smarting

User Manual

mbt | mBrain Train

Contents

1. Safety warnings

Warning signs and examples of symbols shown here are mentioned so you can use the device properly and reduce injury risks.

Warning sign	Meaning
 Warning	Shows possibility of death or physical injury if the instructions in this user manual are not properly followed.
 Caution	Shows possibility of a physical injury or material damage if the instructions in this user manual are not properly followed.

Sign examples	
The triangle sign △ shows that you must be careful (including dangers and warnings). The △ explanation of the warning is adjacent to the figures.	 *Fire Hazard* sign.
The crossed circle ⃠ sign demonstrates that something is not allowed. The explanation of this ⃠ sign is adjacent to the figures.	 *Not allowed to unpack*.
The circle sign● marks that something must be checked or should be taken into notice. The explanation of this sign is adjacent to the ● figures .	 *General Warning*.

⚠ Caution	
CAUTION: All General Safety Information that pertains to equipment of other producers to which SMARTING device is connected while charging or during signal acquisition, apply here as well.	
CAUTION: mBrainTrain products are **NOT** intended for medical purposes or use in patient health care environments.	
CAUTION: mBrainTrain products are not designed for use in inflammable or explosive environments.	
WARNING: Do not connect your amplifier with the EEG cap when the amplifier is being charged via your PC or Tablet.	
CAUTION: It is advised to run the amplifier at room temperature. If you are changing the current environment of the amplifier, it is necessary to leave the amplifier off for 20-30 minutes before connecting it to any devices.	
CAUTION: Amplifier's battery is not replaceable and its replacement could cause certain risks. Please do not try to replace and/or disconnect the battery.	

Warning	
WARNING: Use of controls, adjustments, procedures, connections, or signal types other than those specified in your documentation may result in exposure to shock, electrical hazards, and/or mechanical hazards.	
WARNING: Do not use your equipment in a wet environment. Protect equipment from liquid intrusion. Do not put the EEG cap on your head, if the cap is connected to the amplifier and your hair is wet.	
WARNING: Unit should be supplied by external power supply evaluated according to IEC/EN 60950-1 and comply with SELV requirements.	
WARNING: Electrical shock or Fire Hazard. Do not try to charge your amplifier with anything else but the USB charger that you got with the device. This USB cable must be connected by the USB port of the certified Lap top/PC or certified mini USB charger.	
WARNING: DO NOT try to open the amplifier casing. If it is determined that you have opened the casing, your warranty will no longer be valid.	
WARNING: There is a possibility for external Bluetooth interference. Please, minimize interference issues before connecting to device.	
WARNING: Risk of explosion or personal injury if the amplifier is exposed to conducting materials, liquid, fire, or heat (above 45°C).	

2. Package content

1 	SMARTING EEG Amplifier (s2b Version)	5** 	BlueSoleil's Bluetooth Dongle Class I (Type BS002)
2* 	EasyCap's customized EEG-RBE caps (in different sizes and with adapted electrode layouts)	6 	USB Memory Stick with pre-installed software applications
3* 	EasyCap's Starter SRC Kit (including several consumables for the first couple of testing rounds)	7 	USB Type-C Charger (L0.25m)
4* 	Mobile device with pre-installed SMARTING application	8	Documentation: User Manual Warranty Card CE Certificate Declaration of Conformity

*** Note: the exact package content structure in turns of existence and number of items apart from SMARTING EEG amplifier and accompanying software is subject to specific offer issued.**

**** Note: Please avoid using the USB 3.0 Port on the PC. Using 3.0 USB port may damage the BS005 dongle, consequently the license key for the Bluesoleil software may become inactive. Please use the 2.0 USB port on your PC.**

3. Technical specifications

General characteristics	
Name	SMARTING 24
No of channels	24
Reference	One electrode is a reference (unipolar measurement)
Input impedance	500 MΩ
Input noise	1 µV
Input range	±100 mV
CMMR	>110 dB
Amplification	24
Gyroscope	3D built in

AD Conversion	
Frequency	250Hz or 500 Hz
Method	Parallel sampling
Resolution	24-bits
Bandwidth	0-250 Hz
Anti-alias filter	Yes
Active ground	Yes

Communication type	
Wireless communication	Bluetooth v2.1 + EDR
Max Bluetooth range	7-25 meters

Power	
Power	USB – Type C rechargeable battery
Battery type	Li-Polymer, 560 mAh, 3.7 V
Operational time	~ 4 hours

Connectors	
Electrode connectors	Cristek, IDC

Dimensions	
Physical size of the box	82x51x12 mm
Weight	60 g

Manufacturer:
mBrainTrain LLC
Požarevačka 36/2
11 000 Belgrade, Serbia

Carefully read the user manual

4. SMARTING device description

SMARTING (Figure 4.1) is intended for use as a biofeedback research platform. The amplifier is located in a small casing with the physical dimensions 82x51x12 mm. SMARTING is a mobile EEG amplifier that can be used in unrestricted environment. If the device is moved to an environment with a significant temperature drop/rise, leave the amplifier standing there for 30 minutes, before turning it on. SMARTING must be used in normal temperature and pressure conditions. The device must not be dropped, since it may lead to malfunction.

1. The USB Type – C port is intended only for charging the battery (marked by 1 in Figure 4.1-left). **SMARTING device is not to be charged during recordings! Therefore, make sure the device is removed from charging, before starting the experiments!** Do not use any other adapter for charging the battery! The device is intended to be charged only by USB connector on PC.

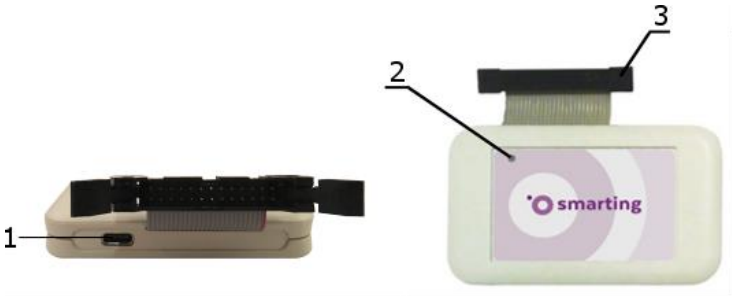


Figure 4.1 The SMARTING

1 – USB Type – C connector; **2** – RGB LED diode; **3** – IDC connector

2. When SMARTING is connected to charging, the red LED will turn on (indicated by number 2, in the left part of Figure 4.1). When the amplifier is fully charged, the green light will be turned on.

3. The device contains a 26-pin connector (number 3 in Figure 4.1 - right). There are 24 pins for channel measurements, 1 pin for the reference electrode (REF), and 1 pin for the ground electrode (GND). This EEG connector connects to an EEG cap of your choice. We recommend using EEG caps made by EASYCAP.

4. The blue LED light on Figure 4.1, marked by number 4, indicates whether the device is connected to your PC/Smartphone or not. If the LED light is blinking, this means that the device is successfully connected.

SMARTING device is approved for use in the EU and USA.

5. Connecting the Device to PC using BlueSoleil Bluetooth driver

Before trying to connect the device to your PC/Tablet or make any measurements, **make sure that the amplifier is charged**. Otherwise your amplifier's Bluetooth might not be visible to other devices. SMARTING can be charged on any PC or any other portable device with the mini-USB port. The charging process lasts approximately **4-5 hours**.

To achieve the best performance with SMARTING device, it is highly desirable to use the BlueSoleil Bluetooth driver. To do that, visit the web page http://www.bluesoleil.com/products/S0001201005190001.html and download the BlueSoleil 10 installation driver. The installation file can also be found on the SMARTING USB dongle that arrived within the SMARTING package (Chapter 2). The license for the driver is embedded in the BlueSoleil dongle that arrived together with your SMARTING package (Figure 5.1).

Figure 5.1 The BlueSoleil dongle

After the installation has been downloaded, unpack the installation file. Click the *setup.exe* file found within the *install* folder. Follow the on-screen instructions to install the BlueSoleil Space. After the installation has been finished, run BlueSoleil Space application from your desktop (Figure. 5.2).

Figure 5.2 BlueSoleil Space application desktop icon

5.1. Connecting SMARTING to PC

Double-click the orange circle (representing Sun - Figure 5.3) in the middle of the BlueSoleil space main window to search for all available devices. When the SMARTING device is detected, double click on the SMARTING icon that appears in the Bluesoleil space in order to search for services. When *searching services* is finished, click with the right mouse button on the device, and choose *pair* from the dropdown menu.

After the device is paired, click again the right mouse button and choose *Connect Bluetooth serial Port (COMxx*) (Figure 5.4). The device icon will become green and the string appears connecting the device icon with the Sun icon (Figure 5.5). This indicates that the device has been successfully connected.

It is important to memorize the Port Number for future use (this is the **COMxx** number in Figure 5.4).

Now that the COM port has been assigned, you need to **disconnect** the device (by right mouse button clicking on the device and choosing *Disconnect the Bluetooth serial Port (COMxx).* The device is now ready to be used by other programs.

BlueSoleil application can always be accessed from taskbar choosing the

B icon (Figure 5.6).

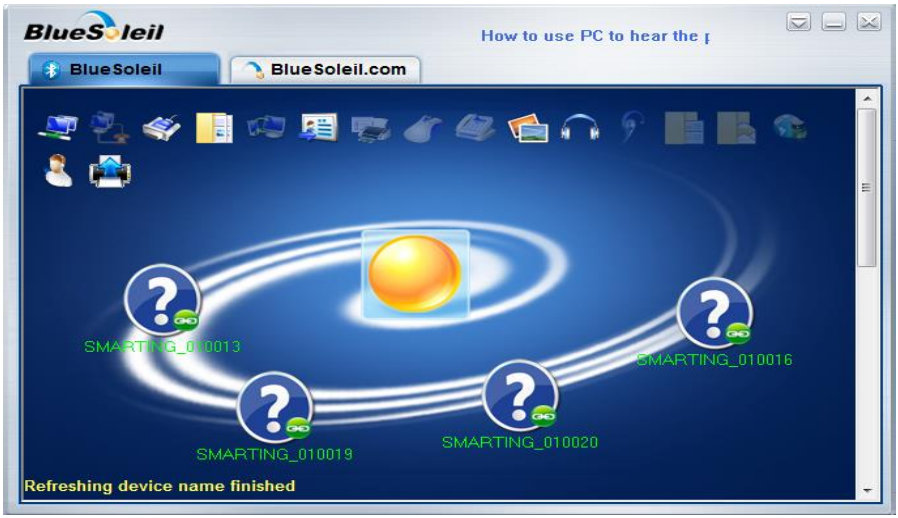


Figure 5.3 Appearance of BlueSoleil Space application after finish of search for devices.

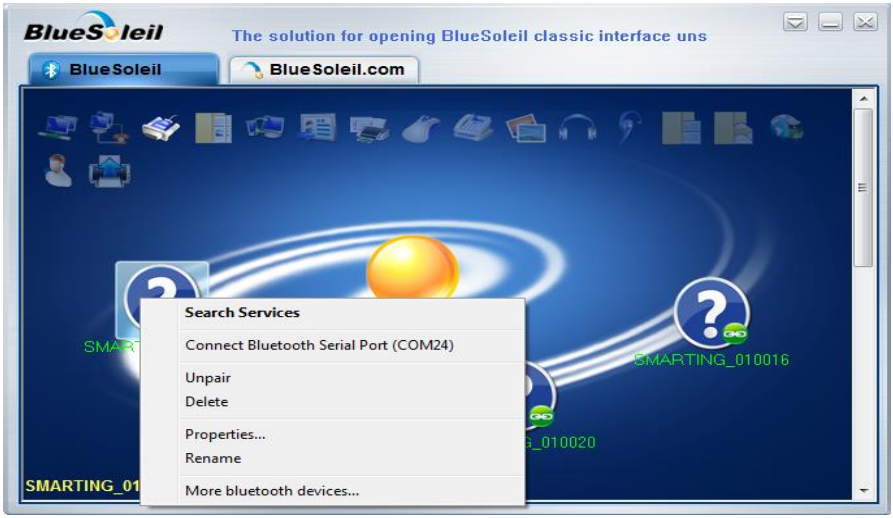


Figure 5.4 By right mouse clicking on the device, one can recheck the Port number. In this example the corresponding port number is 24.

Figure 5.5 Connecting to device

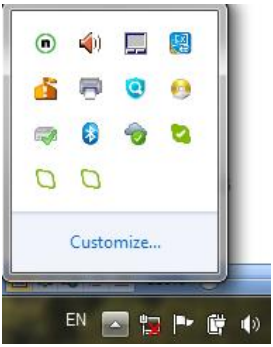


Figure 5.6 Click the *B* sign to access BlueSoleil driver application

Bluetooth Troubleshooting	
Problem	**Solution**
PC cannot see SMARTING	Please check whether the battery is charged before trying to connect the device.
Bluetooth asks for a password	Type: 1111

6. SMARTING Streamer standalone PC utility

SMARTING Streamer represents a standalone utility for PC/Windows that allows visualization and recording of EEG signals, checking and setting up impedance values, registration and visualization of external triggers and other functions that will be further explained.

6.1 Installation:

To install the SMARTING streamer application, please locate the installation file (*SmartingStreamer-setup.exe*) on the USB flash that was delivered inside the SMARTING package, or download the Smarting Streamer application from the website (http://www.mbraintrain.com/support/) using the provided Username and Password credentials located on the USB that came with the package.

After launching the installation file, simply click on *install* and the application will be installed on your PC.

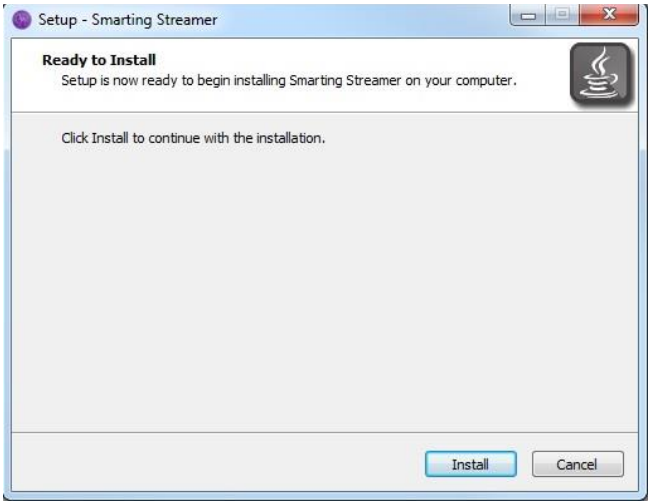


Figure 6.1 Click the *install* button for installing the Smarting Streamer.

After successful installation, Smarting Streamer app will automatically run and the desktop shortcut icon will also be created. The streamer icon can also be found in the Windows Start Menu.

6.2 Starting up (The main window):

Before starting the application, ***please make sure that all firewalls and antivirus programs on your PC are disabled****. It is recommended that other CPU demanding applications (e.g. Google Chrome, Skype etc.) are switched off.*

Start the Smarting Streamer by double clicking the icon on your desktop or in the Windows Start Menu. The window shown in figure 6.2 will appear. To successfully connect your SMARTING device, please click the *connect* button, marked with the number 1 in Figure 6.2.

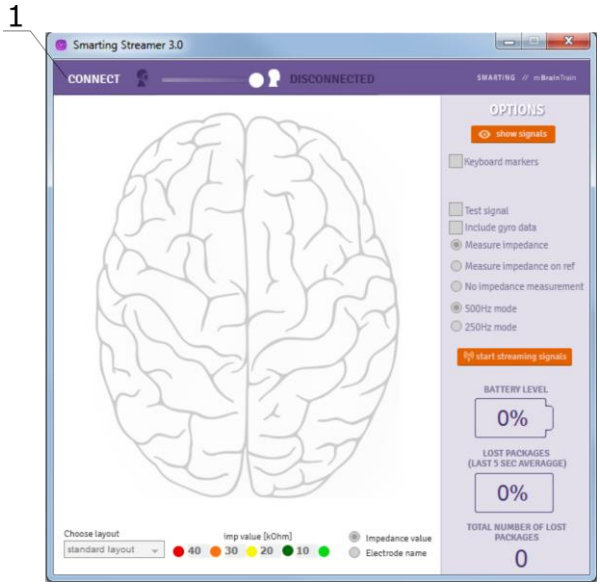


Figure 6.2 The main window that appears when running the SMARTING Streamer. Click on *connect* button (as marked with the number 1) in order to connect SMARTING device to the streamer.

Upon this action, a window will pop-up (Figure 6.3) that allows you to select the appropriate COM port (2), (You can find it in the BlueSoleil window while

connecting SMARTING to your PC, Figure 5.4).
Optionally, it is possible to rename the EEG stream (3), in case you are planning to record multiple EEG streams. Finally, by clicking the *connect* button (4), SMARTING device will connect to the streamer.

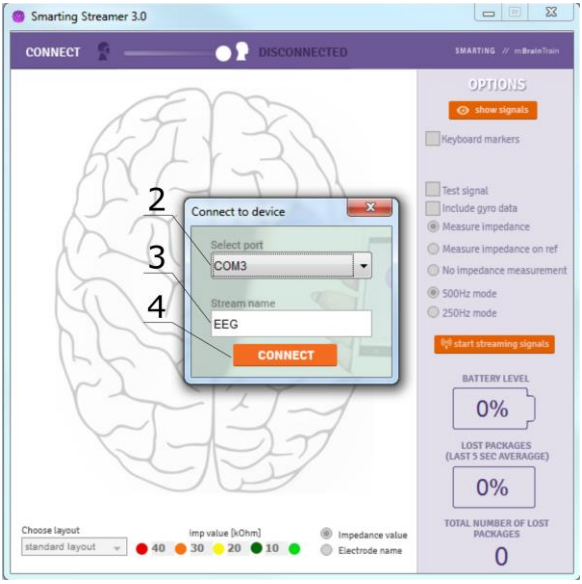


Figure 6.3 The pop-up window in which the COM port can be selected (2). Additionally, the EEG stream name (3) can be modified. The device connects to the streamer by clicking the *connect* button (4).

Once SMARTING is connected the white slider (positioned in the upper-left corner of the Streamer) slides leftwards and the head silhouette turns orange (see Figure 6.4). At this point it is possible to choose the following options from the main window (Figure 6.4):

- The *Choose Layout* menu (5) allows selecting the layout that corresponds to the EEG cap that is used for recording (Standard, Motor or cEEGrid). To load or create custom layouts refer to chapter 14;
- The color-coded impedance values can be setup by changing the values inside the boxes (6);

- The electrodes on the brain sketch can display either the impedance values on each electrode position, or the electrode name, which is user specified option (7)
- If the keyboard marker field (8) is checked, the keyboard stream will become active and the keyboard presses can be visualized and recorded in an XDF file.
- When the *Test Signal* box is checked (9), SMARTING device starts generating and streaming test square signals. This option can be used to check if the device is streaming correctly without connecting the cap and a measurement subject – if signals are appearing and there are no lost data packages, the connection quality is verified;
- To stream the gyroscope data together with the EEG data check the *Include gyro data* box (10);
- To select the impedance values select the *Measure impedance* button (11). Otherwise, select the *No impedance measurement* button (13);
- Selecting the *Measure impedance on Ref* box (12) allows measuring impedances on the reference electrode (explained in subchapter 6.3 and in Figure 6.5);
- The EEG data can be streamed with 500 Hz (14) or 250 Hz (15) sampling frequency.
  Note: If the data are streamed with 250Hz sampling frequency, measuring the impedance values is not possible.

Upon setting up all the desired parameters, the EEG signal starts streaming upon clicking the *start streaming signals* button (16) in the main window (Figure 6.4).

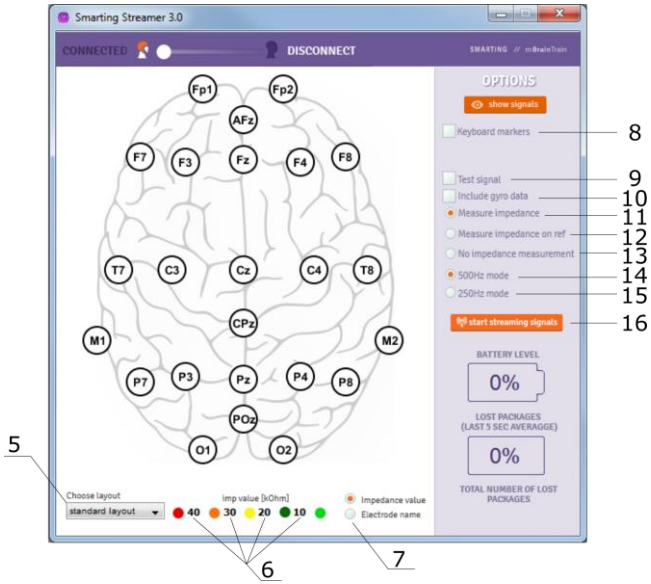


Figure 6.4 The main window - setting up of main parameters for the EEG streaming

6.3 Using the *measure impedance on ref* option

When mounting the EEG cap, we recommend to first check the impedance of the reference electrode, since the reference electrode signal quality influences the EEG signal quality on all other channels.

In order to do so, select the measure impedance on ref box (number 12 in Figure 6.4), and tick the box *500 Hz mode* number 14 in Figure 6.4). Once these two boxes are selected and the button *start streaming signals* (number 16 in Figure 6.4) is clicked on, the reference electrode will appear in the middle of the scalp sketch as shown in Figure 6.5 (17). At the same time, the battery indicator will become active and it will show the current battery status in percentages (18). Additionally, the box that shows the percentage of lost packages (average in last 5 seconds of streaming) (19) and the counter of the total number of lost packages, which shows the cumulative number of lost packages during the signals streaming (20), as depicted in Figure 6.5. Bear in mind that these measures should be close to zero.

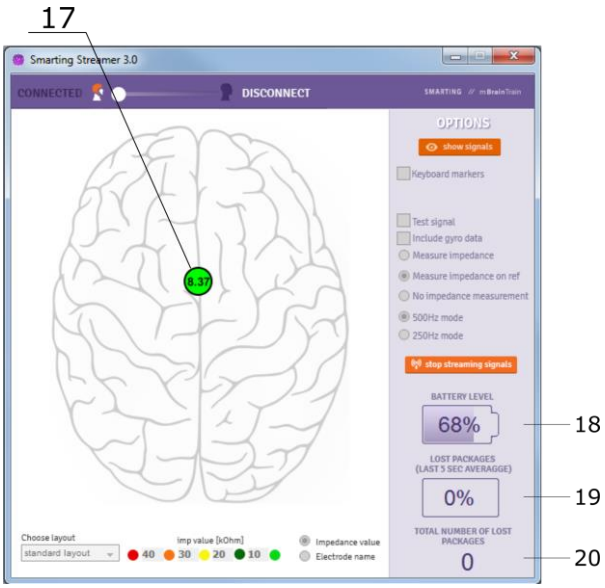


Figure 6.5 The main window when the *measure impedance on ref* and *500 Hz mode* boxes are selected. At this point it is possible to get the information on the battery level (18), percentage of the lost packages in the last 5 seconds of streaming (19) as well as for cumulative number of lost packages (20).

6.4 Using the *measure impedance* option

For measuring impedances, 500Hz sampling mode needs to be selected. Once the signal streaming has started, the main window looks like the one depicted in Figure 6.6. The electrode layout appears on the brain sketch in the bottom-left panel of the streamer (17). The color coded or the numeric impedance values (depending on what is selected under number 7 in Figure 6.4) will appear on the brain sketch.

At the same time, the battery indicator becomes active (18) and the battery percentage is shown (Figure 6.6).

Also, the box that shows the percentage of lost packages (average in last 5 seconds of streaming) (19) and the counter of the total number of lost packages (20) become active, as depicted in Figure 6.6.

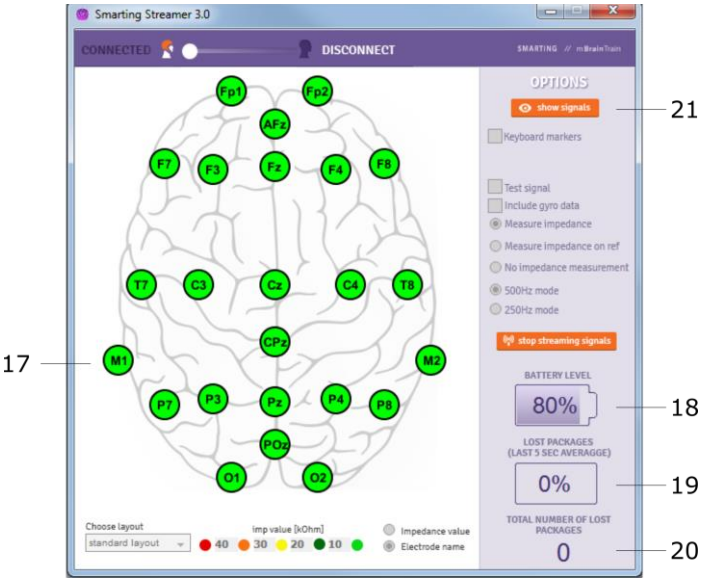


Figure 6.6 The streamer view when the signals are streaming with the impedance measurement switched on

In order to visualize the signals, click the *show signals* button (21) (Figure 6.6), upon which the *Signal display* window is activated (Figure 6.7). If the impedance measurements are selected, the color-coded impedance values may be observed on the left side of the *Signal display* window, next to the electrode names (22). The red line (23) is running in front of the signals and denotes the most recent signal values. With this, it is possible to observe the streamed signals in real-time.

More functionalities of the *Signal display* window will be presented in the subchapter 6.7 (*Signal display* window).

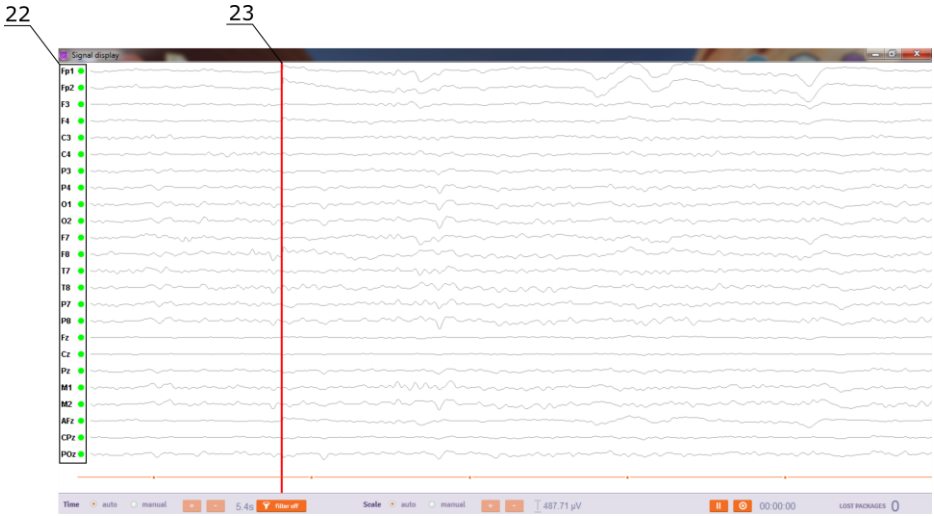


Figure 6.7 The *Signal display* window, in case when the impedance measurement is selected. The indication of the impedance values are presented in the left part of the *Signal display* window (22). The red line denotes the most recent samples (23).

6.5 Streaming signals with 500 Hz sampling frequency and with the impedance measurements switched off

Upon mounting the cap and ensuring the proper electrode contacts, it is advisable to switch off continuous impedance measurement before proceeding to data visualization and acquisition, because this will reduce the high frequency noise components. If the box *No impedance measurement* (number 13 in Figure 6.4) is selected and the sampling frequency is set to 500 Hz (number 14 in Figure 6.4), the streamer main window looks like the one depicted in Figure 6.8. Two main differences between the cases *measure impedance* and *No impedance measurement* is that when impedance measurement is not selected, the electrode layout does not have the color codes (17) and it is not possible to observe impedance values, as it can be seen from Figure 6.8.

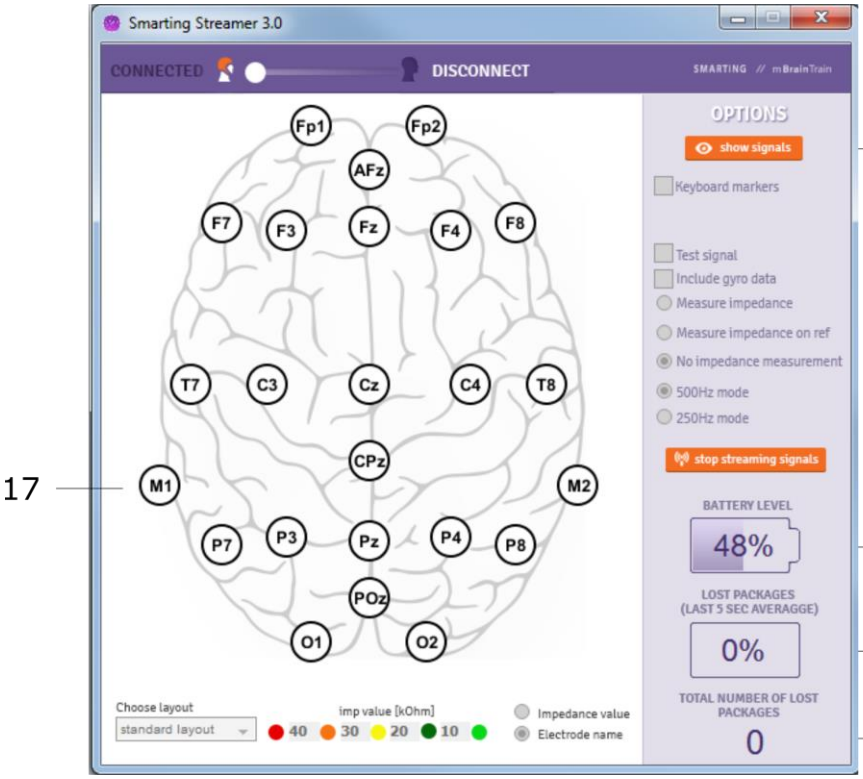


Figure 6.8 The main window interface when the impedances are disabled and the signal streaming is set to 500 Hz sampling frequency

When visualizing the signals in the condition when impedances are switched off, the *Signal display* window does not visualize the color-codded impedance values next to the electrode names (22), Figure 6.9.

Same as in Section 6.4, the red line runs in front of the signals (23).

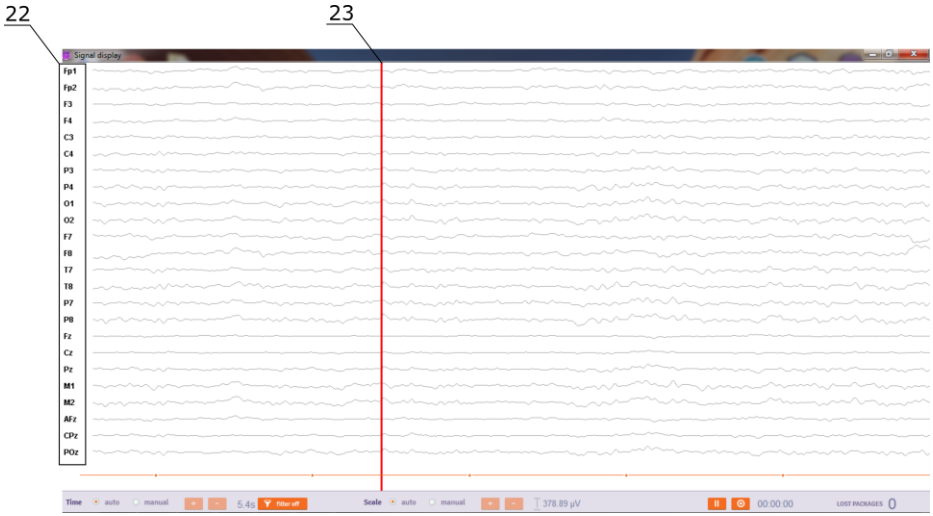


Figure 6.9 The *Signal display* window, in the condition when impedances are switched off. The impedance values are no longer visualized in the left part of the *Signal display* window (22). The red line runs rightwards (23) denoting the most recent samples.

6.6 Streaming signals with 250 Hz sampling frequency

When selecting the signal streaming with *250 Hz mode* (15, in Figure 6.4), the electrode impedance measurement is not enabled, i.e. if the box 15 is checked, the *Measure impedance* (11) and *Measure impedance on ref* (12) options in main window are no longer available (Figure 6.10). There is also a note on the bottom of the streamer explaining it.

All the other functionalities remain the same as in case of the 500Hz sampling rate and when the option *No impedance measurement* is selected (e.g. as in Figure 6.8). The *Signal display* window is also identical to the one depicted in Figure 6.9.

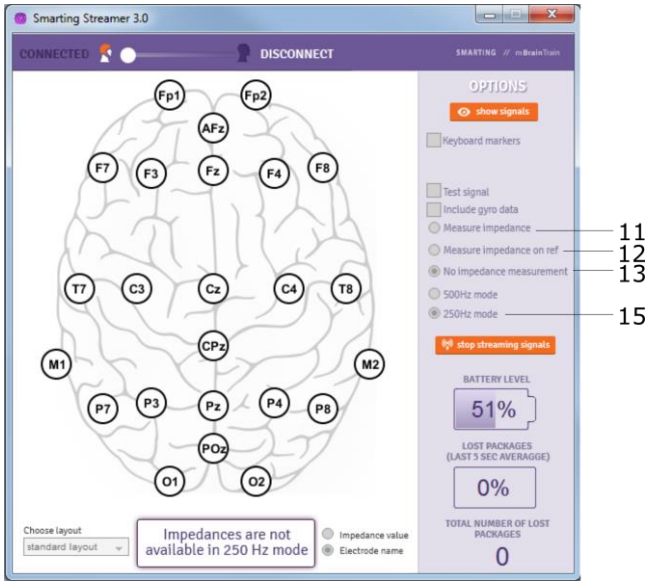


Figure 6.10 The main window interface when the sampling frequency is set to 250 Hz

6.7 *Signal display* window

The click on the *show signals* button (number 21 from Figure 6.8) starts the *Signal display* window, as depicted in Figure 6.11. The *Signal display* window shows the raw EEG signals from each electrode that was selected in the main window.

The *Signal display* window allows visualizing the EEG (also gyroscope) signals in real time. The red line (23) runs in front of the signals and denotes the most recent samples. As mentioned earlier, if the impedances are switched on, the color coded circles, that represent the impedance values, will appear in the left part of the *Signal display* window, next to the electrode names (22).

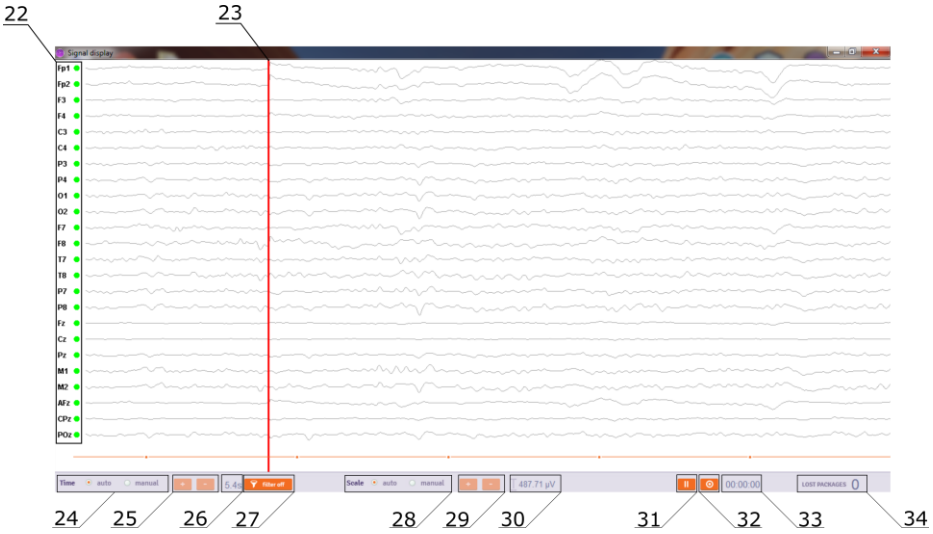


Figure 6.11 The *Signal display* window

The following options for signal visualization are available (Figure 6.11):

- The time scale (24):
  - If set to *auto*, the time scale is automatically set;
  - If set to *manual*, the user can manually change the corresponding time scale by clicking *+* to increase or - to decrease the time scale (25) – this controls the time window being displayed;
  - The time scale value is always shown (26).
- The *Signal display* window shows the filtered signals by default. The filter function is designed by using the bandpass filter (0.1-40Hz). However, this function can be disabled and the raw signals can be visualized by clicking the *filter off* button (27). To observe the filtered data again, click the same button again. ***Note: the signals are filtered for visualization purposes only. When recording or streaming the signals, the streamer stores and transmits the raw (non-filtered) data regardless of the filtering option selected;***
- The amplitude scale is also by default set to *auto* (28). In this way, the scale is optimized to visualizing all the signals from each of the channels. Alternatively, the user can set the scale to manual (28) and adjust it by pressing *+* or - sign (29). The amplitude scale value is always visible, while the *Signal display* window is on (30); For optimal

visualization, manual values between 200 and 500 µV represent good practices.

- For visual inspection, the user can pause the *Signal display* by pressing the *pause* button (31). ***Note: by pressing the pause button, the user just pauses the signal visualization, but not the signal acquisition, streaming or recording;***
- The EEG signals can be recorded directly by the streamer. The EEG signals can be recorded in .BDF or .XDF file formats. By pressing the *record* button (32), the *Recording window* pops-up, where the user can choose the recording options (more on the signals recording will be presented in the subsequent subchapter 6.8). The user can also stop the recording by clicking the same button (32);
- The time length of the recorded file can be tracked during recording (33);
- If any loss of packages occurs, the cumulative number of package loss is continuously visualized (34).

6.8 Recording the EEG signals usng Smarting streamer

For recording the signals from SMARTING streamer, click on the recording button (number 32 from Figure 6.11). Once the recording button is clicked on the *Recording window* pops-up (Figure 6.12), where the user chooses if the recording will be made in .XDF (by checking the XDF file – 35) or .BDF (by checking the BDF file – 36) file format.

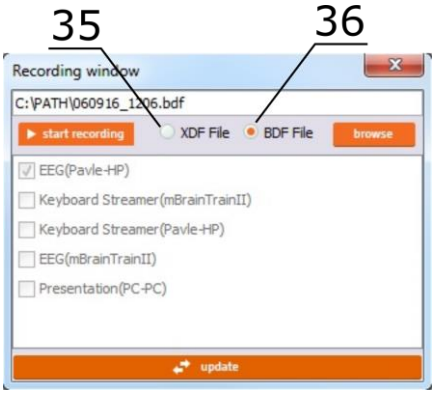


Figure 6.12 The *Recording window* overview

Lab Streaming Layer (LSL) Compatibility:

Lab Streaming Layer (LSL, https://github.com/sccn/labstreaminglayer) is an open-source, free platform that allows precise synchronous recordings of multiple signal streams coming from various sources. As such it is a very convenient approach that allows **very precise triggering**. All available trigger streams will be automatically displayed in the signal display window as vertical colored lines.

Apart from precise triggering, SMARTING Streamer is fully compatible with other platforms that support the LSL protocol. It allows streaming signals into LSL and receiving other LSL streams from networked PCs in real-time. Moreover, with SMARTING streamer, it is possible to record all the available streams in single .XDF file.

The name of the SMARTING stream that is sent to LSL is set up during the connecting phase (Figure 6.3). The name of the stream should be written in the *Stream name* text field.

6.8.1 Using the XDF file format

Once the field *XDF file* is checked (annotation 35 in Figure 6.13) it is possible to choose from the list of available LSL streams (37). The list of available LSL streams is presented in the white box (37). The default stream that is readily available is the SMARTING stream (EEG from the Figure 6.13). The name of the stream appears first (38), while the streaming device name is written in the parentheses (39).

If there are other devices that stream the signal from other networked PC, but those are not visible in the SMARTING streamer, click the *update* button (40). Upon clicking the button *update*, the other visible streams will appear in the white box (as in Figure 6.14). ***Note: If other streams are not visible upon updating the stream names, try disabling windows firewall by clicking the Control Panel->System and Security ->Windows Firewall->Turn Windows Firewall on or off->Turn off Windows Firewall.***

Tick the boxes in front of the streams to be recorded in the single .XDF file and the selected streams will be recorded simultaneously.

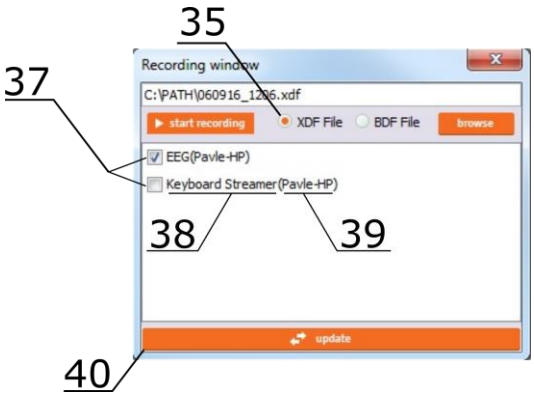


Figure 6.13 The *Recording window* overview, when the user selects the *XDF file* option

Note: In case of recording two SMARTING EEG streams, it is important to provide different names to the EEG streams when connecting the SMARTING device to Smarting Streamer (as described in Figure 6.3). As an example, the EEG streams can be named EEG1, EEG2, etc., as shown in Figure 6.14.

In order to choose the location and the file name of the *.XDF file* to be recorded, choose either to manually enter the path and the filename in the white box (41), to click the *browse* button (42), or keep the automatically generated path and name (as in Figure 6.14).

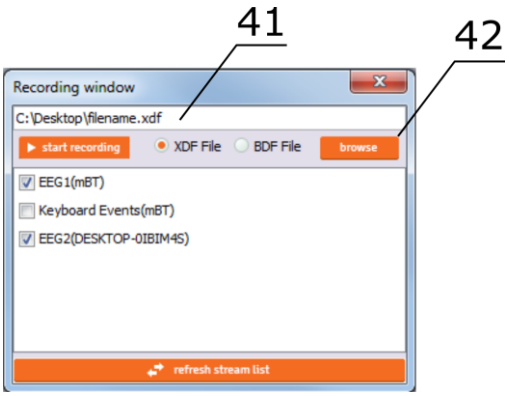


Figure 6.14 The *Recording window* overview with multiple streams from multiple PCs

If the *browse* button (42) is clicked, a new window *choose storage folder* will pop-up in which the location of the file should be defined (the default location is *C:/Smarting Streamer recordings*), as depicted in Figure 6.15.

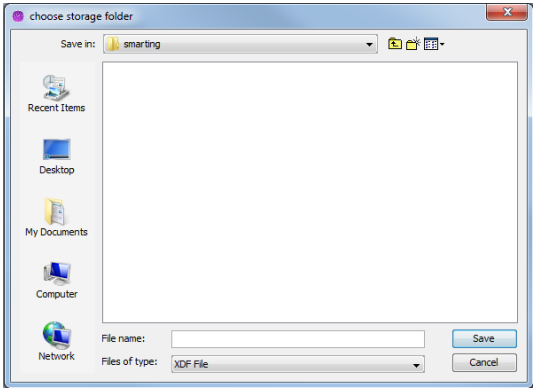


Figure 6.15 The *choose storage folder* window overview

Once the recording folder is set, provide the filename and save the path by clicking the *Save* button (Figure 6.15).

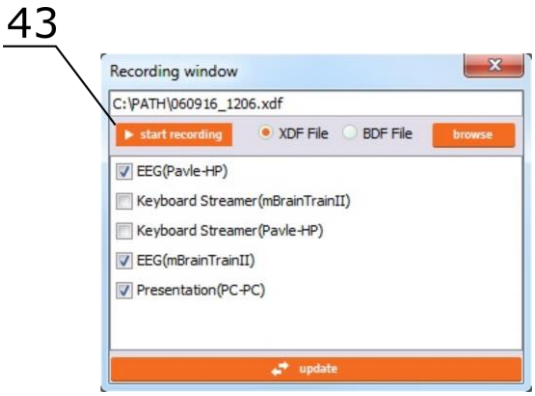


Figure 6.16 The *Recording window* – Start recording signals

In order to start recording a file, press the *start recording* button (43 in Figure 6.16). At this moment, the pop-up window withdraws and the *Signal display* window appears.

To stop the recording, press the recording button in the *Signal display* window (denoted as number 32 in Figure 6.11).

6.8.2 Using the BDF file format

When selecting the *BDF file* option (36, Figure 6.17 the box with the available streams becomes inactive since it is not possible to collect multiple streams when recording a .BDF file format. However, .BDF format generally takes 25% less disk space than if the same data is recorded in .XDF and is generally supported by a larger number of post-processing software as a traditional EEG file format.

The other steps are exactly the same as when recording the *.XDF file* format, i.e. choose the path for the recording the .BDF file (either manually or by clicking the button browse and navigate to the folder by GUI).

When the path is set and the filename is given, simply press the *start recording* button.

To stop the recording, press the recording button in the *Signal display* window (denoted as number 32 in Figure 6.11).

Figure 6.17 The *Recording window* overview, when the *BDF file* option is selected

6.9 Closing the *Signal display* window and disconnecting the amplifier

To close the display window, simply click *hide signals* button in the main window, or close the *Signal display* window by clicking the *x* button in the top right corner.

When the measurement is finished, click the *disconnect* button in the upper left corner of the streamer's main window (Figure 6.4) to put the device in idle mode.

6.10 Software update

Once the updated version of the streamer is available, Smarting Streamer will notify the user.

If the new update contains major modification, the update notifications will pop-up prior to entering the streamer (as shown in Figure 6.18). The user will be asked to choose one of the following options:

- update the streamer;
- get the new notification in 7 days;
- To ignore the current update (by choosing the option never in Figure 6.18), or
- To cancel the notification and receive the update notification next time when the streamer starts.

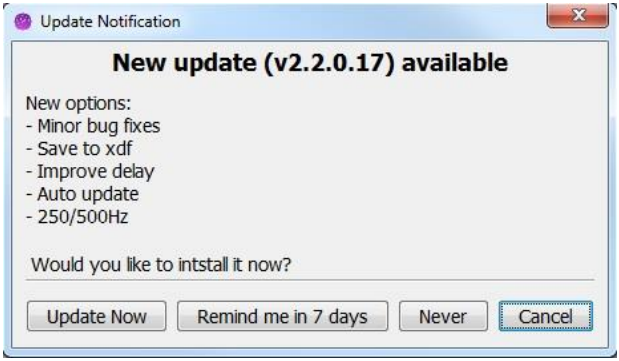


Figure 6.18 The *update notification* window

If the user chooses the *Update Now* option from the update notification window (Figure 6.18), the new streamer version will automatically be downloaded and installed.

Note: It is necessary that your PC is connected to the Internet during the auto update process.

If the user chooses the *Remind me in 7 days* option, the *Update Notification* window will close and the streamer home window will appear with the update notification (47), as shown in Figure 6.19. If the user clicks the update button (47), the *Update Notification* window (Figure 6.18) will pop-up again.

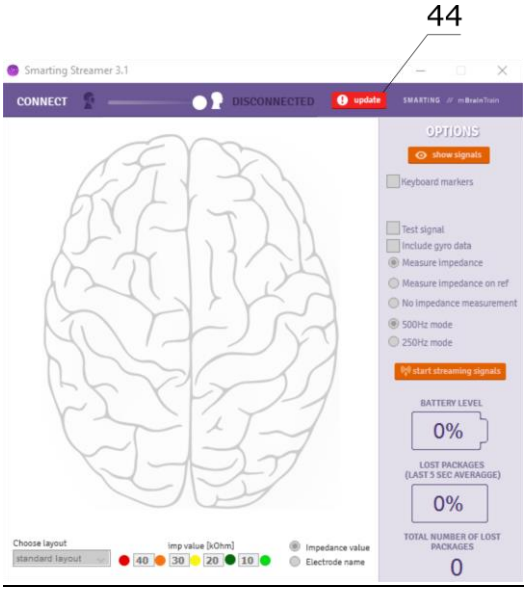


Figure 6.19 The *Update Notification* that appears on the streamer home page, if new major updates are available

If the user chooses the *Never* option, the *Update Notification* window will close and the streamer home window will appear with the *update* notification, as shown in Figure 6.19. If the user clicks the update button, the *update notification* window (Figure 6.18) will pop-up again, and the user can choose one of the available options.

If the user chooses the *Cancel* option, the *Update Notification* window will close and the streamer home window will appear with the update notification, as shown in Figure 6.19. If the user clicks the update button, the *Update Notification* window (Figure 6.18) will pop-up, and user can choose one of the available options.

In case only a minor fix was made to the streamer, the *Update Notification* window will not pop-up during the streamer initialization phase. However, the update notification icon (orange colored) (48) will appear in the streamer home window, as shown in Figure 6.20.

If the user clicks on the *update* icon, the *Update Notification* window will pop-up (as depicted in the Figure 6.18 and the user can choose one of the available options).

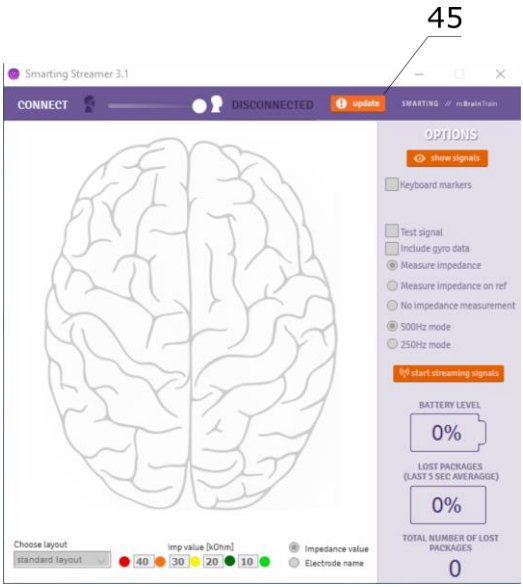


Figure 6.20 The *update* notification that appears on the streamer home page, if the new minor updates are available

7. Setting up the system

This chapter covers the case of using SMARTING to record EEG signals. Similarly one can record other physiological signals.

Note that the SMARTING amplifier is not compatible with other than passive type of recording sensors (passive electrodes).

Figure 7.1 Connect the amplifier to the cap.

Figure 7.2 Position the cap on the subject's head.

Figure 7.3 Carefully insert conductive gel to obtain high signal quality.

In order to obtain high quality EEG recordings, it is important to keep the impedance values low, preferably around 5 kΩ. To check the impedance values in real-time, use the SMARTING streamer described in Chapter 6.

1. Run the SMARTING Streamer application.

2. After connecting to the SMARTING device choose the appropriate layout, as described in Chapter 6.1 (shown in Figure 6.5). Choose impedance ranges for visualization of color indicators in the lower left panel by simply clicking on the value and changing it to the desired one. Click the *Calculate* button to accept the new settings (Figure 6.6).

3. Select channels to record and click Start Streaming signals. Values of electrode impedances should appear in the right panel, and the color coded impedances are shown in the middle of the top panel (Figure 6.6).

4. After the impedances are appropriately set up, the experiment can start. In order to avoid impedance measurements embedded in the data (seen as a 125Hz noise):

    a. Stop the streaming
    b. Choose *no impedance measurements*
    c. Restart streaming

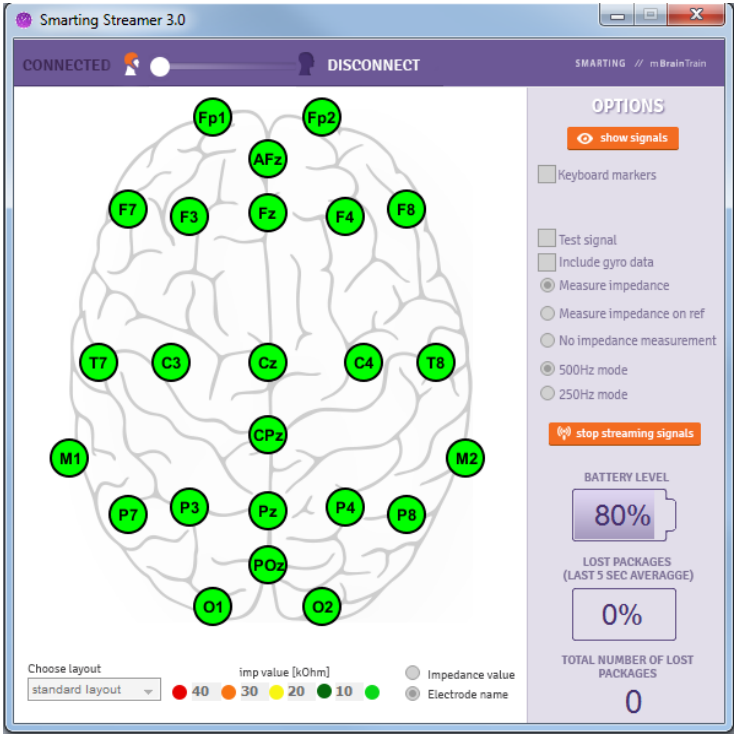


Figure 7.4 The impedance values are shown either as color-codes or the actual impedance values can be shown on the brain sketch (if impedance value option is checked)

8 SMARTING Android

SMARTING Android is mBrainTrain's Android application for fully mobile EEG recordings (Figure 8.1).

Figure 8.1 Android application for recording EEG data

mBrainTrain delivers the pre-installed software on a tested Android platform. Software updates are handled by a user himself, in a simple and intuitive manner. **Note: Not all Android devices ensure reliable performance and it is important that each platform is previously tested and verified by mBrainTrain. Also, SMARTING Android app performs the best on Android versions 7.1.2 and older.**

The newest SMARTING Android software release can always be downloaded from http://www.mbraintrain.com/support/

8.1 Software installation layout

- To install the application, copy the SMARTINGAndroid.apk file to the phone that will be used for recordings.
- Find the file from a file browser on your phone, and click on it to install the application. Prior to installation, make sure that installation from unknown sources is allowed, in your phone settings.
- If the previous version of the application is already installed, make sure to uninstall it before proceeding with the software update.

Note: The mobile phone included in the SMARTING package has already pre-installed Android application.

8.2 Connecting SMARTING

After starting the SMARTING Android application, the home screen will appear requesting to select the SMARTING device to connect to (Figure 8.2).
Note: For the best performance we recommend that the smartphone is in the airplane mode, but with enabled Bluetooth communication.

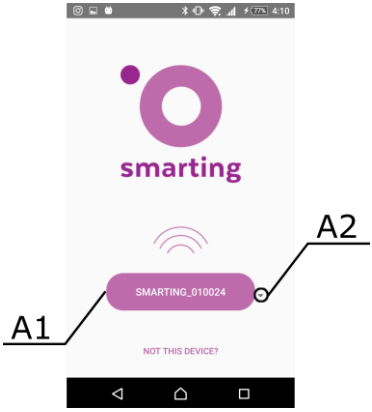


Figure 8.2 Starting screen

If the device name that user seeks to connect to differ from the one denoted with the A1 in Figure 8.2, select the arrow (A2) and the list of paired devices will appear, as depicted in Figure 8.3.

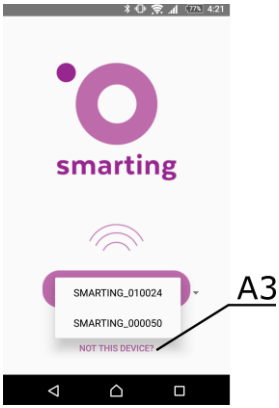


Figure 8.3 The list of paired devices

If the desired device does not appear in the device list, press the button *not this device* (A3 in Figure 8.3), which opens a *Bluetooth* window showing the list of paired devices (Figure 8.4).

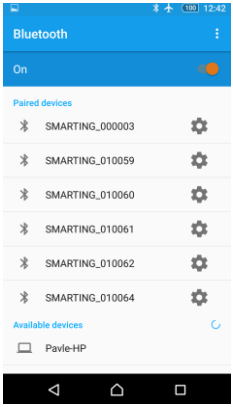


Figure 8.4 The list of paired devices

The list of available devices is displayed bellow the paired devices. Scroll down to choose the desired SMARTING amplifier (Figure 8.5).

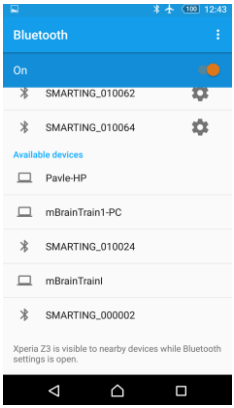


Figure 8.5 The list of available devices

When the device is found in the *Available devices,* select it and the device should pair automatically to the phone. Once the device is paired, click on a *back button*, and when returned to the home screen the paired devices will appear in the *choose device* box (A1 in Figure 8.2). Press the (A1) button, the device will connect to the smartphone, and the main window will appear, as shown in Figure 8.6. One additional indication of a proper connection is the blinking light on a Smarting device being connected.

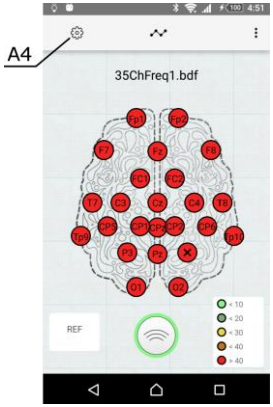


Figure 8.6 The main window overview

8.3 Settings

It is advisable the check all the recording parameters, settings and enabled sensor streams before initiating the recording. For this, the button *settings* should be chosen (A4 in Figure 8.6). By clicking the *settings* button, the settings menu appears (Figure 8.7) and user can choose between the following options:

- *Amplifier settings*
  - Disable or enable the impedances (A5);
  - Enable or disable the test signal (A6).
  - sampling frequency settings – 500 or 250 Hz (A7)

- *Application settings*
  - Impedance settings – Modification of the color-coded impedance threshold (A8)
  - Touchscreen marker settings – enabling/disabling the sound on touch markers and modification of touchscreen marker names (A9);
  - Recording settings (A10).
  - LSL stream settings – choosing which data will be streamed to local area network (LAN) over LSL protocol (A11); ***Note: this option is available for 250Hz sampling frequency only.***

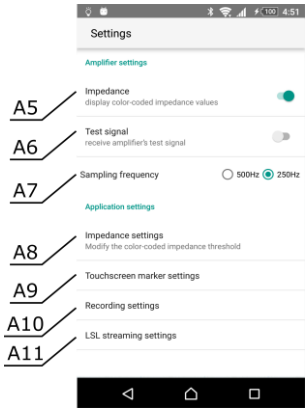
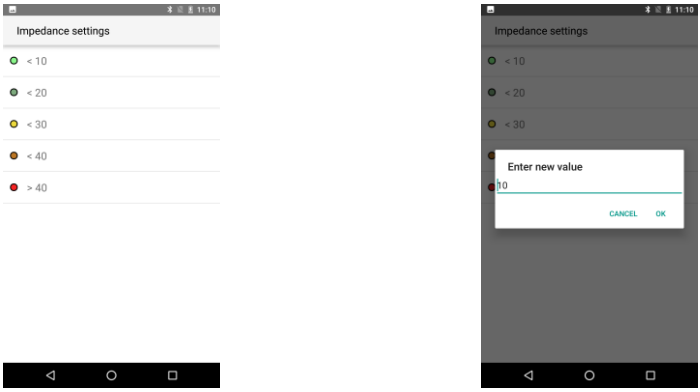


Figure 8.7 The settings window overview

8.3.1 Impedance Settings

The color coded values are set by default to values 10, 20, 30 or 40 kΩ, and above 40 kΩ as depicted in Figure 8.8a. However, the thresholds for color coded values can be manually set by clicking on the desired color and entering the new threshold value in pop-up window, as shown in Figure 8.8b.

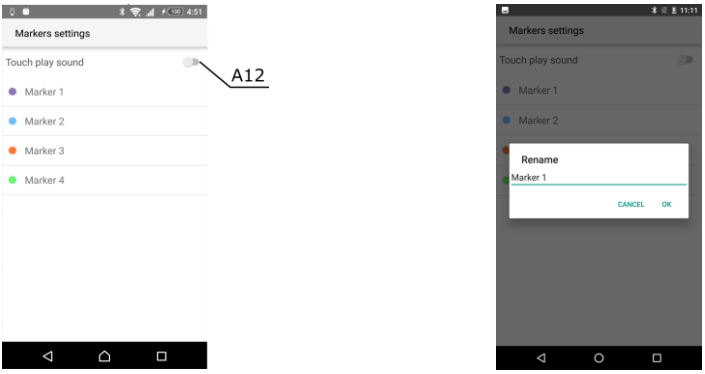


(a) (b)

Figure 8.8 Impedance settings window

8.3.2 Touchscreen marker settings

In touch marker settings window, the user can enable/disable sound for touch markers (A12 in Figure 8.9a). Furthermore, the user can change the marker names by clicking on the marker that should be renamed and enter the desired name in the pop-up window (as shown in Figure 8.9b). ***Note: the marker names can be written only in XDF file format. In the BDF file format the markers will appear in file with generic annotations, namely as 101, 102, 103, 104.***



(a) (b)

Figure 8.9 Touchscreen marker settings window

8.3.3 Recording settings

In the recording settings window the user can choose to record the data in XDF or BDF file format (A13, Figure 8.10).

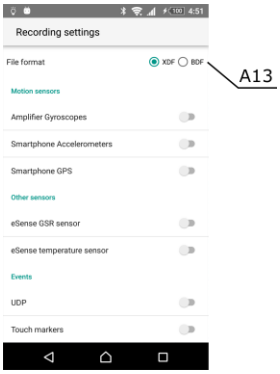


Figure 8.10 Recording settings window – choosing the recording file format

8.3.3.1 Inclusion of Motion sensors into recording file

Apart from choosing the file format, the user can also select to record the data from motion sensor by enabling them (built in gyroscope – A14, Smartphone's accelerometers – A15, Smartphone GPS – A16 in Figure 8.11).

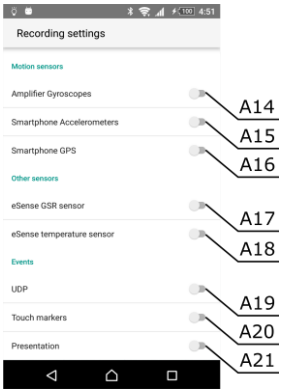


Figure 8.11 Recording settings window – inclusion of other sensors and/or events for synchronous recordings

8.3.3.2 Inclusion of external sensors

SMARTING android application allows the synchronous recording of EEG and other supported sensors in XDF file format (only). External sensors are not included in the default Smarting configuration, and are subject to specific quote that should include them as items.

eSense sensors

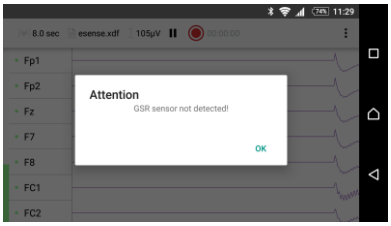
SMARTING android application supports the electrodermal activity (EDA) recordings made using the *Mindfield® Biosystems* eSense Skin Response sensor. More information on eSense Skin response sensor: https://www.mindfield.de/en/Biofeedback/Products/Mindfield%C2%AE-eSense-Skin-Response.html

In order to record the galvanic skin response (GSR), plug in the eSense Skin Response sensor into the smartphone's audio jack. If the sensor is misplaced, or not connected, a warning will appear in the signal display window (as depicted in Figure 8.12a). In that case, ensure that the sensor is inserted properly in to the audio jack, return to the signal display window, and observe no warnings.

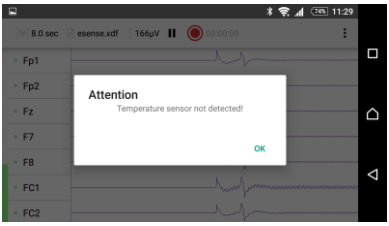
Another external sensor that can be used with SMARTING is the *Mindfield® Biosystems* eSense temperature sensor. More information on temperature

sensor can be found in following link: https://www.mindfield.de/en/Biofeedback/Products/Mindfield%C2%AE-eSense-Temperature.html

In order to record the body temperature, plug in the eSense Temperature sensor into the smartphone's audio jack. If the sensor is misplaced, or not connected, a warning will appear in the signal display window (as depicted in Figure 8.12b). In that case, ensure that the sensor is inserted properly in to the audio jack, return to the signal display window, and observe no warnings.



(a)



(b)

Figure 8.12 The pop-up window that appears if the eSense Skin Response (a) or eSense Temperature sensor (b) is wrongly positioned in the smartphone's audio jack

8.3.3.3 Embedding wireless triggers in EEG data

SMARTING android application allows wireless triggering either over LSL, or UDP protocol.

There are currently two applications available for recording the event-related potential (ERPs) experiments solely using smartphone, namely *OpenSesame (http://osdoc.cogsci.nl/)* and *Neurobs® Presentation* (https://www.neurobs.com/menu_presentation/menu_features/mobile).

OpenSesame uses the UDP protocol for embedding the trigger information in both the BDF and XDF file format. The UDP triggers can be enabled by choosing the option A19 – Figure 8.11.

Touchscreen triggers can be synchronously recorded with the EEG and other sensors data, by enabling the touchscreen markers (option A20 – Figure 8.11). The touchscreen triggers can be recorded in both XDF and BDF file format.

Neurobs® Presentation uses the LSL protocol for sending the timestamps of the triggers that can be recorded solely in the XDF file format (by enabling option A21 – Figure 8.11).

8.3.4 Streaming settings

SMARTING android application allows streaming the data over LAN network, by using the LSL protocol. In order to setup the streaming settings, click on *streaming settings* (option A11 – Figure 8.7). ***Note, the LSL streaming over LAN network is available only when sampling frequency is set to 250 Hz.***

8.3.5 Recording settings

In order to allow the data streaming, enable *stream data to LSL* (A22 – Figure 8.13). Once the LSL data streaming is available, streaming data from motion sensors is available and it can be enabled by selecting the wanted motion sensors (Built-in Gyroscope – A23; Smartphone Accelerometers – A24; and Smartphone GPS data – A25, depicted in Figure 8.13).

8.4 Main Window options

Once the desired settings are completed, the user can return to the main page by clicking the *back* button at the bottom left corner of the application.

If the impedances are enabled, the electrode layout that appears over the scalp sketch will show the impedance values in color codes (A26), and the color coded values are presented in the bottom right corner of the application (A27), as depicted in Figure 8.14.

In order to measure the impedance on the reference electrode, click the *REF* button (A28 – Figure 8.14), and the reference electrode appears in the middle of the scalp sketch. Impedance values are presented in the color codes (A29 – Figure 8.15). To return to the electrode layout, press *REF* button (A28 Figure 8.15).

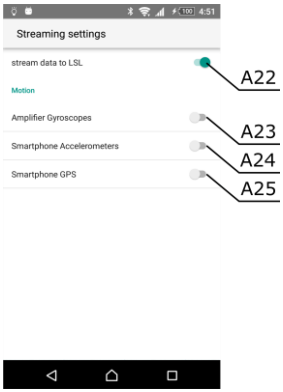


Figure 8.13 Streaming settings window

The electrode layouts can be selected by pressing the menu button (as depicted by A30 in Figure 8.15), and the available layouts will appear in the drop down menu (A31 – Figure 8.15). There are two preinstalled layouts. However, the user can add custom layouts by adding them in the root folder of the cellphone's internal memory. Upon adding the new layouts, they will appear in the drop down menu, after pressing the button (A30 – Figure 8.15).

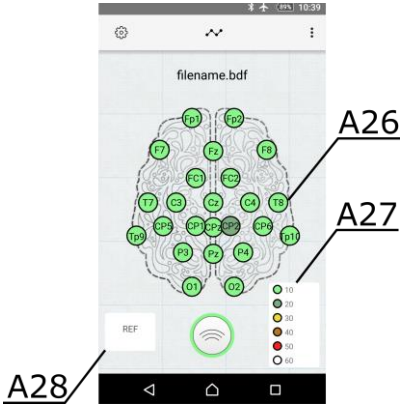


Figure 8.14 The overview of the main window, when the impedances are enabled

If, for any reason, the electrodes should be switched off, the user can simply tap the particular electrode and the electrode will be marked as (x) . Once the electrode is switched off, it will no longer be available neither in *Signal*

display window, nor in the recorded file.

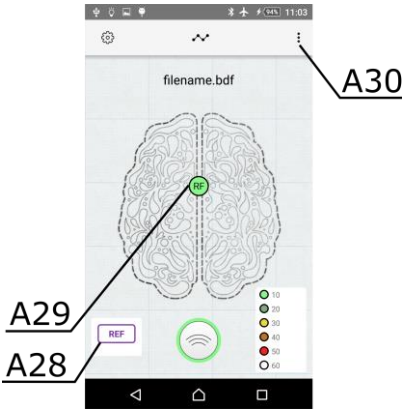


Figure 8.15 The *measure impedance on reference channel* display

If impedances are disabled, the layout without color codes will appear in the main screen (as in Figure 8.16).

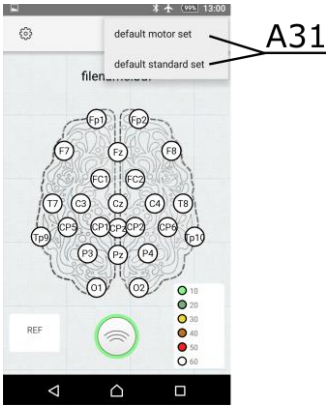


Figure 8.16 The electrode layouts can be chosen from the list of available layouts

To name the file that is to be recorded, click on the field A32 in Figure 8.17 and type the desired name in the pop-up keyboard. Upon naming the file, the arrow pointing down should be pressed (A33 – Figure 8.17) in order to remove the keyboard.

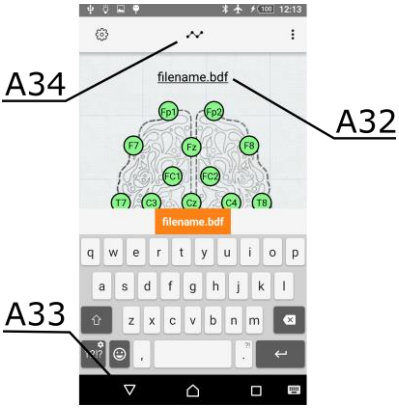


Figure 8.17 Changing the filename

8.5 Signal Display

To visualize the signal, press the button (A34 – Figure 8.17) and the *Signal display* window will appear (Figure 8.17).

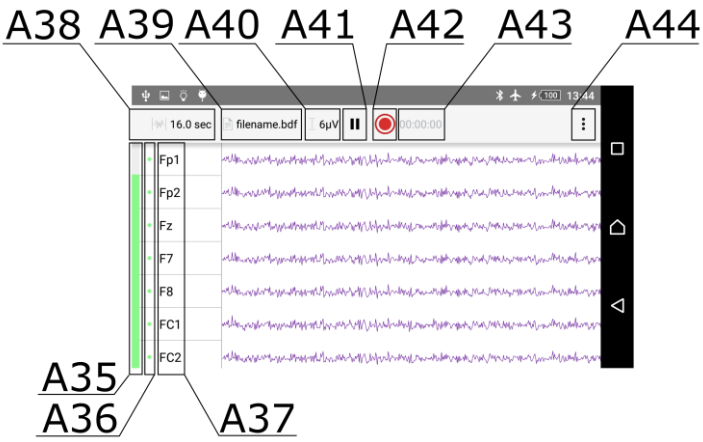


Figure 8.18 *Signal display* window, when the impedances are enabled

The battery level of an amplifier is depicted with the vertical color bar at far left side of the signal display window (A35).

If the impedances are switched on, small color-coded circles (A36) will appear next to the electrode names (A37). However, if the impedances are switched off, no color-coded circles will appear (Figure 8.19).

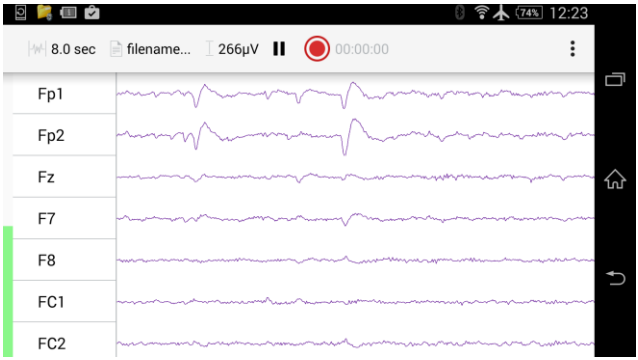


Figure 8.19 *Signal display* window, when the impedances are disabled

The *Signal display* window can visualize up to seven channels at once. In order to visualize the non-visible channels, slide vertically up or down.

The time scale is presented in the upper-left corner of the *Signal display* window (A38 – Figure 8.18). The time can be adjusted by horizontal pinch-to-zoom gesture (as shown in Figure 8.20a).

(a) (b)

Figure 8.20 Adjusting the time scale (a) and magnitude scale (b)

The filename given in the main screen (as in Figure 8.17) can be modified in the *Signal display* window, by clicking at the area A39 in Figure 8.18.

The magnitude scale is depicted in the area A40 (Figure 8.18; By default, the

magnitude scaling is automatic, however, the user can change it by vertical pinch-to-zoom gesture (as depicted in Figure 8.20b)).

The signals can be paused for the visual inspection (A41 in Figure 8.18). ***Note: The pause only freezes the visualization, the signals are still continuously streamed and recorded.***

8.6 Recording the EEG signal

The signals can be recorded by clicking the red *record* button (A42 in Figure 8.18). Once the recording has started, the pop-up window *Recording preview* appears. In the recording preview window, one can check the filename, sampling frequency, number of channels, whether motion data, other sensors and/or events will be included in the recording. The recording preview window is shown in Figure 8.21.

The timer, positioned next to the record button, becomes active (A43 in Figure 8.22) when recording is started. Simultaneously, button for activating touch markers appears (A45 in Figure 8.22) and if this button is clicked, touch marker fields appear on the *Signal display* window as shown in Figure 8.22 (A46).

The press on the *menu* button (A46 in figure 8.23) activates the drop down menu where user can switch off the visualization filter and autoscalling.

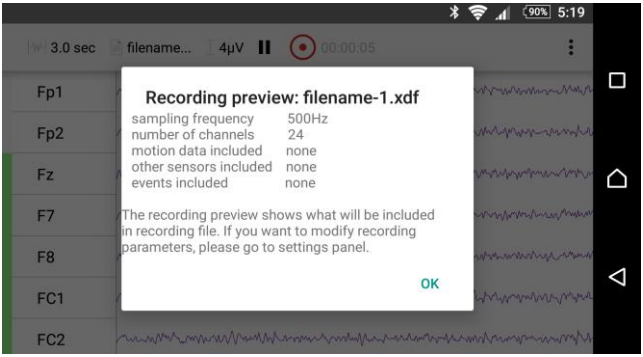


Figure 8.21 Recording preview window

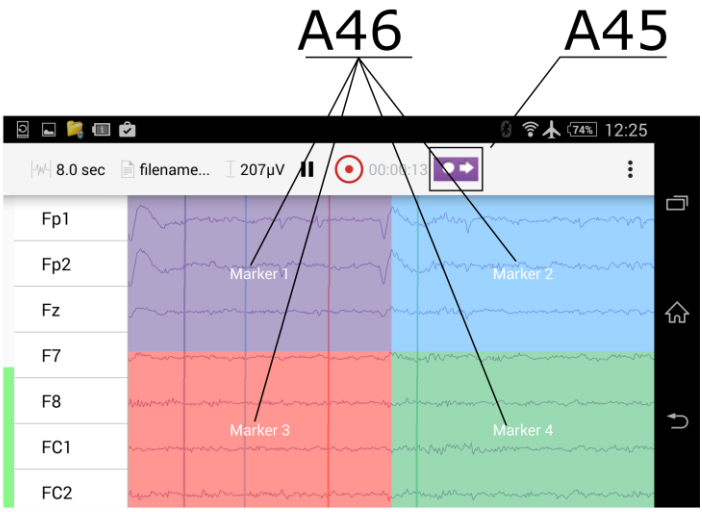


Figure 8.22 Activation of touch markers

To stop recording, click the *record* button once again (A42 in Figure 8.18) and signal recording will cease. When the recording is stopped, an experiment summary window pops-up (Figure 8.23) showing the following information about completed recording:

- filename
- sampling frequency that was used during the recording
- number of events (Triggers)
- The percentage of lost packages for the whole duration of the recording
- Number of Channel

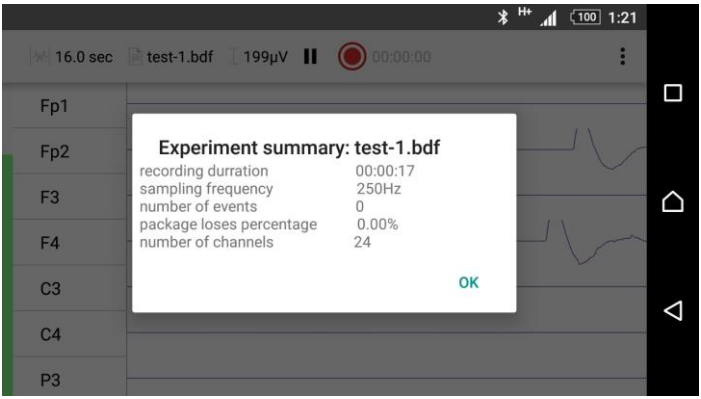


Figure 8.23 The *Experiment summary* window

The *Experiment summary* window is closing upon clicking the button *OK*.

Click the *back* button to return to the main screen.

8.6.1 Recording ERP experiment

As mentioned in the Section 8.3.3.3 the SMARTING android application is capable of recording the ERP experiments, where the stimulus triggers are sent to the application and written into file wirelessly (either over UDP or LSL protocol).

8.6.1.1 Recording ERP experiments with the OpenSesame software

OpenSesame experiments can be written in both available file formats (BDF and XDF). In order to send the markers over the UDP protocol, enable sending the events over UDP protocol in the *recording settings* page (as explained in the Section 8.3.3.3.).

The next step is to give the desired filename, either in the main window (as shown in Figure 8.17), or in the signal display window (as explained in Figure 8.18). After naming the file, click on the recording button (A42, Figure 8.18). **Please read carefully whether the UDP is enabled, in the recording preview window (Figure 8.21, under section *events included*).**

After selecting "OK" in the recording preview window, select the home button on the smartphone (return to the smartphone's home screen) and enter the OpenSesame application.

In the open sesame application, select and run the wanted experiment.

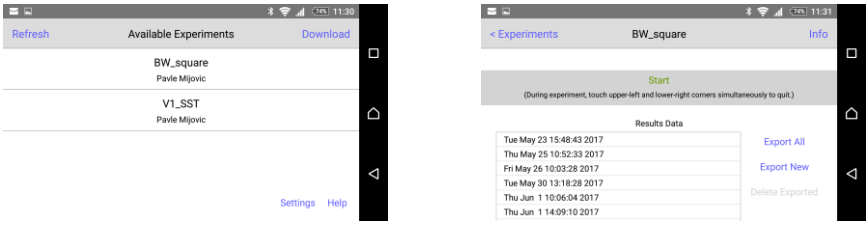
Upon experiment completion, return to the SMARTING application and cease the recording (the information about recorded events will be presented in the recording summary window – Figure 8.23).

NOTE: OpenSesame is the open-source software no longer actively maintained for Android. The user opting for this tool should ensure the reliability of the experiments first.

8.6.1.2 Recording ERP experiments with the Neurobs® Presentation software

Neurobs® Presentation ERP experiments can be written in solely in the XDF file format. In order to record the presentation experiments, enable *presentation* in the recording settings window (as explained in the Section 8.3.3.3.).

Next step is to enter the Presentation application and select the desired experiment from the experiment list (Figure 8.24a) and enter the experiment main screen (Figure 8.24b) in order to initialize the presentation stream. ***Note: do not run the experiment itself at this moment!*** After entering the experiment, return to SMARTING application and name the recording file in the main window (as shown in Figure 8.17). Upon naming the file, select the signal display button (A34, Figure 8.16).



(a) (b)

Figure 8.24 The overview of the Presentation application; (a) – experiment list and (b) – the experiment main screen

NOTE: If the SMARTING application experience difficulties in opening the presentation stream, the following warning will pop-up: "Error in stream opening – Please return to the main window and retry." If the warning

appears, please return to the main window and re-enter the signal display window (A34, Figure 8.16).

Upon entering the signal display window, click on the recording button (A42, Figure 8.18). **Please read carefully whether the presentation is enabled, in the recording preview window (Figure 8.21, under section *events included*).**

After selecting "OK" in the recording preview window, return to the Presentation application and run the experiment.

Upon experiment completion, return to the SMARTING application and cease the recording (the information about recorded events will be presented in the recording summary window – Figure 8.23).

8.7 Disconnecting the Amplifier

In order to disconnect the amplifier from the application click the round button (A47 in Figure 8.25).

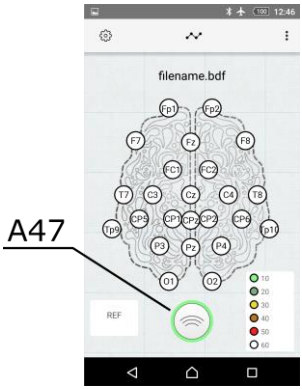


Figure 8.25 Disconnecting the amplifier from the SMARTING android application

When the disconnect button (A47) is pressed, the user is asked to confirm the disconnection of the device (Figure 8.26). Click the *OK* button to finally disconnect.

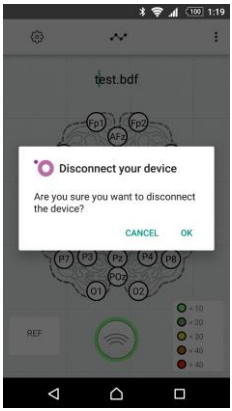


Figure 8.26 *Disconnect the device* window

9. OpenViBE software and SMARTING driver for OpenViBE

SMARTING device is supported by OpenViBE. OpenViBE is an open source platform for brain computer interface and real-time neuroscience experiments, and can be freely downloaded from http://openvibe.inria.fr. We also provide an installer application on the USB stick that comes with the SMARTING package. To install it from the USB, simply launch the installer application file: openvibe-1.1.0-setup.exe and follow the on-screen instructions, briefly described in the figures below.

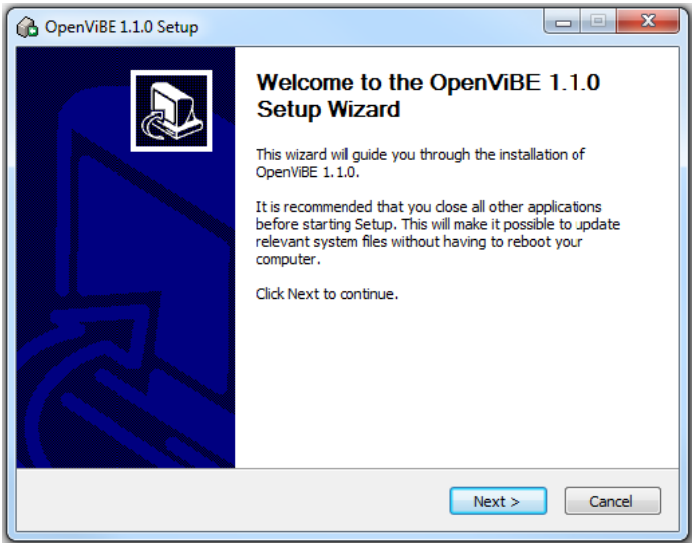


Figure 9.1 Click the *Next* button

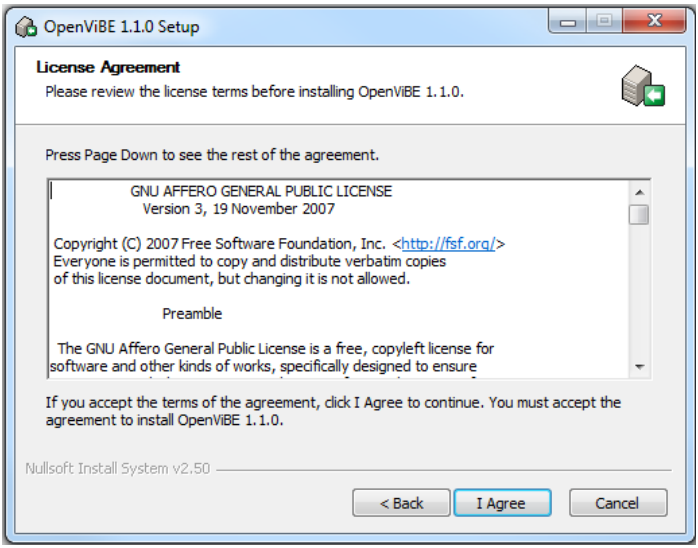


Figure 9.2 Click the *I Agree* button to agree with the open source license

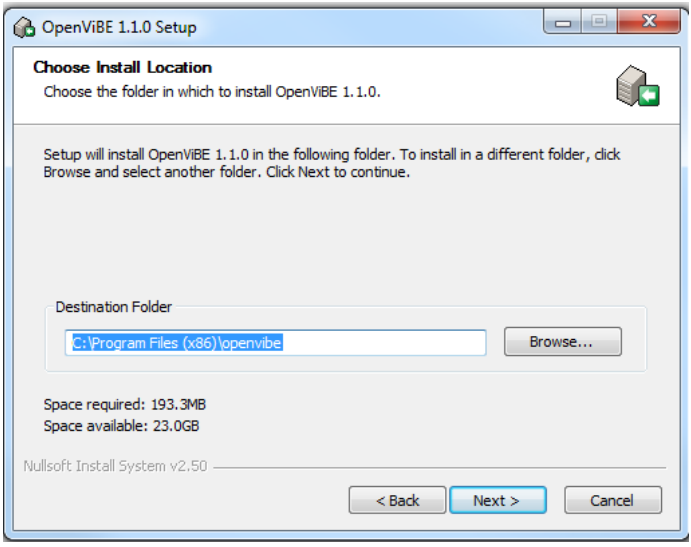


Figure 9.3 Click the *Next* button to proceed with the installation

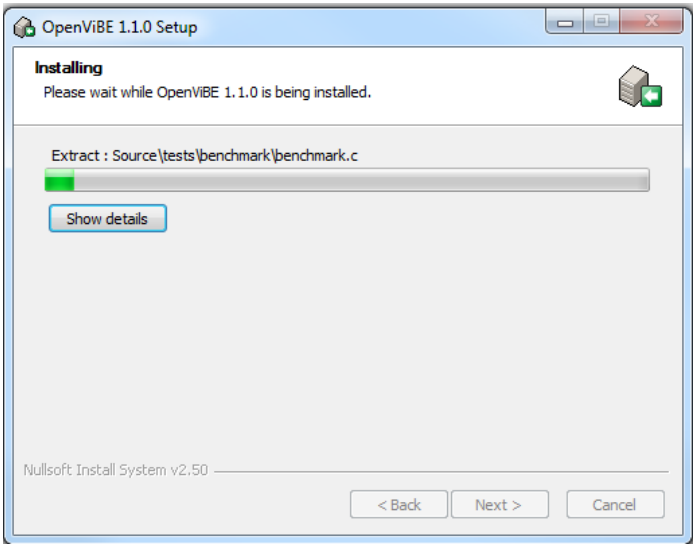


Figure 9.4 Wait until the installation is finished

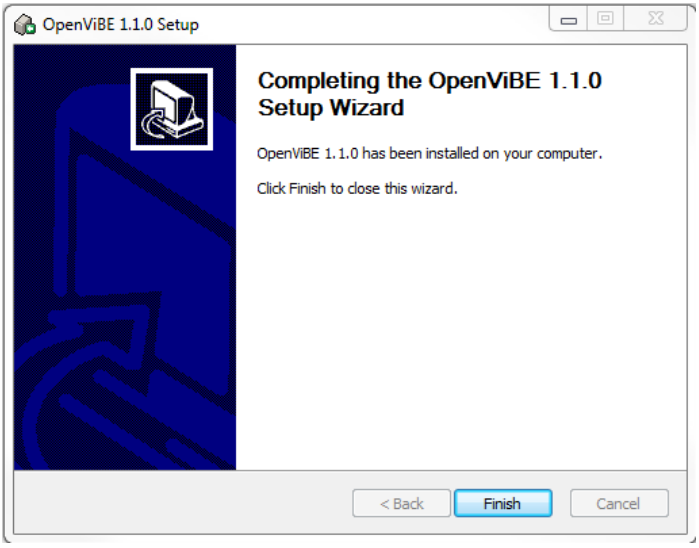


Figure 9.5 Close installation window by clicking the *Finish* button

The OpenViBE driver is now located at *C:\Program Files (x86)\openvibe*

To start acquisition server, run the *OpenViBE acquisition server*. Choose the connection port by clicking the *Driver properties* button (Figure 9.6). Input the correct COM port number in the *Port Number* text box - Figure 9.7 (appropriate COM port can be detected as described in Figure 5.4). It is important to note that after the port number has been input a user must press the keyboard **ENTER (RETURN) key before applying the changes.**

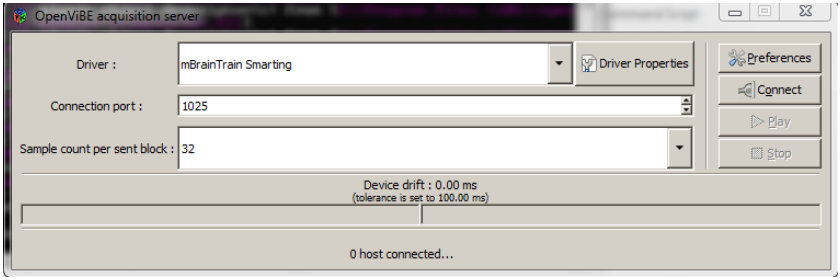


Figure 9.6 *Acquisition server* window

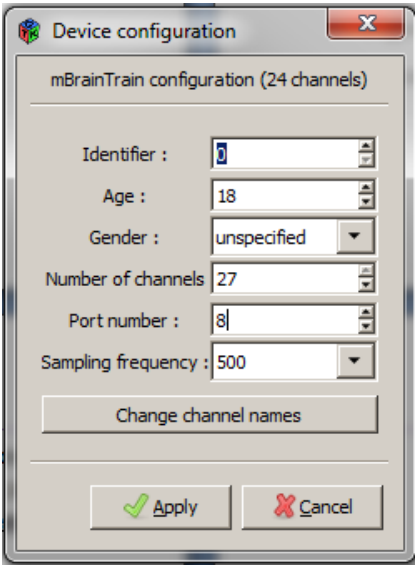


Figure 9.7 *Device configuration* window

10. External triggering

External triggers can be sent wirelessly, both to PC and Android platforms. For precise external triggering, the recommended method is the usage of the LSL protocol (already described in Chapters 6 and 8), through Neurobs® Presentation software (or others, but it is highly recommended to check timing precision beforehand). Another possibility is to use the UDP protocol. One solution is to utilize the OpenSesame software. However, when using the OpenSesame, both the Opensesame and SMARTING device should be connected to the same PC or smartphone. Alternatively, when using LSL protocol (with Presentation or other software or peripheries) triggers can be sent over the LAN and still keep the minimal delay and jitter, usually in the range of sampling rate (e.g. 2 or 4ms).

10.1 Procedure for sending triggers from Neurobs® Presentation

Presentation is renowned stimulus delivery and experiment control program for neuroscience research (https://www.neurobs.com/presentation).

Presentation supports the LSL protocol, which means that the triggers can be sent both if running on the same machine as the SMARTING, or a separate device, as long as they are both connected via LAN/WLAN networks. Please note that for sending triggers over LAN/WLAN, user needs to use Smarting Streamer PC utility. If using Android for signal acquisition/experimentation, the Presentation software must be on the same device as the SMARTING Android application.

In order to enable the LSL triggering protocol in Presentation software, navigate to the settings tab and choose the tab general (as depicted in Figure 10.1).

Under the tab general thick the *Lab Streaming Layer* (Figure 10.1). In order to define the stream name and string marker contents, click on the properties tab, next to the Lab Streaming Layer checkbox and the LSL data port window will pop-up (Figure 10.2).

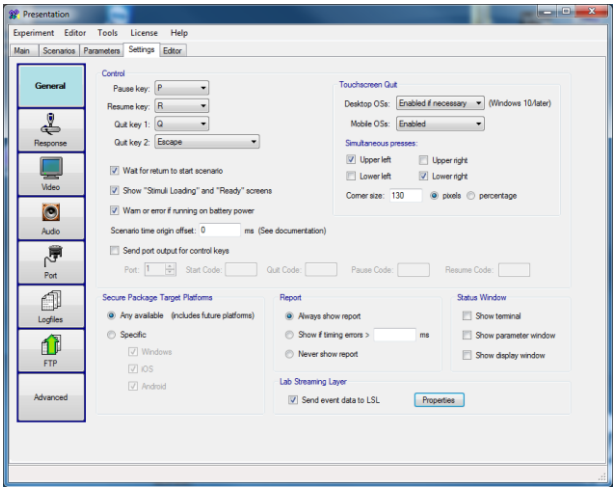


Figure 10.1 Presentation general settings window – Thick the LSL checkbox

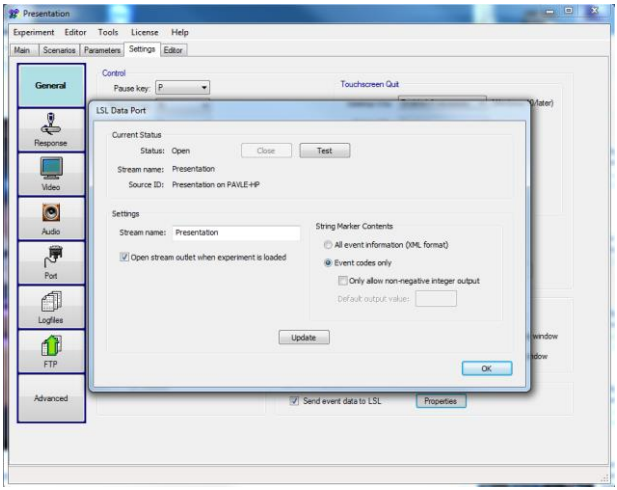


Figure 10.2 Presentation LSL data port window; The LSL stream name and string marker content can be defined here.

Once the LSL data port settings have been completed, in the main window, the LSL Properties box will appear (Figure 10.3). By clicking on it, the LSL properties can be checked and/or modified (Figure 10.4).

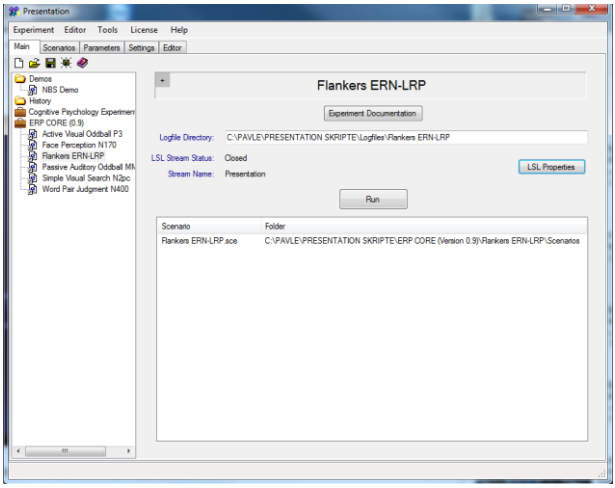


Figure 10.3 Main Window in Presentation software

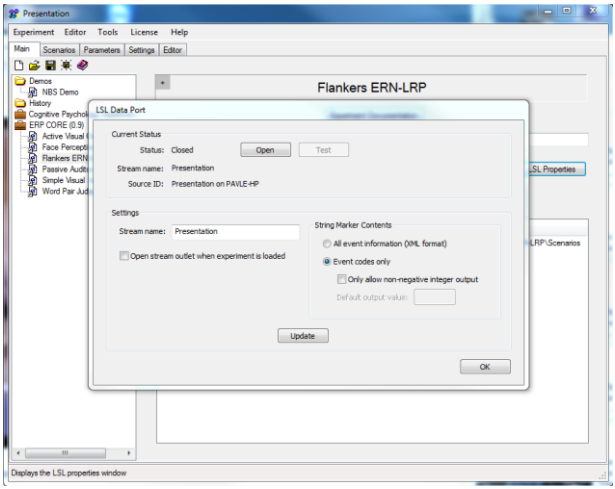


Figure 10.4 Main Window in Presentation with the LSL data port pop-up window

In order to create the mobile experiment and use the smartphone as the presentation device, the secure package should be created and uploaded on the Neurobs presentation website. Latter, the secure package should be downloaded on the smartphone through Neurobs® Presentation application. All the information regarding the Presentation mobile platform and the

experiments creation for the smartphone application can be found here: https://www.neurobs.com/menu_presentation/menu_features/mobile

10.2 Procedure for sending triggers from OpenSesame

Triggers can be sent from OpenSesame using the UDP port. Before scripting you should decide about the type of approach for sending triggers.

Sending triggers includes following steps: opening the UDP port (default port in our applications is 40007), sending trigger commands during experiment, and closing UDP port. All these are implemented using OpenSesame inline scripts.

The basic scripting procedure for sending the triggers over the UDP port includes following steps: creating blank script, enabling the UDP server, sending a trigger and a stimulus, closing UDP server, respectively.

- On the first run of OpenSesame application, choose *Default template* option from *New* window (Figure 10.5). To open an existing script click on *Open an existing experiment*, go to the folder which contains script, and select it.

- *New experiment* window should appear.

To initialize the parameters of a new script, click on the *New experiment* icon and choose *droid* from the *Back-end* drop-down menu. Set the *Resolution* parameter to 1280px x 800px. Right click on the *getting started* notepad, and choose delete from the drop down menu. Do the same for sketchpad. Experiment is now blank as shown in Figure 10.6.

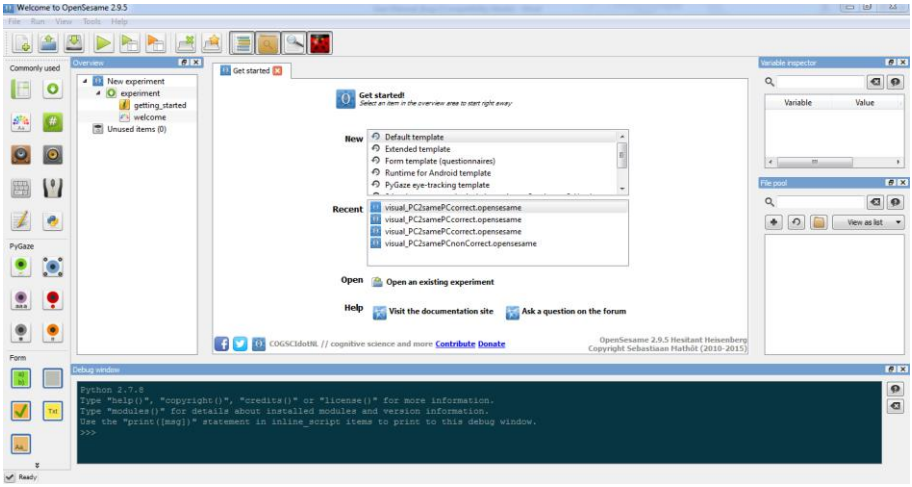


Figure 10.5 Start window after running of *OpenSesame* application

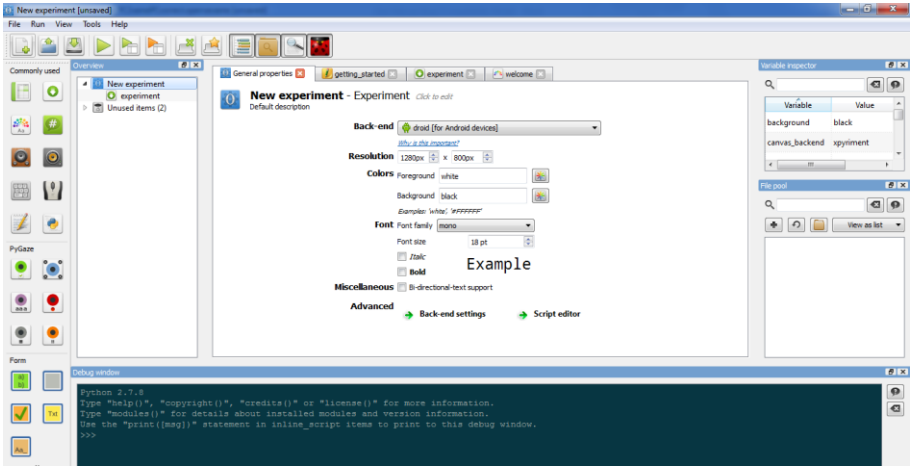


Figure 10.6 Blank experiment

10.2.1 Enabling UDP triggering

- Drag and drop inline script from *Commonly used* section in the menu in the left corner to the experiment in *Overview* menu.

Rename the script to udpsetup by clicking on *inline_script* caption in the right window (Figure 10.7);

- Copy the following text in the Prepare Section, Figure 10.7:

```
import socket
global port
global socket
port = 40007
# A predefined port that matches the SMARTING client
print 'Opening socket'
socket = socket.socket(socket.AF_INET,socket.SOCK_DGRAM)

print 'Server is started ...'
```

To send the triggers that notify about the experiment start trigger (e.g. trigger type 3), write the following text in the Run section (Figure 10.8).

```
socket.sendto('3', ('localhost', port))
```

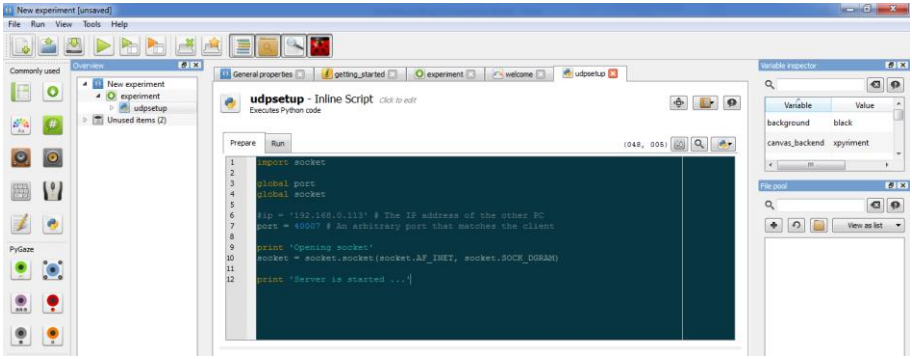


Figure 10.7 Start the UDP server in OpenSesame. Setting up the *Prepare* section

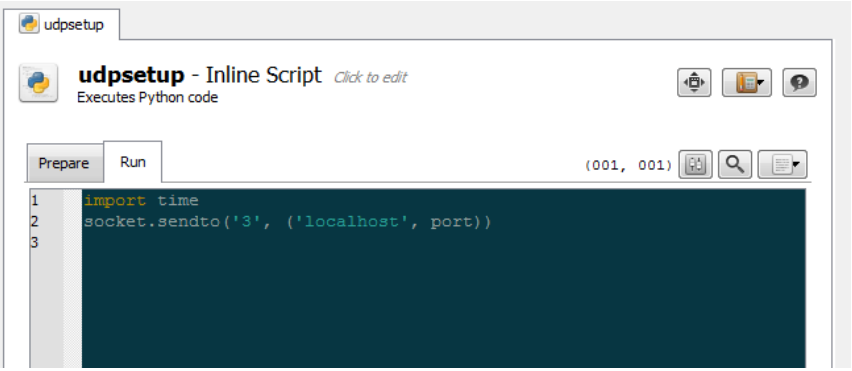


Figure 10.8 UDP Server configurations, *Run* section

- To close UDP setup drag and drop new inline script after udpserver script. Rename it to closeudp and copy following text in *Run* section (Figure 10.9):

```
socket.close();
```

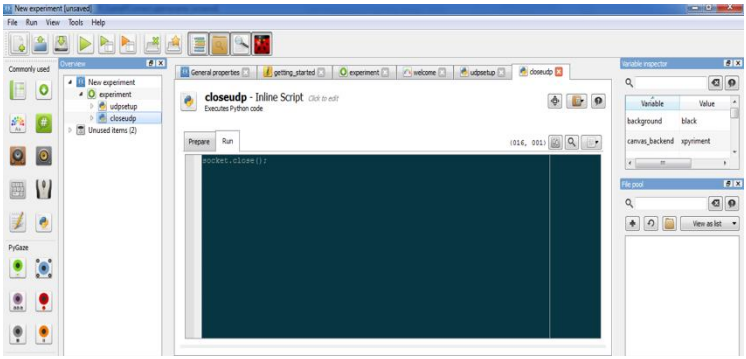


Figure 10.9 Closing UDP server

Sending stimuli and triggers

- To send a sound stimulus, drag and drop the sampler item from *Commonly Used* section into *Overview* menu, between the udpserver, and closeupd icons. (Figure 10.10);

- Rename sampler to sound. Click on file Browse, and choose the .wav or .ogg file from file pool that appears. If there are no sounds inside the pool, insert a sound by dragging and dropping a file from your PC to the file pool. (Figure 10.11);

- Drag and drop a new inline script above the sound item. Rename the *inline_script* to *soundtrigger*. In the *Run* section of the inline script insert (Figure 10.12).

```
socket.sendto('1', ('localhost', port))
```

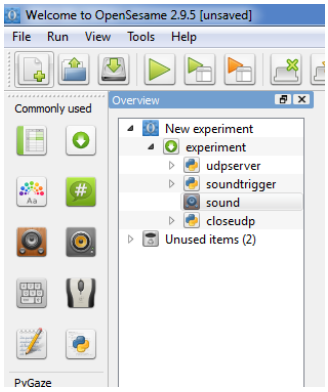


Figure 10.10 Sound experiment task, simple approach

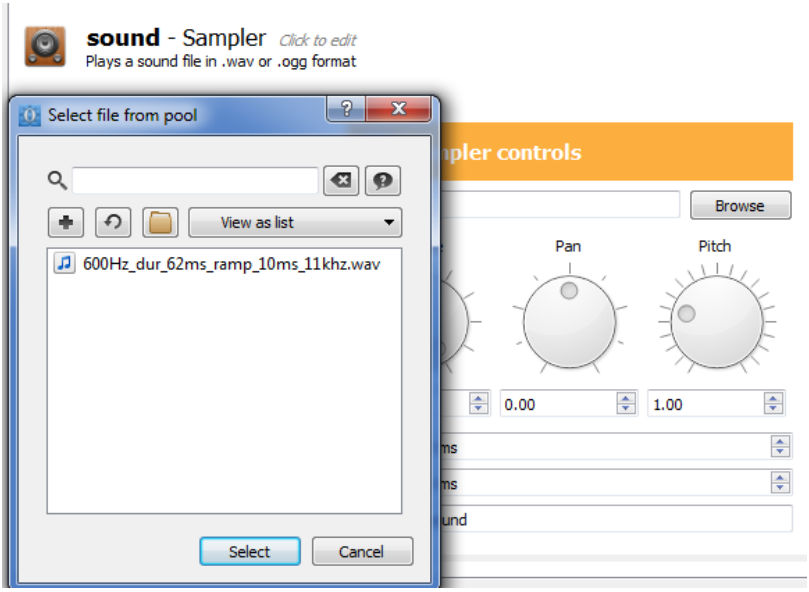


Figure 10.11 Choosing sounds for the events from file pool. Go to your folder, drag and drop files from folder to the file pool, and select desired sound.

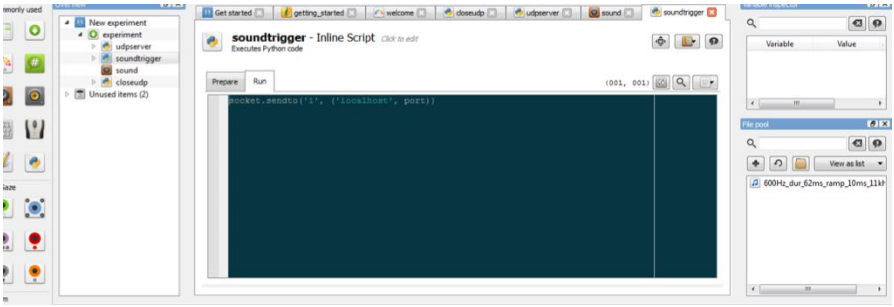


Figure 10.12 Sending trigger according to simple protocol

- Click Run full screen  to start experiment

- In order to save the experiment, please navigate to: *File/Save as/* and select: **OpenSesame script and file pool (*.opensesame.tar.gz type)**

You can always check for examples and more complex scripts in the download section of our website: http://www.mbraintrain.com/support-and-download/

10.2.2 Setting up SMARTING Android and SMARTING Streamer for listening triggers from OpenSesame

To start the recording, turn on saving data to .BDF file by clicking on record button in *Signal display* window (Figure 6.7 and Figure 8.18). After that, application is automatically listening to UDP port.

After this step triggers are embedded together with the data in the .BDF file.

10.2.3 Procedure for offline triggers processing from OpenSesame

You can load, and process data from .bdf files e.g. by using EEGLAB (http://sccn.ucsd.edu/eeglab/). You should check for software updates, and scripts that may assist you in data processing at our FAQ and download sections (http://www.mbraintrain.com/frequently-asked-questions/, http://www.mbraintrain.com/support-and-download/).

11. EEG Cap Maintenance

Although not an integral part of SMARTING system, it is important to note that, especially within the scope of EEG applications, it is crucial to perform proper recording cap maintenance. Acting contrary might induce e.g. high impedance values and disrupt experiments.

We provide short instruction on the maintenance procedure on the example of EasyCap solution:

This EEG Cap contains Silver-Silver Chloride (Ag/AgCl) electrodes. Corrosive substances will damage the electrode. These electrodes should not come into direct contact with metals in order to avoid corrosion. It is extremely necessary to clean the electrodes immediately after the measurements are performed and then let them dry. Rinse the gel by using warm water, but in the same time make sure that you keep the connector dry. If the electrodes absorb the gel (by i.e. not being cleaned properly), it will speed up the process of corrosion and make the measurements contain more *noise*. Afterwards, dry the cap with a towel and hang it to dry completely before taking any other measurements.

The cap should not be stored with metal in such a way that the electrodes touch metal. The cap should be stored in a clean, dry and dark container, such as plastic or glass.

12. Pin arrangement

The Pin Arrangement Sheet shows the connection between pin inputs and how they are presented within the software. Please check the Pin Arrangement Sheet from the cap supplier in order to properly connect the cap pin inputs with the amplifier pin inputs.

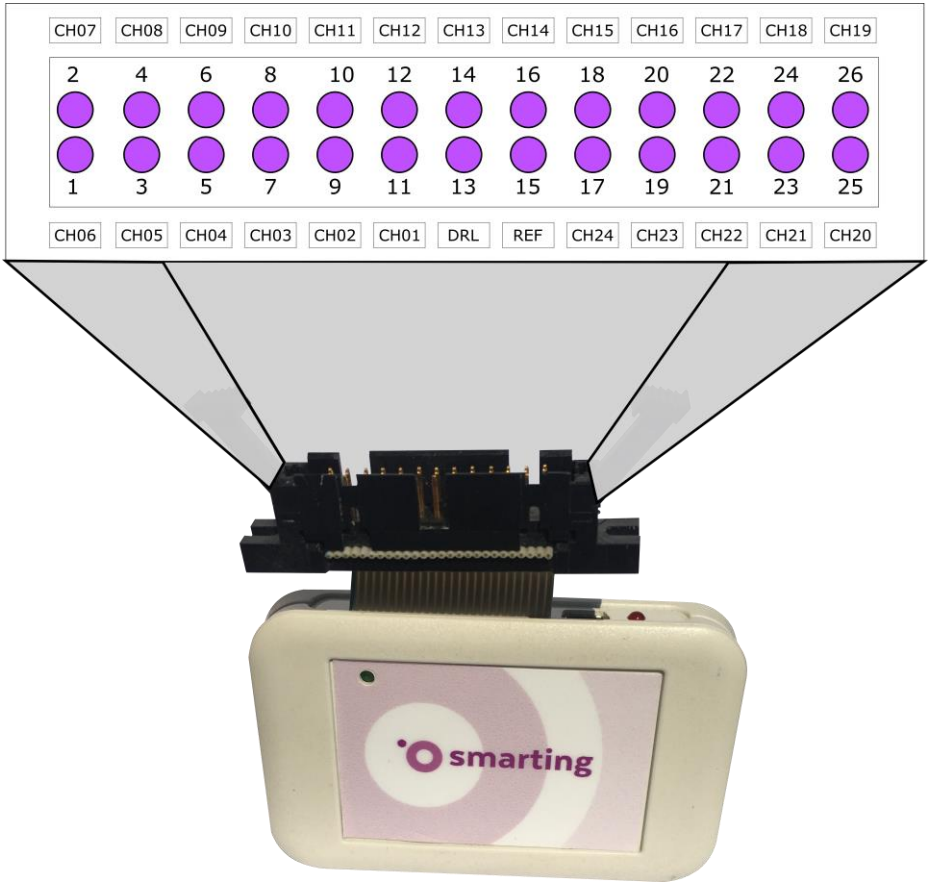


Figure 12.1 Pin arrangement

13. Battery Instructions and Disposal

Do not use the amplifier while charging! In other words, do not start any applications you use for measurements and try to connect with the amplifier via those applications. The amplifier is only to be connected with your PC/Tablet using the mini-USB delivered to you in the package. During charging, the red LED will turn on. When the LED turns off, this is the indicator that the battery is fully charged.

Disposal of old Electrical & Electronic Equipment. This symbol indicates that this product shall not be treated as household waste. Instead it shall be handed over to the appropriate collection point for the recycling of electrical and electronic equipment. The recycling of materials will help to conserve natural resources.

By ensuring this product and its batteries are disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling. For more detailed information about recycling of product batteries, please contact your local city office, your household waste disposal service, or the company where you purchased the product.

14. Custom electrode layouts

- **Input file structure**

Electrode configuration file (Loc file) must contain 24 lines in a defined format in order to work properly

Example for proper formatting (one line example):

FT8 7.6 2.8 3.6

FT8 - Name of electrode, 7.6, 2.8 ,and 3.6 are X, Y and Z coordinates.

File name

File name of the LOC file may be chosen arbitrarily, and the file type should be .txt

Coordinate ranges

X, Y and Z coordinate must be in the range between 0 and 12

All parameters can be chosen arbitrarily within the defined range, but good practice is to rewrite parameters from the following link:
www.easycap.de/e/downloads/electrode_sites_coordinates.htm

- **Prepare input file to use in SMARTING mobile application**

- File must be stored at External Storage;
- If there are other *.txt* files at External Storage move them to other directories;
- Application supports **maximum 5 location files**. Therefore it is important to remove other *.txt* files.

After that, location files are ready to be used in SMARTING mobile application. If file structure is appropriate, electrode layout will be displayed properly. If this is not the case, the layout will be deleted from a list of available layouts, with the error message.

- **Prepare the input file to use in SMARTING Streamer PC application:**

- The location file can be stored at any PC folder

When the application has been started, the option *Choose layout* will be available in the lower left corner of the main window (*standard layout* is offered by default). From the dropdown menu (Figure 14.1), choose the *load new layouts* option. When clicked, choose the folder where the layout files are stored. After that, all *.txt* files from selected directory will be added to the layout list.

When the layout format of the chosen file is not appropriate, that layout is automatically deleted from dropdown menu and the displayed layout is automatically set to *motor layout*.

- **Update for layouts with less than 24 electrodes**

If one does not intend to use/specify all 24 channels, simply writing *NA* in place of a non-used electrode will make the electrode not recording.

Example for first 5 channels with 2 unused electrodes:

```
Fp1     -2.7     8.6     3.6
NA
NA
F7      -6.7     5.2     3.6
F8       6.7     5.2     3.6
```

- **Note for number format**

The program entails local settings for the number format so that LOC file format must be adapted to the language in which you installed Java.

This means that you must pay attention whether the float value has dot or comma as a delimiter and adapt the X, Y, Z to fit the new format in the defined ranges.

Example for 2 different format settings:

Keyboard Input	Decoded in GER java	Decoded in SRB java
1,234	1.234	1234.0
1.234	1234.0	1.234

smarting

Bringing simplicity to complex research experiments

mBrainTrain hereby declares that this SMARTING is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

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