IM_TWIN SHIRT

user manual

ATTENTION
Please read this manual before
using your IM_TWIN T-SHIRT

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Please check your systems after receiving and before using it the first time to confirm if it contains all the ordered sensors, accessories and other components. Contact our support if there are any variations from your original order.

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1 Overview

The IM_TWIN SHIRT consists of two parts which are 1. the Electronic Acquisition Module and 2. the T-shirt, see Figure 1 below.

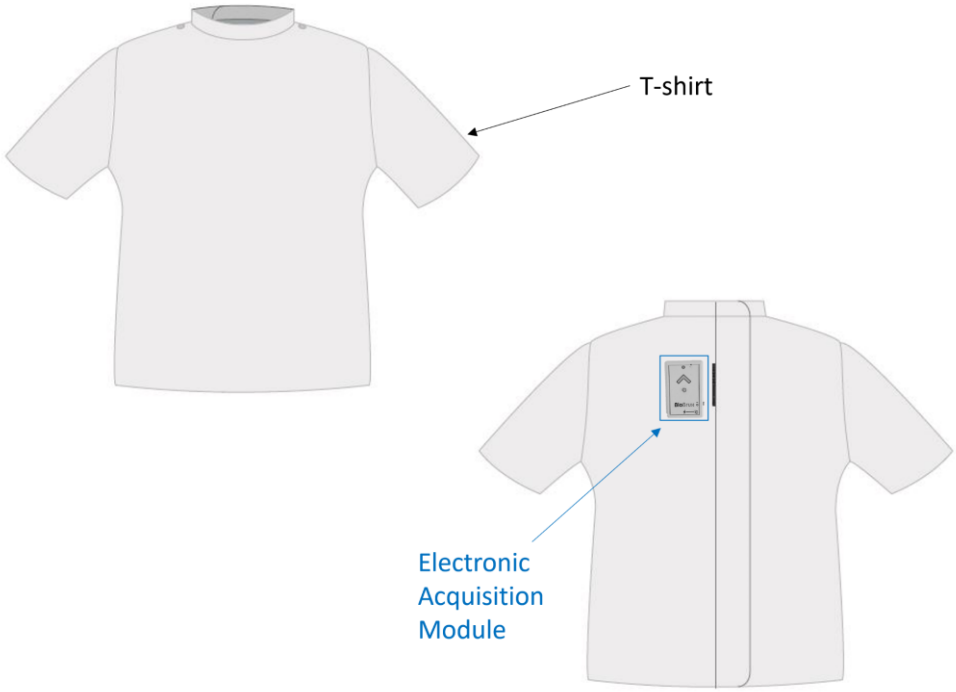


Figure 1 IM_TWIN Shirt front (left) and back (right) with device.

2 Electronic Acquisition Module

The electronic acquisition module (device) contains all sensors such as Electrodermal Activity (EDA), Electroencephalography (ECG), Temperature (TMP), Acceleration (ACC) and Magnetometer (MAG) and sends the signals via Bluetooth to the computer.

2.1 Parts description

Front view of the device

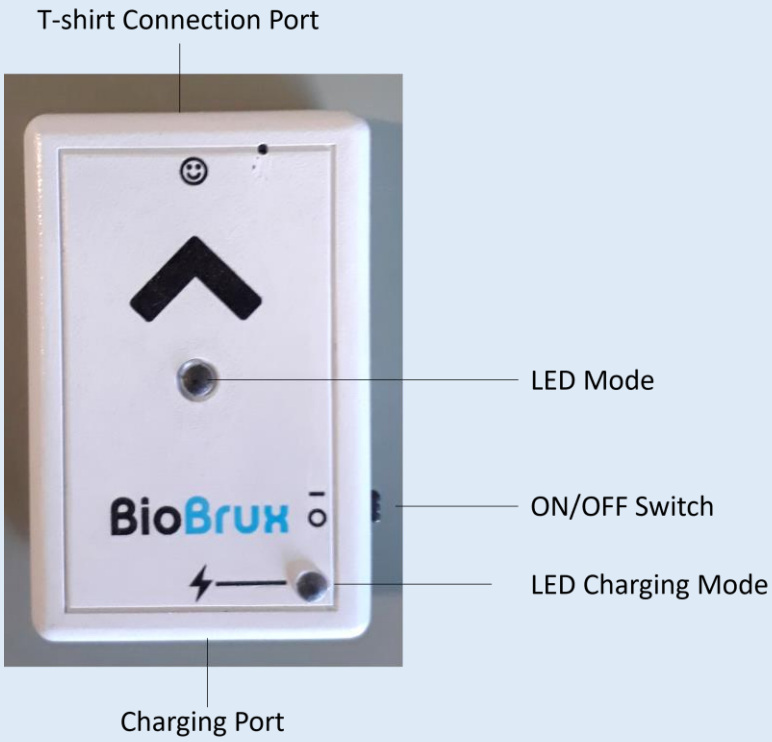


Figure 2 Electronic acquisition module, front view.

Back view of the device with mac address (12 digits)

Figure 3 Electronic acquisition module, back view.

2.2 Sensor Port – Connecting and Disconnecting Sensors

Top view of the device with connection port to T-shirt

Figure 4 Electronic acquisition module connection port, top view.

WARNING
Only connect the device port to the IM_TWIN T-shirt and no other sensors or devices

WARNING
Do not use damaged sensors, devices or components, as this can cause serious injuries and device damages. Contact PLUX's Technical Assistance to report such issues and report malfunctioning devices or sensors without hesitation.

The electronic acquisition module has only a single sensor port where the IM_TWIN Shirt can be connected to the device.
Do not try to connect the sensor into the micro-USB charging port as this might damage the equipment and harm the user. Also, when connecting the sensors, pay attention to where the cables go to avoid device damages or disrupting the user's movements.

Disconnect the T-shirt according to the recommendations displayed below, to avoid damaging the electronic acquisition module or the T-shirt:

- don't twist the sensor while disconnecting
- don't apply upward force or pull the cable
- use minimal force to disconnect
- hold the plug firmly and pull it out
- don't pull the cable

2.3 Micro USB Charging Port & Charging LED – How to Charge the device.

Bottom view of device with charging port

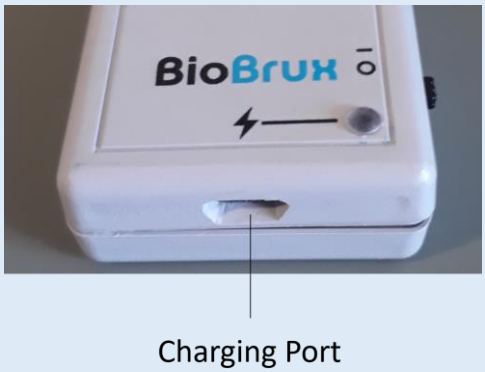


Figure 5 Electronic acquisition module charging port, bottom view.

WARNING
Do not use the device during the charging process.

NOTE
Follow the indications on how to correctly charge your device to prevent any damage of your system or of the user(s).

The device has a battery lifetime of up to 16 hours in continuous usage. Note, that the lifetime might vary depending on the number of active sensors (incl. built-in sensors). The built-in LED will light up red if the battery is running low until the device stops working.

To recharge, turn off your *Device* by sliding the on/off switch into *O-position* (see *Figure 2*) and use the micro USB cable which comes with your kit by connecting the USB-A connector to an USB port of your computer and the micro USB connector to the micro USB charging port of your *Device* (see *Figure 2*). The charging process will take approximately 2 ½ hours to fully charge the battery.

WARNING
Make sure your device is turned off in order to charge it. If the device is turned on during the charging process, the charging LED will turn red and the device will not be charged.

If the charging process is being done correctly, the charging LED will turn purple.

If the charging LED turns red during the charging process, even when the device is turned off, disconnect the micro-USB cable from your *electronic acquisition module* and contact PLUX's Technical Assistance.

The suitable room temperature when charging the device must be between 10°C and 35°C to prevent device or user related damages during the charging process.

WARNING
Unplug the charger from your computer if the battery/device overheats (reaching 60°C) and immediately get in contact with PLUX's Technical Assistance.

2.4 On/OFF Switch

In order for the device to work, it must be turned on. Turning on the device can be done by sliding the on/off switch which is placed at the right side of the device into the on position (I position). After being turned on, the LED status light will blink once per second (green).
Sliding the switch into the off-position (O-position) will turn off the device.

O	OFF
I	ON

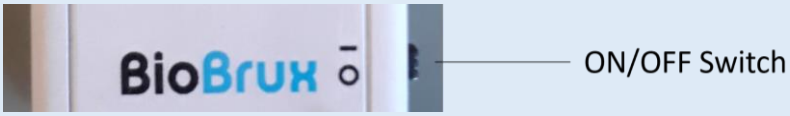


Figure 6 Electronic acquisition module ON/OFF switch.

2.5 Status LED

The status LED at the centre of the Electronic acquisition module provides basic visual information about the current device state:

Main LED

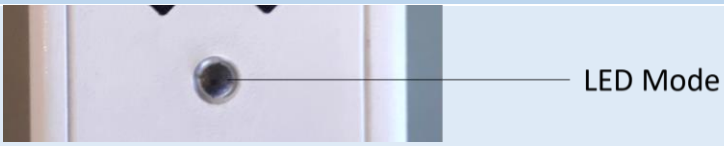


Figure 7 Electronic acquisition module LED mode.

None	○	Off
1 green blink per second	●	Device & Bluetooth on; idle
2 green blinks per seconds	●●	Acquiring/streaming data
2 red blinks	●●	Low battery

Battery – Charging LED

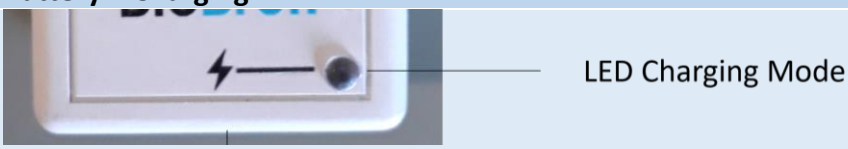


Figure 8 Electronic acquisition module LED charging mode.

Constantly orange	●	Charging
Constantly red	●	Not charging; charging error occurred; switch not in off position
Constantly purple	●	Charging complete

3 T-shirt

The IM_TWIN T-SHIRT contains all sensor electrodes on the inner layer of the shirt as well as cables to connect to the device which are hidden in between the outer and inner layer of the shirt.

3.1 Parts and Unpacking

OVERVIEW	
T-Shirt front	 *Figure 9 T-shirt front view.*
T-Shirt back	 *Figure 10 T-shirt back view.*

T-Shirt Sizes:

24M
30M
36M
42M
48M

(M = months, e.g., age of child**)**

Figure 11 T-shirts in different sizes.

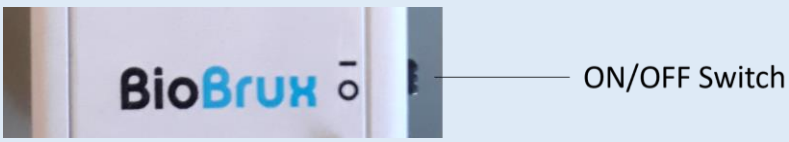
Figure 12 T-shirt size label.

3.2 Preparation before Usage

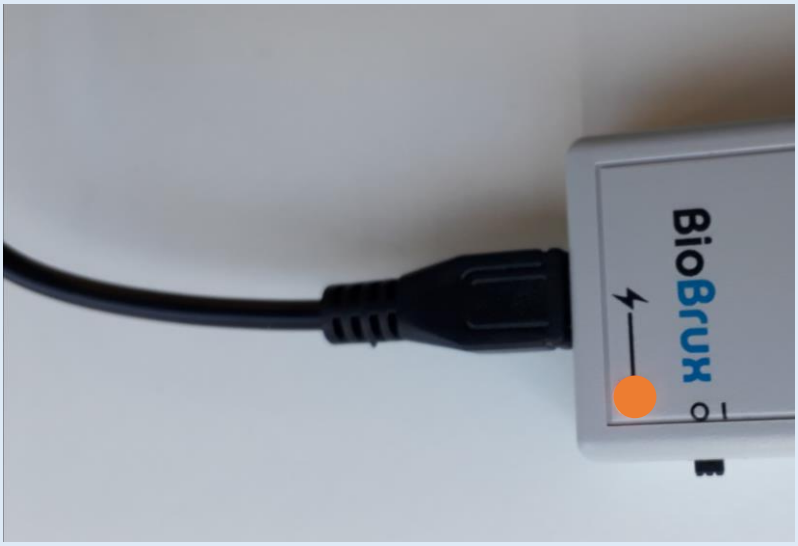
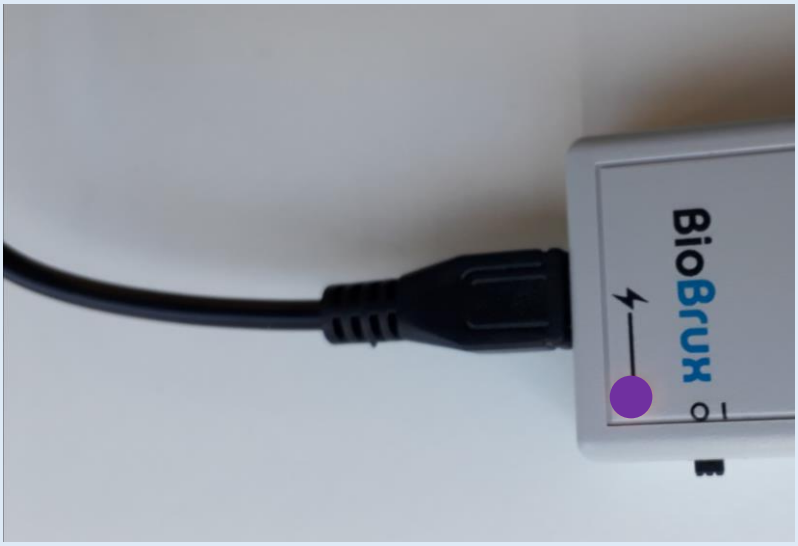
ELECTRODES	
Remove plastic foil from black electrodes before first use (inner layer of the shirt) in case there is one attached to the electrode	 *Figure 13 T-shirt electrodes with plastic protection foil, inner layer.*
REMOVE DEVICE FROM TSHIRT	
Open the pocket in the back	 *Figure 14 T-shirt pocket for device, open zipper.*

Take out the device from the pocket	 *Figure 15 Device connected to T-shirt.*
Disconnect the device from the cable (white)	 *Figure 16 Device disconnected from T-shirt.*

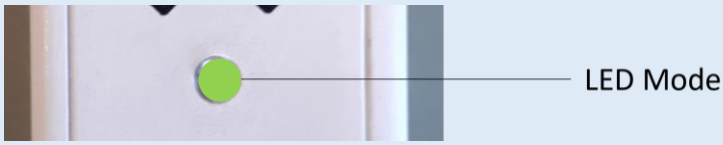
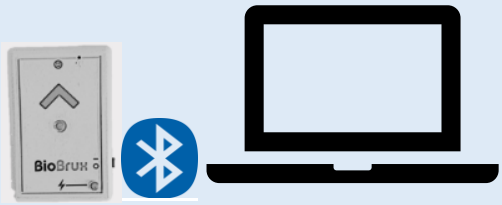
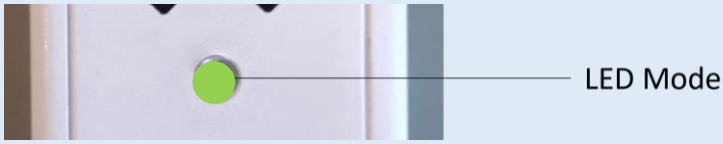
WARNING
Don’t twist the cable while disconnecting, don’t apply upward force or pull the cable, use minimal force to disconnect, hold the plug firmly and pull it out, don’t pull the cable

CHARGING	
Take the device and a charging cable (black)	 *Figure 17 Device and charging cable.*
Connect the device charging port to the charging cable (black)	 *Figure 18 Device connected to charging cable.*
Turn off the device by moving the switch to "0”	 *Figure 19 Device ON/OFF switch.*

WARNING
The device must be switched off while charging

Connect the charging cable to your computer	 *Figure 20 USB charging cable connected to computer.*
The LED will turn orange while charging	 *Figure 21 Device charging, LED orange.*
The LED will turn purple when fully charged (~2.5 hours)	 *Figure 22 Device fully charged, LED purple.*

3.3 Connecting

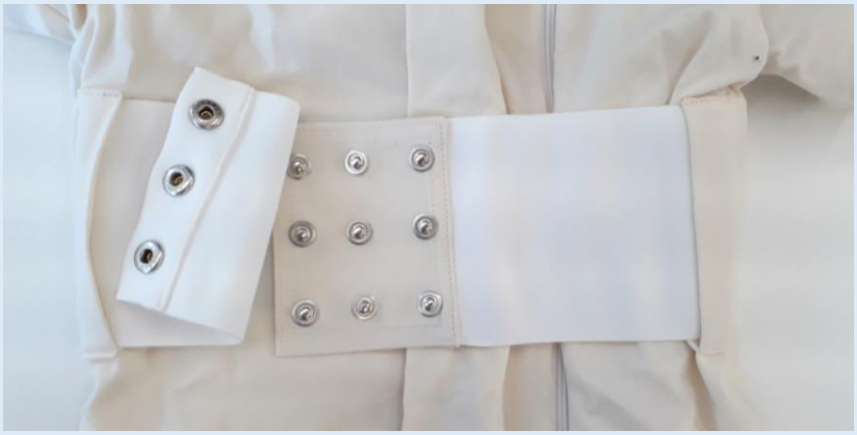
Turn the device ON by switching to **I**	 *Figure 23 Device ON/OFF switch.*
The LED turns green (1 blink per second)	 *Figure 24 Device turned on, LED green.*
Connect the device via Bluetooth with the computer	 *Figure 25 Device connected to computer via bluetooth.*
Start the acquisition (2 green blinks per second)	 *Figure 26 Device acquiring data, LED green.*
Hide the device inside the pocket	 *Figure 27 Device inside T-shirt pocket.*
Close the pocket	 *Figure 28 T-shirt pocket closed.*

3.4 Skin Preparation

By following these steps, you can properly prepare the skin and apply dry electrodes that are integrated in the IM_TWIN T-shirt to ensure accurate and reliable readings.

Information to Users	
Skin	Do not apply any body lotion onto the skin on the day of the acquisition (especially not on the chest and the back).
Cleaning before Usage	
T-shirt Electrodes	Clean the electrodes with a cloth of lukewarm water to remove small pieces of fabric, dust from the air or skin particles from prior acquisitions.  *Figure 29 Black Electrodes inside the T-shirt.*
Skin - back	Clean the back with lukewarm water to remove dead skin cells. Do not use soap or alcoholic cleaning wipes / solutions on the back. Only when the skin is extremely oily (due to body lotions) it is recommended to remove the oil with alcoholic solutions.
Skin - chest	Clean the chest with lukewarm water to remove dead skin cells. In case of extremely oily skin, clean the skin with an alcoholic wipe or solution.

3.5 Dressing the Shirt

DRESSING	
Open the belt in the back	 *Figure 30 T-shirt from back view, belt open.*
Open the zipper in the back	 *Figure 31 T-shirt from back view, zipper opening.*

Dress the shirt from the front (arms of the child into the T-shirt)	 *Figure 32 Child wearing the T-shirt, back view with zipper open.*
Choose the tightest zipper of the 2 options	 *Figure 33 T-shirt from back view, zipper options.*

Close the shirt in the back with the tightest zipper	 *Figure 34 T-shirt back view, zipper closed.*
Tighten the shirt with the belt in the back – use the tightest option	 *Figure 35 T-shirt back view, belt closed.*

ATTENTION

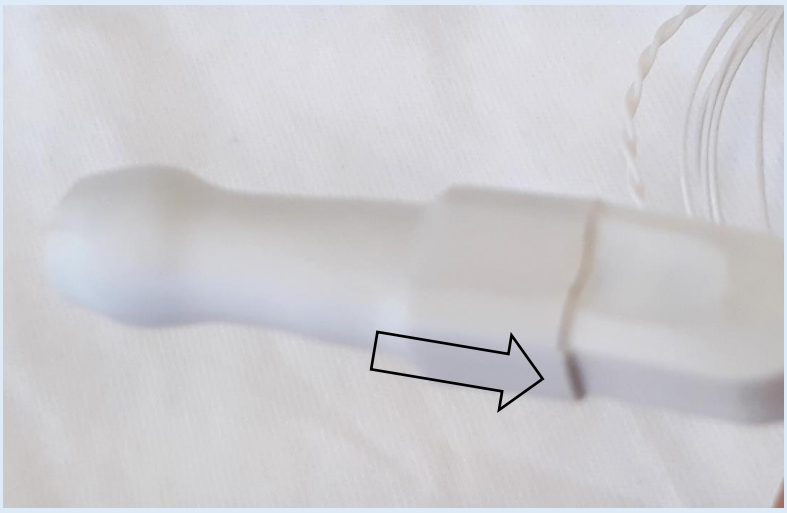
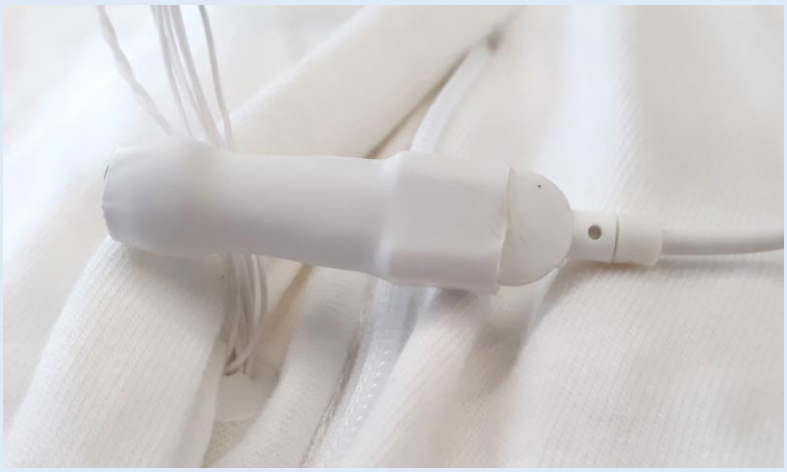
The T-Shirt must sit tight (the fabric allows for a bit of a stretch)

- the inner layer of the shirt must be tight on the skin.
- the belt must sit tight.

3.6 Washing

WASHING	
1. Remove the device from the shirt	 *Figure 36 Device disconnected from T-shirt.*

WARNING
Don’t twist the cable while disconnecting, don’t apply upward force or pull the cable, use minimal force to disconnect, hold the plug firmly and pull it out, don’t pull the cable

SILICON CAP	
2. Slide the silicon cap onto the connector to protect it from water, Align the curved sides with each other	 *Figure 37 T-shirt connector slide onto silicon cap.*  *Figure 38 T-shirt connector attached to silicon cap.*
3. Put the connector with the silicon cap back inside the pocket	 *Figure 39 T-shirt pocked with connector and silicon cap.*

4. Close all zippers and the belt)

Figure 40 T-shirt pocket closed.

WARNING
Do not wash the shirt inside out

5. Put the T-shirt inside a washing bag for delicates

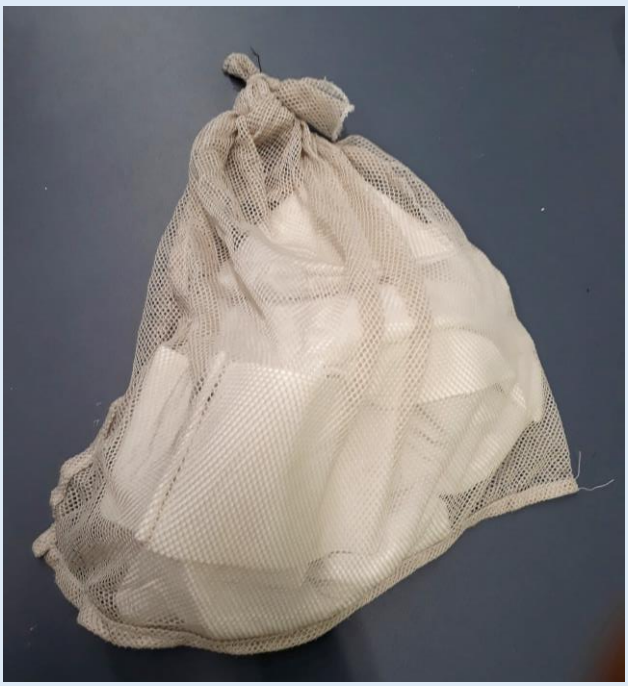
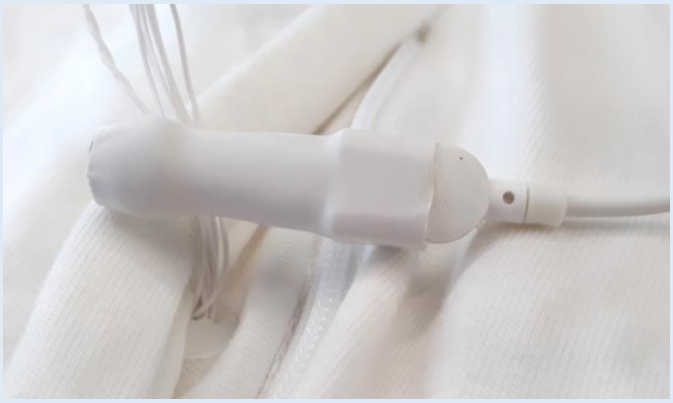
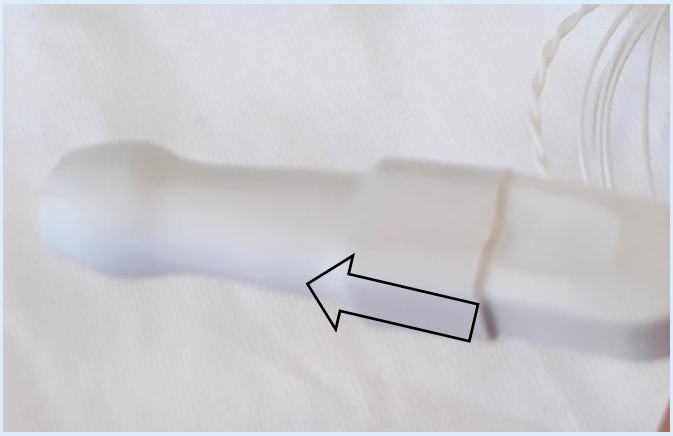


Figure 41 T-shirt inside a washing bag.

6.	Add a load of about 2kg to the machine
7.	Use the lowest temperature possible (max. 20 degrees Celsius) e.g. hand wash / delicates
8.	Select the lowest tumbling (max. 400 cycles) e.g. hand wash / delicates
9.	Use a natural washing soap.
10.	Hang the shirt on an air drying hanger

WARNING
Do not put the shirt into a dryer machine.

11. Open the zipper	 *Figure 42 T-shirt pocket open.*
12. Take the silicon cap	 *Figure 43 T-shirt connector attached to silicon cap.*
13. Remove gently the silicon cap from the connector	 *Figure 44 Silicon cap removal from T-shirt connector.*

WARNING
Disconnect the SILICON CAP according to the recommendations displayed below, to avoid damaging the electronic acquisition module or the T-shirt:

- don’t twist the T-shirt cable while disconnecting
- don’t apply upward force or pull the cable
- use minimal force to disconnect
- hold the plug firmly and pull it out
- don’t pull the cable

4 Communication

The communication with *electronic acquisition module* is done via Bluetooth Class II only. Bluetooth is used to configure the device, to acquire and transmit sensor signals in real-time to the computer and upload new firmware versions to your device.

Since most internal Bluetooth modules are not designed to support high transfer rates as those are needed when acquiring and streaming signals using *electronic acquisition module,* we strongly recommend using the PLUX Bluetooth dongle (which comes with your *IM_TWIN T-SHIRT* kit) to prevent any communication issues or connection losses. These dongles have been tested and verified by PLUX to work properly with any *biosignalsplux* device.

The Bluetooth dongle can be found in our store if several dongles are needed (e.g. to use *electronic acquisition module* on several computers without having to change the Bluetooth dongle every time another computer is being used).

https://www.pluxbiosignals.com/products/bluetooth-dongle

Instructions on how to connect the *electronic acquisition module* via Bluetooth to the computer can be found in the 4 *Bluetooth Setup* section.

If you're experiencing a great number of connection loss events, reconnection problems, missing samples or similar problems, your internal Bluetooth module might be being used for data transmission or your Bluetooth dongle might be configured to use the wrong Bluetooth stack. Instructions to set up the correct Bluetooth stack and to solve such problems can be found in the *5.* Bluetooth section of this manual.

See the table on the following page for detailed Bluetooth specifications of the internal Bluetooth module of *biosignalsplux* devices (incl. *electronic acquisition module IM_TWIN)*

Table 1 : Specifications of biosignalsplux devices' internal Bluetooth modules.

Operating frequency range	2400 – 2483.5 MHz ISM Band
Modulation method	GFSK (1 Mbps) P/4 DQPSK (2Mbps)
Hopping	1600 hops/s, 1 MHz channel space
Transmission power	Min: -11 dBm Max: +3 dBm
Antenna peak gain (XZ-V)	0.5dBi typical
Average antenna gain (XZ-V)	-0.5 dBi typical
Antenna VSWR	2 max
Certifications	Bluetooth, CE, FCC, IC, Japan and South Korea

The *electronic acquisition module* has integrated sensors which are pre-wired and pre-configured inside *OpenSignals (not pre-configured in the API)*, which are a triaxial accelerometer, a triaxial magnetometer, an LED, a custom EDA sensor, an ECG sensor, and a Temperature sensor. The default configuration of the *electronic acquisition module* is displayed in *Table 2*.

Table 2 *Default configuration of the electronic acquisition module.*

CHANNEL	SENSOR
1	ECG
2	RAW (custom EDA)
3	TMP
11	Accelerometer – X-Axis
12	Accelerometer – Y-Axis
13	Accelerometer – Z-Axis
Only API	Magnetometer – X-Axis
Only API	Magnetometer – Y-Axis
Only API	Magnetometer – Z-Axis
Only API	LED control

5 Bluetooth Setup

When connecting the device, you first need to enable Bluetooth on your computer or need to plug in the Bluetooth dongle to your USB port, if Bluetooth is not built in or reliable for your computer. Follow the instructions for your operating system that are displayed on the following pages to connect your *electronic acquisition module* to your computer.

Note
With the firmware update for **MacOS 12** the pin is: 1234 (also for windows, etc.)

5.1 Windows 7

To connect your device to your computer via Bluetooth, click on the start button at the right lower part of the Windows taskbar and click on *Control Panel* to access the control panel of your computer.

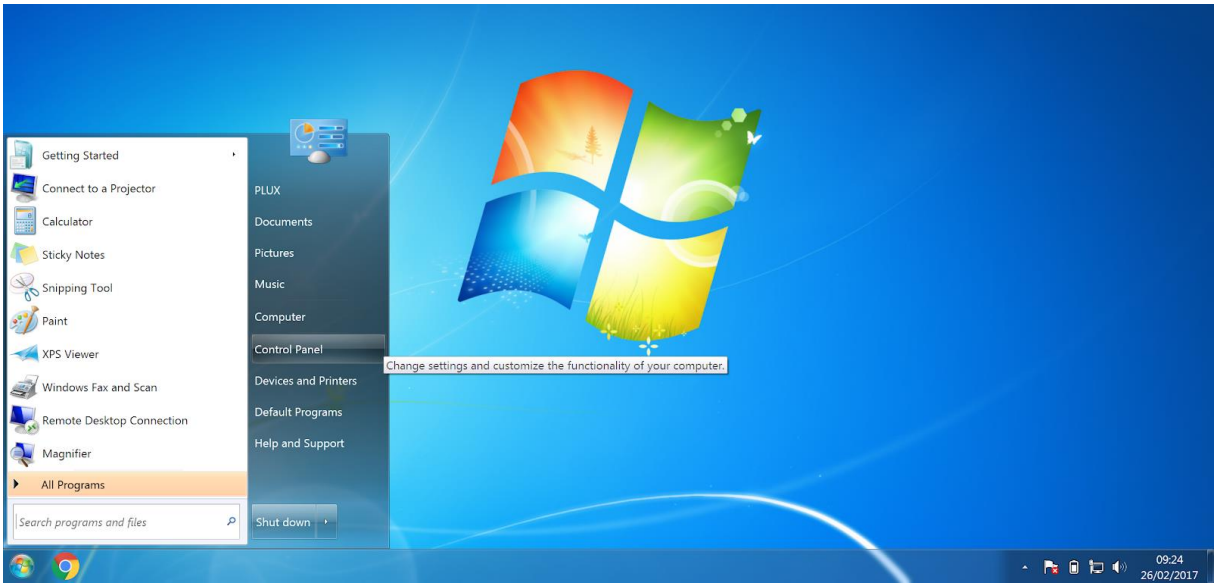


Figure 45 : Access the Windows 7 control panel.

In the control panel, select the *Add a device* option in the *Hardware and Sound* section to add your device.

Figure 46 Select Add a device in the Hardware and Sound section.

At this point, turn on your *electronic acquisition module* (if not done before) and wait until it appears in the list available devices. When your device has been found (here: *biosignalsplux*), click on the device and click on *Next* at the lower right corner of the *Add a device* window.

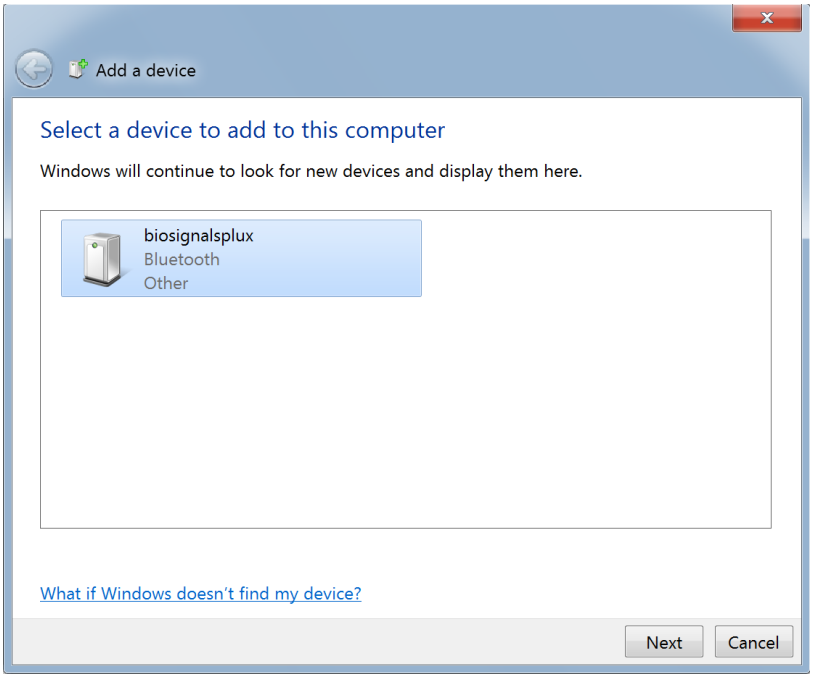


Figure 47 Select your device to add it to your computer.

Click on *Enter the device's pairing code* and click on *Next* at the lower right corner of the window to proceed.

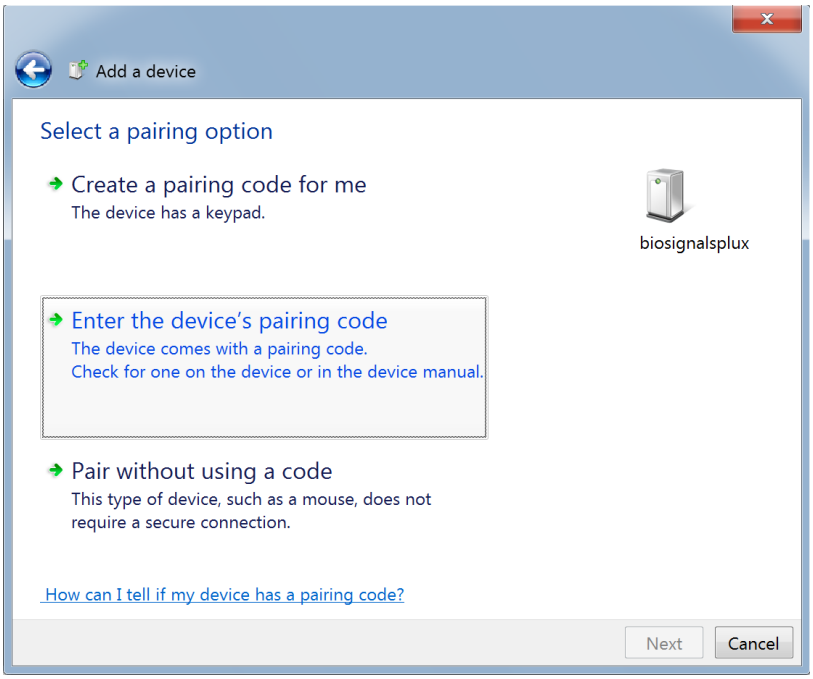


Figure 48 Select Enter the device's pairing code.

Enter 123 and click on *Next* to connect to your device

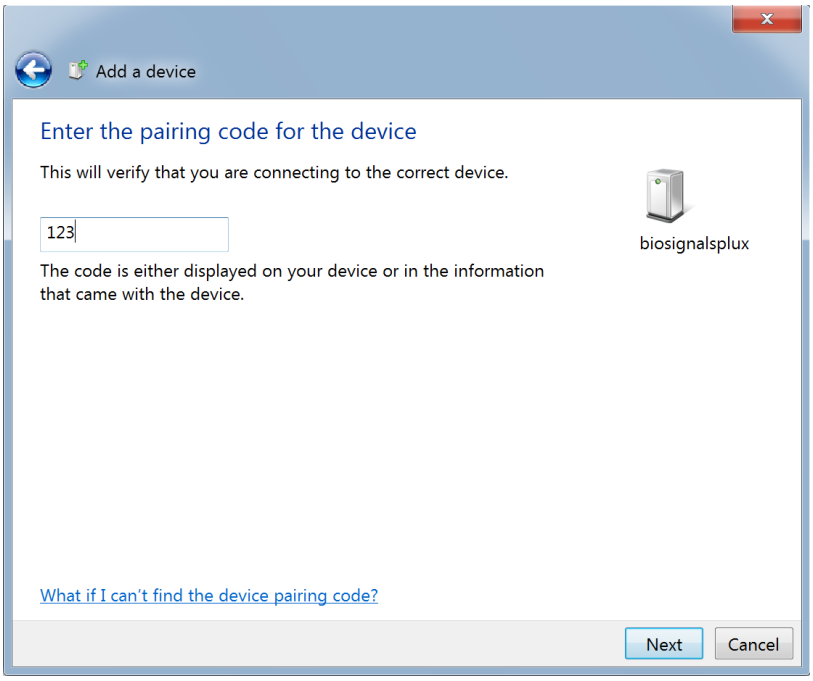


Figure 49 Enter the pairing code to connect to your device.

If Windows confirms that your device has been successfully added to your computer, the connection has been successfully established.

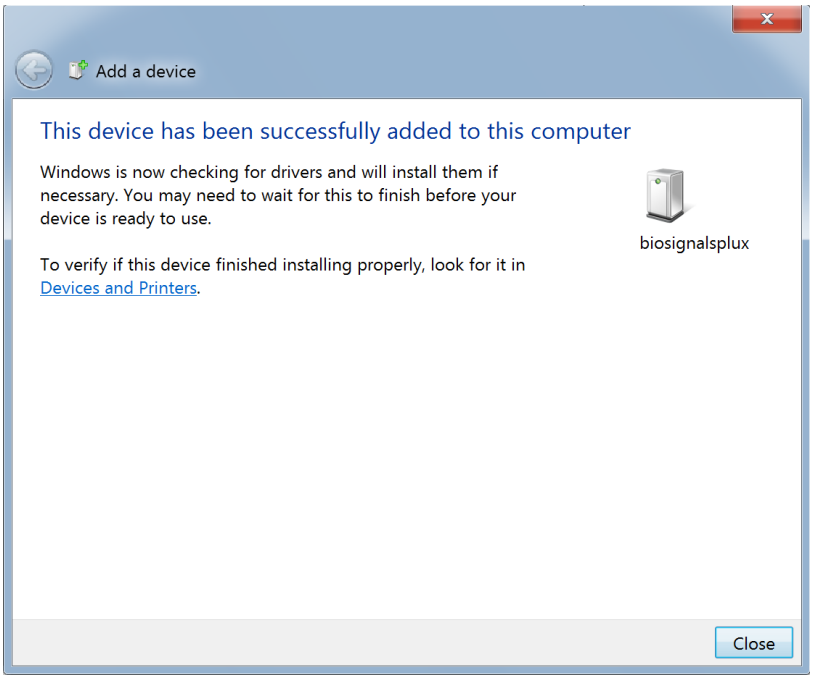


Figure 50 Windows confirmation if the device has been successfully added.

5.2 Windows 8

To connect your *electronic acquisition module* to your computer via Bluetooth, click on the start button at the right lower part of the Windows taskbar, click on the triangle symbol and click on the Bluetooth icon to open the Bluetooth settings panel.

Figure 51 Access to the Bluetooth settings panel in Windows 8.

At this point, turn on your *electronic acquisition module* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *electronic acquisition module* has been found, click on the device and click on *Pair* to connect to your device (may appear as *biosignalsplux*).

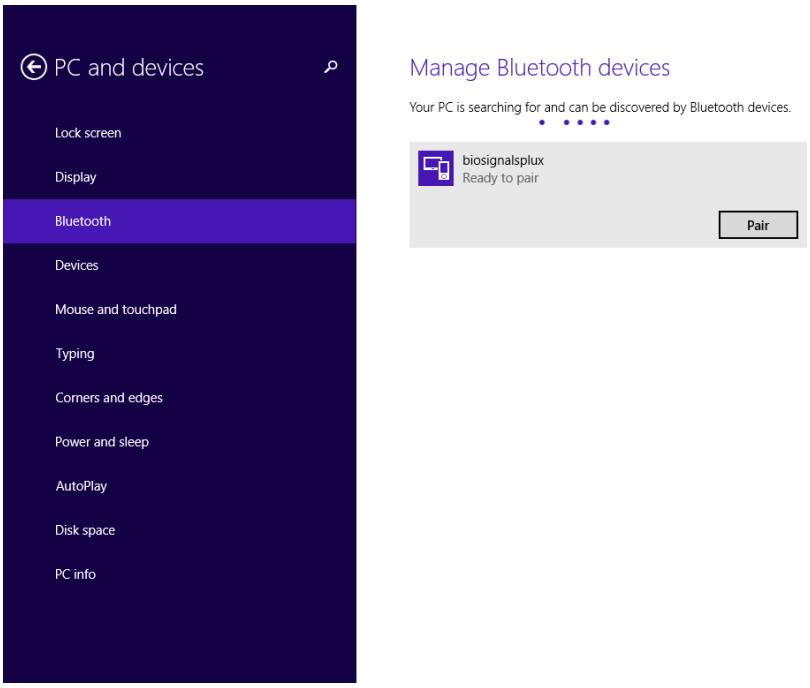


Figure 52 Bluetooth settings panel.

Windows will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on *Next* to connect to *the electronic acquisition module*.

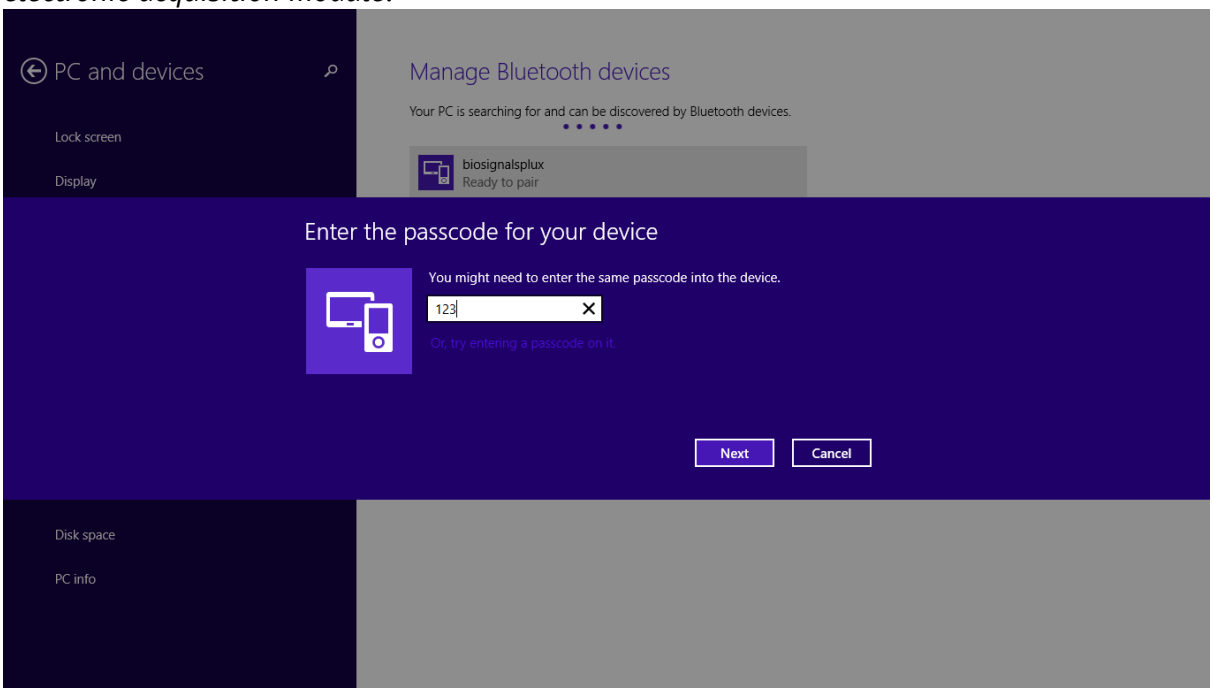


Figure 53 Requesting biosignalsplux' passcode (123).

If *Connected* is displayed under the name of your *Electronic acquisition module* in the Bluetooth settings panel, the connection has been successfully established.

5.3 Windows 10

To connect your *electronic acquisition module* to your computer via Bluetooth, click on the start button at the left lower corner in Windows 10 to open the start menu. Click on the gear symbol to open the settings panel of your operating system as can be seen below.

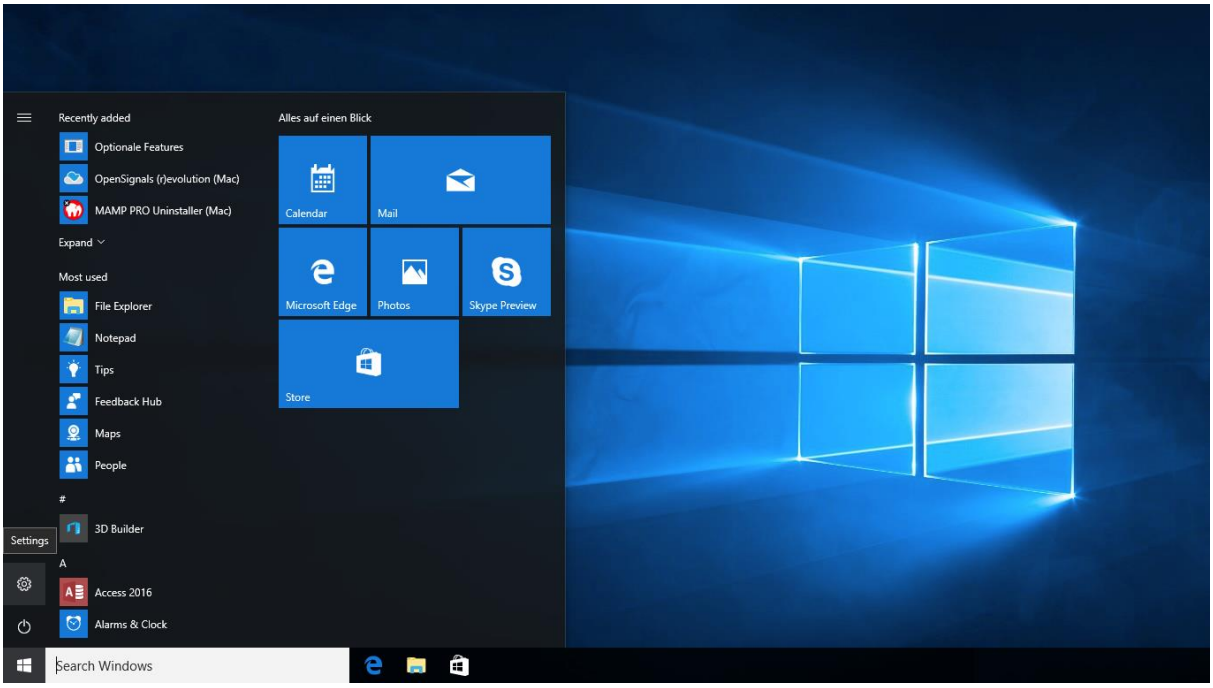


Figure 54 Access to the settings panel in Windows 10.

In the settings panel, click on the *Devices Bluetooth, printers, mouse* field to open the device configurations of your system.

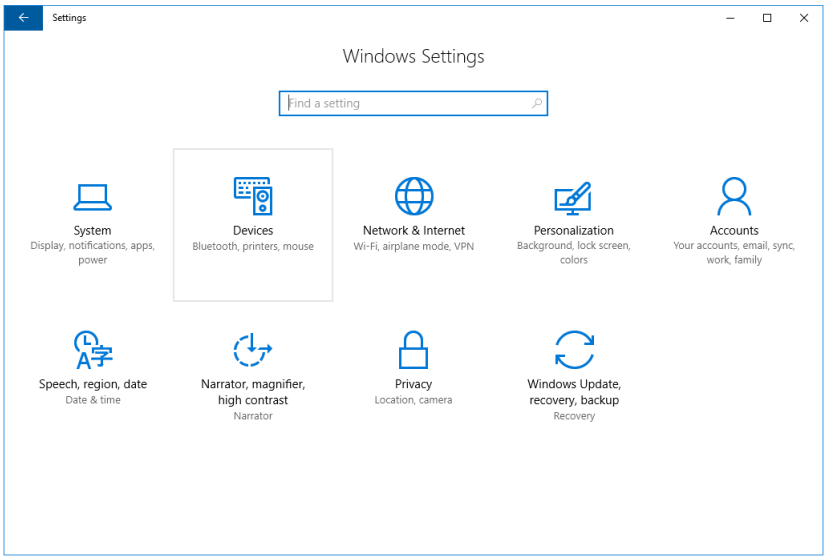


Figure 55 Windows 10 settings panel.

Select *Bluetooth* from the list which is displayed on the left side of your settings window. Note, that in some versions the Bluetooth option might not be available and that Bluetooth devices might be listed under *Other devices* as seen in *Figure 51*.

At this point, turn on your *electronic acquisition module* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *electronic acquisition module* has been found, click on the device and click on *Ready to pair* to connect to your device (may appear as *biosignalsplux*).

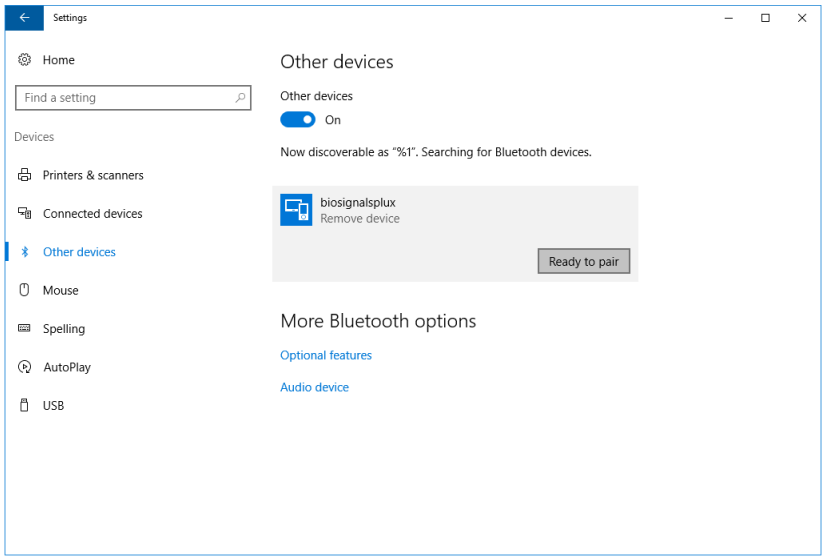


Figure 56 Bluetooth settings panel.

Windows will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on next to connect to *bios Electronic acquisition module*.

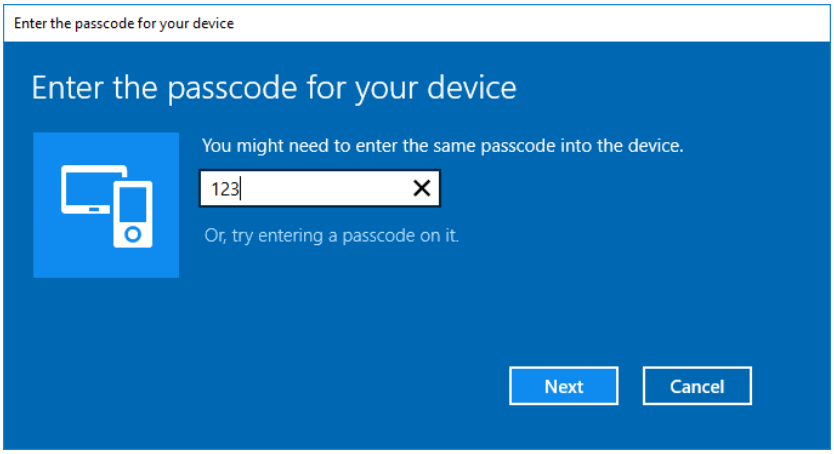


Figure 57 Requesting passcode (123).

If *Pair* is displayed under the name of your *Electronic acquisition module* in the Bluetooth settings panel, the connection has been successfully established.

5.4 Linux

Ubuntu offers two options on how to connect your devices via Bluetooth to your computer. The first option allows you to connect the device via Ubuntu's system settings and the graphical interface. The second option allows you to connect the device via the terminal. However, the second option is recommended for advanced users only.

5.4.1. Connecting via System Settings

To connect your device to your computer via Bluetooth, click on the wheel in the top right corner of the display and click on *System Settings* to access the settings panel of your computer.

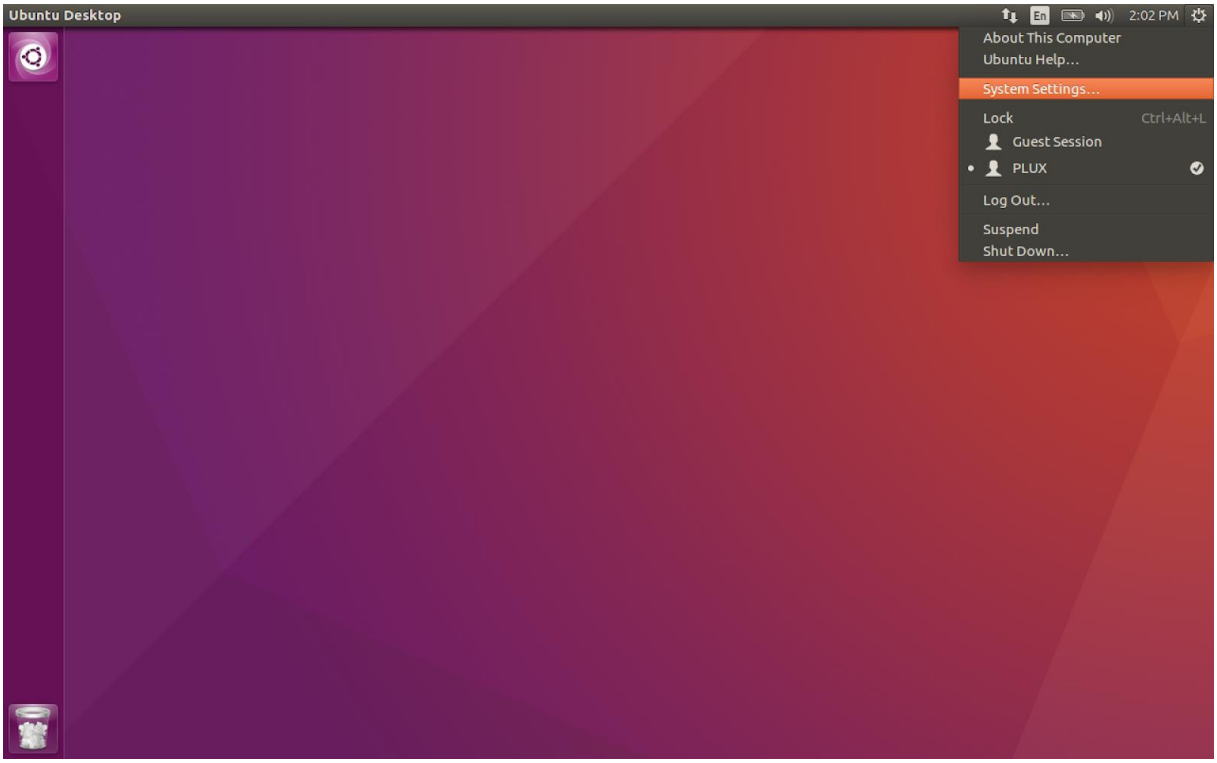


Figure 58 Access the system settings in Ubuntu.

In the settings panel, click on the Bluetooth logo to access the Bluetooth settings panel.

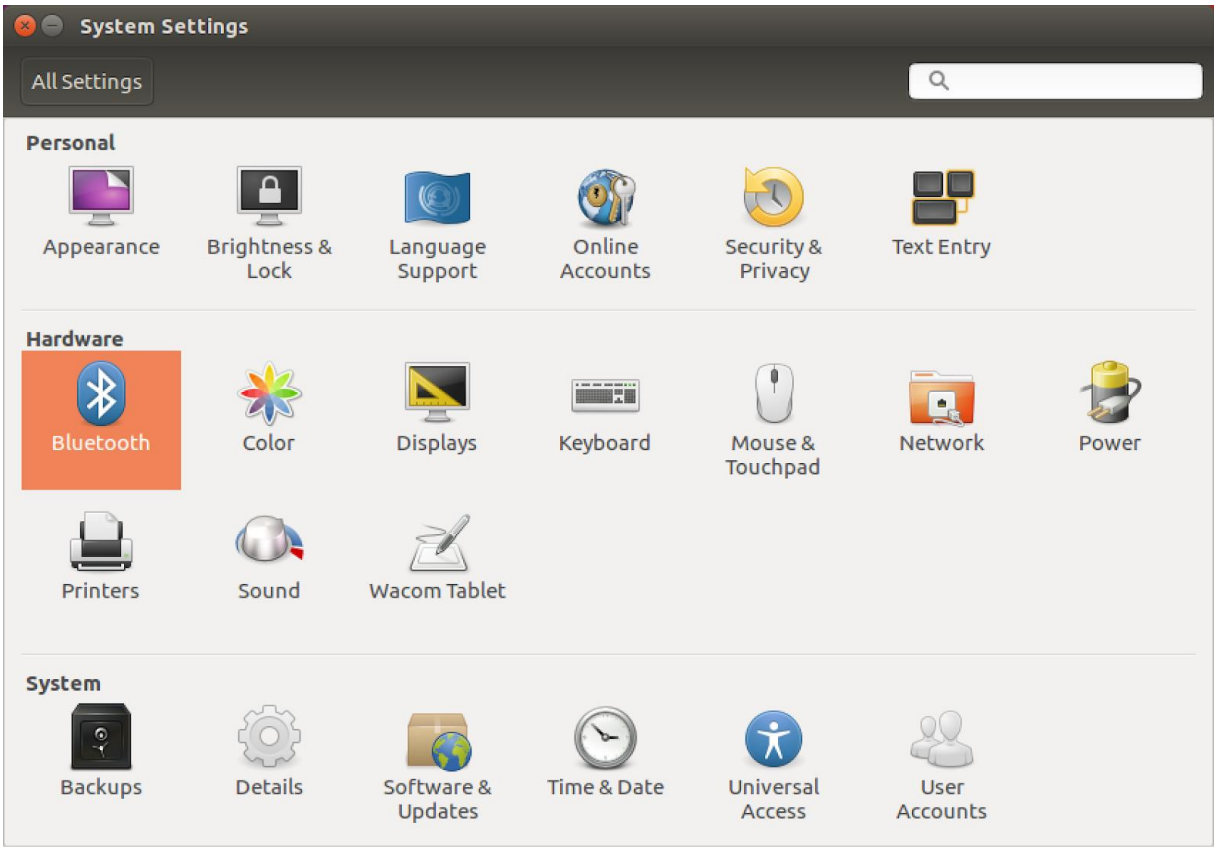


Figure 59 Click on the Bluetooth logo to access the Bluetooth settings.

At this point, turn on your *Electronic acquisition module* (if not done before) and wait until it appears in the list available devices. When your device has been found (here: *biosignalsplux*), it will be listed in the *Device Search* window. Click on the device and select *PIN options…* to enter the device's PIN to proceed.

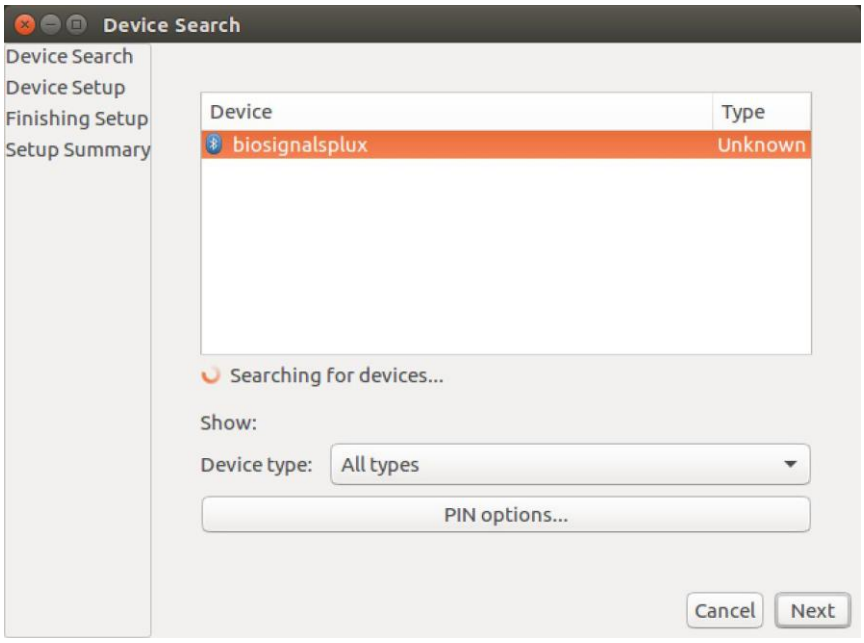


Figure 60 Select your device to add it to your computer.

In the new *PIN* Options window click on *Custom PIN* and enter the device's PIN to connect to your device. For *Electronic acquisition module* devices enter 123 and click on *Next* to connect to your device.

NOTE
If the *Custom PIN* option is not available in this window, follow up with the instructions in *Connecting via Terminal* to connect your device to your computer using the terminal instead of proceeding with the configuration via the system settings.

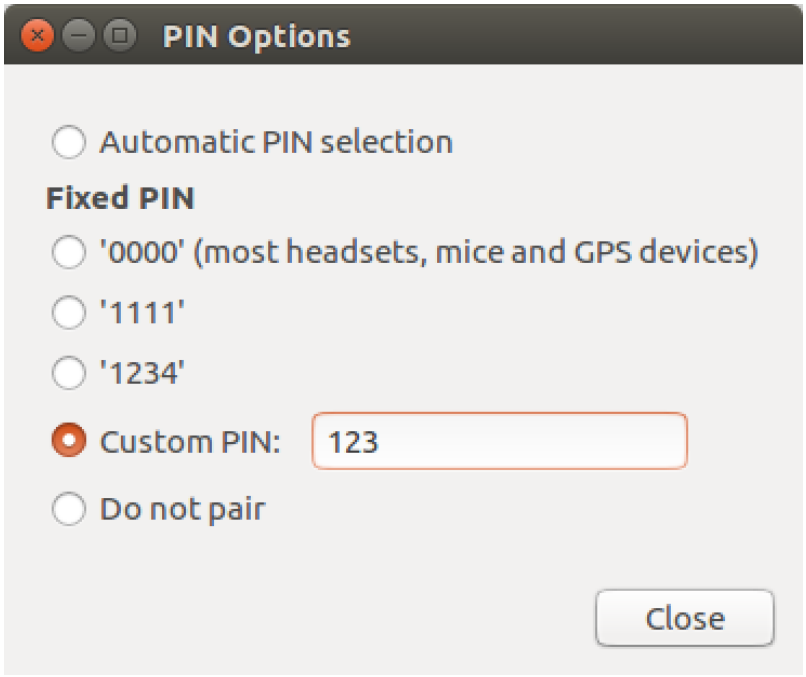


Figure 61 Enter the device's pin to pair.

Click on *Close* to close this window and click on *Next* on the *Device Search* window to connect to your device.

Click on your device in the *Devices* list. If paired is confirmed *(Paired Yes*) your device has been successfully connected to your computer.

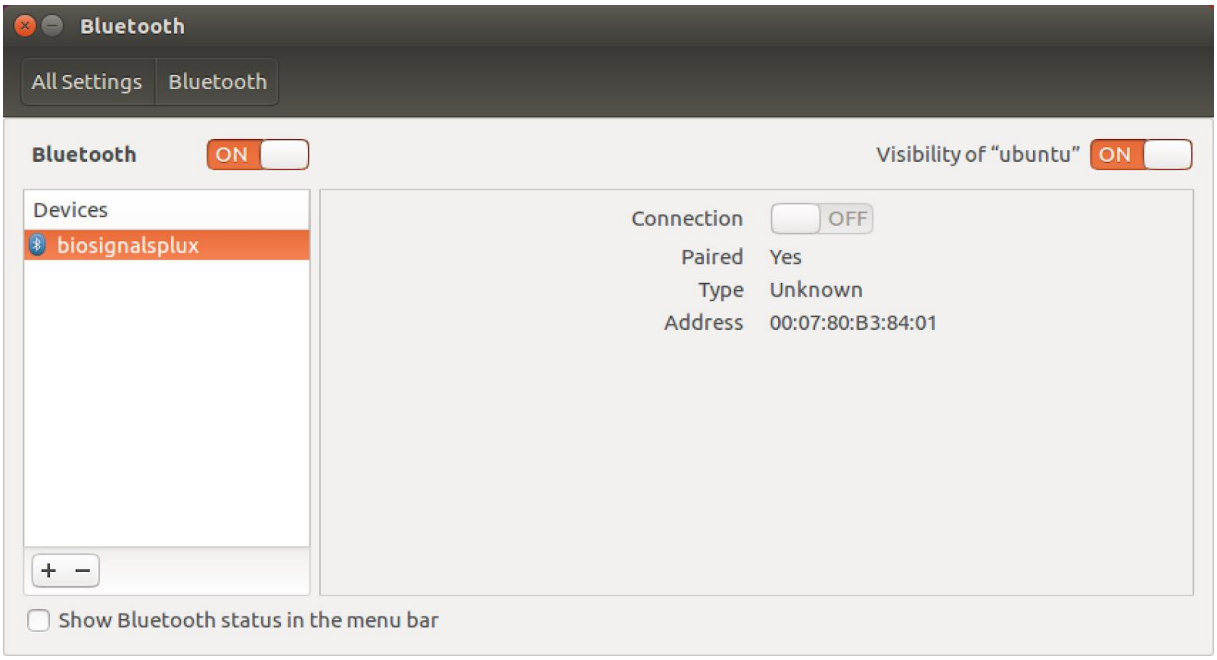


Figure 62 Successfully paired biosignalsplux.

5.4.2. Connecting via Terminal

NOTE
Using the terminal may harm your computer if it is not done correctly. Therefore, this method is recommended for advanced users only and following this method is done at your own risk.

To connect your device to your computer via Bluetooth, click on the *Unity Dash* logo in the toolbar on the left to your desktop open the search function. In the search bar, enter terminal (or Terminal) and click on the terminal logo to open the *Terminal*.

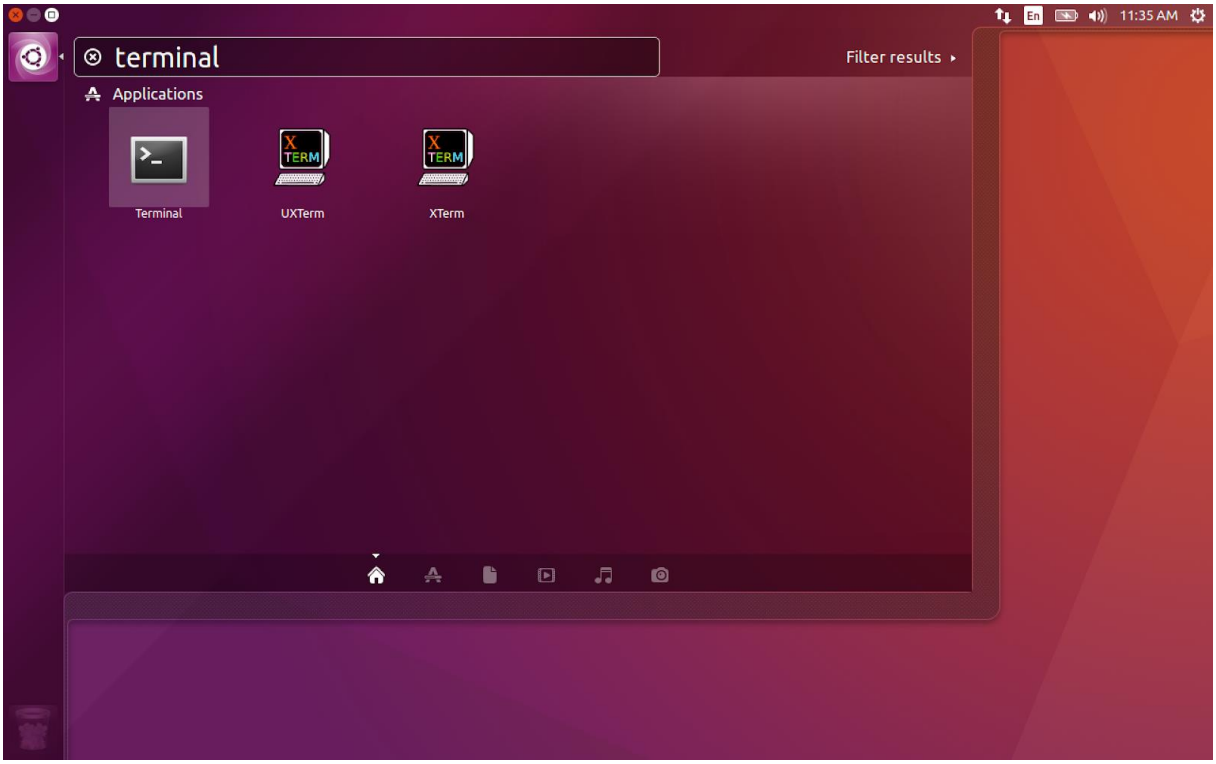


Figure 63 Access the terminal using the search function in Ubuntu.

Enter *bluetoothctl* into the terminal window (without the $). Terminal should answer to this command with the a line displaying the MAC address of your internal Bluetooth adapter. The response should be similar to this (with AA:BB:CC:DD:EE:FF being replaced with your MAC address):

```
$ bluetoothhctl
[NEW] Controller AA:BB:CC:DD:EE:FF ubuntu [default]
[bluetooth]#
```

Next, enter turn on your internal Bluetooth module on (if not done before) by entering *power on* into the Bluetooth prompt line. The response should be similar to this (again, with AA:BB:CC:DD:EE:FF being replaced with your MAC address):

```
[bluetooth]# power on
Changing power on succeeded
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
```

Next, it is needed to turn on a Bluetooth agent. The Bluetooth agents manages the transmission of pin codes (or pairing codes) between devices and is needed here to send the pairing code to the device you want to connect. To do this, enter *agent on*. The terminal response should be similar to this:

```
[bluetooth]# agent on
Agent registered
```

Set up the *default-agent* to proceed with the pairing process.

```
[bluetooth]# default-agent
Default agent request successful
```

At this point, turn on your device (if not done before) and enter *scan on* into the terminal to search for available Bluetooth devices and wait until your device's MAC address appears in the list (here: biosignalsplux, 00:07:80:B3:84:01). Your device's MAC address can be found at the back of the device.

```
[bluetooth]# scan on
Discovery started
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[NEW] Device 00:07:80:B3:84:01 biosignalsplux
```

If your device is listed, enter *pair* followed by the MAC address of your device to start the pairing process which will be respond with requesting the PIN code of your device. For *Electronic acquisition module* devices enter 123 and click on *Next* to connect to your device.

```
[bluetooth]# pair 00:07:80:B3:84:01
Attempting to pair with 00:07:80:B3:84:01
Request PIN code
[agent] Enter PIN code: 123
[CHG] Device 00:07:80:B3:84:01 Connected: yes
[CHG] Device 00:07:80:B3:84:01 Modalias: bluetooth
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 Paired: yes
Pairing successful
[biosignalsplux]
```

If the terminal outputs *Pairing successful* your device has been successfully paired to your computer.

The entire text of your terminal should now be similar to the following:

```
$ bluetoothhctl
[NEW] Controller AA:BB:CC:DD:EE:FF ubuntu [default]
[bluetooth]#
[bluetooth]# power on
Changing power on succeeded
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[bluetooth]# agent on
Agent registered
[bluetooth]# default-agent
Default agent request successful
[bluetooth]# default-agent
Default agent request successful
Discovery started
[CHG] Controller AA:BB:CC:DD:EE:FF Powered: yes
[NEW] Device 00:07:80:B3:84:01 biosignalsplux
[bluetooth]# pair 00:07:80:B3:84:01
Attempting to pair with 00:07:80:B3:84:01
Request PIN code
[agent] Enter PIN code: 123
[CHG] Device 00:07:80:B3:84:01 Connected: yes
[CHG] Device 00:07:80:B3:84:01 Modalias: bluetooth
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 UUIDs: (device specific ID)
[CHG] Device 00:07:80:B3:84:01 Paired: yes
Pairing successful
[biosignalsplux]
```

5.5. Mac OS X

To connect your *biosignalsplux* device to your computer via Bluetooth, click on the Apple symbol at the top left corner of your display and select *System Preferences*…

In the system preferences window click on the Bluetooth symbol to open the Bluetooth settings.

Figure 64 Mac OS X system preferences window.

At this point, turn on your *biosignalsplux* (if not done before) and wait until it appears in the list of Bluetooth devices. When your *biosignalsplux* device has been found, click on the device and click on *Pair* to connect to your device.

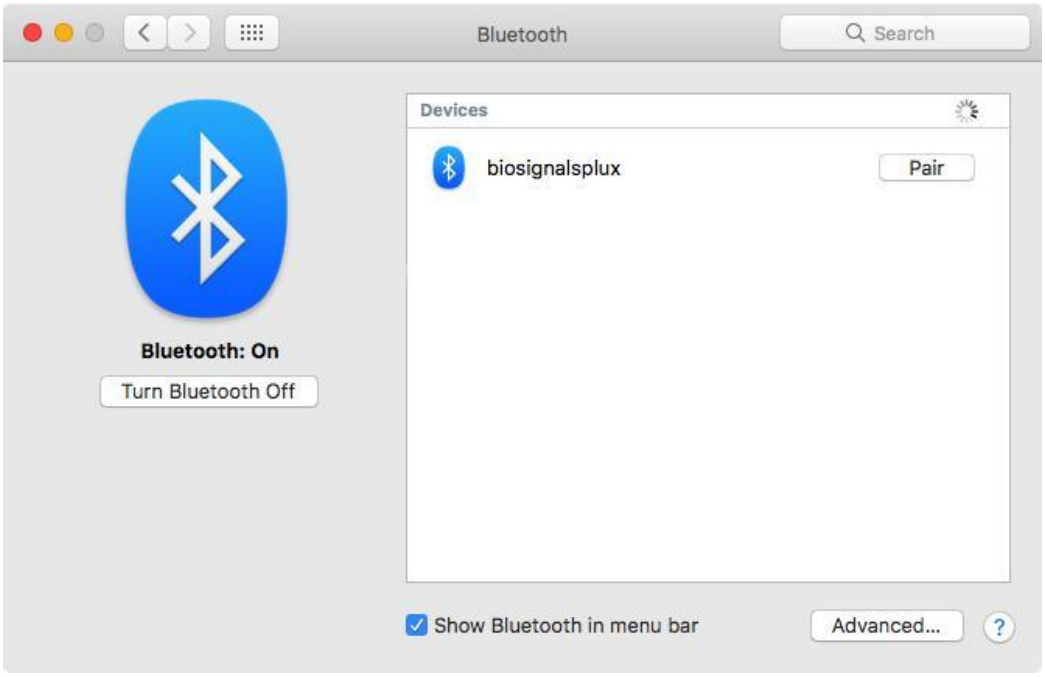


Figure 65 Click on Pair to connect to the biosignalsplux.

An error will occur indicating that the connection could not be established due to a mismatching passkey. Click on *Options…* to enter the passkey (pairing code).

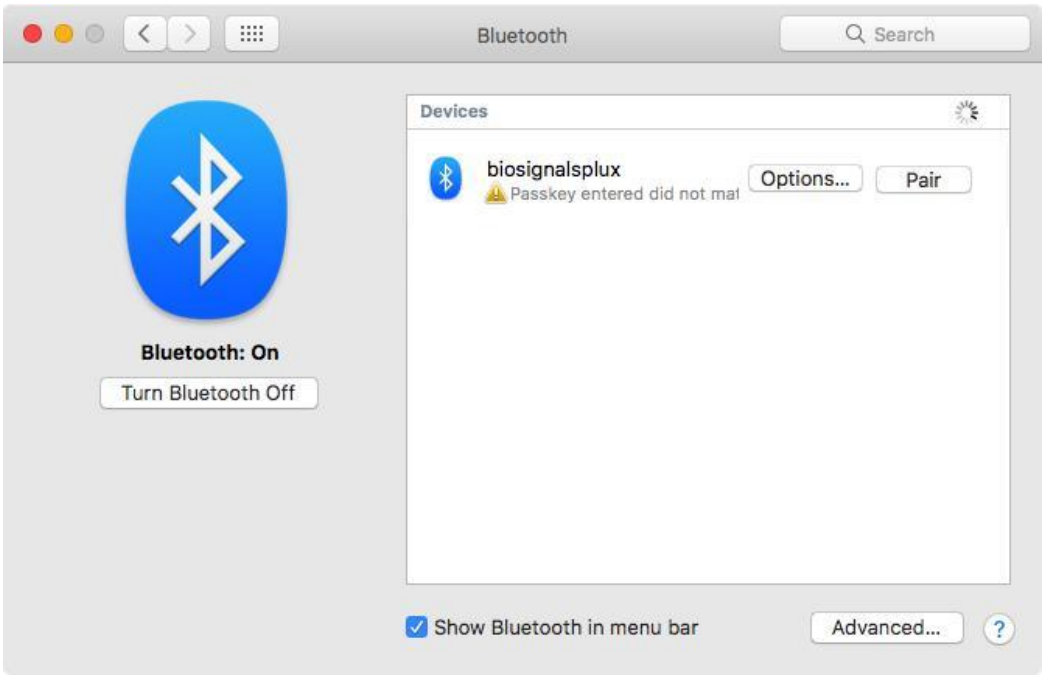


Figure 66 Click on Options… to enter the passkey.

Mac OS X will now try to connect to your device and pop up a window requesting you to enter the passcode (pin) of your device. Enter 123 and click on *Pair* to connect to *biosignalsplux*.

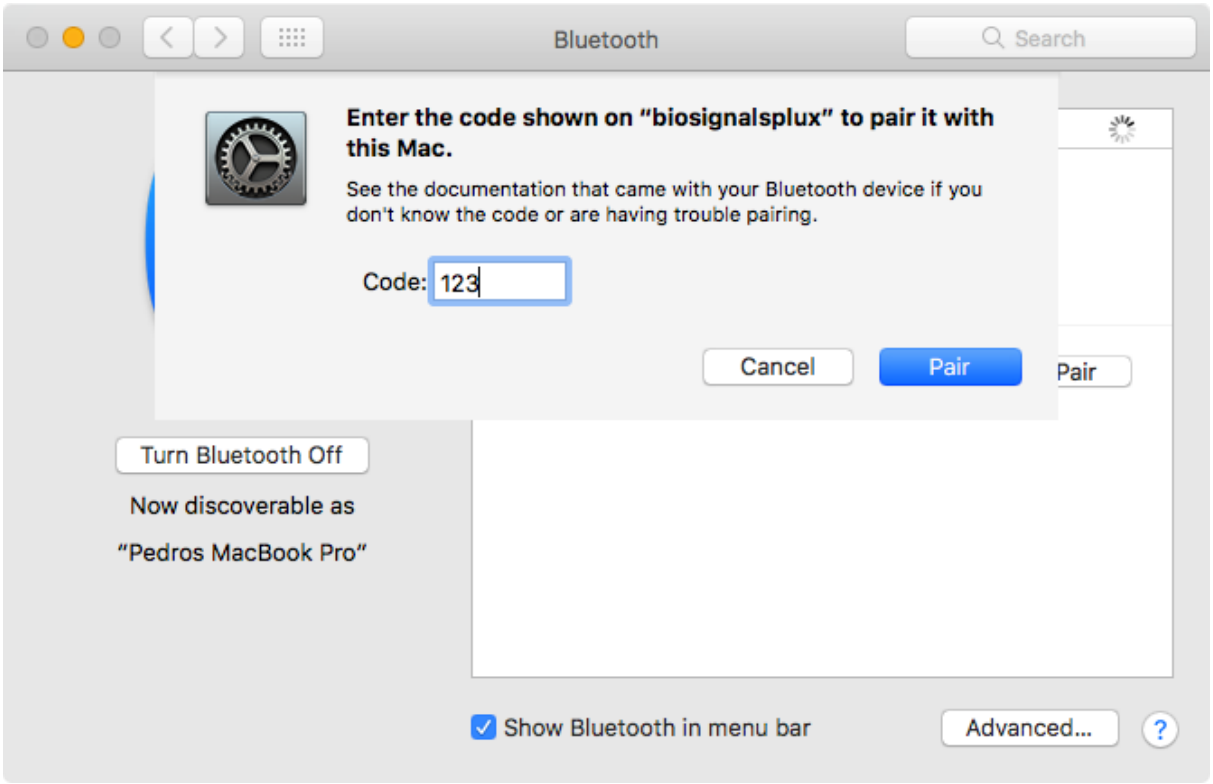


Figure 67 Enter the pairing code

If *Connected* is displayed under the name of your *biosignalsplux* device in the Bluetooth settings panel, the connection has been successfully established.

6. Software & APIs

6.1. OpenSignals (r)evolution

OpenSignals is our easy-to-use, versatile, and scalable software for real-time biosignals visualization, capable of direct interaction with all PLUX devices.

Core functionality includes sensor data acquisition from multiple channels and devices, data visualization and recording, as well as loading of pre-recorded signals. OpenSignals is also a Python-powered web-based software framework, targeted at rapid application development; a bare bone code base is available on GitHub

In addition, OpenSignals has a suite of data analysis add-ons to create reports from the recorded data and extract features directly from the signals without having to do any coding. *biosignalsplux* Research and Professional lab kits already include some or all of the add-ons upon purchase, although add-ons can also be purchased individually in our web store.

You can download the newest version of OpenSignals (r)evolution here:

http://biosignalsplux.com/index.php/en/software/opensignals

WARNING

The Electronic acquisition module is intended to be used with the IM_TWIN API. If the Electronic acquisition module is used with OpenSignals, it is not possible to have access to all sensors:

No Access to the Magnetometer and control of the LEDs.

6.2. OpenSignals Mobile

OpenSignals Mobile is a slimmed down version of *OpenSignals (r)evolution* specifically designed to run on Android® mobile phones or tablets (iOS coming soon), while preserving the ease-of-use and performance for real-time sensor data visualization and recording.

OpenSignals Mobile is currently in development. However, if you are interested in being one of the first few users to get your hands on a beta version of this app, visit our *OpenSignals* website and fill in the form to subscribe for the early access beta version.

http://biosignalsplux.com/index.php/en/software/opensignals

WARNING

The Electronic acquisition module is intended to be used with the IM_TWIN API. If the electronic acquisition module is used with OpenSignals, it is not possible to have access to all sensors:

No Access to the Magnetometer and control of the LEDs.

6.3. APIs

Use the IM_TWIN API to be able to collect data from all sensors and have control over the 2 LEDs for video synchronisation.

7. Troubleshooting

7.1. Bluetooth

Most internal Bluetooth adapters are compatible with PLUX devices. However, if you're experiencing a great number of connection loss events, reconnection problems, missing samples or similar problems, your internal Bluetooth module might not have enough performance to deal with the data throughput of the device you are using. In this case, reducing the sampling frequency or the sample resolution might solve this issue, if a change of these parameters is possible.

For this reason, PLUX has identified Bluetooth dongles that have been tested and are known to work with our devices. We recommend that you use one of these PLUX-tested Bluetooth dongles, which are either already shipped with your device (e.g. in the case of *biosignalsplux* kits) or can be purchased separately from our store. These dongles are compatible to work with data rates up to 24 Mbps.

The solution is to exchange the internal Bluetooth Adapter for an **external Bluetooth USB dongle that uses the Windows native Bluetooth stack**. For this, you'll need to install the Bluetooth dongle properly, as described in the following steps, which are explained in more detail throughout the next pages for the supported operating systems:

Step 1: Removing already paired devices from your operating system
Step 2: Installing PLUX-proven Bluetooth dongle
Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

NOTE
If you're already using PLUX devices with the old Bluetooth stack, please remove your device(s) from your computer **before** changing the Bluetooth drivers/changing to Microsoft Bluetooth Stack.

NOTE
We recommend going through all the following steps to set up your Bluetooth dongle correctly, even if Windows may automatically install and set up your dongle.

NOTE
Installing the Bluetooth dongle and changing the Bluetooth stack is only required for Windows computers only. Computers with a Mac OS X operating system do not need to go through these steps and use the internal Bluetooth adapter instead.

7.2. Windows 7 & Windows 8

Step 1: Removing already paired devices from your operating system

To remove Bluetooth devices, it is needed to access the *Device Manager* on your computer and view the list of connected devices. The device list can be found following these steps:

Start Button > Control Panel > Hardware and Sound > View devices and printers

In the *Device and Printers* window, PLUX devices can be found in the *Unspecified* section. Right-click on the device you want to remove and select *Remove device* (see *Figure 63*)

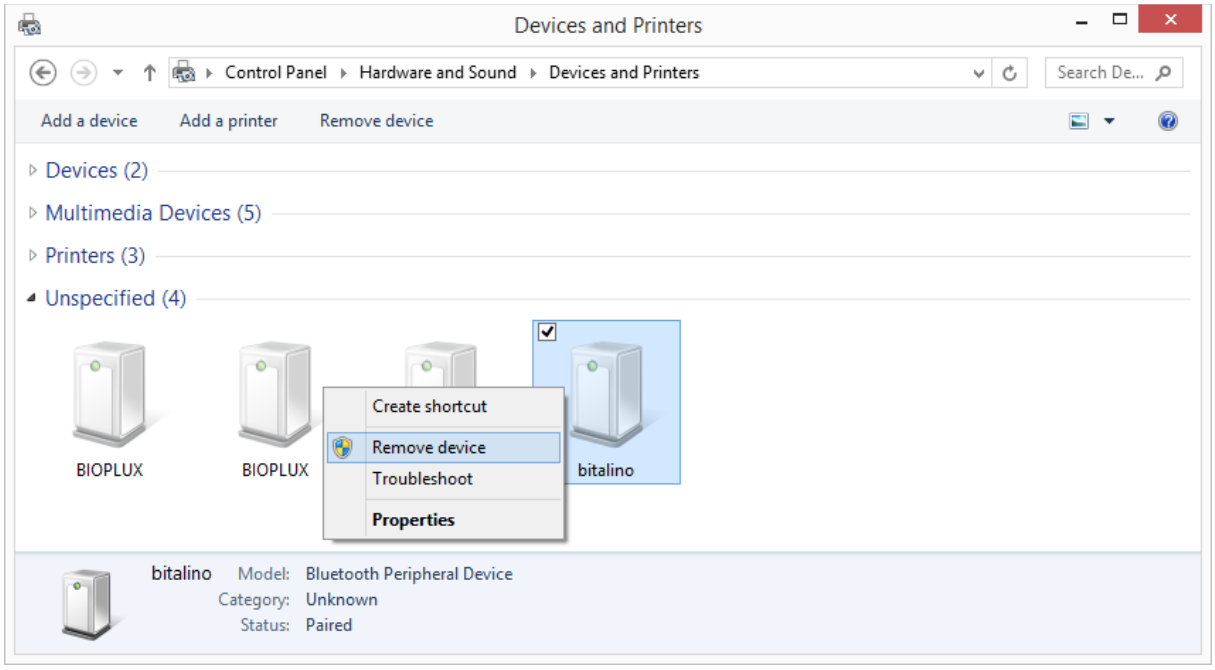


Figure 68 Windows 7 "Devices and Printers" window.

If the device is not listed under *Unspecified* anymore, it has been successfully removed from your system.

Step 2: Installing PLUX-proven Bluetooth dongle

To install the PLUX-proven Bluetooth dongle, plug it in and install all the necessary drivers for the Bluetooth dongle to work (an Internet connection is advisable). Windows should display the window below.

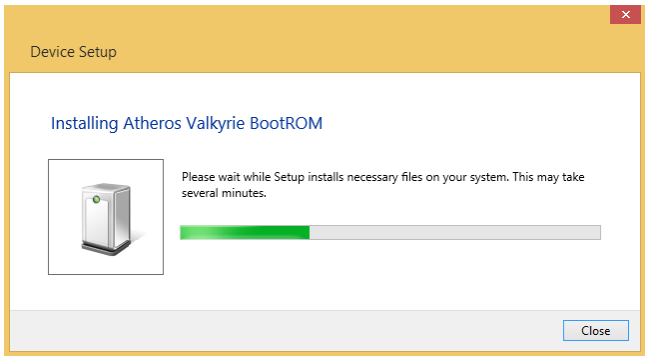


Figure 69 Wait for Windows to install your Bluetooth dongle.

Make sure you wait until your Bluetooth Dongle is installed. Windows will issue a notification and you'll be ready to configure the correct Bluetooth stack following the next step.

Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

To configure the Bluetooth stack of the Bluetooth dongle, you have to connect your Bluetooth dongle to your computer and access the *Device Manager* on your computer. The device manager can be found following these steps:

Start Button > Control Panel > System and Maintenance > Device Manager

In the device manager, the Bluetooth dongle should be listed as *Generic Bluetooth Adapter* (see *Figure 65*). If your machine already has an internal Bluetooth Adapter and you have just plugged in the PLUX-proven Bluetooth Dongle, keep in mind that the last one will be automatically disabled by Windows. This is why one of your Bluetooth adapters under Bluetooth in the device manager shows a yellow warning icon (⚠) stating: *Code 10 - This device cannot start*.

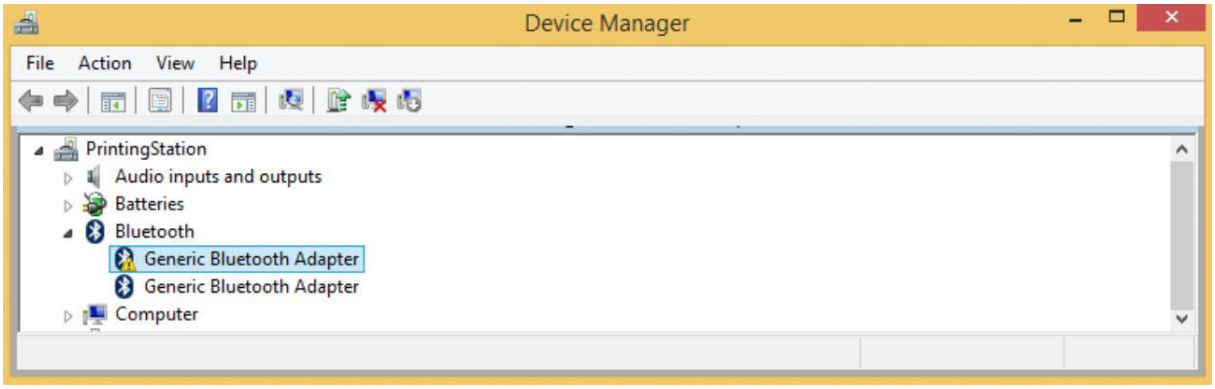


Figure 70 Bluetooth dongle listed in the device manager.

If your Bluetooth dongle is the one disabled, you can manually disable your internal Bluetooth adapter by right-clicking on it in the device manager and selecting *Disable*. This action will enable your Bluetooth dongle by default.

If, after this action, your Bluetooth Dongle continues to display a yellow warning icon (⚠) , it means that it is not installed correctly and you should try to update the drivers by right-clicking on it and selecting *Update Driver Software*... or fix the problem displayed under *Device Status* in the device properties (right-click the Bluetooth device and select Properties; see screenshot below).

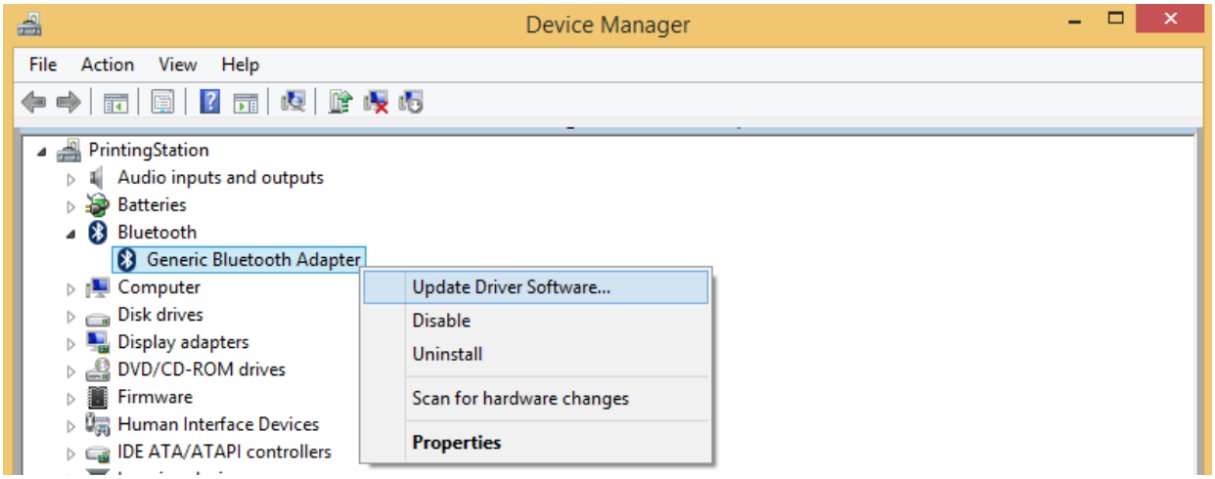


Figure 71 First step to update the driver of the Bluetooth dongle.

Select *Browse my computer for driver software* from the new window.

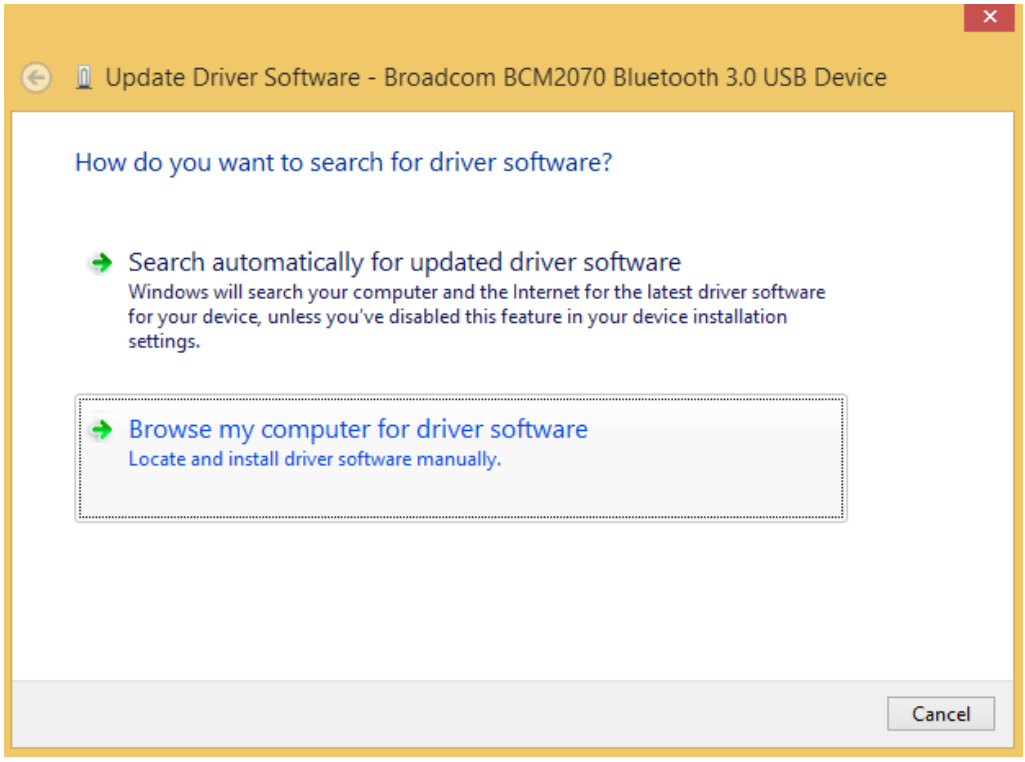


Figure 72 Browse for driver software.

Select *Let me pick from a list of device drivers on my computer*.

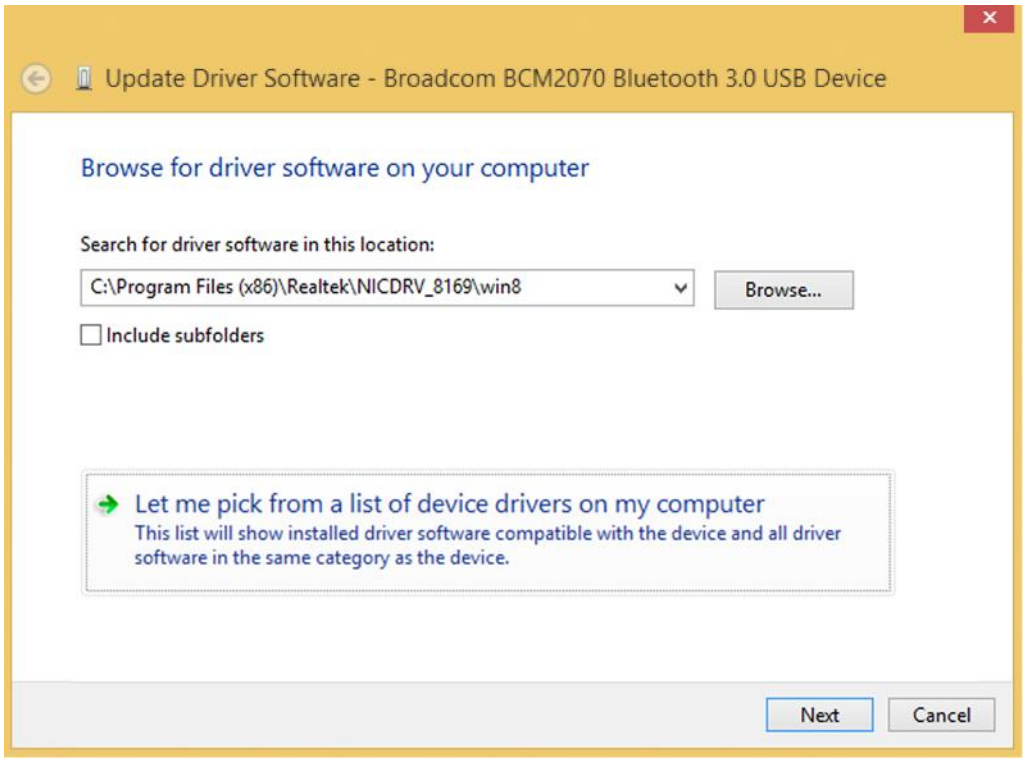


Figure 73 Pick driver from list of device drivers on the computer.

Select *Generic Bluetooth Adapter* and click on *Next* to install the Microsoft Bluetooth Stack. Of several models of *Generic Bluetooth Adapter* are available you can select any of them. It will not make any difference.

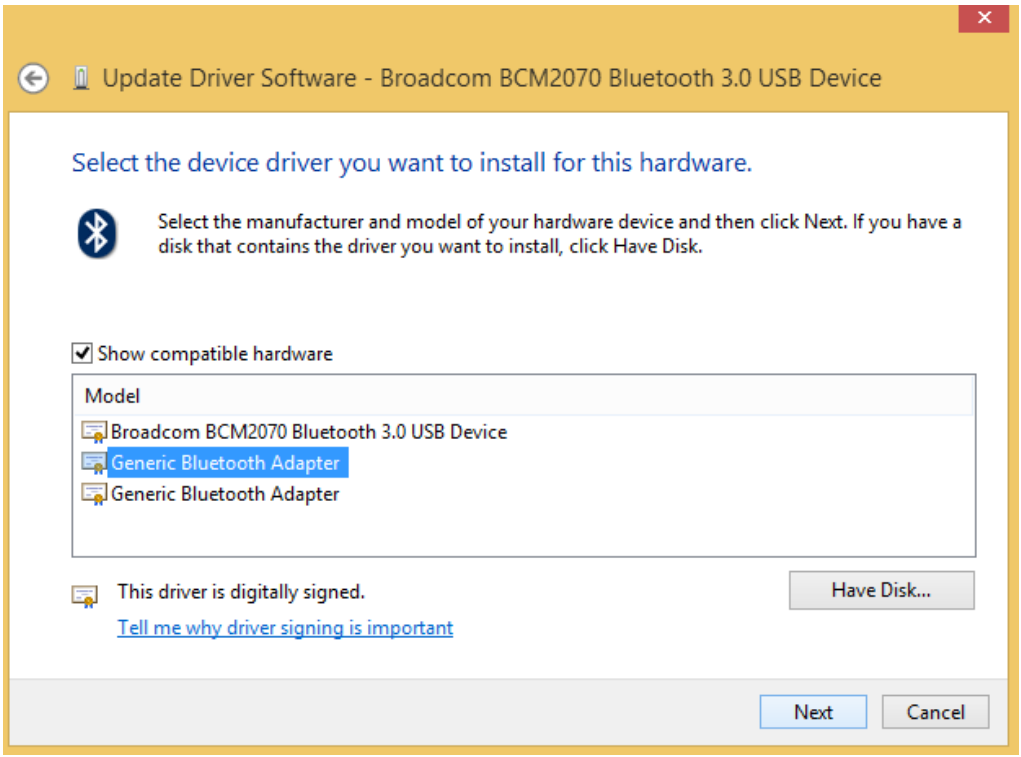


Figure 74 Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your *biosignalsplux* device (see *Bluetooth Setup Windows 7*) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

7.3. Windows 10

Step 1: Removing already paired devices from your operating system

To remove Bluetooth devices, it is needed to access the Bluetooth configuration of your operating system. Click on the start button at the left lower corner in of your desktop to open the start menu. Click on the gear symbol to open the settings panel of your operating system as can be seen below.

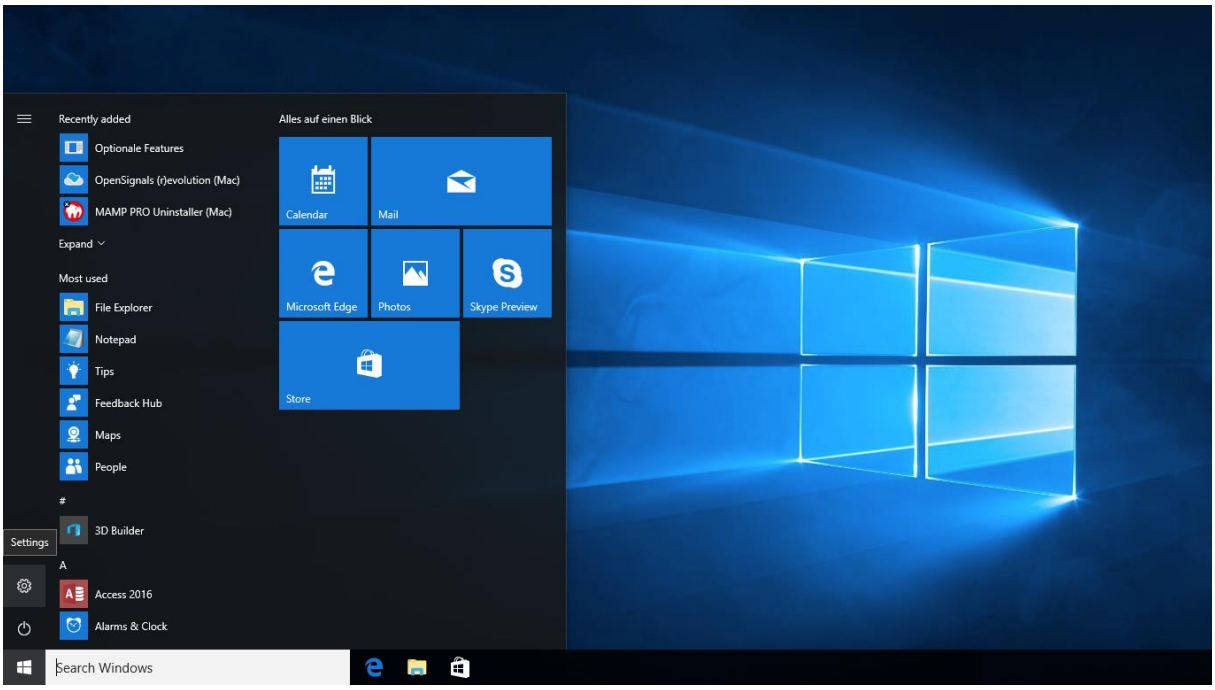


Figure 75 Access to the settings panel in Windows 10.

In the settings panel, click on the *Devices Bluetooth, printers, mouse* field to open the device configurations of your system.

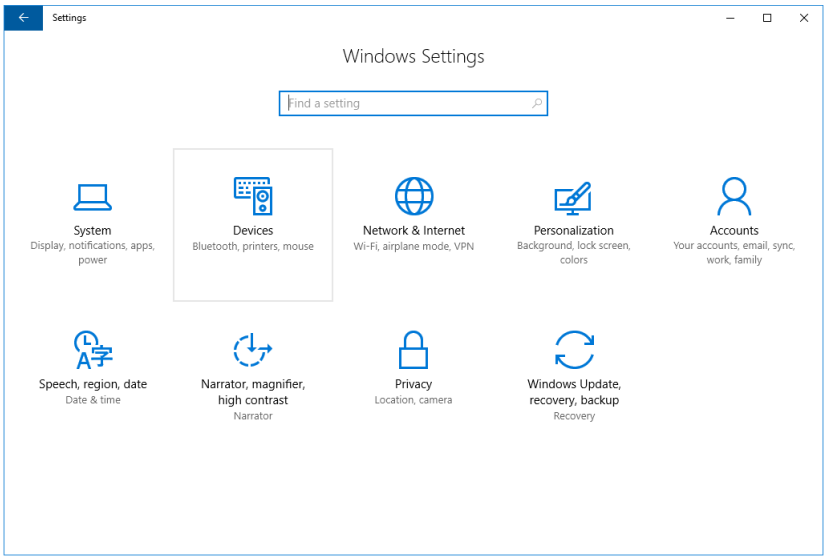


Figure 76 Windows 10 settings panel.

Select *Bluetooth* from the list which is displayed on the left side of your settings window. Note, that in some versions the Bluetooth option might not be available and that Bluetooth devices might be listed under *Other devices*.

Click on your *biosignalsplux* and click on *Remove device* to remove this Bluetooth connection from your computer and confirm the *Are you sure you want to remove this device?* message that will be shown on your screen. Repeat this step with every *biosignalsplux* if you're using several devices.

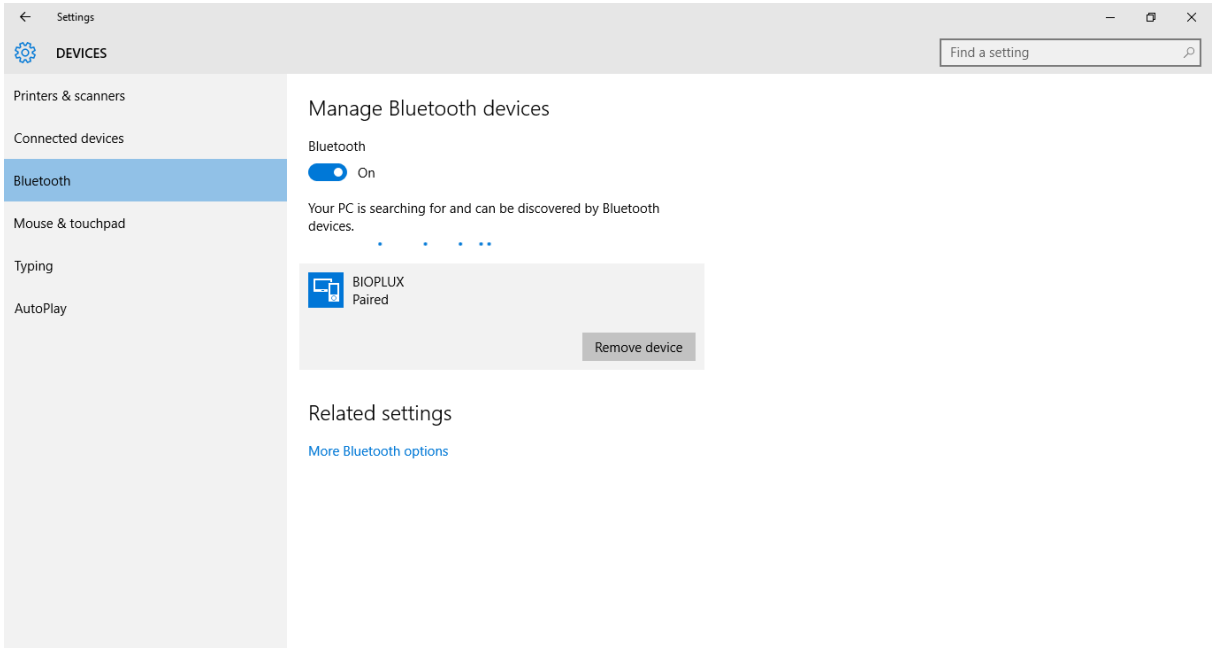


Figure 77 Windows 10 Bluetooth devices

If, after this step, your device is not listed in the list of Bluetooth devices anymore, the device has been successfully removed.

Step 2: Installing PLUX-proven Bluetooth dongle

To install the PLUX-proven Bluetooth dongle, plug it into your computer. Windows will install the Bluetooth dongle and display the window below.

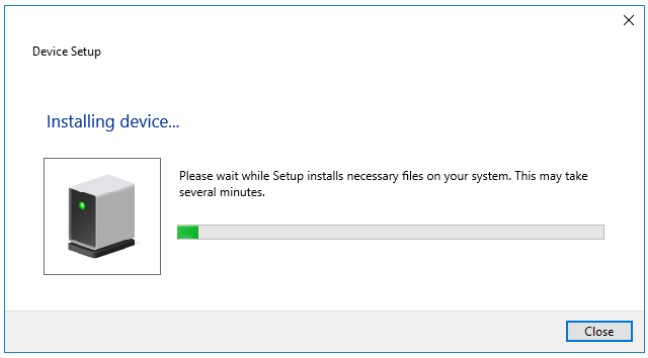


Figure 78 Wait for Windows to install your Bluetooth dongle.

Make sure you wait until your Bluetooth Dongle is installed. Windows will issue a notification and you'll be ready to configure the correct Bluetooth stack following the next step. Note, that this step might require a restart of your system. Make sure to close all your open work and programs properly before restarting the system to prevent data losses or other issues.

Step 3: Changing Bluetooth Stack to Microsoft's native Bluetooth stack

To configure the Bluetooth stack of the Bluetooth dongle, you have to connect your Bluetooth dongle to your computer and access the *Device Manager* on your computer. Enter *Device Manager* into the search field of your taskbar and click on the listed device manager.

In the device manager, the Bluetooth dongle should be listed as *Generic Bluetooth Adapter* (see). If your machine already has an internal Bluetooth Adapter and you have just plugged in the PLUX-proven Bluetooth Dongle, keep in mind that the last one will be automatically disabled by Windows. This is why one of your Bluetooth adapters under Bluetooth in the device manager shows a yellow warning icon (⚠) stating: *Code 10 - This device cannot start.*

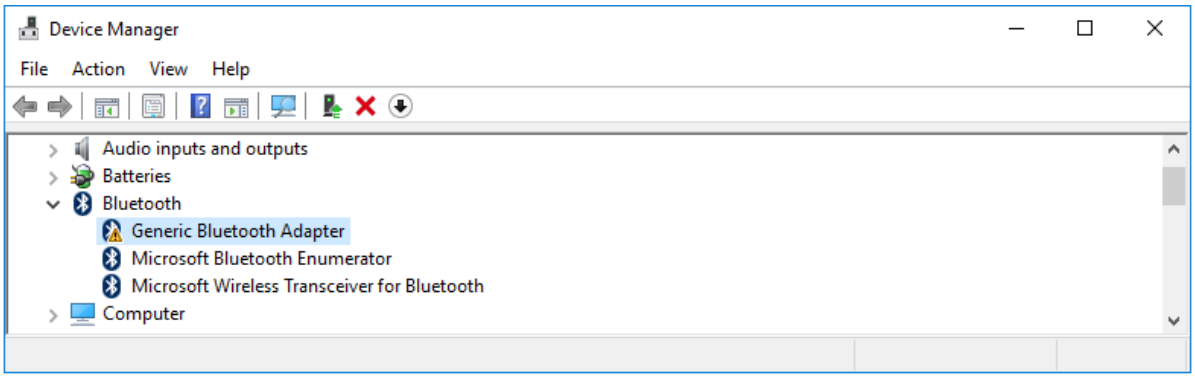


Figure 79 Bluetooth dongle listed in the device manager.

If, after this action, your Bluetooth Dongle continues to display a yellow warning icon (⚠), it means that it is not installed correctly and you should try to update the drivers by right-clicking on it and selecting *Update Driver Software*... or fix the problem displayed under *Device Status* in the device properties (right-click the Bluetooth device and select Properties; see screenshot below).

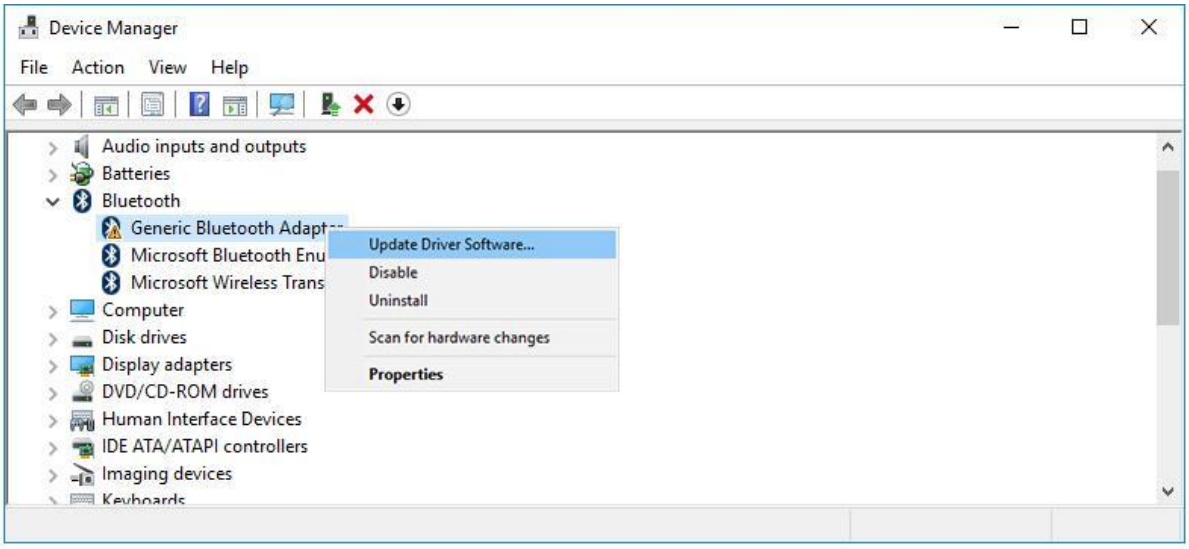


Figure 80 First step to update the driver of the Bluetooth dongle.

Select *Browse my computer for driver software* from the new window.

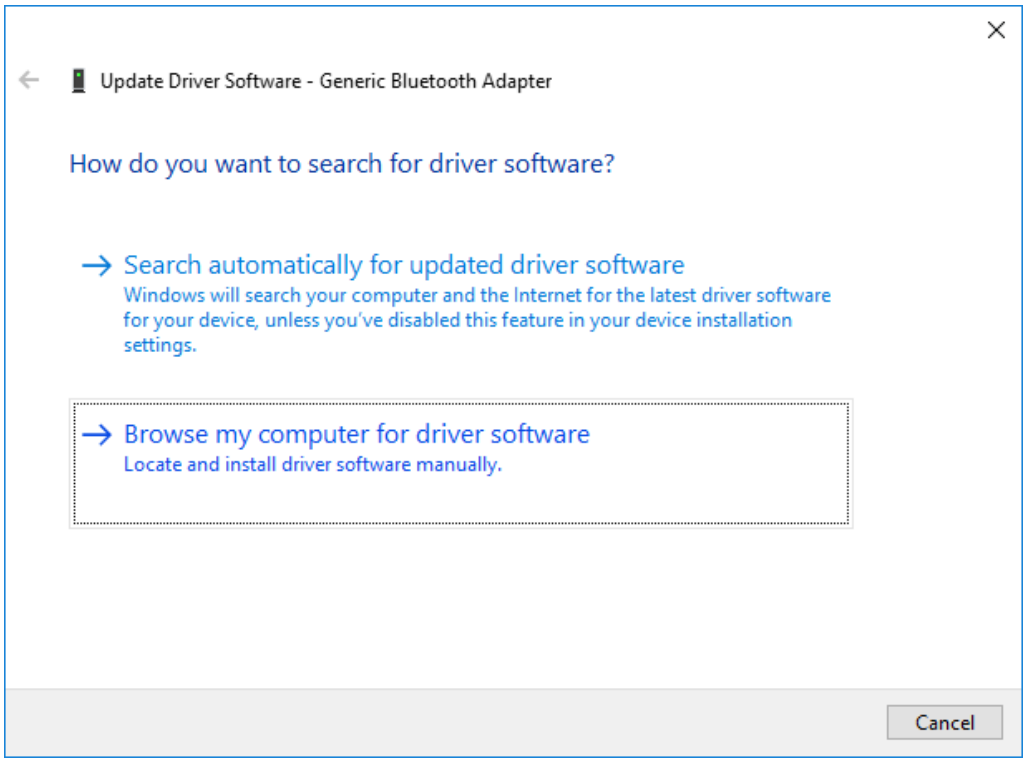


Figure 81 Browse for driver software.

Select *Let me pick from a list of device drivers on my computer*.

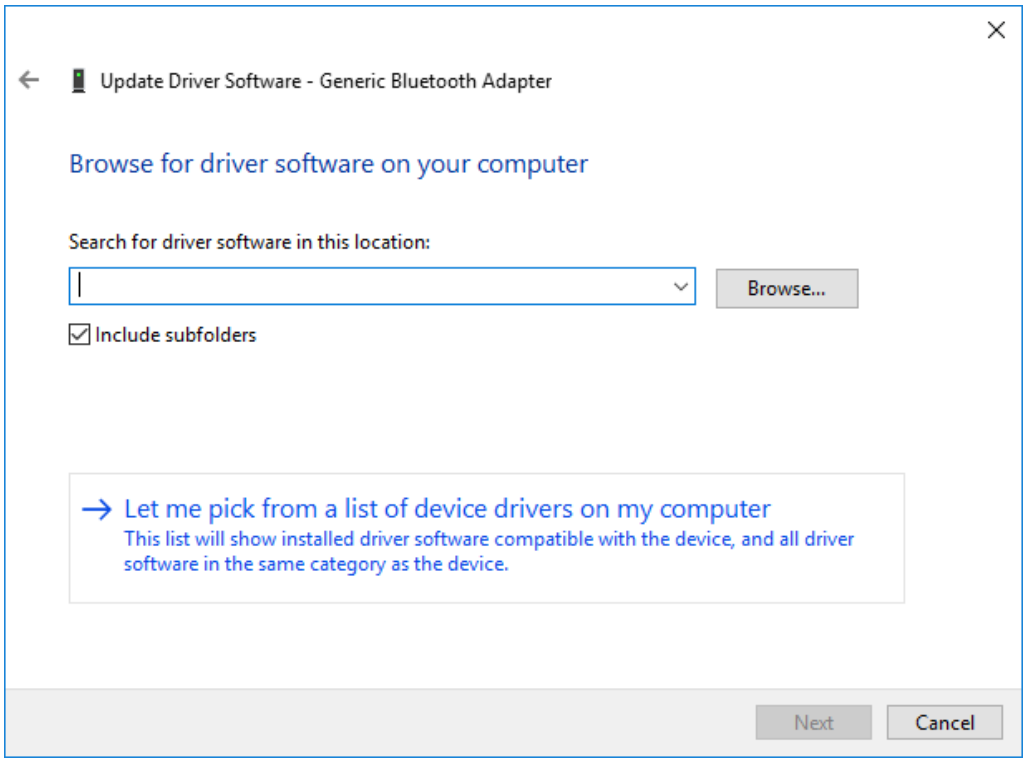


Figure 82 Pick driver from list of device drivers on the computer.

Select *Generic Bluetooth Adapter* and click on *Next* to install the Microsoft Bluetooth Stack. Of several models of *Generic Bluetooth Adapter* are available you can select any of them. It will not make any difference.

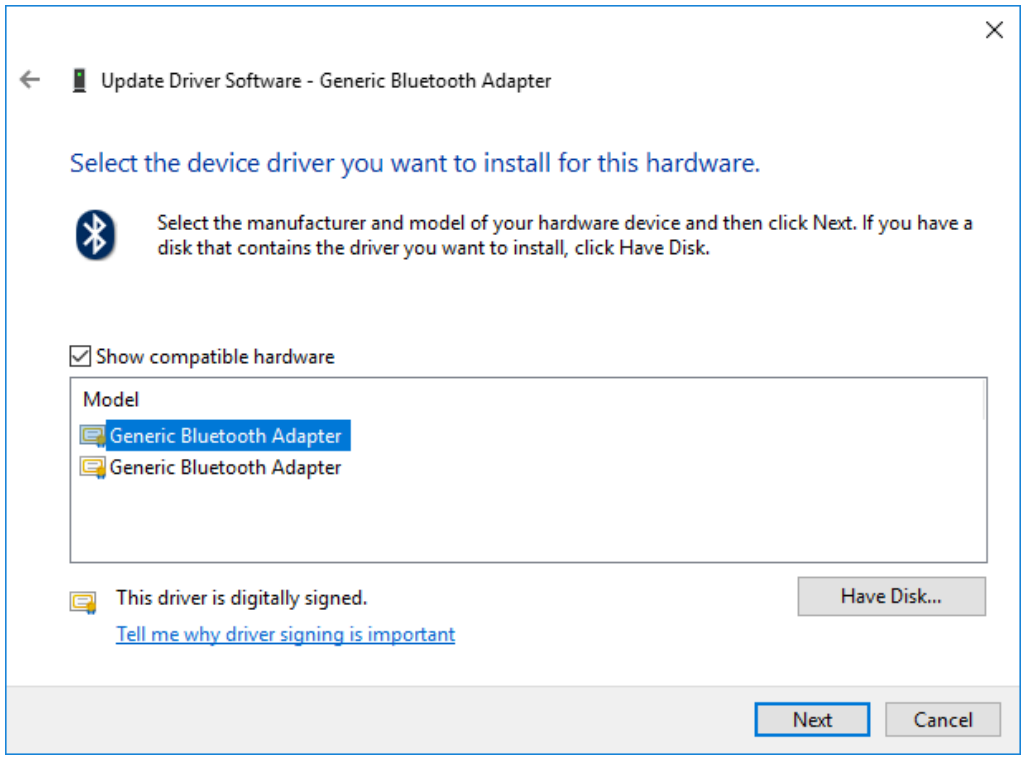


Figure 83 Select Generic Bluetooth Adapter

Your device should now be configured properly and have no warning sign or error message in the device manager. Rebuild the connection with your *biosignalsplux* device (see *Bluetooth Setup* Windows 10) and test your device by recording signals with the *OpenSignals (r)evolution* software. If, after all these steps, you keep experiencing the same issues, contact our support

8. Safety & Maintenance

Please read the following safety instructions **before** using your *biosignalsplux* system to prevent any damages or problems with the user, test persons and/or *biosignalsplux* devices. Violations of these instructions can lead to inferior signal quality and/or damages to the *biosignalsplux* system and user.

- The user should always keep the device and its accessories dry.
- The user must turn off the *biosignalsplux* device and contact Technical Support if the system or accessories reach uncomfortable temperatures.
- The user should not use the *biosignalsplux* device in noisy environments (environments with microwaves and other similar equipment). Doing so will lead to noise increase in the acquired signals and Bluetooth connectivity issues.
- The user must not use the device near the fire or in potentially explosive atmospheres, such as atmospheres with flammable gas.
- The user should only use the detection surfaces or other approved accessories purchased from PLUX or by a PLUX agent.
- The user should inspect the sensors on a regular basis to ensure that they remain in good working order.
- The user should stop using the *biosignalsplux* device if experience any kind of discomfort or skin irritation.
- The user should not use the *biosignalsplux* device continuously for periods of time above 60 minutes. Do not use the system on persons with allergies to silver.
- The user should dispose detection surfaces after using the *biosignalsplux* device. Detection sur- faces are single-user and disposable. Reusable electrodes should be reused by the same user. Do not use reusable electrodes on several users.
- The user must not place the device in the microwave.
- The user must not insert objects into the holes of the device.
- The user should not open the *biosignalsplux* device or its accessories. The repair of the same should be only done by properly authorized PLUX personnel.
- The user should make sure the cables do not obstruct the passage of people.
- The user should use the sensor cables with extreme caution to avoid risk of strangulation.
- The user should keep a safe distance between the *biosignalsplux* device and other devices to ensure their proper functioning.
- The user should only send the device to repair to qualified PLUX personnel.
- The user should not immerse the sensors or the *biosignalsplux* device, nor clean with liquid or abrasives.
- The user should handle the *biosignalsplux* device with caution and not expose the device or accessories to high accelerations and vibrations.

! *biosignalsplux* devices should not be used in patients with implanted electronic devices of any kind, including pace-makers, electronic infusion pumps, stimulators, defibrillators or similar.
! Do not apply electrodes over damaged or irritated skin.

! Do not use your device while charging its internal battery.

8.1. Maintenance Recommendations

8.1.1. Transportation and Storage

Please follow these recommendations to ensure safe transportation and storage of your *biosignalsplux* equipment and sensors to prevent any damaging of your system.

- The *biosignalsplux* equipment and sensors should be stored in the original box in a dry place when those are not being used.
    - Relative humidity: up to 95% with no condensation
    - Ambient temperature: 10°C to 30°C
    - Atmospheric pressure between 500hPa and 1060hPa

- Whenever the equipment needs to be transported, it should be placed in the original box, since this was designed and tested to ensure the equipment and accessories are securely stored.

- Take care while handling the bac and avoid dropping it, since the device is not shock-proof and should not be placed under stress or sudden acceleration.

8.1.2. Cleaning

Please follow these cleaning instructions to prevent any damage of the system or the user because of conducting cleaning methods that may cause any damage.

- The *biosignalsplux* and sensors should be visually checked before each use and cleaning process to ensure that no mechanical damage occurred.

- The *biosignalsplux* equipment and sensors (including the cables) should be cleaned with a slightly damp cloth or suitable absorbent paper, ensuring no liquid enters the equipment of sensors. Do not use detergent or any type of cleaning liquid as these may damage your equipment and/or sensor.

- Do not clean or re-use detection surfaces (electrodes). They are only suitable for single use, and should be disposed of after usage except indicated otherwise.