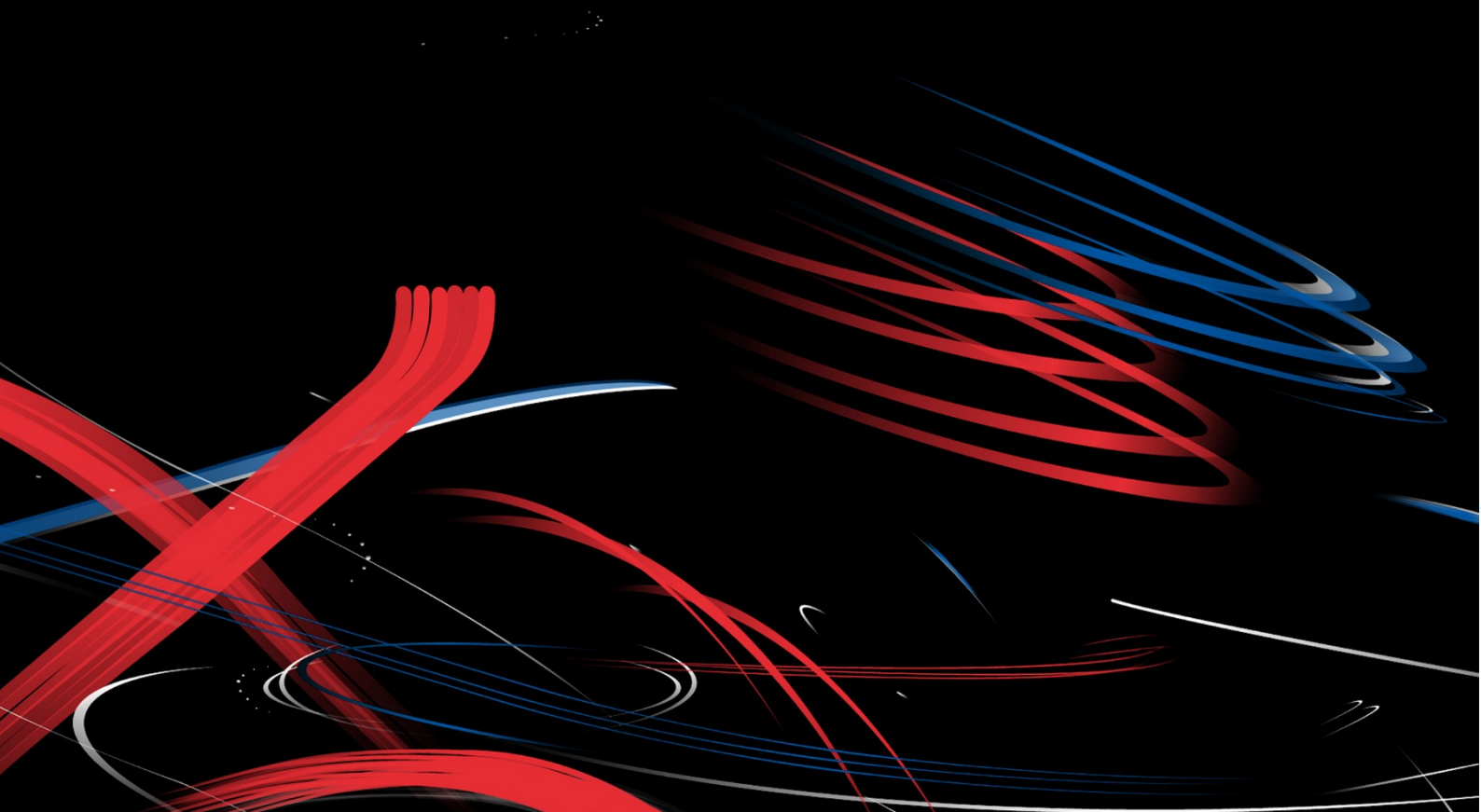
KITT
Engineering



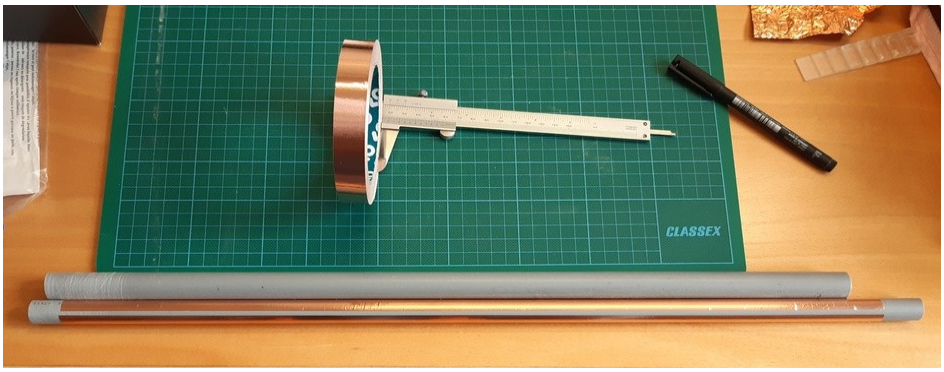
Index

1 Introduction

During the Wetropolis project https://www.wetropolis.nl/ there was demand for a water sensor. As current available sensors were either too small, or had potential corrosion issues a better design was required.

It needed to be built reproducibly, at scale, cheaply, completely insulated, have a low energy consumption. The measurements had to be easy to read on a smartphone.

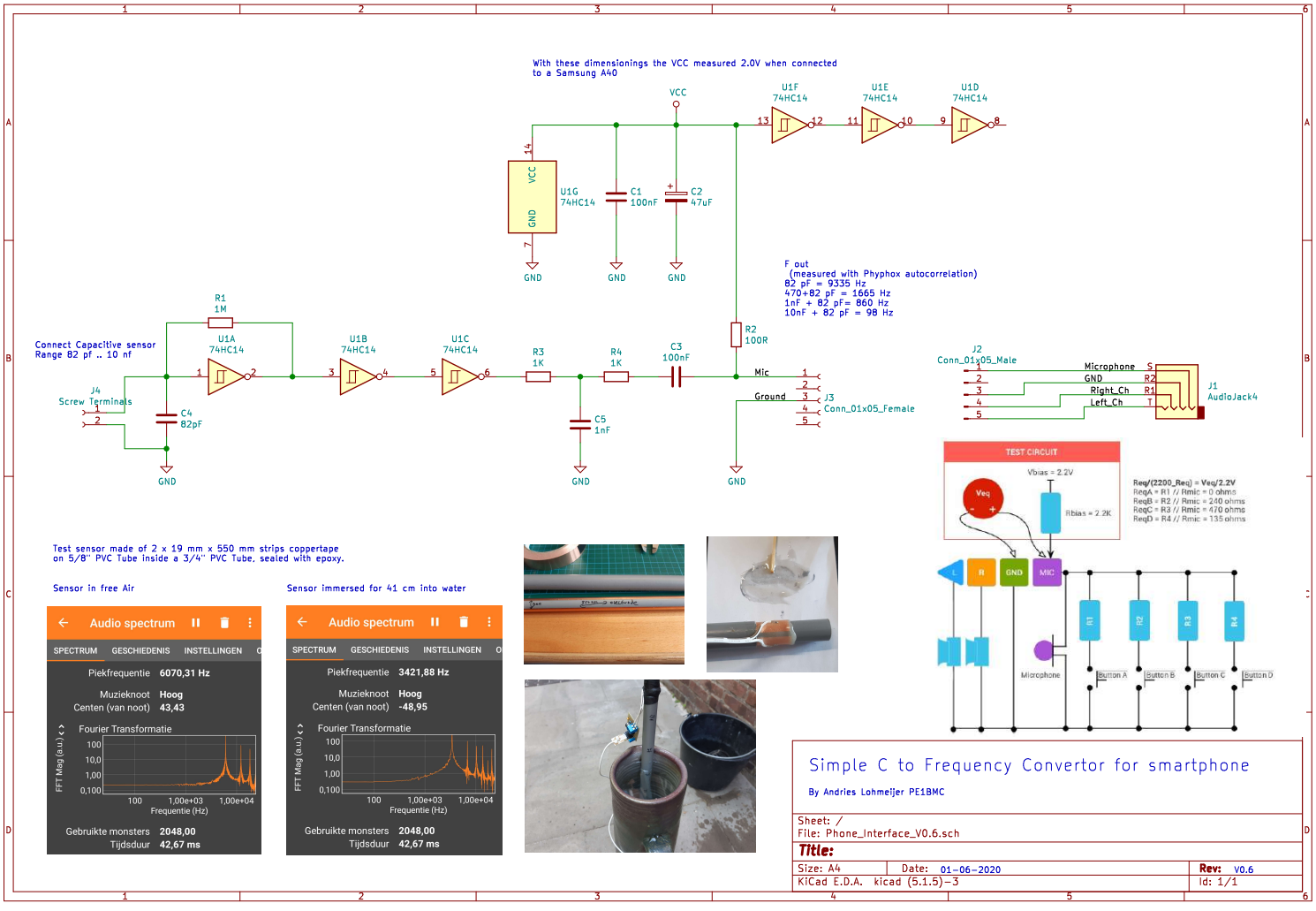
2 Bill of materials



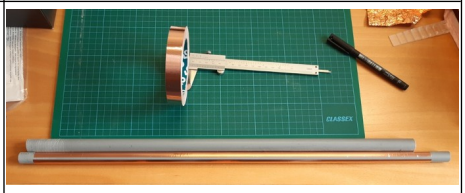
- 19mm copper tape.
- 5/8th inner PVC tube.
- 3/4th outer PVC tube.
- PCB Board.
- Wires.
- Epoxy glue.
    - Depending on your kit you might need a plastic container and brush to apply the epoxy
- black permanent market.
- bucket with water-level.
- Smartphone with Phyphox: https://phyphox.org/
- Saw, for cutting the PVC tubes.
- PVC tape or waterproof textile tape to cover the contacts.

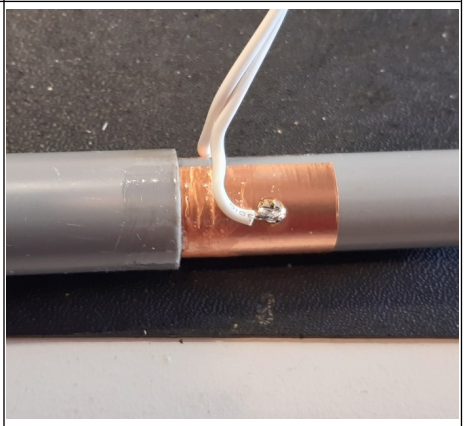
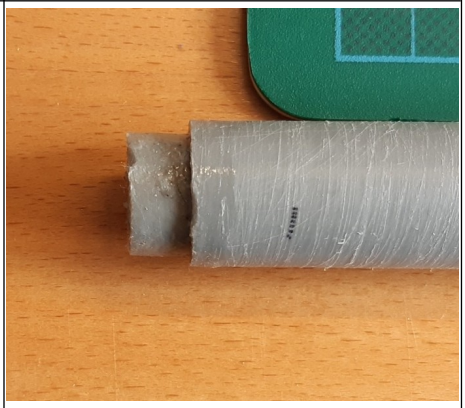
3 Phone interface circuit

Using an inverter combined with the correct resistors it is possible to generate a frequency depending on the electrical capacitance between the two copper strips.



4 Assembly instructions

Step	Description	Illustration
1	Cut the PVC tubes to length: 550mm for the outer 3/4th PVC tube 600mm for the inner 5/8th PVC Tube	
2a	Cut 2 strips of copper tape of the same length, advised is 550mm and tape them on the inner PVC tube (see 2a and 2b for placement)	
2b	fix the two strips on the inner PVC tube Leave a small 3 mm gap between the 2 strips as illustrated	
2c	If fixed correctly there should be a large gap, approx. 9mm at the other side	

3	Slide the outer tube over the inner tube leaving in such a way as to leave the upper part of the copper plate accessible	
4	Solder the wire to the copper plates	
5	The smaller tube should extend out of the bigger tube at the bottom of the device:	
6	Seal top and bottom using epoxy	

7	Cover the electrodes with tape	

5 Calibrating

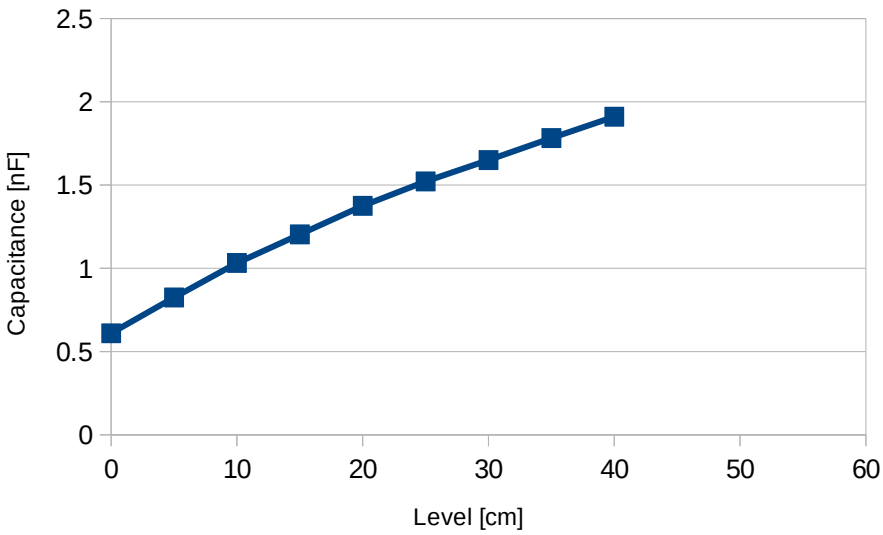
To get correct measurements from the device it needs to be calibrated.

To do this connect the device to a multimeter and take measurements for different depths.

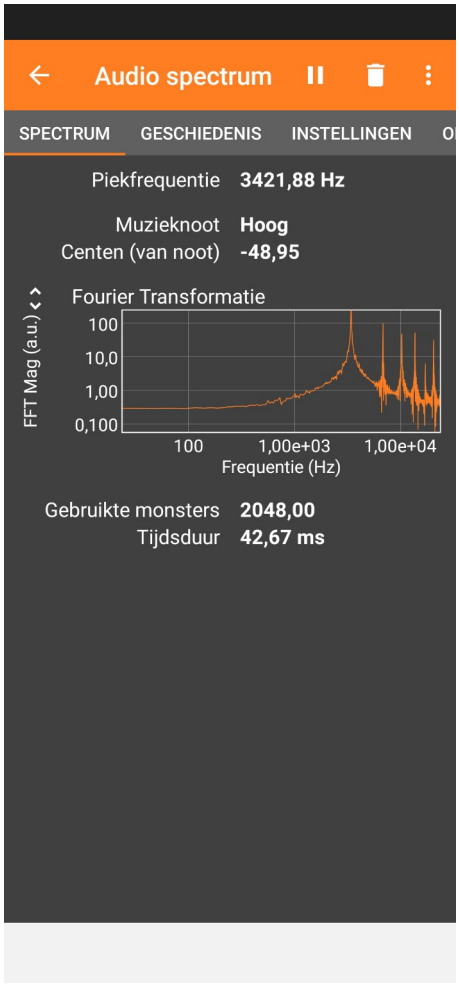
5.2 Example of obtained data-points:

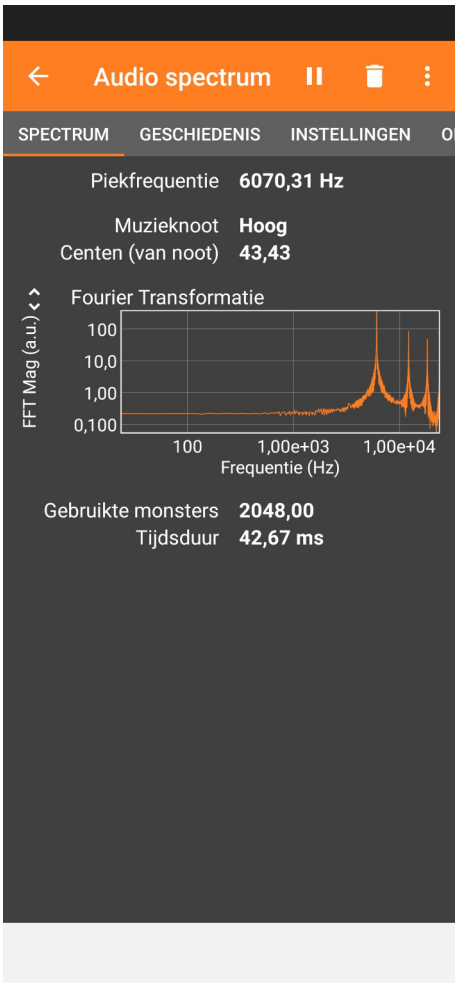
Prototype	
Sensor length	55 cm
Ref. capacitor	470pf
Charge	1 M
Discharge	10K
Supply voltage	3.3V
Supply Current	280 uA

Level [cm]	Capacitance [nF]
0	0.61
5	0.825
10	1.032
15	1.204
20	1.375
25	1.522
30	1.65
35	1.782
40	1.91

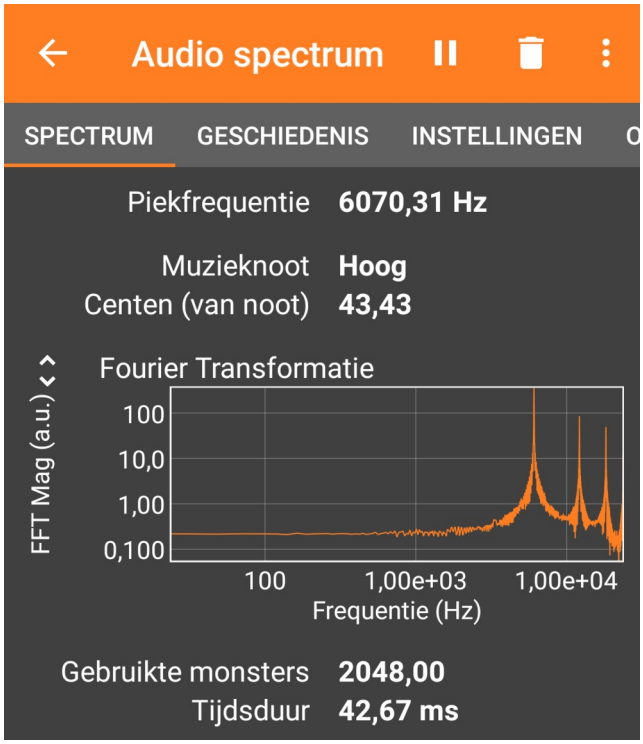
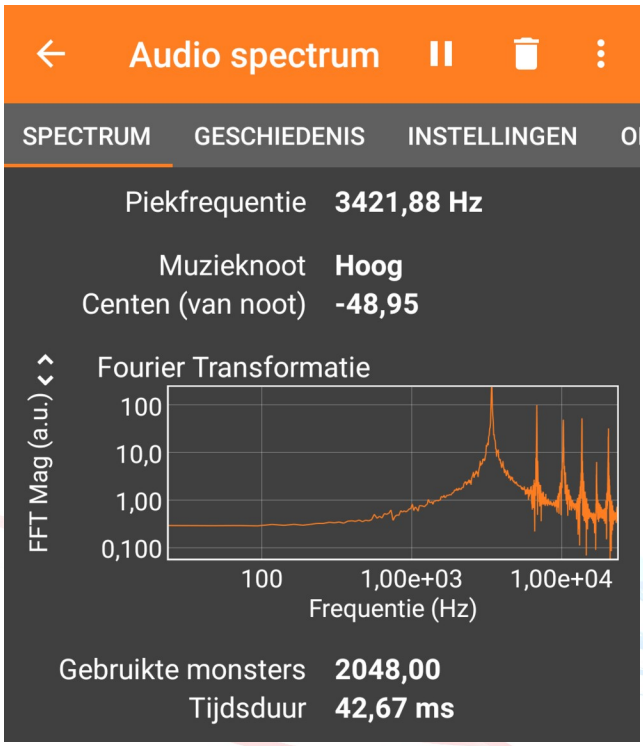


5.3 Depending on the depth different frequencies will be generated





5.3.1 Example results

0cm depth	
41cm depth	

6 Extra information

6.1 Accessory Specification: 3.5 mm Headset

This article specifies requirements for 3.5 mm plug headsets to function uniformly across the Android ecosystem.

Device manufacturers should consult the 3.5 mm jack specification and the Android Compatibility Definition Document (CDD) for additional requirements.

6.1.1 Functions

Function	Accessory Support
Stereo Audio Out	Required
Audio in (Mic)	Required
Ground	Required

6.1.2 Control-function mapping

Control Function	Accessory Support	Description
Function A	Required	Play/pause/hook (Short Press), Trigger Assist (Long Press), Next (Double Press)
Function B	Optional	Vol+
Function C	Optional	Vol-
Function D	Optional	Reserved (Pixel devices use this to launch voice commands)

Assign functions to buttons as follows:

- All one-button headsets must implement Function A.
- Headsets with multiple buttons must implement functions according to the following pattern:
    - 2 functions: A and D
    - 3 functions: A, B, C
    - 4 functions: A, B, C, D

6.1.3 Mechanical

Function	Accessory Support	Notes
4 conductor 3.5 mm plug	Required	Ref: EIAJ-RC5325A standard
CTIA pinout order (LRGM)	Required	Except in regions with legal requirements for OMTP pinout
OMTP pinout order (LRMG)	Optional	
Microphone	Required	Must not be obstructed when operating headset controls

6.1.4 Electrical

Function	Accessory Support	Description
Ear speaker impedance	16 ohms or higher	Recommend 32-300 ohms
Mic DC resistance	1000 ohms or higher	Mic characteristics must be compliant with section 5.4 *Audio Recording* of the current Android CDD
Control Function Equivalent impedance*	0 ohm	[Function A] Play/Pause/Hook
	240 ohm +/- 1% resistance	[Function B]
	470 ohm +/- 1% resistance	[Function C]
	135 ohm +/- 1% resistance	[Function D]

**Total impedance from positive mic terminal to GND when button is pressed with 2.2 V mic bias applied through 2.2 kOhm resistor*

In the following diagrams, Button A maps to Function A, Button B to Function B, and so on.

6.1.5 Reference headset test circuits

The following diagram for Reference Headset Test Circuit 1 shows the CTIA pinout for a 4-segment plug. For the OMTP pinout, switch the positions of the MIC and GND segments.

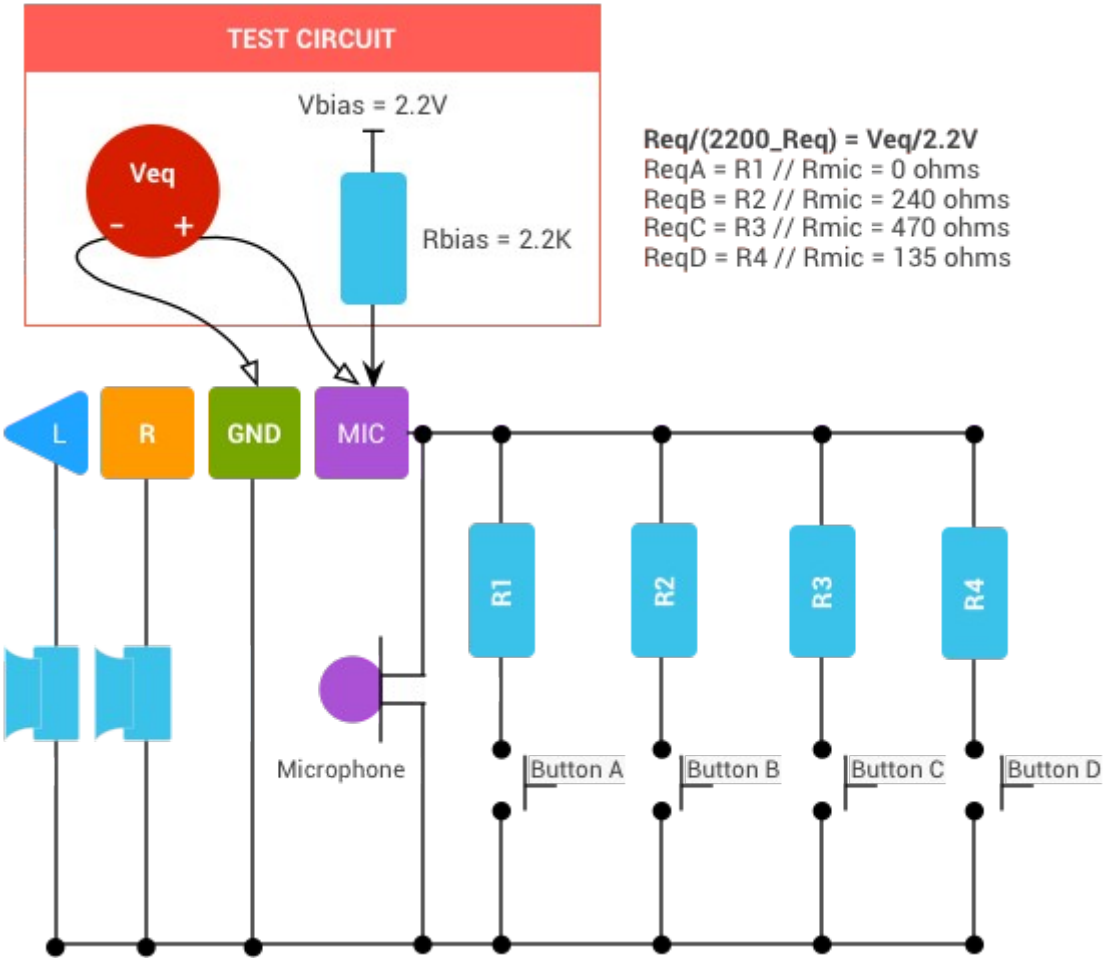


Figure 1. Reference headset test circuit 1

The following diagram for Reference Headset Test Circuit 2 shows how the actual resistor values (R1 - R4) are altered to meet this specification.

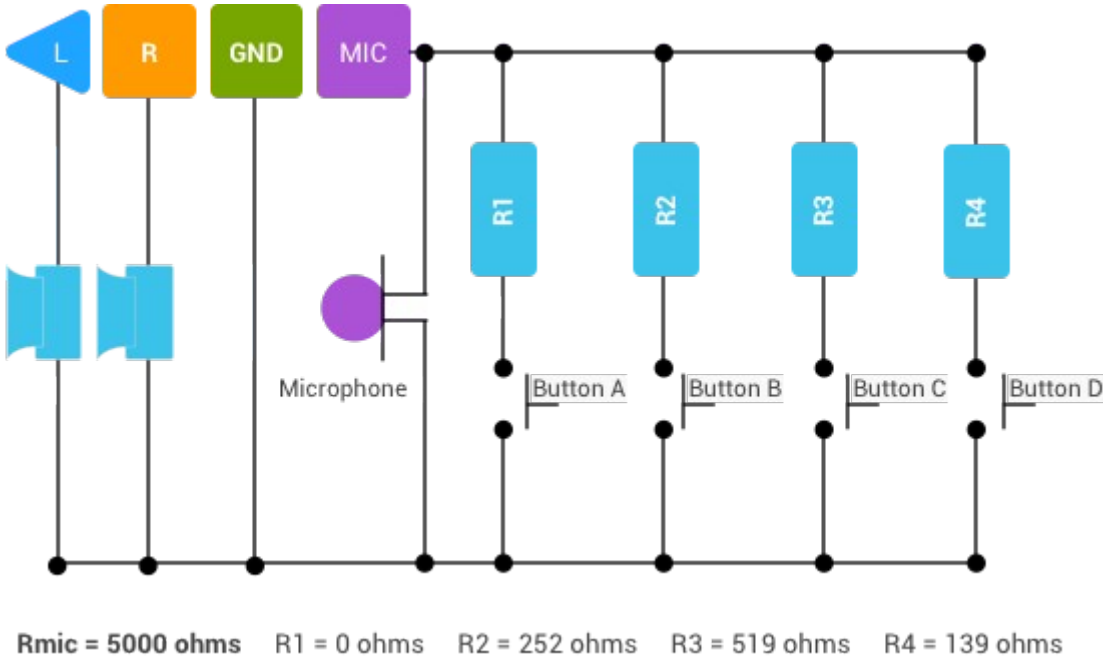


Figure 2. Reference headset test circuit 2

The actual resistance of the buttons parallel with the microphone (R1-R4) is based on the microphone capsule resistance (Rmic) and the equivalent impedance values (ReqA-ReqD). Use the following formula:

$Req_N=(R_{mic}*R_n)/(R_{mic}+R_n)$

Where R*n* is the actual resistance of a button, Req*N* is the equivalent impedance value of that button (provided), and Rmic is the microphone impedance value.

The example above assumes a 5 kohm microphone impedance (Rmic); to achieve an equivalent R4 impedance of 135 ohm (ReqD), the actual resistor value (R4) must be 139 ohms.

THE TECH
BEHIND
DAILY LIFE

WE ARE