# Introduction

* This document has the purpose of guiding the developer through the process of preparing the Stethoscope PCB prior to its integration in the final assembly.
* This guide must be followed by the developers. End-users will receive an assembled Stethoscope, ready to be used. The term developer encompasses the engineer, staff or student of the PD3D group tasked with assembling a Stethoscope.
* Note that a section of this guide requires the use of a Windows 7 machine. Steps may be different if the developer uses a Mac or Linux OS.

# Materials

Preparation of the Stethoscope PCB will require soldering. Developers must ensure that the components listed in Table 1 are available in the lab.

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| **Table 1 – short\*: Components needed in the lab** | | |
| **Component** | **Description** | **Justification** |
| Weller Soldering Station | Solder Station | Needed to solder wires, pin and electrical components |
| Vastar Solder Sucker | Desoldering Vacuum | Needed to remove solder |
| Helping Hand | Helping Hand | Needed to hold parts and components while soldering |
| Solder Tip Cleaning Wire | Cleaning Wire | Needed to clean the tip of the solder iron |
| 0.6 mm Solder Wire | Solder Wire | Needed to solder components |
| Rosin Paste Flux | Flux | Needed to enhance the soldering process |
| Hakko Wire Cutter | Wire Cutter | Needed to cut wires and other components |
| *\*Table 1 – long annexed to this guide* | | |

The materials needed for the preparation of the Stethoscope PCB are listed in Table 2.

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| **Table 2 – short\*: Components needed for the preparation of the Smart Handle PCB** | | | |
| **Component** | **ID** | **Description** | **Justification** |
| Teensy 3.2 | N.A. | Cortex-M4 Microcontroller | Needed to control the transducers of the stethoscope |
| Teensy Audio Board | N.A. | SGTL5000 Audio Board | Needed to process acoustic signals |
| Omnidirectional Electret Microphone | 433-1088-ND | Microphone | Needed to capture physiological sounds |
| BlueSMiRF | WRL-12577 | Bluetooth Antenna | Needed to connect to a control system wirelessly |
| Micro-LiPo Adapter | ADA-1904 | Charger | Needed to charge a LiPo battery and power the rest of the components |
| LiPo Battery | PRT-13851 | LiPo Battery | Needed to power components wirelessly |
| Header Pins | N.A. | Header Pins | Needed to solder boards and breakout boards together |
| Micro-USB to USB-A Cable | N.A. | USB Cable | Needed to connect the microcontroller to the computer |
| Stethoscope Custom PCB | N.A. | PCB | Needed to connect boards, microcontrollers and other components |
| *\*Table 2 – long annexed to this guide* | | | |

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| **Table 3 – short\*: Components needed for the assembly of the Stethoscope** | | | |
| **Component** | **ID** | **Description** | **Justification** |
| Stethoscope | N.A. | Standard Stethoscope | Needed to assemble electronic stethoscope |
| Headphones | N.A. | Standard in-ear headphones | Needed as speakers to play sounds captured by the microphone |
| Stethoscope Housing | N.A. | Plastic Housing and other parts | Needed to enclose and seal electronic components |
| Stethoscope PCB | N.A. | Prepared PCB | Needed as the consolidated electronics of the stethoscope |
| *\*Table 3 – long annexed to this guide* | | | |

# Process

The preparation of the Stethoscope PCB requires software installation as well as a circuit assembly. All of these steps have been consolidated into the following process:

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| SOFTWARE INSTALLATION | |
| 1. [Download Teensyduino](http://www.pjrc.com/teensy/td_download.html), the Arduino IDE add-on for the Teensy board | C:\Users\flobo\Downloads\teensyduino_installer.png |
| 1. On your Windows machine, [install or roll-back the Arduino IDE](https://www.arduino.cc/en/Main/Software) to the [latest version supported by Teensyduino](http://www.pjrc.com/teensy/td_download.html) | C:\Users\flobo\Downloads\arduinoversion.png |
| 1. Connect Teensy to Windows computer using micro-USB cable |  |
| 1. Allow Windows to install the drivers | C:\Users\flobo\Downloads\connectingteensy.png |
| 1. Open Arduino IDE and the most recent version of the Stethoscope.ino sketch | C:\Users\flobo\Downloads\stethoscopeino.png |
| 1. Under Tools, make the following selections:    1. Board: teensy 3.1/3.2    2. USB Type: Serial    3. Keyboard Layout: US English    4. CPU Speed: 96 MHz optimize speed (overclock)    5. Leave the “Port” section unchanged as the Teensy has not been fully detected | C:\Users\flobo\Downloads\teensyselection.png |
| 1. Upload program | C:\Users\flobo\Downloads\uploadcode.png |
| 1. Wait for Teensyduino window to appear and an error message to appear on the Arduino IDE terminal | C:\Users\flobo\Downloads\errorcode.png |
| 1. Press the reset button on the Teensy, as shown in the Teensyduino window, to enter Program Mode | C:\Users\flobo\Downloads\errorcode.png |
| 1. Let Windows install the virtual COM port specific to the Teensy | C:\Users\flobo\Downloads\com75.png |
| 1. Upload the sketch again:    1. Under Tools > Port, update the new port number (COM75 for this guide)    2. Wait for the standard Done Uploading message and no warning on the Arduino IDE terminal | C:\Users\flobo\Downloads\successterminal.png |
| PCB PREPARATION | |
| 1. Solder first set of male header pins to the custom PCB board    1. Use a breadboard to secure the PCB and the pins as shown in the picture    2. Solder the right-most lines, closer to the smallest line of through-holes, as shown in the picture    3. Note that the spacers of the pins are on the top side of the PCB (the top is labeled) | C:\Users\WOLF512\Downloads\Photos\IMG_0743.jpg |
| 1. On the top side (labeled side) of the PCB, solder male pins on the left-most rows of through-holes | C:\Users\WOLF512\Downloads\Photos\IMG_0744.jpg |
| 1. On the top side (labeled side) of the PCB, solder male pins to the remaining through-hole rows | C:\Users\WOLF512\Downloads\Photos\IMG_0746.jpg |
| 1. On the top side of the PCB, solder the Teensy 3.2 microcontroller upside-down, as shown in the picture | C:\Users\WOLF512\Downloads\Photos\IMG_0749.jpg |
| 1. Using needle-nose pliers, form/bend the four pins labeled “Micro LiPo” until the reach a 90-degree angle | C:\Users\WOLF512\Downloads\Photos\IMG_0752.jpg |
| 1. Using a Helping Hand, turn the PCB on its side and place the Micro-LiPo adapter board through the now 90-degree male pins (as shown in the picture) | C:\Users\WOLF512\Downloads\Photos\IMG_0753.jpg |
| 1. Without taking the board from the Helping Hand, solder the fast-charging pads on the edge of the Micro-LiPo board (labeled 500 mA) | C:\Users\WOLF512\Downloads\Photos\IMG_0755.jpg |
| 1. Facing the top of the PCB once again, solder the BlueSMiRF Bluetooth antenna to the remaining male pins, as shown in the picture | C:\Users\WOLF512\Downloads\Photos\IMG_0756.jpg |
| 1. Set the PCB board aside and locate the Omnidirectional Electret Microphone and its spacer | C:\Users\WOLF512\Downloads\Photos\IMG_0758.jpg |
| 1. Place the Omnidirectional Electret Microphone through the spacer    1. Note that there is only a correct orientation. If the holes seem to be too small for the microphone pins to go through, you may be inserting them through the wrong side | C:\Users\WOLF512\Downloads\Photos\IMG_0760.jpg |
| 1. Solder the Omnidirectional Electret Microphone to the microphone pins on the Teensy Audio Board    1. Note that the microphone spacer was designed to avoid surface mount resistors on the Teensy Audio Board. This can also be used to validate the correct positioning/orientation of the spacer | C:\Users\WOLF512\Downloads\Photos\IMG_0761.jpg |
| 1. Solder the Teensy Audio Board to the bottom side of the PCB, as shown in the picture    1. Note the position of Micro-LiPo adapter and the male pins of the Bluetooth antenna for the orientation of the Teensy Audio Board | C:\Users\WOLF512\Downloads\Photos\IMG_0763.jpg |
| 1. Trim male header pins | C:\Users\WOLF512\Downloads\Photos\IMG_0764.jpg |
| STETHOSCOPE ASSEMBLY | |
| 1. Unpack MDF Stethoscope | C:\Users\flobo\Downloads\Photos2\IMG_0804.jpg |
| 1. Using an sharp blade, cut rubber tube to separate the entire piece in three channels, as shown in the picture | C:\Users\flobo\Downloads\Photos2\IMG_0807.jpg |
| 1. Grab the Bottom piece of the Stethoscope Housing and the prepared Stethoscope PCB | C:\Users\flobo\Downloads\Photos2\IMG_0809.jpg |
| 1. Grab the in-ear Headphones and insert them on the cavities of the Bottom piece of the Stethoscope Housing, as shown in the picture    1. Left and Right side headphones go in the Left and Right cavities respectively    2. Use zip-ties and electrical tape to wrap the excess cabling of the stethoscope | C:\Users\flobo\Downloads\Photos2\IMG_0812.jpg |
| 1. Connect the in-ear Headphones to the prepared Stethoscope PCB and place into the Bottom piece of the Stethoscope Housing following the microphone cavity and the anchor columns, as shown in the picture | C:\Users\flobo\Downloads\Photos2\IMG_0814.jpg |
| 1. Connect the diaphragm channel to the front plastic channel of the Bottom piece of the Stethoscope Housing | C:\Users\flobo\Downloads\Photos2\IMG_0816.jpg |
| 1. Separate the in-ear metal channels of the Standard Stethoscope from their metal anchor, as shown in the picture | C:\Users\flobo\Downloads\Photos2\IMG_0819.jpg |
| 1. Connect the remaining cut, rubber channels and the Guide piece of the Stethoscope Housing to the in-ear metal channels to the Standard Stethoscope, as shown in the picture | C:\Users\flobo\Downloads\Photos2\IMG_0821.jpg |
| 1. Connect the in-ear metal channels of the Standard Stethoscope to the plastic channels on the back of the Bottom piece of the Stethoscope Housing, as shown in the picture | C:\Users\flobo\Downloads\Photos2\IMG_0824.jpg |
| 1. Connect the 400 mAh LiPo battery to the prepared Stethoscope PCB and insert the battery in its corresponding compartment | C:\Users\flobo\Downloads\Photos2\IMG_0827.jpg |
| DONE!!! | |