



# ABBI Advanced User Manual

Version 2.0.4 February 2017

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## 1.1. History

<b>Ver.</b>	<b>Date</b>	<b>Author</b>	<b>Description</b>
1.0.0		Gabriel Baud-Bovy	Original draft of the ABBI User Manual for Experimenter.
1.0.1	20/10/2014	Ben Lopes Proquis Gabriel Baud-Bovy	Editing.
2.0.0	05/01/2016	Gabriel Baud-Bovy	Updated manual fto reflect current state of the ABBI device and Windows applications (ABBI3Gui and FileManager)
2.0.1	28/01/2017	Francesco Maria Rietti	Small edits.
2.0.2	15/02/2017	Hector	Added Smartphone App sections
2.0.3	18/02/2017	Gabriel Baud-bovy	Reorganization and formatting
2.0.4	22/02/2017	Euan Freeman	Documented the Android library demo app

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## 2. ABBI device



The Audio Bracelet for Blind Interaction (ABBI) is a wearable device with an integrated audio system and motion sensing capabilities. Besides producing sounds, the ABBI device can also function as a motion sensor and beacon device. All ABBI functions can be configured and controlled remotely from a smartphone or personal computer (PC) via Bluetooth.

### 2.1. ABBI interface and control

The ABBI device is a highly versatile and configurable device but it has a very simple physical interface composed of a button, leds and audio signals (jingles). More advanced functions are controlled via Bluetooth and/or USB links.

#### Button

- Single click: Mute/Unmute
- Double click: Start advertising
- Long push (> 5 sec): Software reset

#### LEDs

- Blue led: ABBI is powered on by USB
- Red led: ABBI is charging
- Yellow led: ABBI is muted. Note that the yellow led is also used for [Troubleshooting](#).

#### Audio jingles:

Short sequence of audio notes are used to signal:

- When the ABBI device starts advertising
- When ABBI device wakes up (transition from STAND-BY to AWAKE states)
- When the ABBI device goes to sleep (transition from AWAKE to STAND\_BY states)
- When the ABBI device goes into deep sleep (transition from STAND-BY to ASLEEP states)

Jingles can be disabled and jingle volume can be changed with the ABBI3GUI application (see below).

### 2.2. Bluetooth connection

The ABBI can connect to an application running on an Android phone or PC through a Bluetooth Low-Energy (BLE) link (also called Bluetooth 4.0 or Smart Bluetooth). The Bluetooth connection offers an almost complete control of the ABBI device functions via GATT-based services.

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To establish the connection, it is necessary to **start advertising**, which can be done by

- 1) **shaking the device**
- 2) with a **double-click** on the button
- 3) connecting the device to a USB port

When device is not connected to USB port, the ABBI device stops advertising after 20 sec to save battery. Once the device is connected, it stays connected until it receive a command to disconnect from the application or the link is lost for any reason (e.g. distance is too large). At the end of the connection, the ABBI device will not advertise automatically; it is necessary to shake it to make it advertise again.

### Advanced functions

ABBI has advanced functions which can be enabled and controlled from a smartphone or PC applications via Bluetooth. Note that some applications might only use a subset of these functions.

#### Sound synthesis and control:

The ABBI device offers various ways to control the onset/offset of the sound:

- **Movement-triggered sound:** Sound can be triggered by the movement of the device. This feature has been used to implement movement-based sound games for visually impaired person.
- **Remote-controlled sound:** the sound can also be controlled remotely from an smartphone or PC application.
- **Interactive control:** a MIDI-like interface allows a program to start/stop to play notes in an interactive manner.
- **Movement sonification:** ABBI device can modulate sound parameters (e.g. volume, frequency) as a function of its motion.

The sounds are synthesized by configurable five-channel audio synthesizer, which can combine different sound sources such as audio files and sound waves. Each channel has the ability to produce periodic sounds. The synthesizer parameters are saved internally in *audio configurations*.

#### Motion sensing:

The ABBI device can broadcast (notify) the values of its motion sensors (accelerometer, gyroscope and magnetometer) to a smartphone or PC application via Bluetooth up to 100 Hz.

#### Motion logging:

The ABBI device can log the motion of the device in its memory. The movement parameters and logging period can be configured via Bluetooth. The motion log files can be downloaded to monitor daily activity for example.

#### iBeacon:

The ABBI device can broadcast iBeacon messages so that a smartphone application can detect its presence and estimate its distance from it. Application that use this function can trigger audio message on the ABBI device to indicate the position of the ABBI device. iBeacon messages might also be used for indoors localization application.

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## 2.3. Memory

ABBI device contains two Flash memories (2x 8 MB or 2X16 MB) and an EEPROM memory. The first Flash memory stores the audio files (.wav) files while the second Flash memory stores three log files:

- **Event.log:** Contains a list of event such transition between states with time stamps
- **Motion.log:** Store statistics about the motion of the device (see Motion data logging)
- **System.log:** For system messages/troubleshooting/debugging.

The EEPROM memory stores ABBI configuration parameters.

### ABBI configuration parameters

The ABBI device stores configuration parameters into databases (a database is an independent set of parameters). For example, the audio configurations in the audio module are stored in databases.

ABBI configuration information is stored internally at multiple levels:

- **RAM.** When ABBI is in the awake state, all configuration information is stored in the RAM. Normally, application controlling ABBI via Bluetooth will change the values of the corresponding parameters only in the RAM. Note that information in the RAM is lost when the battery is removed or is empty and the device shutdowns.
- **EEPROM:** ABBI configuration information is saved in the EEPROM automatically when ABBI goes into ASLEEP state. During the boot process and when ABBI wakes up, this information is recovered from the EEPROM and stored in the RAM. In this manner, ABBI configuration parameters are not lost if ABBI battery discharge completely and ABBI shutdowns.
- **Hard-coded values.** If the information in the EEPROM is corrupted or absent, hard-coded (default) values are used.
- **Externally.** Database can be downloaded and uploaded to and from a PC or Smartphone via Bluetooth.

Database storage can be controlled by applications via the BLE-based GATT services, which has commands to:

- Download/upload databases to and from a PC or smartphone application
- Save/Restore databases in/from the EEPROM
- Save/Restore hard-coded database

## 2.4. USB connection

The USB connector is used to charge the ABBI device. In addition, the USB link can be used to update the firmware and manage the Flash memory (file transfer).

### Power management

ABBI goes automatically in low-power consumption (STAND-BY state) mode when it is not moved.

**Moving the device will wake it up automatically** (AWAKE state). If the battery runs low, it will go in a deep sleep mode (ASLEEP state) from which it cannot be awoken unless it has been recharged or it is charging. Note that the device continues to consume a bit of energy even in the STAND-BY and ASLEEP modes to keep the clock and a minimum of functionality. When the voltage goes below a critical value, it will completely shut down. In this case, the time of the day and date information is lost

The maximum battery charge of the ABBI device is about 300 mAh. The battery can be recharged through a standard USB port (Type-A/Micro-B cable adapter similar to the adapter used on many cell phones). A blue led signals the connection to a powered USB port. A red LED turns on while the battery is charging and it turns off when the battery is fully charged. The full recharge cycle requires from 2 to 4 hours.

The energy consumption depends on the use of the ABBI device. In the AWAKE mode, the power consumption is about 15 mAh + 8 mAh if the ABBI device is advertising and/or connected through the Bluetooth link + 10-100 mAh depending on the audio signal. The power consumption is heavily affected by the characteristics of the audio signal. Producing intermittent sounds and lowering the volume can improve considerably the autonomy of the device. In the STAND-BY or ASLEEP mode, it is necessary to recharge every 2-3 days to avoid that it completely turns off.

## Firmware update

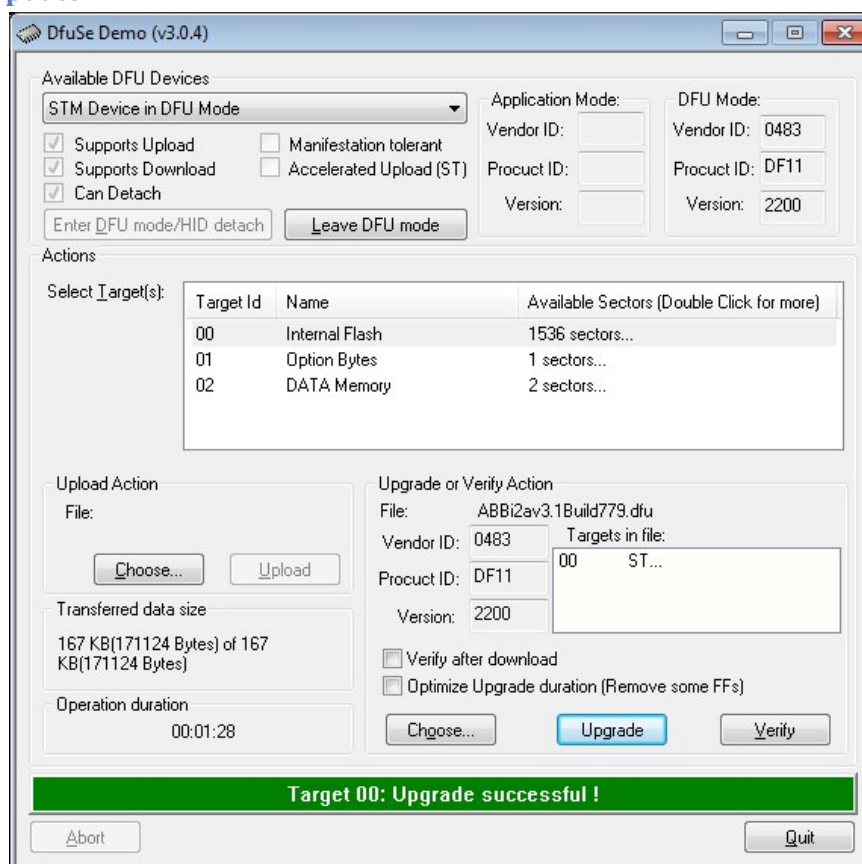


Figure. Firmware Update program

To update the firmware, it is necessary to install the ST DfuSeDemo program from STM electronics (<http://www.st.com/en/development-tools/stsw-stm32080.html>). The firmware update consists in one .dfu file which can be loaded via the USB port. To that end, it is necessary to put the ABBI device in dfu mode with the [File Manager](#) or [Abbi3Gui](#) applications. The procedure is the following:

- 1) Connect the ABBI device with micro USB cable to the PC
- 2) Put the ABBI device in dfu mode:
  - a. procedure with [File Manager](#) program:
    - i. Select Maintenance tab

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- 
- ii. Check dfu
      - iii. Close connection
    - b. procedure with [Abbi3Gui](#) program:
      - i. Connect to the ABBI device
      - ii. Select the System Panel
      - iii. Check prepare for DFU (this will automatically disconnect ABBI)
  - 3) Launch DfuSeDemo program,
    - a. Make sure that the text “STM Device in DFU Mode” should appear in “Available DFU Devices” box.
    - b. In “DFU Mode” box, set the following parameters if necessary
      - i. Vendor ID: 0483
      - ii. Product ID: DF11
      - iii. Version: 2200
  - 4) In “Actions box”, select / highlight “Target: Internal Flash”
  - 5) In “Upgrade or Verify Action” box
    - a. Click Choose... to elect DFU file with
    - b. Check Verify after download
  - 6) Click Upgrade button. Confirm the action if necessary and wait until upgrade successful message (about 30 seconds). The update process should go through Erase, Upgrade and Verify phase.
  - 7) Press Leave DFU Mode. The device should reboot. If you have quitted or closed the application, you need to unplug and plug the USB cable to reboot.

## 2.5. Troubleshooting

There are several actions that can be taken to fix eventual problems with ABBI.

### How to reset all configuration parameters to factory

By default, any change to configurations parameter are saved in the EEPROM when ABBI goes to sleep and used again during the boot process and/or when ABBI wakes up. If these parameters have been corrupted for any reason, it is possible to restore their default hard-coded values with the [File Manager](#) or [Abbi3Gui](#) applications:

- [File Manager](#) program: see Maintenance tab.
- [Abbi3Gui](#) program: This application gives a fine-grained control of the databases. It is possible to reset specific databases or configuration parameter to the default hard coded values.

### How to do a software reset

There are several ways to do a software reset if the ABBI device is stuck for some reason. . Note that it makes sense to try the different methods to do a software reset if one does not work as they executed by different tasks of ABBI firmware.

- a. Push the button for 5 seconds.
- b. Use the [Abbi3Gui](#) program (see System Service panel)
- c. Use the [File Manager](#) program (see Maintenance tab)

After a software reset, it is necessary to plug in the USB connector to restart the ABBI device. Note that a software reset will not reset ABBI parameters to default factory values.

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### How to do a hardware reset

Open the ABBI device, disconnect and reconnect the battery. After a software reset, it is necessary to plug in the USB connector to restart the ABBI device. Note that the date & time will be lost. Hardware reset will not reset ABBI parameters to default factory values.

### Issue: ABBI stops communicating with a smartphone or windows application

- Check your application to make sure that the ABBI device is still connected.
- If you are not sure if ABBI is still connected, connect the ABBI device with the USB and try to connect from another machine. If ABBI is still connected to the non-responding application, you should not be able to connect from another machine.
- If ABBI was disconnected, reconnect. Note that there are multiple reasons why ABBI could disconnect such as the distance between the two devices is too large, interferences, etc.). If ABBI is still connected but not responding, then the problem might be either related to the application or to ABBI. You can try the following steps:
  - 1) Kill the application to force a disconnection and reconnect
  - 2) Force disconnection on ABBI side with a software reset (see [How to do a software reset](#)).

### Issue: ABBI the device does not make sound when moved.

- 1) Make sure that the yellow light is not on. If the yellow light is on, unmute with the button or some application.
- 2) If the yellow light is not on, make sure the device battery is loaded. Connect the ABBI device to the a USB port with the micro USB cable.
- 3) If the battery is loaded and the light not on, make sure the device is configured in movement-triggered mode. To do that, you can use [Abbi3Gui](#) program / Audio Panel.

### Issue: Difficulty to connect to smartphone or PC.

Make sure that the ABBI device is advertising (see [Bluetooth connection](#) section). To see if the ABBI device is advertising independently from any ABBI app or program, you can install any Bluetooth app that scan for Bluetooth device (many are available on Google Play Store for example).

### Issue: Yellow light is on.

Yellow led is normally on when the device is muted. Pushing the button should normally unmute the device. If the yellow light does not go off when pushing the button, the light might indicate:

- 1) a problem with completing the audio buffer in time, which could be at the origin of a distorted sound.
- 2) an EEPROM operations in progress (e.g., formatting and compacting memory after firmware update). Wait until the operation is completed.
- 3) a firmware error (e.g. stack memory overflow). In this case, the ABBI will not advertise when connected to USB and software reset is not effective. A hardware is needed in this case (see [How to do a hardware reset](#)).

### Issues: Yellow light off, ABBI device does not respond to anything.

Charge the battery by connecting the ABBI device to the USB connector. While the ABBI device is charging, the ABBI device should be advertising and you should be able to connect to with [Abbi3Gui](#) for example.



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## 3. Abbi3Gui

*Abbi3Gui provides a GUI to control ABBI device at low-level, which can possibly results in a non-functioning ABBI if misused. This program was not designed to be user-friendly or safe.*

### 3.1. Requirements

ABBI3GUI is PC application to control the ABBI device via the Bluetooth Low-Energy (BLE). The application works with Windows XP and above on a PC equipped with a Bluetooth LE USB dongle from BlueGiga (BLED112).

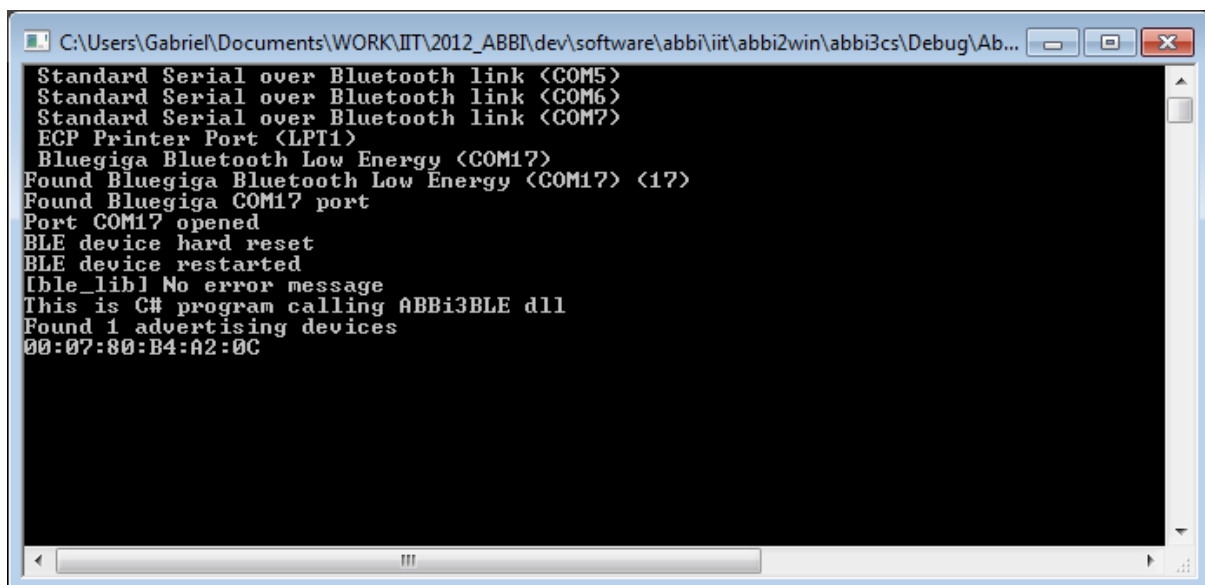
The application is compatible with ABBI firmware versions 3.3x and above. Some features are disabled for firmware versions under 3.3x.

### 3.2. Installation

An MSI installer is provided to install both FileManager and Abbi3Gui.

### 3.3. Console

When executing, a console provides additional information to the user. The console is mostly used for troubleshooting.

A screenshot of a Windows console window titled "C:\Users\Gabrie\Documents\WORK\IIT\2012\_ABB\dev\software\abbi\iit\abbi2win\abbi3cs\Debug\Ab...". The console displays the following text:

```
Standard Serial over Bluetooth link <COM5>
Standard Serial over Bluetooth link <COM6>
Standard Serial over Bluetooth link <COM7>
ECP Printer Port <LPT1>
Bluegiga Bluetooth Low Energy <COM17>
Found Bluegiga Bluetooth Low Energy <COM17> <17>
Found Bluegiga COM17 port
Port COM17 opened
BLE device hard reset
BLE device restarted
[ble_lib] No error message
This is C# program calling ABBi3BLE dll
Found 1 advertising devices
00:07:80:B4:A2:0C
```

Figure. ABBI3Gui Console. Note the message indicating the Bluegiga Bluetooth port has been found.

### 3.4. Abbi3Gui Main Window

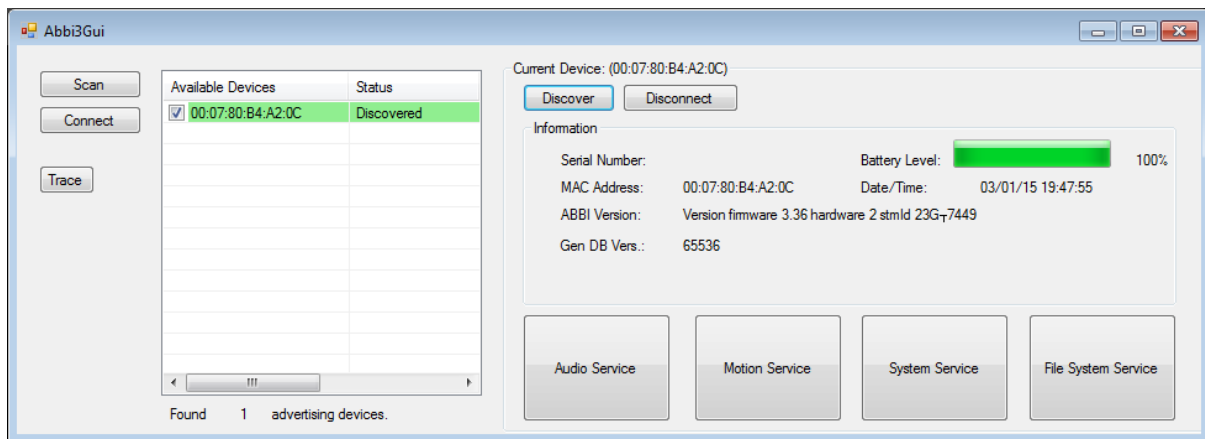


Figure. Abbi3Gui main window after connection and discovery of an ABBI device.

ABBI3Gui Main Window allows the user to connect to one or more ABBI devices. Once is it connected, it provides basic information about the ABBI device states

- **Serial Number:** Serial Number (SN) of the ABBI and firmware version. ABBI2-0032 indicates the SN stored in the EEPROM of the ABBI device. It should correspond to the number printer on the sticker on the circuit and on ABBI enclosure.
- **Mac Address:** Bluetooth Mac Address (unique for each BLE module of the ABBI device)
- **ABBI Version:** ABBI microprocessor unique ID
- **Battery level:** The battery level is automatically updated every 5 sec.
- **Date/Time:** Data and time of the Real-Time Clock (RTC) of the ABBI device. Date and time can be set in the system service.
- **Gen DB Version:** (undefined)

The large buttons provides access to ABBI device main service:

- **Audio service:** configuration and control of audio functions
- **Motion service:** configuration and control of motion sensing functions
- **System service:** control of sound (.wav) files and log files
- **File service:** control of sound (.wav) files and log files.

The **trace button** is for troubleshooting. If enabled, the bytes sent and received to and from the ABBI device will be displayed on the console.

#### Connection

In order to connect, make sure that

1. the BlueGiga port has been found when starting the application (see Console)
2. There is an ABBI device advertising, which can be done by
  - a. connecting the ABBI device to micro USB port (advertising is automatically activated when the ABBI device is plugged in the USB port)
  - b. shaking the device (advertising will stop after 20 seconds)
  - c. clicking on the ABBI device button twice (advertising will stop after 20 seconds).

The following steps need to be completed in Abbi3Gui to connect an ABBI device:

1. **Scanning:** Use the Scan button to start and stop scanning to find advertising ABBI devices. Advertising devices are displayed after scanning has been stopped.
2. **Connection:** Select a device using the check box and click the connect button. Status should indicate connected.
3. **Discovery:** Select an ABBI device by clicking on it and click on the discover button. Discovery is necessary to read all ABBI parameters. It takes several seconds to be completed.

### 3.5. ABBI Audio Service

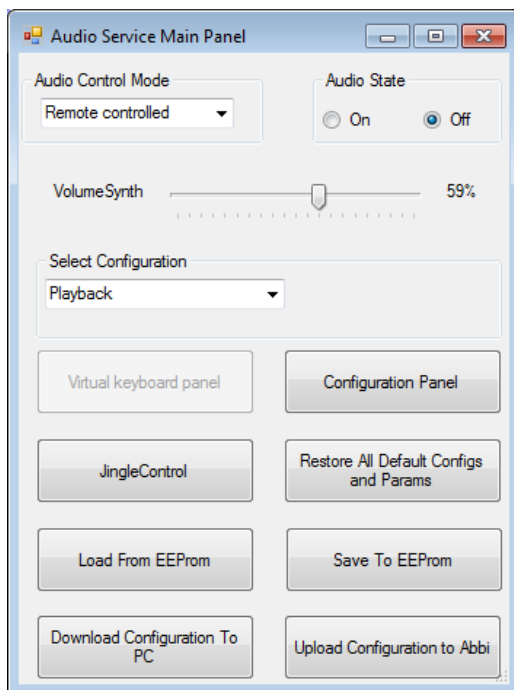


Figure. ABBI Audio service main panel.

The ABBI device has a sophisticated control of its sound capacities. The Audio Service Main Panel provide control of audio basic functions:

- **Audio Control Mode**
  - Remote controlled: application must start/stop the audio
  - Movement triggered: movement start/stops audio automatically
- **Audio State**
  - Start/stop audio in remote controlled mode
  - Mute/unmute audio in movement triggered model
- **Volume Synthesizer:** Sound volume
- **Current audio configuration:** The menu can be used to selected current audio configuration from a list of seven audio configuration, which stored in ABBI. These configurations are divided into three groups:
  - **Interactive:** the interactive configuration enable to control ABBI with a simple MIDI-like interface. It must be selected to enable the virtual keyboard panel (see below).

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- Interactive **standard audio configurations**: the user can fully configure the standard audio configurations via the Synth. Configuration Panel. The only difference between the four standard configuration is the default hard-coded values.
    - Continuous
    - Intermittent
    - Playback
    - User
  - **Movement sonification**:
    - Sonification Angular Velocity
    - Sonification Angular Velocity 3

Panel buttons:

- **Restore All default Configuration and Parameters**: Restore *hard-coded default values* for the audio service.
- **Load from EEPROM**: Load parameters of current configuration from EEPROM
- **Save to EEPROM**: Save parameters of current configuration to EEPROM
- **Download Configuration to PC**: Download parameters of current configuration in an audio configuration file on the PC.
- **Upload Configuration from PC**: Upload parameters of current configuration from an audio configuration file on the PC.

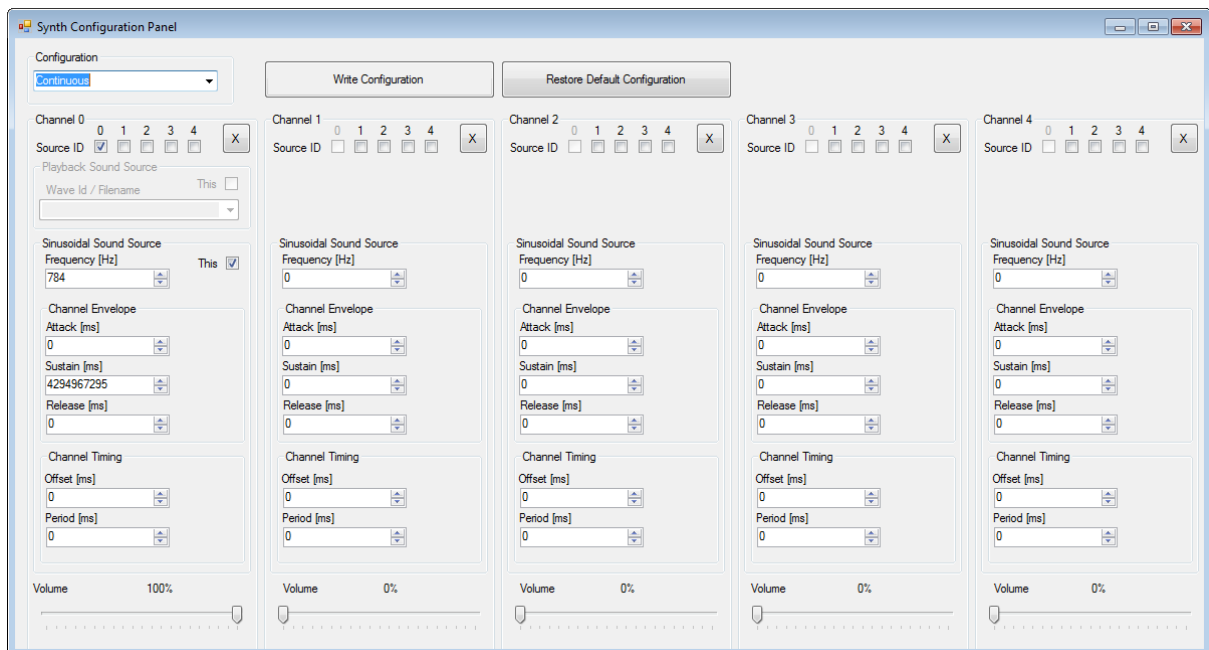
Notes:

- The current values of audio configurations are automatically saved in EEPROM when the device goes into ASLEEP state.
- The audio configuration files are in binary format (see XXXX document for more information) and contain all parameters of the corresponding audio configuration. In particular, movement sonification audio configuration parameters can be changed by editing the corresponding files.
- The interactive configuration does not have parameters.

Additional panels provide access more advanced functions

- **Virtual Keyboard panel**: Enabled only if Interaction Configuration is selected
- **Synth. configuration panel**: configure standard audio configuration
- **Jingle Control panel**: configure jingles

## Synth configuration panel



The synth configuration panel can be used to configure standard audio configurations. Each configuration can define up to five channels (the maximum number of ABBI synthesizer).

**Configuration:** Select audio configuration to be configured. Must be a standard audio configuration

**Channel parameters:**

- Sound sources: The first channel can be either a playback channel (playing a wave file) or a sinewave channel. The other channel must be sinewave channels.
- Channel Envelope: The envelope parameters include Attack (A), Sustain (S) and Release (R) parameters.
- Channel Timing. Parameter to produce a periodic sound (the period must be larger than the duration of the sound defined by ASR parameters).
- Volume: channel volume.

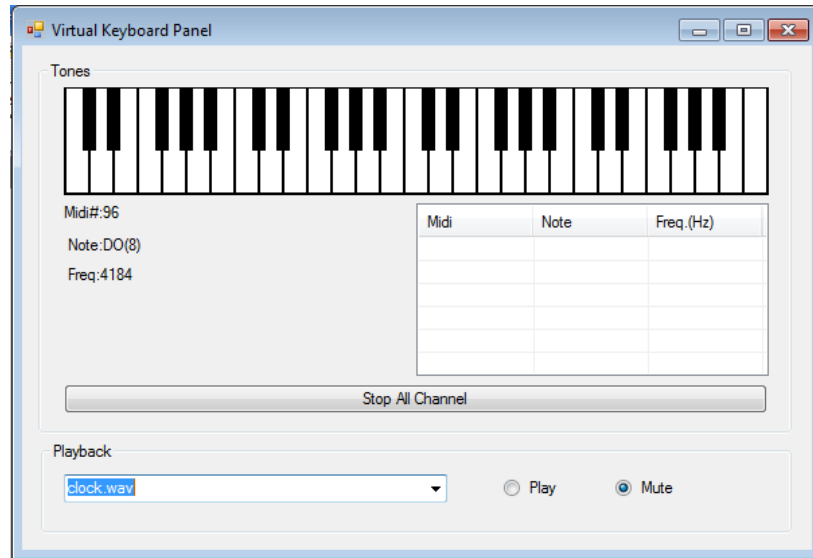
**Adding/removing a channel:**

- Remove a channel: X button
- Add a channel: adding a channel is obtained by selecting a source Id and fully configuration the channel parameters (ASR, timing, volume).
- To hear the effect of adding/removing channels on the current configuration, it is necessary to reselect the current configuration in the main audio panel after writing the configuration.

**Write configuration:** Send commands corresponding to the parameters in the panel to the ABBI device. If selected configuration corresponds to the current configuration in the main menu and the audio is one, writing the configuration will immediately affect the sound produced by *existing* channels. To add a new channel, it is necessary to reselect the current audio configuration in the main menu.

**Restore default configuration:** Restore hard-coded configuration

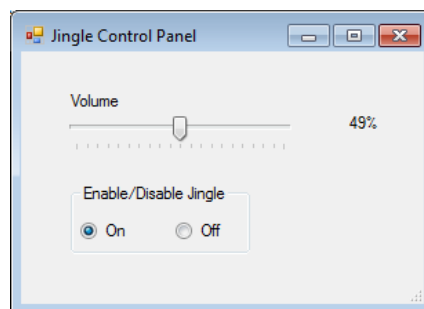
## Virtual keyboard panel



The virtual keyboard panel can be accessed only if the interactive configuration in the main audio menu has been selected.

The keyboard can be used to start playing up to five notes simultaneously. The user needs to click on the note in the table to stop it. Alternatively, the Playback menu can be used to select and start playing an audio file.

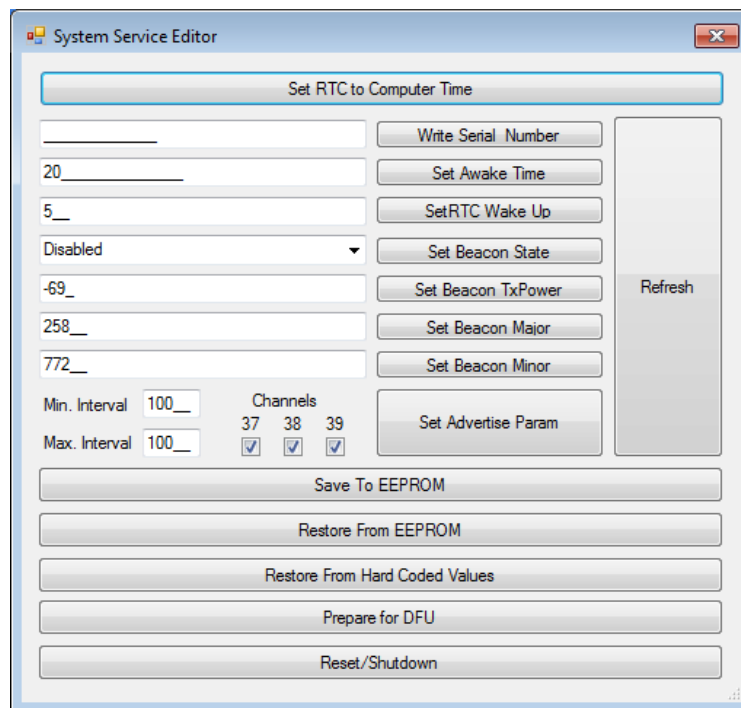
## Jingle control panel



This panel allows to enable/disable jingles and to control their volume.

### 3.6. ABBI System Service

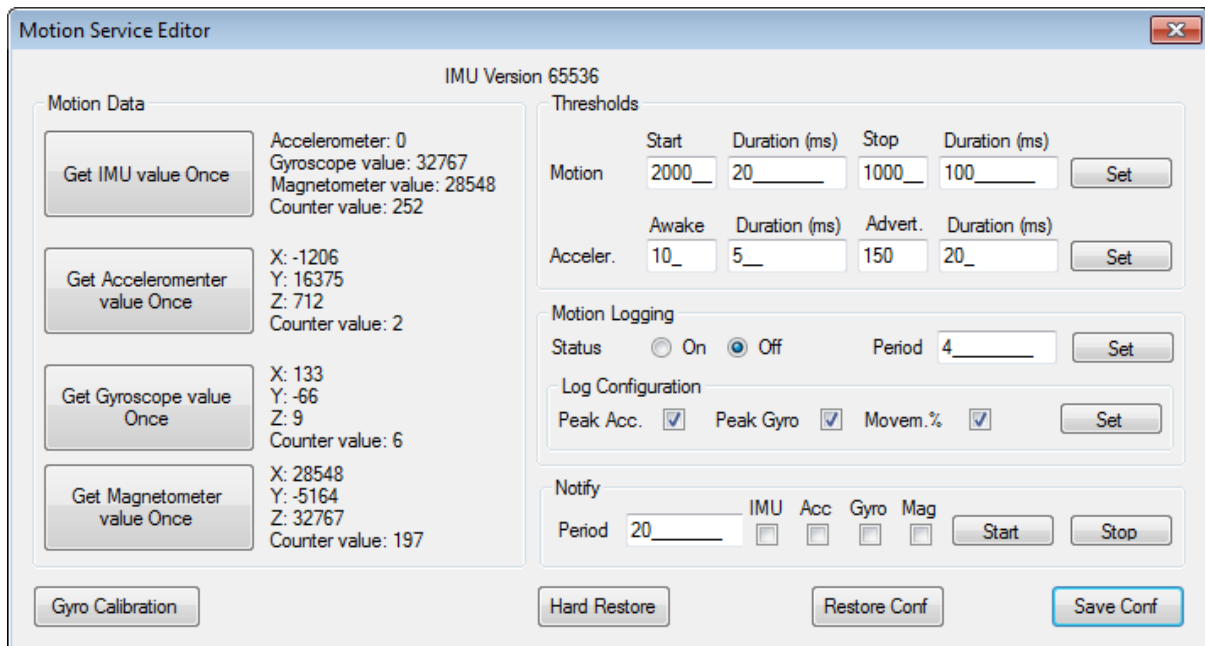
ABBI System service manages parameters and functions related to identification and connection with the ABBI device as well as system functions such as firmware update or shutdown.



- **Set RTC to Computer Time:** Set RTC time displayed in main window
- **Write Serial Number:** set serial number displayed in main window
- **Set Awake Time:** delay after the end of a movement before transitioning to STANDBY state
- **SetRTC wake up:** frequency of RTC callback checking battery state in STANDBY and ASLEEP state.
- **Beacon parameters:**
  - Beacon state:
    - Disabled: no Beacon message
    - Enabled: Beacon messages are when ABBI is in AWAKE state. Transition into STAND-BY states occurs normally.
    - Persistent: Beacon messages are sent and transition to STAND-BY state is prevented.
  - Tx Power: RSSI signal at one meter distance. This needs to be adjusted to get correct distance estimate.
  - Beacon Major, Beacon Minor
- **Advertisement parameters**
  - Min. Interval, Max Interval, Channels
- **Database management:**
  - Restore from EEPROM, save to EEPROM
  - Restore hard-coded values
- **Prepare for DFU:** Prepare firmware upload
- **Reset/shutdown:** Reset and shutdown ABBI device. The device needs to be connected to USB plug to start device.

### 3.7. ABBI Motion service panel

The ABBI motion service manage parameters and functions related to the 9-axis Inertial Motion Unit (IMU).



- Motion data:
  - Get IMU, Accelerometer, Gyroscope and Magnetometer Once buttons: get current MEMS values.
  - The counter values (max 256) is automatically incremented by the ABBI device each time the MEMS values are internally updated (internal update frequency).
- Thresholds
  - Motion: Parameters of the algorithm used to trigger audio when the ABBI device is moved.
    - Start threshold: 2000 (default)
      - Duration: 20 ms (default)
    - Stop threshold: 1000 (default)
      - Duration: 100 ms (default)
  - Awake: Parameters used to trigger transition from STAND-BY to AWAK state.
    - Threshold value: 10, Duration: 5
  - Advertising: Parameter used to start advertising (“shake” movement)
    - Threshold Value : 150, Duration: 20 ms (default)
- Motion Logging: Store statistics about the motion of the ABBI device in the motion log.
  - Status: On/Off
  - Period: logging period (sec)
  - Data to be store for each record: Peel acceleration, peel rotational velocity, Percentage of the record duration where movement was detected.



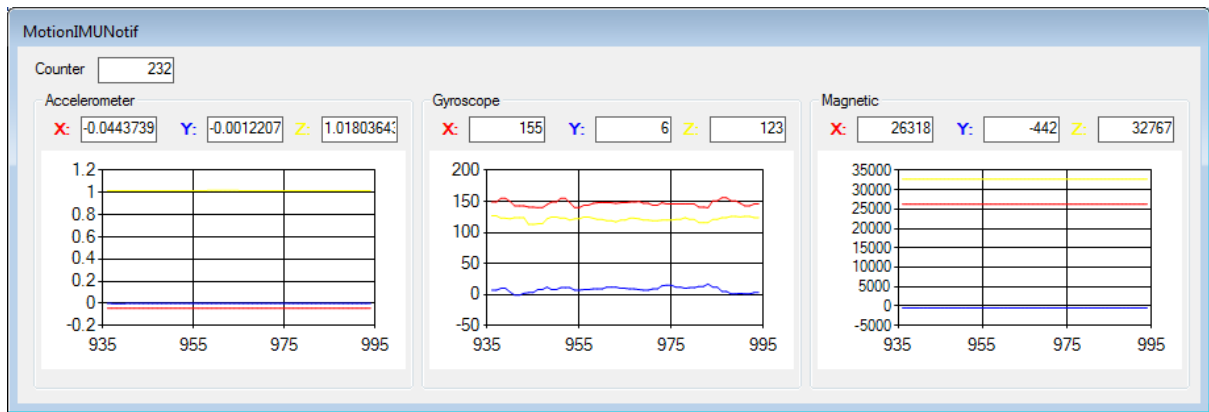


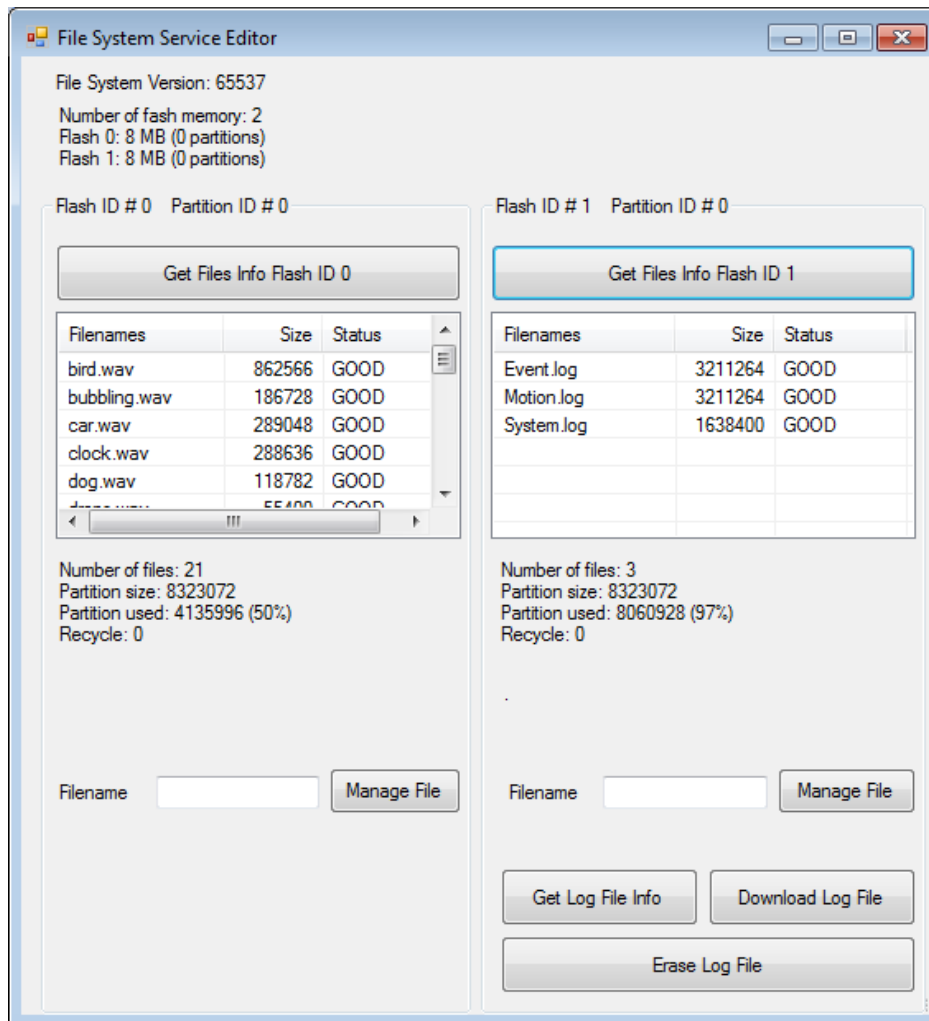
Figure. ABBI motion sensing pane.

- **Notify:** control motion data notification. When enabled, the motion data are displayed in a window (see above figure).
  - Notification period: minimum notification period is 10 ms (~100 Hz)
  - Select motion data: IMU, Acc., Gyro, Mag.
  - Start/Stop button:
  
- **Gyro Calibration.** Compute and remove offset from the gyro. The ABBI device should not be moved during calibration (approximately 5 sec)
  
- **Database management:**
  - Hard Restore: restore hard-coded values
  - Restore Conf: restore parameters from EEPROM
  - Save Conf: save parameters in EEPROM

### 3.8. ABBI File service

ABBI File services manages files stored in the two Flash memories. Each Flash memory contains a small file system with a directory. Flash 0 is used to store audio files (.wav) while Flash 1 is used to store log files.

More flexible advanced functions are available in the File Manager application and USB virtual serial port.



- **Get Files Info Flash ID button:** Read file directory information of the corresponding files
- **Manage File:** Delete/undelete file. Note that that files are not really erased but the file is indicated as deleted in in the directory. When undeleting, a new entry is created in the directory
- **Get log File info:** Get information about the number of records stored and free space in the log files.
- **Download log file:** download a log file on the PC. Note that faster download can be achieved via the USB link.
- **Erase log file:** Erase selected log file. Note that the log file is not removed from the directory structure. Only its content is erased.

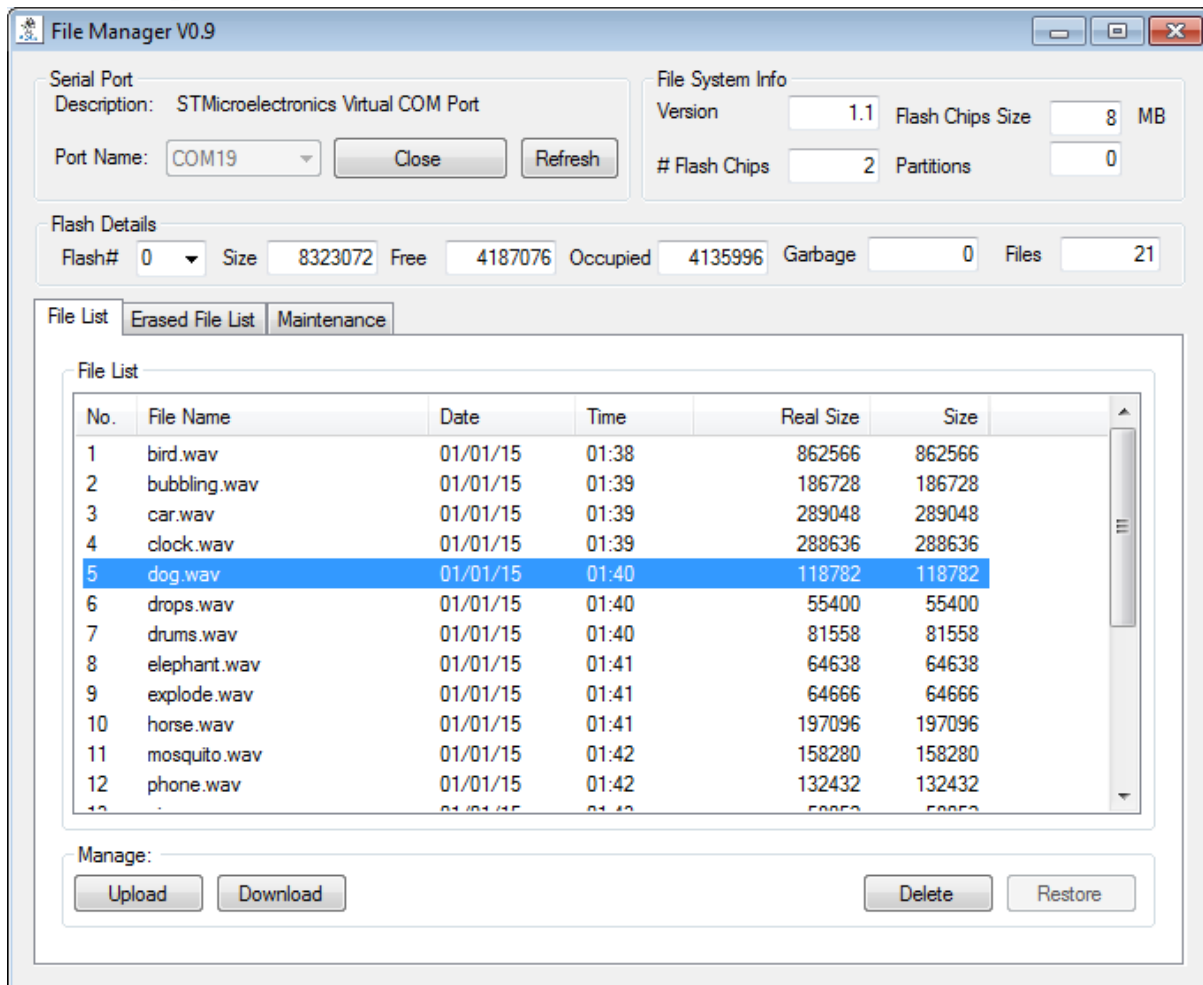
## 4. File Manager

The file Manager application manages files in the two flash memories of the ABBI device.

### 4.1. Installation

An MSI installer file is provided to install both Abbi3Gui and FileManager; to connect a virtual COM port driver is need see” <http://www.st.com/en/development-tools/stsw-stm32102.html>” and download driver (registration required)

### 4.2. Main panel



### Connection

To use the File Manager application it is necessary to connect the ABBI device to the PC with a USB cable. Once it is connected, it is necessary to select STMicroelectronic Virtual COM port.

#### Serial Port information

- **Port Name:** name of the serial port
- **Refresh:** Update serial port information.
- **Open/Close:** Open and close serial port connection with the ABBI device

#### Flash information

- **Flash#:** select flash number (0 or 1).

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## Tabs

The main panel contain three tabs to manage:

- **File List:** list of valid files
- **Deleted File List:** List of deleted file. Note that these files are not actually erased from the Flash but their entry in the file directory structure has been marked as deleted.
- **Maintenance:** special maintenance functions

### 4.3. Audio Files

When Flash 0 is select, the File List panel shows all audio files in the Flash memory. The following operations are possible

- **Upload:** upload a file from the PC
- **Download:** download file to the PC
- **Delete:** mark file as deleted in the file directory structure
- **Restore:** create a new entry for a deleted file in the file directory structure (enabled if the deleted file list tab has been selected)

Note that it is not possible to actually erase an audio file but only to mark its entry in the directory structure as deleted. It is possible to erase the whole flash (see Maintenance tab).

### 4.4. Log files

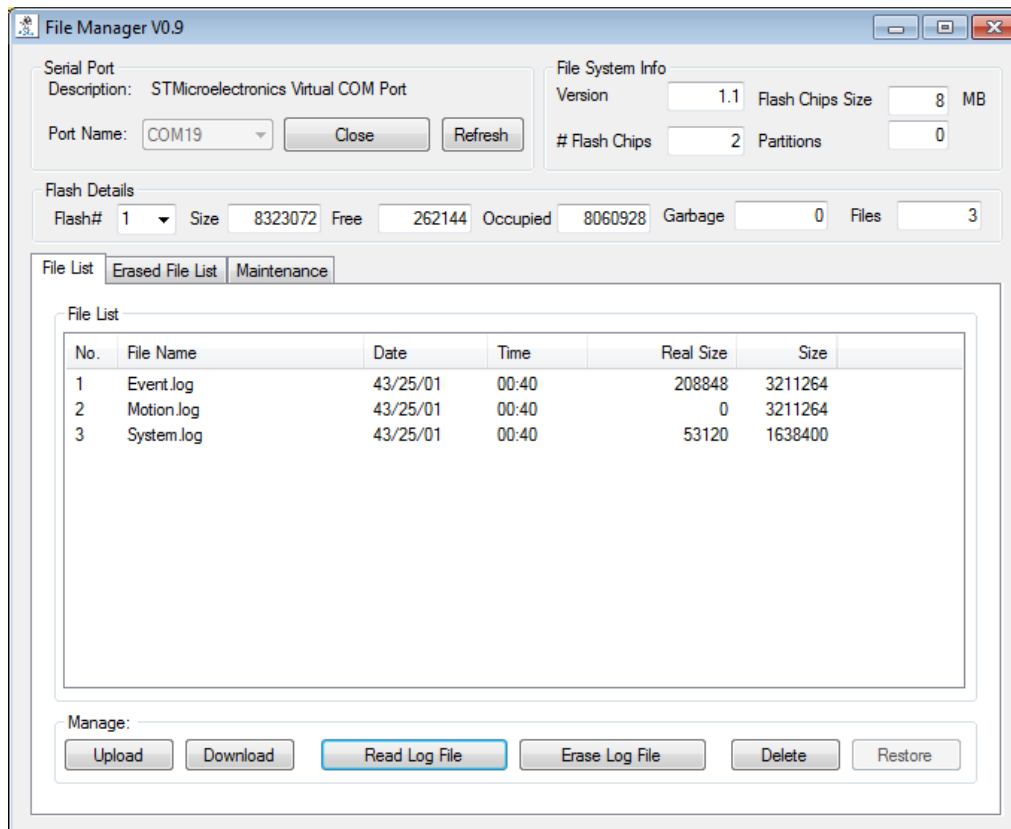


Figure. List of Log files in Flash #1.

When Flash 1 containing log files is selected, to additional buttons are present:

- **Read Log file:** Downloaded log file in a window in text format (see Log File Viewer window).
- **Erase Log file:** Erase the content of a log file.

For log files, the real size can differ from the file size. File size refers to the maximum size of the log files while real size refers to the actual size, which depends on how many records have been stored in the file.

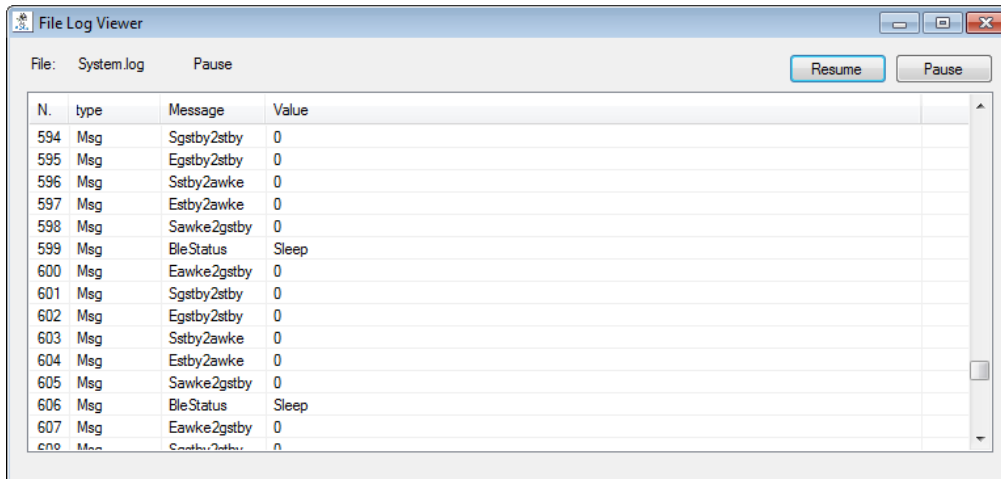
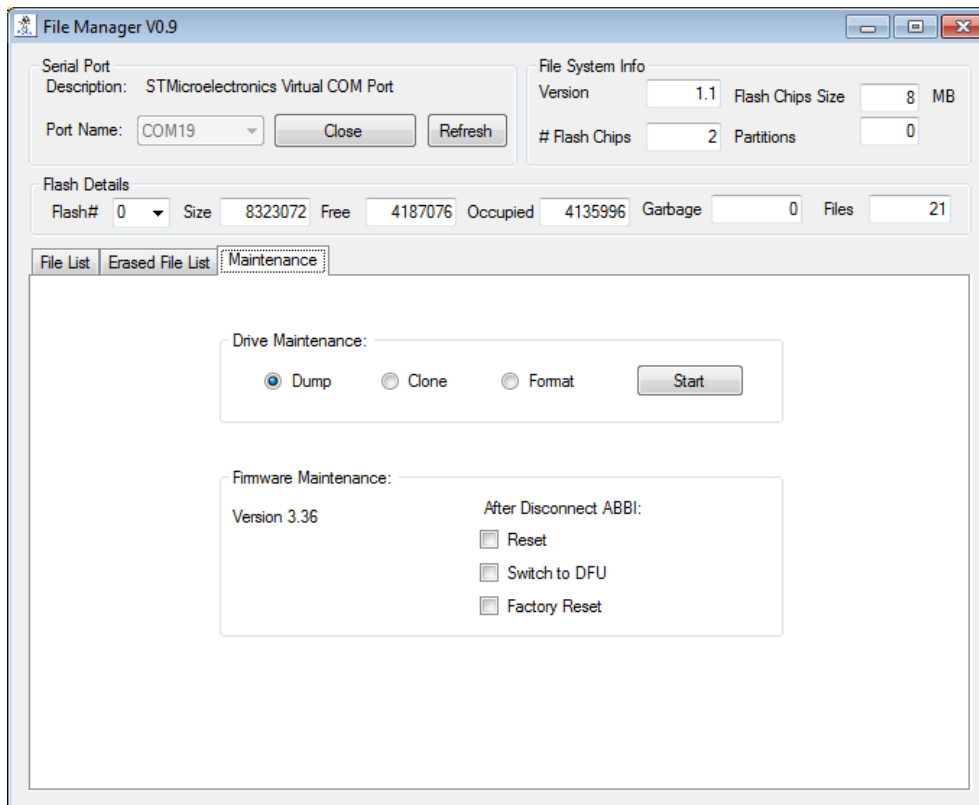


Figure. Log file Viewer window

It is possible to select the content of the Log File View (Ctrl+A, Ctrl+C) and copy it to an Excel worksheet (Ctrl-V).

## 4.5. Maintenance



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### Drive Maintenance:

- **Dump:** dump whole flash content to PC
- **Clone:** upload whole flash content from PC
- **Format:** erase and reformat flash.
  - For Flash #1, this will recreate the log files.

### Firmware Maintenance:

- **Reset:** Reset ABBI device.
- **Switch to DFU:** Prepare ABBI device to update firmware
- **Factory reset:** Reset all configuration parameters (databases) to their default hard-coded values.

Reset and Switch to DFU operation occurs when closing the connection<sup>1</sup>

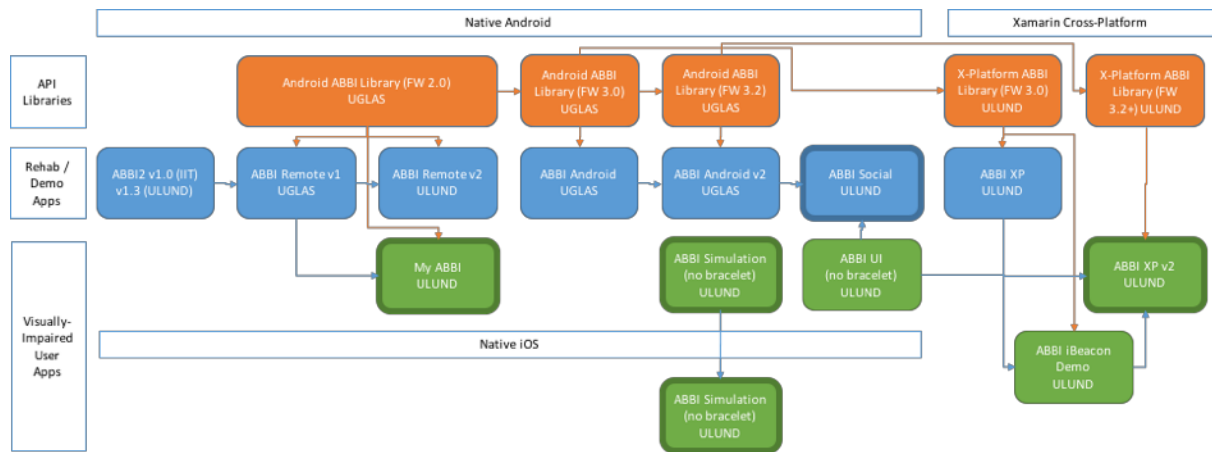
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<sup>1</sup> The label of the Close button changes to indicate the action to be performed when closing the connection.

## 5. Smartphone applications

### 5.1. Overview

There has been multiple ABBI smartphone applications (apps) developed for the Android smartphone platform. ABBI apps are supported for all android smartphones with android 4.3 or above. ABBI apps have been used mainly for mobility and spatial rehabilitation studies at Chiossone and IIT. The requirements for the ABBI control app when being used by the rehabilitator and when being used by the children are different. The rehabilitator needs to be able to remotely turn on and off the sound coming from ABBI without having to look at the phone. Therefore, a large start/stop button is needed. Moreover, other "advanced" functions that are not expected to be used much need to be hidden so they are not easily accessible from the main screen. However, blind and low-vision children have different requirements for an ABBI control app. For these users, is very important that the app is screen-reader compatible and always shows the current state of sound parameters.



The figure above shows the development overview of ABBI smartphone applications. Firmware dependent APIs are orange, rehabilitation or demo apps are blue, and apps with focus for usage by Visually-impaired persons are green. Apps with thicker frames are available on the App Store or Google Play. Some of the apps are designed to simulate ABBI and do not connect to the ABBI bracelet. Some apps were developed natively for Android smartphones or iOS smartphones, while other apps are cross-platform (Android and iOS). Orange arrows represent usage of the library in an app, while blue arrows represent that the app was derived or some elements were taken from another app. The order of the boxes does not correspond to the chronological order of development.

The final apps are:

- First ABBI2 series with firmware version 2.0 (old ABBI GATT services)
  - **ABBI Remove v2.0** or **My ABBI** apps providing basic control of an ABBI device
- Second and third ABBI2a and ABBI3 series with firmware version 3.3x (new ABBI GATT services)
  - **ABBI XP**. Multi-platform app providing advanced control of an ABBI device for a visually-impaired individual
  - **ABBI Social**. App to configure multiple ABBI for various ABBI-based children games.
- **ABBI Simulation**. App simulating some function of the ABBI device on a smartphone

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## 5.2. ABBI Remote and My ABBI (for FW 2.0)

In the fall of 2015, ULUND developed two different apps: ABBI Remote v2.0 – For usage by experimenters and My ABBI – For usage by visual impaired users. The new apps are based on the ABBI Remote v1 demo app (UGLAS), and are based on requirements expressed by the trainers at Chiossone and the technical team. These apps used the Android Library developed by UGLAS.

### Installation

ABBI Remote and My ABBI apps are available in the owncloud repository “WP3/Distrib/AndroidApps/”. To install follow these steps:

1. download the “ABBI\_Remote.apk” or “My\_ABBI.apk” from the owncloud repository “WP3/Distrib/AndroidApps/”
1. Transfer the file to your android device using USB connection
2. Open the apk file from your device

Additionally, one can instal the “My ABBI” app directly from google play:

<https://play.google.com/store/apps/details?id=com.lth.certec.abbi2>

### Usage

ABBI Remote and My ABBI apps allows the user to check the battery level, mute the speaker, adjust the sound volume and change the sound type of the bracelet. It also allows the user to modify some sound parameters such as pitch, beats per minute or change the sound-file to playback when moving the ABBI bracelet.

In contrast with the ABBI2 app, A different app is targeted by rehabilitators (ABBI Remote 2.0) and by Visually impaired users (My ABBI). The main difference is on the main screen. Where ABBI Remote has a large ON/OFF button to remotely control the sound of ABBI. Choosing the type of sound can be done from the options menu in the upper right corner. The My ABBI app does not allow to remotely control the sound of ABBI, instead the ABBI sound will be triggered by moving the bracelet. One can still mute and unmute ABBI so it does not sound when moved. The type of sound (Intermittent or Playback) can be changed from the main screen.





Figure 1. New ABBI control apps. Left: main screen in the experimenter app (ABBI Remote v2). Right: main screen of the user app (My ABBI)

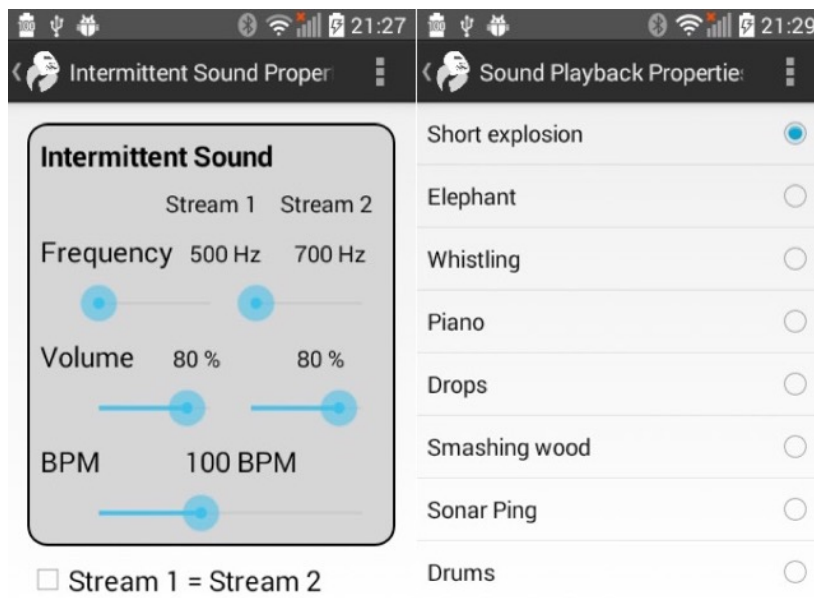


Figure 2. My ABBI Intermittent sound properties (left) and sound playback file selection (right) activities

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### 5.3. ABBI XP (Visually Impaired User App)

Based on the ABBI UI app and using the new cross-platform ABBI PCL ported from the Android ABBI Library, another cross-platform app was developed for iOS and Android.

#### Installation

The ABBI XP app for Android is available in the owncloud repository “WP3/Distrib/AndroidApps/”. To install follow these steps:

2. download the “ABBI\_xp.apk” from the owncloud repository “WP3/Distrib/AndroidApps/”
3. Transfer the file to your android device using USB connection
4. Open the apk file from your device

The ABBI XP app for iOS is available in the App store:

<https://itunes.apple.com/us/app/abbi/id1197920082?mt=8>

Note that the Android app has some problems with Bluetooth connection. Is recommended to use the iOS app. The screenshots below are taken from the iOS app, but the functionality for Android and iOS apps are exactly the same.

#### Usage

Some Elements of ABBI UI and ABBI Social have been ported to ABBI XP. However ABBI are not automatically connected when discovered. Instead: ABBI not in range appear grayed out. Selected/Connected ABBI will have a green checkmark. Available ABBI are marked with a letter “A”.

- If the ABBI you are looking for does not appear in the list. Shake the ABBI to make it advertise, then start a new scan by tapping on the “Start Scan” button or pull down the list to refresh it.
- Tap available ABBI to connect or disconnect to them. If the ABBI has not been paired a popup window will ask you to give the ABBI a name. One can connect to up to 8 ABBI at the same time.
- Tap on the “X” symbol to forget an ABBI and remove it from the list. If you want to connect again to that ABBI you will need to Start a new scan and rediscover give it a name again.
- Once you have selected (green checkmark) click the “Control ABBI” button to proceed.

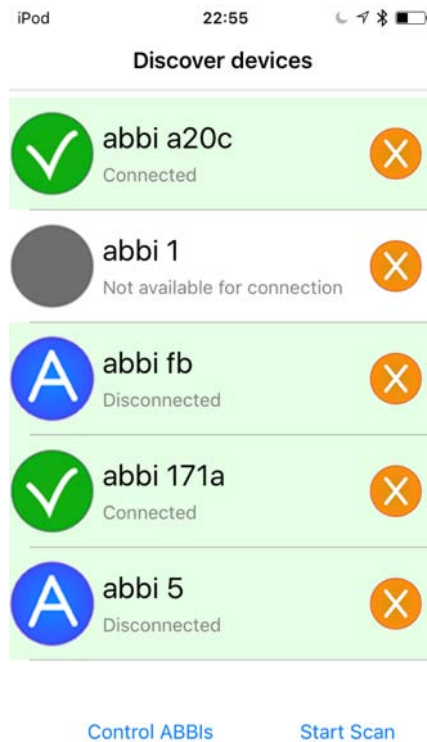


Figure 3. ABBI Discovery screen – On this screen one can scan for ABBIs and select them from the list to connect to them.

The next step is to configure or control all selected ABBIs. At the top of the screen a list of selected ABBIs will appear showing the name and battery status. Below the list, one can find simple controls that will modify the sound configuration of all connected ABBIs at the same time. We designed the views with few controls each to make it easier to handle for visually impaired persons. These controls are grouped into four categories, each category under a navigation “tab”. One can swype between tabs or navigate using the tab icons at the bottom of the screen.

- The Profiles tab allows you to load a specific sound configuration to all connected ABBIs. One can also create new profiles based on the sound configuration of a connected ABBI (Figure 19). All profiles have a name and a short description, to help identification when the number of profiles increase.
- The Volume tab allows one to modify the volume of connected ABBIs and also to mute or unmute them.
- The Sensitivity tab allows one to modify the threshold on how much you need to move the ABBI to make it respond.
- The Remote control tab is specially designed for the rehabilitation and allow remote control (turning ABBIs on or off without the need of moving them).

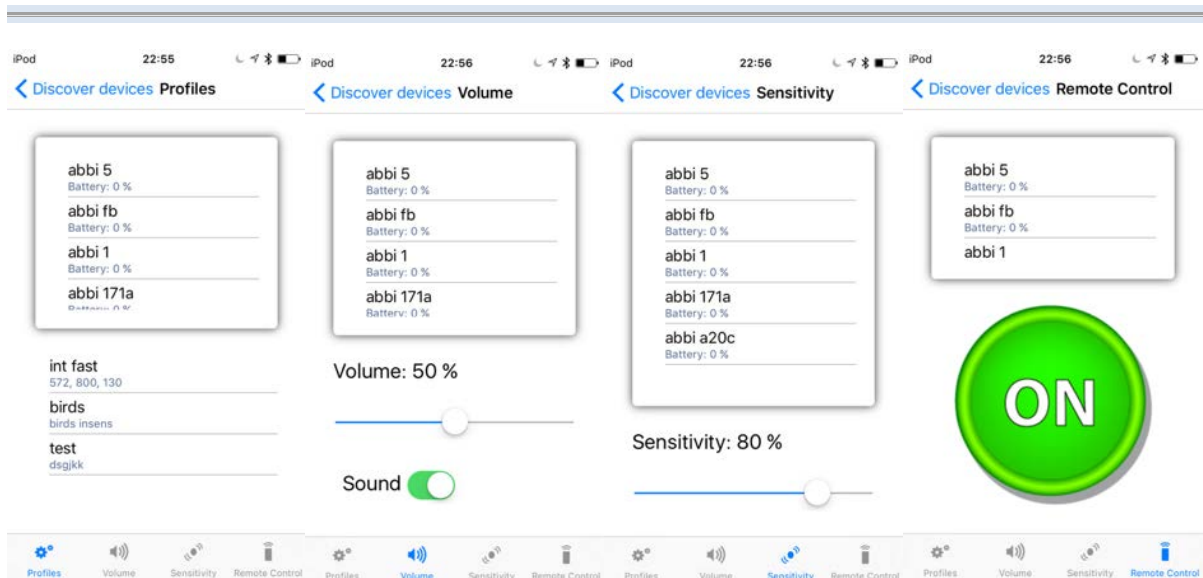


Figure 4. ABBI group control tabs: One can navigate between the four tabs in the bottom: Profiles, Volume, Sensitivity, Remote Control. Each tab contains different controls that will configure or control the group of selected ABBI.

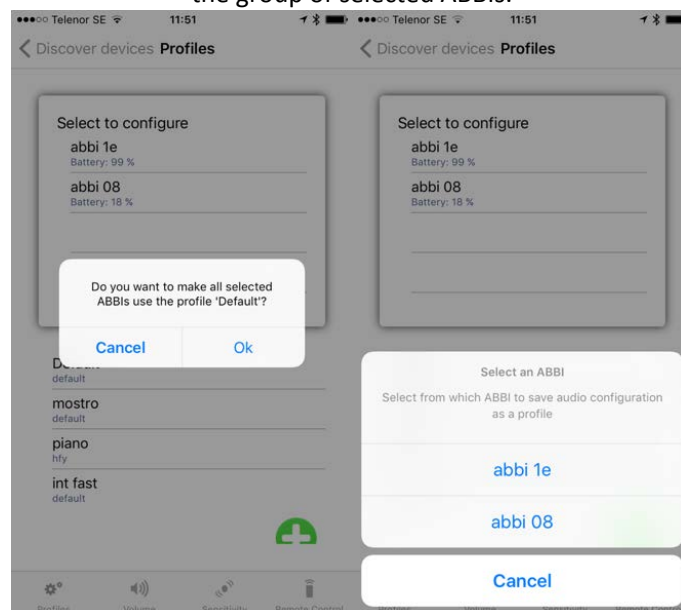


Figure 5. Loading a profile (sound configuration) to all connected ABBI (left). And creating a new profile based on the sound configuration of a connected ABBI (right).

Moreover, one can tap on any ABBI in the list to modify the sound configuration of that specific ABBI. The Sound Type (Continuous, Intermittent, Playback and Sonification) will change the type of sound that the ABBI bracelet emits. Certain sound types allow further configuration of parameters. Such as frequency of different audio channels and the rapidity of the intermittent sound (beats per minute) for continuous and intermittent audio modes, or different audio files for the playback audio mode. One can swype left or right on the screen to change between configuring the audio mode or the volume of the selected ABBI. One can also save the current configuration as a profile and give it a name and a description.

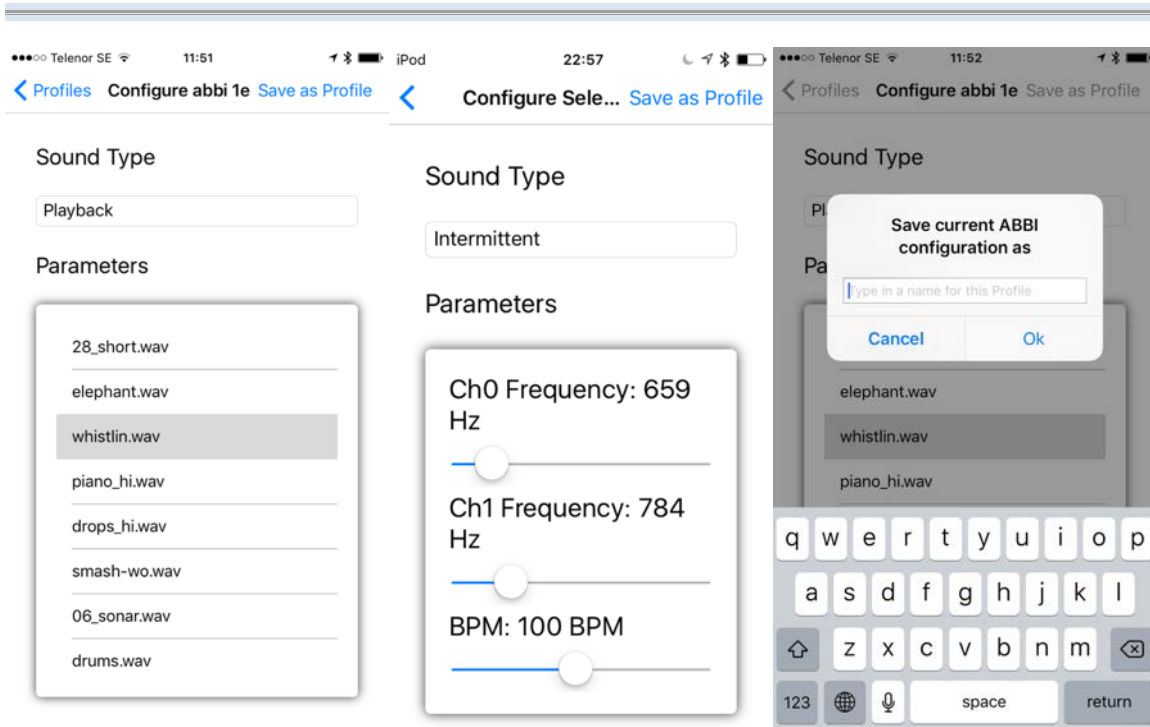


Figure 6. Configuring single ABBI from the list. Changing the sound type and sound type parameters (left and middle), and saving the current sound configuration as a profile (right).

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## 5.4. ABBI Social

The ABBI Social app was designed to be used for rehabilitation sessions at the Chiossone Institute for groups of children. The app consists of 11 preconfigured games with the possibility to add custom games or edit the existing ones. For each game, the app gives the possibility to choose quickly specific/preselected sound configurations adapted to the current exercise. Each game loads specific sound configurations to the connected ABBIs. Up to 8 ABBIs can be connected at the same time. The sound configurations for the connected ABBIs can be the same or different for each ABBI, depending on the game. The user interface for this app is based on the ABBI UI app.

### Installation

ABBI Social is available in Google Play

<https://play.google.com/store/apps/details?id=se.lth.certec.abbisocial>

### Available games

#### *Home base/Home plate (Casa base)*

All children are assigned to two groups, each group having a leader who chooses the preferred sound of ABBI. Both leaders turn on their ABBIs at the same time and the children have to localize and reach their leader by following the sound. The exercise ends when all children reach the correct position of the sound/leader. Instructions: all the children except the leaders start from the same starting point (three starting points: opposite to the leader; opposite to the leader in a diagonal; center of the room)

#### *Touch and find (Tocca e scappa)*

All children are positioned in a circle. Each child in turn comes out from the circle and touch the shoulder of one of the other children. The two children walk following the perimeter of the circle and trying to find their own original places. To help them finding the original place, the two children positioned next to them turn on their ABBI providing them a sonorous cue.

#### *Musical chairs (Chi v  pe rostu u perde u postu)*

According to the number of children participating, several chairs are positioned in circle in the room (number of children minus one) and one ABBI is positioned on each chair. The experimenter turns the music on for several seconds, then he stops the music: when the music stops, all the ABBIs are activated and all children have to find as soon as possible a free chair and sit down. To find the closest free chair they will be guided by the sound of ABBI. At the end, one child will remain without a chair where to sit so he is excluded from the following session. As the game goes on, one chair has to be removed from the circle.

#### *Capture the flag (Gioco del fazzoletto)*

All children are assigned to two groups except one child who is the leader. Children in each group are assigned to a number and a specific sound. The leader has the flag and chooses a specific sound of ABBI, different from the other children participating. The leader calls a number and the children corresponding to that number in each group has to localize the sound produced by the ABBI belonging to the leader, run towards the leader and capture the flag. The main objective is to localize a single sound embedded in a complex sonorous context.

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### ***Red light/ Green light (Un, due, tre stella!)***

All children line up on one side wearing ABBI, each child with a different sound. One child stays on the other side of the room and leads the game. When the leading child says “green light”, all the children run as fast as they can towards him, while when he says “red light”, everyone stops: whoever doesn't stop is out of the game. The leading child can recognize if a child did not stop in time thanks to the sound made by ABBI. The game continues until all the children are out or has gone from one end of the field back to where they started from. The main objective for the leader is to localize sounds in the space, the main objective for the other children is to adjust the velocity of their pace thanks to the sound attached to their body in order to be ready to stop in time.

### ***Find your team-mate (Trova l amico)***

All children are paired up: children belonging to a pair have ABBI set with the same sound. The experimenter turns the music on until all children are separated from each other. When the experimenter stops the music, all children have to find their team-mate by localizing in the far space the same sound produced by their own ABBI.

### ***Grab the sound (Rincorresi)***

The child is requested to run in order to follow and intercept the sound produced by the experimenter wearing the ABBI device on the wrist and running randomly in the room without pauses. The experimenter and the child are positioned at the same starting point. The main objective is to promote locomotion and improve the fluency of movements in the space.

### ***Pass the object (Passa l oggetto)***

The children are seated in a circle and they have to pass a sounding ABBI to their closest pair in a clockwise order. Two levels: Children are very close to each other (level1); Children are more separated from each other so that passing the object is more difficult and they have to be more precise in their movements (level2).

### ***Scavenger hunt (Caccia al tesoro)***

Several ABBI are hidden in the room. When the game starts, each ABBI in turn is switched on and the children have to localize it. Three levels: all ABBI have the same sound (level1); all ABBI have different sounds (level2); the ABBI are positioned at different heights so the vertical dimension is also explored (level3).

### ***Swap the chair (Sedia scambio)***

All children seat in a circle, but two children at a time play the game. The experimenter calls two children: these children have to stand up, take off their ABBI and leave them on the chair. The experimenter then activates the ABBI and each child has to find the chair belonging to the other child by following the sound produced by ABBI. Three levels: all the chairs are positioned inwards (level1); all the chairs are positioned outwards (level1); half of the chairs are positioned inwards and half of the chairs are positioned outwards (level3).

### ***Lightningbusters (Acchiappa fulmine)***

The children are assigned to one of three different roles: the lightningbuster (who makes the other children immobile when he touches them) , the saviours (who make the paralyzed children free when they touch him), and the fugitives (who run away from the lightningbuster until he finds them). All the children except the lightningbuster don t wear ABBI and they all run in the room. As

soon as the lightningbuster touches a child, the child immediately paralyze. All the saviors can try to find the paralyzed child and make him free by touching him again.

### Usage:

The first step is to select a game (activity) that will be used during the rehabilitation session. Selecting the game will only tell the app which sound configuration to load on each ABBI that will participate in the activity. One can also create a new game in which case a popup window will appear asking for the name of the game, a description and which type of sound control will the activity use. Sound control types are “Movement triggered” in which case, ABBIs will sound when they are in movement and will stay silent while being still. “Remote control” sound types will require the rehabilitator to trigger the sound of ABBI with a button in the app.

The next step is to select which ABBIs will participate in the activity. Available ABBIs will appear on the screen. Selected ABBIs will have a green checkmark. Connected ABBIs will be marked with a letter “C”. Grayed out ABBIs are ABBIs that are not connected yet.

- Tap a disconnected ABBI to connect to it. If the ABBI has not been paired a popup window will ask you to give the ABBI a name.
- Tap connected ABBIs to select or de-select it. Select only the ABBIs that will be used in the game.
- Tap on the “X” symbol to disconnect and forget an ABBI. If you want to connect again to that ABBI you will need to give it a name again.
- Once you have selected (green checkmark) the ABBIs to use in the game, click the “connect” button to proceed.



Figure 7. First screen: List of games – each game contains a predetermined AudioMode and Audio configuration. Second screen: ABBI identification. – a pre-selection of ABBIs to be used in the game –

Clicking on the connect button will load the “Game configuration” to each of the selected ABBIs. A list of ABBIs participating in the game appear at the top of the game screen. One can turn on or off the sound of individual ABBIs through an “audio switch” next to the ABBI name. For games that use the



“movement trigger” audio mode, ABBIs will sound only when moved and if the audio switch is “on”. For games using the “remote control “ audio mode, ABBIs will immediately sound if the audio switch is “on” even if they are still.

One can also select one or more ABBIs to add them to the “group control” and control them at the same time. A large control will appear at the bottom of the screen that will control the sound of multiple ABBIs at the same time. One can swype left or right on the screen to change between controlling sound state (on / off) or volume. The large controls will only appear if one or more ABBIs are selected for “group control”. The individual switches and the button get updated when the states of one or the other change. The switch of the bracelet that is added to the selection immediately takes the state of the ABBIs already in the group.

Clicking on the Config button of each ABBI will allow you to fine-tune the Audio configuration of each ABBI. There you will find volume and audio configurations for each ABBI. Selecting an audio mode (Continuous, Intermittent, Playback and Sonification) will change the type of sound that the ABBI bracelet emits. Certain audio modes allow further configuration of parameters. Such as frequency, volume or other envelope parameters for continuous and intermittent audio modes, or different audio files for the playback audio mode. One can swype left or right on the screen to change between configuring the audio mode or the volume of the selected ABBI.

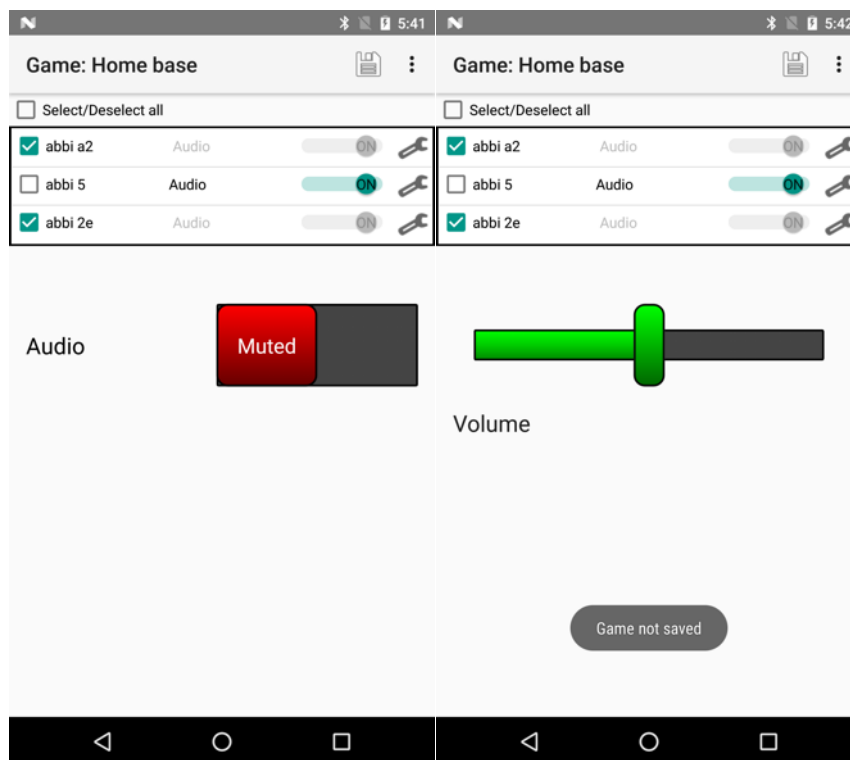


Figure 8. Third screen: The Game Activity containing the list of ABBIs with checkboxes and switches on the top and a On-Off button in the bottom.

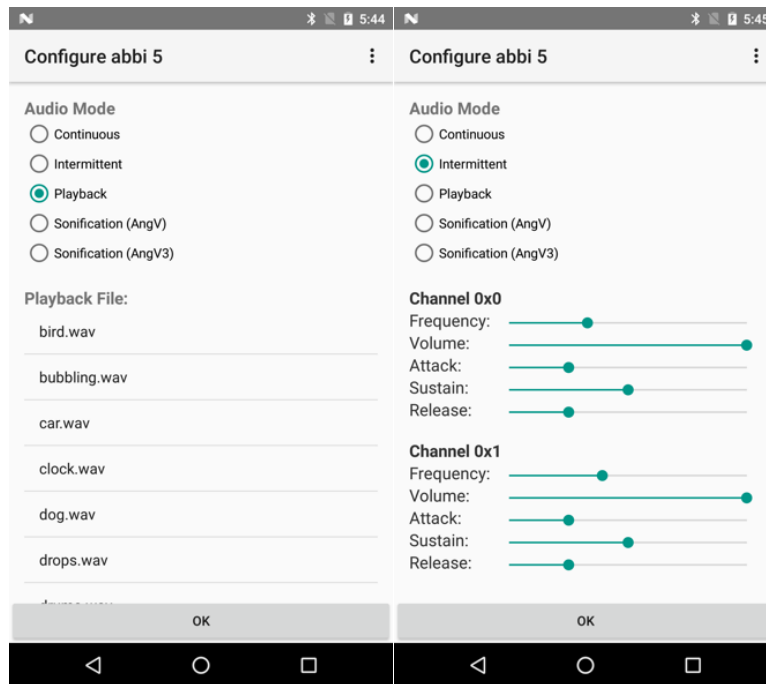


Figure 9. Fourth screen: Individual ABBI configuration screen. Selecting audio mode and its parameters. Going back to the game list and selecting another game will overwrite the audio configuration of the ABBI's so configuring ABBI's only works for the current game. However, one can save the current sound configuration of multiple ABBI's as a new game by clicking the save button at the top of the game screen. By default the app will want to overwrite the current game. If you wish to save it as a new game instead of overwriting the existing one just write a new name for the game.

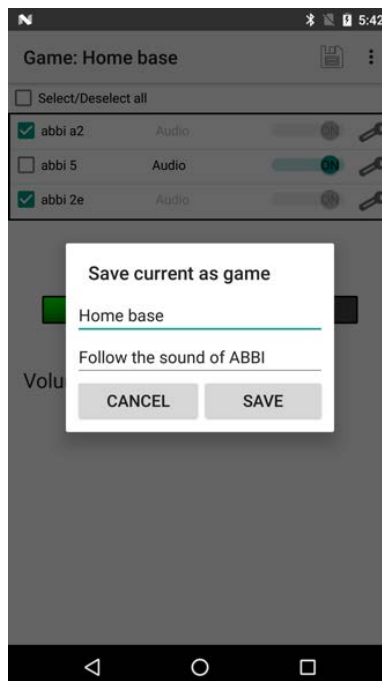


Figure 10. Save the current sound configuration of multiple ABBI's as a new game or overwrite an existing one.

## 5.5. ABBI Simulation

The ABBI Simulation app was specially designed to simulate the ABBI device. This can be useful to demonstrate the capabilities of ABBI when no physical device is available. When using this app, the mobile phone acts as an ABBI and emits a sound when moved. The user can select which sound to trigger and how easy it is to trigger a sound. The app is also designed for users with Visual impairments and works well with screen reader such as Talkback or VoiceOver. This app is available for Android and iOS.

### Installation

ABBI Simulation is available on Google Play and on the App Store.

- <https://play.google.com/store/apps/details?id=se.lth.certec.abbisimulation>
- <https://itunes.apple.com/us/app/abbi-simulation/id1199476945?mt=8>

### Usage

The ABBI simulation app does not contain many of the configuration functions of the other ABBI apps. It basically consists of one screen only. With this app one can set the Sensitivity threshold for the movement. The higher the threshold (tröskel) the more acceleration will be required to make the phone produce a sound. One can also select the type of sound the phone will produce when moved. This can be an intermittent beep (Pip) or playback of a recorded sound (Inspelning). For the intermittent beep one can select the frequency (pitch) of the sound in Hz and the beats per minute (BPM) of the beeping sound. When the recorded sound type is selected, one is able to select which sound to playback when ABBI is moved. The ABBI Simulation screenshots for Android and iOS are illustrated in Figure 21 and Figure 22, respectively.

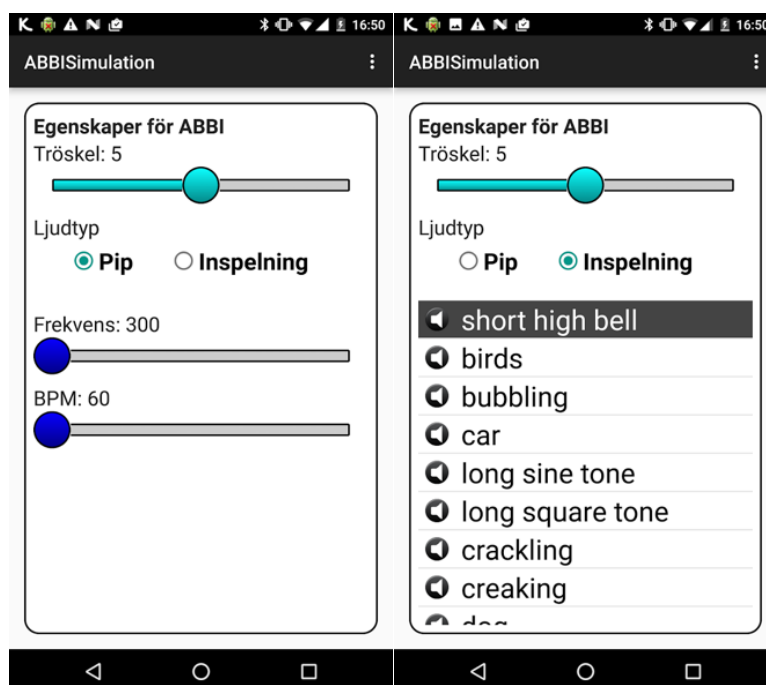


Figure 11. ABBI Simulation screenshots for Android

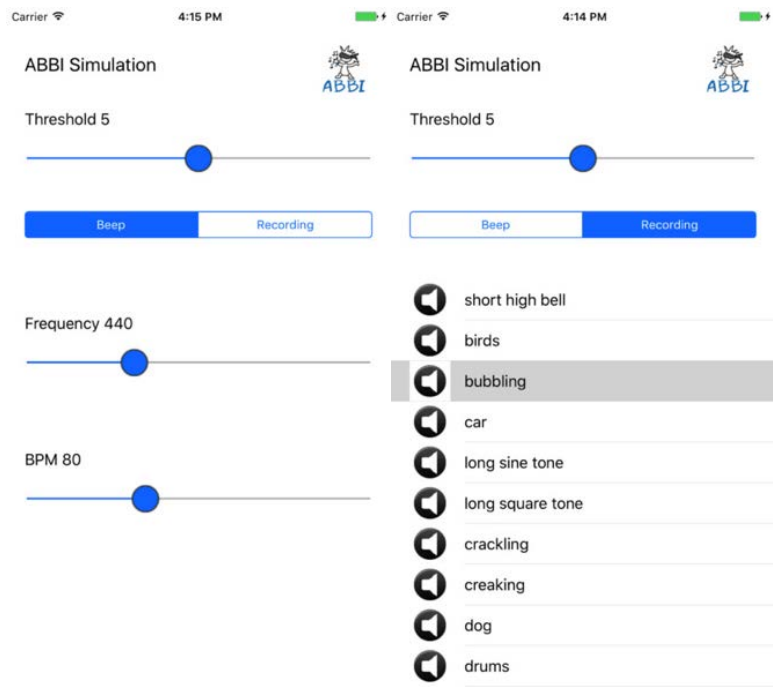


Figure 12. ABBI Simulation screenshots for iOS

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## 6. Experimental and deprecated apps

This section groups app that are experimental and/or deprecated

- **Android ABBI v1 and v2:** Prototype app demonstrating how to use the ABBI Android library (compatible with firmware version  $\geq 3.2$ )
- **ABBI UI:** Prototype app to test user interface (does not require ABBI device) .
- **ABBI2 app:** Original app developed to work with the first series of ABBI device (works with firmware version 1.x and 2.0)
- **Beacon app:** Experimental app to test ABBI beacon abilities.

### 6.1. ABBI Android (for fw 3.2)

Two versions of an Android ABBI library were developed by UGLAS. The ABBI Android demo application was developed and updated to work together with the Android ABBI Library. The ABBI Android v2 demonstrated how to connect to multiple ABBIS, log ABBI data and use ABBI as an iBeacon. This application serves as a demonstration of how to use the ABBI Android library to build applications; in this sense, the source code is more important than the actual application.

#### Installation

The Android library should be imported to Android Studio and then built. This will install it on an Android phone connected in development mode. If the Android phone is using Android 6.0 (or more recent versions) then the first time the application runs you will have to grant it permission to access Bluetooth; a dialog will appear, if necessary, prompting you to do this.

#### Usage

The main screen in the application (below, left) can be used to scan for nearby ABBI bracelets. The refresh icon in the toolbar will start scanning; this will be animated for the duration of the scan. Any detected ABBI bracelets will be shown in a list (below, left). The list item will show basic information about the device: e.g., it's Bluetooth address, ABBI version number, battery level, volume level. The corresponding source code demonstrates how to scan and connect to ABBI devices.

Selecting an ABBI device from the list will make the application establish a connection with the device. The screen shown below on the right will then be displayed, showing basic information about the ABBI device. You can reconfigure the ABBI bracelet using the widgets; for example, dragging the volume slider will cause the ABBI bracelet volume to be updated. Sliding the screen to the left or right will move through different views, each corresponding to a different Bluetooth service on the bracelet. For example, there is a view for the Motion service and a view for the Audio service. These views show the current bracelet configuration and allow some values to be changed, although the purpose of these is to provide a source code example for communicating with the ABBI hardware.

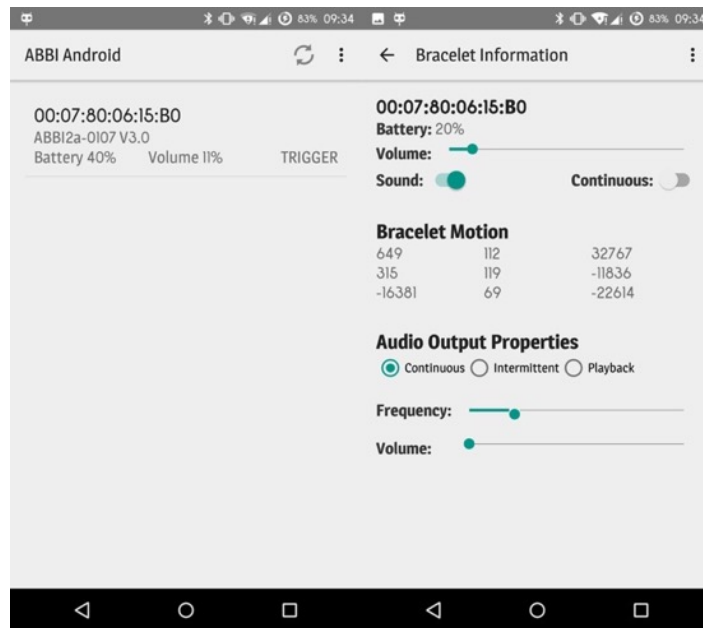


Figure 13: Screenshots of the basic ABBI smartphone application. The left screenshot shows which ABBI bracelets have been detected. The right screenshot shows its audio properties and motion data. This User Interface component has been developed for debugging the application and shows more technical details than would be required by most end-users.

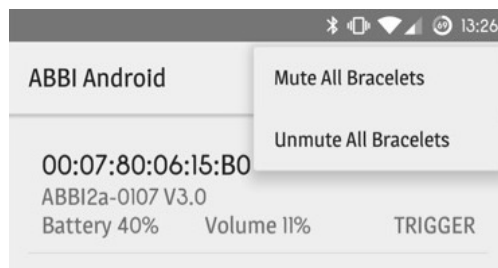


Figure 14: Examples of bracelet operations which can be applied to all nearby ABBI bracelets.

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## 6.2. ABBI2 (Deprecated)

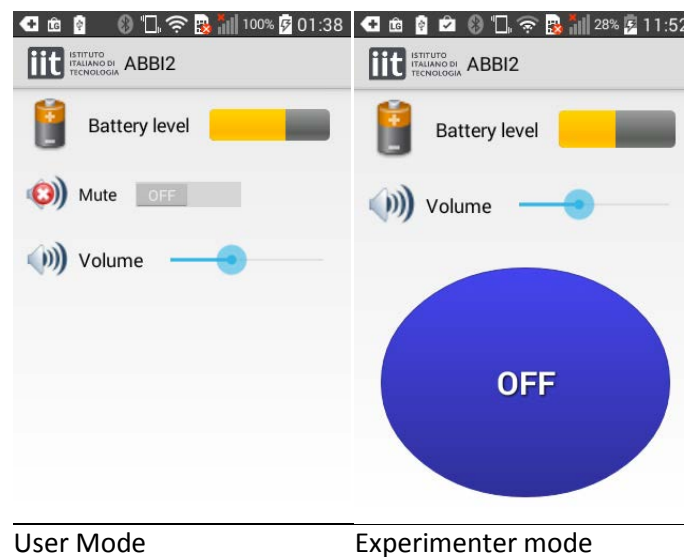
This ABBI app is not supported since September 2015. It was removed from google play. ABBI Remote v2.0 or My ABBI are recommended for usage of ABBI with Firmware version 2.0.

### Installation

To install ABBI 2 v1.3, follow these steps:

1. download the ABBI2\_v1.3.apk from the owncloud repository “WP3/Distrib/AndroidApps/”
2. Transfer the file to your android device using USB connection
3. Open the ABBI2\_v1.3.apk file from your device

### Usage



The Android application has one user mode and one experimenter mode. To switch between the two modes, you need to click 9 times on the IIT logo in the top left corner. Note that you cannot switch mode a second time unless you exit first from the application.

Note that the application is localized according to the language setting of the phone (at the moment, only English and Italian).

### User mode

The user mode allows simply controlling the volume and checking the battery level (see ABBI User Manual). When using it, the ABBI device is configured so that sounds are triggered by the user movement.

*Connection.* The first time the application is started it is necessary to pair the application with a device. The next times, it will remember the identity of the device (MAC address) and automatically connects when the device is advertising.

To change the device which the Android device is paired in the user mode, you need

1. switch to the experimenter mode and exit the application
2. restart the application and pair with the new device
3. switch back to the user mode and exit the application.

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Alternatively, you can reinstall the application.

*Timeout.* The screen timeout of the Android phone stops the application and therefore the connection with the ABBI device (usually after 1 minute of non-use). To reconnect with the ABBI, it is necessary to reactivate the application on the phone and shake again ABBI.

### **Experimenter mode**

The experimenter mode allows the experimenter to remote control the beginning and end of the current sound with the ON/OFF button. *You need to put back the application in the user mode to configure the device with movement triggered-sound.*

*Connection.* When starting the application in the experimenter mode, it is possible to choose with which device to connect. You need to push the SCAN button while the device is advertising and select the device in the list. If you wait too long to select the device, it is possible that the device stops advertising (but it does not disappear from the list). In this case, it is not possible to connect and you need to make it advertise by shaking it.

*Timeout.* When using the android Application in Experimenter mode, the screen timeout of the Android phone is deactivated to avoid losing the connection.



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## 6.4. ABBI UI

The ABBI UI application allows the exploration of functions and user interface of ABBI applications without having an ABBI bracelet available. ABBI functions and responses are faked in this app, since there is no bracelet connectivity.

### Installation

ABBI UI is available in the owncloud repository “WP3/Distrib/AndroidApps/”. To install follow these steps:

1. download the “ABBI\_UI\_release.apk” from the owncloud repository “WP3/Distrib/AndroidApps/”
2. Transfer the file to your android device using USB connection
3. Open the apk file from your device

### Usage

In this UI we selected the navigation drawer approach to be able to show all graphic elements (the navigation drawer design has additional graphical elements, as was stated earlier, it is easy to change this to a swiping design involving the same fragment screens).

The menu structure is illustrated in Figure 5. The first item allows you to select the ABBI’s you want to control. This is followed by items that allow you to select a profile, to change volume and sensitivity, and to remotely turn an ABBI on or off. The advanced items (which only work together with a single ABBI) allow you to save the settings on the selected ABBI as a profile, to select sounds to use on the ABBI and to transfer and delete sound files to the ABBI.

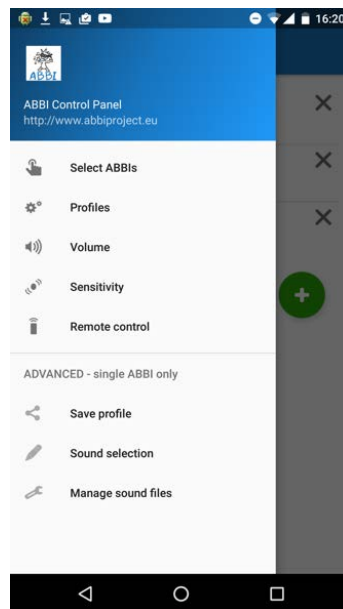


Figure 15. Navigation drawer menu.

### Basic functions

The select ABBI's screen (Figure 6) shows the names of the ABBI's, the battery status, the address and the selection status. The green circle indicates selection, the blue (with a C) indicates connection and the gray circle is an ABBI you have previously connected to but which isn't currently connected/available.

New ABBI's can be added to the list by pressing the green button with a "+". When this is done, a dialog pops up where you can scan for available ABBI's, select the one you want and assign a name to it (see Figure 6).

To make it easier for users with only one ABBI, the first connected item in the selection list is selected by default.

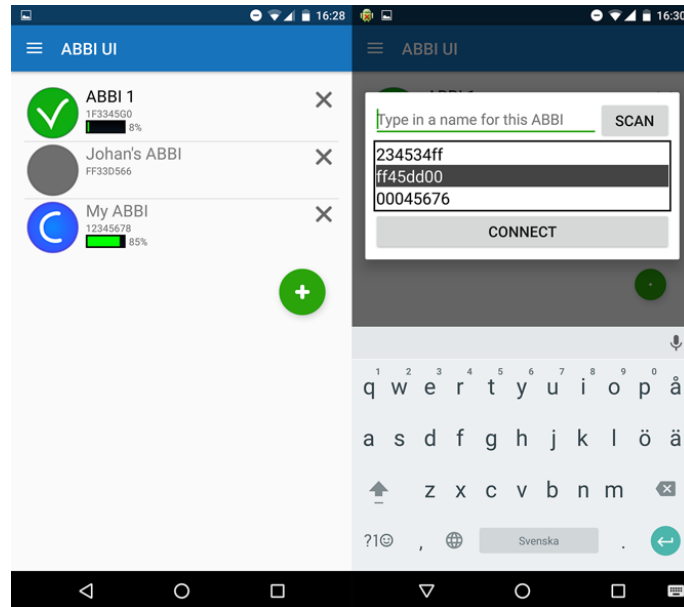


Figure 16. Select ABBI's screen (left) and add new ABBI dialog (right).

The next screen is the profile selection. In this view you can select the profile you want, to assign the profile settings to the selected ABBI's visible in the list in the top part of the screen. The list shows the profiles saved on the phone. If you want to remove a profile from the phone you can press the cross icon on that list item (this generates a "do you really want to.." dialog).

To import a profile from the web you press the green "+" button. The following dialog allows you to type in part of the name or description to search for to limit the size of the displayed list (Figure 7). An alternative way of importing a profile is to tap a NFC tag to the back of the phone in this screen.

All profiles have a name and a short description, to help identification when the number of profiles increase.

The next two views control volume and sensitivity (how much you need to move the ABBI to make it respond). We designed the views with only one slider each to make it easier to handle for visually impaired persons (Figure 8).

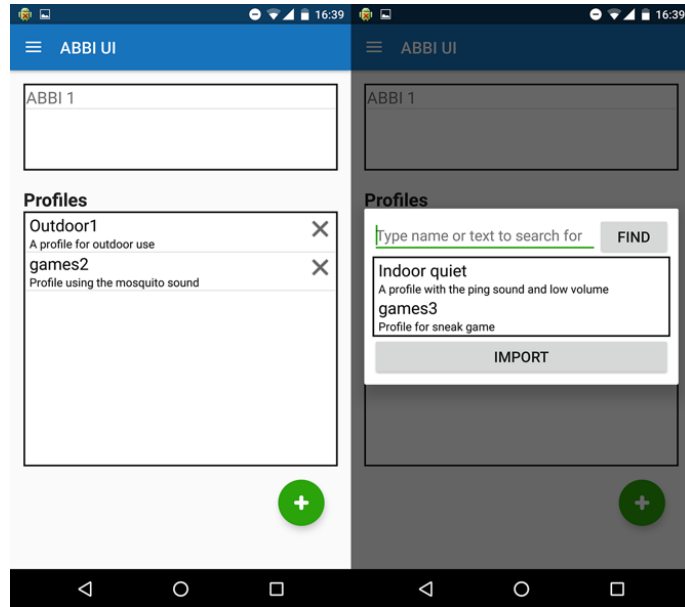


Figure 17. The fragment screen for profile selection, and the import profile dialog.

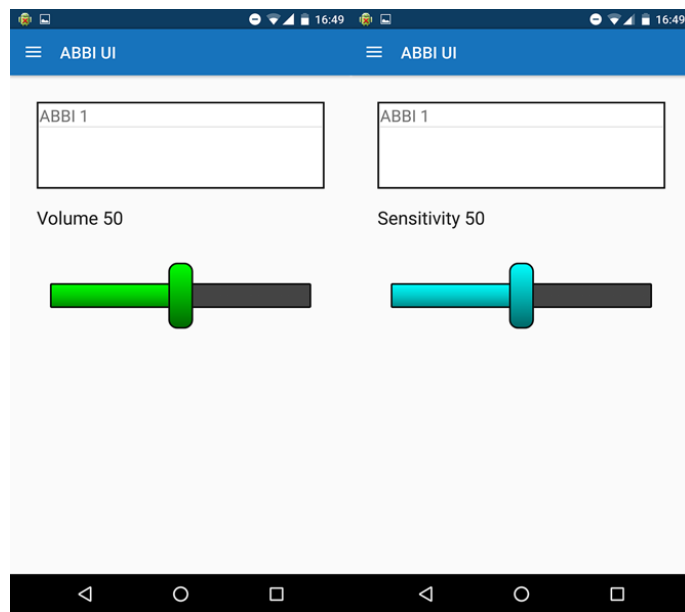


Figure 18. Fragment screen for volume and sensitivity.

The final screen is specially designed for the rehabilitation and allow remote control (turning them on or off) of several ABBI's (Figure 9).



Figure 19. The remote control screen.

### *Advanced fuctions*

The advanced fuctions are designed to be used by persons who are expert ABBI users. All these functions work together with a single selected ABBI – if more (or fewer) are selected, the user gets a warning message and cannot access the function.

The first advanced screen (Figure 10) allows you to save the settings of the selected ABBI to a profile. If a NFC tag is touched to the phone the settings of the selected ABBI should be saved to the tag as a profile.

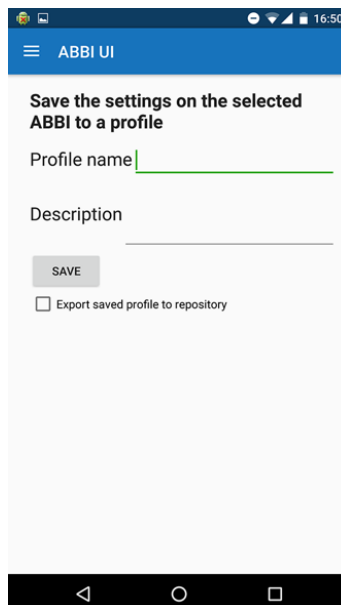


Figure 20. Save the settings of the selected ABBI to a profile.

The second screen allows you to change sound parameters. We currently have continuous sound, intermittent sound, playback and two sonifications available. The sonifications have no parameters,

while the continuous, intermittent and playback selections have additional parameters that can be set (Figure 11).

The final screen allows you to transfer sound files from the phone to the ABBI (only valid sound files that can be played by the ABBI should be displayed in the list). You can also delete sound files from the ABBI by tapping the cross in each list item (Figure 12).

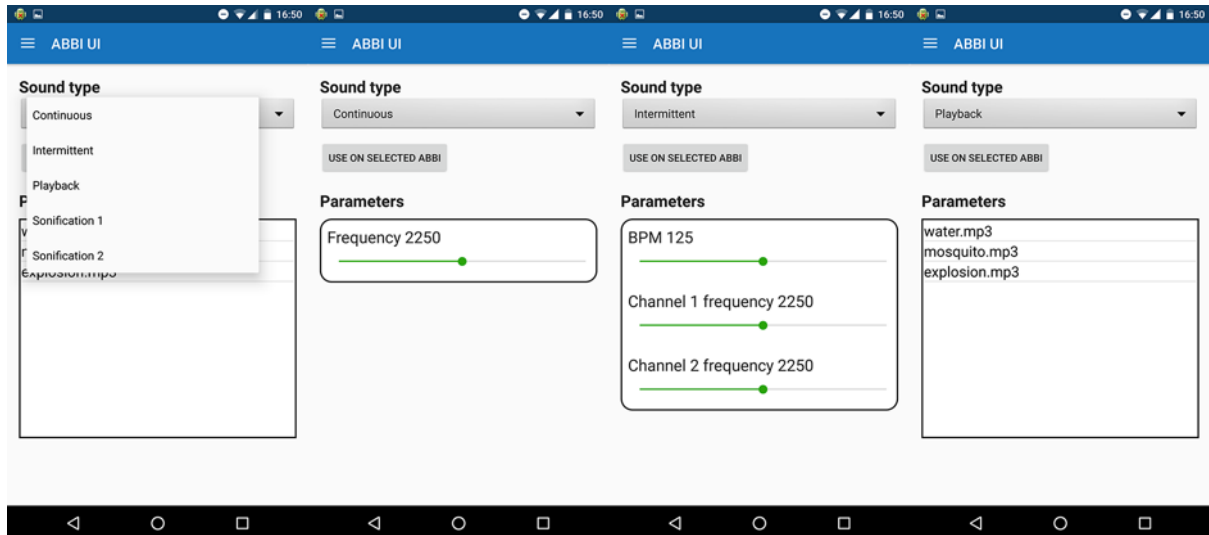


Figure 21. Select type of sound feedback, and set the parameters for the selection.

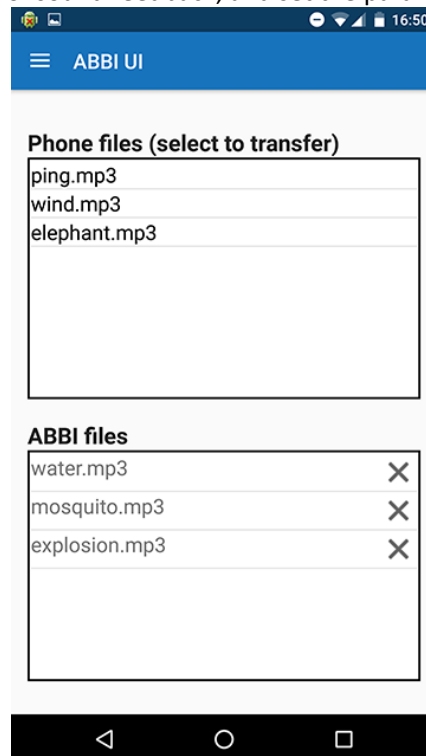


Figure 22. Screen allowing you to transfer files to the ABBI, and delete files on the selected ABBI.

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## 6.5. ABBI Beacon Demo

The ABBI Beacon Demo app is a cross-platform iOS and Android application that can be used to help visually-impaired persons to navigate from the entrance to the Chiossone's villa to the elevator inside the building.

### Installation

The ABBI Beacon Demo app for Android is available in the owncloud repository "WP3/Distrib/AndroidApps/". To install follow these steps:

1. download the "ABBI\_beacon\_demo.apk" from the owncloud repository "WP3/Distrib/AndroidApps/"
2. Transfer the file to your android device using USB connection
3. Open the apk file from your device

The ABBI Beacon Demo app for iOS is available in the owncloud repository "WP3/Distrib/iOSApps/". To install follow these steps<sup>2</sup>:

1. download the "ABBI\_beacon\_demo.ipa" from the owncloud repository "WP3/Distrib/iOSApps/"
2. Transfer the file to your iOS device using iTunes

### Usage Example

The Chiossone Villa was equipped with audio beacons which might help visually-impaired persons to orient themselves from the entrance to the Villa to the Elevator inside the Villa. Audio beacons are devices placed at strategic locations that can automatically make a sound and/or give information when visually-impaired persons equipped with a smartphone are in the vicinity.



Figure 23. Indicative placement of ABBI Audio Beacons in Chiossone's villa . P: Parking. A: Entrance (not used). B: Entrance. C: Elevator. 0,1,2,3: Target Audio Beacons location

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<sup>2</sup> This installation method will only work for devices using Apple IDs registered in the Apple iOS University Developer Program.

Figure 23 shows an aerial view of the Chiossone villa. A navigating difficulty that the visitor is facing is that s/he should find an entrance (B) in the backside of the building that is difficult to find even for sighted persons instead of not the main entrance (A) which is not used because of a stairway. The elevator inside the building (C) is not located at the entrance but out of view at the end of a hallway.

When the application starts, it will scan for ABBI devices that have enabled iBeacon functionality. All found devices are listed according to their hardcoded address, e.g., Beacon 0 will appear before Beacon 1 even if it is found later (Figure 24). After scanning finishes the app tries to connect to all the beacons on the list and configure the sound parameters depending on their detected distance.

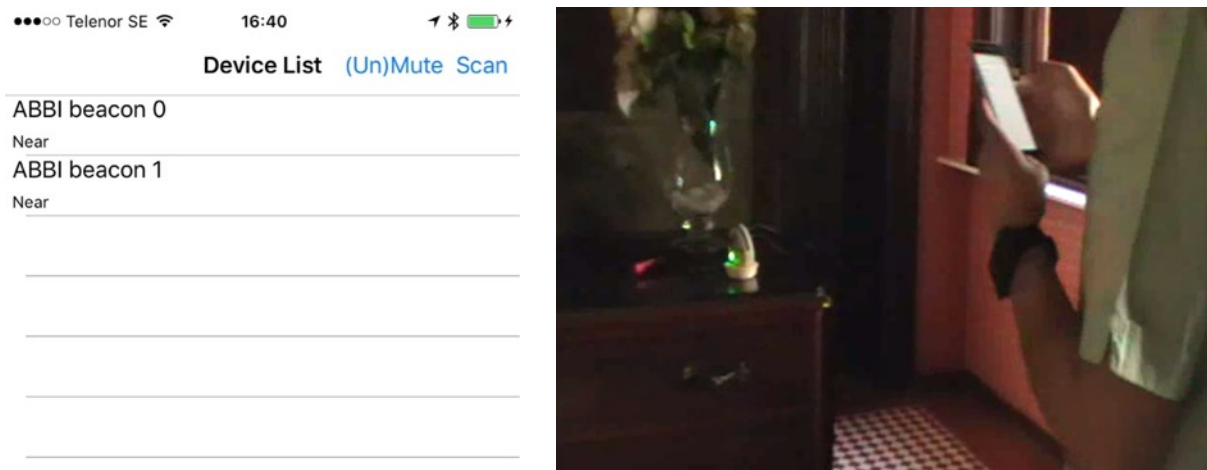


Figure 24. ABBI Beacon app scanning for iBeacon enabled ABBI (on the table). The distance to the beacon is divided in three ranges: “far” (>3m), “near” (0.5m-3m), and “immediate” (<0.5m). When the phone is “near” a beacon, that beacon starts beeping and the previous beacon stops beeping. If the user reaches the “immediate” range, it will trigger the sound file corresponding to the specific beacon.

As one leaves the immediate region, that beacon turns off, and the next beacon starts beeping, so one can follow the sound. Once one reaches the immediate region of the beeping beacon, then it will play the sound file.

The procedure continues until one reaches the last beacon in the list. Once the last beacon’s immediate region is entered (i.e., Beacon 4), the “next” beacon becomes the one with the previous “minor” (i.e., Beacon 3), and the procedure goes backwards.

The following sounds are recorded in the ABBI beacons:

- Beacon 0: “Welcome. Chiossone Institute parking area is straight ahead”
- Beacon 1: “Welcome to the Chiossone Institute. The entrance door is 10 meters further along this path in the direction of the other audio signal. Be careful with the steps at the door.”
- Beacon 2: “You are at Chiossone entrance door, be careful with the steps. Enter the building and follow the direction of the next audio signal to reach the elevator”
- Beacon 3: “You have reached the elevator”