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# 1x PDI Calibration

*Release 6.12.60*

**Embention**

**2024-05-09**



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1x PDI Calibration setups calibration parameters for Autopilots 1x. It also allows the user to calibrate sensors and configure the radio module.

**Warning:** Ensure to select your version before reading any user manual for software. The following image shows where to select a version from any Embention user manual.

A screenshot of the 1x PDI Calibration user manual page. The page has a blue header with navigation links: Home, Version-6.8.69 (highlighted with a red box), Languages-EN, and Download. Below the header, the breadcrumb 'Docs &gt; 1x PDI Calibration' is visible. The main content area features the title '1x PDI Calibration' and the logo. A red arrow points from the version selection dropdown menu to the main content area. The dropdown menu shows two options: '6.8.67' and '6.8.69'. Below the logo, there is a paragraph of text: '1x PDI Calibration setups calibration parameters for 1x autopilots. It also allows the user to calibrate sensors and configure the radio module.' Below this paragraph, the version and date are listed: 'Version: UM.317.6.8.69' and 'Date: 2023-08-02'. At the bottom of the page, there is a 'Quick Start' link and a copyright notice: '© Copyright 2023, Embention.'



## 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**.

### 1.1 Download

Once the **Veronte Autopilot 1x** has been purchased, a GitHub release should be created for the customer with the application.

To access to the release and download the software, read the [Releases](#) section of the **Joint Collaboration Framework** manual.

### 1.2 Installation

To install 1x PDI Calibration on Windows just execute “1xVerontePDICalibration.exe” and follow the indications of the *Setup Wizard*.

**Warning:** If users have any problems with the installation, please disable the antivirus and the Windows firewall. Disabling the antivirus depends on the antivirus software.

To disable the firewall, go to “Control Panel” → “System and Security” → “Windows Defender Firewall” and then, click on “Turn windows Defender Firewall on or off”.

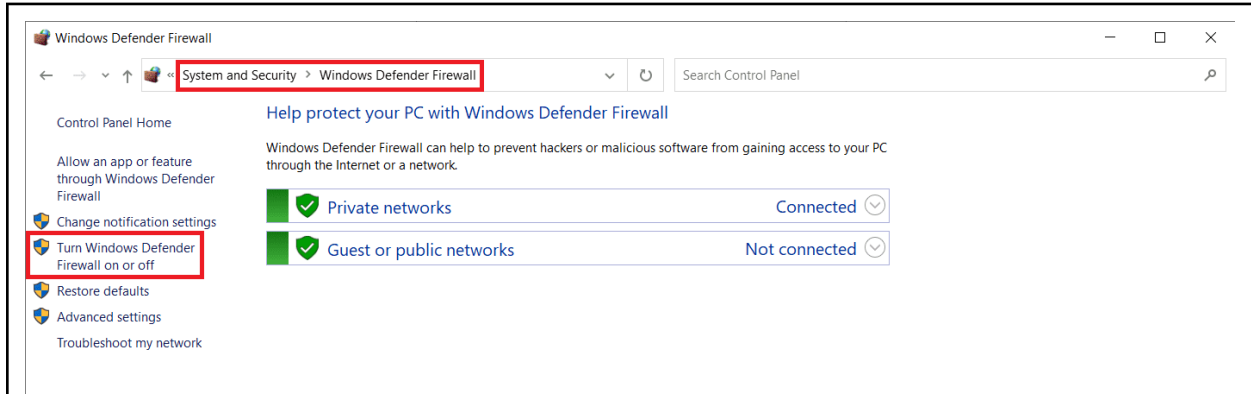


Fig. 1: Windows Defender Firewall

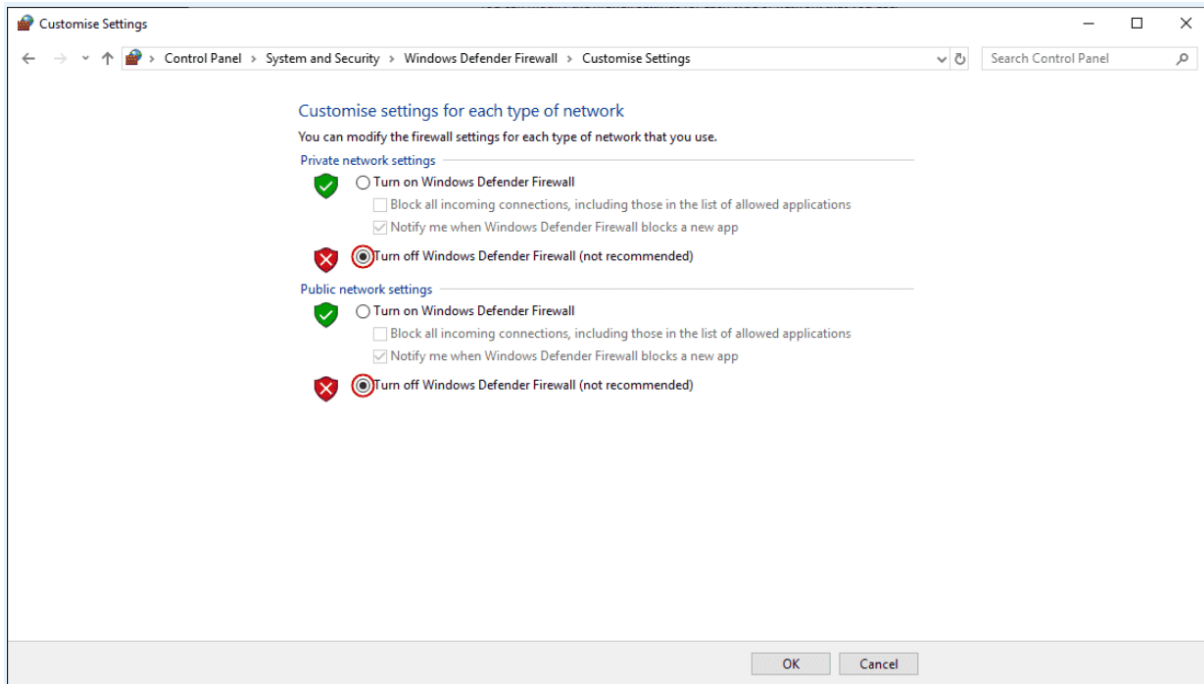


Fig. 2: Windows Defender Firewall: Customize Settings



## OPERATION

Once the installation is finished, open 1x PDI Calibration and select the unit.

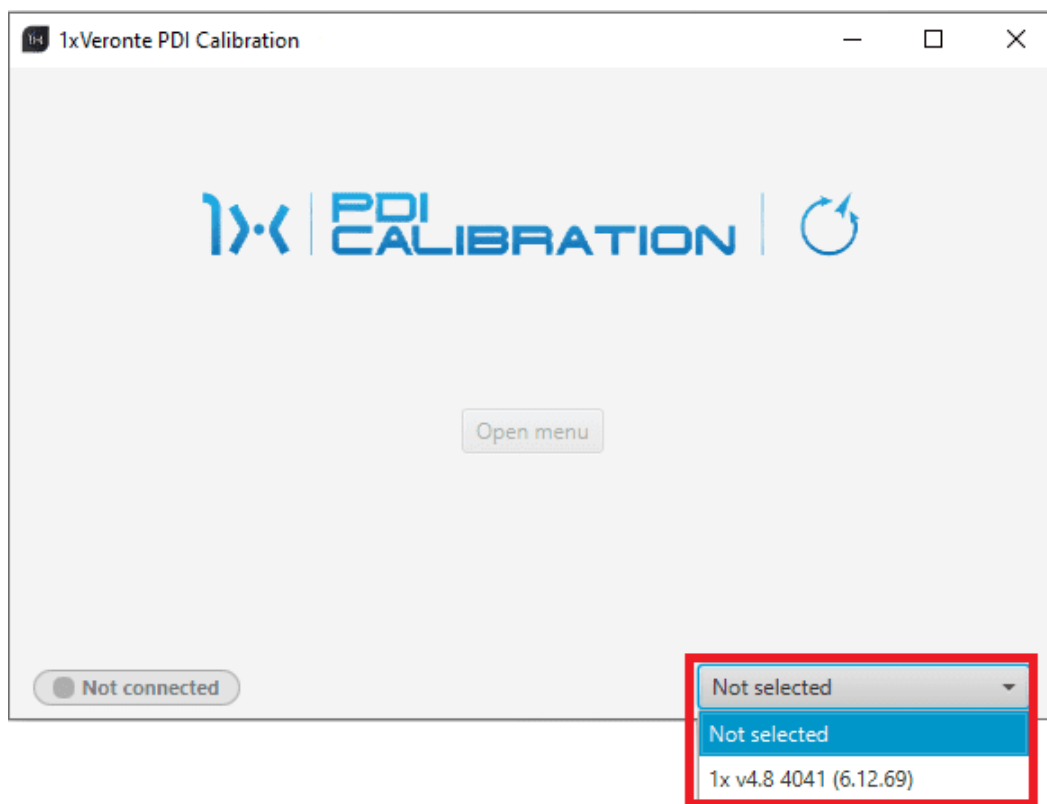
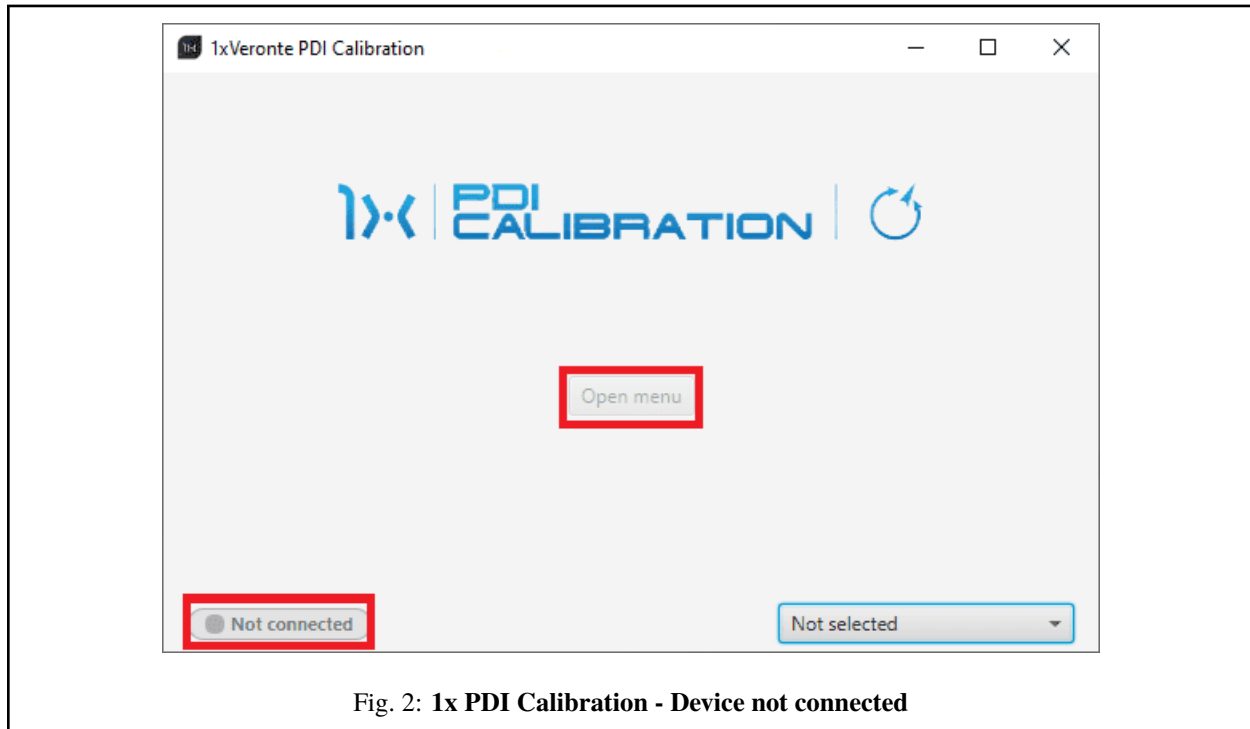
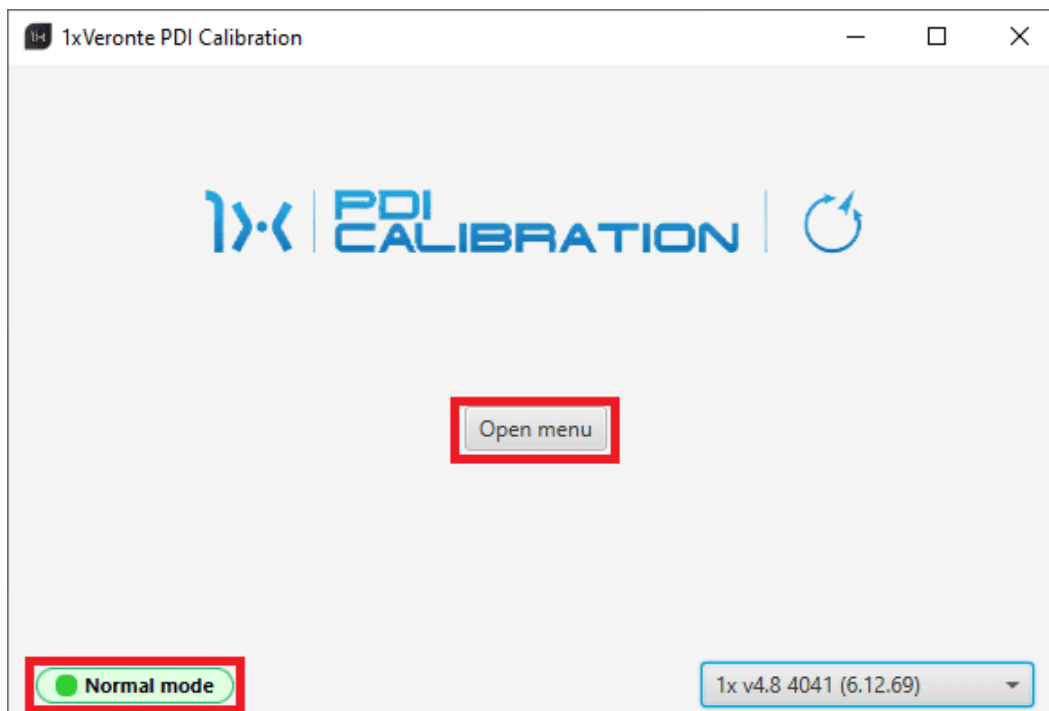


Fig. 1: Select device

**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.



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



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 the software by clicking on ‘**Open menu**’. Then, the following window will be displayed:

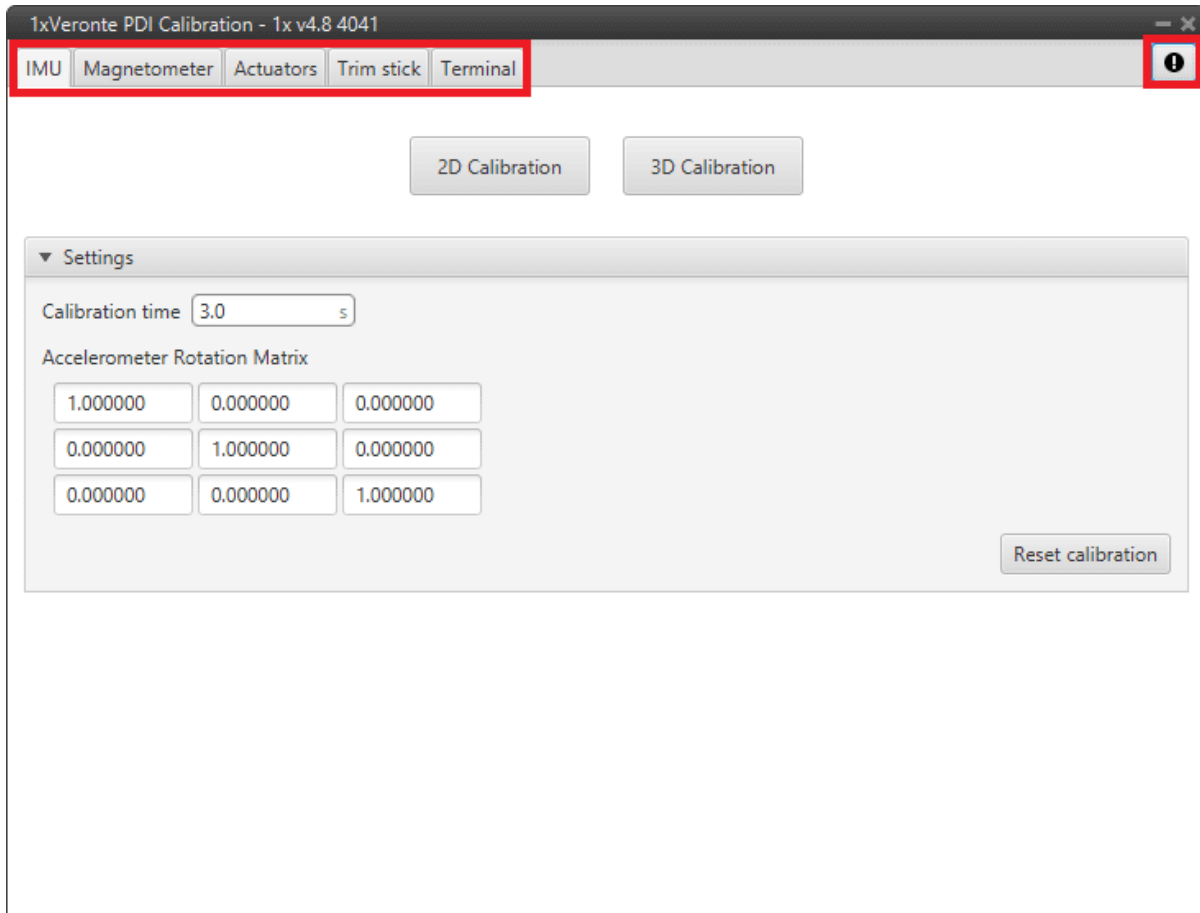



Fig. 4: Initial menu

-  **Feedback** button: Users can report a problem they have encountered by **creating an issue in their own ‘Joint Collaboration Framework’**.

The ‘**Download**’ button downloads a zipped folder with the current 1x configuration and more information needed for Embention to resolve the issue. It is advisable to attach this folder when creating the issue.

**Note:** The user’s ‘Joint Collaboration Framework’ is simply a **own Github repository for each customer**.

If the user has any questions about this Joint Collaboration Framework, please see the [Joint Collaboration Framework user manual](#) or contact [sales@embention.com](mailto:sales@embention.com).

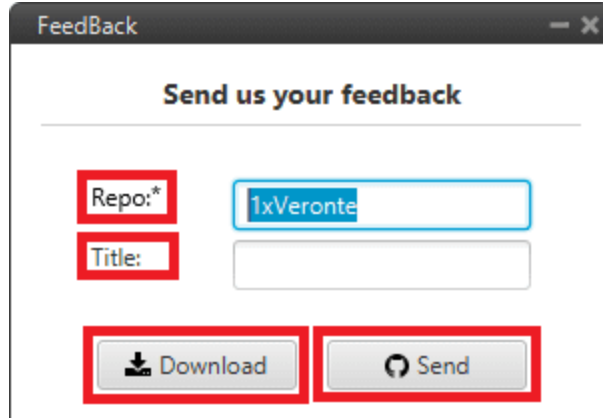


Fig. 5: Feedback

- 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.

## 2.1 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.

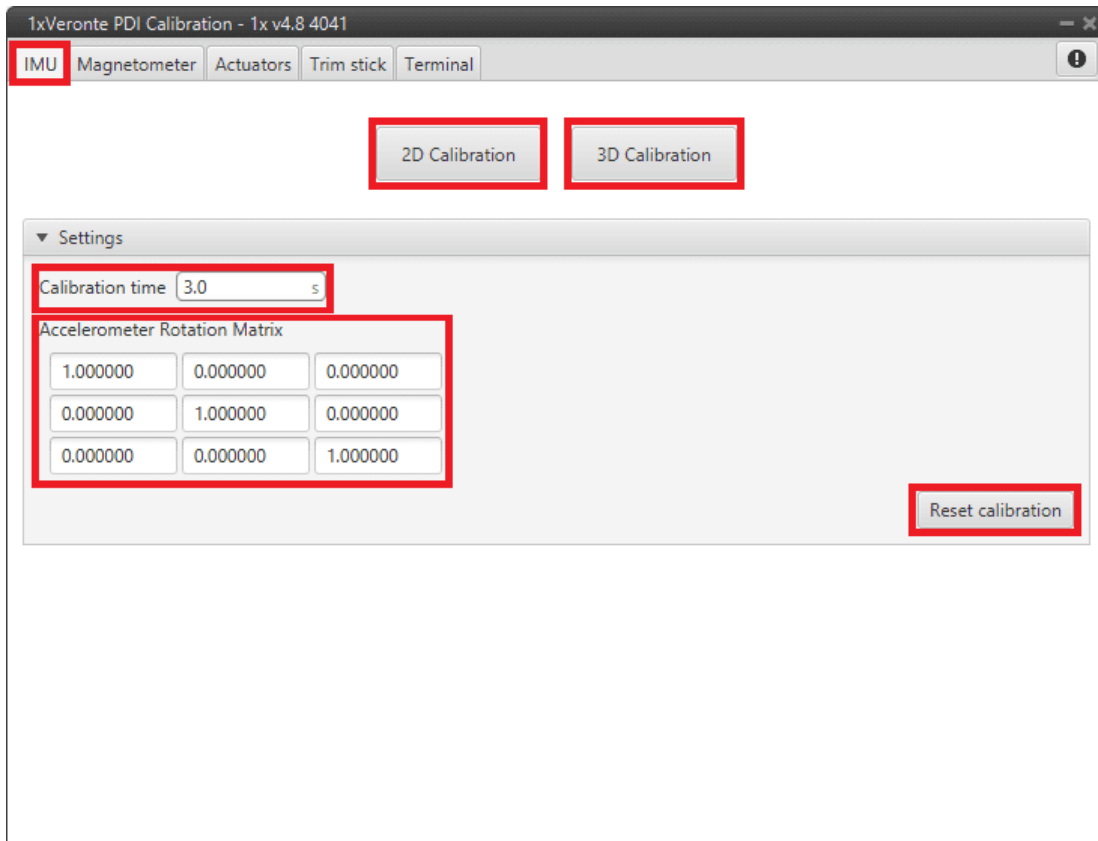


Fig. 6: IMU Calibration menu

**Note:** Notice that the **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:

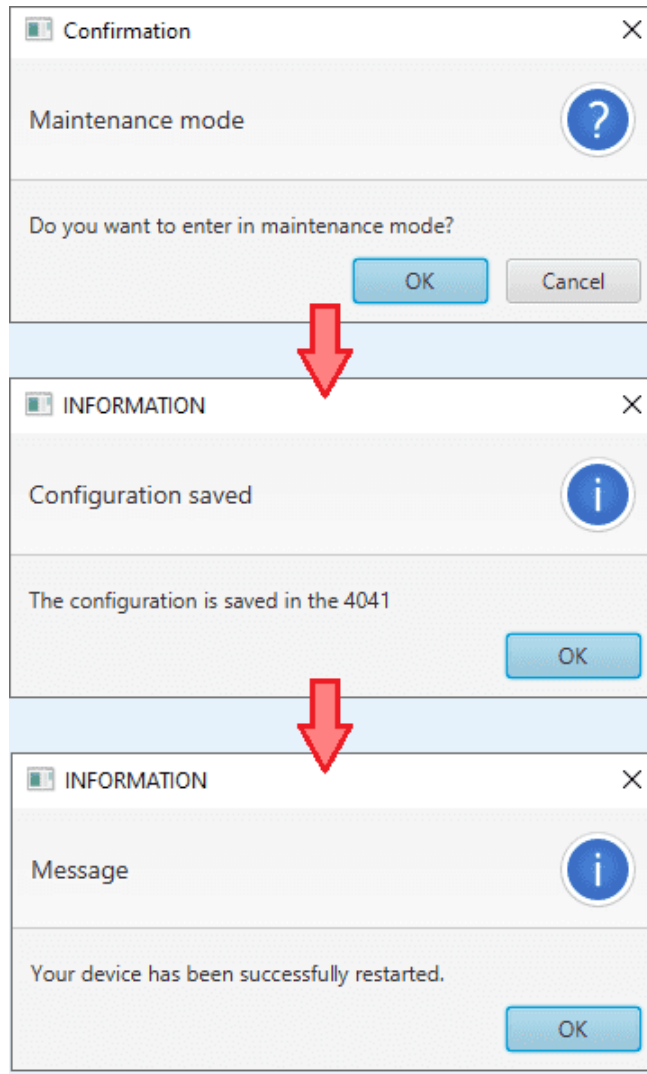


Fig. 7: Confirmation panels

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There are 2 calibration options available:

- **2D Calibration:** Only calibrates **pitch** and **roll angles**. The platform must be **horizontal** during the calibration process:

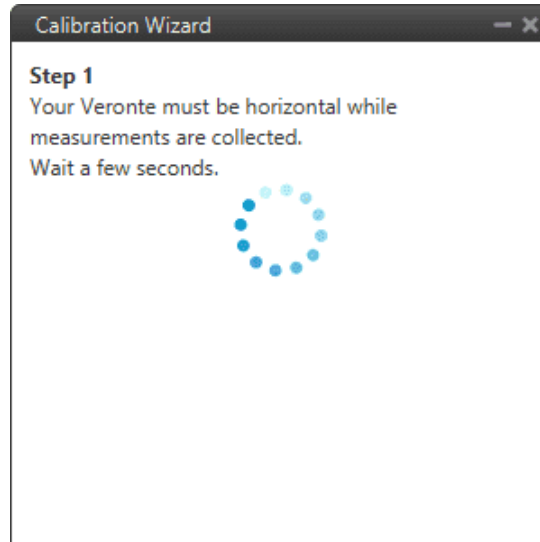


Fig. 8: 2D Calibration

**Warning:** The autopilot 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**.

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

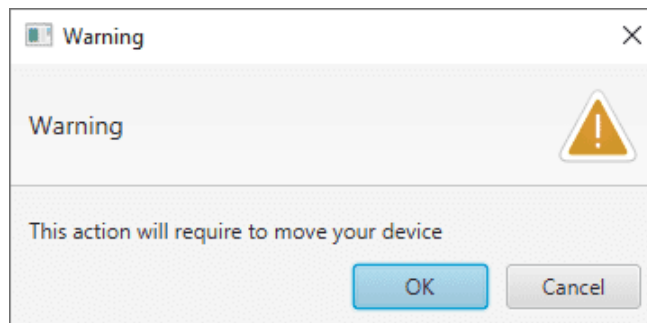


Fig. 9: 3D Calibration - Warning

- During the first measurement the platform must be horizontal:

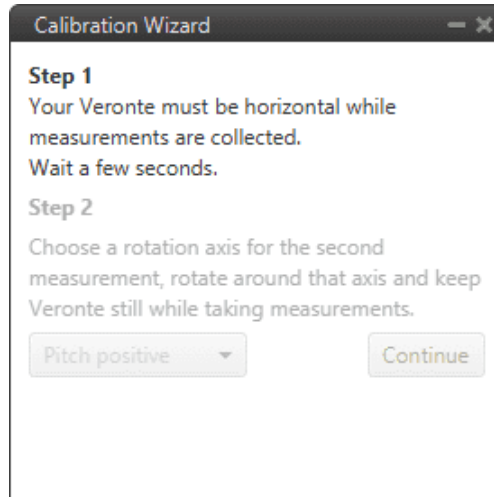


Fig. 10: 3D Calibration - First measurement

- 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*.

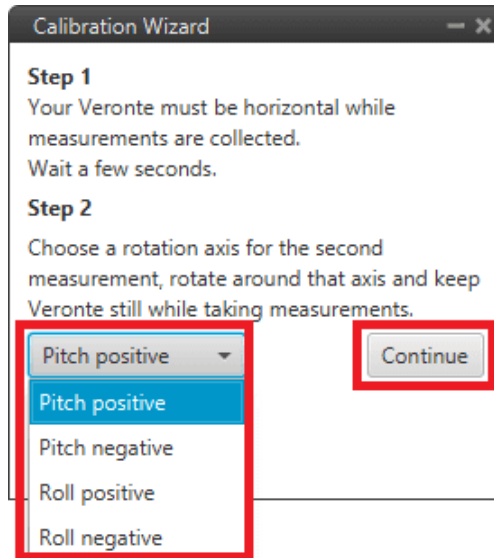


Fig. 11: 3D Calibration - Second measurement options

Once the rotation axis has been selected, click on '**Continue**' to perform this second measurement:



**Warning:** The autopilot will **restart** when the calibration is done.

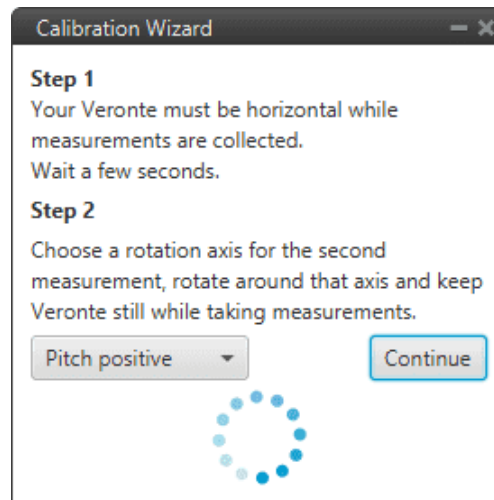


Fig. 12: 3D Calibration - Second measurement

**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:

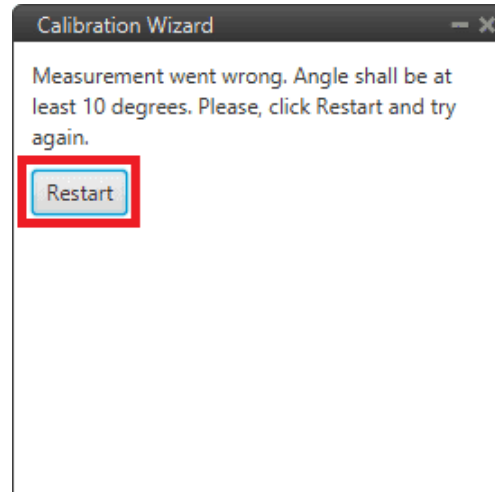


Fig. 13: 3D Calibration error

- **Settings:**

- **Calibration time:** Users can modify the time during which the software is requesting values from the Autopilot 1x for calibration.
- **Accelerometer 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:

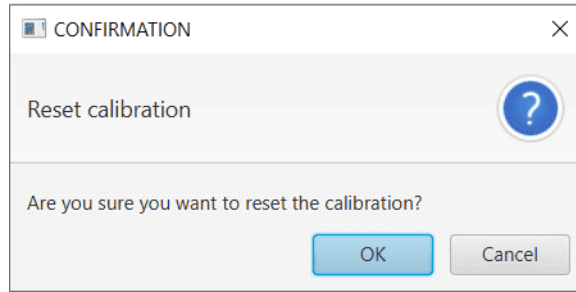


Fig. 14: Confirm Reset

**Warning:** The autopilot will **restart** when the reset is done.

## 2.2 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.

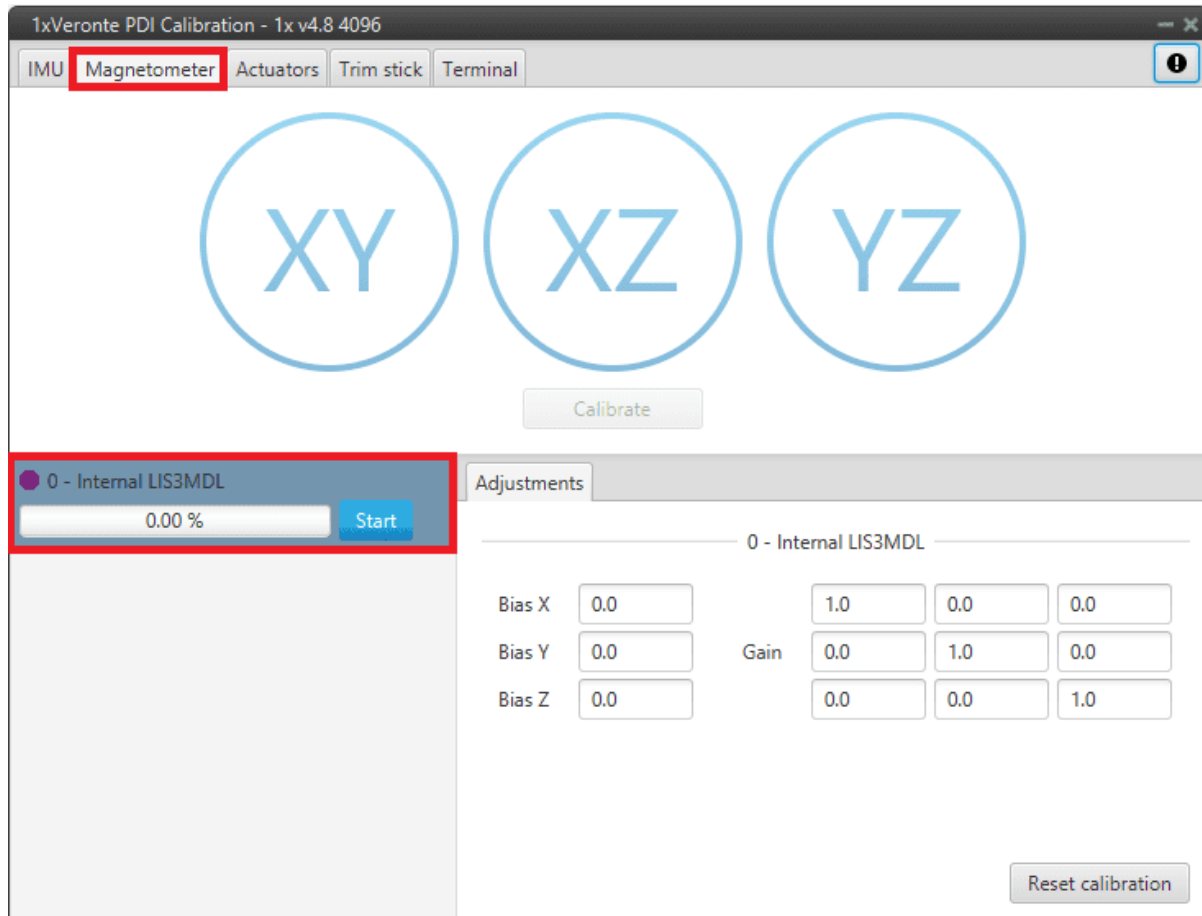


Fig. 15: Magnetometer Calibration menu

**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.

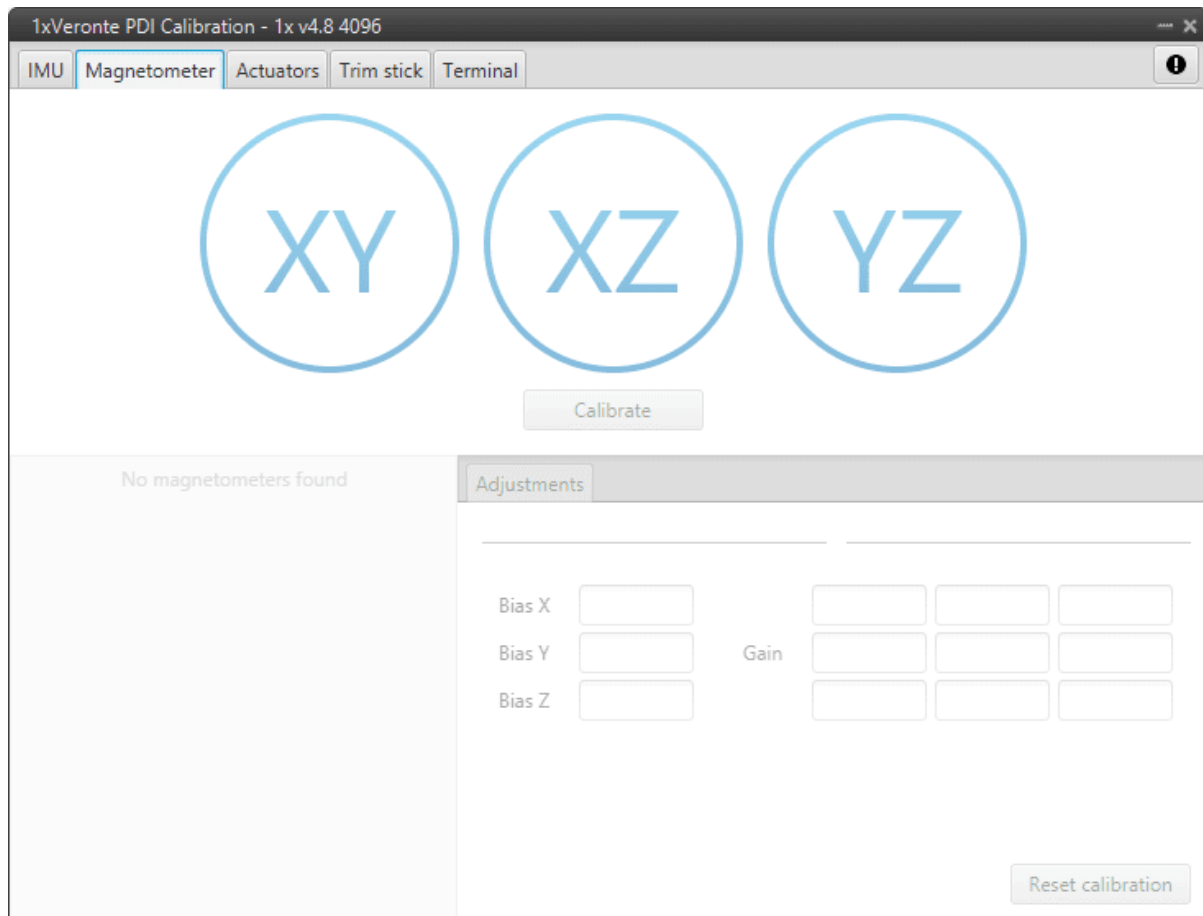


Fig. 16: No magnetometers found

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.

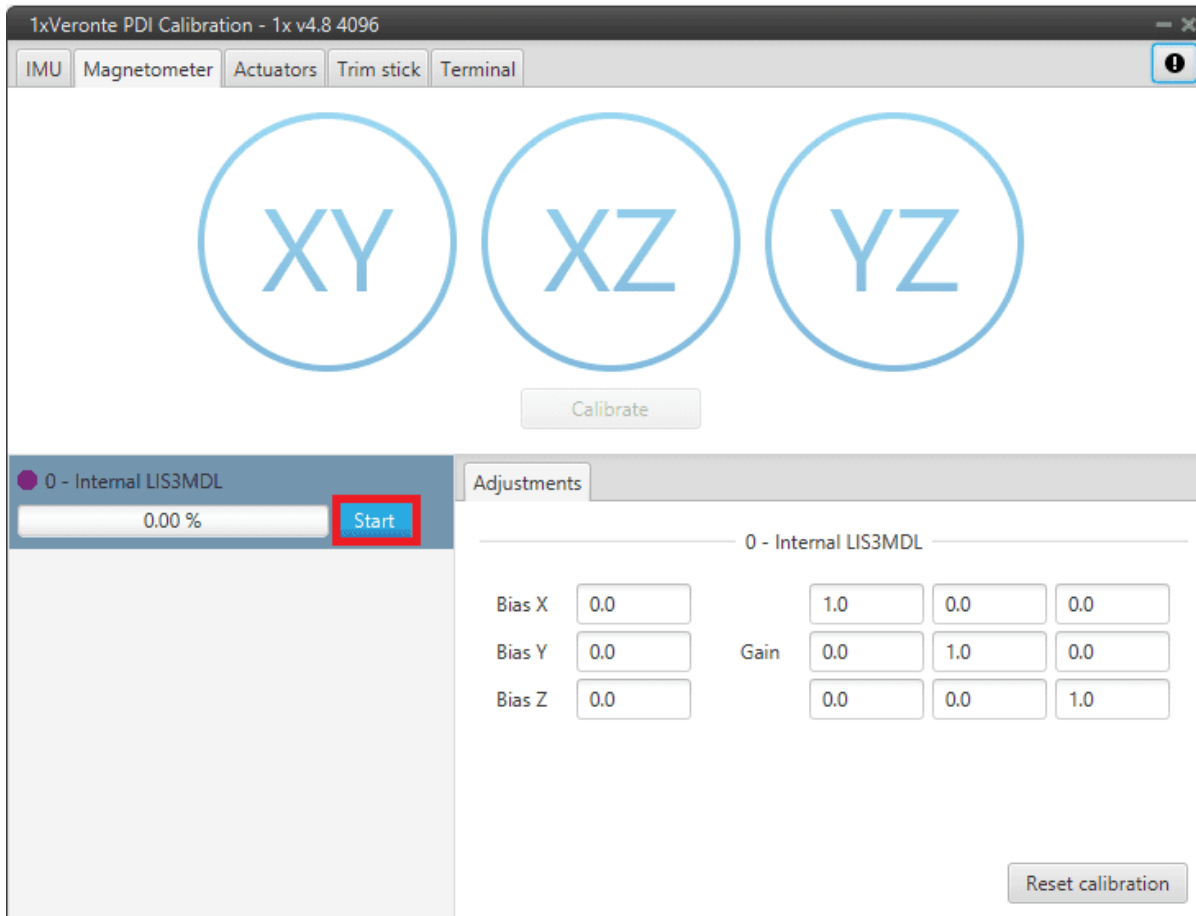


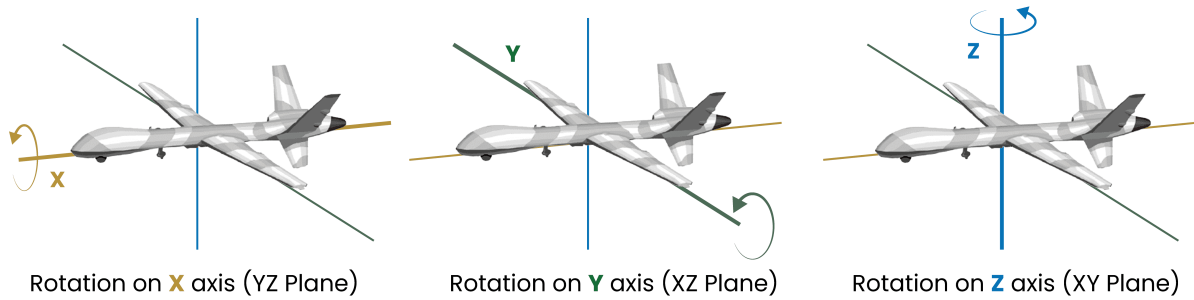
Fig. 17: Magnetometer Calibration menu

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.



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):

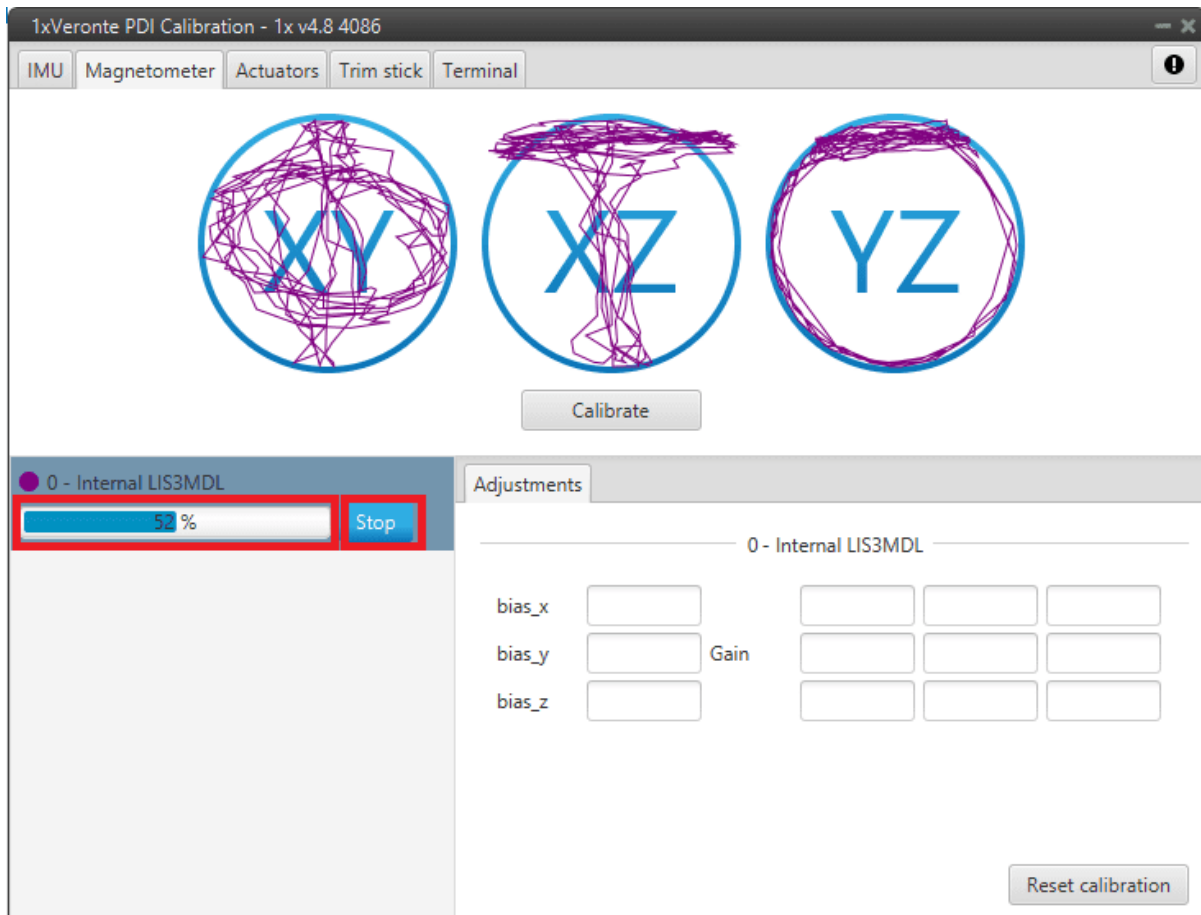


Fig. 18: Calibration process

**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:

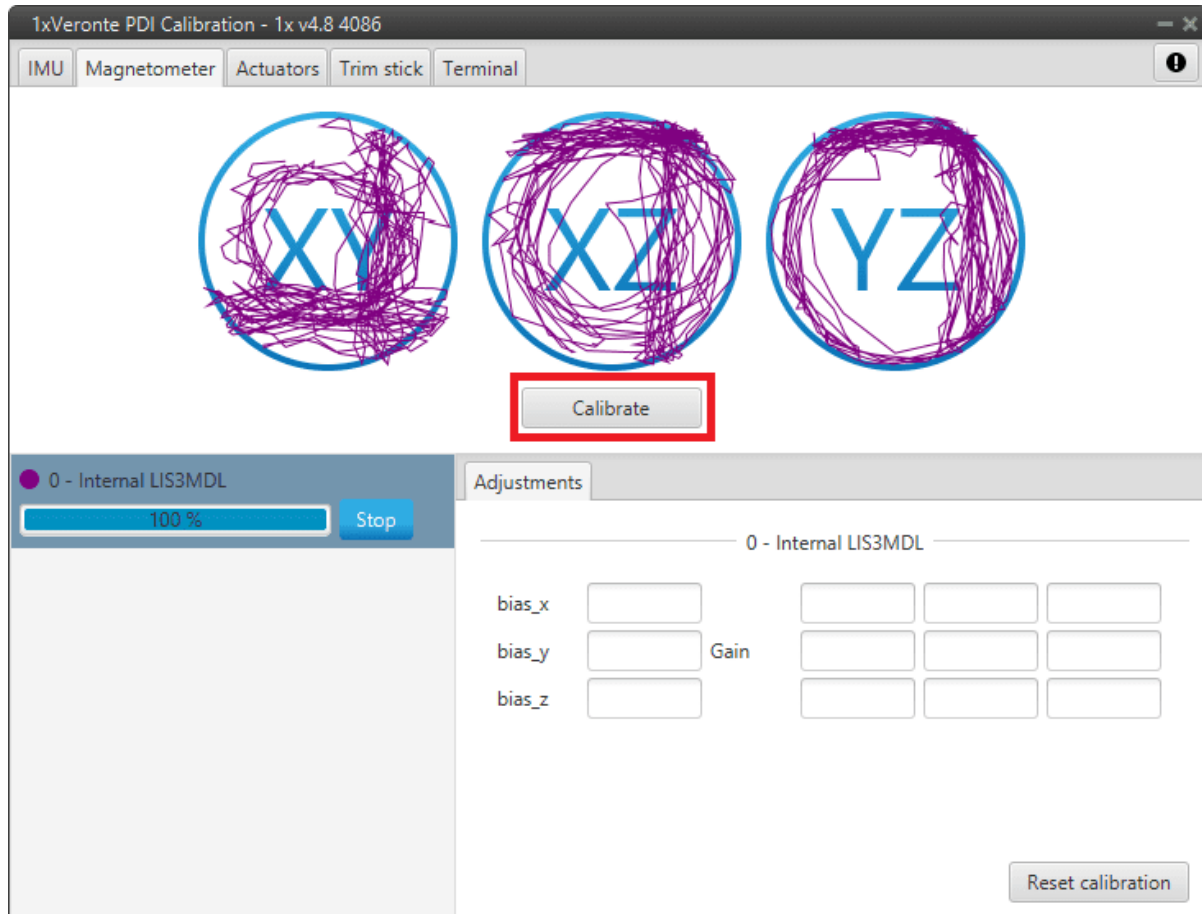


Fig. 19: Calibrate

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:

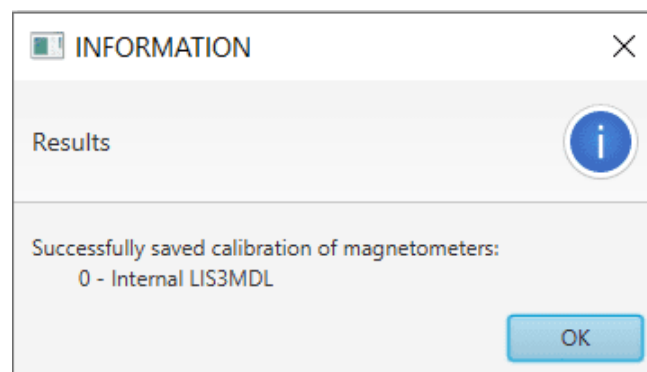


Fig. 20: Calibrate success message

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

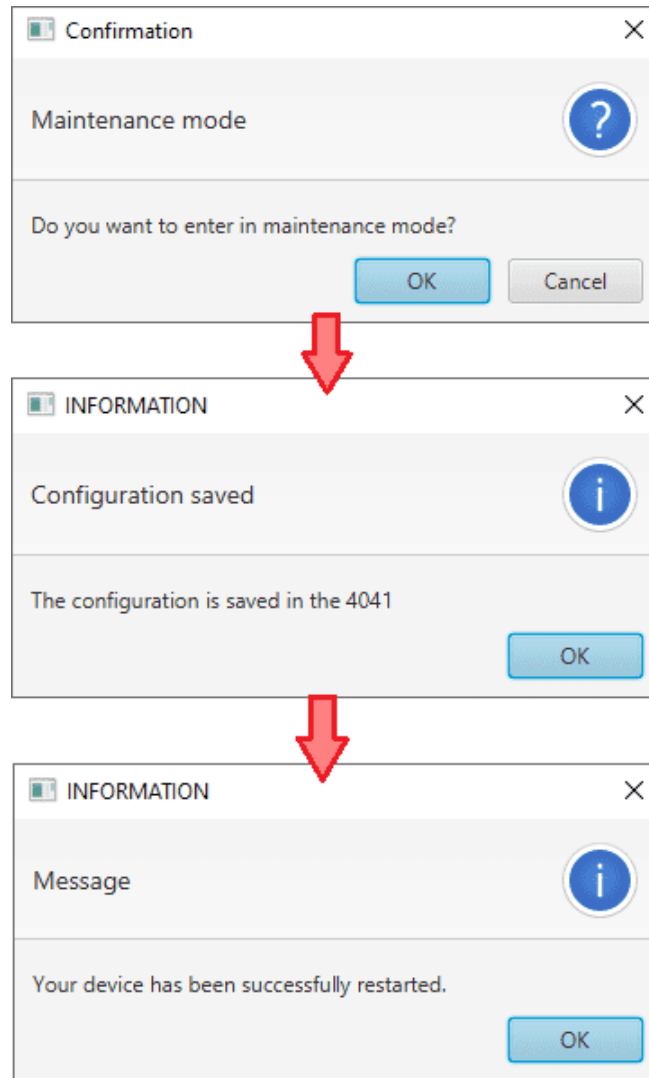


Fig. 21: Calibration success message

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.



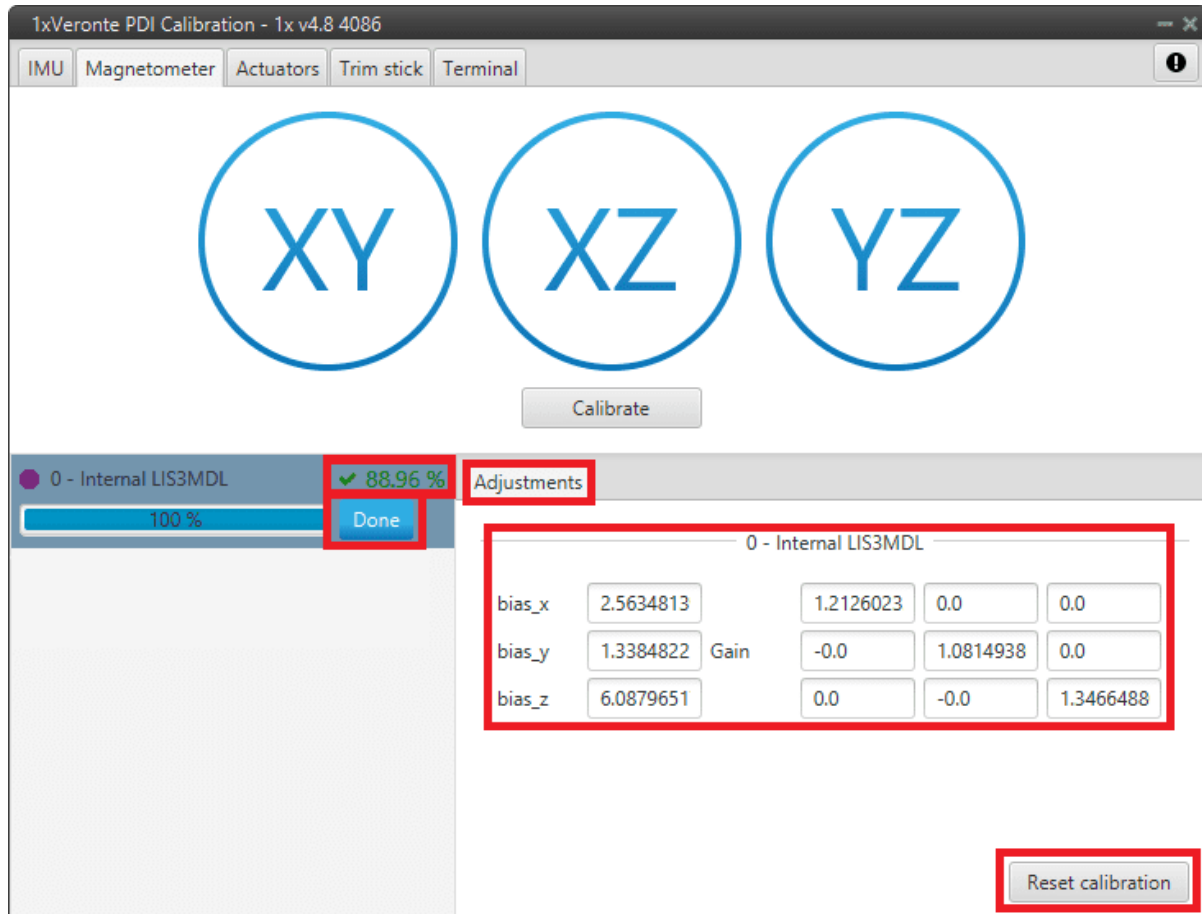


Fig. 22: Calibration done

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:

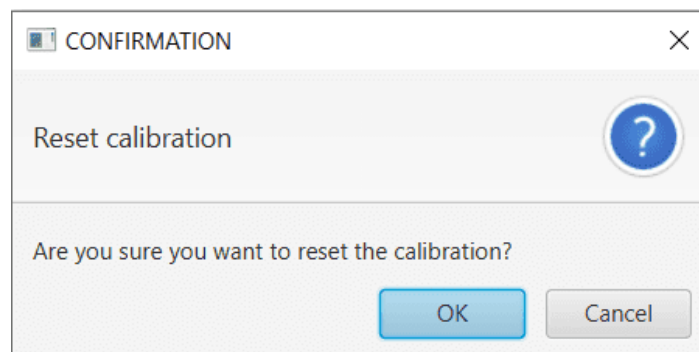


Fig. 23: Reset calibration

#### 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.

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**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.

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## 2.3 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.

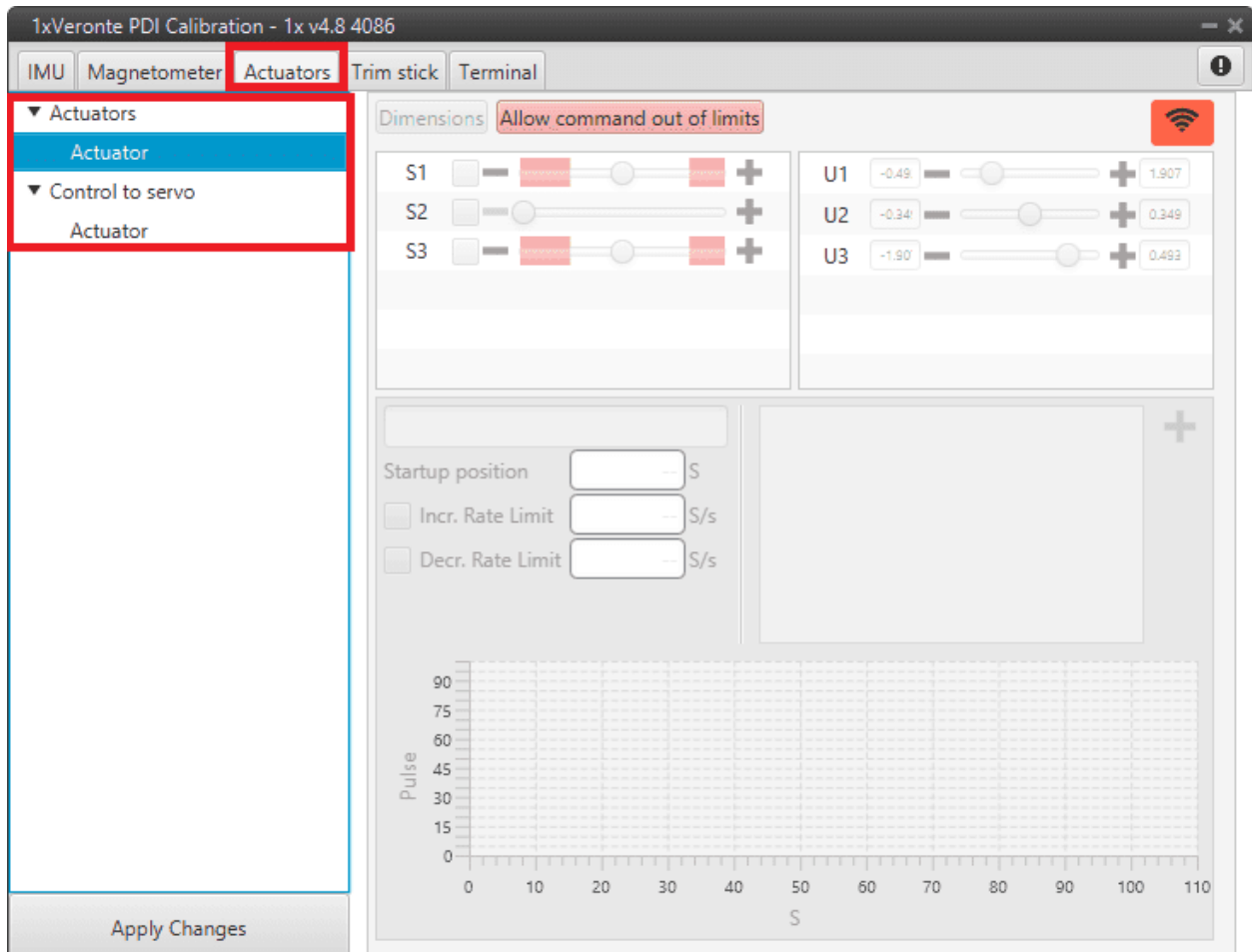


Fig. 24: Actuators Calibration menu

The options of this calibration menu are presented below:

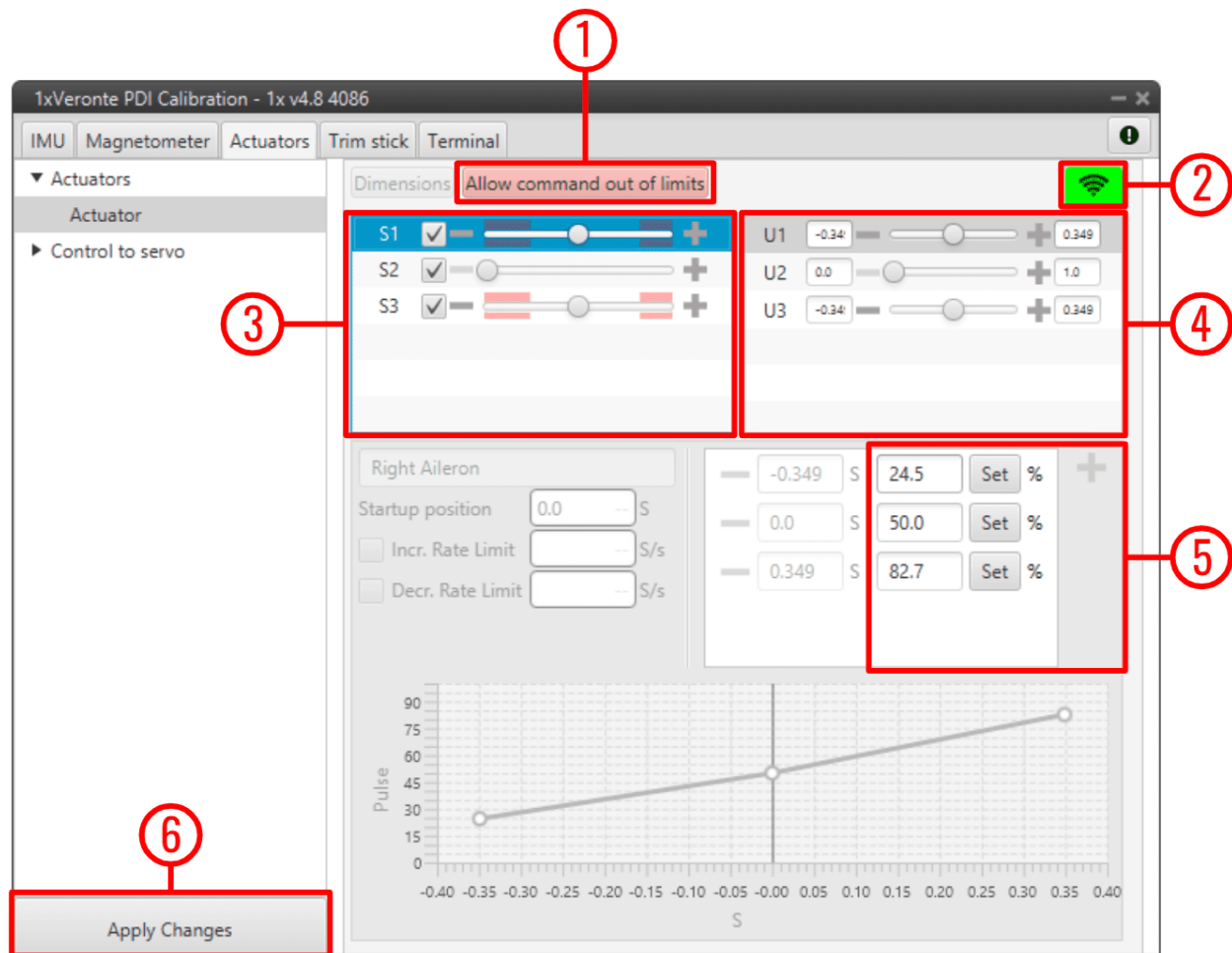


Fig. 25: Actuators Calibration parameters

**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 predetermined, 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**.

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**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**.

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For example, in the figure above, a  $20^\circ$  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:

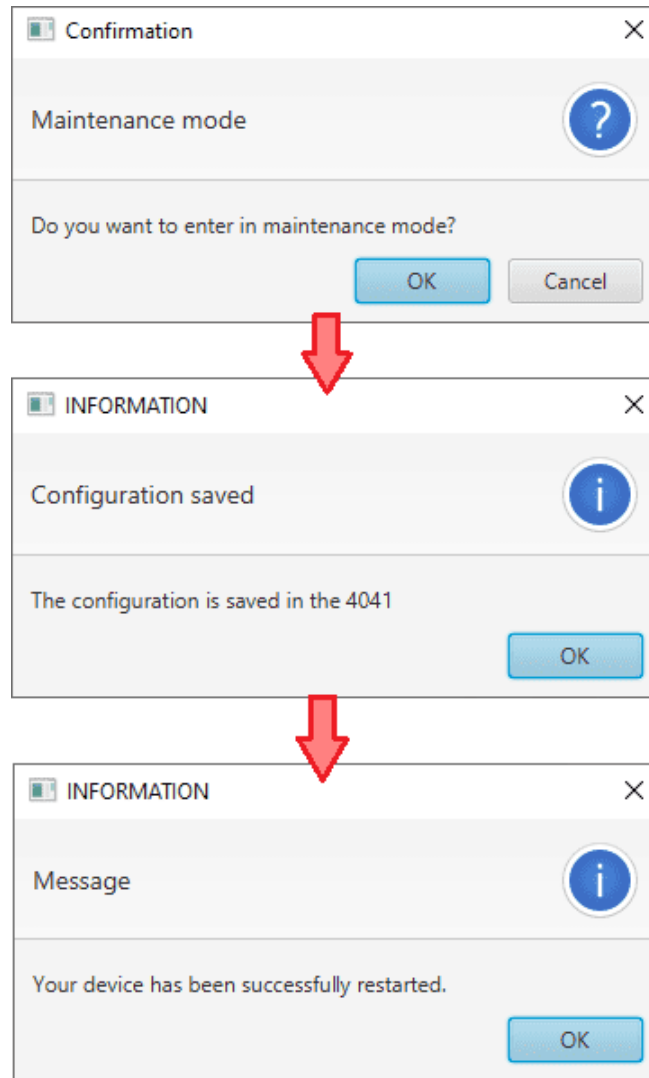


Fig. 26: Actuators Calibration - Apply Changes confirmation messages

### 2.3.1 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  $\Rightarrow$  24.5% PWM output.
- **Zero position**: 0 [rad] deflection  $\Rightarrow$  50% PWM output.
- **Maximum**: 0.349 [rad] deflection  $\Rightarrow$  82.7% PWM output.

## 2.4 Trim stick

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

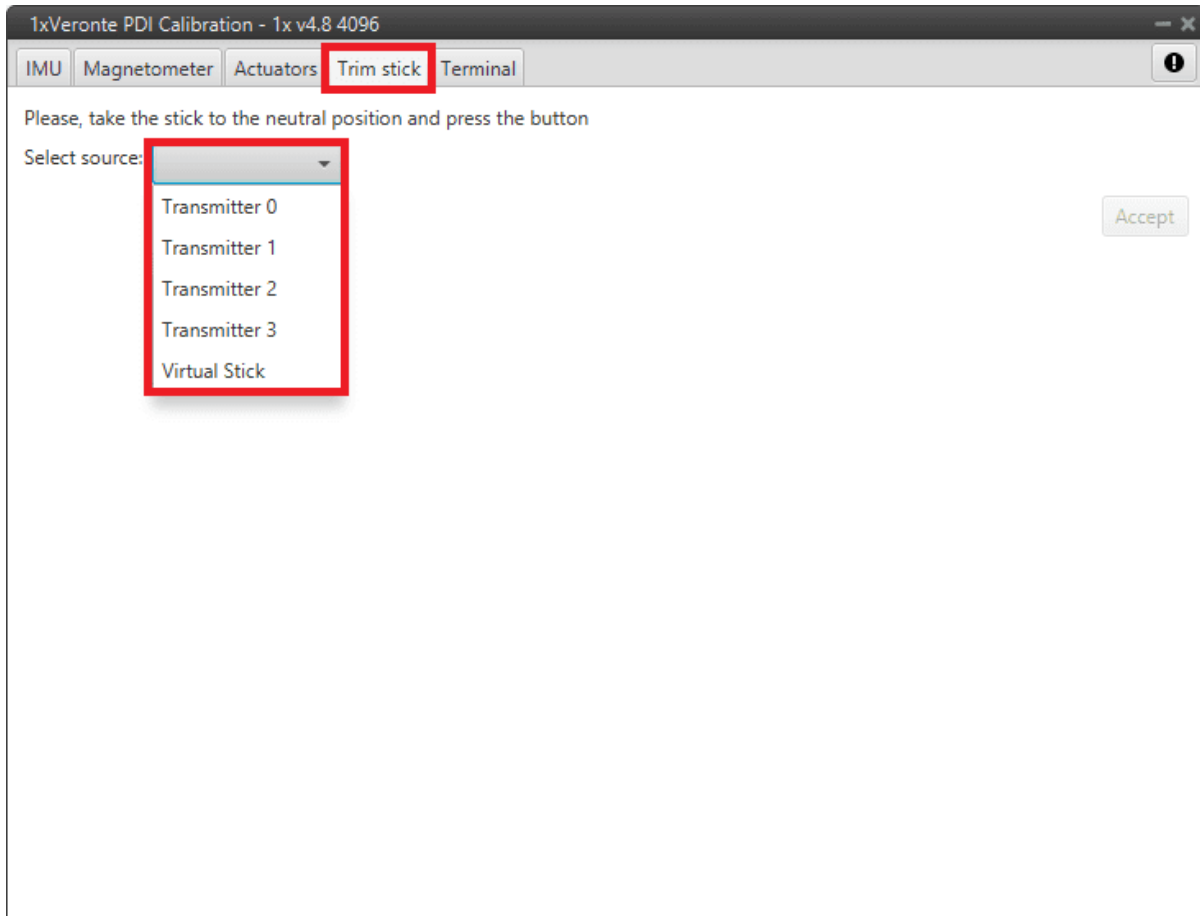


Fig. 27: **Trim Stick menu**

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

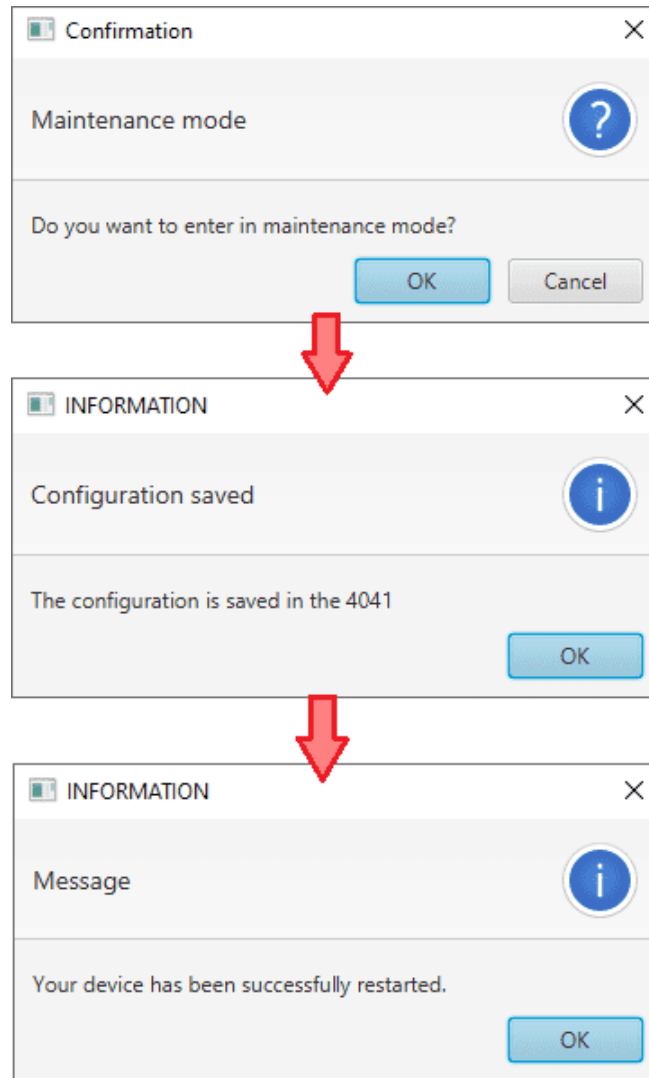


Fig. 28: Confirmation Panels

## 2.5 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.

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### 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:



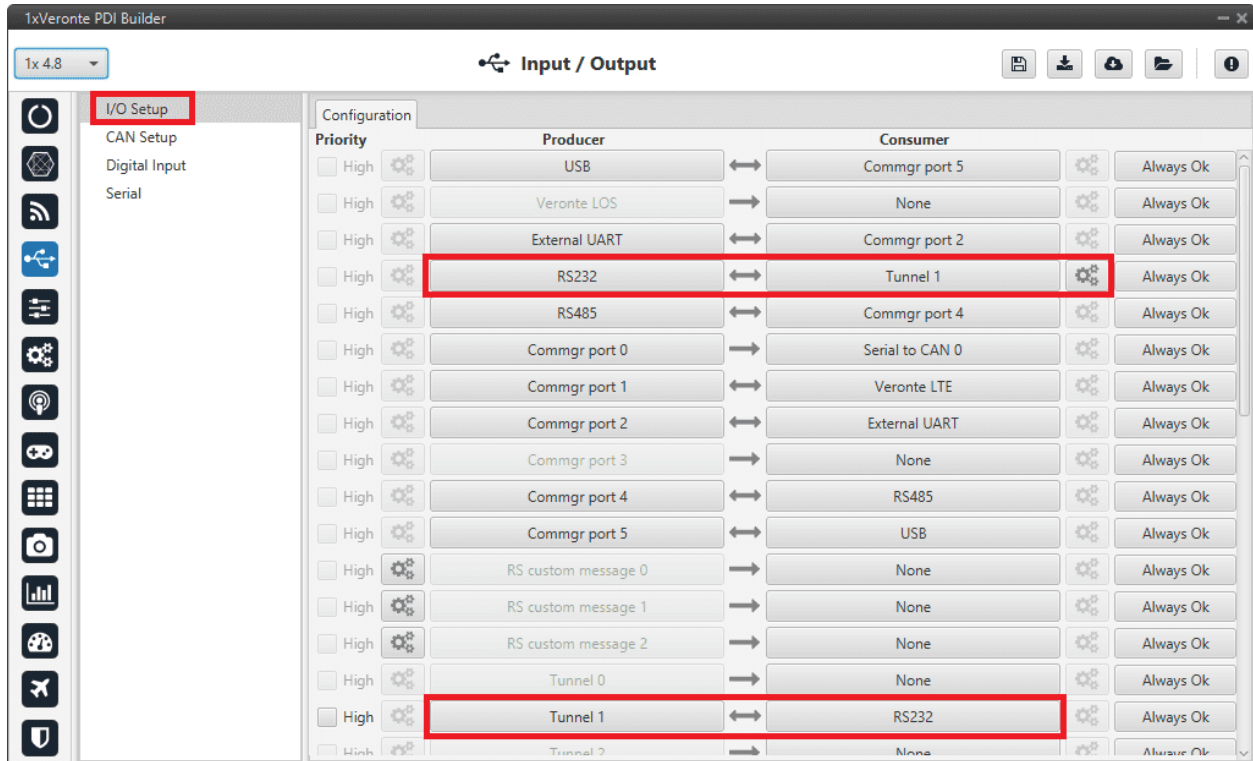


Fig. 29: 1x PDI Builder - RS232 ↔ Tunnel 1

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:

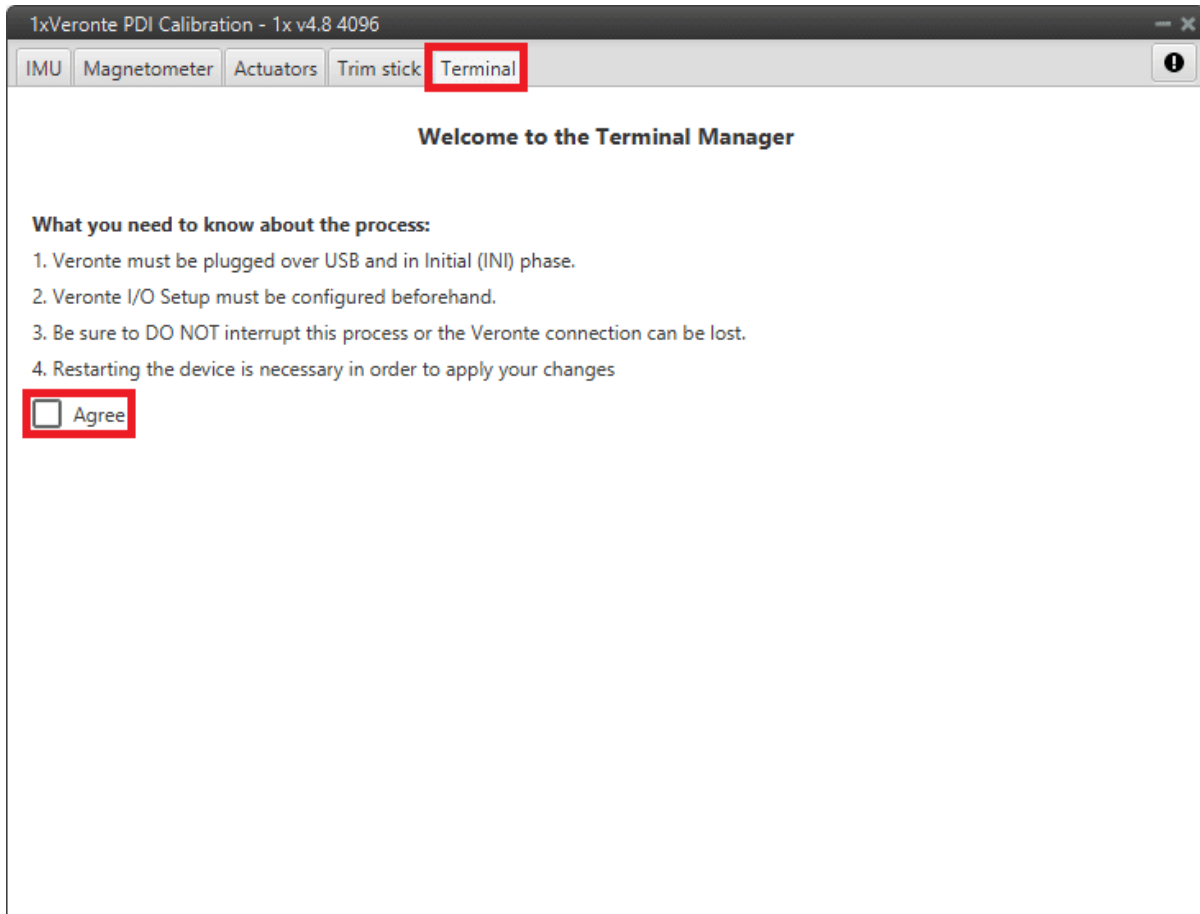


Fig. 30: Terminal Manager menu

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

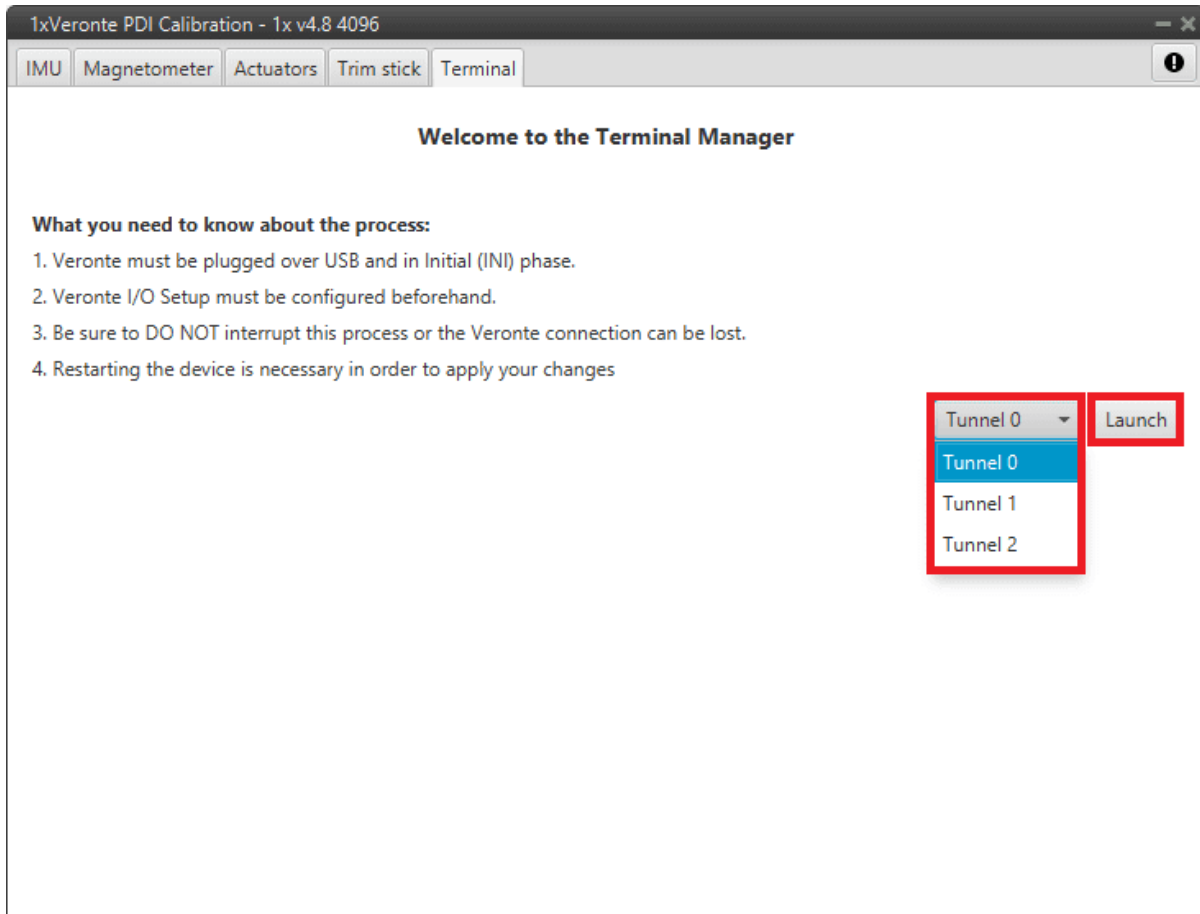


Fig. 31: Terminal Manager menu

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:

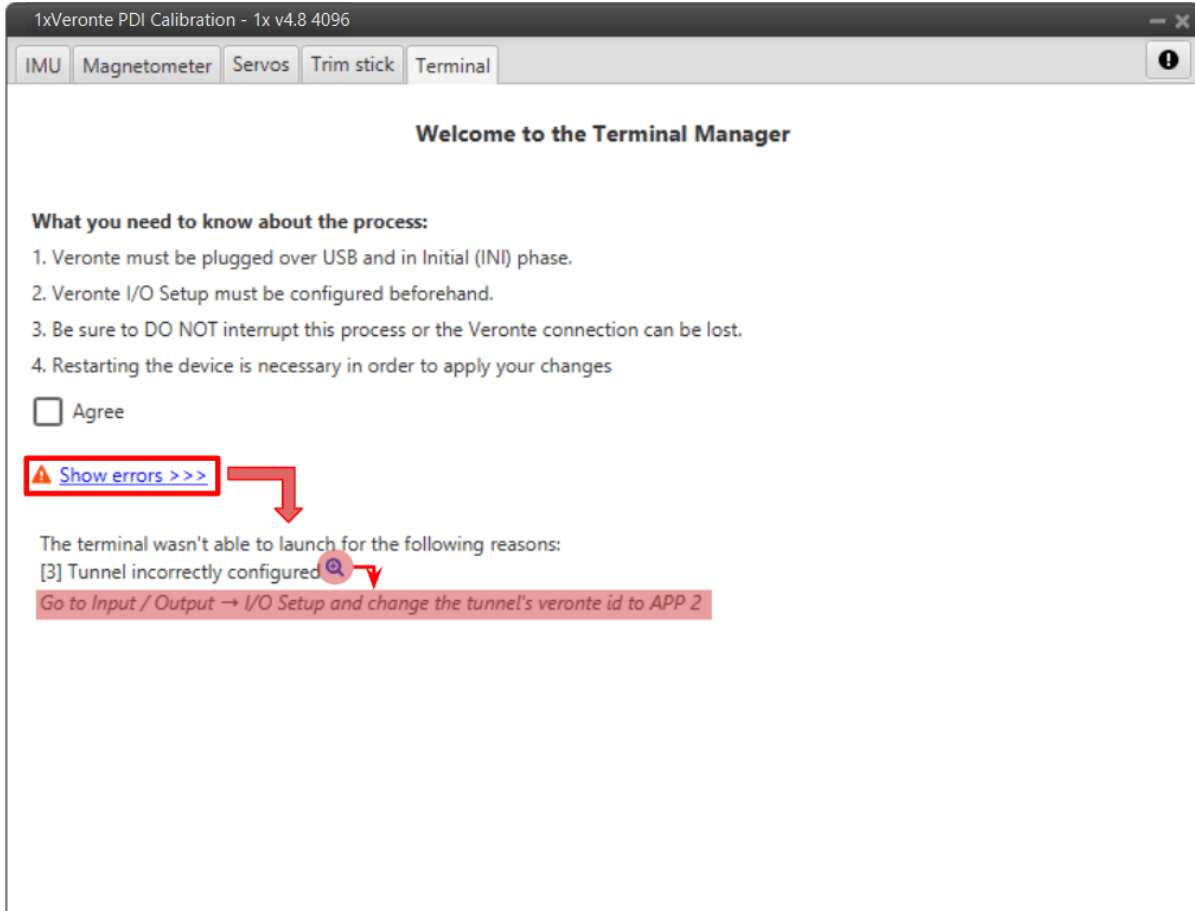


Fig. 32: Terminal - Launch failed

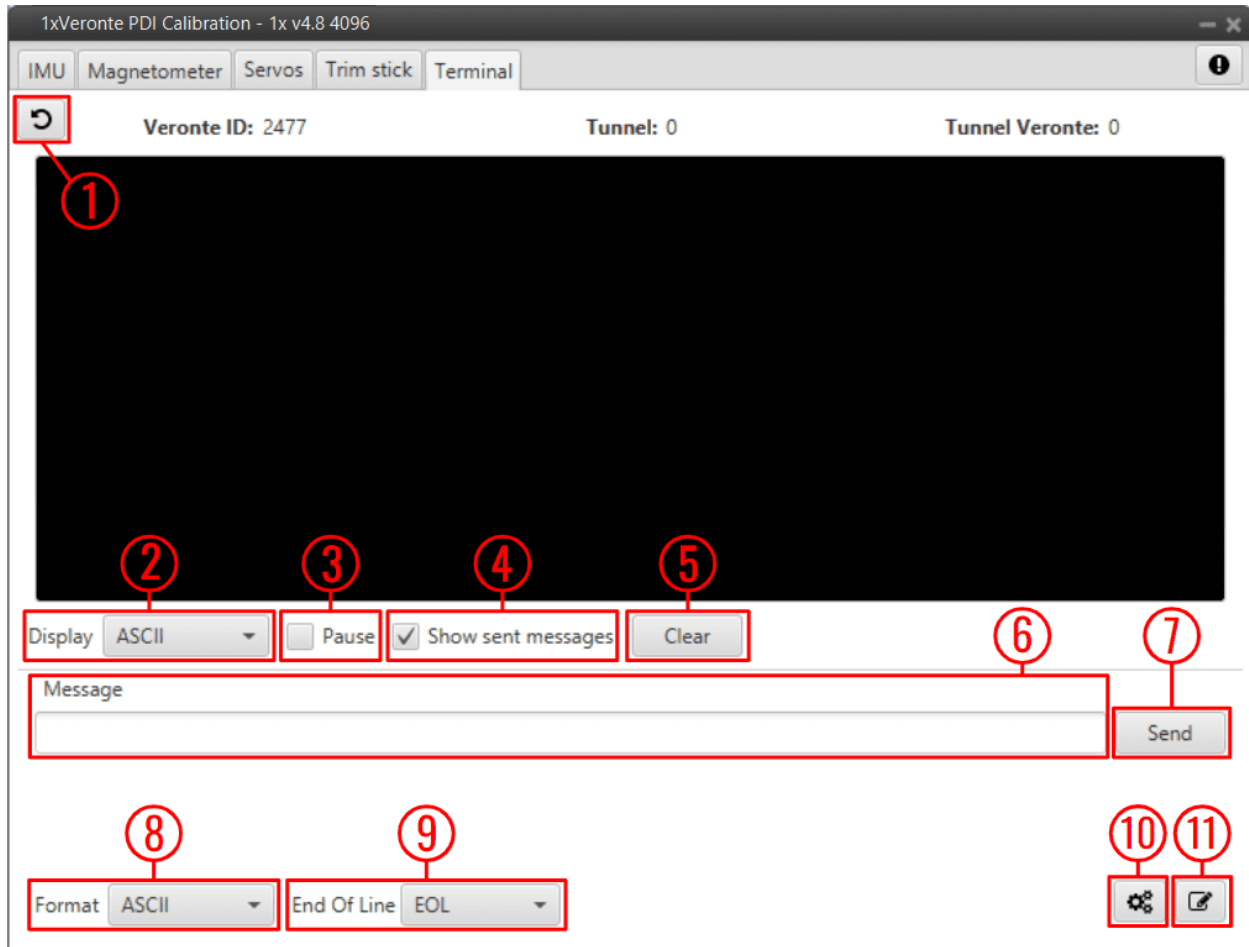


Fig. 33: Tunnel Console

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.

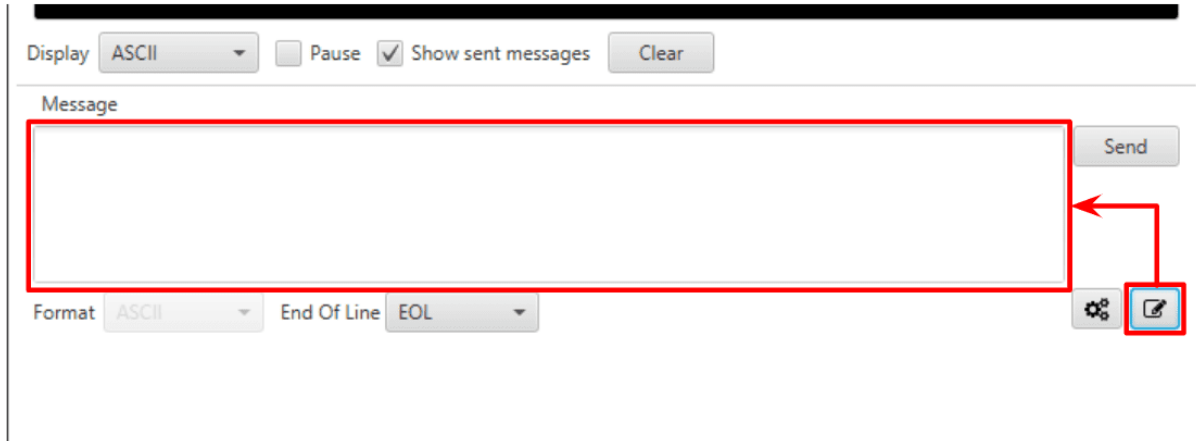



Fig. 34: Tunnel Console - Edit message

### 2.5.1 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:

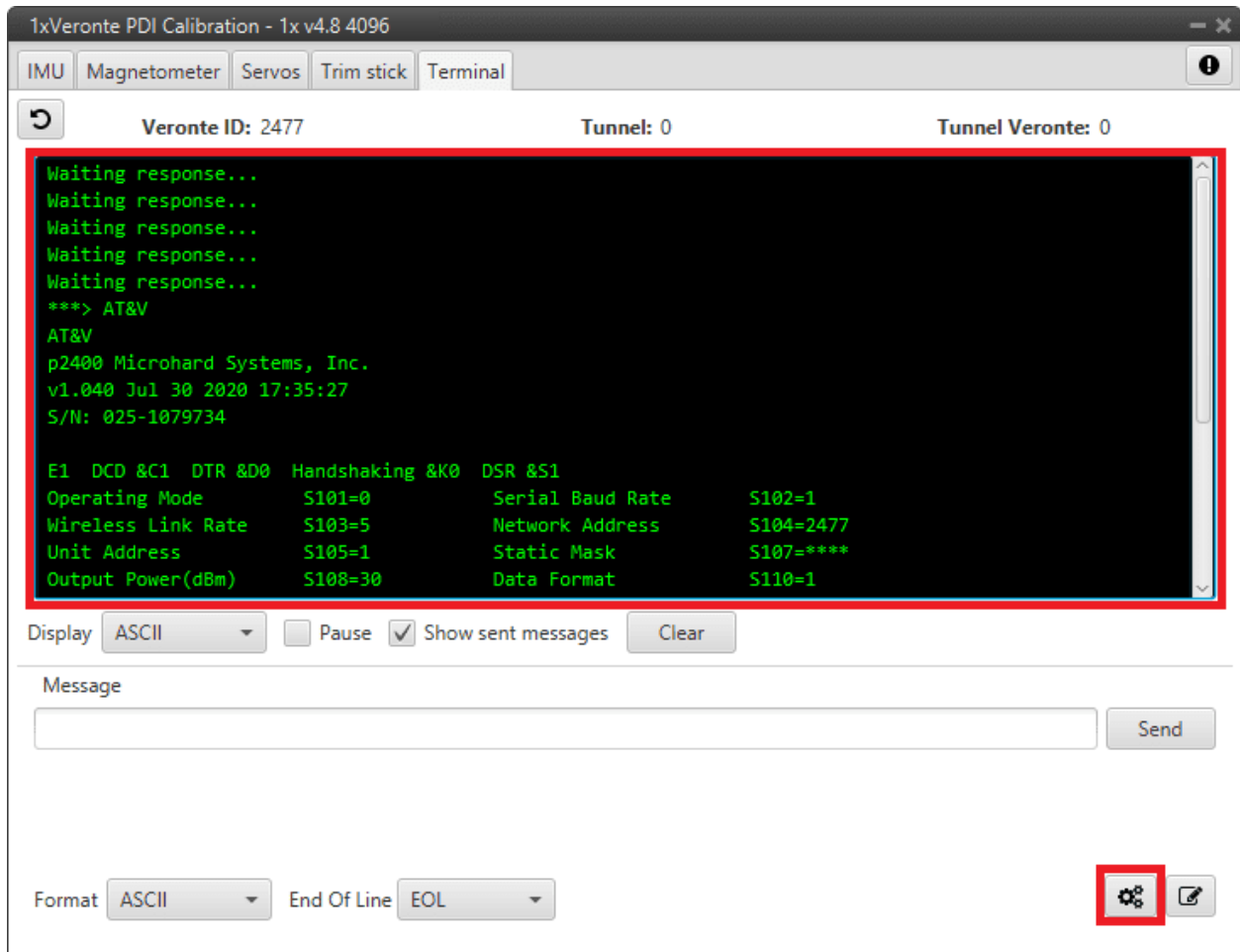


Fig. 35: Microhard Wizard - Tunnel Console

The following **Wizard menu** is displayed:

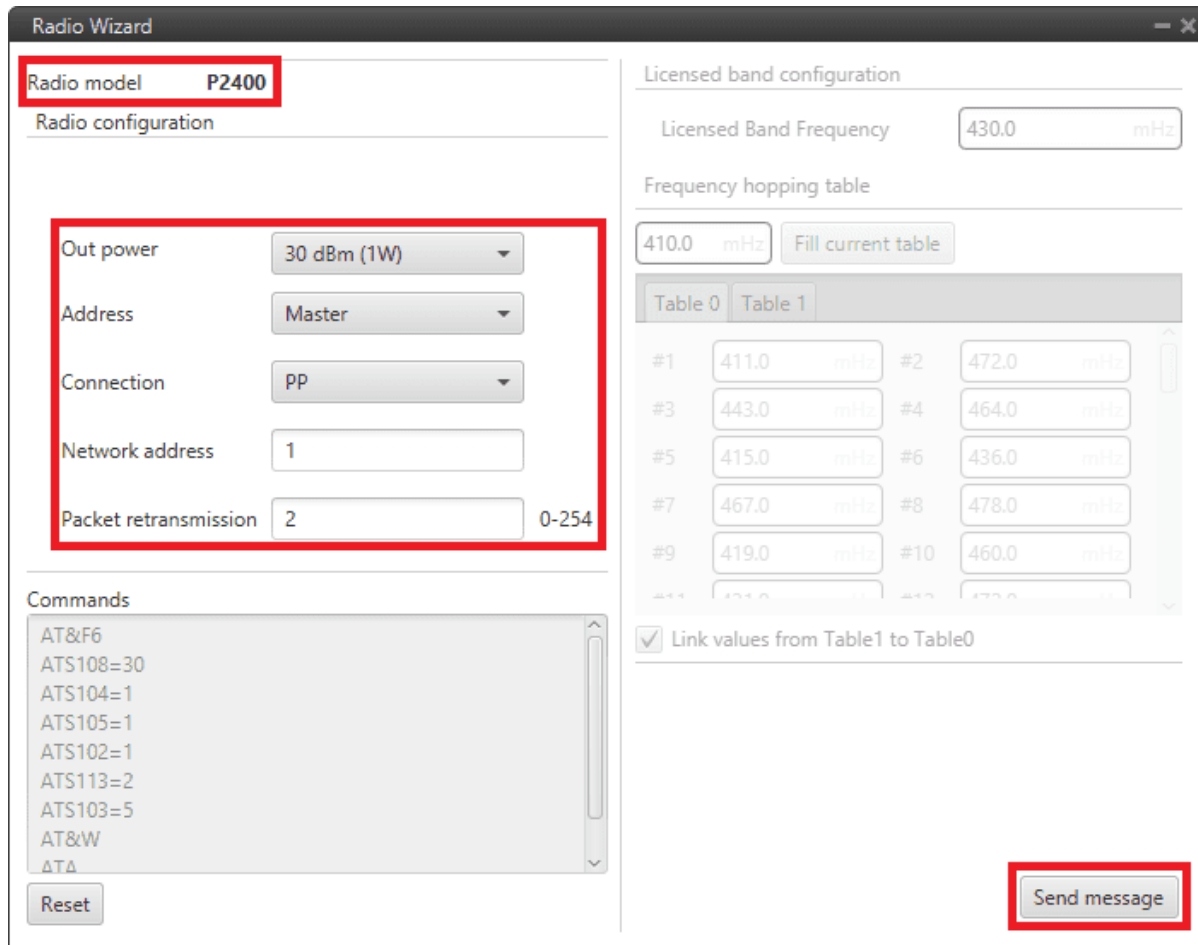


Fig. 36: Microhard Wizard menu

**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.**



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

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- **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**.

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**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:

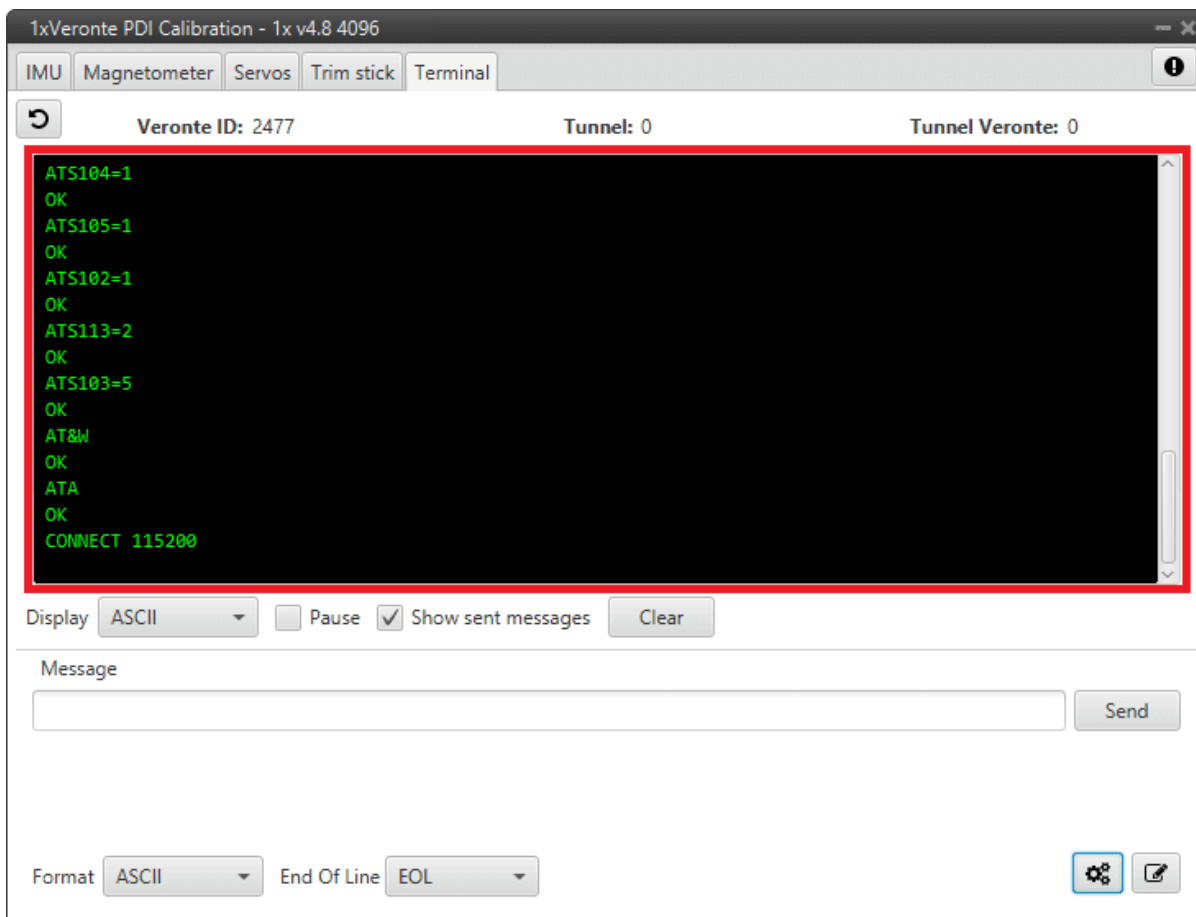


Fig. 37: Tunnel Console - Radio module configured

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

### 3.1 An instance of the selected device is already opened

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

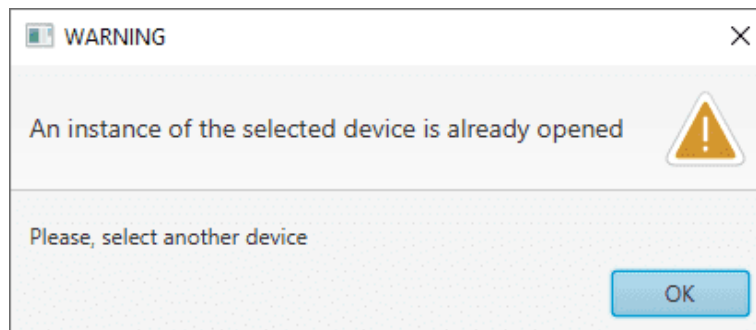


Fig. 1: **Warning: Menu is already opened**

### 3.2 Configuration Override

**1x PDI Calibration** works with a **snapshot** of the current Autopilot 1x configuration (taken when the user clicks *Open Menu* in the first panel). This implies that, if the calibration configurables are modified from another tool while using **1x PDI Calibration**, these changes would be applied on the Autopilot 1x but disregarded in the snapshot. Consequently, those modifications would be overwritten when trying to save the calibration in **1x PDI Calibration**. The user should ensure there is no data loss to continue and accept the confirmation panel below.

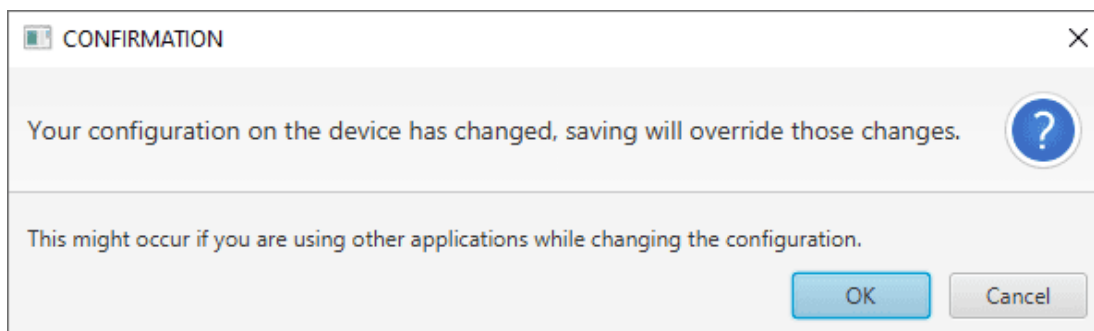


Fig. 2: **Confirmation: Configuration Override**

### 3.3 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.

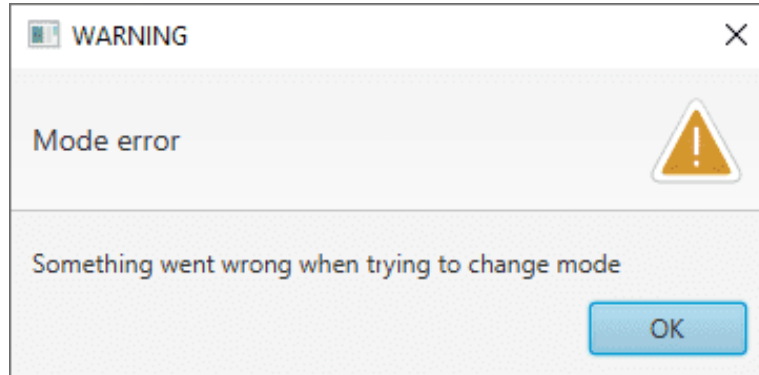


Fig. 3: **Warning: Mode error**

### 3.4 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:

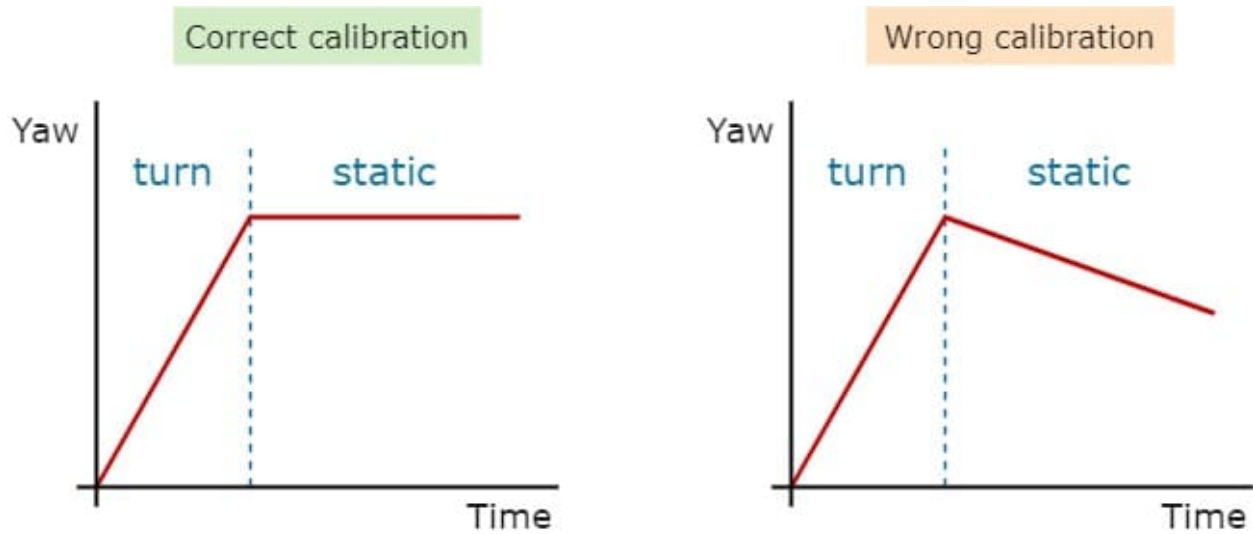


Fig. 4: Yaw behavior graph

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.

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**Hint:** **90° rotations** are recommended. A deviation of  $\pm 6$  is acceptable.

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### 3.5 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**.

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

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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.

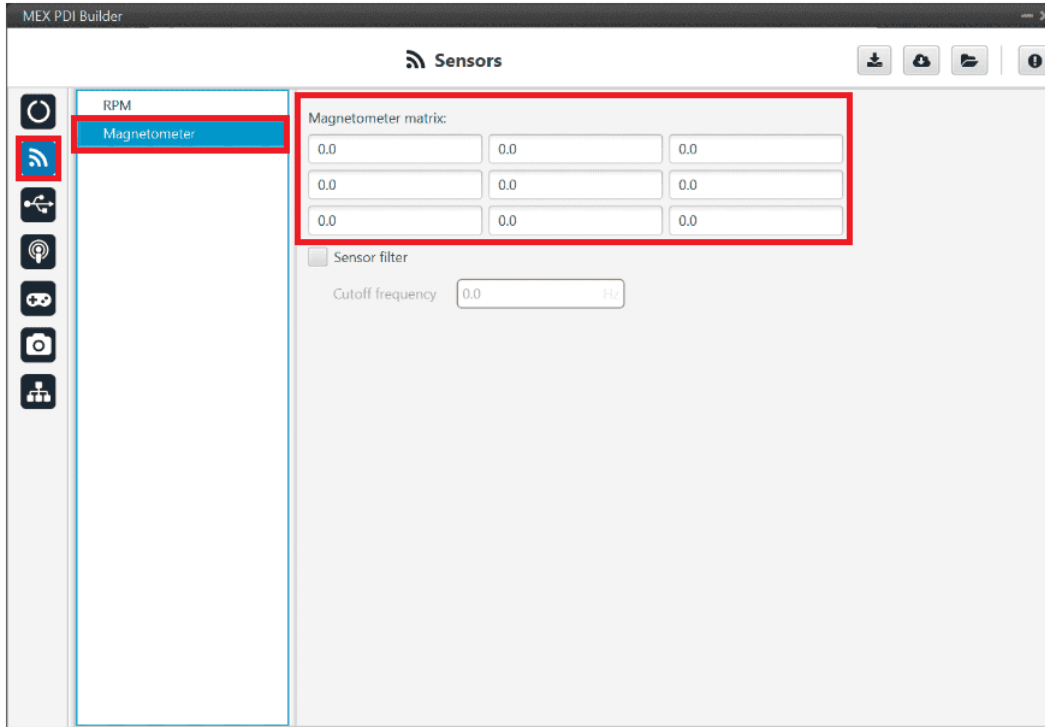


Fig. 5: MEX PDI Builder - Invalid magnetometer rotation matrix

### 3.6 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 must be plugged over USB and in Initial (INI) phase.
2. Veronte 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.

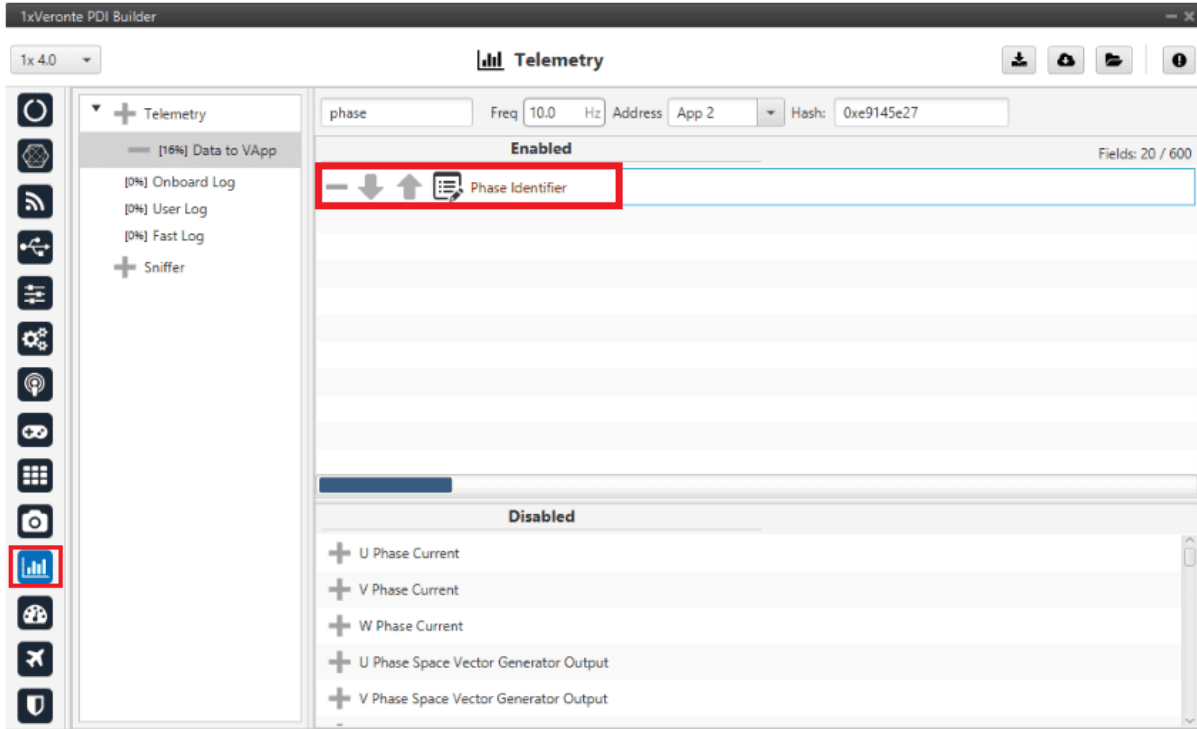


Fig. 6: 1x PDI Builder: Telemetry

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.6.12.58) and the current one (v.6.12.60).

### 4.1 Improved

- Compatibility with **Autopilots 1x** that include an internal transponder; i.e. (variants **With Remote ID** and **With ADS-B**).