Circuit Assembling Instruction of Button Simulator

This document is the assembling instruction of the button simulator, which is a part of the Button simulation via FDVV Models project. For more details, please refer to our project page at:
https://userinterfaces.aalto.fi/button-design

Our paper (Button Simulation and Design via FDVV Models, CHI'20) can be found at:
https://dx.doi.org/10.1145/3313831.3376262
https://arxiv.org/abs/2001.04352

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If you have any questions regarding assembling, installation, or running the system, please contact me via the above email.

1. Preparation and required components

If you haven't assembled the prototype yet, please read the other document "Prototype_assembling_instruction.pdf" first.

Then, you need to purchase all these electronical components (which are the same as in the readme.pdf file).

Microprocessors:

Adafruit ItsyBitsy M0
https://www.adafruit.com/product/3727

Arduino Uno X 2
https://www.amazon.com/s?k=arduino+uno&ref=nb_sb_noss_2

Linear position sensor:

MHR 250
https://www.electronicsdatasheets.com/manufacturers/measurement-specialties/parts/mhr-250

LVM-110 signal conditioner
https://www.te.com/usa-en/product-CAT-PSI0006.html

MAX17681 DC-DC converter
https://katalog.we-online.de/en/icref/MAX17681-DB-MAX17681EVKIT-Rev-1_Buck_1

Linear force actuator:

Moticont HVCM-025-022-003-01
http://www.moticont.com/HVCM-025-022-003-01.htm

DRV8871 DC Motor Driver Board
https://www.yeint.fi/elektroniikka/development-tools/internet-of-things/adafruit-drv8871-dc-motor-driver-br?gclid=Cj0KCQiAvc_xBRCYARIsAC5QT9kZnoEcDxlqUGjKIAIgjoIY3VakaAh1fXZxD4W5rhSpwIlI-mDv4u8aAnmFEALw_wcB

Vibration motor:

Tectonic TEAX13C02-8/RH
https://www.parts-express.com/tectonic-teax13c02-8-rh-13mm-exciter-8-ohms--297-214

Adafruit Wave Shield for Arduino Kit
https://www.adafruit.com/product/94

Others:

SG90 tower pro
https://www.banggood.com/TowerPro-SG90-Mini-Gear-Micro-Servo-9g-For-RC-Airplane-Helicopter-p-1009914.html

Sparkfun logic level shifter
https://www.sparkfun.com/products/12009

16V Power supply X 1

9V Power supply X 1

2. Step-by-step instructions

1. 1D position sensor

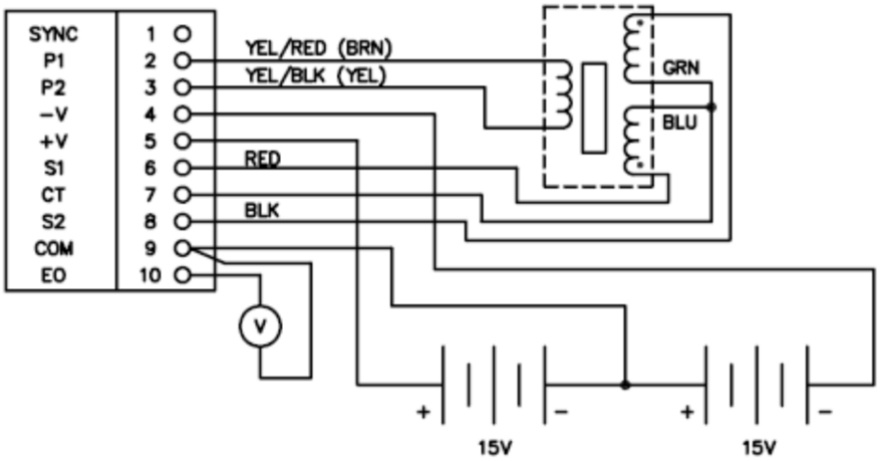
To run MHR250 position sensor, we need two other electronic parts: LVM-110 and MAX17681.

- MHR250 is a LVDT that provides precise measurements in one-dimensional movement. The full sensing scale is +-0.25 inch; the sensitivity is 1.6 V/V/inch under 2.5 kHz and 2.07 V/V/inch under 10 kHz.
- LVM-110 is the Voltage Output and LVDT signal conditioner with 2 DIP switches which can be controlled manually.
- MAX17681 is a DC-DC converter that converts a 16V DC input into +-15V DC output.

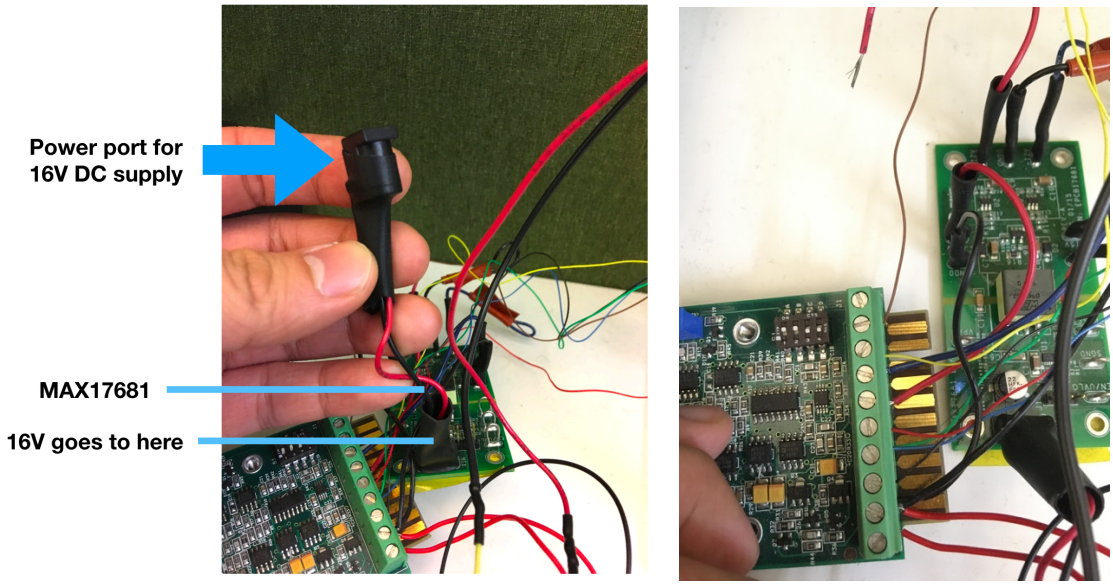
Detailed steps:

1. Connect 16V DC power supply to MAX17681 on the VIN port, and then the +-15V output port should be able to supply power to the LVM-110 board.

2. Connect the wires of all the parts together as instructed in the LVM-110 figure, as shown in the document of LVM-110:



Here are more photos for references:

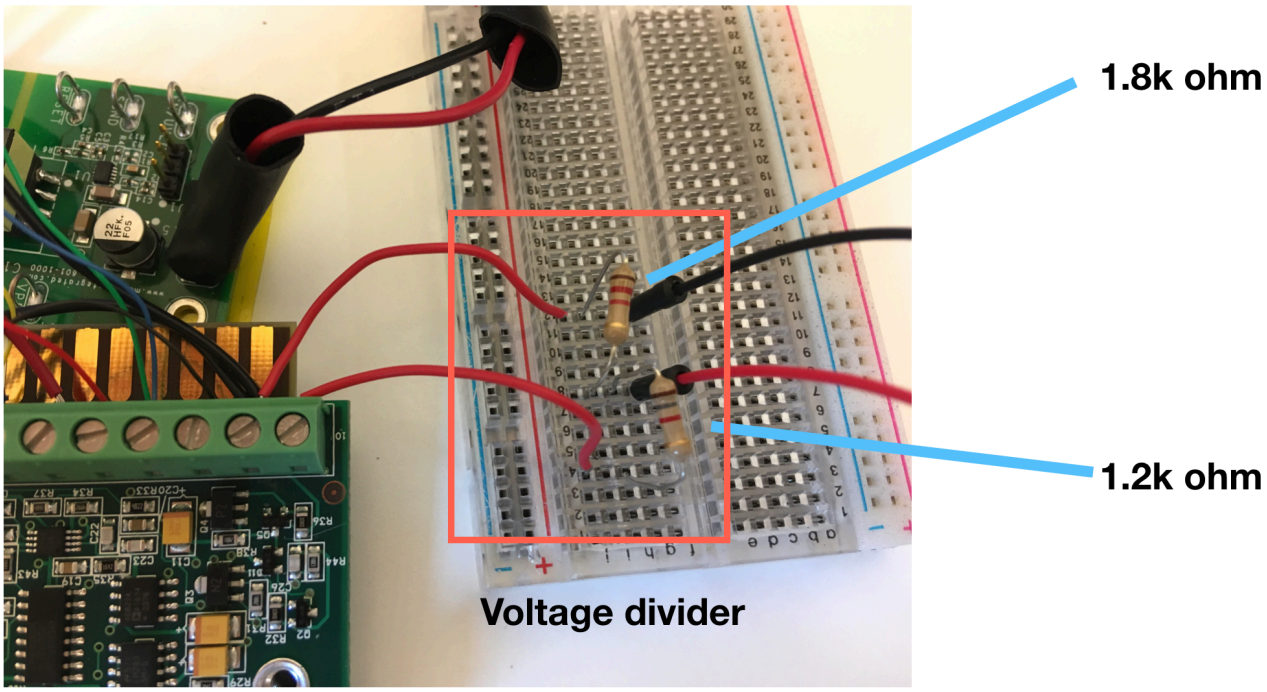


3. Setup the DIP switches on the LVM-110 as follows **(this is important)**:
S1: on/on/off/off
S2: off/off/off/on

After doing so, the voltage output of LVM-110 should range from -2V to 10V when the button is pressed. (check with Multimeter please)

4. Tune the Zero offsets **(this is important)**, you can then adjust the output voltage to 0V to 12V if you now press the button.

5. However, for microprocessors, they can handle the signals of 0V – 5V in their analog input ports. Thus, we need one last step to reduce the output voltage range. The easiest way doing it is to create a voltage divider by 1.2k and 1.8k ohm resistors, it will result in the 0V – 4.8V.

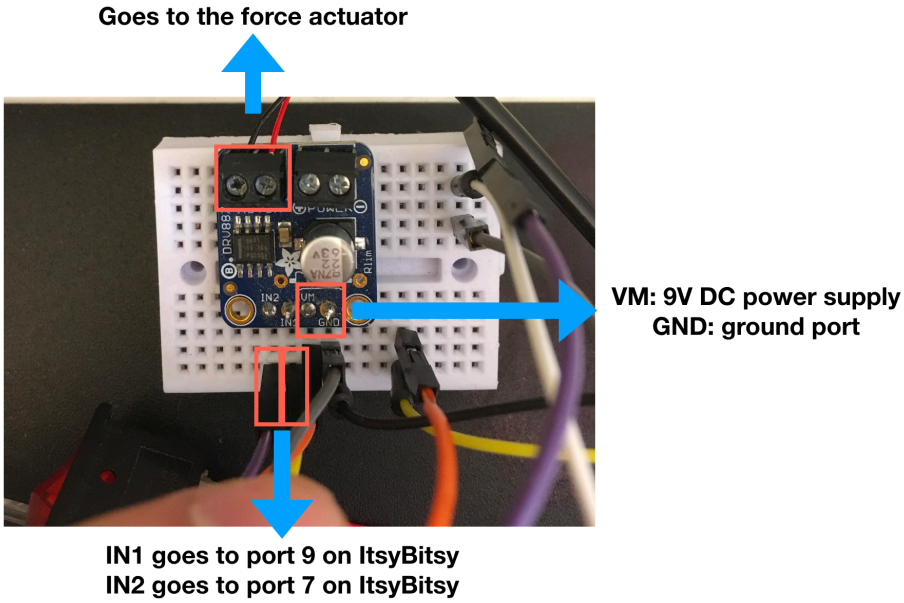


6. Connecting the output to the ItsyBitsy A1 port and connect the ground to ground of ItsyBitsy.

2. Force actuator

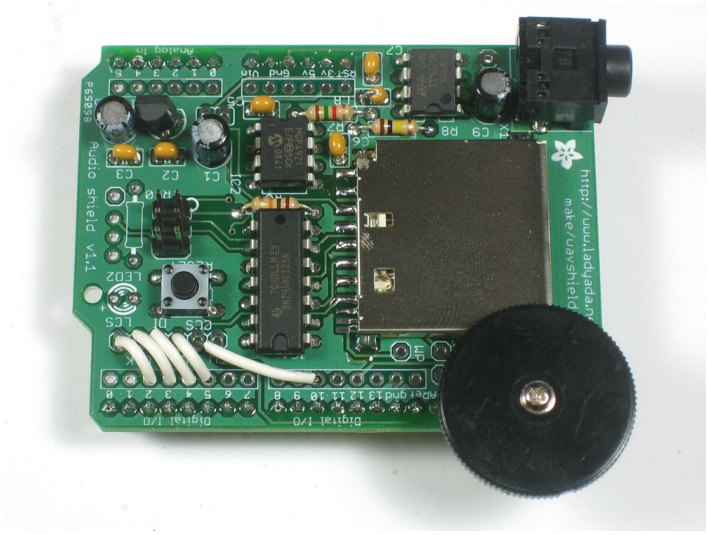
The force actuator (Moticont HVCM-025-022-003-01) is driven by DRV8871 DC Motor Driver Board. The drive needs a 9V DC power supply. (We here use an Arduino board's Vin port to provide that, which is powered by another 9V power supply. You can directly provide 9V DC to the driver board of course).

Then connect the in1 and in2 on the driver board to the 7 and 9 ports on the ItsyBitsy board.



3. Vibration motor

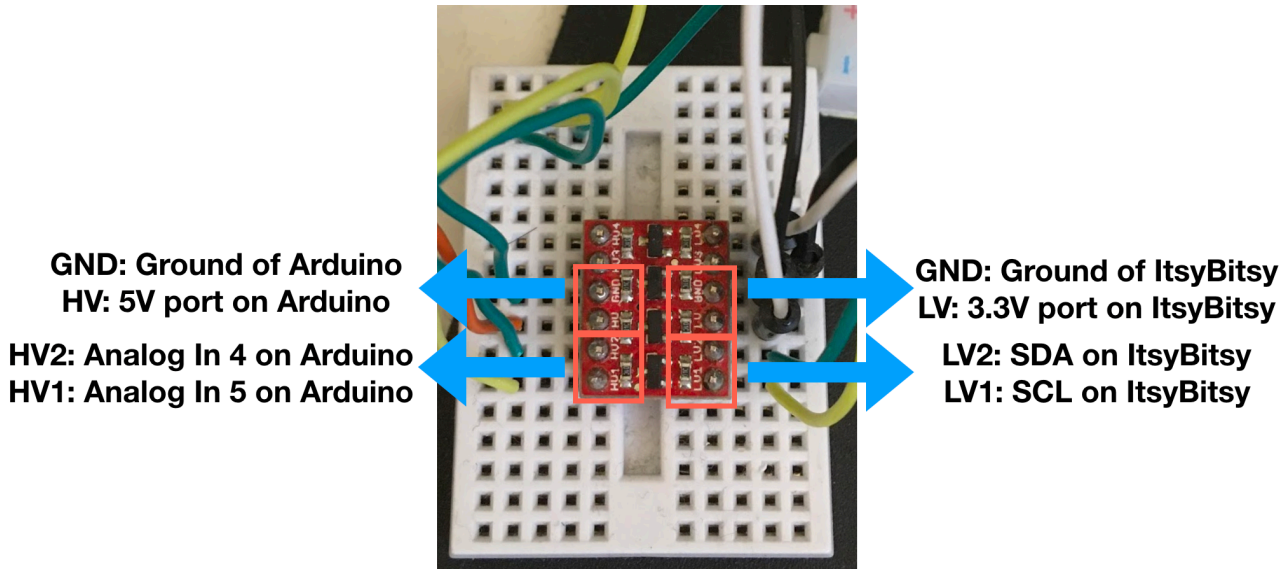
1. assemble the Arduino soundwave shield as instructed on the product page (https://learn.adafruit.com/adafruit-wave-shield-audio-shield-for-arduino/make-it).



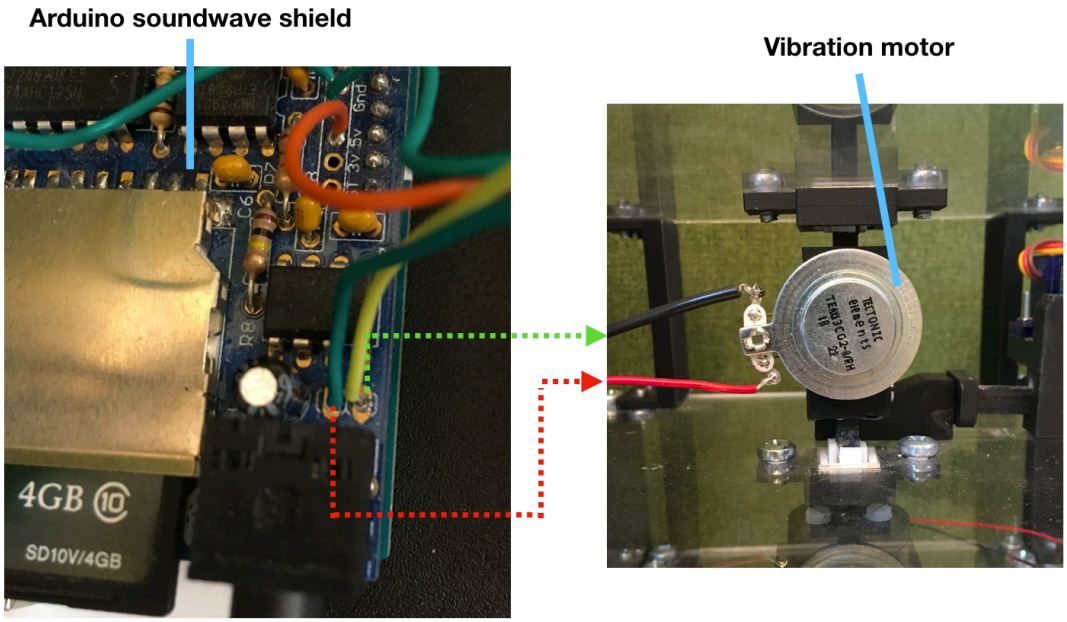
Attach this with an Arduino Uno when it's done.

2. Upload all the soundwave files under "4. source_code/all_sound_wave" to the SD card which attached on the Arduino soundwave.

3. We communicate the ItsyBitsy board and Arduino through I2C channel. However, these two boards' operation voltage are different (ItsyBitsy: 3.3 V, Arduino: 5 V), we have to apply a level shifter to mediate the signal. Please refer to the below figure to see how it should be connected.



4. Connect the vibration motor (Tectonic TEAX13C02-8/RH) onto the Arduino soundwave shield.



4. Travel range control

The servo motor for travel range control (sg90) is powered by the 3.3 V port of ItsyBitsy board, and the signals to control the motor is given by port 11 of ItsyBitsy.