# 1x PDI Calibration

**Release 7.6.15/1.0**

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# Contents

# Scope of Changes

- Version 1.0
  - Added:
    - First version issued.

# Quick Start

1x PDI Calibration is the application tool that allows the user to perform certain **calibrations** of a Veronte Autopilot 1x and **trim stick inputs**. The calibrations that can be performed from this app are as follows:

- Sensors Calibration: **IMUs** and **Magnetometers**
- Calibration of **Servos**

In addition, it also includes a **Terminal Manager** that can be used, for example, to configure the **Microhard internal radio** (Veronte Autopilot 1x with `hardware version 4.5` internal radio).

Once Autopilot 1x has been detected on Veronte Link, install **1x PDI Calibration**.

## System Requirements

Before executing this software, users should check the following sections with the minimum and recommended PC hardware requirements.

**Minimum requirements**

- CPU: Intel Core i5-8365UE
- RAM: 8 GB DDR4
- STO: 256 GB SSD

**Recommended requirements**

- CPU: 12th Gen Intel(R) Core(TM) i7-12700H 14 cores up to 4,70 GHz
- RAM: 32,0 GB
- STO: 1TB SSD M.2 NVMe PCIe

## Download and Installation

**1x Veronte PDI Calibration** software is available in the **Veronte Toolbox** platform. From there, users can download and install the application. For more information, please refer to the Veronte Toolbox user manual.

A **personal account** is required to access **Veronte Toolbox**; create a Ticket in the user's **Joint Collaboration Framework** and the support team will create it for you.

# Operation

Once the installation is finished, open 1x PDI Calibration and log in.
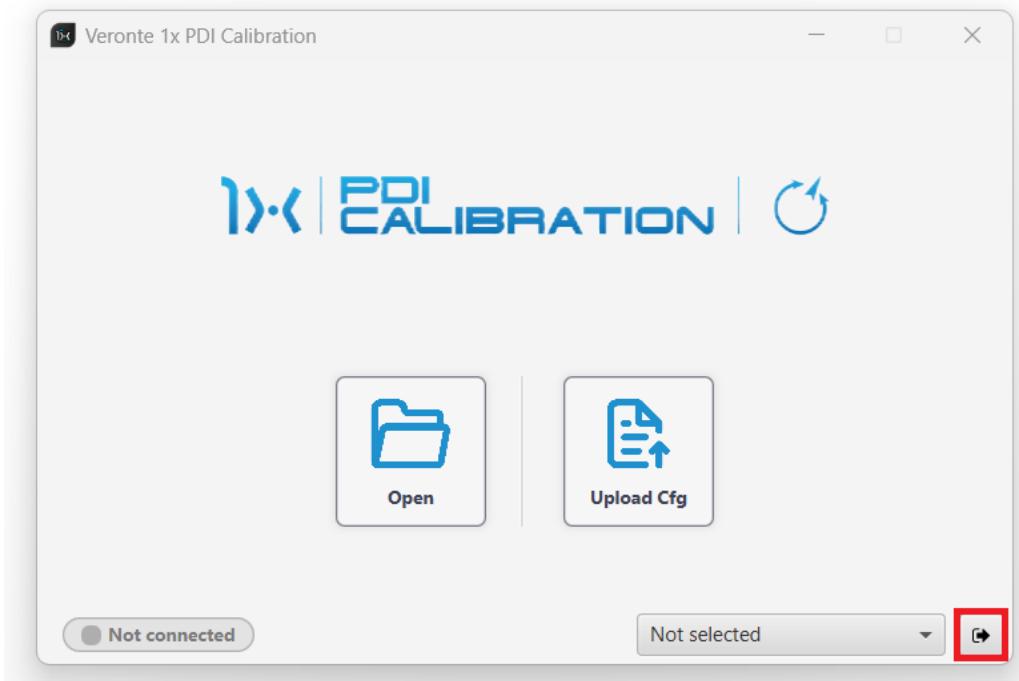


**Log in**

After clicking **Sign in**, a new window will open for users to enter their credentials. If users do not have credentials, do not know what they are or have any problems logging in with them, please contact the support team via the Joint Collaboration Framework opening a Ticket or contact sales@embention.com.

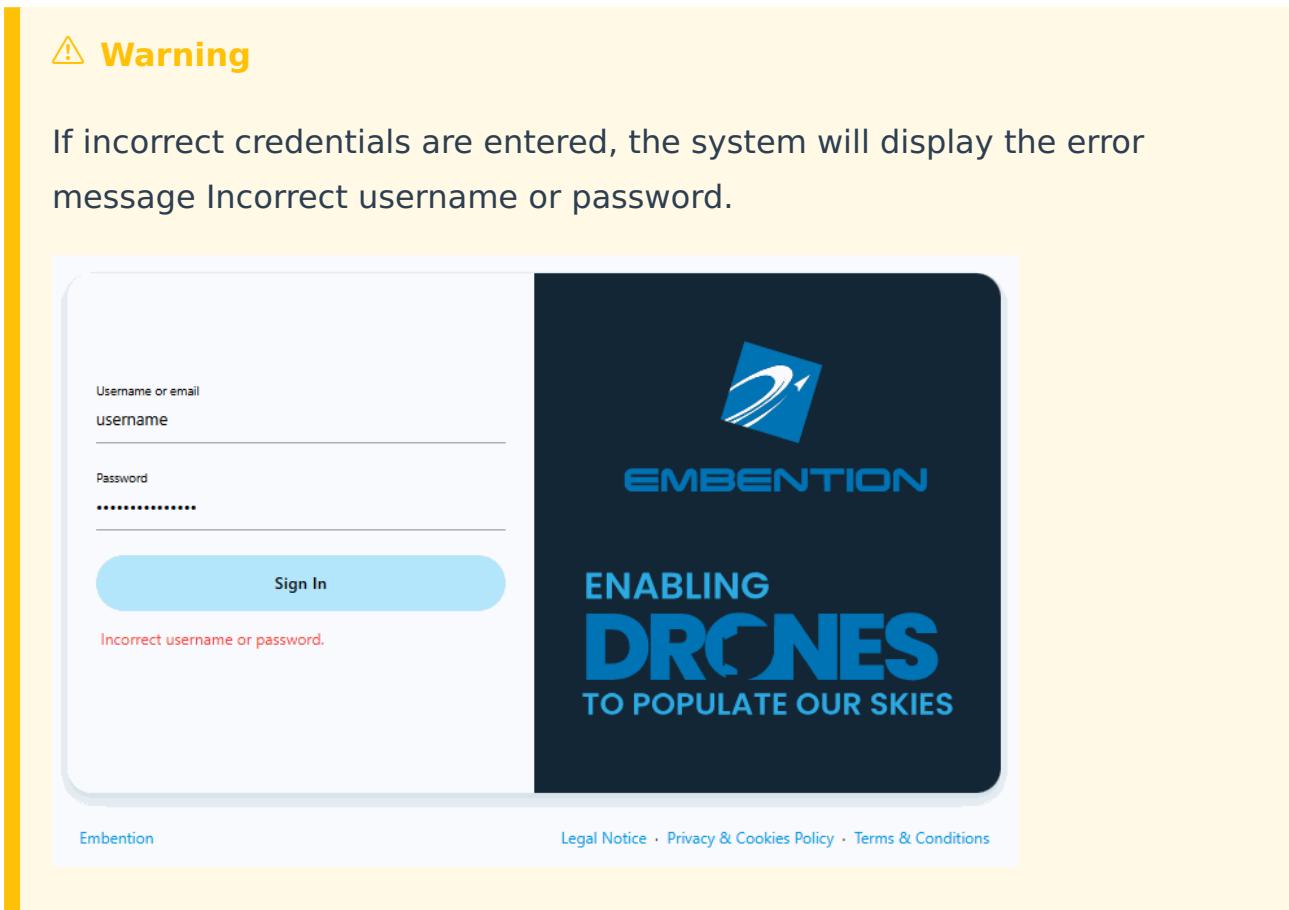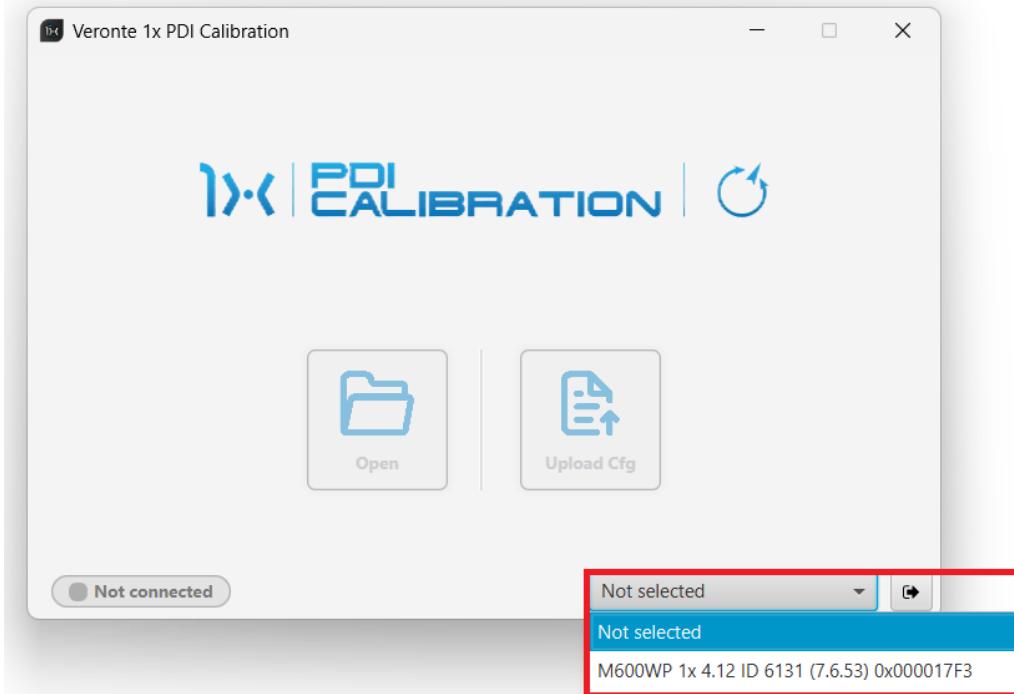If the login is successful, the screen will change as shown below:

**Login successful**

> ⚠ **Warning**
>
> If incorrect credentials are entered, the system will display the error message Incorrect username or password.
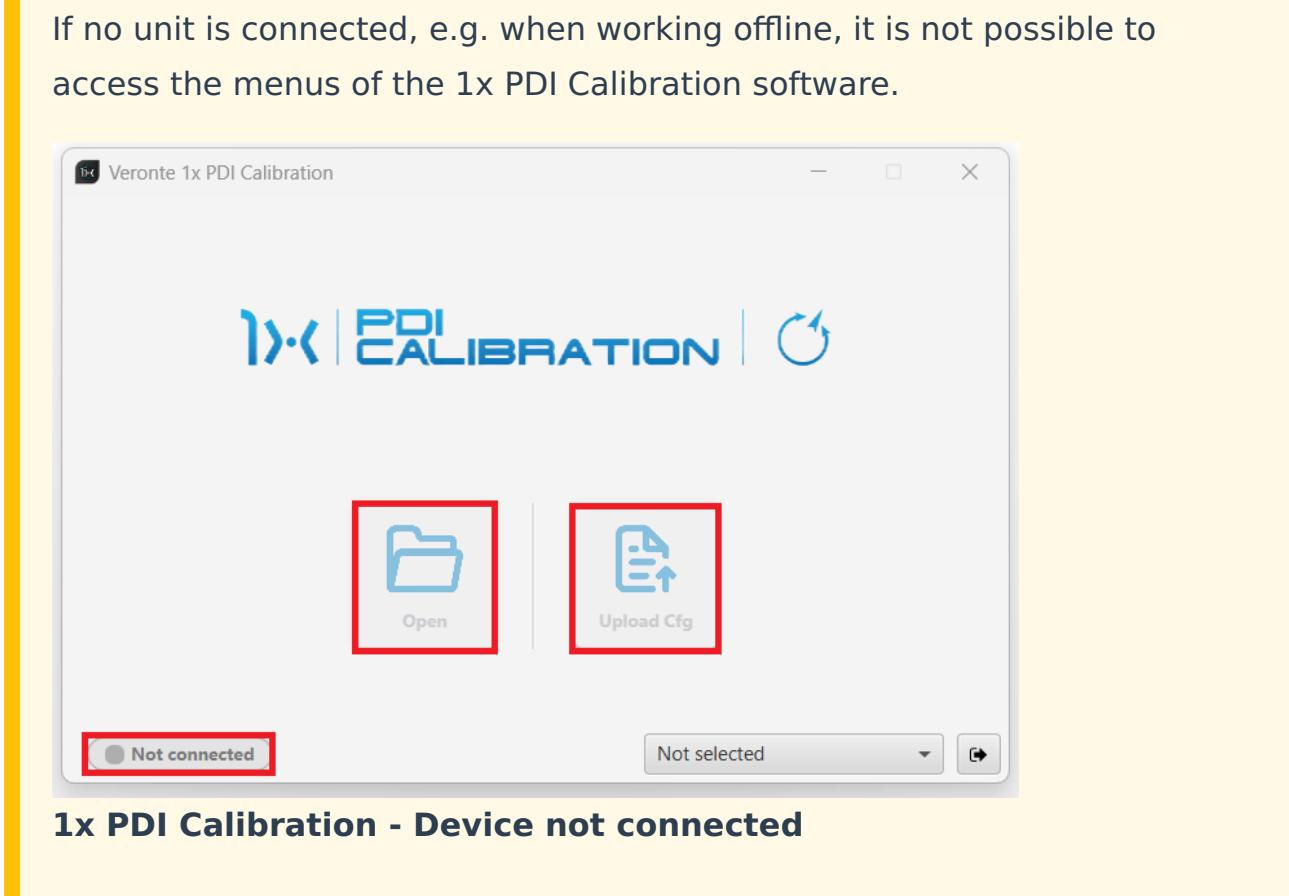>
> 

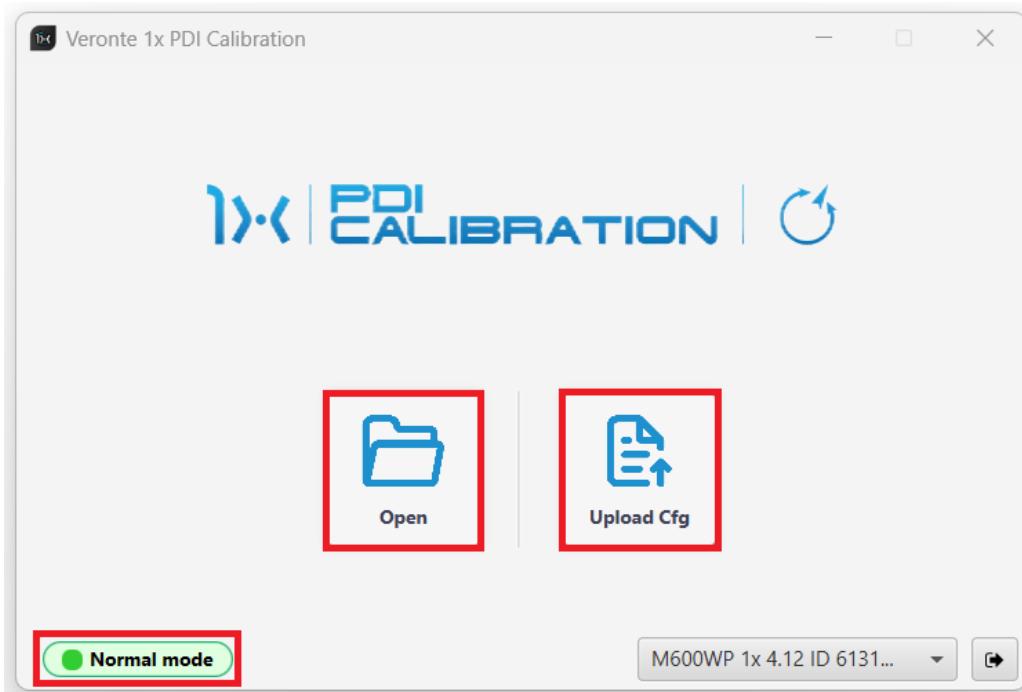After signing in, select the unit.

**Select device**

> ⚠ **Warning**
>
> If no unit is connected, e.g. when working offline, it is not possible to access the menus of the 1x PDI Calibration software.
>
> 
>
> **1x PDI Calibration - Device not connected**

If it is correctly connected, it should appear in **Normal mode** as shown in the following figure.



**1x PDI Calibration**

> ### ⓘ Note
>
> - 1x unit can also appear as: Maintenance mode, Maintenance mode (loaded with errors) or Normal mode - Disconnected.
> - **Maintenance mode (loaded with errors)** appears when something is wrong in the configuration.

The user can now access 2 calibration options:

- **Open**: By clicking on this option, **1x PDI Calibration** main interface opens with the calibration files loaded in the connected 1x. Then, the user can calibrate it.
- **Upload Calibration**: A previously exported calibration files can be imported to the linked 1x.

> ⓘ **Note**
>
> When using the **Upload Calibration** option, **Autopilot 1x** will automatically enter **Maintenance Mode** to safely receive and apply the new calibration file.

Finally, click on **'Open'** to open the calibration loaded and start modifying it. Then, the following window will be displayed:
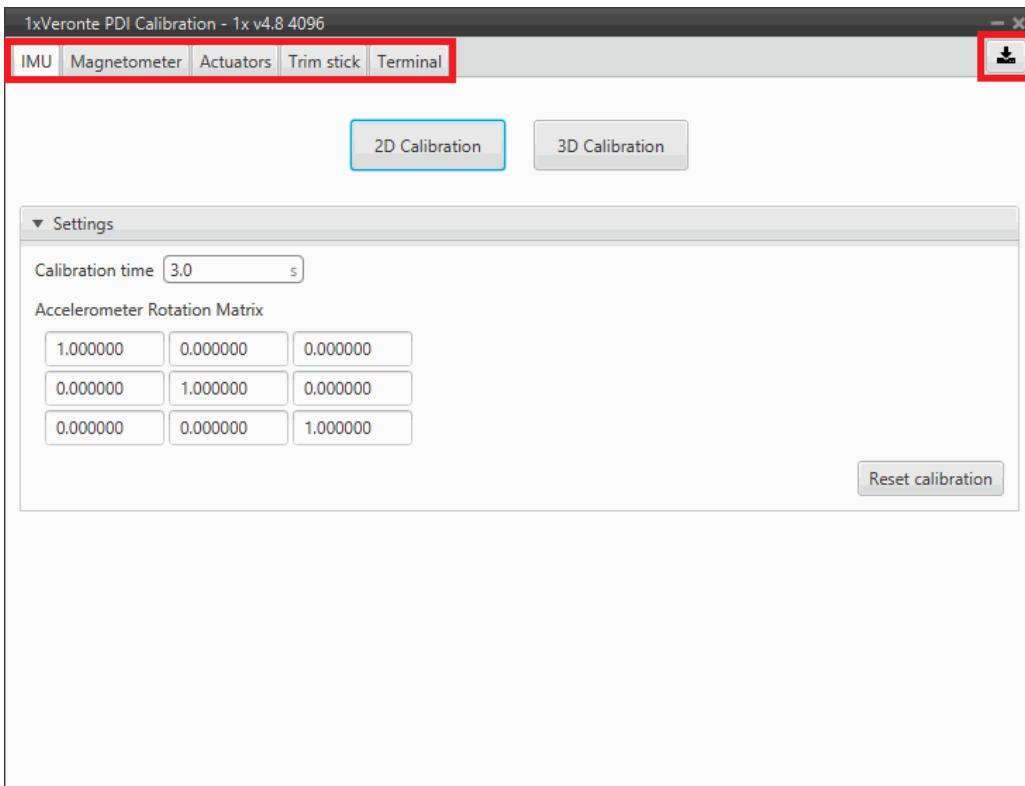


**Initial menu**

-  **Export calibration files**: After calibration **Autopilot 1x**, press this button to store the calibration files in the local storage. Users can store this calibration in an empty folder or in the folder where the previously imported calibration is stored. With the latter option, the "original" calibration will be overwritten by the one with the new values.
- The 5 different tabs that can be seen in the figure above are explained in detail in the following sections:
  - IMU: Calibration of the current IMU (selected in the **1x PDI Builder** software).
  - Magnetometer: Calibration of all magnetometers sensors.
  - Actuators: Calibration of actuators.

◦ Trim stick: Trimming the neutral position of channels.

◦ Terminal: Terminal Manager.

## IMU

This menu allows the user to recalibrate the IMU, as they are factory calibrated, to correct any bias in the IMU calibration, including mounting offsets.
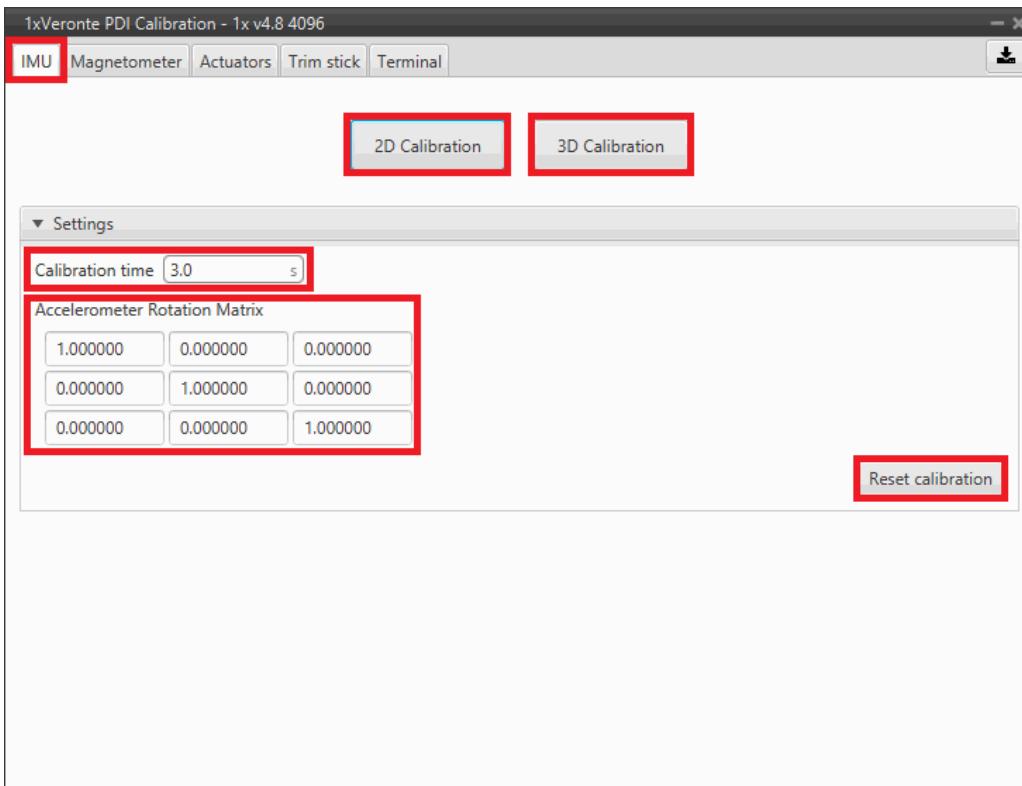


**IMU Calibration menu**

> ⓘ **Note**
>
> Note that **Autopilot 1x** will need to **enter Maintenance Mode and be restarted** to modify its calibration values. After each calibration process, these confirmation panels will pop up:
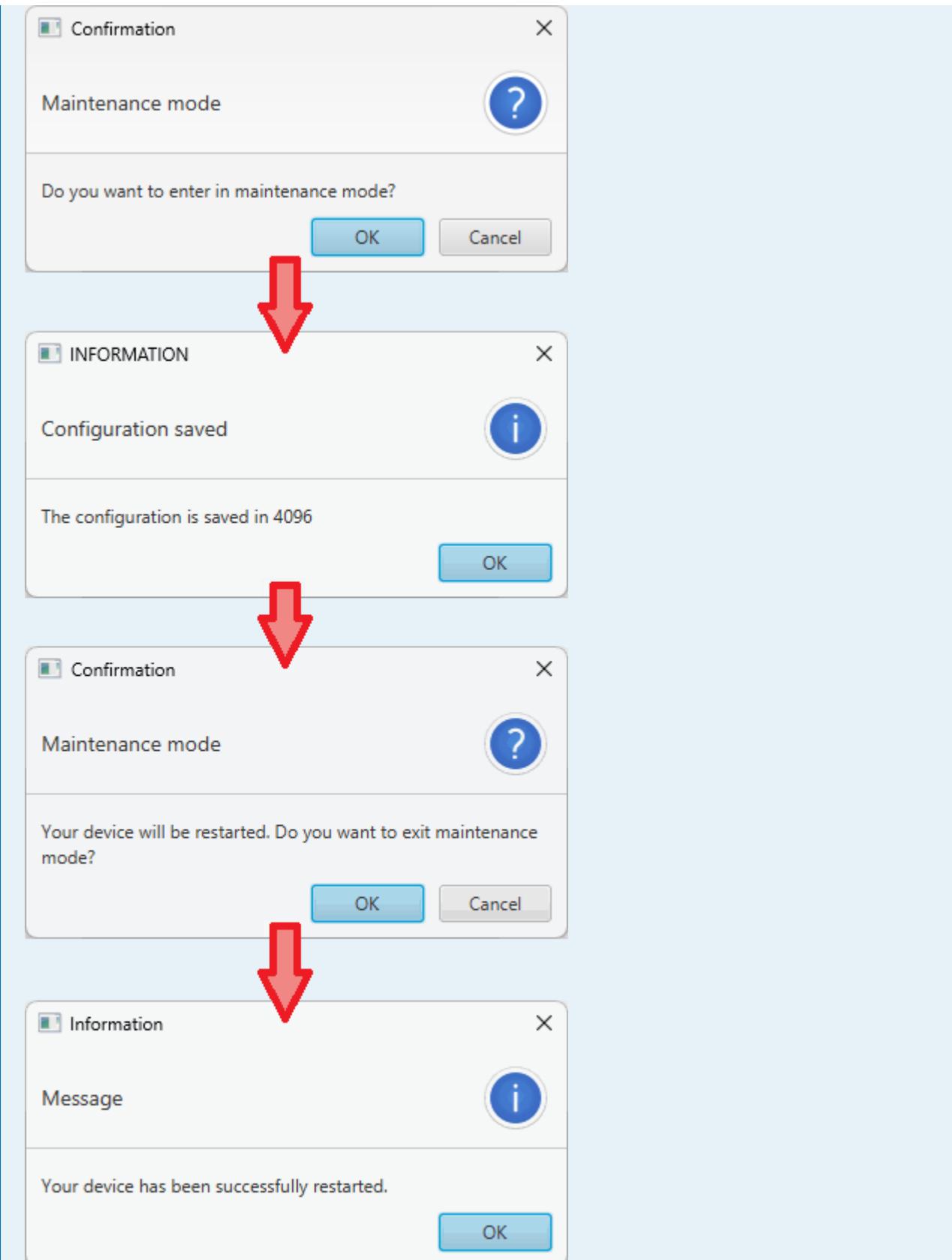
**Confirmation panels**
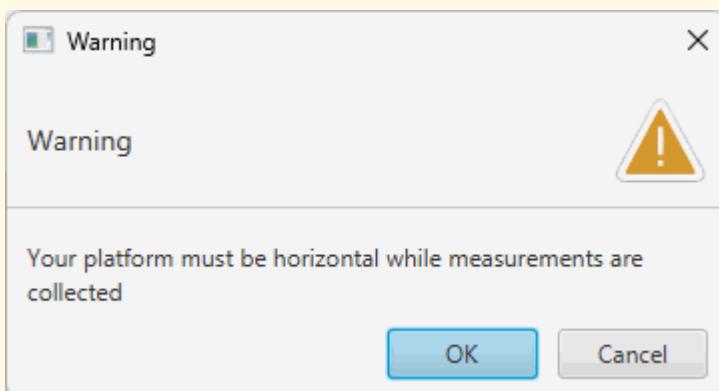
There are 2 calibration options available:

- **2D Calibration**: Only calibrates **pitch** and **roll angles**.

  > **Calibration Explanation**
  >
  > The process collects accelerometer data while the platform is in a horizontal position. The system calculates an average vector from the measured gravity and compares it to an ideal gravity vector to compute a rotation matrix. This matrix corrects for deviations in the **pitch** and **roll** angles.

  > ⚠ **Warning**
  >
  > Before the calibration process starts, a panel pops up warning the user that the platform must be in a **horizontal** position during the calibration process.
  >
  > 
  >
  > **2D Calibration - Warning message**
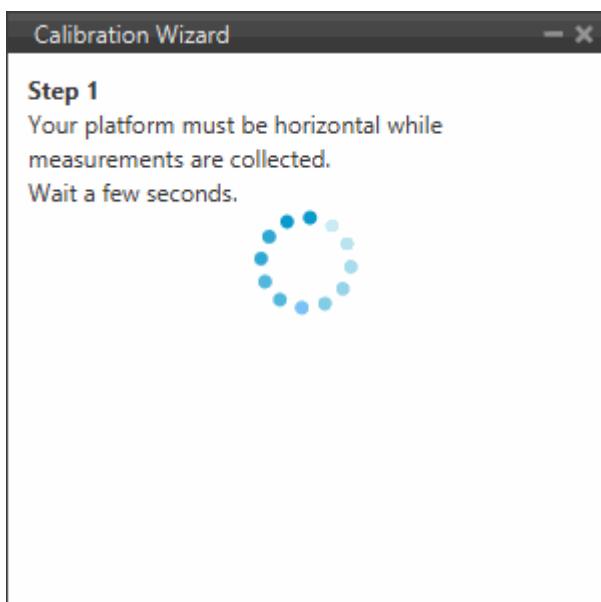
**2D Calibration**

> ⚠ **Warning**
>
> Autopilot 1x will **restart** when the calibration is done.

- **3D Calibration**: Calibrates **pitch**, **roll** and **yaw angles** and it needs to take measurements in **two orientations**.

> ⓘ **Note**
>
> Rotation nomenclature is defined according to the Axes - Software applications section of the **1x Software Manual**.

> **Calibration Explanation**
>
> This method performs the same process as the 2D calibration twice: once with the platform horizontal, and a second time with the platform tilted more than 10 degrees on a selected axis. By using two non-collinear measurements, the system can compute a more complete rotation matrix that corrects not only for **pitch** and **roll**, but also for **yaw**.

  ◦ Before the calibration process starts, a panel pops up warning the user about the movement requirements of the procedure.
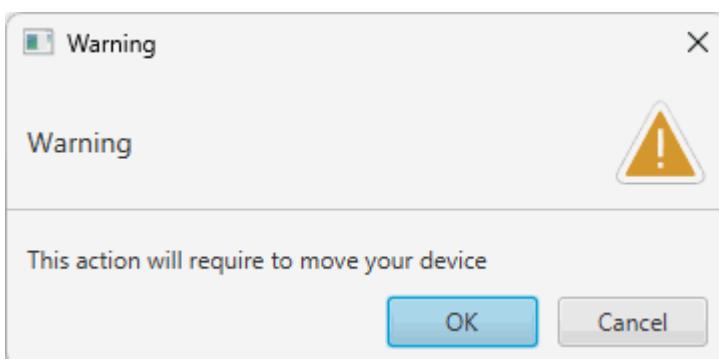


  **3D Calibration - Warning**

  ◦ During the first measurement the platform must be horizontal:
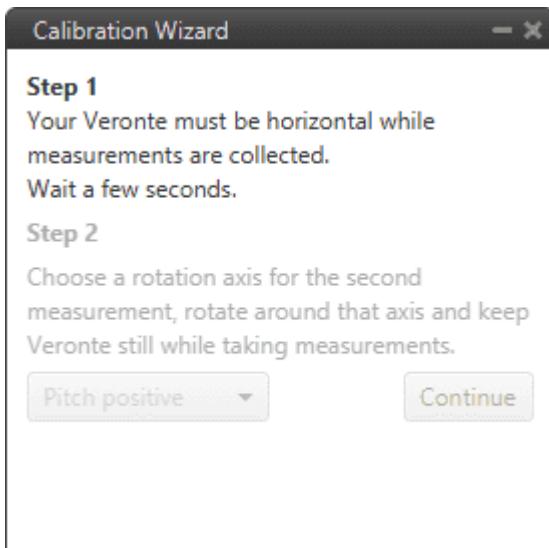
**3D Calibration - First measurement**

◦ The second measurement requires to **tilt the platform around the selected axis and keep it still**.

The options are: Pitch positive, Pitch negative, Roll positive or Roll negative.

> ⓘ **Note**
>
> To complete the 3D calibration, you only need to take the measurement in **one** of the four possible orientations. It is not necessary to go through all the available options.
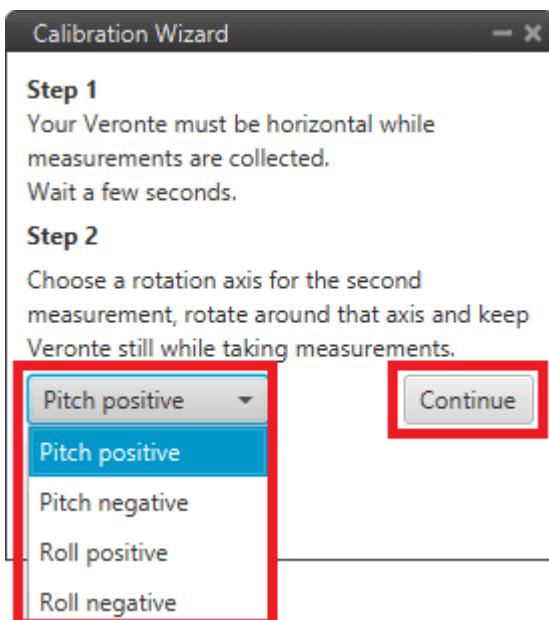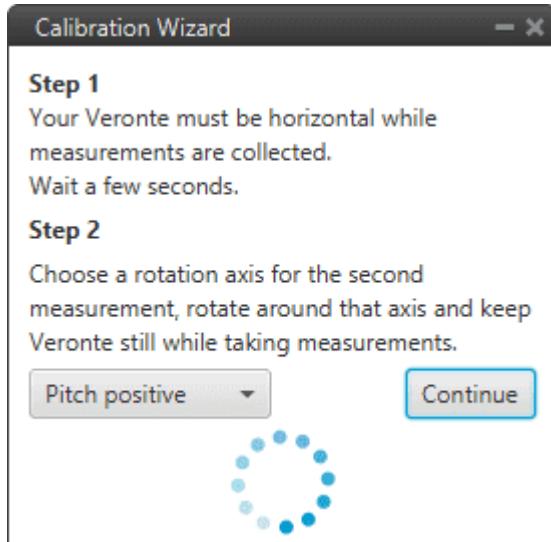


**3D Calibration - Second measurement options**

Once the rotation axis has been selected, click on **'Continue'** to perfom this second measurement:
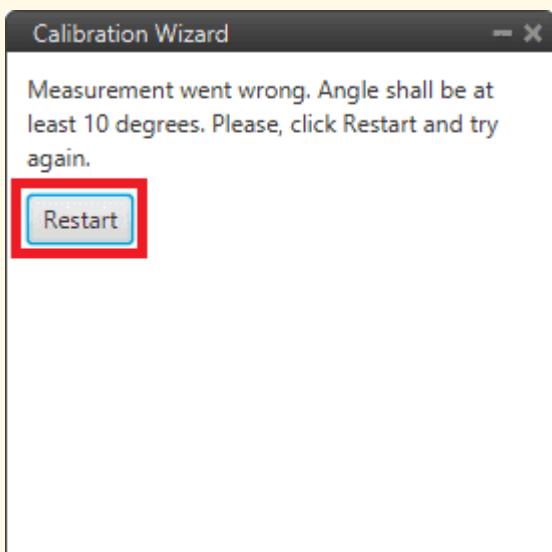
> ⚠ **Warning**
>
> The autopilot will **restart** when the calibration is done.



**3D Calibration - Second measurement**
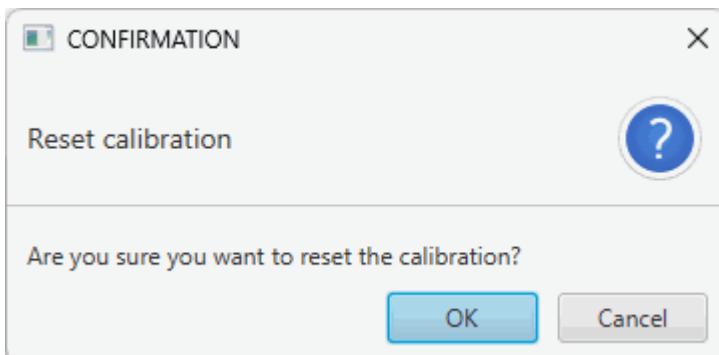
> ⚠ **Warning**
>
> The platform must be **turned more than 10 degrees** in the selected axis. Otherwise, the calibration will not be performed and the following message will appear to reset the calibration:



**3D Calibration error**

- **Settings**:
  - **Calibration time**: Users can modify the time during which the software is requesting values from the Autopilot 1x for calibration.
  - **Accelorometer Rotation Matrix**: This rotation matrix is the result of the calibration performed. **Cannot be modified by the user**.
  - **Reset Calibration**: This button will **delete** the current calibration on the connected Autopilot 1x. The user must confirm this operation in the following panel:
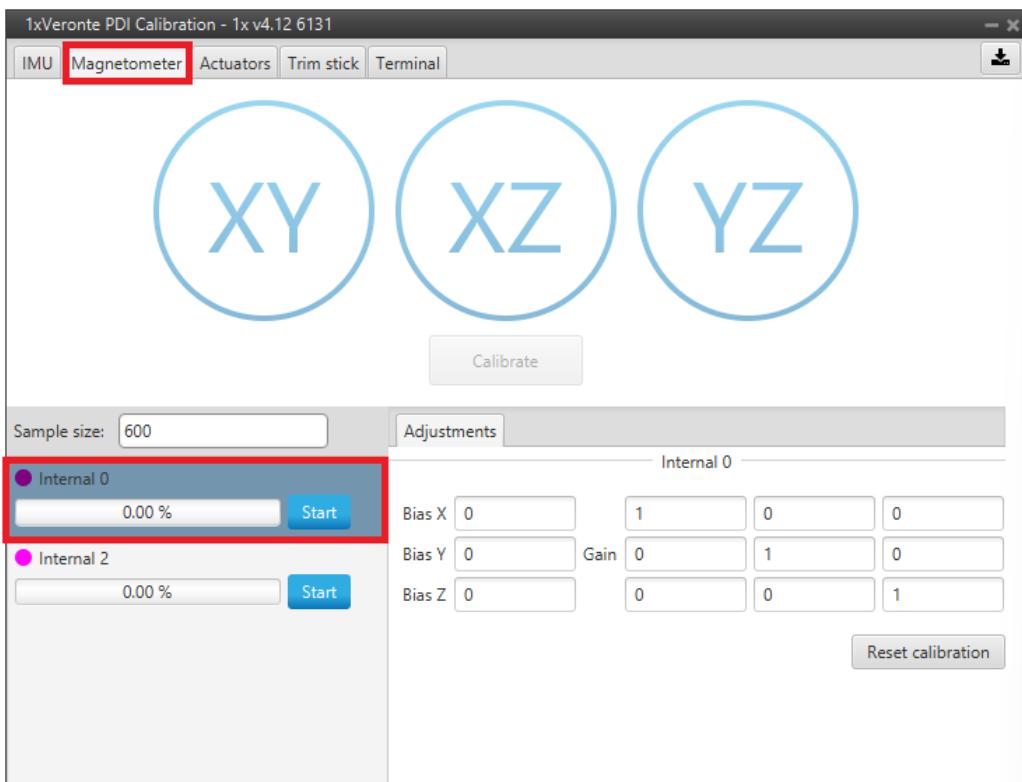


**Confirm Reset**

> ⚠ **Warning**
>
> The autopilot will **restart** when the reset is done.
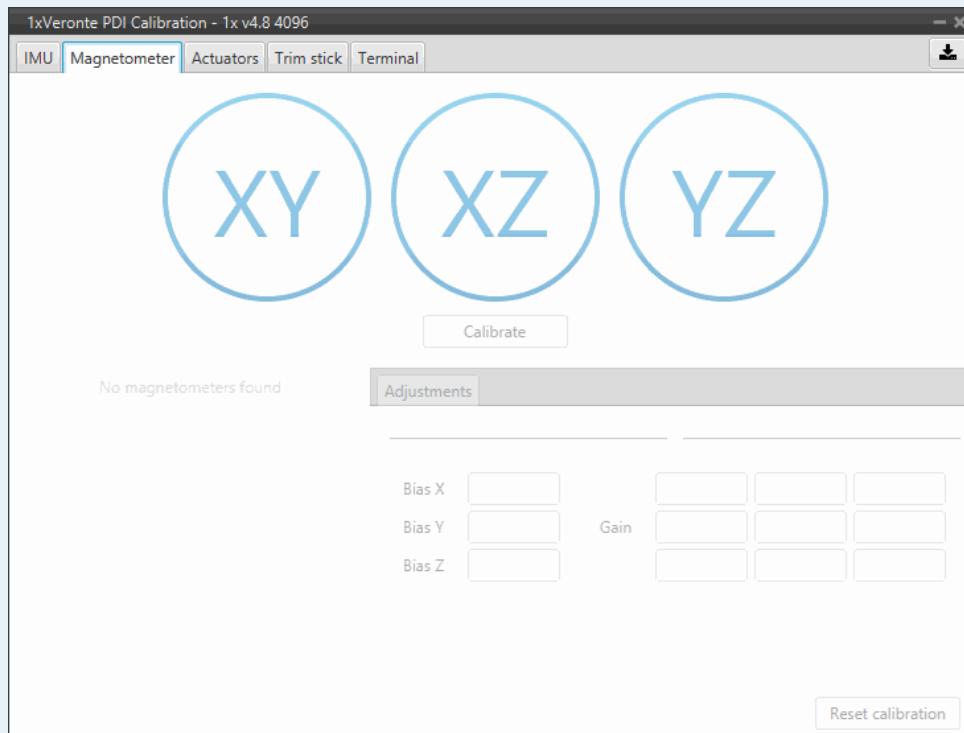
# Magnetometer

Magnetometer calibration should be performed once Veronte Autopilot 1x has been installed on the platform, so that the magnetic field during operation is similar to that measured during calibration.

**Magnetometer Calibration menu**

> ### ⓘ **Note**
>
> The magnetometers listed in this menu depend on the configuration of the autopilot. If no valid magnetometers are configured, this menu will be disabled, as shown in the image below.
>
> 
>
> **No magnetometers found**
>
> For more information, please consult Magnetometer - Sensor block section of the **1x PDI Builder** manual.

To start the calibration, press the **Start** button of the magnetometer sensor to be calibrated, so that the system can capture the data from the magnetometer.
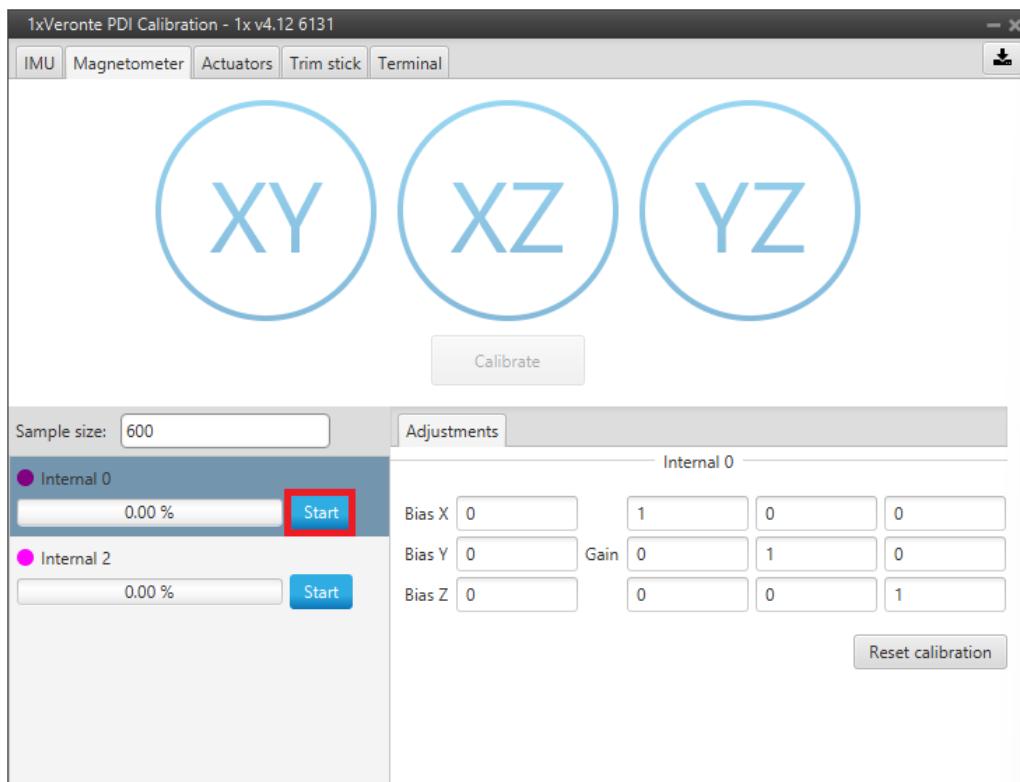
**Magnetometer Calibration menu**

- **Sample size**: The total number of samples required to ensure a statistically accurate calibration.

During calibration, the system must be rotated around all 3 axes, X, Y and Z, in order to capture sufficient data. It is important to have approximately the same number of samples for each axis of rotation, so rotate it around a different axis every 33% approximately.

The calibration procedure should be performed as follows:

1. Rotate the platform around the Z-axis (XY plane) until the progress bar reaches approximately **33%**.
2. Repeat the same process for the Y-axis (XZ plane) until the progress bar reaches approximately **66%**.
3. Finish the calibration by repeating this process for the X-axis (YZ plane) until **100%** is reached.

> ⓘ **Note**
>
> The order in which the user rotates the platform about each of the axes does not affect the calibration, this is just an example of how to do it. So the user can first rotate on the Y-axis, then on the X-axis and finally on the Z-axis.



Rotation on **X** axis (YZ Plane)       Rotation on **Y** axis (XZ Plane)       Rotation on **Z** axis (XY Plane)
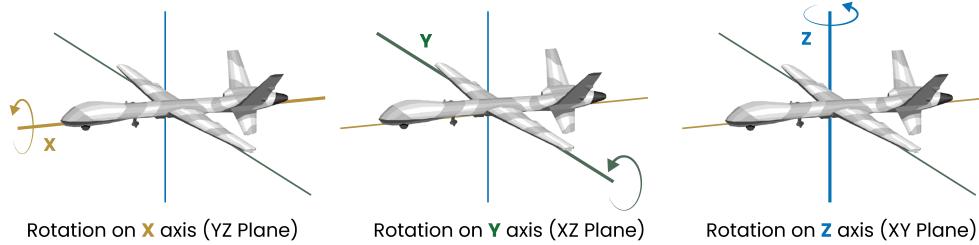
The progress bar will increase according to the number of samples measured, and these samples will be drawn in each circle (one circle for each plane of rotation):
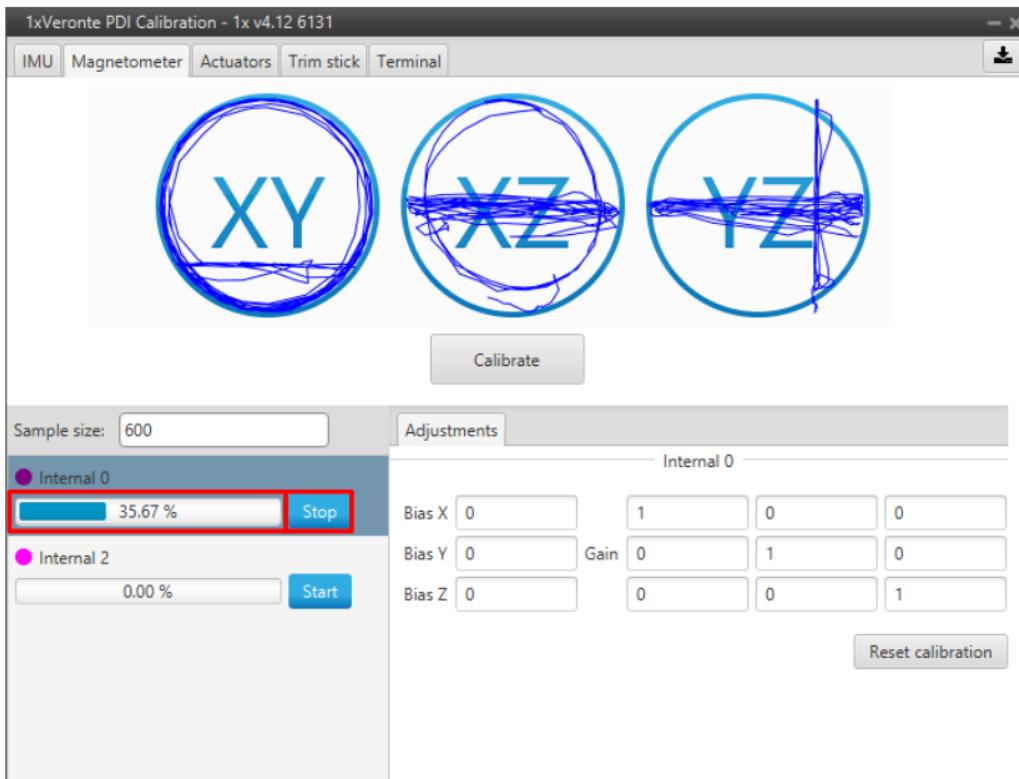


**Calibration process**

> ⓘ **Note**
>
> If the user wishes to interrupt the calibration, simply click on the **'Stop'**
> button.

Once 3 circles have been drawn on the screen and the progress bar reaches the
100%, the calibration process is complete. The following image shows an
example of the calibration:
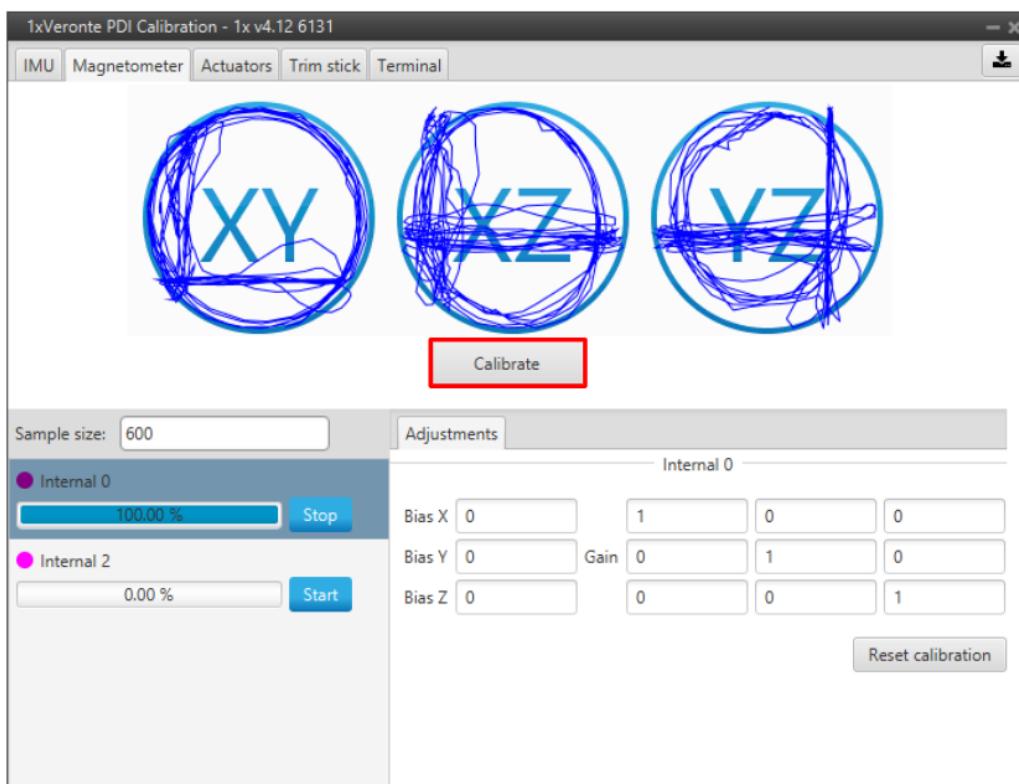


**Calibrate**

Once the calibration progress bar is completed, press the **'Calibrate'** button to
save the calibration in **Autopilot 1x**. If the calibration process has been
successful, this window will pop up:
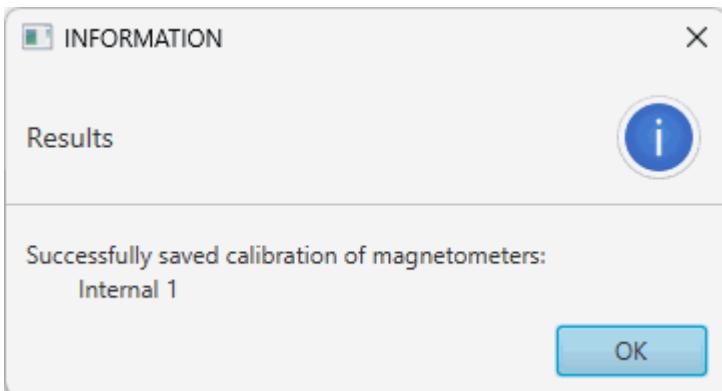
**Calibrate success message**

Then, since the autopilot needs to **restart**, the following confirmation messages will need to be accepted by the user:
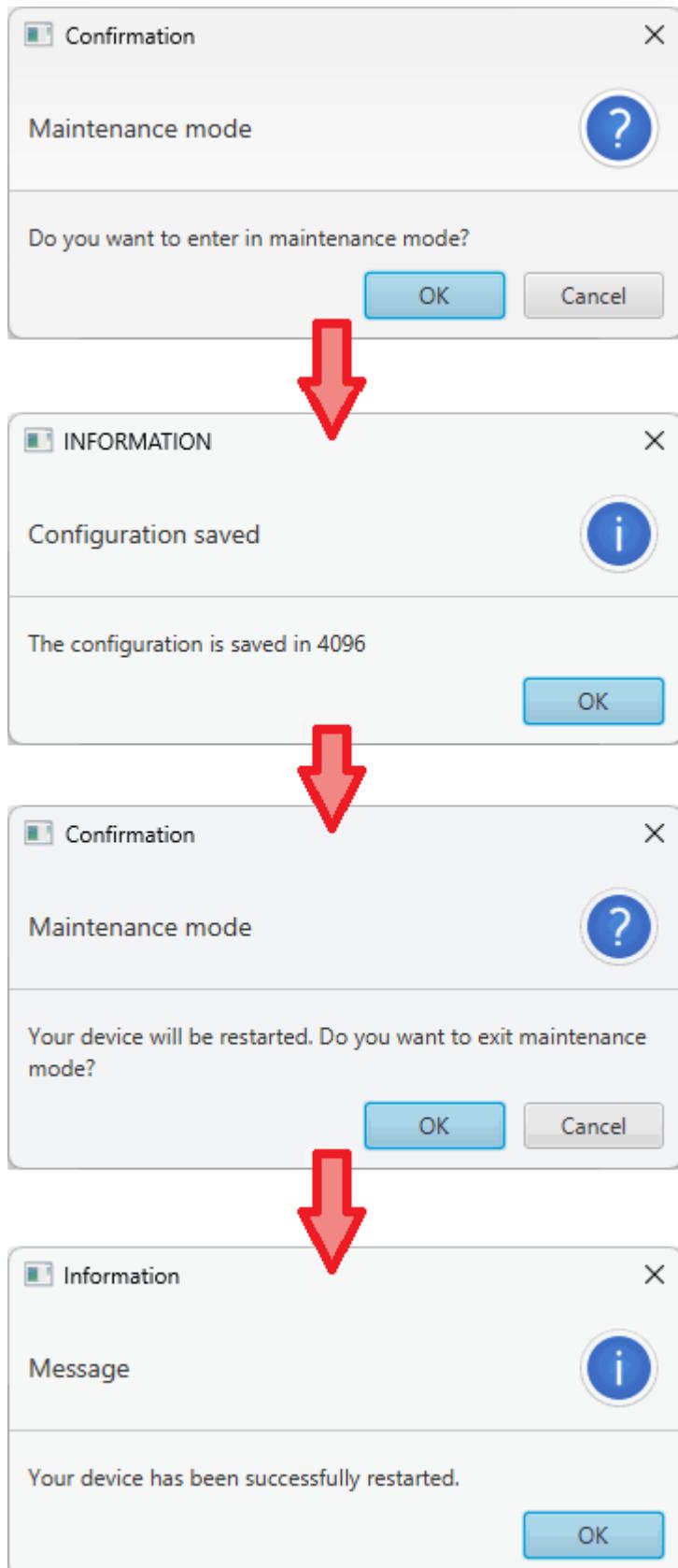
**Calibration success message**

Finally, at the end of the calibration process, this interface informs the user about:

- The quality of the calibration measurements by means of a colored percentage:
  - **Red (0-39%)**: Repeating calibration is recommended.
  - **Orange (40-79%)**: Acceptable.
  - **Green (80-100%)**: Optimal.
- The calibration results, **Bias X/Y/Z** and **Gains** measurements, displayed in the **Adjustments** tab.
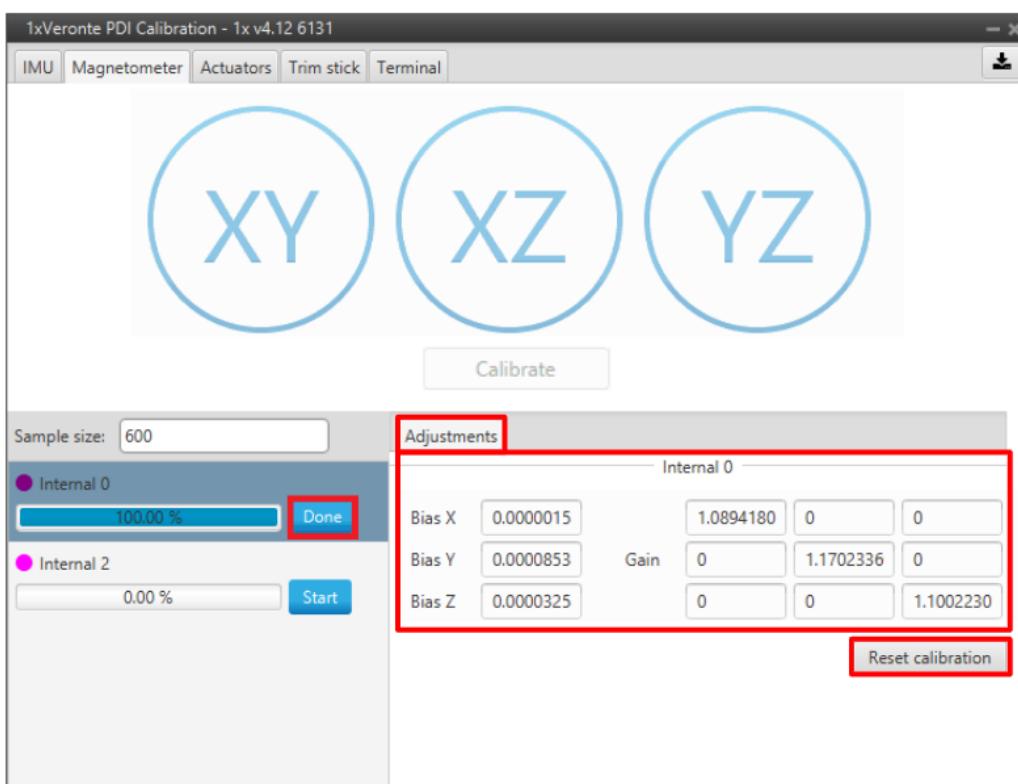


**Calibration done**

If the calibration is good enough, click **'Done'**. Otherwise, if the calibration is not satisfying, click **'Reset calibration'** to delete the current calibration on the connected Autopilot 1x. The user must confirm this operation in the following panel:
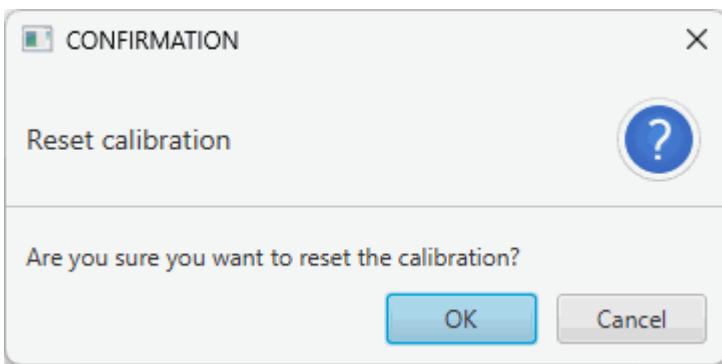
**Reset calibration**

**Errors which may occur during the calibration process**:

- If the 'Calibrate' button is pressed before the progress bar is completed, there may not be enough samples for the calibration to be conducted.
- If the variability of the collected samples is too low, it may not be possible to perform the calibration due to the lack of information.
- The resulting **rotation matrix rank** may be **deficient** due to several reasons:
    - Lack of samples
    - Measurement errors
    - Lack of representativeness
    - Lack of diversity in samples
- **Invalid measurements** may interfere with the calibration process.
- The **scale factor** used to adjust the measurements is **too high** in relation to the expected value.

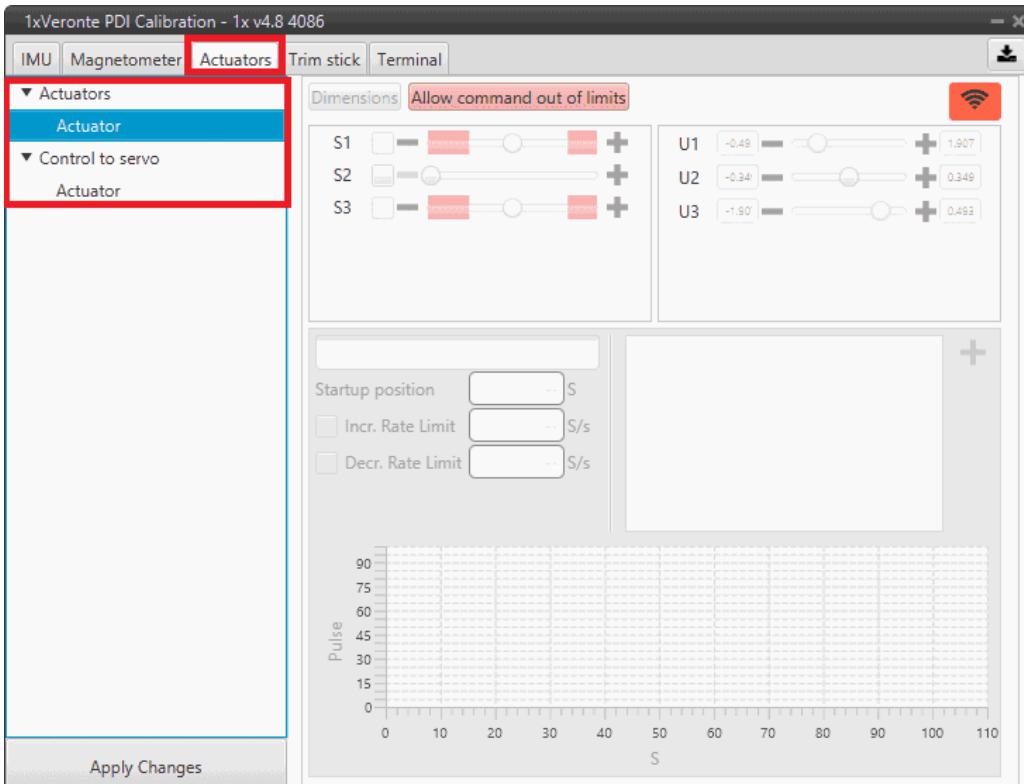> ⚠ **Important**
>
> When one of these errors occur, the calibration process must be repeated. If the results of the calibration are still not satisfactory, please refer to the Magnetometer wrong calibration - Troubleshooting section of the present manual.

# Actuators

Actuators tab displays the Actuator blocks as created and configured in **Block Programs** of **1x PDI Builder** app.

This menu allows the calibration of all the connected actuators that control the attitude of the aircraft. It is possible to set actuator position for each control signal/output, allowing to configure the maximum and minimum values and its custom performance.



**Actuators Calibration menu**

The options of this calibration menu are presented below:
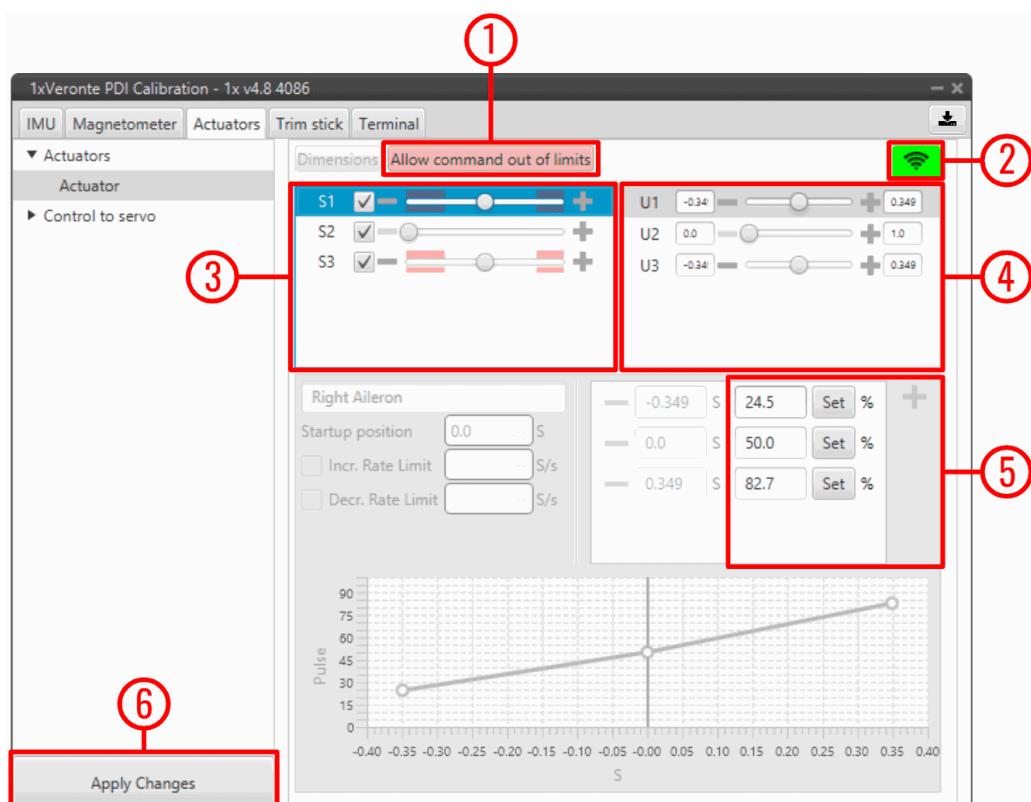
**Actuators Calibration parameters**

> ◈ **Important**
>
> Only the parameters that can be modified in this menu are explained. Therefore, those that are disabled, cannot be modified here, this is because they must be configured in the corresponding Actuator block of the **1x PDI Builder** software.

1. **Allow command out of limits**: Allows out-of-limits motion for the selected actuator.

   > 💡 **Tip**
   >
   > When the user is in the **trimming process**, it is possible that the desired servo position is in the **Out of range** zone (red zone), so by pressing this button it is possible to move the actuator completely and find the correct position.

2. **Enable/Disable command**: Enables/Disables commands to move the servos. It is enabled when the icon is **green** and disabled when it is **red**.

3. **Servos (actuators)**: This menu contains the servos of the aircraft.

Moving the scrolling bar will change the servo position, but the signal to the system will only be sent if the checkbox next to the servo number (S1, S2, ...) is marked.

> ⊘ **Error**
>
> The **manual movement of the servos** can **only** be performed in the "Initial"    phase (when there is no phase selected in the **Veronte Panel** of **Veronte Ops**).

4. **Control Signals**: This menu contains the variables representing the control signals/outputs U generated by the system. Control outputs are not predeterminated, they depend on SU matrix configuration. For more information regarding U control outputs, please refer to the Actuator - Servos blocks of **Block Programs** section in the **1x PDI Builder** user manual.

   Considering that the above example is for a flying wing, the controls are pitching (U1), thrusting (U2) and rolling (U3), so there are 3 different controls in total. When moving the scroll bar of one of the control channels, the corresponding movement in the servos will also be represented.

5. **Servo Position - PWM**: This option is used to set the transformation **from a control position**    S    **to PWM signal**.

   > ⓘ **Note**
   >
   > Notice that the desired control position S needs to be clicked on in order to interact with this section. Once a control position is selected, **only the PWM percentage can be changed**.

   For example, in the figure above, a 20º degrees deflection (0.349 rad) of the right aileron corresponds to an 82.7% pulse to be sent to the corresponding servo.

   For more information on the **PWM percentage**, refer to the PWM - Connections section of the **1x PDI Builder** user manual.

6. **Apply Changes**: After making the necessary customizations, the user should click on this button to save the changes.

   As this action will restart the device, the following confirmation messages will appear when clicked:
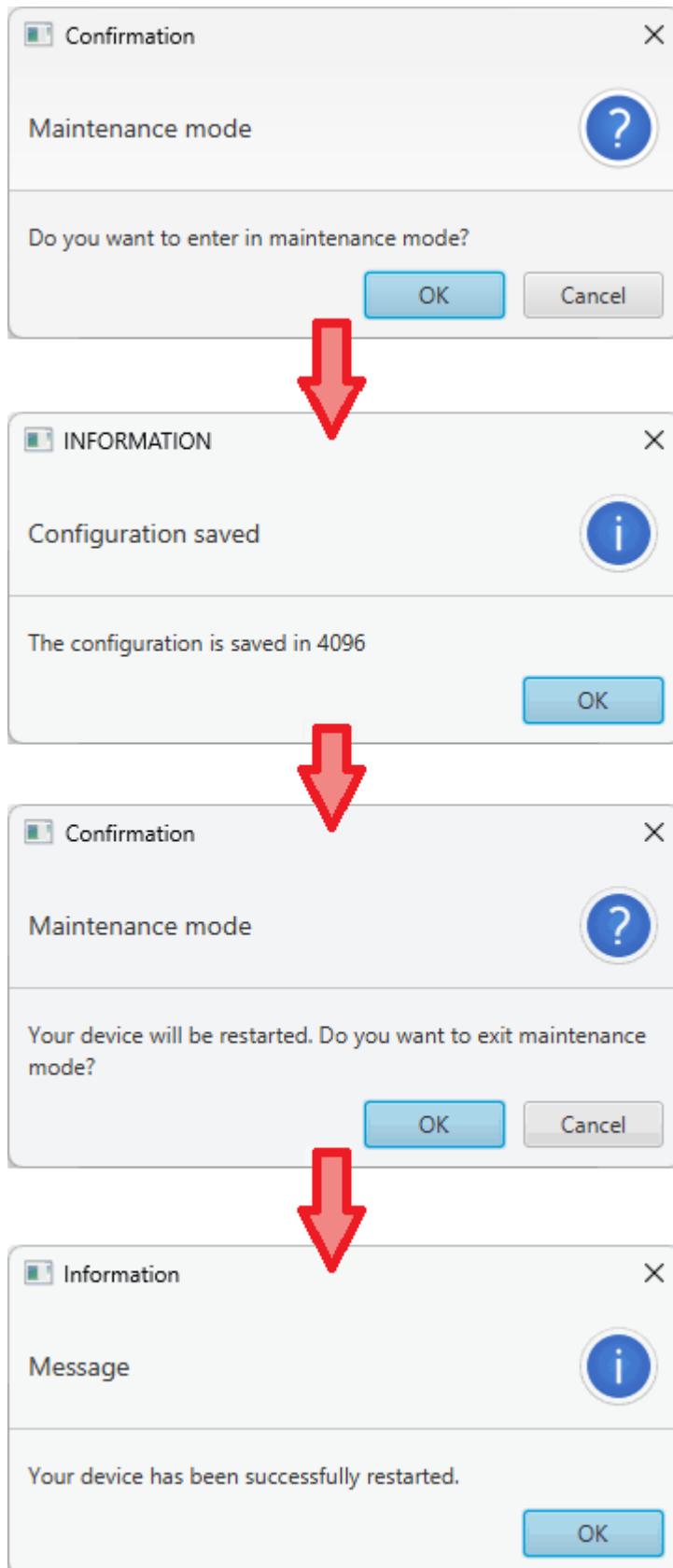
**Actuators Calibration - Apply Changes confirmation messages**

## Trimming

Trimming can be performed by **moving the servos in three different positions**: zero position, minimum and maximum deflection angle (angles are usually physically limited). These positions must be entered and saved in the software by clicking on **'Apply Changes'** when the actuator is in the desired position. Otherwise, the position can be entered manually.

The figure above shows the setting of the right aileron:

- **Minimum**: -0.349 [rad] deflection ⇒ 24.5% PWM output.
- **Zero position**: 0 [rad] deflection ⇒ 50% PWM output.
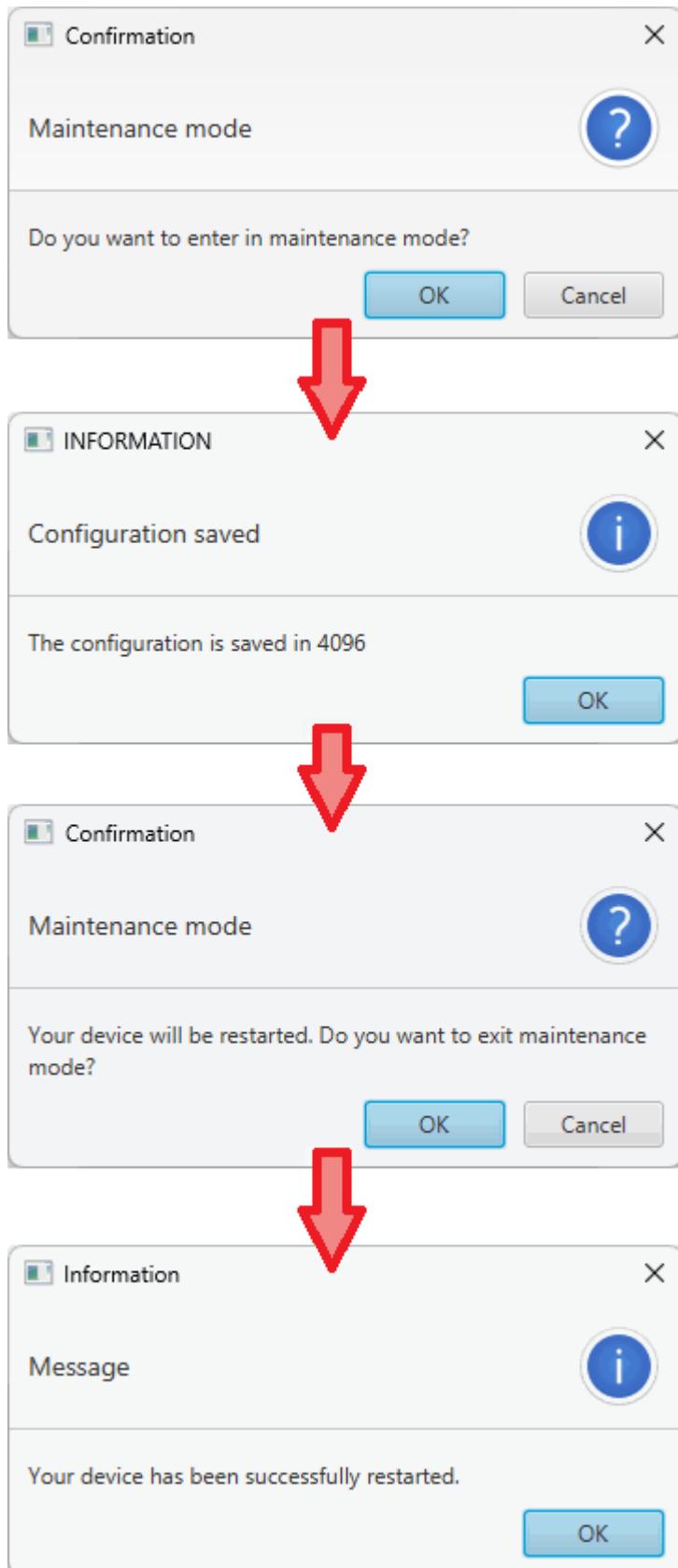- **Maximum**: 0.349 [rad] deflection ⇒ 82.7% PWM output.

# Trim stick

In this menu it is possible to trim the neutral position of the channels of the selected stick.
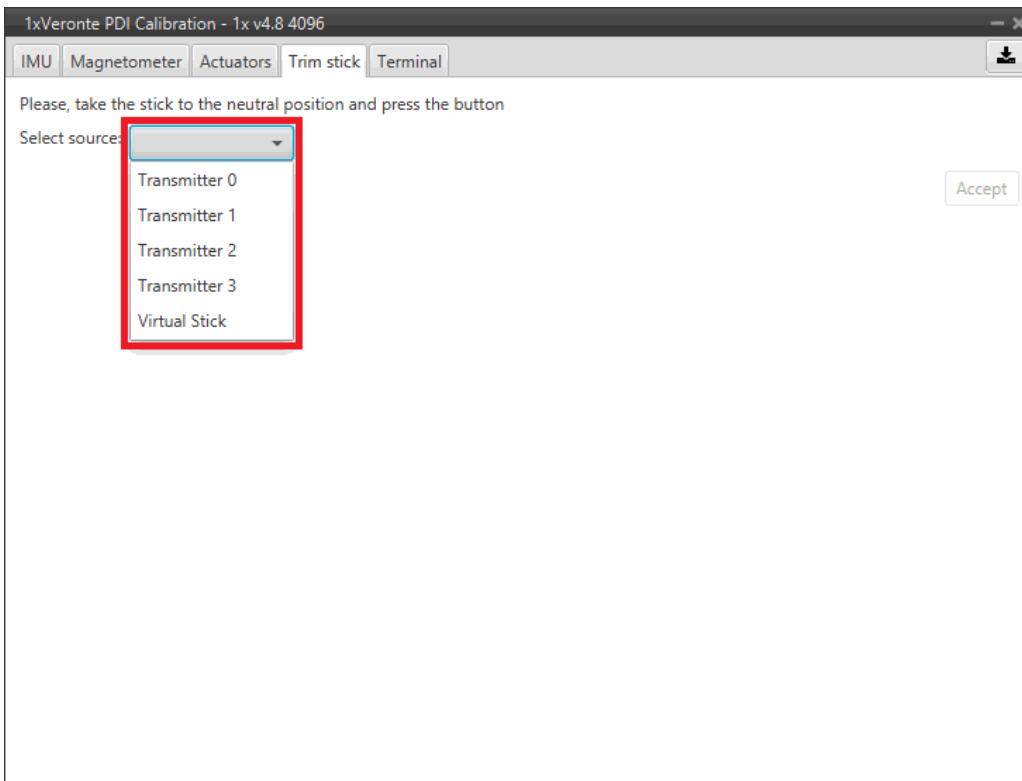


**Trim Stick menu**

The user simply selects the desired stick and the clicks **'Accept'**. Then the following confirmation panels must be accepted to complete the process:
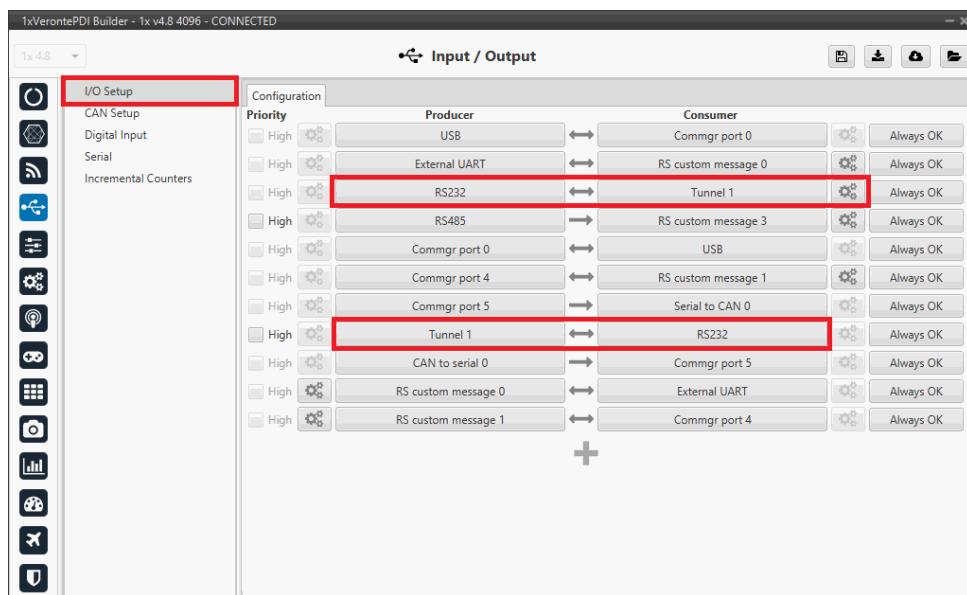
**Confirmation Panels**

# Terminal

The Terminal Manager allows the user to access a **Tunnel Console**.

This allows the user to see the information/data coming into a certain port (e.g. a serial port) where the device is connected.

> **Example**
>
> If the device is connected to a **RS-232** port, in the **1x PDI Builder** software the **RS232 producer** must be bidirectionally connected to a **Tunnel consumer** and vice versa:
>
> 
>
> **1x PDI Builder - RS232** ↔ **Tunnel 1**

In the case of Veronte Autopilot 1x `v4.5`, it is integrated with the **Microhard Pico Series internal radio** module and its configuration can be modified by using the Microhard setup helper.

First, the user must agree the information about the process:
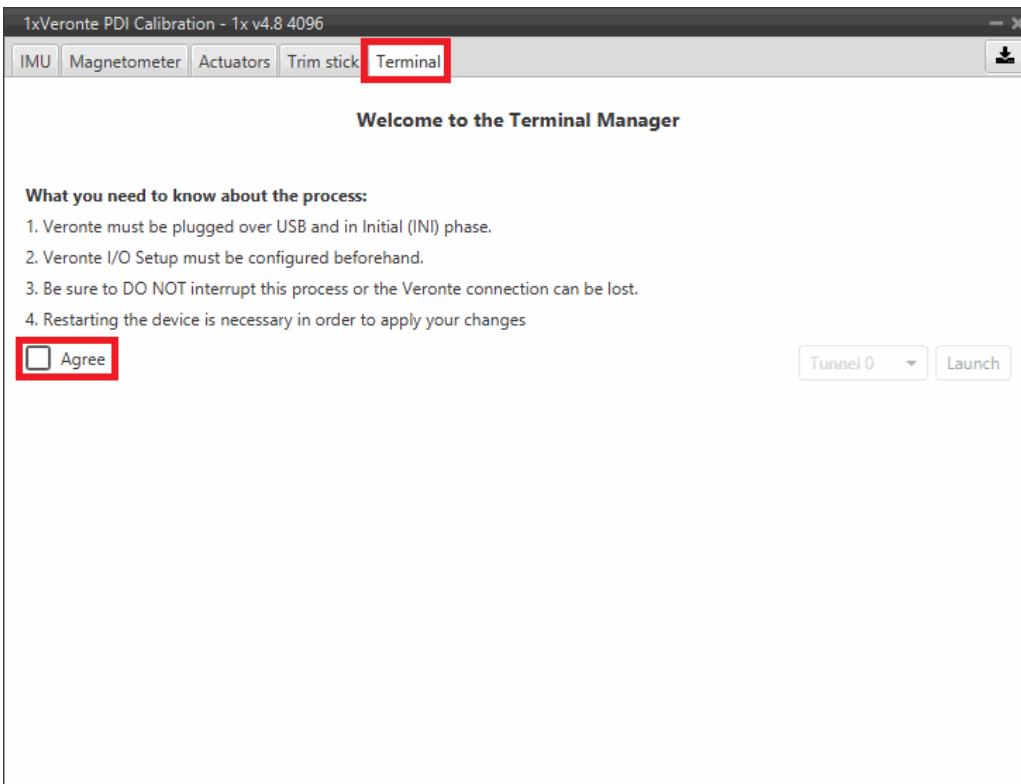
**Terminal Manager menu**

It is then possible to select the **Tunnel** (Tunnel 0, 1 or 2) that the user has configured and needs.
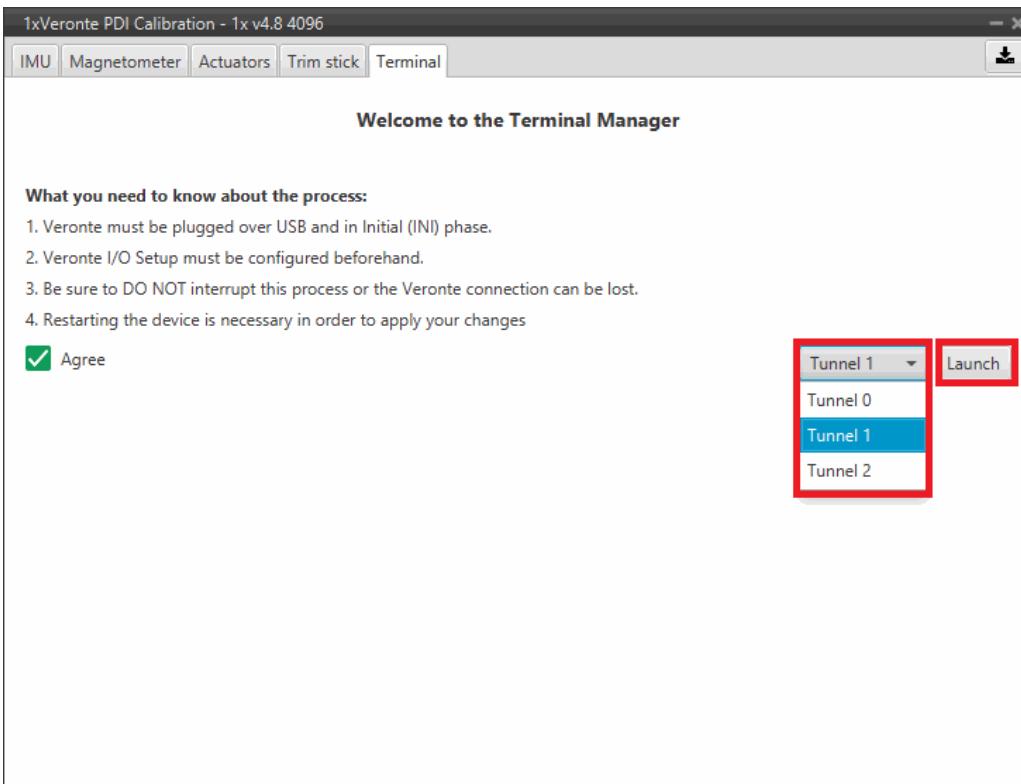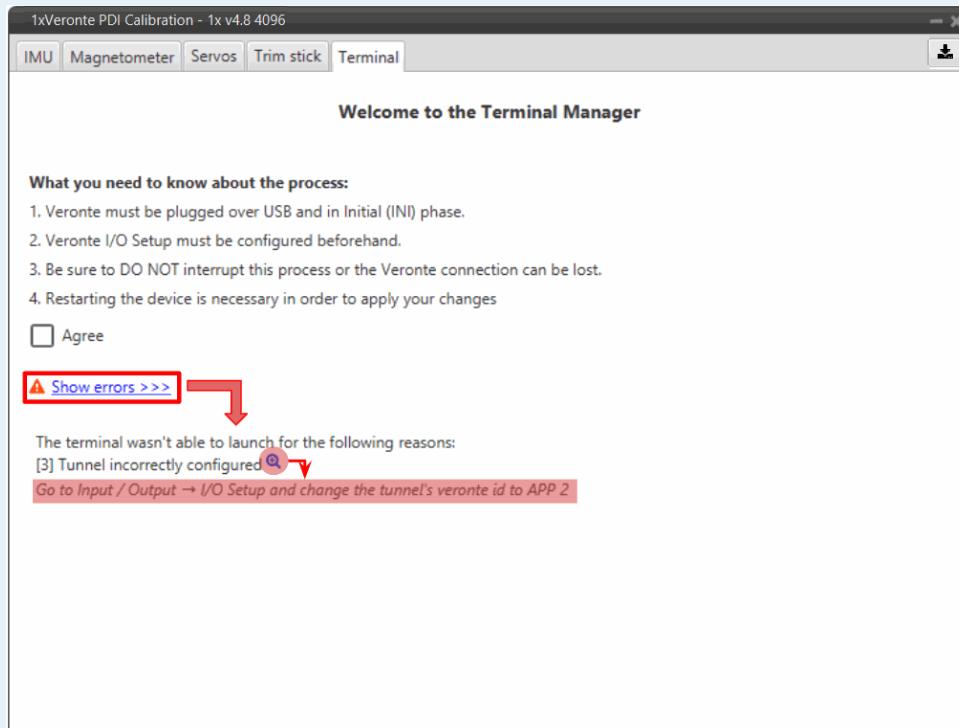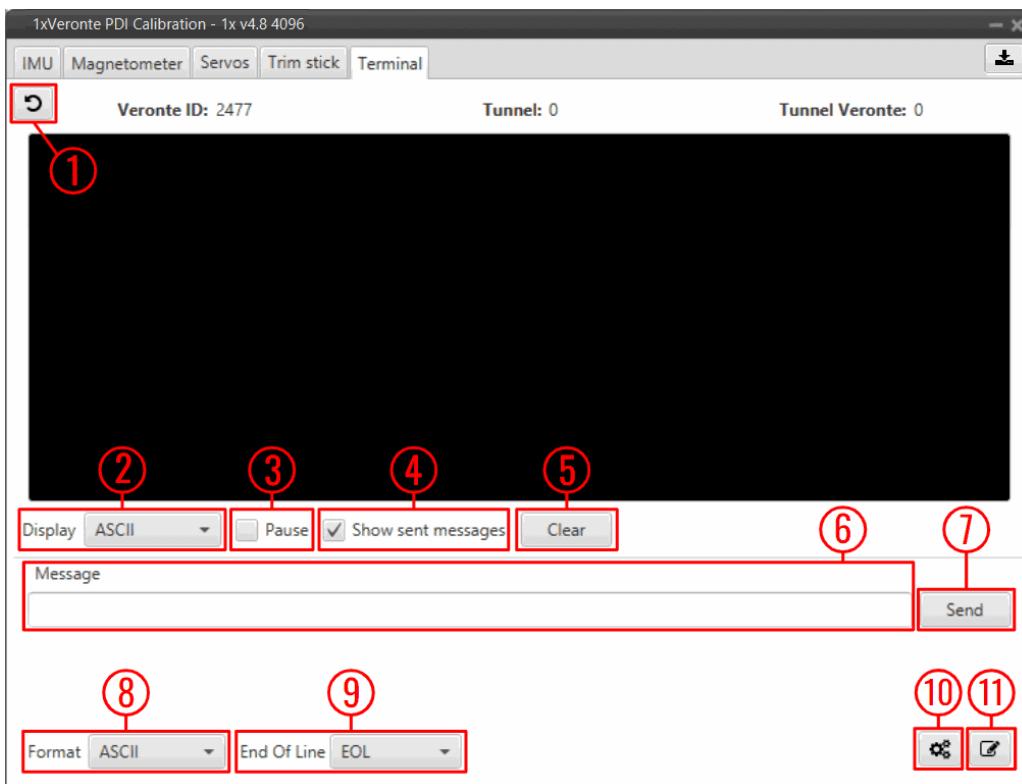


**Terminal Manager menu**

Once the process is launched (just click on **'Launch'**), everything is correctly configured, the **Tunnel Console** appears.

> ⓘ **Note**
>
> If something has gone wrong, the Tunnel Console will not open and, instead, the panel will report of the error occurred and how to fix it:
>
> 
>
> **Terminal - Launch failed**

**Tunnel Console**

1. **Back to Terminal**: Click here to return to the initial terminal menu.

2. **Display**: Data can be **displayed** in **ASCII** or **Hexa** format.

3. **Pause**: When the data stream is running, it is possible to pause it by enable this option.

4. **Show sent message**: If enabled, the sent messages are shown in the console.

5. **Clear**: Clears the last console data.

6. **Message**: Message content.

7. **Send**: When clicked, the current message is sent.

8. **Format**: Data can be **sent** in **ASCII** or **Hexa** format.

9. **End Of Line**: Message "End of line" configuration. The available 'characters' are EOL (actually it is the combination of CR and LF), CR, LF or None.

10. **Microhard Wizard**: See related subsection below.

11. **Edit**: By clicking here, it is possible to construct larger text messages, as well as copy and paste.
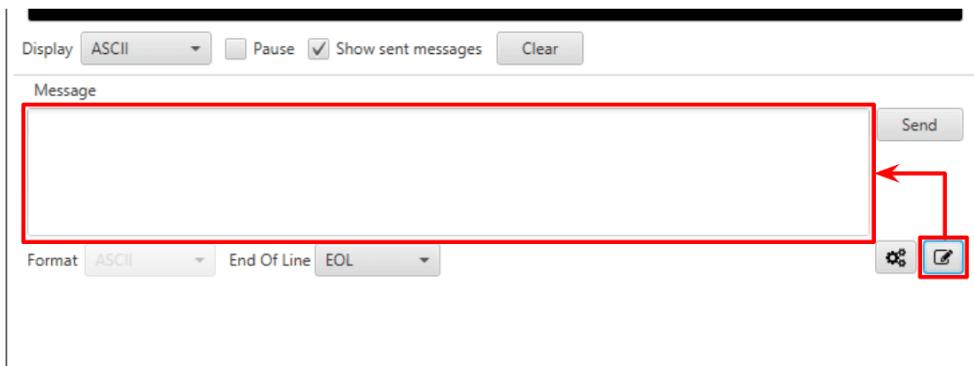
**Tunnel Console - Edit message**

## Microhard setup helper

The **Microhard setup helper** can be used to easily **configure the Microhard internal modules** (Veronte Autopilot 1x with `hardware version 4.5` internal radio). To do this, the user must click on the dedicated button 🞿 and the Wizard will automatically start the radio searching.

Once the radio is found, its model and the **configured parameters** are displayed on the console:
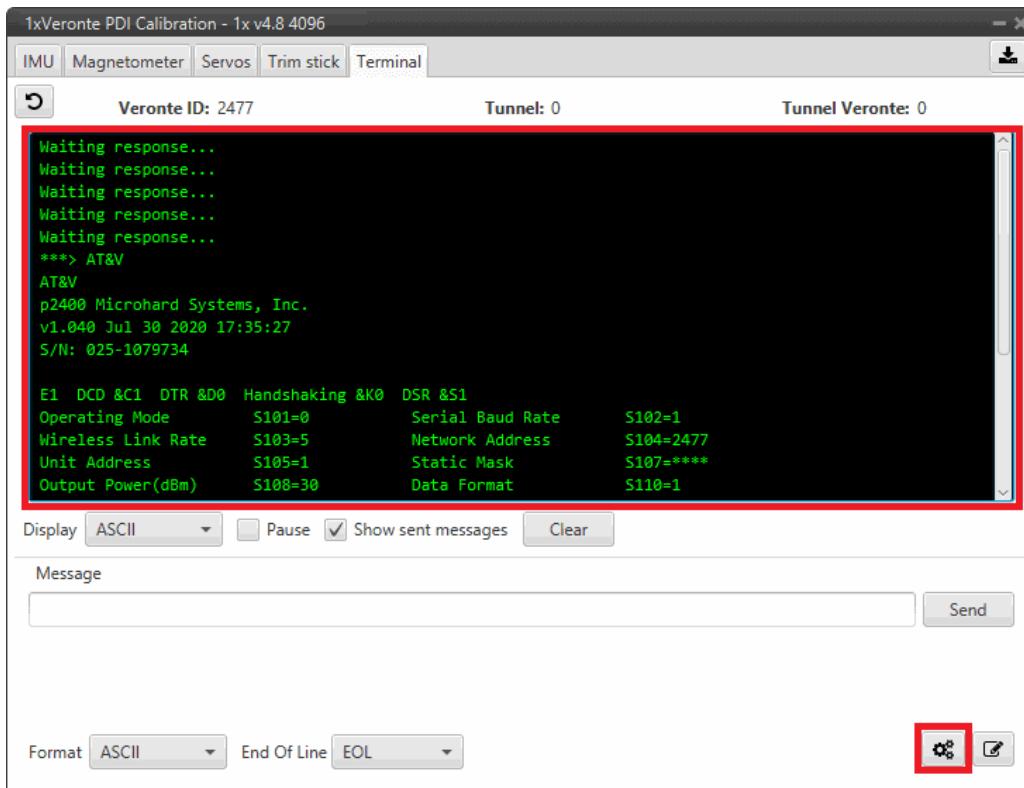


**Microhard Wizard - Tunnel Console**

The following **Wizard menu** is displayed:
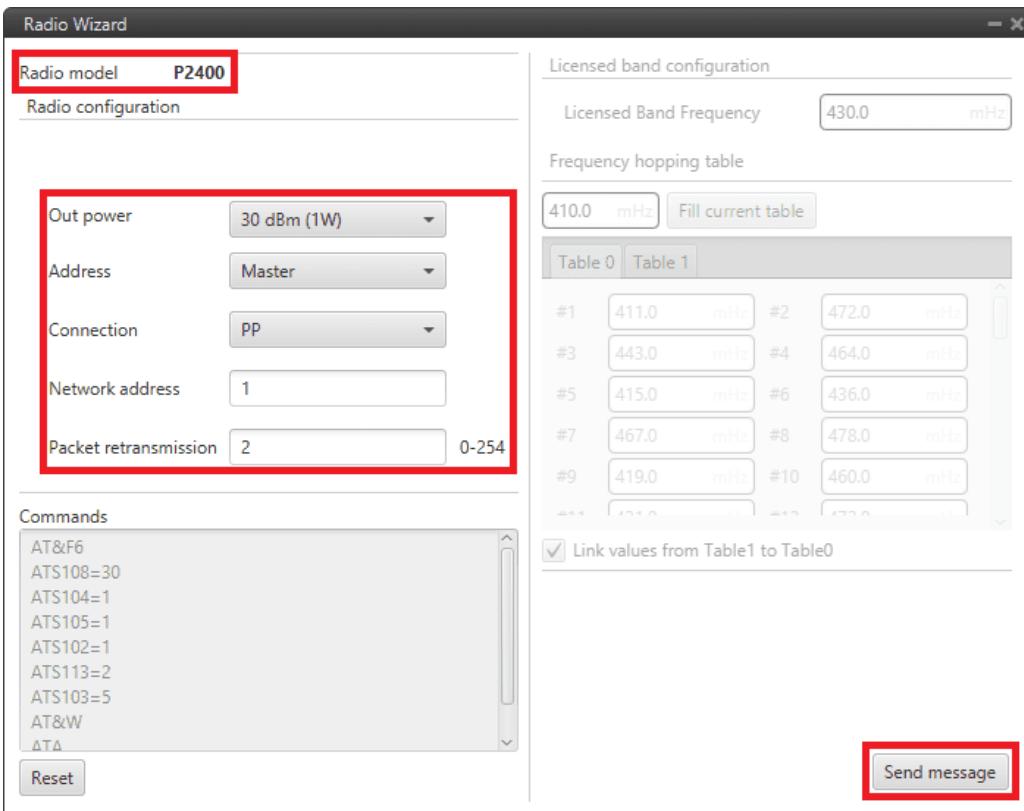
**Microhard Wizard menu**

> ⚠ **Warning**
>
> The parameters shown in this **wizard menu** are **not** those **configured in the radio module**.
>
> The **default wizard parameters** are shown **here**, the ones configured in the radio module are shown in the tunnel console as shown in the figure Microhard Wizard - Tunnel Console.

These parameters have to be configured according to the radio module installed in the Veronte Autopilot 1x.

- **Radio model**: Each Autopilot 1x has only one of the following radio modules **P400**, **P900** and **P2400**.
- **Output power**: Sets the available output power.
- **Address**: Select the role for each Autopilot 1x by selectig **Master** or **Slave**. By default, **Air units** are defined as **Slave** and **Ground units** are defined as **Master**.

- **Connection**: **PP** (Point to Point) or **PMP** (Point Multi Point) connections. By default all units are paired with **PP connection**.
- **Network address**: This is the address of the network to which the autopilot with this radio module installed belongs.
  **This number must be the same for all Veronte Autopilots 1x on the same network**.

> 💡 **Tip**
>
> Usually, the address of the ground unit is set as the network address for easy recall.

- **Packet retransmission**: Each data packet is sent as many times as defined here. It is recommended to leave the default value.

By pressing **'Send message'**, the user is able to **send all these parameters to the Microhard module**.

> ⓘ **Note**
>
> The **commands** can also be **sent manually**. For **advanced** Microhard **configuration**, please refer to the User Manual of the specific radio module: Microhard - Pico series.

Once the configuration is sent, the radio wizard menu closes and the tunnel console should appear as shown in the figure below:
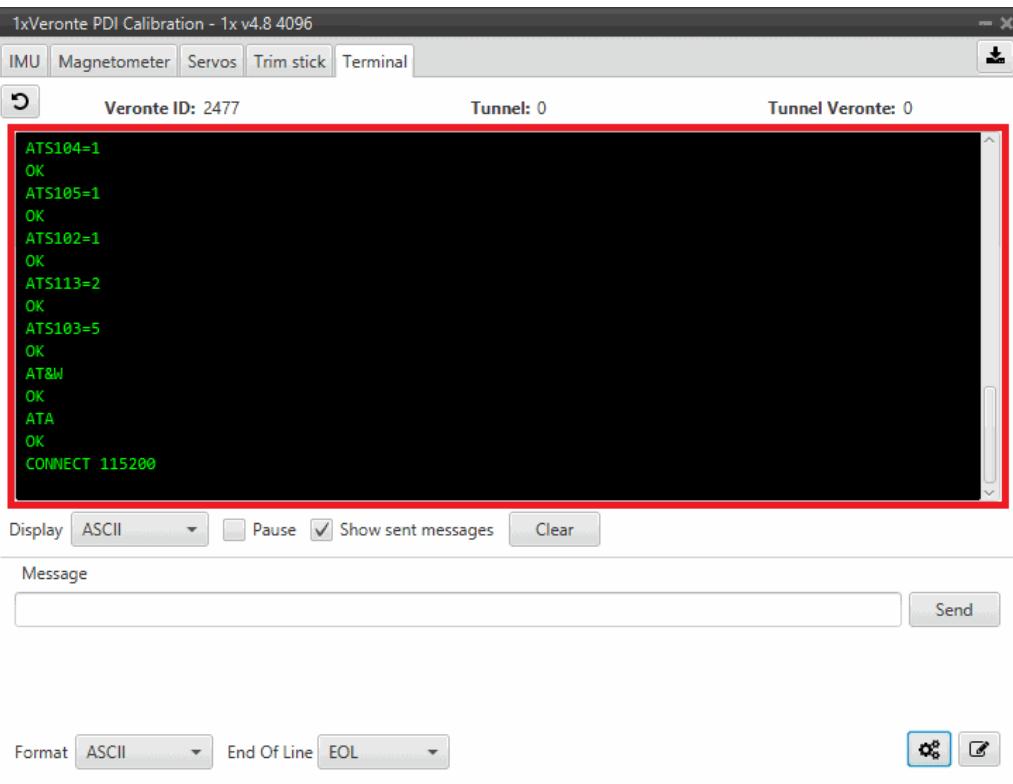
**Tunnel Console - Radio module configured**

The Microhard radio module is now configured.

Finally, the **Microhard radio module must be restarted** so, the user must **restart the Veronte Autopilot 1x**.

# Troubleshooting

## An instance of the selected device is already opened

If the user tries to reopen the initial menu by clicking on Open when it is already opened, the following warning panel will pop up:
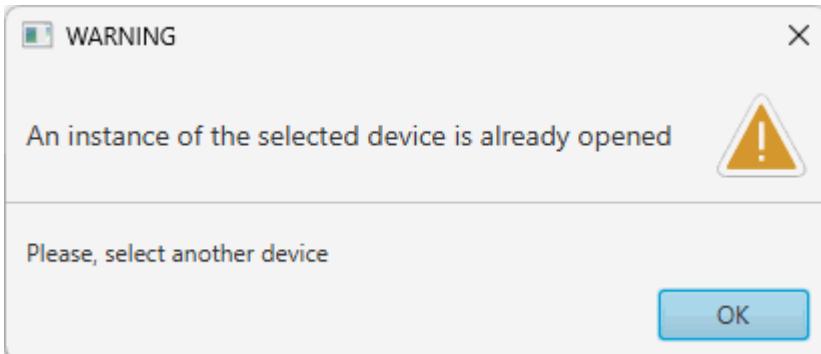


**Warning: Menu is already opened**

## Error entering Maintenance Mode

An error may occur while the Autopilot 1x is entering Maintenance Mode for saving changes in its configuration. The user must simply accept the following informative panel and repeat the desired process.
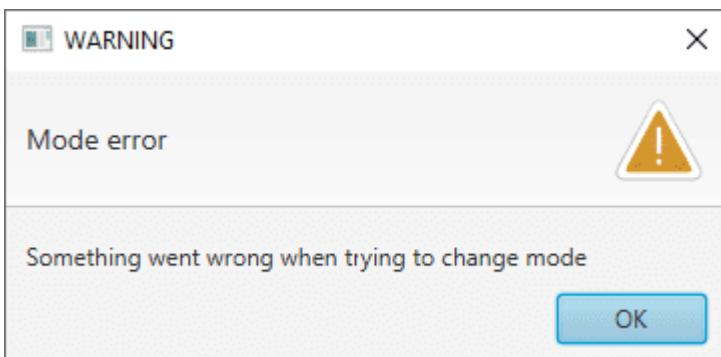


**Warning: Mode error**

# Magnetometer wrong calibration

Users often have problems when working with magnetometers. Please check the following:

- The magnetometer has been correctly **calibrated**. For more information about its calibration, please refer to the Magnetometer section of this manual.
- The **rotation matrix** of the magnetometer is **not a zero matrix** and is set respecting the orthogonality of the axes. Consult the Magnetometer - Sensors in the **Configuration** section of the **1x PDI Builder** user manual.
- The **'ok'** output of the **Misalignment block** is **true**, i.e. the measurement has passed the module checks. Check Misalignment - Navigation blocks in the **Block Programs** section of the **1x PDI Builder** user manual.
- **Yaw measurement does not drift** after a turn, i.e. the yaw remains static at one value after a turn. Drifting will mean a wrong calibration. The following graph illustrates this behavior:
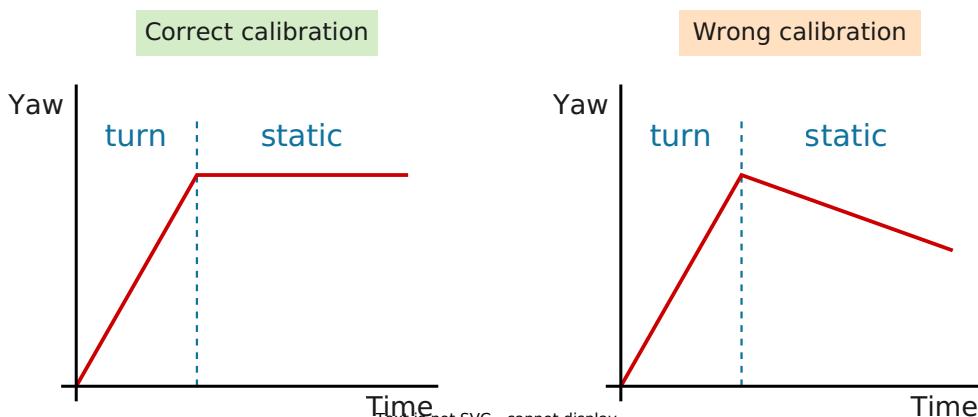


**Yaw behavior graph**

In addition, it is also a useful check **to compare the magnetometer measurement with another instrument** (i.e. a mobile phone) pointing at different points.

> 💡 **Hint**
>
> **90º rotations** are recommended. A deviation of **±6º** is acceptable.

---

# MEX magnetometer calibration unable to start

When using MEX as **Magnetometer Honeywell HMR2300**, if the calibration process of the magnetometer has been started, but the calibration status bar does not indicate any progress, **the configuration of the sensor** may be **invalid**.
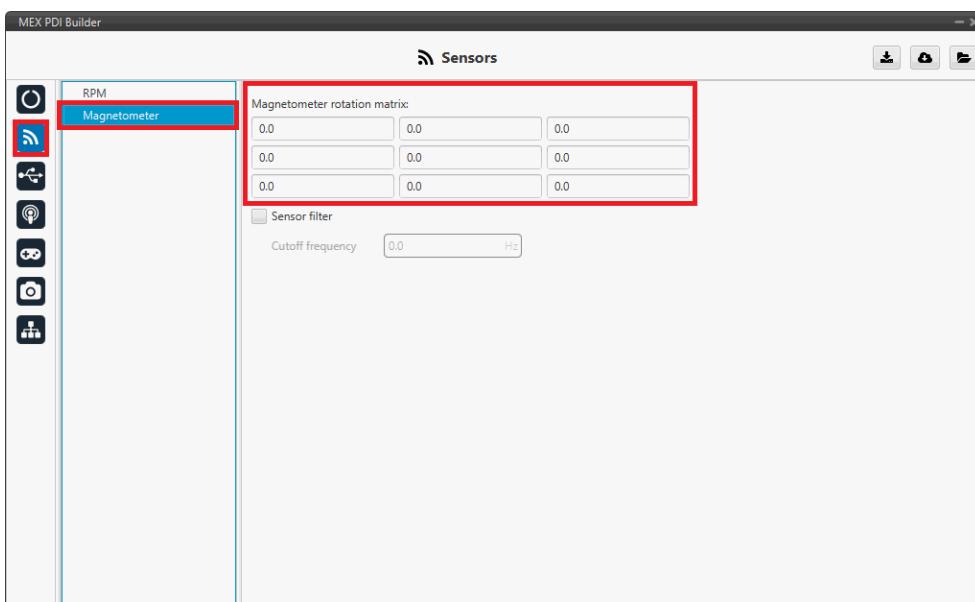
To solve this problem:

1. Open **MEX PDI Builder**.

> ⓘ **Note**
>
> Consult the MEX PDI Builder manual for more details on how to proceed.

2. Go to Sensors menu → **Magnetometer tab**.
3. Ensure that the **Magnetometer rotation matrix** is **not** a zero matrix and respects the orthogonality of the axes.



**MEX PDI Builder - Invalid magnetometer rotation matrix**

# Tunnel Console does not appear

The Terminal Manager tab allows the user to access a **Tunnel Console**.

In order to access this **Tunnel Console**, certain requirements must be met:

1. **Veronte Autopilot 1x** must be plugged over USB and in Initial (INI) phase.

2. **Autopilot 1x** I/O Setup must be configured beforehand.

If these requisites have been fulfilled and the **console will not pop up**, the problem may be in the **1x PDI Builder** Telemetry configuration. The variable Phase Identifier must be enabled in at least one Telemetry vector.
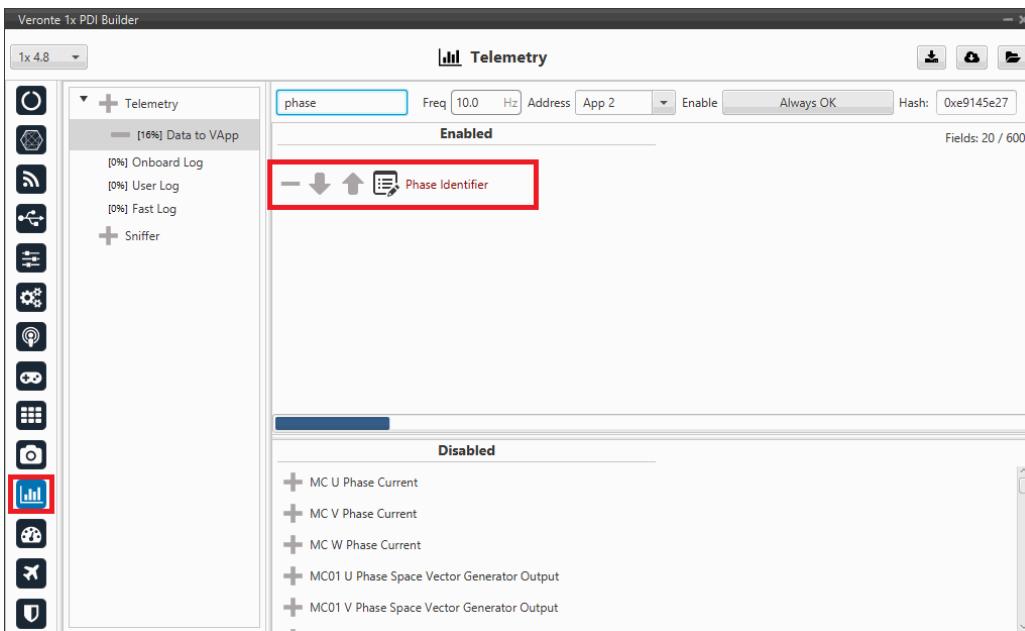


**1x PDI Builder: Telemetry**

For further information, please refer to Telemetry - Telemetry section of the **1x PDI Builder** user manual.

# Software Changelog

This section presents the changes between the previous software version **v. 6.14.32** and the current one **v.7.6.15**.

**Added**

- Central login
- Device name include product name and version
- Sample size in 'Magnetometer'