VESNA AQ Personal Sensor Unit: User manual

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1 Overview and main specifications

VESNA AQ (Air Quality) Personal Sensor Unit has been purposely developed for the air quality monitoring in the FP7 CITI-SENSE project. It is battery powered device (a battery pack consisting of 3 AA size rechargeable batteries) in an ABS plastic casing equipped with gas sensors for NO_2, O_3 and CO on an Alphasense 3-sensor AFE-A4 board, two temperature sensors, a relative humidity sensor and an accelerometer. For the gas sensors there are three round holes on the top front part of the casing (see Figure 1). For proper operation these sensors should not be blocked or obstructed in any way. Also, they should not be disposed to water or very high humidity, nor to excessive gaseous shocks (e.g. automotive exhaust).

Figure 1: VESNA AQ device.

The device connects to an Android smartphone with a custom developed mobile app via Wi-Fi connection. Data is stored on the smartphone (no storage for data enabled on the device itself), where some basic visualization is supported in the mobile app, but it is also periodically or upon request (depending on settings) sent to the remote server for analysis, post-processing and advanced visualization. The configuration of settings is explained in Section 3.

The basic device specifications are summarized in Table 1.

Dimensions (W x L x D)	100 mm x 210 mm x 32 mm
Weight	270g appox.
Battery pack	3.6 V 2850 mAh NiMh
Expected autonomy	20 h

Table 1: Device specifications.

2 Using VESNA AQ device

2.1 Powering-on the VESNA AQ device

To start using the VESNA AQ device, the power switch has to be slid to the ON position. The power OFF position is shown in Figure 2 and power ON position is depicted in Figure 3.

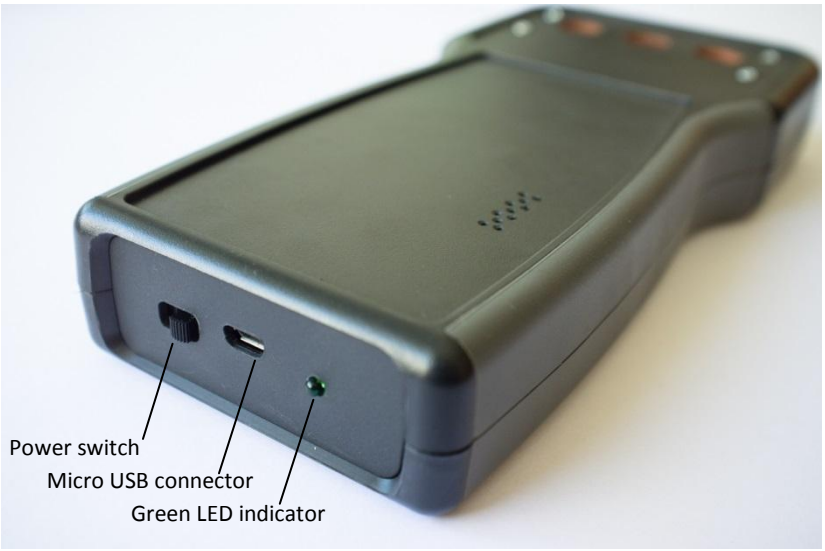


Figure 2: VESNA AQ device switched off.

2.2 Device charging

Before the first use the device should be fully charged. The device can be charged through a micro USB connector on the bottom side between the green LED and the power switch. For charging the power switch has to be slid to the ON position, as depicted in Figure 3.

If the device is plugged in a charger it is operating in both battery switch positions but it is charging only when the power switch is ON.

When the device is connected to a USB power, the green LED is blinking with a period of 0.5 seconds.

The time needed to fully charge the batteries is around 10 hours. The best way to charge it is to leave the device connected to a charger over the night.

NOTE - There is no indication or stop condition for charging so it is better not to leave the device connected to the power for more than 10 hours!

The device is functioning normally during the charging period.

Quick charging guide:

- Connect a micro USB power cable (not supplied) to the device.
- Slide the power switch to the ON position as shown in Figure 3.
- Wait for 10 hours.
- Disconnect the device.
- Use it.

Figure 3: VESNA AQ device prepared for charging.

2.3 Status LED signals

With the green LED indicator on the bottom of the device next to the micro USB power socket and the power switch, the device is indicating several operating modes, summarized in Table 2.

Setup mode: while the device is preparing for operation, green LED is constantly turned on. It can take from few seconds to one minute for the device to finish setup. If the setup mode is not finished after 1 minute, then it is better to power the device off and on again.

Normal operation mode: when the device is functioning normally and is prepared to acquire air quality samples, the LED indicator is blinking whit **short** blinks in intervals of approximately 3 seconds.

Low battery normal operation: when battery level drops under 20% and the device is in normal operation mode, the LED indicator is blinking with **short** blinks with frequency of approximately 3 Hz (3 times per second).

Charging mode: when the device is connected to the USB power, the battery charger is enabled. The LED indicator is blinking with **long** pulses with the frequency of approximately 2.5 Hz. The battery switch should be switched to the left as depicted in Figure 3 to enable battery charging. If battery switch is not switched to the left, battery is not charging and device is operating normally from USB power without using energy stored in batteries.

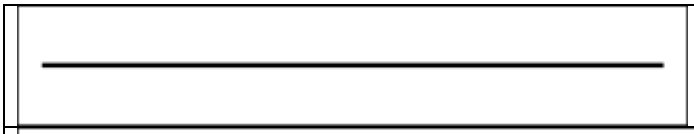
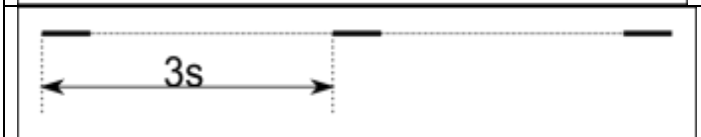
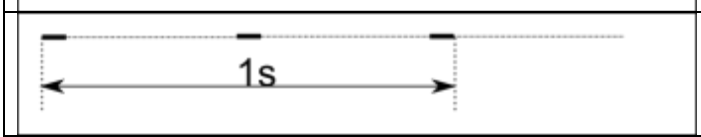
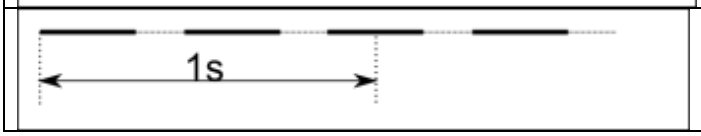
	Setup mode
	Normal mode
	Low battery normal operation mode
	Charging mode

Table 2: Device LED signals.

3 IJS AQ App – the mobile app for connecting VESNA AQ device

This section describes the mobile app IJS AQ App developed for Android smartphones, needed for collection of data from the VESNA AQ device, basic visualization and the transfer of data to the remote server via the WEB data download API. In particular, this section covers the installation of the app, the first time connection of the VESNA AQ device and IJS AQ App, collection of measurements, the data overview tab, the context description tab, posting of data to the remote server and error log tab. At the end of the section a simple WEB API for data acquisition is also described.

3.1 Installation

The installation of the IJS AQ App apk file, which is not obtained through Google Play Store, requires a file system explorer, which in turn can be obtained for free from the Google Play Store, i.e. https://play.google.com/store/apps/details?id=com.estrongs.android.pop&hl=en.

1. Next you need to allow the installation of apps from unknown sources. Go to settings -> security and put a tick at Unknown sources.
2. Now download the apk to the phone memory, locate it using the file system explorer and run it. This will install the app on the phone.
3. After the installation find among your apps the app named IJS AQ App and run it. The icon of the app is depicted in Figure 4.

Figure 4: IJS AQ App icon.

3.2 First time connection, context setting and collection of measurements

When running the app for the first time, you will see the screen as shown in Figure 5.

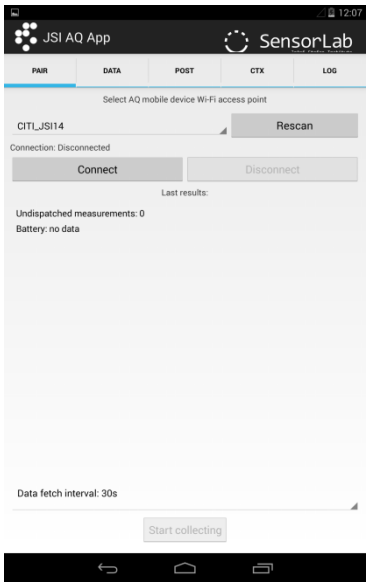


Figure 5: IJS AQ App start screen.

1. If the VESNA AQ device is turned on and within the range, the mobile app will automatically detect it (e.g. CITI_JSI14 in Figure 5). All you need to do is to click the connect button. When connecting a given device for the first time, it will ask for the access point password, which is by default for all VESNA AQ units set to *passphrase* (unless you are instructed otherwise). This step is shown in Figure 6.

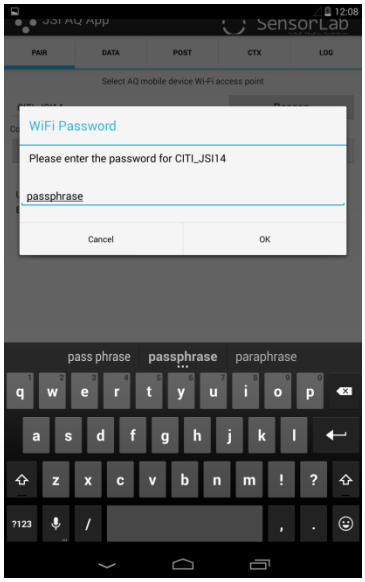


Figure 6: Entering Wi-Fi password.

2. Before starting with the measurements collection you need to set the context of the measurements. Once the context is set, it is attached to all the collected measurements until it is modified again. To set/change the context, go to the tab CTX and enter new context, click Add to list, select this context from the list and click OK (see Figure 7).

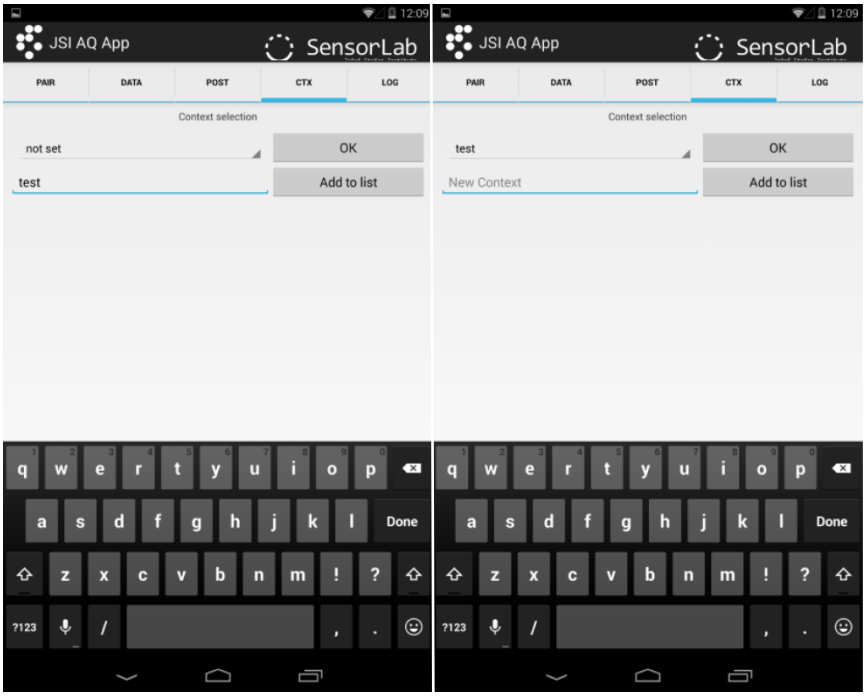


Figure 7: Entering the context.

3. To start collecting measurements go to the PAIR tab and choose the period of data sampling. The period can be selected from a predefined set of 5s, 30s, 1min, 5min.

3.3 Data overview

The tab DATA is used to visualize the data which are stored locally on the smartphone. Simple graphs of subsequent samples can be drawn for each of the supported sensors (cf. Figure 8). Note, the x-axis is merely giving a sequential number of measurement point and not any time information. For time information the sequential number needs to be multiplied by the sampling period. There is also no indication in data if sampling period has been changed during a measurement activity, so it is recommendable to make a note of such change in the context (CTX tab).

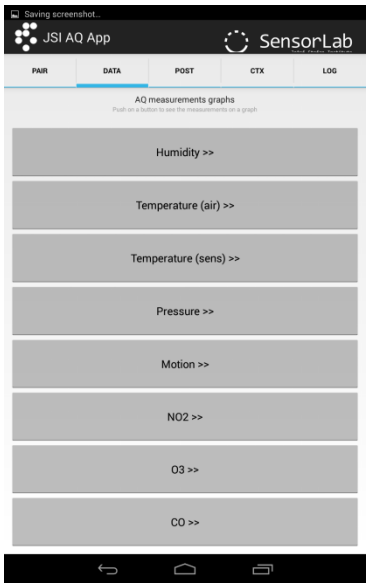


Figure 8: Data visualization tab.

3.4 Posting of data to the remote server

The POST tab is used to forward the collected measurements to the online database at the remote server, which stores the data and forwards it further to the Snowflake platform. In this tab you have to choose the appropriate type of connection. If you have a flat data plan for your smartphone you can chose any internet connection type, but you can also restrict data uploading only via Wi-Fi connections, when in the range of a known WiFi AP. For the remote server you should insert the URL http://sms.ijs.si/videk/api.php and click Set URL. Then you can *post measurements*. There is also an option to clean up the posted or all measurements, if you do not need them anymore locally.

NOTE - If you discard posted or all measurements, those measurements can no longer be recovered. There is NO UNDO to this function!

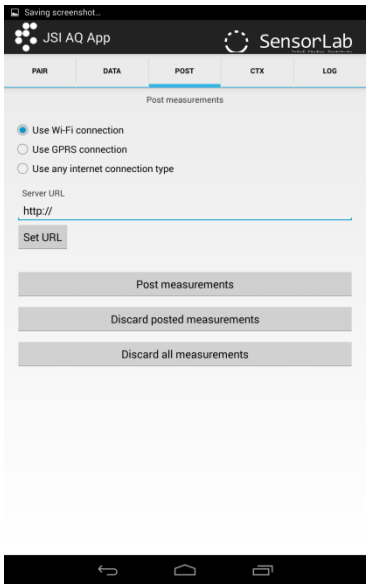


Figure 9: POST tab.

3.5 Error logging

The last tab is LOG tab. It is used to log events and activities and helps with identifying any possible unexpected behavior. In this tab there is also an option to export collected measurements to local (on the smartphone) text file with a given name.

Figure 10: Log tab.

3.6 Access to posted data through the web

This subsection describes a simple website which allows you to download the measurements that you posted to the server and is not part of the JSI AQ App. The website is located at the address http://sms.ijs.si/videk/measurements.html and is depicted in Figure 11. It provides two fields, whose values get translated through the WEB API for data acquisition.

In the first field, i.e. node name, you enter the name of the unit you are interested in. The information about the name of the unit can be obtained from the IJS AQ App PAIR tab. The number is the same as the access point number, for instance in Figure 11 the access point name is CITI_IJS14. For access point number below 10, for instance CITI_IJS9, the node name is CS009.

The second field is used to limit the number of requested measurements. The default is 100,000 but one can chose numbers from 1 on. If selected settings are OK, the response to clicking on the Submit button will be an option to download a CSV file containing requested measurements.

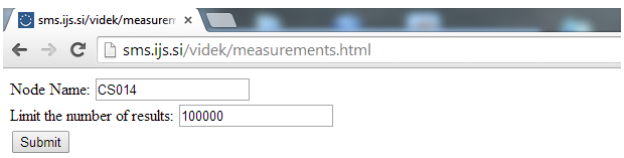


Figure 11: Downloading collected measurements.

4 Disassembly of VESNA AQ unit

In case you need to perform any maintenance on the device you can do so according to following instructions, but also feel free to contact the JSI team for further instructions, if unsure. Typically you may need to open the device to change a gas sensor or a board with gas sensors in the VESNA AQ device (to be provided in case of any malfunction), or to replace the battery pack.

To open the device you will need a standard screwdriver for a phillips head, M3 size screw. Turn the VESNA AQ device with its back side up (cf. Figure 12) and unscrew all 6 screws.

Figure 12: Back side of the VESNA AQ device.

The next step is to separate the two parts of enclosure, as shown in Figure 13.

NOTE - Be careful as both parts are connected with 2 wires.

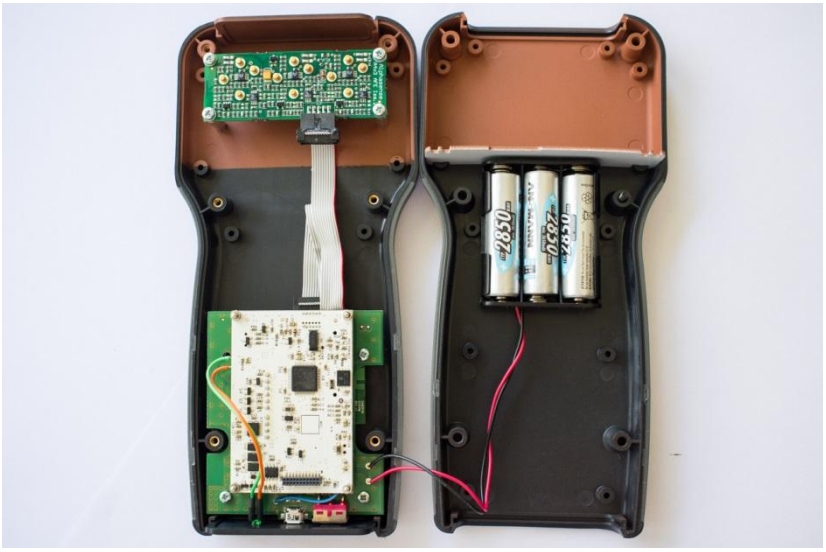


Figure 13: Openning the VESNA AQ device.

To remove the Alphasense AFE (analog front end) sensor board, further 4 phillips head screws need to be removed (cf. Figure 14).

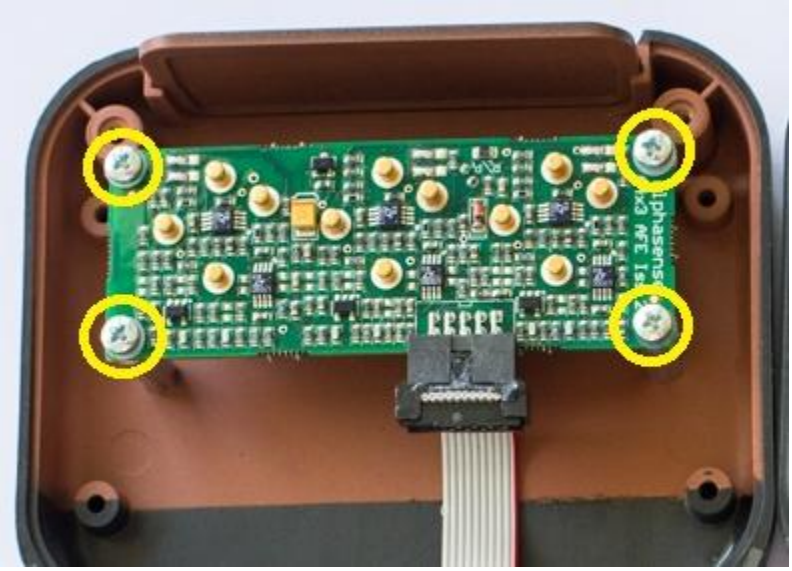


Figure 14: Removing Alphasense AFE board.

If you have a replacement board, remove the connector from the old board, connect it to a new board and insert and securely screw the new board in the box. If you received only a single replacement sensor, you must change the sensor on the board. You can change the sensor with ease, as depicted in the following figures (Figure 15-Figure 17).

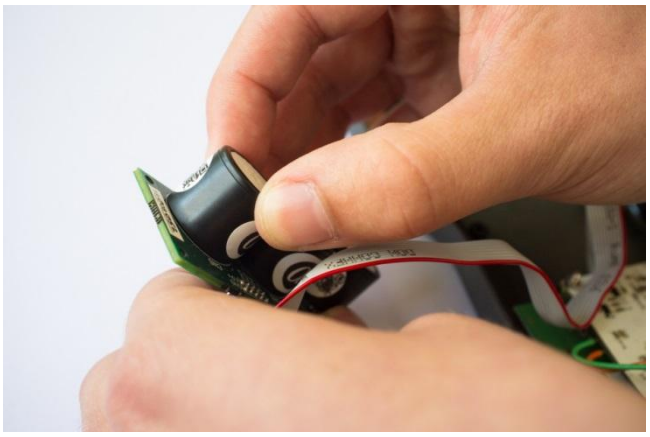


Figure 15: Grab the AFE board and the sensor you want to replace.

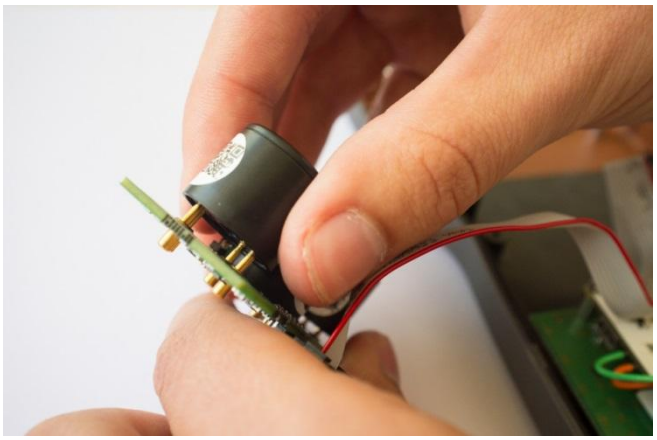


Figure 16: Pull sensor.

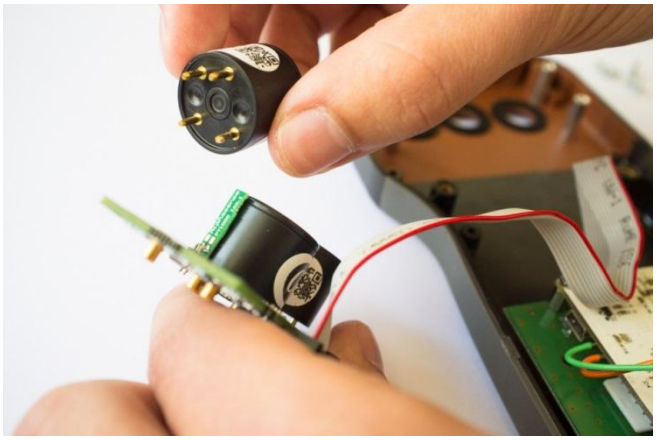


Figure 17: Sensor is removed.

After the sensor is removed, insert the new sensor.

NOTE - If you are changing more than one sensor on the same board, do NOT mix the position of sensors.

Each sensor from Alphasense has different calibration data, so to make the device as accurate as possible, the VESNA AQ device firmware needs to be updated after the change of a sensor. The firmware will be provided to you along with the replacement sensor or sensor board as a binary file. For loading this file to the device refer to Section 5.

5 Loading binary file to the VESNA AQ device

Whenever a change in the device firmware will be needed an appropriate binary file will be provided to you by JSI team, to be loaded to your device. To load a binary file to the VESNA AQ device, you will need a standard USB to serial cable/connector, as depicted in Figure 18. If you are using Windows 7 or higher, the driver for the cable should be installed automatically.

Figure 18: USB to serial connector.

After you plug the cable in your computer, you should see if the cable is set properly in the Control Panel -> Device manager under Ports (COM & LPT), as depicted in Figure 19.

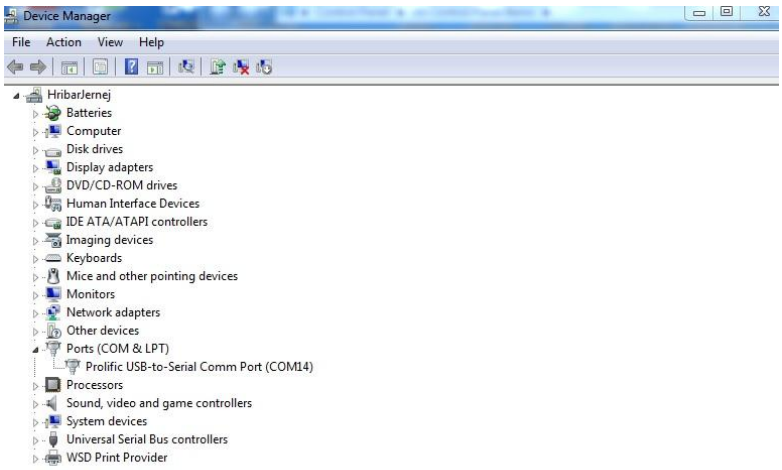


Figure 19: Device manager.

The serial cable needs to be connected to the VESNA SNC board in the VESNA AQ device. To get to the connector on the VESNA SNC board, you must open the box (cf. Section 4) and take the SNC and SNE-AQA boards out of the case. Remove 3 screws (cf. Figure 20) and remove the boards.

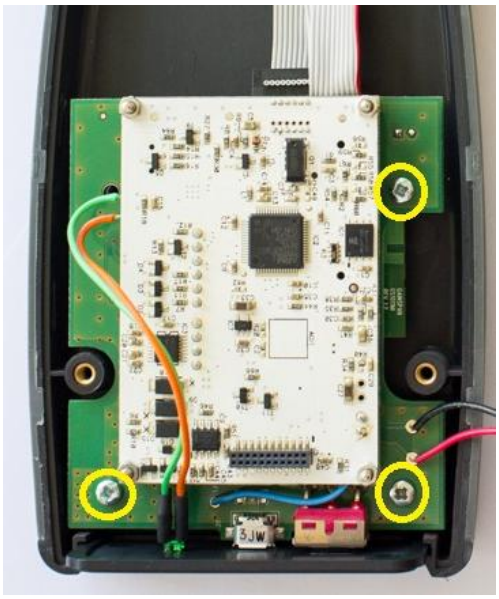


Figure 20: Removing VESNA SNC and SNE-AQA boards.

After the boards are removed, rotate them and connect the cable provided with the VESNA AQ device on one side to the connector indicated in Figure 21 and on the other side to the serial cable, as shown in Figure 22.

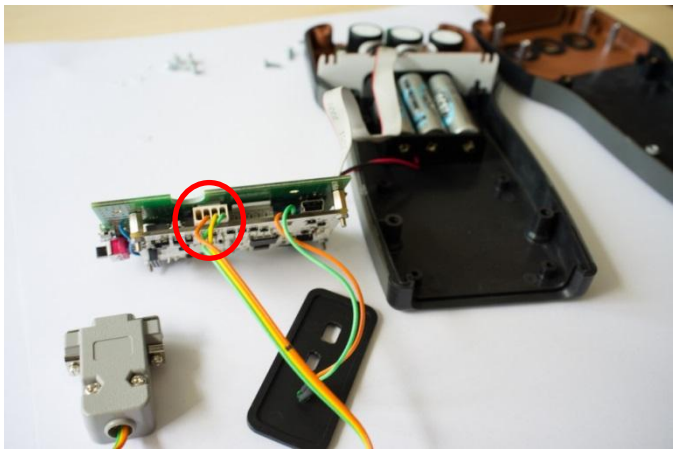


Figure 21: Serial cable connected to the VESNA SNC board.

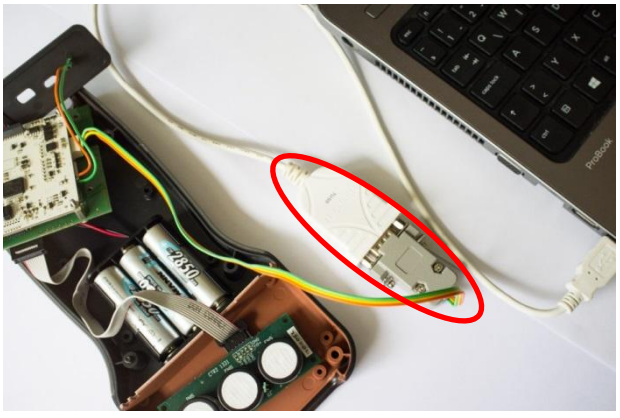


Figure 22: VESNA SNC board connected to a computer.

The next step is to download and install *Flash Loader Demonstrator* application from the STM website:

http://www.st.com/web/en/catalog/tools/PF257525

After the installation open the *Flash Loader Demonstrator* application and set the configuration as seen in Figure 23. The only difference you will have is the port number. Choose the port number you have indicated in the Device manager (see Figure 19).

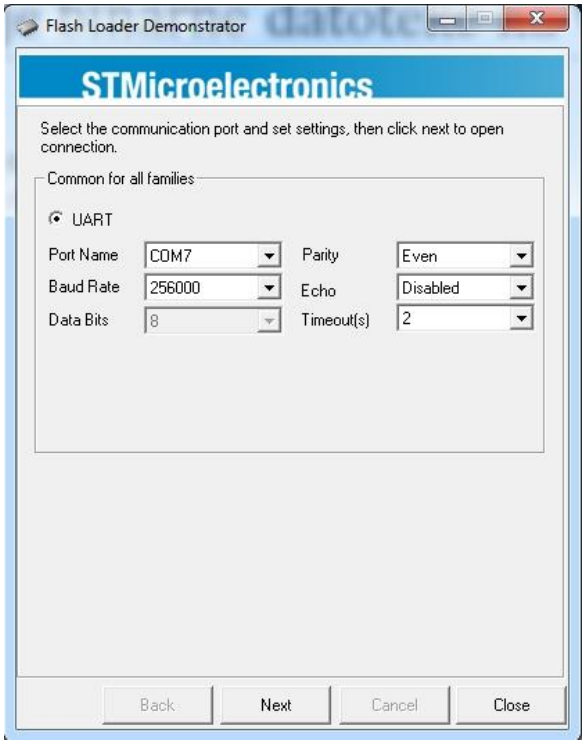


Figure 23: Settings of Flash Loader Demonstrator application.

On the VESNA SNC board next to the serial connector locate a small button (encircled in yellow in Figure 24).

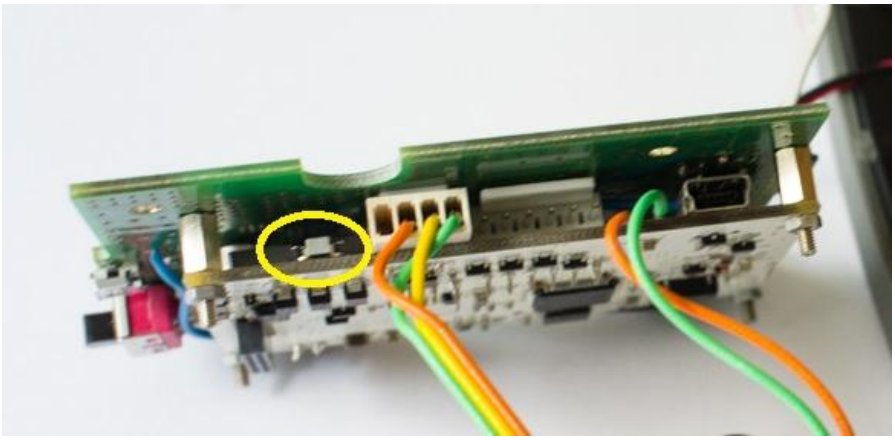


Figure 24: Button on the VESNA SNC board.

Press and hold the button for at least 10 seconds. Then wait 5 seconds and click next in the *Flash Loader Demonstrator* application. If you did everything correctly, the window shown in Figure 25

should open. The device needs to have a power source. If installation process gives you an error, check the STM *Flash Loader Demonstrator* settings. Check serial cable if it is connected and if the VESNA AQ device has a power source (battery or micro USB power cable plugged in).

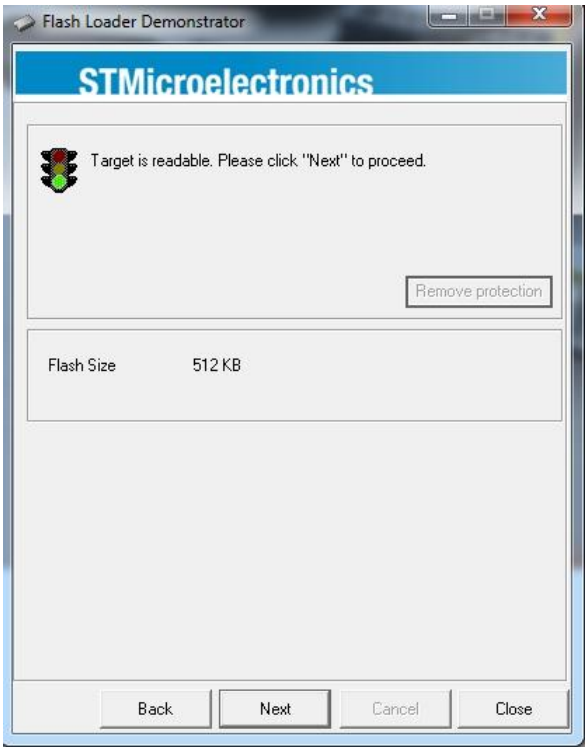


Figure 25: Successful connection with the device.

Click next. Select the correct target as indicated in Figure 26.

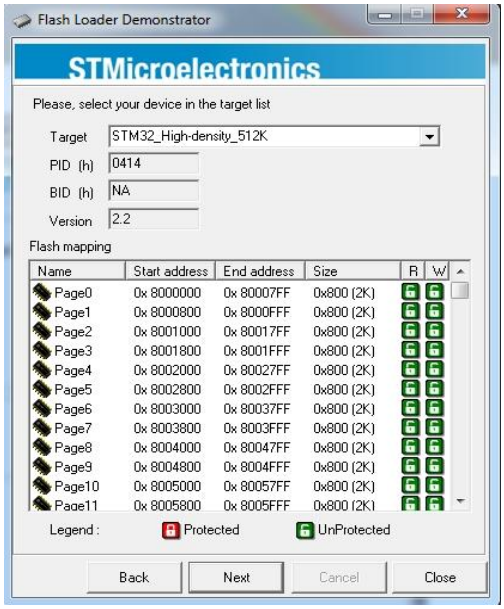


Figure 26: Selecting the correct target.

Next, select download to device and make sure that other settings are the same as shown in Figure 27. Select the correct (downloaded) binary file. Binary files are provided by the JSI team. Click next and downloading to the device should begin.

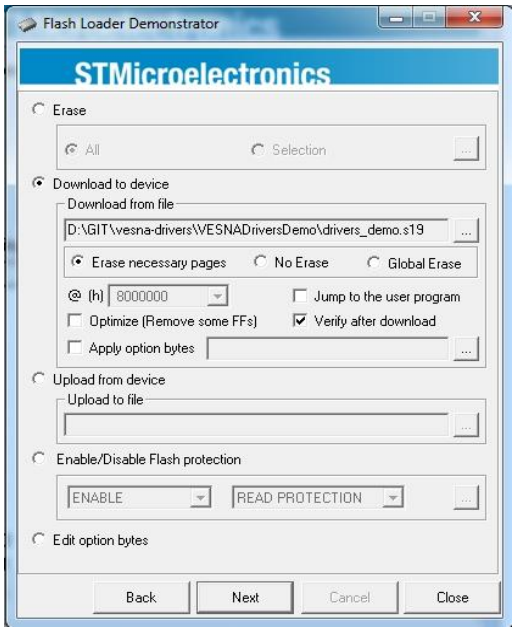


Figure 27: Select the binary file.

If downloading the binary file was successful you should see a window as shown in Figure 28.

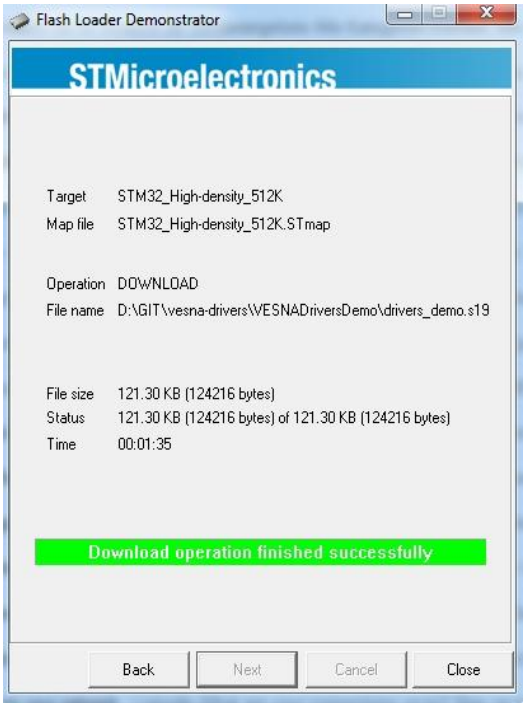


Figure 28: Binary file successfully downloaded to the VESNA AQ device.

Congratulations, you have successfully programed your VESNA AQ device with a new firmware.

You can close the window, re-assemble the unit and start using it.