENING INSIDE THE RASPBERRY?



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WHAT'S HAPPENING INSIDE THE RASPBERRY?



OSC
open sound control

THE PYTHON CODE

```
# import some external libraries
```

```
import spidev
```

```
import time
```

```
import os
```

```
import OSC
```

```
# initialize the SPI bus
```

```
spi = spidev.SpiDev()
```

```
spi.open(0,0)
```

```
# read SPI data from MCP3008 chip
```

```
def readadc(adcnum):
```

```
    r = spi.xfer2([1,(8+adcnum)<<4,0])
```

```
    adcout = ((r[1]&3) << 8) + r[2]
```

```
    return adcout
```

```
# we define the input channels
```

```
adc_vol = 1
```

```
adc_note = 0
```

```
# start OSC Server
```

```
client = OSC.OSCClient()
```

```
client.connect(('127.0.0.1', 9001))
```

```
# main loop
```

```
while True:
```

```
# reading values from sensors
```

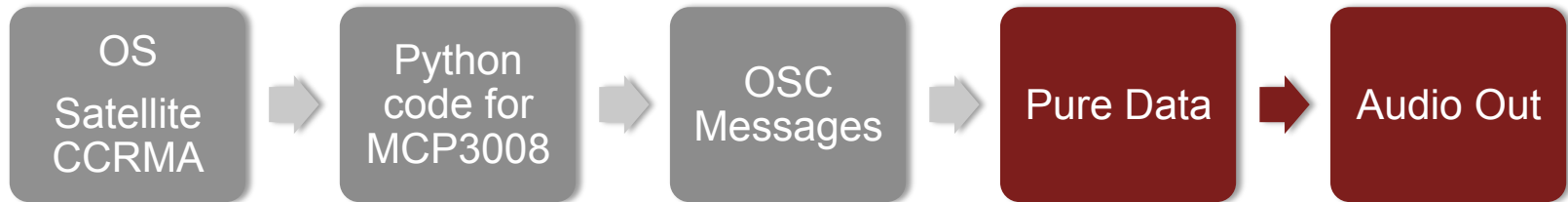
```
    note = readadc(adc_note)
```

```
    vol = readadc(adc_vol)
```

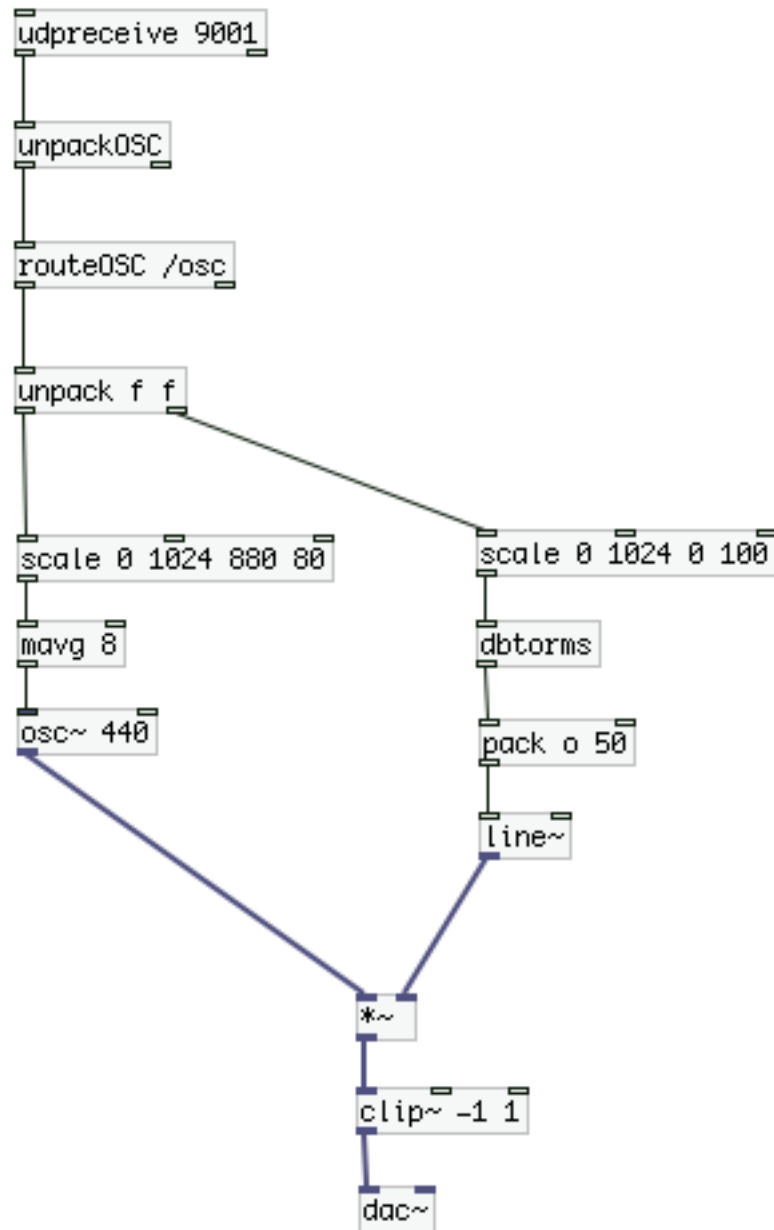
```
# send a OSC message
```

```
client.send(OSC.OSCMessage("/osc", [vol,note]))
```

WHAT'S HAPPENING INSIDE THE RASPBERRY?



THE PURE DATA PATCH



FUTURE IMPLEMENTATIONS



OSC
open sound control



FM

LFO

AM

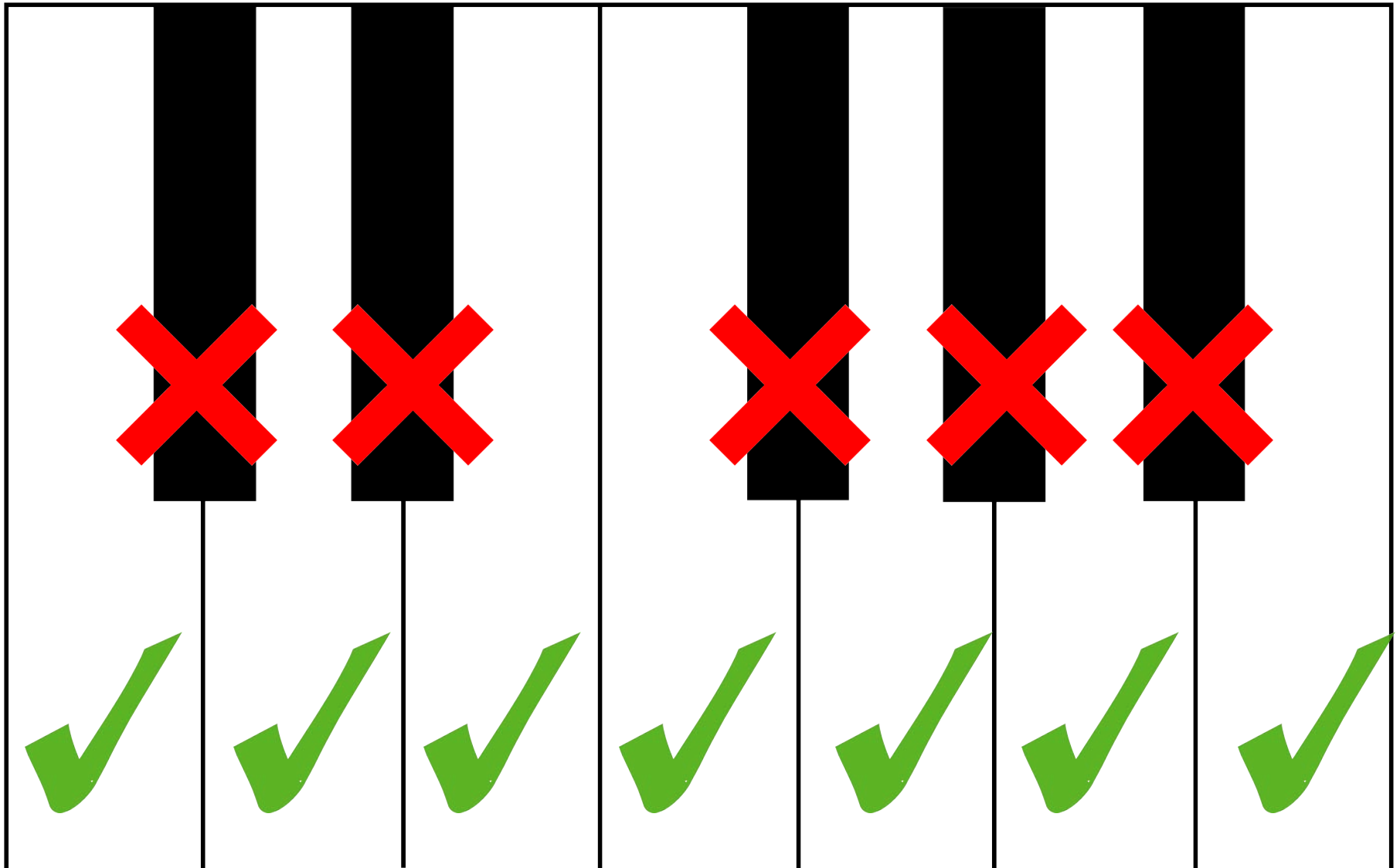


AUTO-TUNE FUNCTION

here's why you'll love this theremin

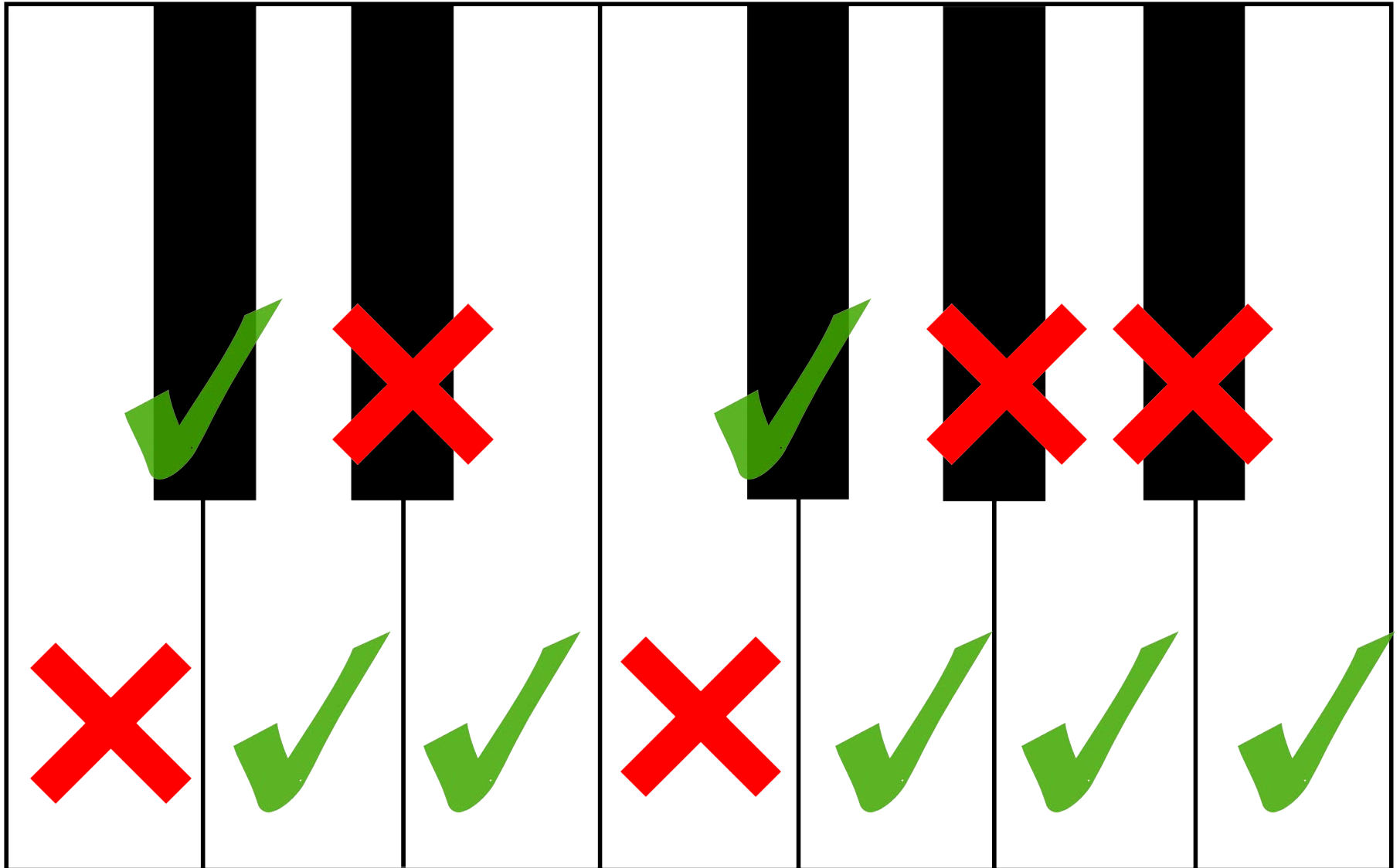
AUTO-TUNE FUNCTION

C Major Key



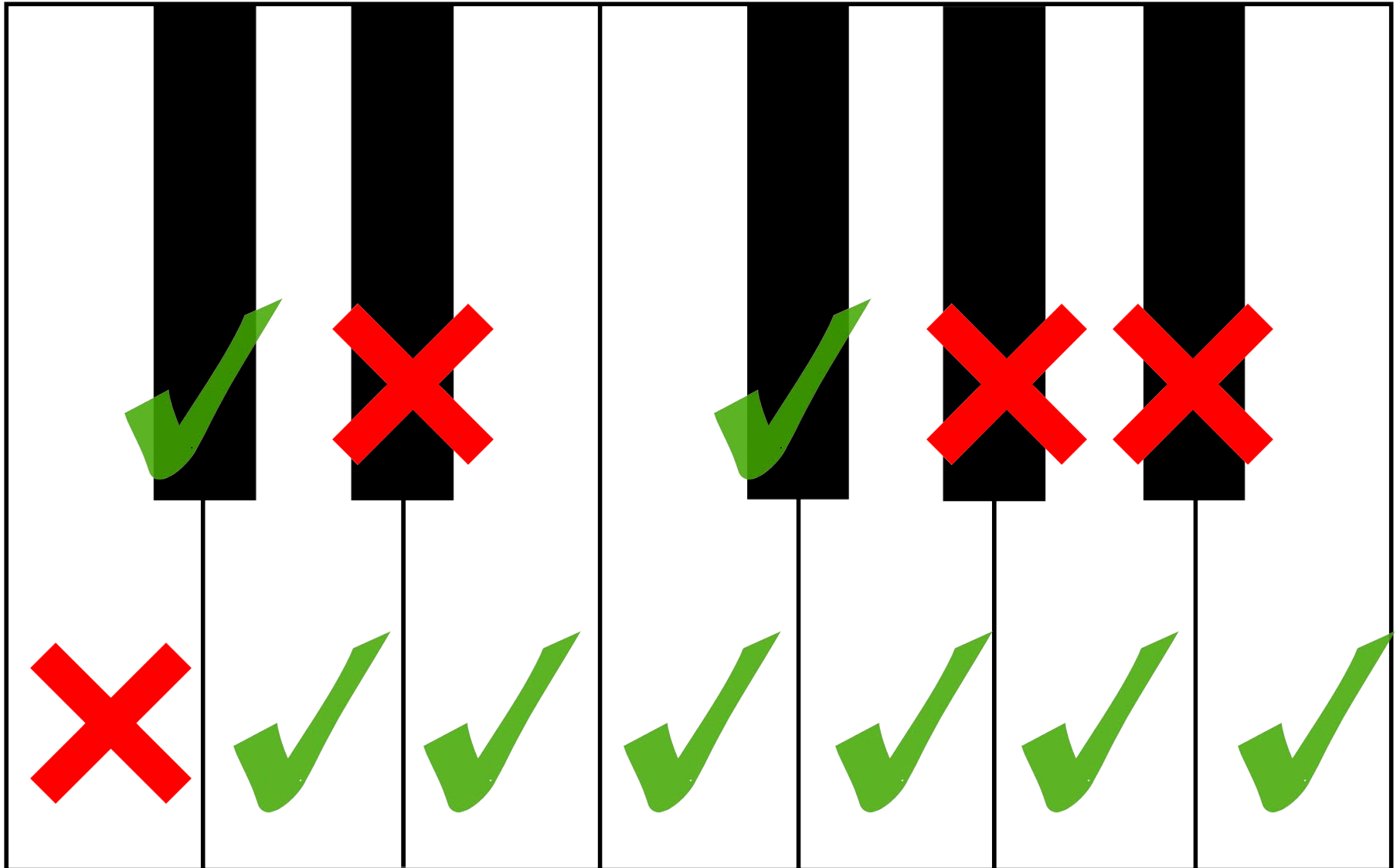
AUTO-TUNE FUNCTION

D Major Key example



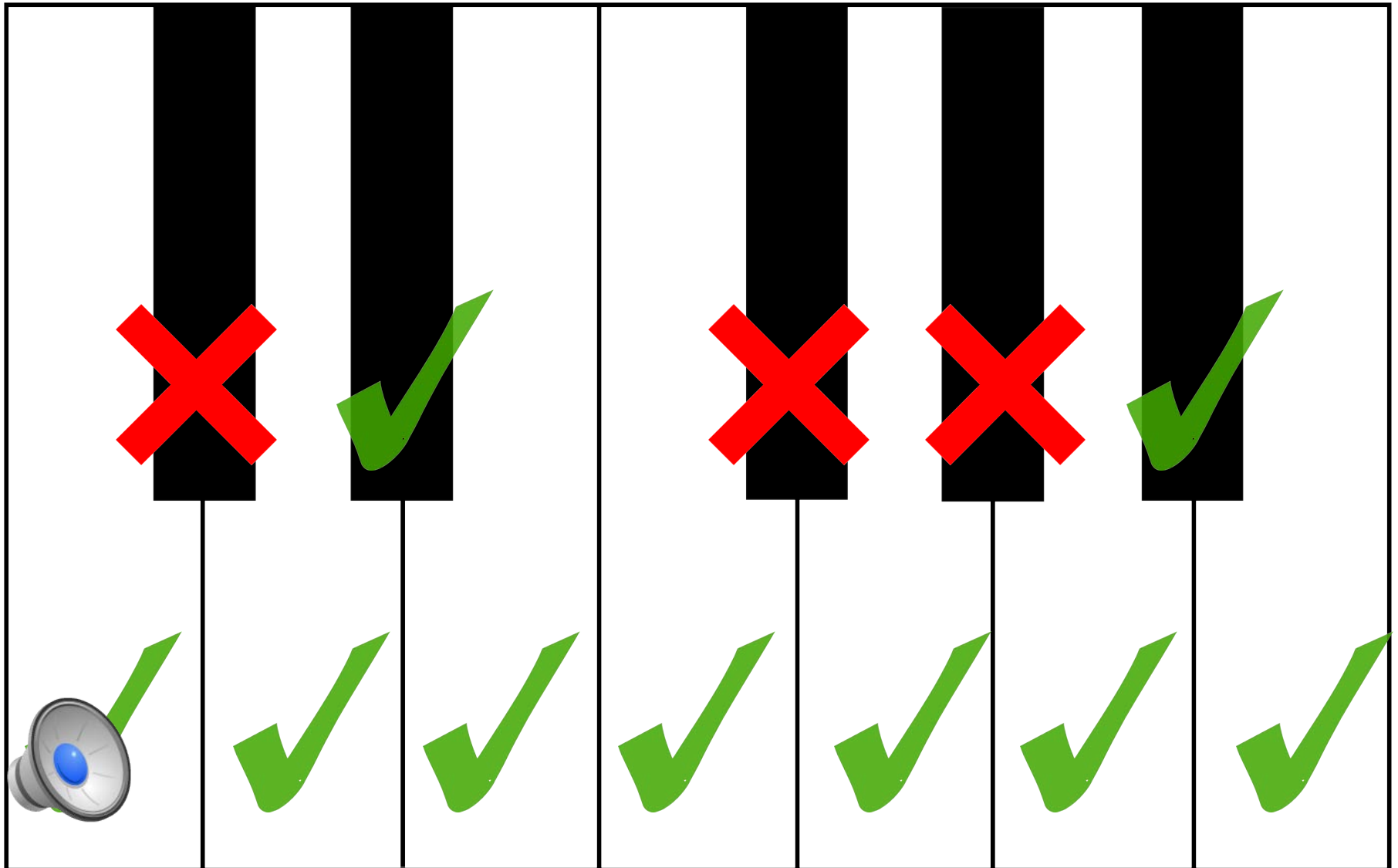
AUTO-TUNE FUNCTION

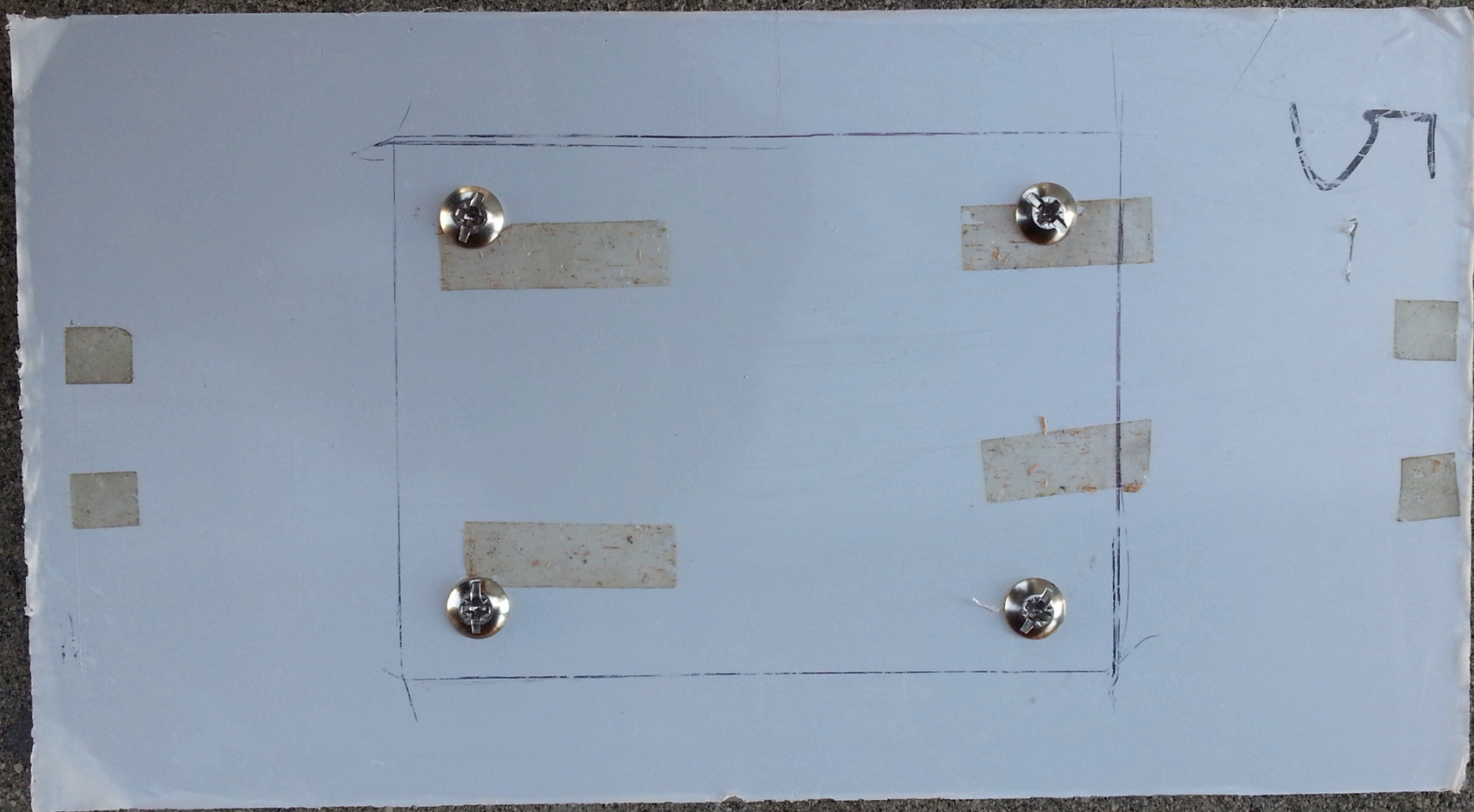
Custom configuration example

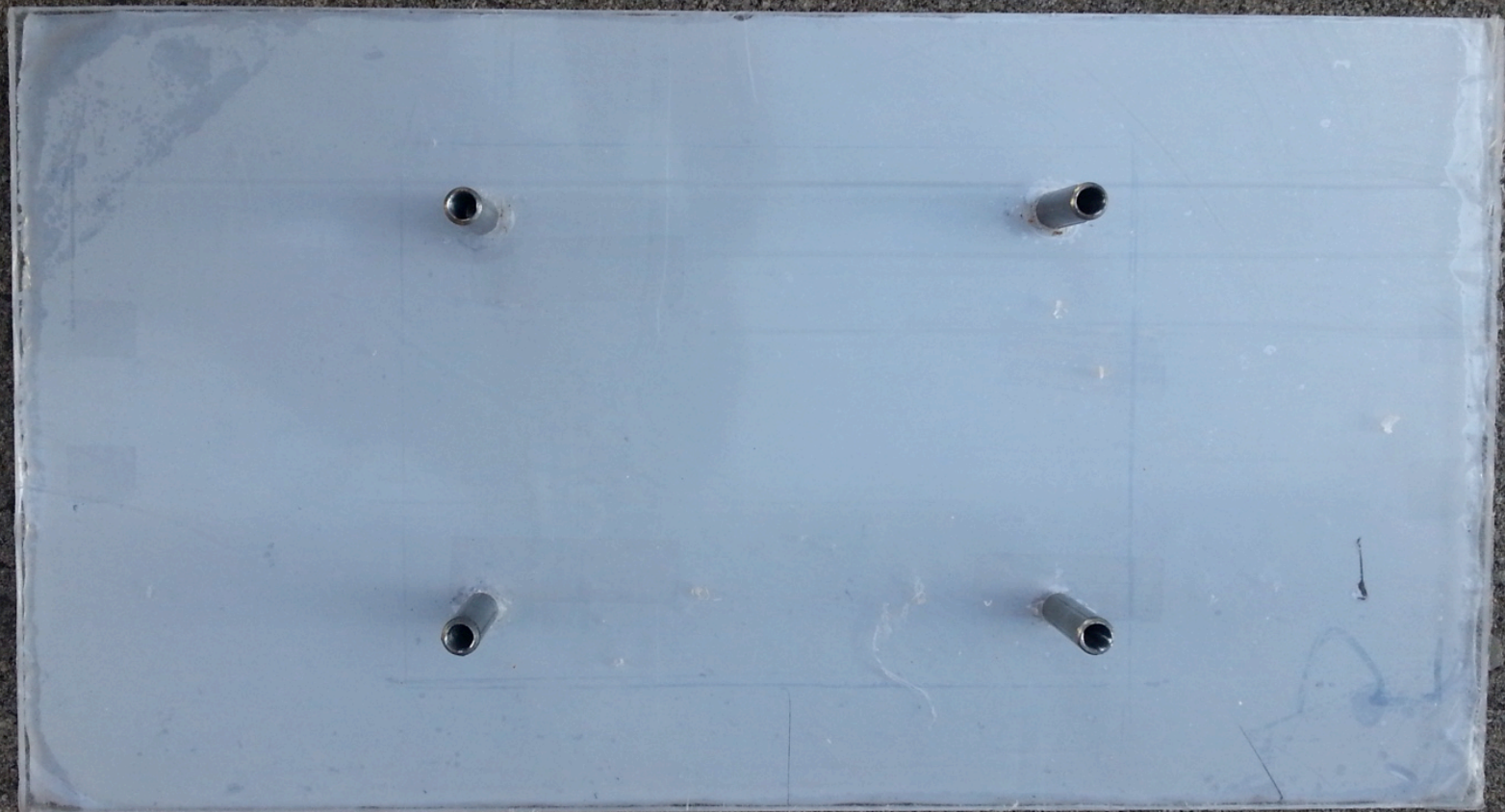


AUTO-TUNE EXAMPLE

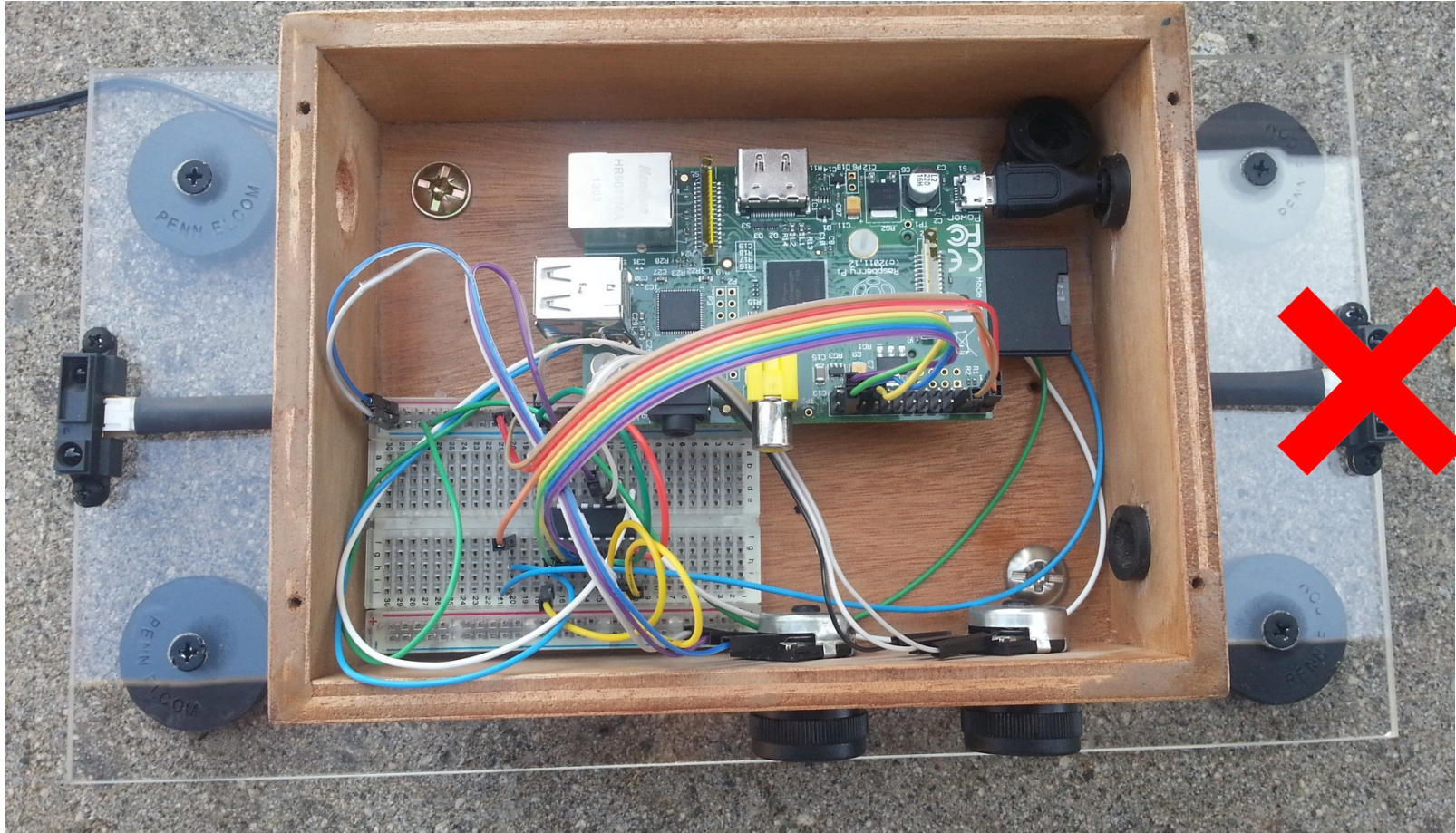
Blues in C key





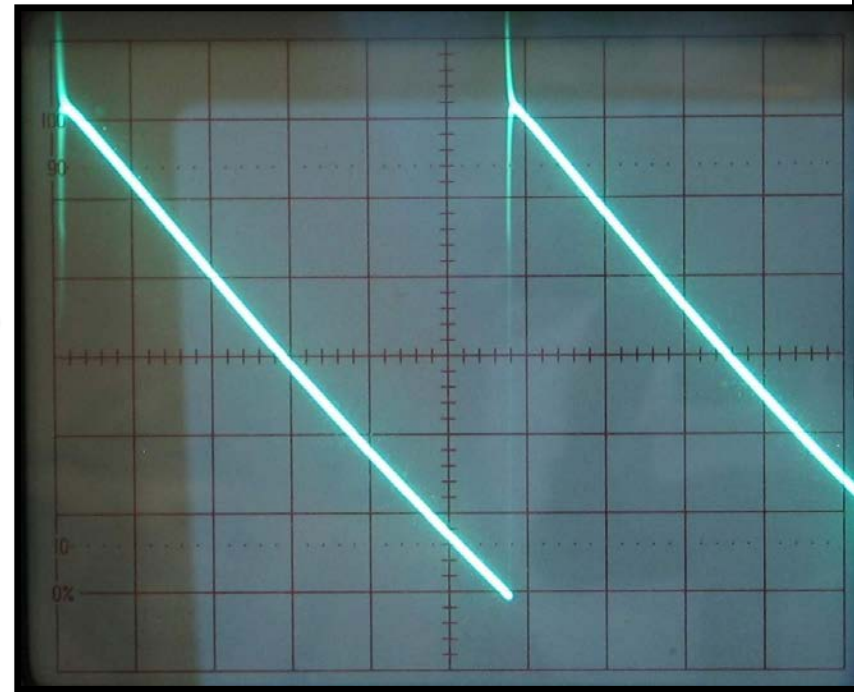
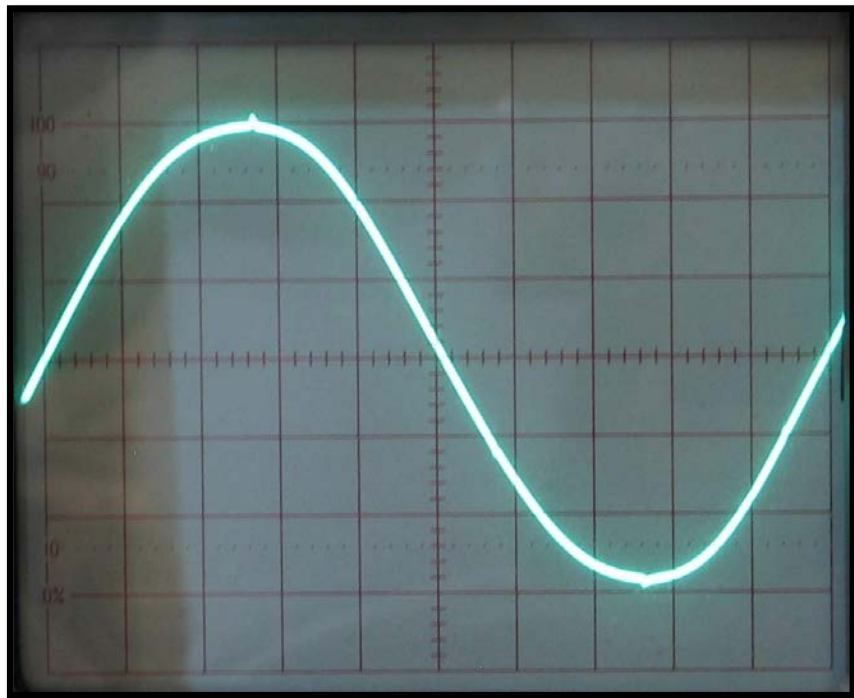


PITCH ONLY MODE





CHANGE WAVEFORM FROM SINE TO SAWTOOTH



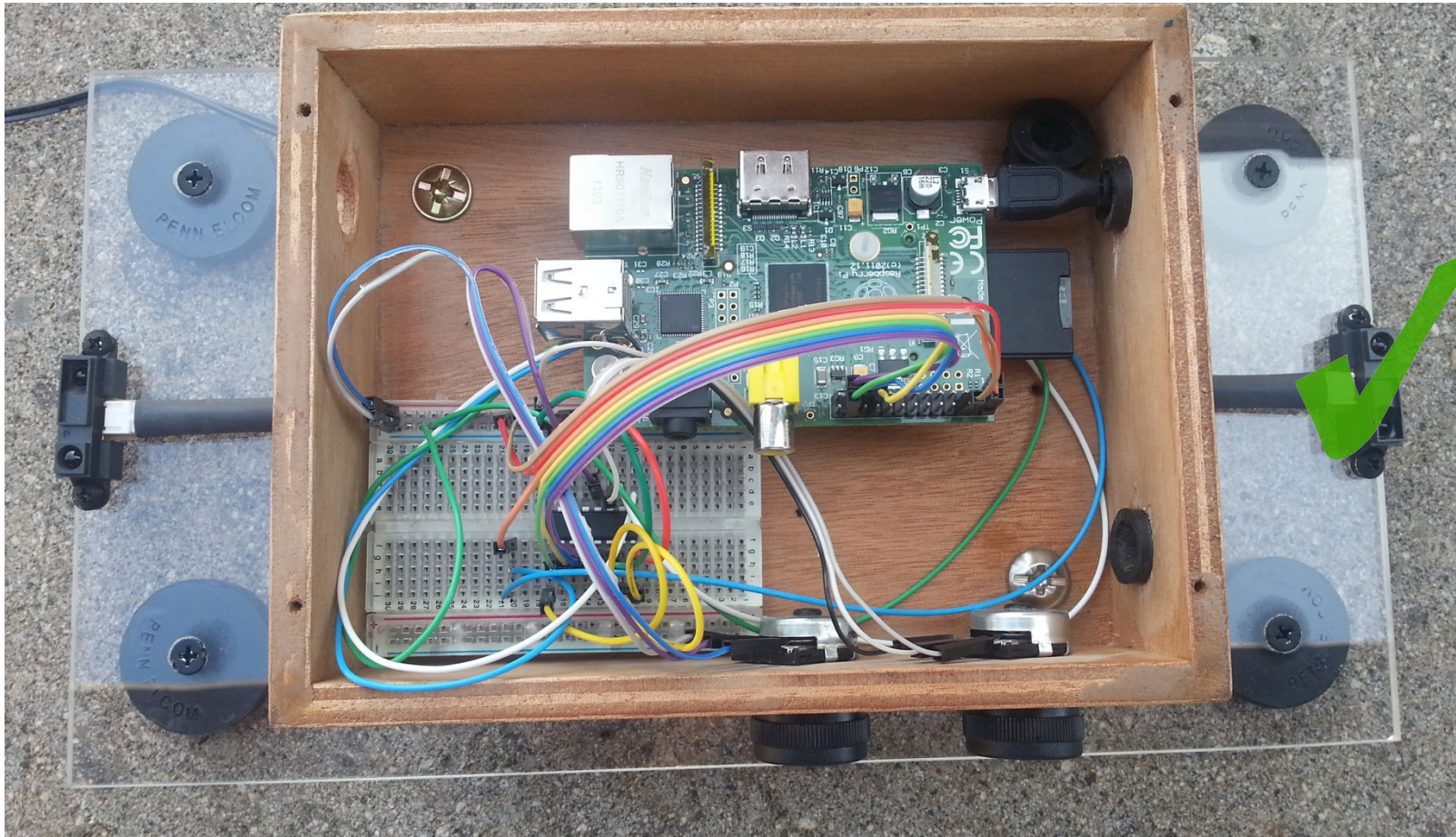


ELEKTRON
BECKUM
2 0 0 0

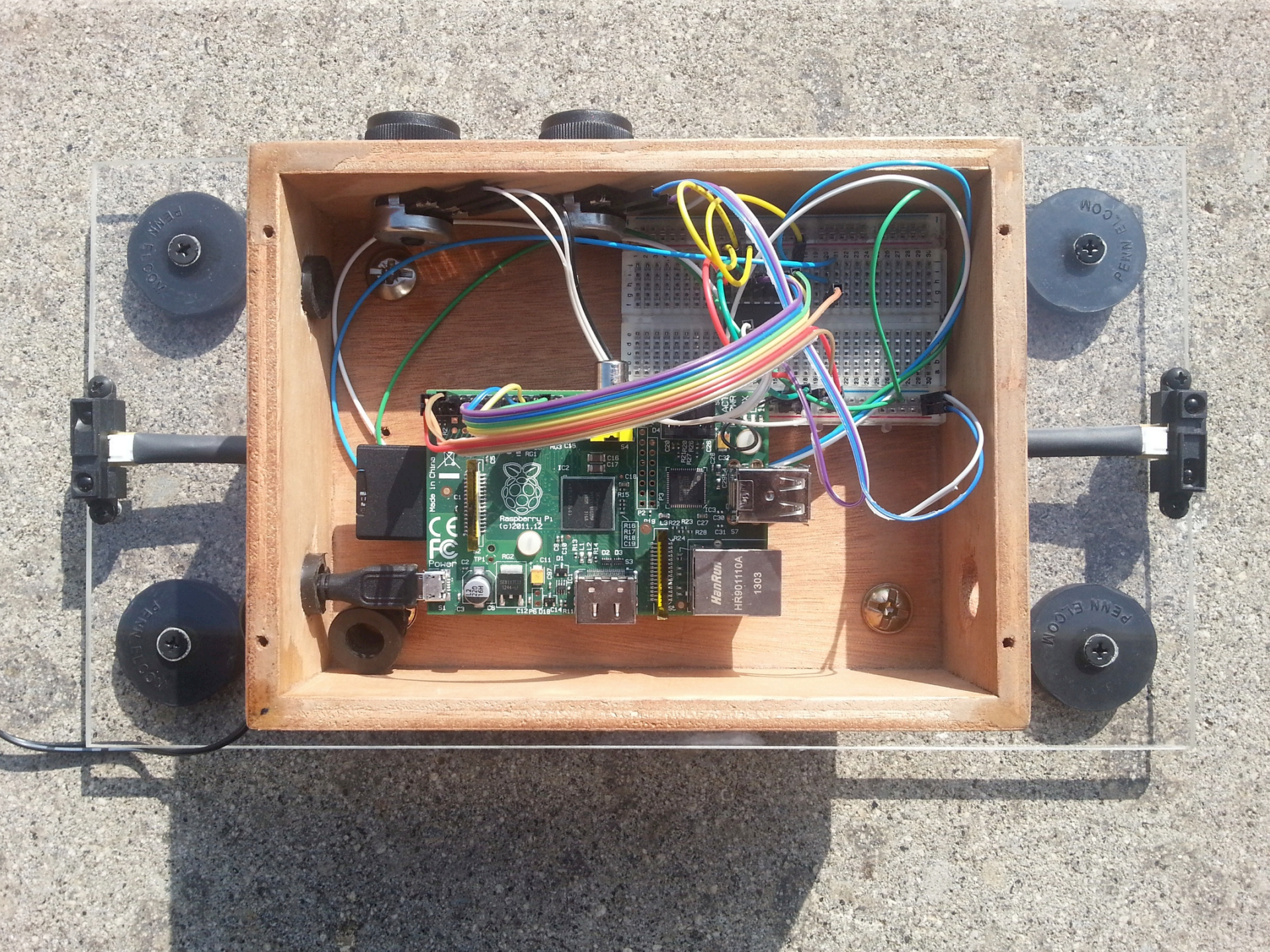




VOLUME SENSOR NOW CONTROLS VIBRATO EFFECT



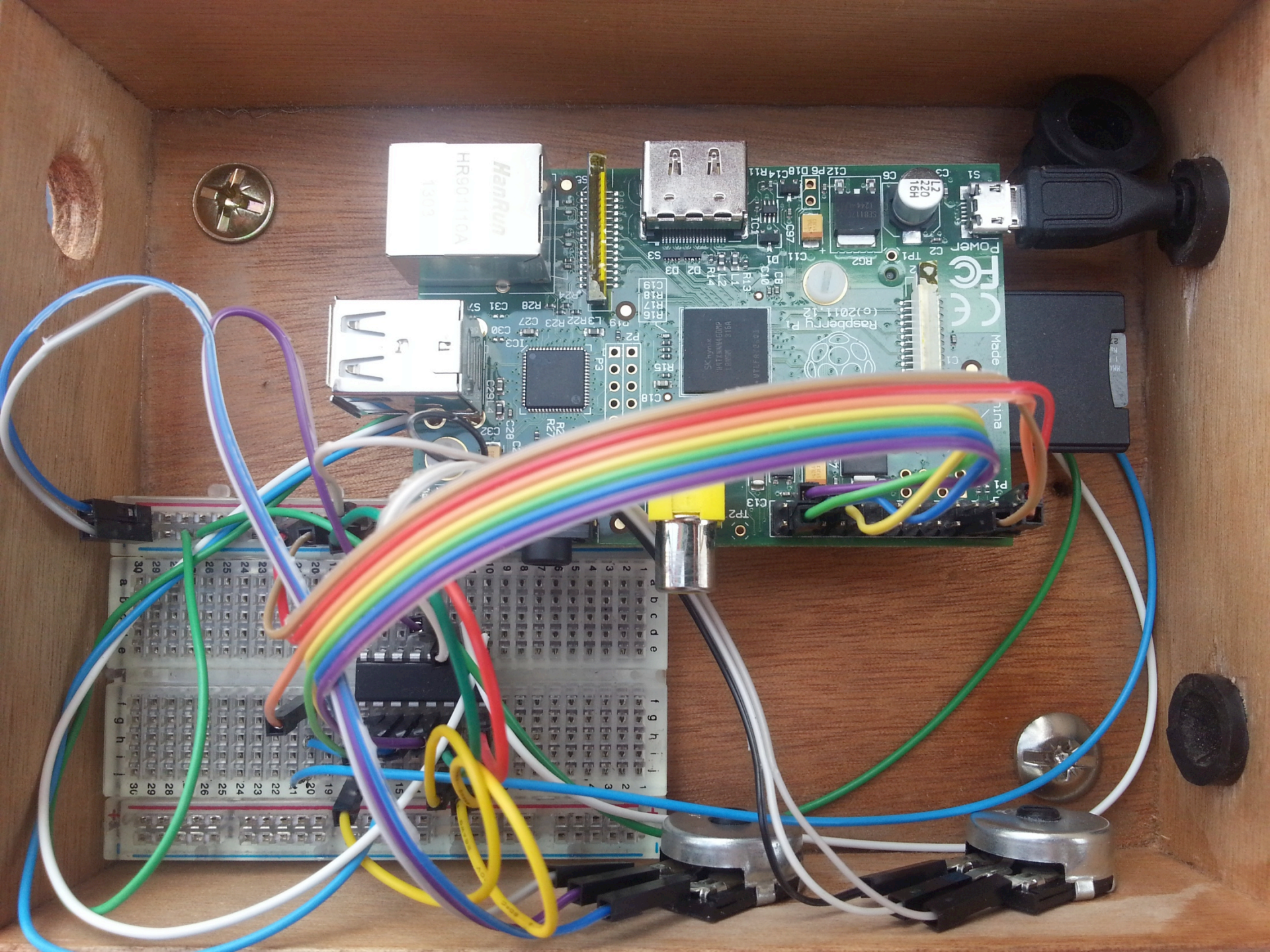






Waveform Knob

Playing-mode Knob





THANK YOU FOR YOUR ATTENTION