# Veronte Autopilot (Up to HW 4.5 / SW 6.4) Release 6.4.68

Embention

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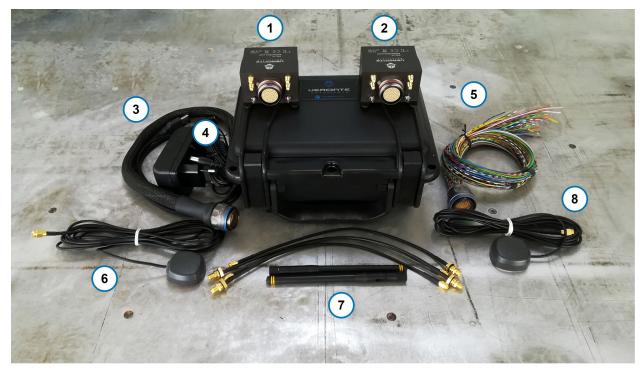
## CHAPTER

## ONE

## **QUICK START**

## 1.1 First Steps

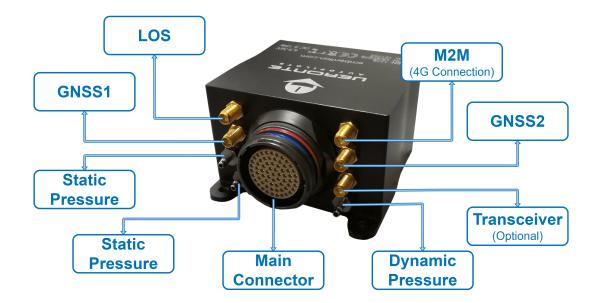
This section provides basic information of the connections of the autopilot and how to have it ready-to-use connected to the provided software **Veronte Pipe**.

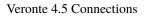


Autopilot Kit

## 1.1.1 Kit Elements

- 1. Veronte Autopilot
- 2. Veronte Autopilot
- 3. Autopilot Harness CS, including USB & Joystick connectors and 50cm wire leads
- 4. 12V Power Supply (European plug)
- 5. Autopilot Harness including 50cm wire leads
- 6. GNSS Antenna (Standard, SSMA Male connector)
- 7. 2x LOS Antenna SMA Male connector + SMA/SSMA adapters
- 8. GNSS Antenna (Standard, SSMA Male connector)





For more information about the autopilot's hardware (vibration isolation, orientation and location on the platform, pressure lines, etc) check *Hardware Installation*.

## 1.1.2 Veronte Pipe

Once the Veronte is delivered, a shared folder between the Customer and Embention is automatically created. The user will receive an email from the Support Team containing the information needed to access. If the email is not received within 72h, please contact with support@embention.com and our Support Team will be happy to help you.

		) this site is not private rname		
	Products Services Projec	FTP Access		
FILES Update 538.8.update Veronte Pipe Veronte Pipe_x64-vr538.16.exe				
	Autopilots - Veronte - NM&-UAS/F Privacy - Work with us Email Subcor	Alicante (Spain)   +34 965 115 421	8)	

### FTP folder content

The shared folder contains the last version of Veronte Pipe and firmware. Please, download and install the executable file provided. Veronte units are normally shipped with the last version of firmware.

🗢 Setup - VerontePipe — 🗆 🗙	n
Select Destination Location Where should VerontePipe be installed?	
Setup will install VerontePipe into the following folder.	
To continue, dick Next. If you would like to select a different folder, dick Browse. C:\Program Files (x86)\Embention\VerontePipe Browse	
At least 504,7 MB of free disk space is required.	
< Back Next > Cancel	

#### Pipe Installation

For more information about Veronte Pipe intallation process, system requirements and OS, please check the *Pipe Configuration* section.

Once Veronte Pipe is installed it is necessary to configure the connection to the autopilot.

Click on Main Menu and then select Preferences in the pull-down menu. Now click on Add -> Serial COM. If only one unit is connected to the computer via USB, only one COM port will be available.

Cloud	Preferences 🗱 🐼 🛡 🥓 🕽	۲ ۲								
Mission	TCP Server	Send telemetry								
Log	Enable	Enable								
Post Flight	Port 3	Host 127.0.0.1 Port 3000 Frequency 10.0 Hz								
License	Autodiscover COMs									
Manual										
ullet										
	Add 👻									
	Ethernet									

Connections Menu

This step is only performed once with every new unit. Once the configuration is done, the Veronte autopilot will be automatically detected by Veronte Pipe and it will show up in the right bar.

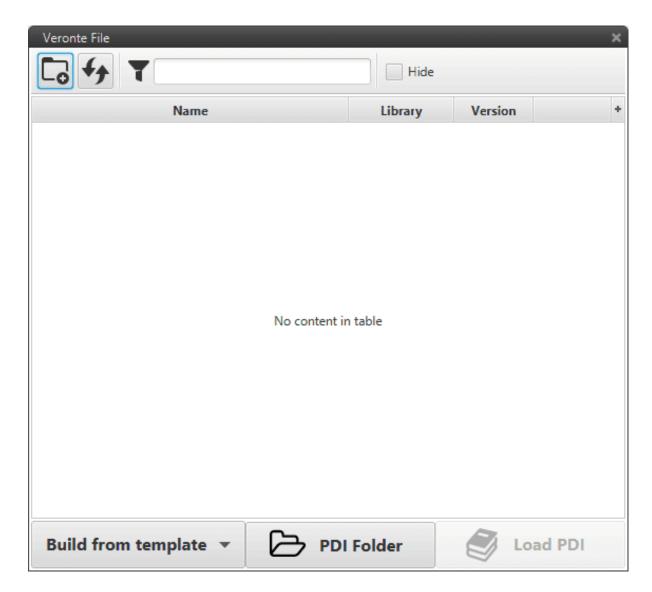
For more information about the Connection's menu check Connections.

## **1.2 Model Simulation**

This section will allow the user to load a pre-existing model/configuration to the autopilot and perform a mission simulation with the combined help of the software X-Plane. The content is organized in 3 sub-sections: how to load the template into Veronte autopilot, setting XPlane and Veronte Pipe so they can communicate, and how to run a simulation.

### 1.2.1 Loading a Template to the Autopilot

When the autopilot is connected, in the side panel click on **under the side panel click on** and then click on Import PDI.



#### Import a Configuration File

The **Import Configuration** option displays a window (shown in the previous figure) where the user can select a file to be uploaded. The option of interest for the scope of this section is **Build from template**. The software is fitted with a set of default configurations (templates) so the user can have reference of what a fixed wing, quadcopter or ground configuration should look like.

There are three other options to select a configuration file. For more information about the logical calibration of the servos check *Import Configurations*.

The configuration file is loaded in the software (Veronte Pipe), but it is not loaded on the autopilot until the Save button

B is pressed.

## 1.2.2 X-Plane and Veronte Pipe Setup

Integration of Veronte Autopilot within the X-Plane simulator enables the user to perform a Harware-In-the-Loop (HIL) simulation. HIL simulation enables testing an effective model of the vehicle by adding the complexity of the plant under control.

### 1.2.2.1 Veronte Pipe

Once a template has been loaded into the autopilot, the HIL simulation parameters need to be set. On the side panel,

click on and then click on HIL. A pop-up window will appear (see the figure below) and it has to be filled in as follows:

IP	127.0.0.1
Receive Port	49005
Send Port	49000



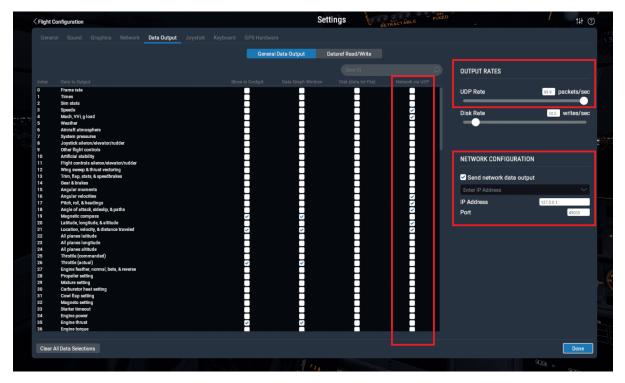
Veronte Pipe - HIL Configuration

#### 1.2.2.2 X-Plane

X-Plane 10 or 11 are compatible with Veronte Pipe to perform HIL simulations. Here, necessary settings on X-Plane 11 to communicate with Veronte Pipe are detailed. If X-Plane 10 is used, the user can check *X-Plane 10 Settings*.

On X-Plane's main menu, go to Settings and then to Data Output. Here, the data tha will be shared with Veronte Pipe is defined:

- Variables 3, 4, 16, 17, 18, 20 and 21 should be selected on the column Network via UDP.
- UDP rate should be set to its maximum value of 99 packets/sec.
- Network configuration should be set to IP Address 127.0.0.1 and Port 49005.



X-Plane 11 I/O configuration

X-Plane 11 provides a tool called Plane Maker where the user can create the platform model. Once the vehicle model has been created, it can be integrated on the X-Plane 11 simulator by following next steps:

- Copy the model folder to the Aircraft folder within the X-Plane 11 installation directory.
- Copy the content of the *Airfoils* folder available on the aircraft model folder to the *Airfoils* directory within the X-Plane 11 installation directory.

## **1.2.3 Executing a Simulation**

Before starting a simulation with one of the built-in templates of Veronte Pipe, the user needs to take into account the following:

- The missions defined on this configurations are set at Alicante's airport (LEAL), with runway 10 as the default one.
- The flight envelope and all the flight control settings and transitions are tailored for the template model. Therefore, the user might need to modify some parameters in order to have their own model flying as desired.

Let us supose the user has created a fixed wing model with a V-tail configuration on Plane Maker. Then, the most suitable template on Veronte Pipe would be Fixed Wing V-Tail:



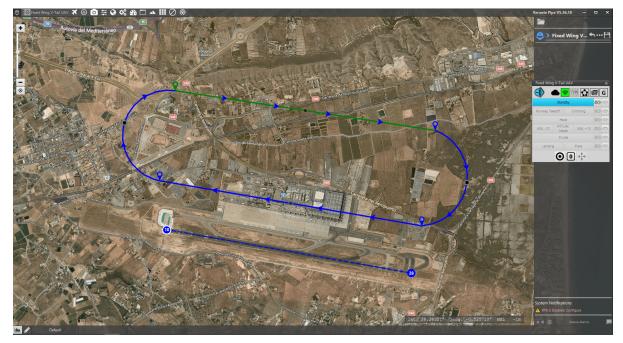
Fixed wing V-Tail template

A configuration merge and Migration windows will pop-up (see figure below). The user should accept both of them as they are. For more information on this topic go to *Import Configurations*.

Migration	x
Result of Setup migration	
Read the details of this panel for information on possible changes in the configuration	
<ul> <li>Migrating to version 5.25</li> </ul>	~
<ul> <li>Migrating to version 5.26</li> </ul>	
<ul> <li>Migrating to version 5.27</li> </ul>	
<ul> <li>Migrating to version 5.28</li> </ul>	
<ul> <li>Migrating to version 5.29</li> </ul>	
<ul> <li>Migrating to version 5.30</li> </ul>	
<ul> <li>Migrating to version 5.31</li> </ul>	
<ul> <li>Migrating to version 5.32</li> </ul>	
<ul> <li>Migrating to version 5.33</li> </ul>	
<ul> <li>Migrating to version 5.34</li> </ul>	
<ul> <li>Migrating to version 5.35</li> </ul>	
<ul> <li>Migrating to version 5.36</li> </ul>	
<ul> <li>Migrating to version 5.37</li> </ul>	
<ul> <li>Migrating to version 5.38</li> </ul>	
Migrating to version 5.38 Migrated version 5.38	~
<[	
Accept	

### Pop-up window to end the import process

The Fixed Wing V-Tail template mission should look like this:



### Template's mission

Now, the user needs to open X-Plane 11 and click on New Flight. On that menu the user will select the custom-made model and Alicante as the desired location (see the figure below):

AIRCRAFT	Al Aircraft (3)	LOCATION	Customize
All Classes V All Engine Types V All Manufacturers V All Studios V Search			
15 Results Show extra	aircraft from old versions	AIRPORT NAME Alexis creek Alfenas	ID FEATURES AL5 Grass Strip SNFE
Sikorsky S-76C 🗘		Alford A. Bratcher Alfredton Alfatver Alge Alger Houari Bournediene Algodoeira Algodoeira Algoante	SOK8     Grass Strip       NZAN     Grass Strip       BIAL     3D       SOH0     Grass Strip       DAAG     Strip       LEAL     3D
Military		Start at Runway 10	
F-4 Phantom II ↔ Lockheed SR-71 ↔ Penguin ↔ Penguin ↔ Penguin ↔		WEATHER Clea Customiz	
Seaplane		TIME OF DAY	Customize
Cessna Skyhawk (Floats) 🟠		12:13 kc 11:13 ut	
		Etas "	Start Flight

X-Plane 11: new flight

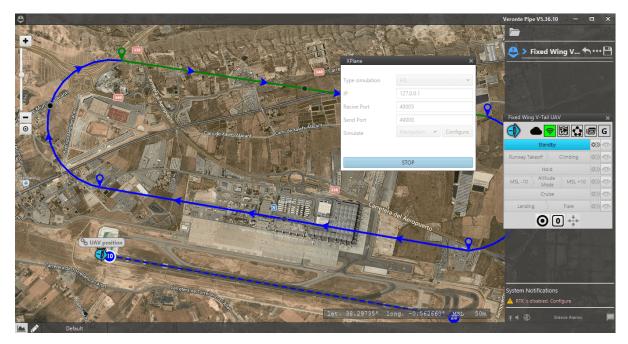
One should click on *Customize* in order to select the desired runway for take-off (see the figure below):

Alexander Fld South Wood Co Alexander Ranch Alexandra	ID FEATURES KISW 3D 5T3 Grass Strip NZLX 3D N85	
Alexandria Homestead Alexandroupolis Dimokritos Alexis creek Alfonas Alford A. Bratcher Alfratton Alfartver Alge Alger Houari Boumediene Algodoeira	199           YALX         Dirt Strip           LGAL         3D           AL5         Grass Strip           SNFE         50K8           SOK7         Grass Strip           BIAL         3D           SOH0         Grass Strip           BIAL         3D           SOH0         Grass Strip           DAAG         SIWF           Gravel Strip         EEAL	
BURWAY         BURWAY           Runway 10         3132×45 m           Runway 28         3132×45 m           Halipad H2N         25×25 m           Helipad H2N         25×25 m           Helipad H1N         25×25 m           Helipad H1N         25×25 m           Helipad H1N         25×25 m	On runway Asphalt Asphalt Concrete Concrete Concrete	Alicante 38.28°N / 0.56°W 142 ft MSL 00°W magnetic variation
Special Starts		Confirm

X-Plane 11: runway selection

After that the flight can already be started (click on *Start Flight*). The aircraft will appear at the header of runway 10 of Alicante's airport. Once that is done, connection between X-Plane 11 and Veronte Pipe can be stablished. Go to Pipe,

click on **W**, then HIL and click on Start. Autopilot must be in the initial phase. On the contrary, click on Advanced and then on Restart Veronte. If every step was correctly done, GPS is simulated (from X-Plane) and then the UAV must be visible on Veronte Pipe map.



Autopilot visible on Veronte Pipe

Now the user can pass the system to Standby phase to start the flight. To do so click on the panel and the word *Standby* will turn green. After that, click on *Runway Takeoff* and the aircraft will carry on autonomously until reaching a Cruise phase. The transition between phases is defined in the Automations menu. For more infomation regarding that subject check *Automations*.



Take-off phase

The transition from take-off phase to climbing phase happens when the Indicated Air Speed (IAS) is greater than 20 m/s. The climbing phase (see figure below) automatically traces a climbing path.



Climbing phase

But transittioning to cruise phase happens when only one condition is met: above ground level (AGL) altitude of more than 100 m.



Cruise phase

Once in cruise mode the aircraft will follow the mission displayed above in blue, being in creen the present route. Unless you define an event to motivate the entry of landing phase (a certaing flight time, a certain altitude, etc), this template does not have that part automated. Upon clicking on *Landing*, a landing path is automatically traced.



#### Landing phase

The condition to change from landing to flare phase is double: having an AGL smaller than 10 m **and** having passed by a waypoint. For more information on mission planning/design check *Mission* chapter.



#### Flare phase

After that, the aircraft will have succesfully landed and gone back to Standby phase. If the user need to adapt the flight phases to it's model, one needs to go to the **Control** menu, and then go to **Phases**. There, parameters as take-off speed, cruise speed, among others, can be modified. For more information please check *Phases* definition.

All the steps above should serve as a starting point for the user to become more acquainted with HIL simulations. With the latter he or she will improve the definition and operation of the mission and the performance and control of the

platform.

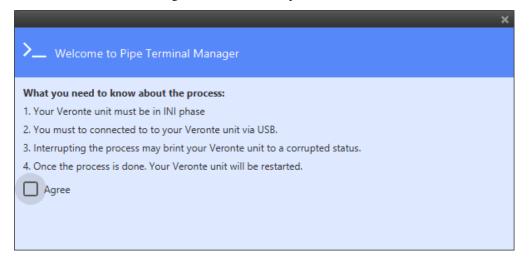
## 1.3 Radio Pairing (LOS)

This panel allows the user to easily access to the Pipe Terminal and modify the desired radio module settings. In the case of Veronte 4.0 and 4.5, they are integrated with Microhard Pico Series internal radio modules and their configuration can be modified by using the Microhard Setup Helper.

Veronte Pipe V6.2.51 -	⊂ x
😃 м400	<b>~</b>
	Setup
	Opera <sup>:</sup> on
	Export <sup>9</sup> DI
	Import PDI
	About
	HIL 🕹
Restart Veronte	Advanced
Pipe Terminal	ł
Enter maintenance mode	
Update	
SD Card	
	0

#### Veronte Pipe Terminal Setup

In order to start the configuration, the user should open the Setup by clicking on **u**, then on Advanced and finally on Pipe Terminal. After this, the following window will show up.



Veronte Pipe Terminal Manager agreement

		×
> Welcome to Pipe Terminal Manager		
What you need to know about the process:		
1. Your Veronte unit must be in INI phase		
2. You must to connected to to your Veronte unit via USB.		
3. Interrupting the process may brint your Veronte unit to a corrupted status.		
4. Once the process is done. Your Veronte unit will be restarted.		
	Veronte LOS 🔹	Launch
	Veronte LOS	
	RS232	
	RS485	

### Serial selection

Veronte Pipe is able to automatically set up the required tunnel over LOS, RS232 or RS485 depending on the user configuration and needs. In case of internal radio module configuration, the LOS option must be selected. If some external module is plugged over some external serial port, then RS232 or RS485 option must be used.

Once the process is launched, the Tunnel Console shows up.

Tunnel C	onsole							×
Veronte	ID: 1	120	Tunr	nel Pipe:	0	Tunnel	Veronte:	0
								â
								~
		Display	ASCII	•	Clear	Pause	✓ Show sen	ded Msgs
Message	2							
							ľ	O <sub>0</sub>
R								
Send	ASCII	*		End Of Line	EOL	-	Send	

#### Tunnel Console

This console allows the user to communicate with the desired device (internal LOS or external device) by configuring the listed parameters:

- Display: Data can be displayed in Ascii or Hexa format.
- Clear: Clears the last console data.
- Pause: When the data stream is running, it is possible to pause it by enable this option.
- Show sent messages: If enabled, the sent messages are shown in the console.
- Message: Message content.
- Microhard setup helper: Check the related sub-section below.
- Send: Data sent in Ascii or Hexa format.
- End Of Line: Message "End of line" configuration.
- Send: Sending button. When clicked, the current message is sent.

## 1.3.1 Microhard setup helper

The **Microhard setup helper** can be used in order to easily configure the Microhard internal modules. In order to do this, the user should click on the dedicated button and the Wizard will automatically start the radio searching.

Veronte ID:       1120       Tunnel Pipe:       0       Tunnel Veronte::       0         Waiting response       Waiting response       Waiting response       Image: Constraint of the constraint of t	Tunnel Console					×
Waiting response Waiting response Waiting response ***> AT&V AT&V p2400 Microhard Systems, Inc. v1.027 Jul 14 2017 11:56:37 S/N: 025-1026227 MAC: 00:00:00:00:00:00 E1 DCD &C1 DTR &D0 Handshaking &K0 DSR &S1 Operating Mode S101=2 Serial Baud Rate S102=1 Wireless Link Rate S103=5 Network Address S104=1 Unit Address S105=2 Static Mask S107=**** Output Power(dBm) S108=30 Data Format S110=1 Packet Retransmissions S113=2 Packet Retry Limit S213=5 Repeat Interval S115=3 Character Timeout S116=10 Roaming S118=1 RSSI from Uplink,dBm S123=N/A RSSI from Downlink,dBm S124=N/A Network Type S133=1 Destination Address S140=1 Serial Channel Mode S142=0 Protocol Type S217=0 Sync Mode S158=0 Fast Sync Timeout,hops S151=100 Address Tag S153=0 FfC Mode S158=6 Sync timeout S248=512 Compatible _21 at 345k S139=0 OK Message	Veronte ID:	1120	Tunnel Pipe:	0 <b>Tu</b>	nnel Veronte:	0
Message	Waiting resp Waiting resp Waiting resp Waiting resp Waiting resp ***> AT&V AT&V p2400 Microh v1.027 Jul 1 S/N: 025-102 MAC: 00:00:0 E1 DCD &C1 Operating Mo Wireless Lin Unit Address Output Power Packet Retra Repeat Inter Roaming RSSI from Do Destination Protocol Typ Fast Sync Ti FEC Mode Compatible _	onse onse onse onse ard System 4 2017 11: 6227 0:00:00:00 DTR &D0 de k Rate (dBm) nsmissions val wwnlink,dBm Address e meout,hops 21 at 345k	56:37 Handshaking &K0 S101=2 S103=5 S105=2 S108=30 S113=2 S115=3 S118=1 S124=N/A S140=1 S217=0 S151=100 S158=6 S139=0	Serial Baud Rate Network Address Static Mask Data Format Packet Retry Limit Character Timeout RSSI from Uplink,dB Network Type Serial Channel Mode Sync Mode Address Tag Sync timeout	S104=1 S107=**** S110=1 S213=5 S116=10 Bm S123=N/A S133=1 e S142=0 S150=0 S153=0 S248=512	
Recorte de ventana	Manage	Dispidy	ASCI			ieu misys
Recorte de ventana	message					**
Send ASCII   End Of Line EOL   Send	Recorte					w <sup>a</sup> b
	Send ASCI	•	End Of Line	EOL -	Send	

#### Terminal Console - Radio found

Once the radio is found, its model is shown in the upper-left corner of the window and the configured parameters in the console. The following Wizard menu is displayed.

Radio Wizard									×
Radio model P2400			License	ed band con	figuratio	n			
Radio configuration	Licensed Band Frequency 430.0					Hz			
			Freque	ency hoppin	g table				
Out power	30 dBm (1W) 👻								
Address	Master -								
Connection	pp 👻								
connection									
Network address	1								
Packet retransmission	2	0-254							
Commands			V Link	values fron	n Table1	to Tab	le0		
AT&F6		â							
ATS108=30									
ATS104=1									
ATS105=1									
ATS102=1 ATS113=2									
ATS103=5									
AT&W		0							
ΔΤΔ		~							
Reset							Se	end mes	sage

#### Radio Panel

These parameters have to be set accordingly to the radio module installed in Veronte.

- **Radio Module:** Each Veronte has only one of the following radio modules P400, P900 and P2400. Select here the radio module installed.
- Output power: Sets the available power output.
- Connection: Point to Point or Point Multi Point. By default all units are paired with PP connection.
- Address: Master or Slave . Select the role for each Veronte by selectig Master or Slave. By default the air unit is defined as Slave and ground units as master.
- Network address: the network address is a number that must be equal between Verontes using the same network.
- Packet retransmission: Each data pack is sent as much times as defined here.

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

The commands can be also manually sent. For advanced Microhard configuration, please check the specific radio module User Manual here.

Once the configuration is sent, the console is closed and the **Close & Restart** button appears. By clicking this button, the user can exit the configuration process and the Veronte unit is restarted. The Microhard radio module is now configured.

> Welcome to Pipe Terminal Manager
What you need to know about the process:
1. Your Veronte unit must be in INI phase
2. You must to connected to to your Veronte unit via USB.
3. Interrupting the process may brint your Veronte unit to a corrupted status.
4. Once the process is done. Your Veronte unit will be restarted.
Close & Restart Veronte LOS 🗸 Launch

Veronte Pipe Terminal closing and Veronte restart

## 1.4 Calibrating Servos

This section includes the information of how to calibrate the servos that control the attitude of the platform. Configuration of the servos includes: assignment of PWM pins to each servo, controller output to servo output relation, and trimming of the servos.

## 1.4.1 Servos Output

The first step of the process is the servos/actuators configuration. Let's consider a flying wing as our platform.

The controls in this case are the two control surfaces (elevons) and throttle. Each one of these control variables corresponds to a PWM pin of the connector and they must be positioned in the same order in an S vector representing the **Actuator/Servo Outputs**.

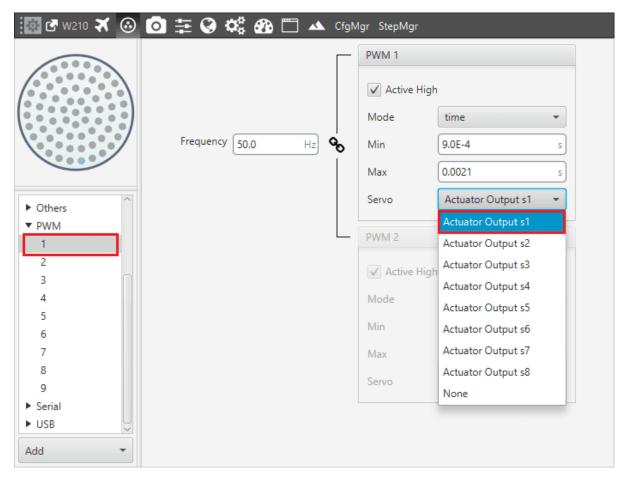
To assign the actuator outputs go the side panel , click on Setup, then go to Connections and open the PWM tab.

🔯 🛃 W210 🛪 📀	o 🏝 🛛 🗱 🚱 🗔 🔺 🖉	CfgM	gr StepMgr			
	]	-	PWM 1			
			✓ Active High	I.		
			Mode	time	-	
	Frequency 50.0 Hz	5	Min	9.0E-4	s	
			Max	0.0021	s	
► Others			Servo	Actuator Output s1	•	
▼ PWM		_	PWM 2			
2			🗸 Active High			
4			Mode		-	
5			Min	9.0E-4	s	
7			Max	0.0021	s	
8			Servo	Actuator Output s8	v	
► Serial						
► USB						
Add 👻						

Output-PWM pin links

In this case, only 3 pins are used:

- Output 1 Actuator Output s1 (Elevon 1)
- Output 2 Actuator Output s2 (Elevon 2)
- Output 3 Actuator Output s3 (Throttle)



Output 1 – PWM pin 1 configuration

### 1.4.2 SU Matrix

At this point, the **S** vector is defined and the **SU** matrix can be edited. At the Setup menu, go to Devices , then open the Actuators tab, and click on Logical. By clicking on **Edit** it is possible to configure the relation between the **Controller Outputs** (U vector) and the servo movements (**S** vector).

Vehicle name W210 If Type Type US Set inv(SU) Edit	•
SU Set inv(US) Edit	
Edit X	
Control Output u1 - Control Output u2 - Control Output u3 - Pitching Thrusting Rolling	
- Actuator Output s1 1.0 0.0 -1.0 +	
- Actuator Output s2 1.0 0.0 1.0	
- Actuator Output s3 0,0 1.0 0.0	
+	
Apply	

#### SU matrix editing

A flying wing is configured as follow:

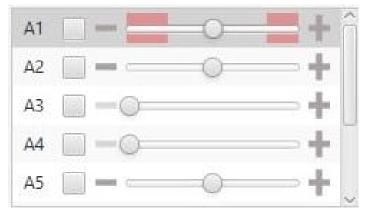
- 1. **Pitch Control:** control surfaces must be moved in the same direction to modify the pitching angle. The contribution of the actuators has same magnitude and direction.
- 2. Thrust Control: the Actuator Output 3 is the only one that allows a thrusting change.
- 3. **Roll Control:** in this case, the contribution of the actuators must be set with the same magnitude and reverse direction in order to perform a rotation around the body axis of the aircraft.

**Warning:** The panel above considers the reference system of the aircraft. It should match the Autopilot's one. In case it would not, it can be edited by clicking on the corresponding axis in order to reverse its direction.

For more information about the logical calibration of the servos check Logical.

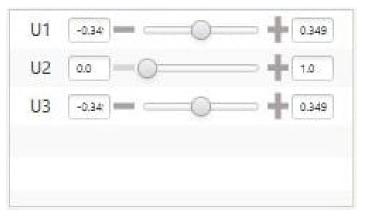
### 1.4.3 System Trim

As a final step, the system has to be trimmed. At the Setup menu, go to Devices , then open the Actuators tab, and click on Physical. The options that appear on the screen are presented as follows:



Servos Configuration Display

• Servos: this menu contains the servos of the platform. The signal to the system will only be sent if the checkbox next to the servo number (A1, A2...) is marked.



Control Signals Configuration Display

• **Control Signals:** this menu contains the variables (U vector) that represent the control signals generated by the system.



Servo PWM Configuration Display

- Servo Position PWM: this option is used to set the transformation from a control position to a PWM signal. The example above is: a 20° degrees deflection (0.349 rad) of the right elevon corresponds to an 81'5 % pulse to be sent to the corresponding servo.
- The other options that appear on the screen are:
  - To start up: set initial values.
  - To current value: set the current value.
  - Change size actuators: change the number of actuators.
  - Allow command out of limits: allow manual control over the actuators limits established.
  - Wizard: recommended on first system configuration. It guides the user for configuring actuator limits and performance.
  - Disable/Enable servos: menu for enabling servos with their limits or just to disable them.
  - Start up servo position: set the pulse value for the Start up.
  - Increasing/Decreasing Rate Limit: set a limit for increasing/decreasing value of the servo.

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

🔣 🛃 W210 🛪 🙆 💽 🗄	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
► Micro	
Sensors	
► Stick	A3 - 0 + U U3 -0.34 - 0 + 0.349
► Veronte	A4 — — — — — — — — — — — — — — — — — — —
► Others	A5 ~ ~ ~
	Actuator Output s1 PWM 1 Set -0.349 S 4.66 %
	Disable servo Set 0.0 S 46.73 %
	Start up 0.0 s Set 0.349 S 76.89 %
	Limit acceleration
	Limit deceleration
	100 85 70 55 40 25
	-0.40 -0.35 -0.30 -0.25 -0.20 -0.15 -0.10 -0.05 -0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
Add device 👻	S

#### Actuator 1 Trimming

The picture above shows the setting of the elevon number 1:

- Minimum: -0.34906 [rad] deflection; 4.66% PWM output.
- Zero position: 0.0[rad] deflection; 46.73% PWM output.
- Maximum: 0.34906 [rad] deflection; 76.89% PWM output.

**Warning:** The actuators can be moved directly from Veronte Pipe only when the system is in an Initial phase (when there is no phase selected in Veronte Panel). During the actuator run, if the desired position is in the **Out of range** zone (red zone), it is possible to click on **Allow command out of limits** in order to move completely the actuator and find the correct position.

This procedure can be performed in the same way by using the **Wizard**. This tool allows moving actuators limits easily and finding the correct range, as show below.

Trim											×
Limits											6
Actuator Output s1	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s2	- 	_			40				Q.,		in in in
Actuator Output s3	Q										
	0	10	20	30	40	50	60	70	80	90	100
Stop PWM					Cance	el	Finish		Previous		Next

#### Trim wizard tool

In order to perform a final check, it is possible to select the desired channel and test pitch, roll and thrust control.

The image below shows a pitching output testing. By moving the U1 control, surfaces must change the position according to the reference system: positive corresponds to nose down and negative to nose up.

Actuators	💿 🏗 📀 🤹 🏤 🗂 🔺 CfgMgr StepMgr To start up To current value Change size actuators Allow command out of limits Wiz
Micro     Sensors     Stick     Veronte     Others	A1 $\checkmark$
	A5         Actuator Output s2       PWM 2         Disable servo         Start up       0.0         Limit acceleration         Limit deceleration         100
Add device	-0.40 -0.35 -0.30 -0.25 -0.20 -0.15 -0.10 -0.05 -0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35

#### Pitching test

For more information about the physical calibration of the servos check *Physical*.

# **1.5 External Transmitter Configuration**

This section includes the information of how to connect an external PPM transmitter to control the platform fitted with the autopilot.

To use the joystick in the system, connect the PPMout of the trainer port to a digital input of Veronte and configure that digital input as the radio input in Pipe.

If the PPM level is 3.3V, pins 1-8, 10-17 and 55-58 pins can be used.

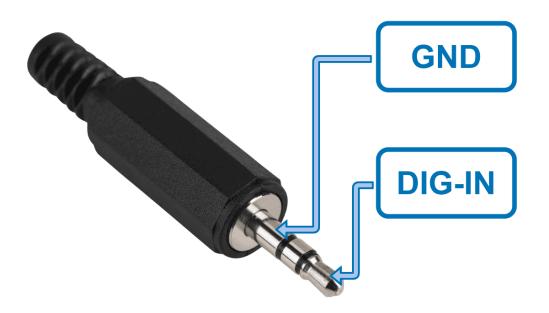
Veronte is compatible with standard Pulse Positon Modulation (PPM) signals between 8 and 16 channels.



#### Jeti DC-16 Transmitter

**Warning:** Caution!! PPM signal must be into the Veronte voltage ranges. Some joysticks may need an adaptation board, please ask our team to check compatibility.

Veronte connector for CS is provided with 3.5mm stereo plug connector as follows:



Male Jack connector (3.5mm) pinout - CS Harness

In the side panel , click on Setup, go to Devices , the open the Stick tab, and finally go to the Local sources tab. A menu opens up with 4 tabs on top: PPM, Exponential, Trim and Output.

### 1.5.1 PPM

м400 🛪 💿 🖸 🗄	🛛 📽 🏖 🗆	🔺 🏭 🖉 🖗		
Actuators	PPM Exponential	Trim Output		
Communications	Brand Futaba	▼ Model 8J/10J/	12K/14SG 👻 Char	nnels 8 👻
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Pulse polarity	Positive      Negative	Sync time	0.004 s
▼ Stick	Min pulse	2.5E-4 s	Max pulse	5.0E-4 s
Arcade trim   Local sources	Position			
Transmitter 1	Min accepted	8.0E-4 s	Max accepted	0.0022 s
Transmitter 2	Min value encoded	9.0E-4 s	Max value encoded	0.0021 s
Transmitter 3 Transmitter 4	Min channels	7	Max channels	8
Virtual Stick	Channel (DISABLE	DEnabledFilter) 1 2	3 4 5 6 7 8 9	10 11 12 13 14 15 16
Test Stick	Non linear low pas	is filter		
Stick	Min delta	0.0	Max delta	1000.0
<ul> <li>Veronte</li> <li>Others</li> </ul>	Min delta alpha	1.0	Max delta alpha	0.02
Add device 👻				

Stick Transmitter - PPM Configuration Parameters

Veronte Pipe can help the user by configuring the PPM panel in order to read the PPM output from the most famous transmitter brands:

- Brand, Model & Channels:
  - Futaba.
    - \* Model 8J/10J/12K/14SG with 8 channels.
    - \* Model 12K/14SG with 12 channels.
    - \* Model T18SZ with 8 channels.
  - Jeti.
    - $\ast\,$  DC 16 / DC 24 with 16 channels.

- FrSky.
  - \* Taranis 9XD with 8 channels.
  - \* X12S with 8 channels.

If the User's transmitter is not present in the previous table, it is also possible to configure the PPM parameters in order to match with the transmitter's PPM output.

Please check the *Stick Configuration* section for more information. In the same section, it's possible to find further information about Exponential and Trim configurations.

### 1.5.2 Output

Once the stick has been configured, the commands that arrive at the ground autopilot have to be sent to the air one.

🔯 M400 🛪 🛞 🙆 葦	🚱 🗱 🖽 🗂 🔺 🏭 ⊘ 🖗
<ul> <li>Actuators</li> </ul>	PPM Exponential Trim Output
<ul> <li>Communications</li> <li>Payload</li> </ul>	Enable Initial Channel at destination 1 Port 0
<ul> <li>Sensors</li> <li>Stick</li> </ul>	Remote UAV M400 (Vero - Min period 0.0 5 Delta 0
Arcade trim	Max period 0.0 s
<ul> <li>Local sources</li> <li>Transmitter 1</li> </ul>	Enable Initial Channel at destination 1 Port 0
Transmitter 2 Transmitter 3	
Transmitter 4	Remote UAV Min period 0.0 s Delta 0 Max period 0.0 s
Virtual Stick Test Stick	
Stick Veronte	
► Others	
Add device 👻	

#### Stick Transmitter - Output

Toggling the option *Enable*, the user indicates at which channel of the **AIR** autopilot will be sent the first channel received in the **GND** autopilot. The channels arrive at the platform by order and without spaces between them i.e, if the external transmitter is sending the **GND** the channels 1,2,3,4 and 6, then the **AIR** autopilot will arrive channels 1,2,3,4 and 5, where channel 5 of the **AIR** will actually be channel 6 of the external transmitter.

The alternate option *Remote* permits the delivery of the commands to the platform by indicating the address on UAV (when *Broadcast* is selected, the commands are sent to all the air autopilots linked to the ground one).

# 1.6 Pre-flight Checklist

This section provides the necessary information on how to implement/prepare a pre-flight checklist. The latter will be sensitive to every vehicle and its mission. It is fundamental for the user to know the set of sensors and/or events that must be evaluated before allowing the vehicle to enter a ready-to-fly phase.

However, there is a set of critical parameters that should always be on the user's checklist. There are others worthconsidering too. Both of them will be introduced hereafter with detail on the implementation in Veronte Pipe.

### 1.6.1 Main Checklist

Within the software, it is possible to define a checklist for every phase created. Such checklist can be tailored so that if one item is not satisfactorily fulfiled upon phase changing, the vehicle won't be able to swap to the desired/programmed phase.

These checklist are also helpful for the user to check relevant vairables when a phase change occurs. But for what it is concerned in this section, a checklist needs to be defined on the Precalibrate phase, i.e. the initial default phase of the autopilot.

Go to *weight*, then click on Setup. On the Setup toolbar then go to Panel *weight*. And finally click on Checklist. There the user should select the Precalibrate phase.

м400 🛪 💿 💿 葦 (	🛛 🗱 🌆 🗖 🔺 🏭 🖉 🖗	
Sort Phases	Precalibrate 👻	
Checklist	Precalibrate	Name
Confirmation Notifications	Standby	
	Hold	- 0
	VHold	Required for phase change
	Hover	Show only once
	Cruise	
	Landing	
	Ready	
	Return to Home	
	Add	

Panel Checklist - Precalibrate Phase

When creating a new element the user can select among many options: from commanding a certain action (position, yaw, etc), calibrating a sensor, to check that a variable or group of variables are within a range of values (see figure below). Then there are also the options "Required for phase change" and "Show only once", which are self-explanatory. "Required for phase change" should be selected for every item as the user does not want to start the flight without this checklist completely verified.

100 🛪 🛞 🙆 1	🗄 🚱 🗱 📾 🗖 🔺 🎞 🖉 🙊	
Sort Phases	Precalibrate -	
Checklist		Name
Confirmation	New Element	Link quality
Notifications		None 🔻 🧖
		None
		Calibrate Atmosphere
		Calibrate DEM
		Automation
		Command Position
		Command Yaw
		Enter Wind Information
		In Range Check
		Select PID
		Change active sensor
	Add	

Options for New Element

The main checklist is composed of:

• Link quality: radio connection from the GND unit to the AIR unit can be evaluated with 2 built-in variables. They measure the transmitting and receiving error rate, i.e. the percentage of messages that are not received or transmitted correctly. What is set is that this variables' values shoud not be bigger than 0.7 (option "In Range Check") and the option "Automatic Check" should be toggled so this is reviewed automatically (see the figure below).

м400	🔇 💿 🗄 🚱 📽	🍪 🗀 🔺	∎⊘®	
Sort Phase	es Precali	brate	-	
Checklist	InRangeCheck		×	
Confirma	Automatic Check			Link quality
Notificati	Variable	Min	Max	In Range Check 🔹 🥒
	TX Packet Error Rate (on boa	0.0	0.7	Required for phase change
	RX Packet Error Rate (on bo	0.0	0.7	Show only once
	< [			
	Add variable	Cancel	Accept	
		Add	Accel	
		Add		

#### Link Quality Parameters

• **GPS signal OK**: if the GPS module is not working correctly there is a boolean variable called "Position not fixed" that will be turned to 0. Therefore option "In Range Check" is selected with a value between 1 and 1, i.e. the boolean variable should be *true*. Option "Automatic Check" should also be toggled.

Phases clist	Precalibrate Link quality	•	Name
In Panga Chask	Link quality		GPS Signal OK
cati			In Range Check
Variable	Min	Мах	Required for phase change
Position not fixed	1.0	1.0	Show only once
< (			>

#### **GPS Signal Parameters**

• **Battery voltage / fuel volume**: a system variable shoud be used to monitor the voltage of the battery of the amount of fuel left on the tank of the vehicle. Then, option "In Range Check" should be selected setting the range of possible values, e.g. 21 V and 25.2 V for 6 Cell LiPo Battery. Option "Automatic Check" should also be toggled.

Sort Phase Checklist Confirmati Notificatio	15	Precalibrate Link quality	₩ Ø ® -	Name Battery voltage In Range Check -
	Variable Power Input	Min 21.0	Max           25.2	Required for phase change Show only once
	Add variable	Cancel	Accept	

Battery Voltage Parameters

• **Sensors OK**: there is a boolean variable that checks all the autopilot's avialable sensors called "Sensors Error". If any of the sensors is not working then this variable will be 0. Therefore option "In Range Check" is selected with a value between 1 and 1, i.e. the boolean variable should be *true*. Option "Automatic Check" should also be toggled.

Confirmation	Li	Precalibrate		Name Sensors OK
Notificat InRangeChec			د	In Range Check -
Va	riable	Min	Max	Required for phase change
				Show only once

Sensors Checkup Parameters

• Stick OK: there is a boolean variable that checks that there is an external transmitter connected to the GND autopilot. The latter is essential so the mission can be carried in "Manual mode" if ever necessary. The variable is called "Stick not detected" and if there's no external transmitter connected it will be 0. Therefore option "In Range Check" is selected with a value between 1 and 1, i.e. the boolean variable should be *true*. Option "Automatic Check" should also be toggled.

Checklist Confirmation Notificat InRangeCheck	Li	recalibrate ink quality	Name Stick OK In Range Check	
	iable	Min	Max	Required for phase change

**External Transmitter Parametters** 

### 1.6.2 Other Items

Other parameters worth-considering to be on the user's checklist:

- Terrain Mesh OK
- Mission OK
- Automations OK

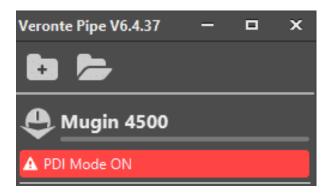
# 1.7 PDI Mode

This section will describe all the functionalities of the PDI mode. In order to access to this mode, the user should open the drop-down by clicking on the on Advanced and finllay on Enter PDI Mode as shown below.

Veronte Pipe V6	Veronte Pipe V6.4.37 — 🗆 🗙				
	<ul> <li>Mugin 4500</li> </ul>				
😃 Mugin					
	Setup				
	Operation				
	Export PDI				
	Change config				
	About				
	Import .ver				
	Export .ver				
	Refresh communica ons				
	ні. 💙				
Restart Veronte	Advanced				
Pipe Terminal					
Enter maintenance mode					
Enter PDI Mode					
Update					
SD Card					

Veronte Pipe Enter PDI Mode

After selecting PDI mode Veronte will reboot to enter this mode correctly. Once Veronte is in this mode, the following label will appear.



Veronte Pipe Inside PDI Mode

To exit this mode the user must follow the same procedure as to enter, and Veronte will have to restart.

PDI mode allow the user to change the setup if Veronte is not in INI phase (no phase in green in Veronte panel). Being normal mode, the user **cannot do** out of the INI phase:

- Reboot Veronte.
- Change Veronte setup (i.e. save to SD card).
- Enter in maintenance mode.

Warning: The following errors prevent normal mode operation:

- Memory allocation (Bit 8): Problems with memory allocation for system variables. This error occurs when initializing the system.
- PDI version not compatible (Bit 11): PDI version is higher than Veronte verion. See *Pipe Configuration*.
- System power up BIT Error (Bit 12): Check that the whole system has started correctly. This error occurs when initializing the system.
- Stack Core 1 usage FAIL (Bit 16): Memory overflow allocated for local variables of Core 1.
- Stack Core 2 usage FAIL (Bit 17): Memory overflow allocated for local variables of Core 2.
- Main Power Error (Bit 117): System power problems. The user should check that the power supply is in good condition.
- Those bits selected by the user in Setup Devices Veronte Safety Bits.

If **any** of the above bits is false, the System Error (Bit 7) will be set to false. PDI mode allows the user to operate even if there are any of the previous errors.

**Tip:** It is recommended to use normal mode when the configuration is finished, while PDI mode is useful during the development process.

This quick start guide provides the necessary information to have Veronte Autopilot set up and functional to operate its mission.



#### Veronte 4.5

This guide covers the following points:

- First steps: veronte autopilot connections and software installation.
- HIL simulation: how to perform a simulation with an existing configuration using veronte autopilot.
- Internal radio module pairing: how to pair of the ground segment (GND) and onboard (AIR) autopilots.
- **Outputs configuration:** how to calibrate the servos for a good control of the surfaces/devices that determine the attitude of the platform.
- Transmitter: how to set up an external transmitter to control the vehicle when necessary.
- **Pre-flight checklist:** set of sensors, communications, and other events that should be verified before starting the mission.

#### CHAPTER

TWO

# SYSTEM LAYOUT

# 2.1 Communication Layouts

Veronte allows for a wide variety of communication solutions in order to adapt to each mission and platform specifications

**Tip:** Most of the following communication solutions can be used independently, or in combination to create redundant systems or backup solutions.

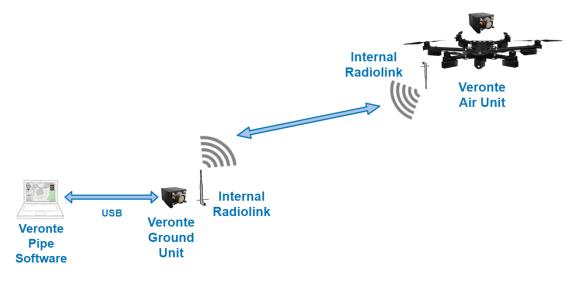
## 2.1.1 Air Segment

Communication solutions between the air and ground segments

#### 2.1.1.1 Line-of-Sight (LOS)

#### 2.1.1.1.1 Internal Radiolink

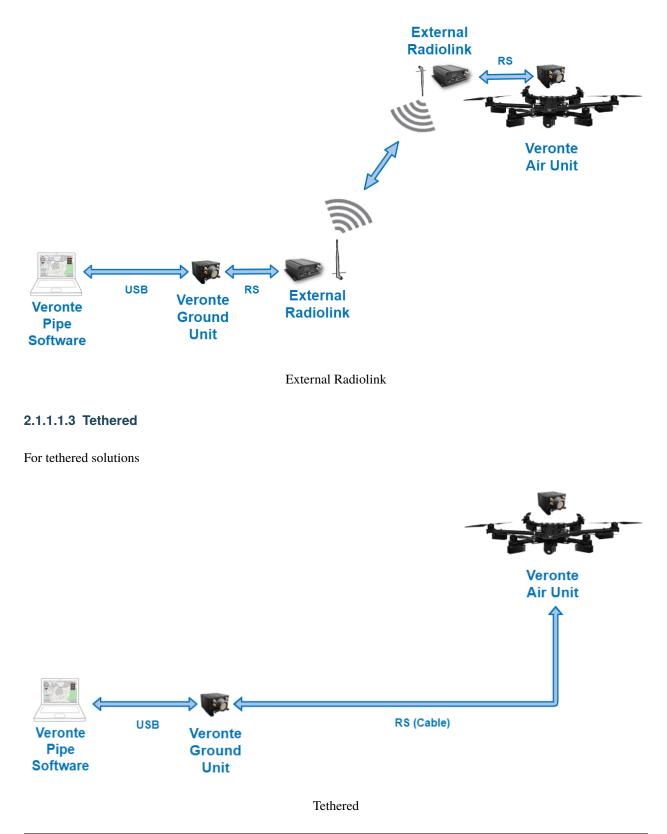
Standard setup



Internal Radiolink

#### 2.1.1.1.2 External Radiolink

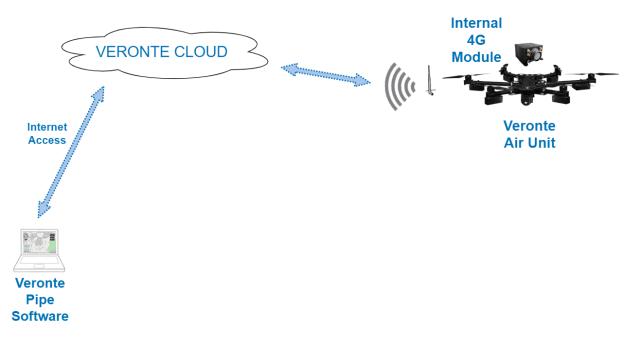
When increased range, bandwidth or channels are needed



#### 2.1.1.2 Beyond Line-of-Sight (BLOS)

#### 2.1.1.2.1 Internal 4G + Veronte Cloud

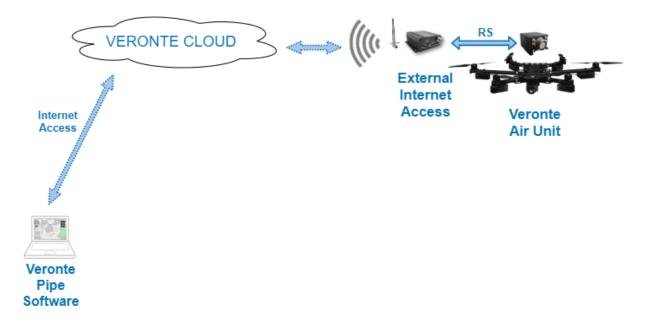
Standard BLOS



Internal 4G + Veronte Cloud

#### 2.1.1.2.2 External Internet access + Veronte Cloud

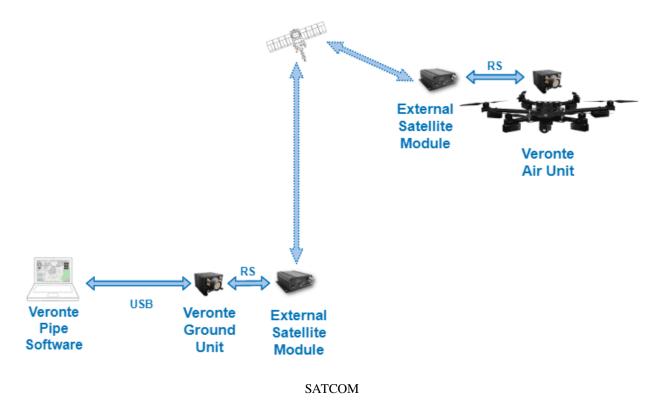
For alternative internet access



External Internet + Veronte Cloud

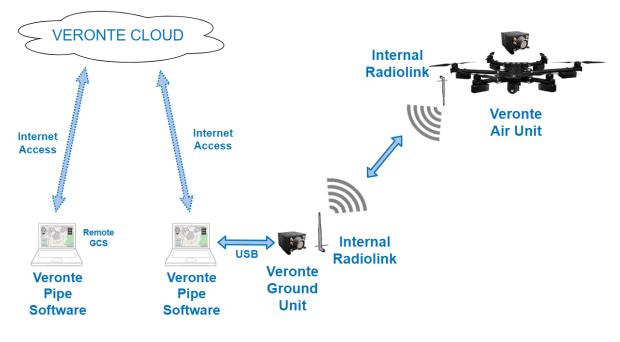
#### 2.1.1.2.3 External Satellite communication

For maximum reliability



#### 2.1.1.2.4 Remote GCS

For remote solutions with LOS backup operator



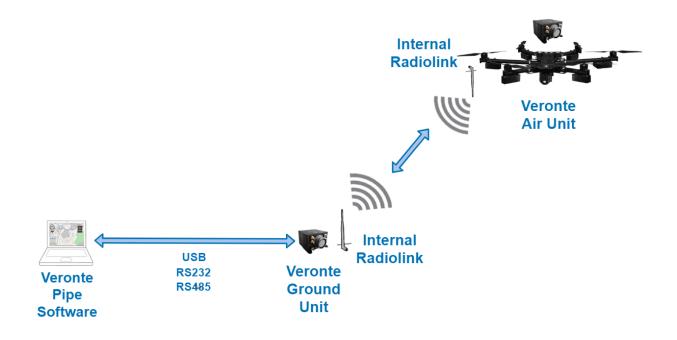
Remote GCS

### 2.1.2 Ground Segment

Comunication solutions between the different GS devices

#### 2.1.2.1 Serial Interface

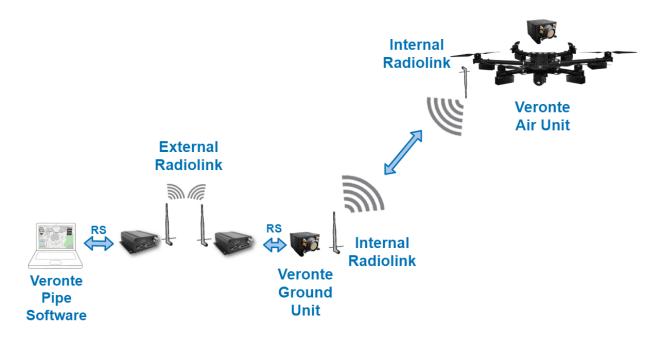
Standard setup



Serial GS

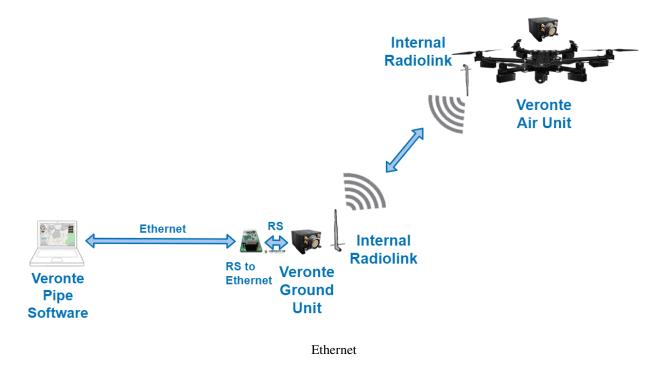
#### 2.1.2.2 External Radiolink (GS)

For modular ground stations



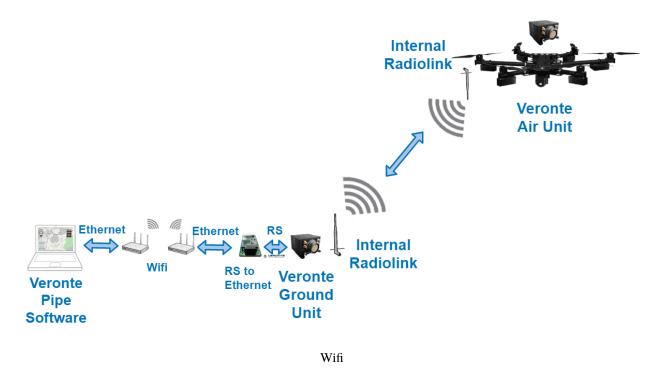
#### 2.1.2.3 Ethernet

For complex Ground stations with several online devices



#### 2.1.2.4 Wifi

For operation with laptops or tablets



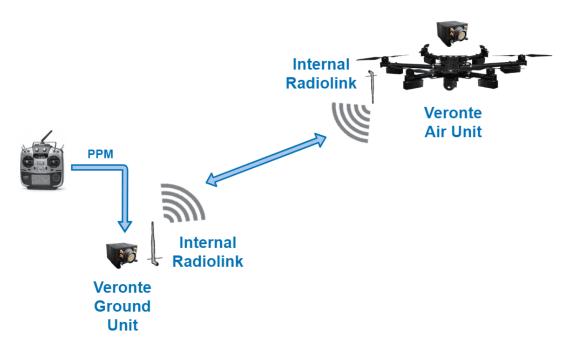
## 2.2 Manual Control Layouts

Veronte allows for a wide variety of pilot interface solutions in order to interact with manual flight modes, assisted flight modes (arcade) or payloads.

**Tip:** The following control solutions can be used independently, or in combination to create redundant systems, parallel channels (flight control + payload) or backup solutions.

### 2.2.1 PPM to Ground Unit

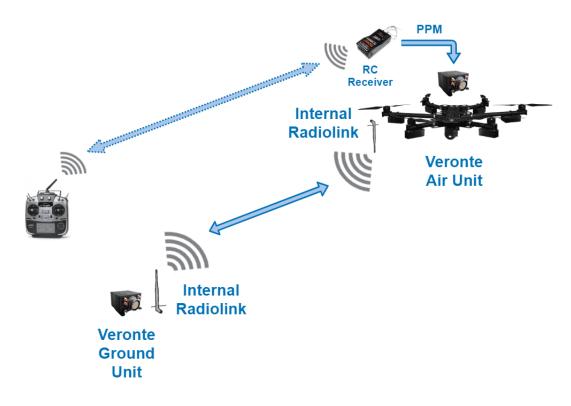
Standard setup. Allows the usage of a single radio channel both for stick, control commands and telemetry, minimizing any potential interferences.



Combined Radiolink

### 2.2.2 PPM to Air Unit

Allows for a backup manual channel in case there is a main channel loss and an emergency manual landing is needed. Recommended for initial development stages where automatic landing phases are not defined yet.

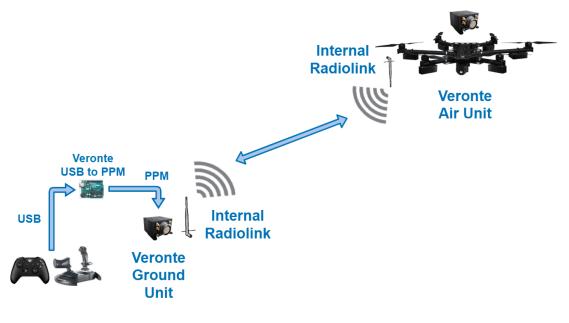


Parallel radiolink

### 2.2.3 USB to PPM

The USB to PPM solution allows for the integration of commercial flight station devices and remote controllers.

Note: Veronte PPM to USB device is sold separately. Please contact sales@embention.com for more information.

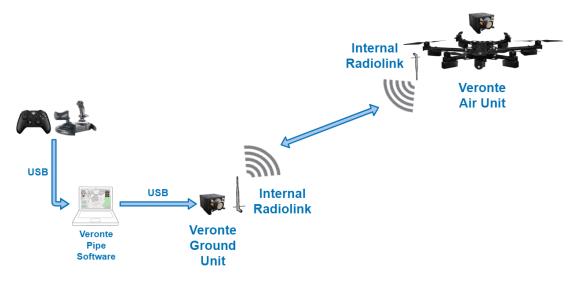


USB to PPM

### 2.2.4 USB to Pipe

Allows the use of any device that is detected as a remote controller by the operative system

**Warning:** This setup is dependent on external hardware and software (PC) and any potential issue will also affect the availability of the stick. It is recommended to use this solution for non-critical systems only. For critical systems (i.e. flight control), use the USB to PPM option instead.





### 2.2.5 Virtual Stick

The Virtual stick feature allows to integrate as a stick controller any device that can interface with Veronte Ground or Air unit (RS232, RS485, ADC, CAN,...) and can provide control reference values.

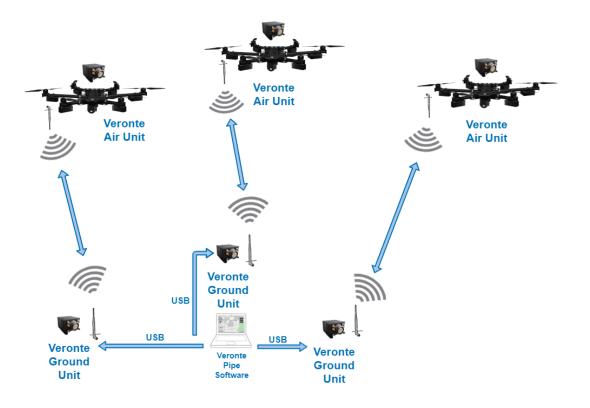
While the configuration will be slightly more complex, this feauture allows using a wide variety of devices as flight control interfaces.

# 2.3 Point to Multipoint Layouts

Due to Veronte's modular configuration, it is possible to integrate several air and ground units within the same network.

### 2.3.1 Point to Point with single Pipe

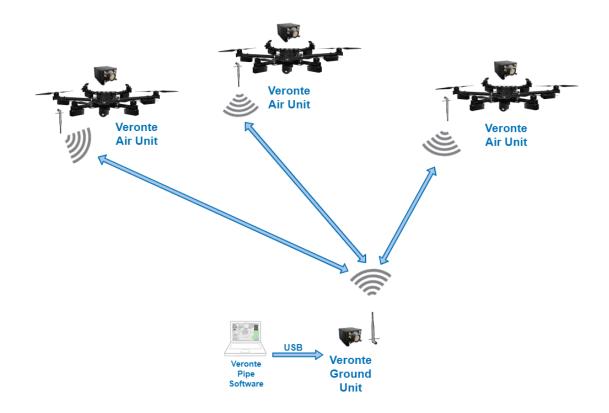
Standard multiplatorm setup.



Multiple Air units - Point to Point

### 2.3.2 Point to Multipoint with single GS

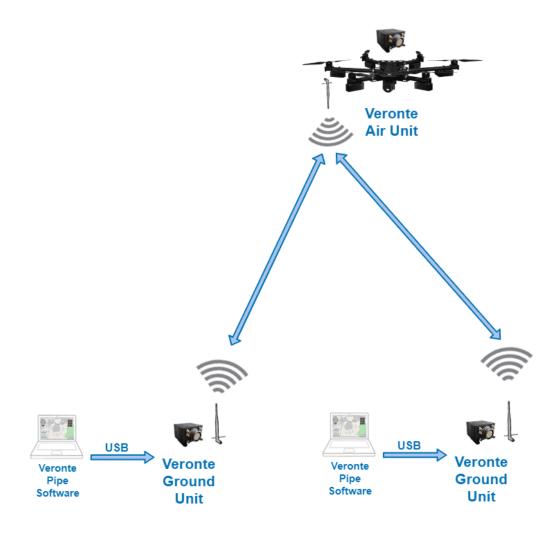
For managing several platforms with a single radiolink



Multiple Air units - Point to Multipoint

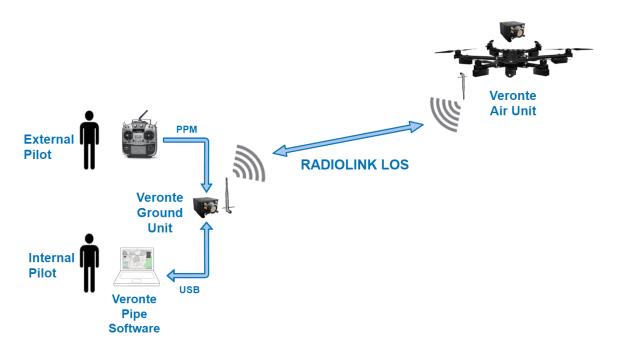
### 2.3.3 Multipoint to Point with multiple GS

For long range operations with several LOS stations



Multiple Ground Stations

The following image shows the **standard Veronte System Layout** for operation:



Veronte Standard Layout

In the standard layout, an **Operator** (**Internal Pilot**) controls the UAV from the **Ground Station** using **Veronte Pipe Software**.

Additionally, a **Safety Pilot** (External Pilot) is connected to the **Ground Station** using an RC Controller. The stick commands are read by the **Ground Unit** and re-routed to the **Air Unit**. The **Safety Pilot** is able to take control of the flight at any point using an *Automation* 

While this is the most common setup, there is a wide variety of options, including:

- BLOS (Beyond Line-of-sight) communications
- Onboard RC receivers
- Point-to-Multipoint configurations

#### CHAPTER

### THREE

# HARDWARE INSTALLATION

# 3.1 Veronte Autopilot

### 3.1.1 Aircraft Mounting

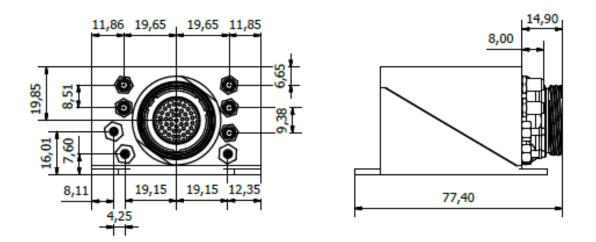
There are two versions of Veronte autopilot: with or without enclosure.

#### 3.1.1.1 Enclosure

Veronte is provided using an anodized aluminium enclosure with enhanced EMI shielding and IP protection. A high reliability connector is also provided in this version. The total approximate weight is 190 g.



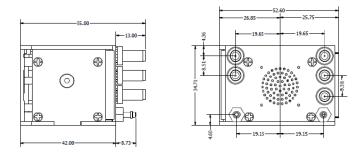
Veronte with aluminium enclosure



Veronte dimensions

#### 3.1.1.2 OEM

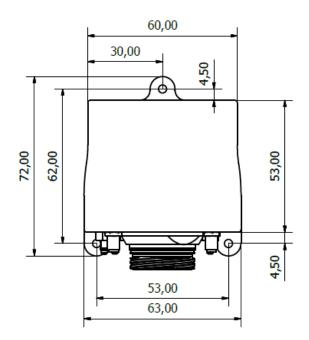
Veronte can be provided in OEM version too. The total approximate weight is 90g.



OEM dimensions

### 3.1.1.3 Mechanical Mounting

M3 screws are recommended for mounting. In saline environments such as coastal and oceanic, the screw material must be stainless steel.



Veronte Top View

### 3.1.1.4 Vibration Isolation

Although Veronte ultimately rejects noise and high-frequency modes of vibration with electronic filters and internal mechanical filters, there might be situations where external isolation components might be needed.

Veronte can be mounted in different ways in order to reject the airframe vibration. The simplest could be achieved by just using double-sided tape on the bottom side of Veronte. Other ways may use some external structure which could be rigidly attached to the airframe and softly attached to Veronte (e.g. foam, silent blocks, gel, etc)



#### Veronte mounts

The user should take into account that wiring should be loose enough so vibrations may not be transmitted to Veronte.

In cases where Veronte isolation is not viable, it is possible to use soft engine mounts. It is also recommended when there are other sensible payloads like video cameras or for high vibration engines.

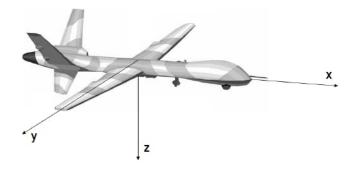
### 3.1.1.5 Location

The location of Veronte has no restrictions. You only need to configure its relative position with respect to the centre of mass of the aircraft and the GNSS antenna. The configuration of the location of Veronte can be easily configured using Veronte Pipe Software.

### 3.1.1.6 Orientation

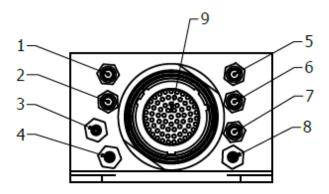
The orientation of Veronte has no restrictions either. You only need to configure Veronte axes with respect to the aircraft body axes by means of a rotation matrix or a set of correspondences between axes. The configuration of the orientation of Veronte can be easily configured using Veronte Pipe Software.

Veronte axes are printed on the box and aircraft coordinates are defined by the standard aeronautical conventions (see image below)



Aircraft Coordinates (Standard Aeronautical Convention)

### 3.1.1.7 Connector Layout



Veronte Connectors

Index	Connector
1	LOS SSMA connector
2	GNSS1 SSMA connector
3	Static pressure port (Fitting 5/64in) [for MS56 and DPS310 sensors]
4	Static pressure port (Fitting 5/64in) [for HSC sensor]
5	M2M SSMA connector
6	GNSS2 SSMA connector
7	TPDR (Transponder) SSMA connector
8	Dynamic pressure port (Fitting 5/64in)
9	68-pin connector

For the pressure ports, mating with clamped 2mm internal diameter flexible tubing is recommended.

The two static pressure ports must be used for sensor redundancy (Y tubing connection is strongly recommended).

### 3.1.1.8 Mating Connector

Index Connector		Mating Connector
1	RF antenna	SSMA male Plug, low-loss cable is recommended.
	(SSMA Jack	
	Female)	
2,6	GNSS antenna	SSMA male Plug, low-loss cable is recommended. Active Antenna GNSS: Gain min 15dB
	(SSMA Jack	(to compensate signal loss in RF Cable) max 50dB, maximum noise figure 1.5dB, power
	Female)	supply 3.3V max current 20 mA
5	M2M antenna	SSMA male Plug, low-loss cable is recommended.
	(SSMA Jack	
	Female)	
7	TPDR antenna	SSMA male Plug, low-loss cable is recommended.
	(SSMA Jack	
	Female)	
9	Connector	Mating connector P/N: FGW.LM.368.XLCT Mating harness is available on demand.
	HEW.LM.368.X	LNP

### 3.1.1.9 Antenna Integration

The system uses different kinds of antennas to operate that must be installed on the airframe. Here you can find some advice for obtaining the best performance and for avoiding antenna interferences.

Antenna Installation
Maximize separation between antennas as much as possible.
Keep them far away from alternators or other interference generators.
Always isolate antenna ground panel from the aircraft structure.
Make sure the antenna is securely mounted.
Always use high-quality RF wires minimising the wire length.
Always follow the antenna manufacturer manual.
SSMA connections shall be tightened applying 1Nm of torque
For all-weather aircraft, insert SSMA lightning protectors.

GNSS Antenna
Antenna top side must point the sky.
Install it on a top surface with direct sky view.
Never place metallic / carbon parts or wires above the antenna.
It is recommended to install it on a small ground plane.
For all-weather aircraft, insert SSMA lightning protectors.

### 3.1.1.10 Pressure lines

Veronte has three pressure input lines, two for static pressure to determine the absolute pressure and one for pitot in order to determine the dynamic pressure.

Pressure Intake
Pressure intakes must be located in order to prevent clogging.
Never install pressure intakes on the propeller flow.
Design pressure tubing path in order to avoid tube constriction.

### Static Pressure

It is not recommended to use inside fuselage pressure if it is not properly vented.

#### Pitot Tube

Pitot tube must be installed facing the airflow.

It is recommended to install it near the aircraft's x axis in order to avoid false measures during manoeuvres. For low-speed aircraft it is recommended at least 6.3mm tubes to prevent any rain obstruction.

# 3.1.2 Electrical

### 3.1.2.1 Power

Veronte can use unregulated DC (6.5V to 36V). Pins used for power and ground are the same for both Ground and Air configurations.

LiPo batteries between 2S and 8S can be used without regulation needs. Remaining battery level can be controlled by the internal voltage sensor and by configuring the voltage warnings on the Pipe software.

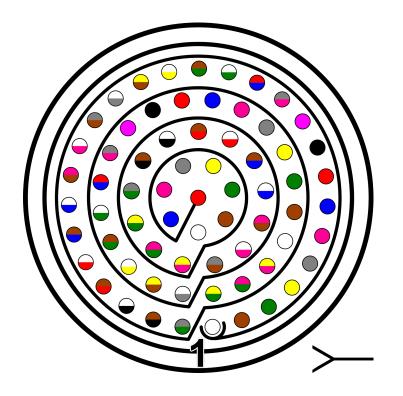
For higher voltage installations, voltage regulators must be used. For dimensioning voltage regulators take into account that a blocked servo can activate regulator thermal protection.

**Warning:** Caution!! Power Veronte out of the given range can cause irreversible damage to the system. Please read carefully the manual before powering the system.

Veronte and servos can be powered by the same or different batteries. In case of having more than one battery on the system, a single point ground union is needed to ensure a good performance. The ground signal should be isolated from other noisy ground references (e.g. engines). If all grounds need to be connected, the connection should be made on the negative pole of the battery.

It is recommendable to use independent switches for autopilot and motor/actuators. During the system initialization, the PWM signal will be set to low level (0V), please make sure that actuators/motor connected support this behaviour before installing a single switch for the whole system.

# 3.1.2.2 Veronte I/O Signals



68 pin connector for Veronte Autopilot (frontal view)

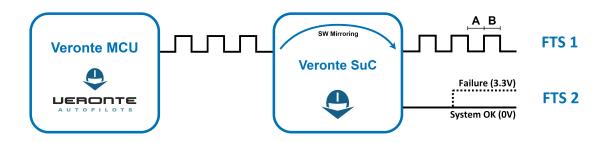
Pin	Signal	Туре	Comments
1	I/O1	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
2	I/O2	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
3	I/O3	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
4	I/O4	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
5	I/O5	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
6	I/O6	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
7	I/O7	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
8	I/O8	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
9	GND	GROUND	Ground signal for actuators 1-8
10	I/O9	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
11	I/O10	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
12	I/O11	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
13	I/O12	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
14	I/O13	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
15	I/O14	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
16	I/O15	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
17	I/O16	I/O	PWM / Digital I/O signal (0-3.3V). Protected against ESD and short circuit
18	GND	GROUND	Ground signal for actuators 9-16
19	RS 232 TX	Output	RS 232 Output (-13.2V to 13.2V Max, -5.4V to 5.4V Typical). Protected against ESD and
20	RS 232 RX	Input	RS 232 Input (-25V to 25V Max, -0.6V Low and 2.4V High Threshold). Protected against
21	GND	GROUND	Ground signal for buses
22	Analog 4	Input Analog	Input 0-3V. Protected against ESD and short circuit
23	Analog 5	Input Analog	Input 0-3V. Protected against ESD and short circuit

Table 1 - continued from pr

Pin	Signal	Туре	Comments
24	GND	GROUND	Ground signal for buses
25	CanA P	I/O	CANbus interface, up to 1Mbps (2.3V Typical, 1.2V-2.3V Differential). Protected against
26	CanA N	I/O	Twisted pair with a 120 Zo recommended (2.3V Typical, 1.2V-2.3V Differential). Protect
27	GND	GROUND	Ground signal for buses
28	CANB_P	I/O	CANbus interface. It supports data rates up to 1 Mbps. Protected against ESD
29	CANB_N	I/O	Twisted pair with a 120 Zo recommended. Protected against ESD
30	GND	GROUND	Ground signal for buses
31	I2C_CLK	Output	Clk line for I2C bus (0.3V to 3.3V). Protected against ESD and short circuit
32	I2C_DATA	I/O	Data line for I2C bus (0.3V to 3.3V). Protected against ESD and short circuit
33	GND	GROUND	Ground for 3.3V power supply
34	3.3V	POWER	3.3V - 100mA power supply. Protected against ESD short circuit with 100mA resettable
35	GND	GROUND	Ground for 5V power supply
36	5V	POWER	5V – 100mA power supply. Protected against ESD short circuit with 100mA resettable fu
37	GND	GROUND	Ground for analog signals
38	ANALOG_1	Input	Analog input 0-3V. Protected against ESD and short circuit
39	ANALOG_2	Input	Analog input 0-3V. Protected against ESD and short circuit
40	ANALOG_3	Input	Analog input 0-3V. Protected against ESD and short circuit
41	GND	GROUND	Ground for FTS signals
42	FTS1_OUT	Output	Deadman signal from comicro. Protected against ESD and short circuit
43	FTS2_OUT	Output	SystemOK Bit. Protected against ESD and short circuit
44	GND	GROUND	Ground signal for safety buses
45	V_ARB_TX	Output	Veronte comicro UART output to activate safety mechanism. Protected against ESD and
46	V_ARB_RX	Input	Veronte comicro UART output to activate safety mechanism. Protected against ESD and
47	GND	GROUND	Ground signal comicro power supply
48	V_ARB_VCC	POWER	Veronte comicro power (6.5V to 36V). Protected against ESD and reverse polarity
49	FTS3_OUT_MPU	Output	MPU alive voting signal, to use with 4xVeronte. It is a Square Wave at [100,125] Hz. Pro
50	OUT_RS485_P	Output	Non-inverted output from RS485 bus (-7V to 12V Max, -2.3V to 2.3V Typical). Protected
50	OUT_RS485_N	Output	Inverted output from RS485 bus (-7V to 12V Max, -2.3V to 2.3V Typical). Protected aga
52	IN_RS845_N	Input	Inverted output from RS485 bus (-7V to 12V Max, -2.3V to 2.3V Typical). Protected agai
53	IN_RS845_P	Input	Non-inverted output from RS485 bus (-7V to 12V Max, -2.3V to 2.3V Typical). Protected ugan
54	RS-485_GND	GND	Ground for RS-485 bus
55	EQEP_A	I/O	DIGITAL output / DIGITAL input / Encoder quadrature input A (0-3.3V). Protected agai
56	EQEP_B	I/O	DIGITAL output / DIGITAL input / Encoder quadrature input R (0 3.3 V). Protected agai
57	EQEP_S	I/O	DIGITAL output / DIGITAL input / Encoder quadrature input B (0.5.5V). Protected against ESI
58	EQEP_I	I/O I/O	DIGITAL output / DIGITAL input / Encoder index input (0.5.3.V). Protected against EST DIGITAL output / DIGITAL input / Encoder index input A (0-3.3V). Protected against EST
59	GND	GROUND	Ground for encoders
60	V_USB_DP	I/O	Veronte USB data line. Protected against ESD
61	V_USB_DN	I/O I/O	Veronte USB data line. Protected against ESD
62	V_USB_ID	I/O I/O	Veronte USB ID line. Protected against ESD and short circuit
63	FTS_OUT_MPU	Output	Abort mission voting signal from MPU, to use with 4xVeronte. Bit Low (0V) if mission (
64	FTS2_OUT_MPU	Output	Abort mission voting signal 1 from MPU, to use with 4x veronte. Bit Low (0V) if mission Abort mission voting signal 2 from MPU, to use with 4x Veronte. Bit Low (0V) if mission
65	GND	GROUND	Veronte ground input
66 66	ND	GROUND	Veronte ground input
67	VCC	POWER	Veronte ground input Veronte power supply (6.5V to 36V). Protected against ESD and reverse polarity
67 68	VCC	POWER	Veronte power supply (6.5V to 36V). Protected against ESD and reverse polarity Veronte power supply (6.5V to 36V). Protected against ESD and reverse polarity
00	nic	IUWEK	veronic power suppry (0.5 v to 50 v). Frotectica against ESD and reverse polarity

Warning: Remember!! All Veronte's GND pins are common.

### 3.1.2.3 Flight Termination System (FTS)



Flight Termination System

Veronte integrates two different FTS pins (42 and 43):

**FTS1 - Deadman (Pin 42):** On this pin, Veronte outputs a square wave with A = -5ms and B = -5ms (3.3V). Its frequency can be higher right after the rebooting (around 300-400Hz), but A and B must be always < 8ms.

**FTS2 - !SystemOK (Pin 43):** Its output is 0V when the system is working as expected and 3.3V when some error is detected. In detail, pin 43 goes high if A > 8ms or B > 8ms in the deadman signal sent by the Main Processor Unit (MPU).

### 3.1.2.4 Joystick

To use the joystick in the system, connect the PPMout of the trainer port to a digital input of Veronte and configure that digital input as the radio input in Pipe.

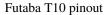
If the PPM level is 3.3V, pins 1-8, 10-17 and 55-58 pins can be used.

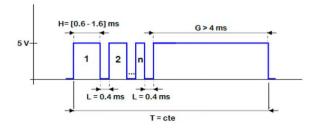
Veronte is compatible with standard Pulse Positon Modulation (PPM) signals, Futaba radios between 8 and 12 channels are recommended.



Futaba T10 Joystick

Pin	Designation	Connector
Shield	Ground	
1	VENCODER	
2	<b>PPM</b> out	$(50 \ 6 \ 0)$
3		
4	V <sub>enc2</sub>	
5	VBATTERY	
6	Unknown	
Pin	Designation	Connector
1	NC	
2	Ground	
3	<b>PPM</b> out	30 20 10
4	VBATTERY	60 50 40
5	VENCODER	
6		



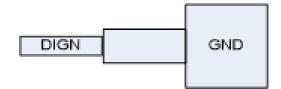


PPM signal

As default, channel 8 is reserved for manual / auto switch. High level is used for automatic flight and low level for manual control. This channel can be configured on Veronte Pipe.

**Warning:** Caution!! PPM signal must be into the Veronte voltage ranges. Some joysticks may need an adaptation board, please ask our team to check compatibility.

Veronte connector for CS is provided with 3.5mm stereo plug connector as follows:





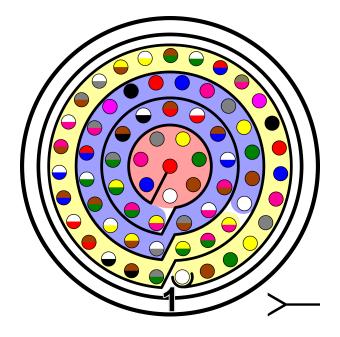


PPM connector

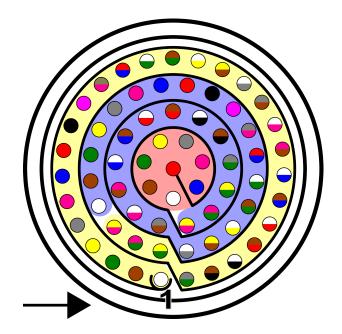
# 3.1.3 Performances

Variable	Value
Weight (with enclosure	190 g
and connector)	
Weight (OEM)	90 g
Power Input	6.5 V to 36 V
Minimum Temperature	-40 °C
Maximum Temperature	+55°C (No convection, ask for increased limits (up to 71°C))
Max. Internal	+85°C
Temperature	
Minimum Pressure	0 kPa
Maximum Pressure	104 kPa
Maximum Dynamic	6 kPa (Ask for increased limits (up to 50kPa))
pressure	
Protection Rating	IP67 enclosure version
Acceleration Limits (3	$\pm 2$ g to $\pm 16$ g (for sustained maneuvers, transitional higher accelerations are possible
axes)	(e.g. catapult launch). Ask for increased limits.)
Angular Velocity Limits	$\pm 125$ deg/s to $\pm$ 2000 deg/s (for sustained maneuvers, transitional higher angular
(3 axes)	velocities are possible. Ask for increased limits.)
Magnetic Field Limits (3	$\pm 4$ to $\pm 16$ Gauss
axes)	
GNSS	72 channels, GPS L1C/A, GLONASS L1OF, BeiDou B1I
Datalink	410 to 480 MHz licensed or FHSS/902-928MHz FHSS/2.4 to 2.483 GHz ISM
	Band/869.5-869.75 MHz ISM Band

# 3.1.4 Annex 1: Connector colour code



Connector HEW.LM.368.XLNP



CS harness plug

**Warning:** Check the pin number before connecting. The colour code is repeated 3 times due to the amount of pins. First section (yellow) corresponds to pins 1-30, the second section (blue) to pins 31-60 and the third one (red) to pins 61-68. Pin number increases following the black line of the pictures above: counterclockwise for the connector and clockwise for the plug.

PIN	Color code	PIN	Color code
1	White	35	Gray
2	Brown	36	Pink
3	Green	37	Blue
4	Yellow	38	Red
5	Gray	39	Black
6	Pink	40	Violet
7	Blue	41	Gray – Pink
8	Red	42	Red – Blue
9	Black	43	White – Green
10	Violet	44	Brown – Green
11	Gray – Pink	45	White – Yellow
12	Red – Blue	46	Yellow – Brown
13	White – Green	47	White – Gray
14	Brown – Green	48	Gray – Brown
15	White - Yellow	49	White – Pink
16	Yellow – Brown	50	Pink – Brown
17	White – Gray	51	White – Blue
18	Gray – Brown	52	Brown – Blue
19	White – Pink	53	White – Red
20	Pink – Brown	54	Brown – Red
21	White – Blue	55	White – Black
22	Brown – Blue	56	Brown – Black
	(	continu	es on next page

PIN	Color code	PIN	Color code
23	White – Red	57	Gray – Green
24	Brown – Red	58	Yellow – Green
25	White – Black	59	Pink – Green
26	Brown – Black	60	Yellow – Pink
27	Grey – Green	61	White
28	Yellow – Green	62	Brown
29	Pink – Green	63	Green
30	Yellow – Pink	64	Yellow
31	White	65	Grey
32	Brown	66	Pink
33	Green	67	Blue
34	Yellow	68	Red

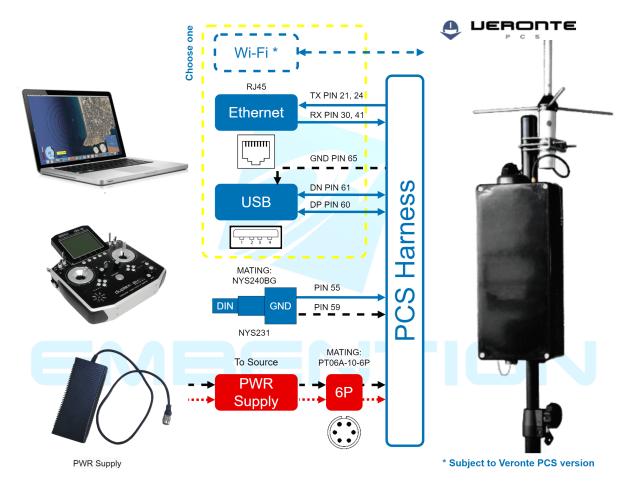
Table 2 – continued from previous page

# 3.1.5 Annex 2: Connection examples

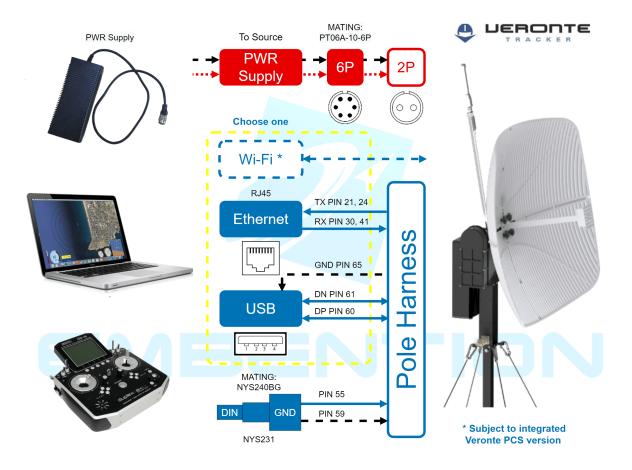
### 3.1.5.1 Ground Stations



Basic Veronte Autopilot Ground Station



Veronte PCS Ground Station



Veronte Tracker Ground Station

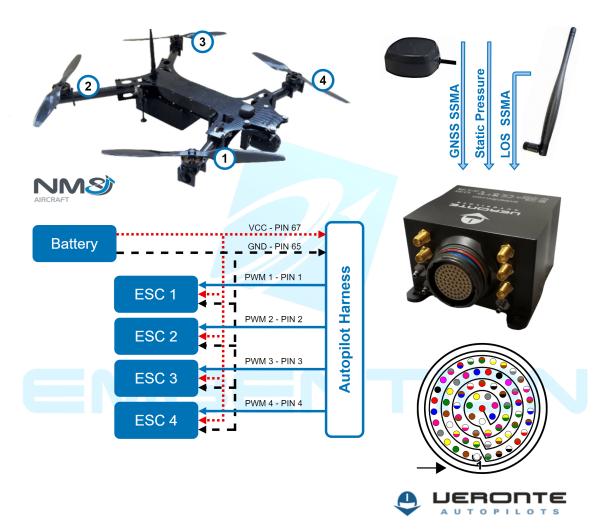


Check individual equipment diagrams for further details

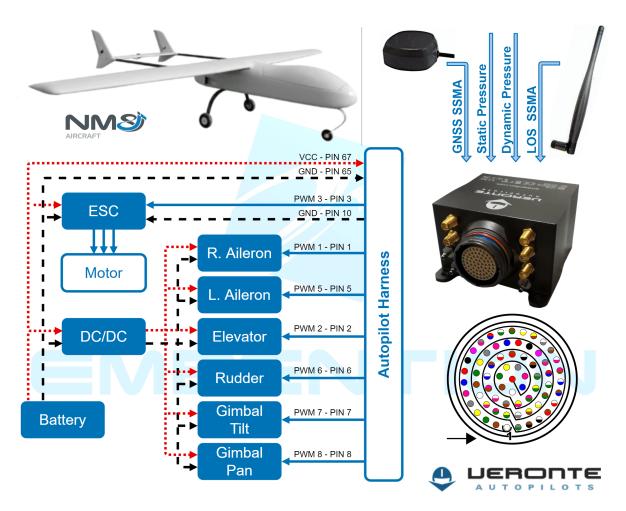
Veronte MCS Ground Station

**Warning:** Veronte equipment harnesses have specific pin layouts. Only use their own matting connectors, do NOT mix harnesses: misuse can lead to destruction.

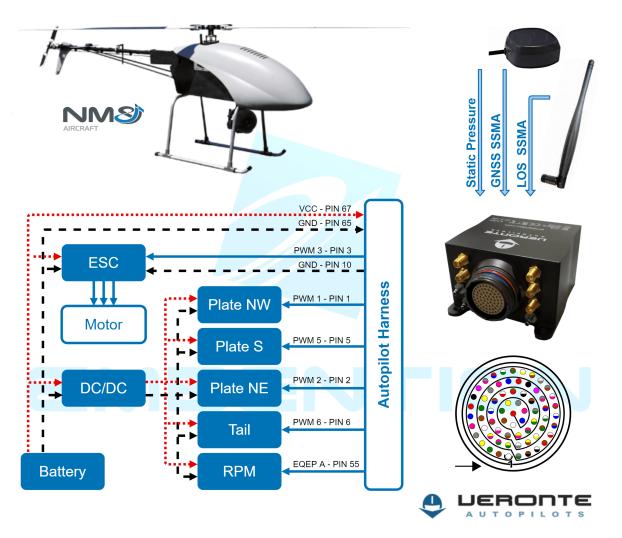
## 3.1.5.2 Aircrafts



Multicopter



Fixed Wing Airplane



Helicopter



Veronte Autopilot

**Veronte Autopilot** is a miniaturized high-reliability avionics system for advanced control of unmanned systems. This control system embeds a state-of-the-art suite of sensors and processors together with LOS and BLOS M2M datalink radio, all with reduced size and weight.

# 3.1.6 Operation

The unique **Plug 'n Fly** control system, Veronte Autopilot ads fully autonomous control capabilities to any unmanned system for complete operation, compatible with: UAV, Drone, RPAS, USV, UGV...

- **Highly configurable:** Veronte control system is fully configurable; payload, platform layout, control phases, control channels... even the user interface layout can be user-defined.
- Custom routines: User selectable automatic actions, activated on system event or periodically.
  - Actions: phase change, activate payload, move servo, go to, onboard log, parachute release...
  - Events: waypoint arrival, inside/outside polygon, alarm, variable range, button...
- **Telemetry & log:** Embedded datalink for system monitoring and telecommand and customizable user log in both onboard and control station, all with user-defined variables and frequency record.
- External sensor: Support for external sensor connection: magnetometer, radar, LIDAR, RPM, temperature, fuel level, battery level, weather...
- **Payload & Peripheral:** Transponder, secondary radios, satcom transceivers, camera gimbals, motor drivers, photo cameras, flares, parachute release systems, tracking antennas, pass through RS232, RS485 & CAN tunnel...

## 3.1.7 Platforms

The Veronte Autopilot is designed to control any unmanned vehicle, either aircraft such as: multirotors, helicopters, airplanes, VTOL, blimps... as well as ground vehicles, surface vehicles or many others. Custom flight phases and control channels provide support for any aircraft layout and performance by using the same software and hardware for: UAS, RPAS, Drone, USV / ASV, UGV...



Veronte FCS overview

Veronte contains all the electronics and sensors needed in order to properly execute all the functions needed to control the UAV. A Veronte-based FCS contains the following elements:

• Veronte (Air): it executes in real time all the guidance, navigation and control algorithms for the carrying airframe, acting on the control surfaces and propulsion system and processing the signals from different sensors: accelerometers, gyroscopes, magnetometer, static pressure, dynamic pressure, GPS (EGNOS/Galileo compatible).

- Veronte (Ground): apart from linking to other flying Veronte units and supporting manual and arcade modes with conventional joysticks, it can also control a directional antenna in order to expand the maximum range. It communicates to Veronte Pipe (software for ground segment mission management).
- Veronte Pipe: software for mission management at the ground segment. It monitors flying vehicles in real time and can also reproduce past missions in an offline manner. It is also the graphical user interface where commands and flight plans are produced.

# 3.1.8 Safety

Veronte autopilot includes the following features in order to provide your UAS with the best safety performances:

- Redundant IMU.
- Redundant GNSS receiver.
- Redundant Pressure sensor.
- Dual core principal microprocessor + dissimilar safety microcontroller (comicro).

Independent power supply for main system and safety microcontroller.

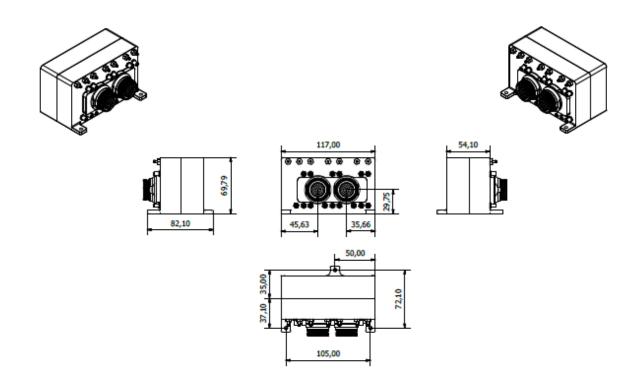
In case any malfunction occurs in the microprocessor, the comicro can activate different safety mechanism by means of 2 digital outputs and 1 serial port.

# 3.2 4x Veronte Autopilot

# 3.2.1 Aircraft Mounting

### 3.2.1.1 Enclosure

4xVeronte is provided using an anodized-aluminium enclosure with enhanced EMI shielding and IP protection. The approximate total weight including radio modules is 750g. The following figure show the dimensions of the enclosure. M4 screws are recommended for mounting.



4xVeronte dimensions (mm)

### 3.2.1.2 Vibration Isolation

Although Veronte rejects noise and modes of vibration with internal electronic and mechanical filters, an external vibration isolation might be needed depending of the vehicle.

Veronte can be mounted in different ways in order to reject the airframe vibration if needed. One way to avoid vibration would be the use of some external structure which could be rigidly attached to the airframe and softly attached to Veronte (e.g. foam, silent blocks, etc.)

The user should take into account that wiring should be loose enough so vibrations may not find another way to enter the aircraft system.

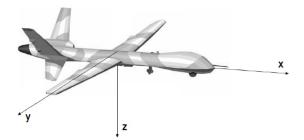
### 3.2.1.3 Location

The location of 4x Veronte has no restrictions. You only need to configure its relative position with respect to the centre of mass of the aircraft and the GNSS antenna. The configuration of the location of Veronte can be easily configured using Veronte Pipe Software.

### 3.2.1.4 Orientation

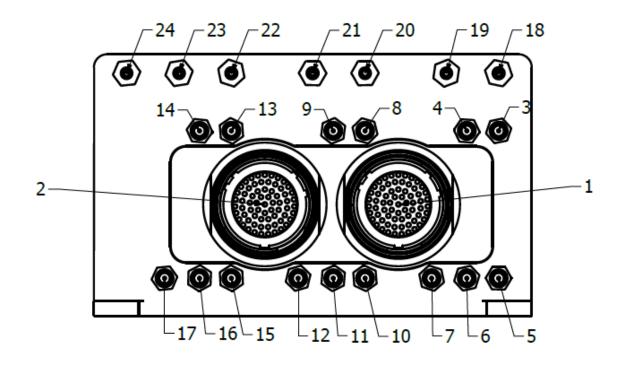
The orientation of 4xVeronte has no restrictions either. You only need to configure Veronte axes with respect to the aircraft body axes by means of a rotation matrix or a set of correspondences between axes. The configuration of the location of Veronte can be easily configured using Veronte Pipe Software.

Veronte axes are printed on the box and aircraft reference frame are defined by the standard flight dynamics conventions.



Aircraft Mounting

# 3.2.1.5 Connector Layout



4xVeronte Connectors

Index	Connector
1	
-	Redundant (Critical) connector
2	Arbiter (Optional) connector
3	LOS SSMA connector for Veronte 3
4	GNSS1 SSMA connector for Veronte 3
5	M2M SSMA connector for Veronte 3
6	GNSS2 SSMA connector for Veronte 3
7	TPDR (Transponder) SSMA connector for Veronte 3
8	LOS SSMA connector for Veronte 2
9	GNSS1 SSMA connector for Veronte 2
10	M2M SSMA connector for Veronte 2
11	GNSS2 SSMA connector for Veronte 2
12	TPDR (Transponder) SSMA connector for Veronte 2
13	LOS SSMA connector for Veronte 1
14	GNSS1 SSMA connector for Veronte 1
15	M2M SSMA connector for Veronte 1
16	GNSS2 SSMA connector for Veronte 1
17	TPDR (Transponder) SSMA connector for Veronte 1
18	Dynamic pressure port (Fitting 5/64in) for Veronte 3
19	Static pressure port (Fitting 5/64in) for Veronte 3
20	Dynamic pressure port (Fitting 5/64in) for Veronte 2
21	Static pressure port (Fitting 5/64in) for Veronte 2
22	Dynamic pressure port (Fitting 5/64in) for Veronte 1
23	Static pressure port (Fitting 5/64in) for Veronte 1
24	Static pressure port (Fitting 5/64in) for all Verontes

For pressure ports, mating with clamped 2mm internal diameter flexible tubing is recommended.

The static pressure port for all Verontes sets the 4xVeronte internal cage pressure.

## 3.2.1.6 Mating Connectors

Index	Connector	Mating Connector		
3,8,13	RF antenna/(SSMA	SSMA male Plug, low-loss cable is recommended.		
	Jack Female)			
4,9,14,	16GN\$\$	SSMA male Plug, low-loss cable is recommended./Active Antenna GNSS: Gain		
	antenna/(SSMA	min 15dB (to compensate signal loss in RF Cable) max 50dB, maximum noise		
	Jack Female)	figure 1.5dB, power supply 3.3V max current 20 mA		
10,12,1	4M2M	SSMA male Plug, low-loss cable is recommended.		
	antenna/(SSMA			
	Jack Female)			
1	Redundant	Mating connector P/N: FGW.LM.368.XLCT/Mating harness is available on		
	Connector/Connector	demand.		
	HEW.LM.368.XLNP			
2	Arbiter	Mating connector P/N: FGR.LM.368.XLCT/Mating harness is available on		
	Connector/Connector	demand.		
	HER.LM.368.XLNP			
7,12,17	TPDR antenna	SSMA male Plug, low-loss cable is recommended.		
	(SSMA Jack Female)			

### 3.2.1.7 Antenna Integration

The system uses different kinds of antennas to operate that must be installed on the airframe. Here you can find some advice for obtaining the best performance and for avoiding antenna interferences.

Antenna Installation
Maximize separation between antennas as much as possible.
Keep it far away from alternators or other interference generators.
Always isolate antenna ground panel from the aircraft structure.
Make that the antenna is securely mounted.
Always use high-quality RF wires minimising the wire length.
Always follow the antenna manufacturer manual.
SSMA connections shall be tightened applying 1Nm of torque
For all-weather aircraft, insert SSMA lightning protectors.

GNSS Antenna
Antenna top side must point the sky.
Install it on a top surface with direct sky view.
Never place metallic / carbon parts or wires above the antenna.
It is recommended to install it on top of a ground plane.
For all-weather aircraft, insert SSMA lightning protectors.

### 3.2.1.8 Pressure lines

4xVeronte has 6 pressure input lines, 3 for static pressure to determine the absolute pressure and 3 for pitot in order to determine the dynamic pressure on each internal autopilot.

Absolute pressure connection on the aircraft is mandatory while pitot port can be obviated in some aircrafts. Pitot port absence must be configured on Veronte Pipe software.

Pressure Intake Pressure intakes must be located in order to prevent clogging. Never install pressure intakes on the propeller flow. Design pressure tubing path in order to avoid tube constriction.

Static Pressure It is not recommended to use inside fuselage pressure if it is not properly vented.

### Pitot Tube

It is recommended to install it near the aircraft axis in order to avoid false measures during manoeuvres. For low-speed aircraft it is recommended at least 6,3mm tubes for preventing rain obstruction. Pitot tube must be installed facing the airflow in the direction of the "x" axis of the aircraft.

# 3.2.2 Electrical

### 3.2.2.1 Power

4xVeronte can use unregulated DC (6.5V to 36V) for the internal Veronte autopilots and also for the arbiter.

LiPo batteries between 2S and 8S can be used without voltage regulation. Remaining battery can be controlled by the internal voltage sensor and by configuring the voltage warnings on the PC application.

For higher voltage installations, voltage regulators must be used. For dimensioning voltage regulators take into account that a blocked servo can activate regulator thermal protection.

**Warning:** Caution!! Power Veronte out of the given range can cause irreversible damage to the system. Please read carefully the manual before powering the system.

Veronte and servos can be powered by the same or different batteries. In case there are more than one battery on the system, a single point ground union it is needed to ensure a good performance. The ground signal should be isolated from other system ground references (e.g. engines).

It is recommendable to use independent switches for autopilot and motor / actuators. During the system initialization, PWM signal will be fixed to low level (0V), please make sure that actuators / motor connected support this behaviour before installing a single switch for the whole system.

Despite the names, all GND connectors share the same line, meaning they can be used for any ground connection required.

Harness ended in Blue matting connector will refer to Redundant connector, and the one ended in Yellow (reverse polarity) will refer to Arbiter connector.

PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
1	I/O1	I/O	A	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
2	I/O2	I/O	В	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
3	I/O3	I/O	A	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)

### 3.2.2.2 Redundant Connector Pinout

PIN	SIGNAL	TYPE		COMMENTS
		110	POWER DOMAIN	
4	I/O4	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
F	1/05	1/0		(0-3.3V)
5	I/O5	I/O	A	MUXED PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
6	I/O6	I/O	В	MUXED
0	1/00	1/0	B	PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
7	I/O7	I/O	A	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
8	I/O8	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
9	GND	GROUND		GROUND SIGNAL
			•	FOR ACTUATORS
				1-8
10	I/O9	I/O	A	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
11	I/O10	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
12	U/011		•	(0-3.3V)
12	I/O11	I/O	A	MUXED
				PWM/DIGITAL OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
13	I/O12	I/O	В	MUXED
15	1/012	10	U U	PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
				tinues on next nage

Table 3	<ul> <li>continued</li> </ul>	from	previous	page
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PIN	SIGNAL	3 – continued from TYPE		COMMENTS
	SIGNAL		POWER DOMAIN	COMMENTS
14	I/O13	Ι/Ο	A	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
15	I/O14	I/O	В	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
16	I/O15	I/O	A	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
17	I/O16	I/O	В	MUXED PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
18	GND	GROUND	•	GROUND SIGNAL FOR ACTUATORS 9-16
19	RS_232_TX	OUTPUT	A	MUXED RS-232 OUTPUT
20	RS_232_RX	INPUT	A	REDUNDANT RS- 232 INPUT
21	V2_USB_DP	I/O	•	VERONTE 2 USB DATA LINE
22	ANALOG_4	INPUT	В	REDUNDANT ANALOG INPUT 0-36V
23	ANALOG_5	INPUT	В	REDUNDANT ANALOG INPUT 0-36V
24	V2_USB_DN	I/O	•	VERONTE 2 USB DATA LINE
25	CANA_P	I/O	•	CANbus interface. It supports data rates up to 1 Mbps.
26	CANA_N	I/O	•	Twisted pair with a 120 Zo recommended
27	GND	GROUND	•	GROUND SIGNAL FOR BUSES

Table 3 – continued from previous page

PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
• •			POWER DOMAIN	
28	CANB_P	I/O		CANbus interface.
			•	It supports data
20		1/0		rates up to 1 Mbps.
29	CANB_N	I/O		Twisted pair
			•	with a 120 Zo
				recommended
30	V2_USB_ID	I/O		VERONTE 2 USB
			•	ID LINE
31	I2C_CLK	OUTPUT A		MUXED CLK
			•	LINE FOR I2C
				BUS
32	I2C_DATA	I/O	A	MUXED DATA
				LINE FOR I2C
				BUS
33	GND	GROUND		GROUND FOR
			•	3.3V POWER
				SUPPLY
34	3.3V	POWER	В	3.3V-100mA
				POWER SUPPLY
35	GND	GROUND		GROUND FOR 5V
			•	POWER SUPPLY
36	5V	POWER	В	5V-100mA POWER
50	5.	FOWER	D	SUPPLY
37	GND	GROUND		GROUND
57	GND	UKUUND		FOR ANALOG
				SIGNALS
38	ANALOG_1	INPUT	A	REDUNDANT
50	ANALOO_1		Δ	ANALOG INPUT
				0-36V
39	ANALOG 2	INPUT	A	REDUNDANT
57		nuer	1	ANALOG INPUT
				0-36V
40	ANALOG_3	INPUT	A	REDUNDANT
				ANALOG INPUT
				0-36V
41	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
42	V3_USB_DP	I/O		VERONTE 3 USB
42	V 2_028_DF	1/0		
			•	DATA LINE
43	V3_USB_DN	I/O		VERONTE 3 USB
			•	DATA LINE
44	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
				tinues on next nage

Table	3 – continued from previous page
Table	5 – continued norn previous page

PIN	SIGNAL	3 – continued from		COMMENTS
			POWER DOMAIN	
45	UART_TX	OUTPUT	В	MUXED UART OUTPUT
46	UART_RX	INPUT	В	REDUNDANT UART INPUT
47	GND	GROUND	•	GROUND SIGNAL FOR BUSES
48	GND	GROUND	•	GROUND SIGNAL FOR BUSES
49	V3_USB_ID	I/O	•	VERONTE 3 USB ID LINE
50	OUT_RS485_P	OUTPUT	В	NON-INVERTED OUTPUT FOR MUXED RS-485 BUS
51	OUT_RS845_N	OUTPUT	В	INVERTED OUTPUT FOR MUXED RS-485 BUS
52	IN_RS845_N	INPUT	•	INVERTED INPUT FOR MUXED RS- 485 BUS
53	IN_RS485_P	INPUT	•	NON-INVERTED INPUT FOR MUXED RS-485 BUS
54	RS-485_GND	GROUND	•	GROUND FOR RS- 485 BUS
55	EQEP_A	INPUT	A FOR VERONTE 1&2 B FOR VERONTE 3	ENCODER QUADRATURE REDUNDANT INPUT A (0-5V)
56	EQEP_B	INPUT		ENCODER QUADRATURE REDUNDANT INPUT B (0-5V)
57	EQEP_S	INPUT		ENCODER STROBE REDUNDANT INPUT (0-5V)
58	EQEP_I	INPUT		ENCODER INDEX REDUNDANT INPUT (0-5V)
59	GND3	GROUND	•	VERONTE 3 GROUND INPUT
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Table 3 – continued from previous pag
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PIN	SIGNAL		INTERNAL	COMMENTS
			POWER DOMAIN	
60	V1_USB_DP	I/O		VERONTE 1 USB
			•	DATA LINE
61	V1_USB_DN	I/O		VERONTE 1 USB
			•	DATA LINE
62	V1_USB_ID	I/O		VERONTE 1 USB
			•	ID LINE
63	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
64	VCC3	POWER		VERONTE 3
			•	POWER SUPPLY
(7	CNID2	CROUND		(6.5 to 36V)
65	GND2	GROUND	•	VERONTE 2 GROUND INPUT
			•	GROUND INPUT
66	GND1	GROUND		VERONTE 1
			•	GROUND INPUT
67	VCC2	POWER		VERONTE 2
			•	POWER SUPPLY
				(6.5 to 36V)
68	VCC1	POWER		VERONTE 1
			•	POWER SUPPLY
				(6.5 to 36V)

Table	3 – co	ntinued	from	previous	page
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## 3.2.2.3 Arbiter Connector Pinout

Although being the same part, Arbiter connector and the Redundant connector are polarized differently to avoid wiring swapping.

PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
1	EXTERNAL FCU I/O1	I/O	A	EXTERNAL FCU PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V). Input current must be limited to 25mA.

PIN	SIGNAL		n previous page	COMMENTS
	SIGNAL	ITE	POWER DOMAIN	COMMENTS
2	EXTERNAL FCU	I/O	B	EXTERNAL FCU
2	I/O2	1/0	В	PWM/DIGITAL
	1/02			OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
3	EXTERNAL FCU	I/O	A	EXTERNAL FCU
5	I/O3	1/0	1	PWM/DIGITAL
	100			OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
4	EXTERNAL FCU	I/O	В	EXTERNAL FCU
•	I/O4			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
5	EXTERNAL FCU	I/O	А	EXTERNAL FCU
-	I/O5			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
6	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O6			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
7	EXTERNAL FCU	I/O	A	EXTERNAL FCU
	I/O7			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
8	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O8			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
			COL	ntinues on next page

Table 4 – continued from previous	s page
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PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
			POWER DOMAIN	
9	EXTERNAL FCU	I/O	A	EXTERNAL FCU
	I/O9			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
10	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O10			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
11	EXTERNAL FCU	I/O	А	EXTERNAL FCU
	I/O11			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
12	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O12			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
13	VCC2	POWER		VERONTE 2
			•	POWER SUPPLY
				(6.5 to 36V)
14	EXTERNAL FCU	OUTPUT	A	EXTERNAL FCU
	ANALOG INPUT 1			ANALOG INPUT
				(0-36V). This is
				the analog signal
				corresponding
				to Analog signal 1 on Redundant
15	EXTERNAL FCU	OUTPUT	A	connector. EXTERNAL FCU
13	ANALOG INPUT 2	UUIPUI	A	ANALOG INPUT
	ANALOG INPUT 2			(0-36V). This is
				the analog signal
				corresponding
				to Analog signal
				2 on Redundant
				connector.
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Table 4 – continued from previous page

PIN	SIGNAL	TYPE		COMMENTS
			POWER DOMAIN	
16	EXTERNAL FCU ANALOG INPUT 3	OUTPUT	A	EXTERNAL FCU ANALOG INPUT (0-36V). This is the analog signal corresponding to Analog signal 3 on Redundant connector.
17	EXTERNAL FCU ANALOG INPUT 4	OUTPUT	B	EXTERNAL FCU ANALOG INPUT (0-36V). This is the analog signal corresponding to Analog signal 4 on Redundat connector.
18	FLIGHT TERMINATION SIGNAL STAGE B	OUTPUT	B	OPEN DRAIN OUTPUT FROM VOTING STAGE B (Sensed by arbiter)
19	EXTERNAL FCU TO PAYLOAD UART SIGNAL	INPUT	A	EXTERNAL FCU UART OUTPUT. (0-3.3V) THIS SIGNAL WILL BE AN INPUT FOR THE RS_232 OUTPUT MULTIPLEXER. MULTIPLEXED OUTPUT ON REDUNDANT CONNECTOR PIN 19
20	PAYLOAD TO EXTERNAL FCU UART SIGNAL	OUTPUT	A	EXTERNAL FCU UART INPUT. (0-3.3V) THIS SIGNAL WILL BE THE OUTPUT OF THE RS_232 MULTIPLEXER. MULTIPLEXED INPUT ON REDUNDANT CONNECTOR PIN 20

Table 4 – continued from previous p	bage
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DIN		TYPE		COMMENTS
PIN	SIGNAL		INTERNAL POWER DOMAIN	COMMENTS
21	PAYLOAD TO	OUTPUT	TOWERDOWAR	RS-485_P
21	EXTERNAL FCU	001101	•	OUTPUT SIGNAL
	RS-485_P			FROM PAYLOAD
	KS-+05_1			(REDUNDANT
				CONNECTOR
				PIN 53)TO FCU
				RS-485_P INPUT
22	PAYLOAD TO	OUTPUT		RS-485_N
22	EXTERNAL FCU	001101		OUTPUT SIGNAL
	RS-485 N			FROM PAYLOAD
				(REDUNDANT
				CONNECTOR
				PIN 52)TO FCU
				RS-485_N INPUT
23	EXTERNAL FCU	INPUT	В	RS-485 P
25	TO PAYLOAD	nuer		OUTPUT
	RS-485_P			SIGNAL FROM
				EXTERNAL FCU
				(REDUNDANT
				CONNECTOR PIN
				50)TO PAYLOAD
				RS-485_P INPUT
24	EXTERNAL FCU	INPUT	В	RS-485_N
	TO PAYLOAD			OUTPUT
	RS-485_N			SIGNAL FROM
	_			EXTERNAL FCU
				(REDUNDANT
				CONNECTOR PIN
				51)TO PAYLOAD
				RS-485_N INPUT
25	CANA_P	I/O		CANbus interface.
			•	It supports data
				rates up to 1 Mbps.
26	CANA_N	I/O		Recommended
			•	cable is a twisted
				pair with a 120 Zo.
27	VCC1	POWER		VERONTE 1
			•	POWER SUPPLY
				(6.5 to 36V)
28	CANB_P	I/O		CANbus interface.
			•	It supports data
				rates up to 1 Mbps.
29	CANB_N	I/O		Recommended
			•	cable is a twisted
20				pair with a 120 Zo.
30	ARBITER_RS485_O	υΦ <u>υ</u> ΡΓΡυΤ	ARBITER	NON-INVERTED
				OUTPUT FOR
				ARBITER'S RS-
				485 BUS

Table 4 – continued from previous	page
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PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
31	ARBITER_RS485_O	U <b>Ø<u>L</u>N'</b> PUT	ARBITER	INVERTED OUTPUT FOR ARBITER'S RS- 485 BUS
32	ARBITER_RS485_IN	I_INPUT	ARBITER	INVERTED INPUT FOR ARBITER'S RS-485 BUS
33	ARBITER_RS485_IN	I_INPUT	ARBITER	NON-INVERTED INPUT FOR ARBITER'S RS- 485 BUS
34	ARBITER_ARINC_1	XXXUTPUT	ARBITER	ARBITER'S ARINC POSITIVE OUTPUT
35	ARBITER_ARINC_1	X <b>D</b> UTPUT	ARBITER	ARBITER'S ARINC NEGATIVE OUTPUT
36	ARBITER_ARINC_F	XMPUT	ARBITER	ARBITER'S ARINC POSITIVE INPUT
37	ARBITER_ARINC_F	X <b>N</b> PUT	ARBITER	ARBITER'S ARINC NEGATIVE INPUT
38	GND	GROUND	•	GROUND SIGNAL FOR BUSES
39	ARBITER_I2C_SCL	OUTPUT	ARBITER	CLK LINE FOR ARBITER'S I2C BUS
40	ARBITER I2C_DATA	I/O	ARBITER	DATA LINE FOR ARBITER'S I2C BUS
41	ARBITER_RS232B_	RINPUT	ARBITER	ARBITER RS-232 INPUT B
42	ARBITER_RS232B_	ΓΙΟΟΤΡΟΤ	ARBITER	ARBITER RS-232 OUTPUT B
43	ARBITER_RS232A_	RINPUT	ARBITER	ARBITER RS-232 INPUT A
44	ARBITER_RS232A_	TØUTPUT	ARBITER	ARBITER RS-232 OUTPUT A
45	GND	GROUND	•	GROUND SIGNAL FOR ANALOG SIGNALS
46	ARBITER ANALOG_INPUT_1	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)

Table 4 – continued from previous page

PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
47	ARBITER ANALOG_INPUT_2	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
48	ARBITER ANALOG_INPUT_3	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
49	ARBITER ANALOG_INPUT_4	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
50	ARBITER ANALOG_INPUT_5	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
51	ARBITER ANALOG_INPUT_6	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
52	ARBITER ANALOG_INPUT_7	I/O	ARBITER	ARBITER ANALOG INPUT (0-36V)
53	FLIGHT TERMINATION SIGNAL STAGE A	OUTPUT	A	OPEN DRAIN OUTPUT FROM VOTING STAGE A (Sensed by arbiter)
54	ARB_GPIO9	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
55	ARB_GPIO10	Ι/Ο	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
56	WD_EXT	Ι	ARBITER	WATCHDOG SIGNAL FROM EXTERNAL AUTOPILOT TO ARBITER (0-3.3V)
57	EXT_DETECT	Ι	ARBITER	CONNECT TO GND IF EXTERNAL FCU IS CONNECTED. OTHERWISE, LEAVE OPEN
58	GND	GROUND	•	GROUND SIGNAL FOR GPIO

Table	4 – continued fi	rom previous page
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PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
59	ARB_GPIO1	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
60	ARB_GPIO2	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
61	ARB_GPIO3	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
62	ARB_GPIO4	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
63	ARB_GPIO5	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
64	ARB_GPIO6	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
65	ARB_GPIO7	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
66	ARB_GPIO8	I/O	ARBITER	ARBITER'S PWM/DIGITAL OUTPUT/DIGITAL INPUT SIGNAL (0-3.3V)
67	GND_ARBITER	GROUND	•	ARBITER GROUND INPUT
68	VCC_ARBITER	POWER	•	ARBITER POWER SUPPLY (6.5 to 36V)

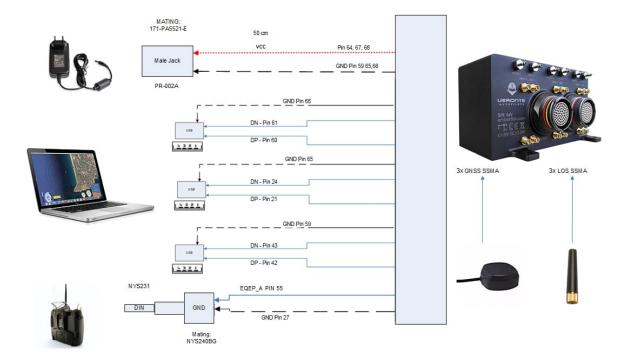
Table 4 – continued from previous page

# 3.2.3 Performances

Variable	Value
Weight (radio	750 g
included)	
Power Input	6.5 V to 36 V
Minimum	-40 °C
Temperature	
Maximum	+55°C (No convection, ask for increased limits (up to 71°C))
Temperature	
Max. Internal	+85°C
Temperature	
Minimum Pressure	0 kPa
Maximum Pressure	104 kPa
Maximum Dynamic	6 kPa (Ask for increased limits (up to 50kPa))
pressure	
Protection Rating	IP67 enclosure version
Acceleration Limits	$\pm 2$ g to $\pm 24$ g (for sustained maneuvers, transitional higher accelerations are possible (e.g.
(3 axes)	catapult launch). Ask for increased limits.)
Angular Velocity	$\pm 125$ deg/s to $\pm 2000$ deg/s (for sustained maneuvers, transitional higher angular velocities
Limits (3 axes)	are possible. Ask for increased limits.)
Magnetic Field	$\pm 4$ to $\pm 16$ Gauss
Limits (3 axes)	
GNSS	72 channels, GPS L1C/A, GLONASS L1OF, BeiDou B1I
Datalink	410 to 480 MHz licensed or FHSS/902-928MHz FHSS/2.4 to 2.483 GHz ISM Band/869.5-
	869.75 MHz ISM Band
Special Datalinks on	920 – 925 MHz, Singapore regulation compliance/869.5-869.75 MHz ISM Band
request	

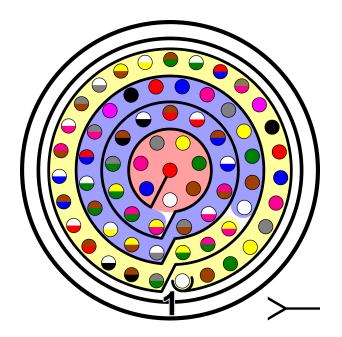
# 3.2.4 Annex 1: Connection Examples

### 3.2.4.1 Ground Station



**Connection Example** 

# 3.2.5 Annex 2: Connector colour code

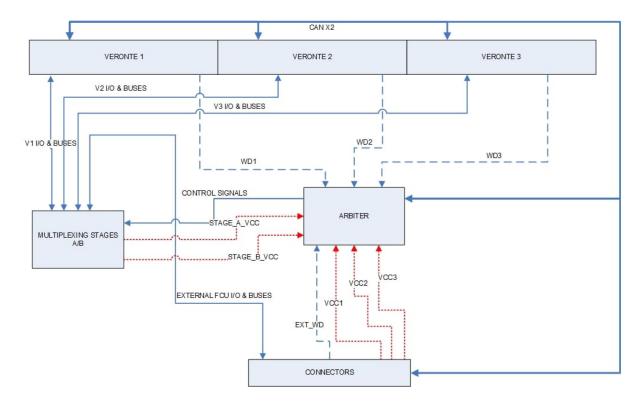


PIN	Color code	PIN	Color code
1	White	35	Gray
2	Brown	36	Pink
3	Green	37	Blue
4	Yellow	38	Red
5	Gray	39	Black
6	Pink	40	Violet
7	Blue	41	Gray – Pink
8	Red	42	Red – Blue
9	Black	43	White – Green
10	Violet	44	Brown – Green
11	Gray – Pink	45	White – Yellow
12	Red – Blue	46	Yellow – Brown
13	White – Green	47	White – Gray
14	Brown – Green	48	Gray – Brown
15	White – Yellow	49	White – Pink
16	Yellow – Brown	50	Pink – Brown
17	White – Gray	51	White – Blue
18		52	Brown – Blue
19	Gray – Brown White – Pink	53	White – Red
20	Pink – Brown	54	Brown – Red
21	White – Blue	55	White – Black
22	Brown – Blue	56	Brown – Black
23	White – Red	57	Gray – Green
24	Brown – Red	58	Yellow – Green
25	White – Black	59	Pink – Green
26	Brown – Black	60	Yellow – Pink
27	Grey – Green	61	White
28	Yellow – Green	62	Brown
29	Pink – Green	63	Green
30	Yellow – Pink	64	Yellow
31	White	65	Grey
32	Brown	66	Pink
33	Green	67	Blue
34	Yellow	68	Red

#### Connector HEW.LM.368.XLNP

**Warning:** The colour code is repeated due to the amount of pins. Check the pin number before connecting. Pin number increases following the black line of the picture above.

**4xVeronte Autopilot** is a **triple redundant** version of the Veronte Autopilot. It includes three complete Veronte Autopilot modules together with a dissimilar arbiter for detecting system failures and selecting the module in charge of the control. The autopilot selected as the master will be the one controlling the actuators and communicating with the payloads, as seen in the following block diagram.



#### 4xVeronte Overview

Each Veronte autopilot contains all the electronics and sensors in order to properly execute all the functions needed to control the UAV. Veronte executes in real time all the guidance, navigation and control algorithms for the carrying airframe, acting on the control surfaces and propulsion system and processing the signals from different sensors: accelerometers, gyroscopes, magnetometer, static pressure, dynamic pressure, GNSS and external sensors.

Additional I/O port is available for the connection of an external control system in case it is required and include it in the redundant scheme. It provides the system with full dissimilarity for high demanding environments as required by civil aviation authorities.

Datalink communications can be also redundant, being possible to install inside the autopilot 3 radios of different frequencies. For example, it allows you to have two radios working in the 900MHz frequency and one in the 2.4GHz, so in case there is any issue in the 900MHz band the module connected to the 2.4GHz band will take control. In addition, an external radio can be controlled as a critical device using the serial port in the redundant connector.

All three modules are managed by a dissimilar microprocessor. This arbiter includes voting algorithms for managing the module in charge of vehicle control. This microprocessor compares data from all modules in real time and processes it for discarding any autopilot module showing an undesired performance.

4xVeronte also includes two separate flight termination voting logics, completely dissimilar and implemented with simple hardware, with the purpose of giving the internal three Veronte Autopilots a way to decide by consensus if a flight termination signal should be activated or not.

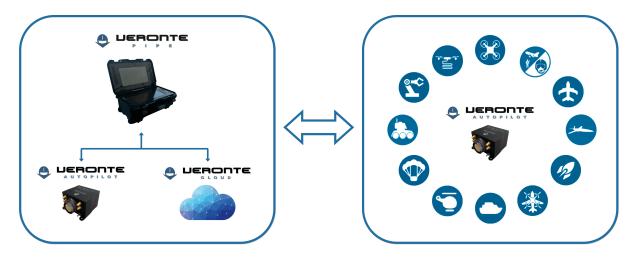
This redundant device allows platforms to perform **sensitive flight mission** and transport **valuable payload** with advanced safety conditions and high reliability. By installing a triple redundant core it is possible to extend the MTBF (Mean Time Between Failures) in the system. This control module is also suitable for both, fail-safe and fail-operational missions. Extending the operability of the system.



Veronte Autopilot Kit

This section provides the information about the Hardware of Veronte Autopilots. The content includes enclosure and mating connectors references, general informations about electrical connections and Veronte specifications.

Veronte is the main element in our Flight Control System for UAS. As shown in the following diagram, Veronte AP is used both in the ground segment (GND) and onboard (AIR).



#### System Overview

Veronte includes the required electronics and sensors in order to be able to properly execute all the needed functions for the UAS control. A Veronte-based FCS consists of the following components:

- Veronte AIR It executes GNC algorithms in real time in order to accomplish the planned mission and handle the payload.
- Veronte GND Link between Veronte Pipe and the AIR Units. It supports manual and arcade modes with conventional joysticks, it's capable to control a directional antenna in order to expand the maximum range and it

can be equipped with external physical interfaces in order to operate the system without Veronte Pipe.

• Veronte Pipe - Software dedicated to mission planning, configuration and operation. It allows the user to monitor the connected UAS in real time, to interact with them and to replay previous missions for post-flight analysis.

## CHAPTER

## FOUR

# **PIPE CONFIGURATION**

# 4.1 Installation

## 4.1.1 System Requeriments

Minimum Hardware Specification for installation:

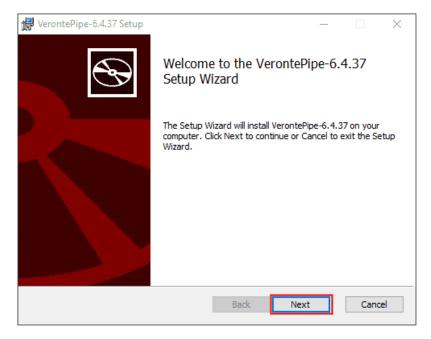
- CPU: Intel Core i5 6600K at 3.5 ghz or faster.
- RAM: 8 GB.
- VIDEO CARD: DirectX 11-capable video card.
- FREE DISK SPACE: 10 GB

Veronte supports the main Operating Systems (Windows, Linux and MacOS X). Contact Embention and we will provide you with the software that better fits your requirements. Also, you must have updated the latest version of java.

## 4.1.2 Windows

To install Veronte Pipe on Windows just execute "Veronte\_Pipe.exe" and follow the indications.

1. Click on Next.



Windows Installation Step 01

2. Select the directory where you want to Install and click on next.

₩ VerontePipe-6.4.37 Setup —		×
Destination Folder		
Click Next to install to the default folder or click Change to choose another.		<b>A</b>
Install VerontePipe-6.4.37 to:		
C:\Program Files\Embention\VerontePipe\6.4.37\		
Change		
۲۲		
Back Next	Can	cel

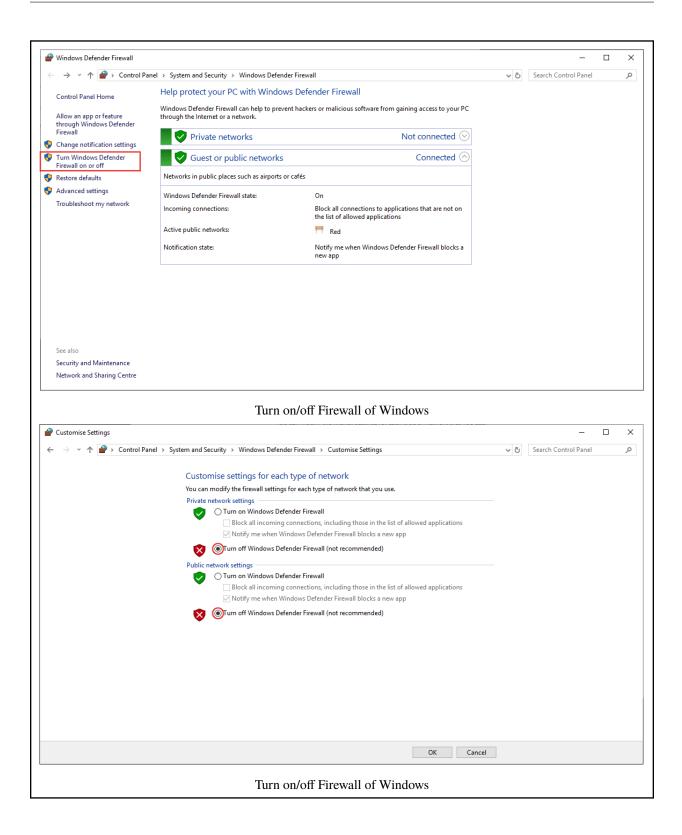
Windows Installation Step 02

3. Finally, click on Install (administrator rights are needed):

👷 VerontePipe-6.4.37 Setup	_		×
Ready to install VerontePipe-6.4.37			Ð
Click Install to begin the installation. Click Back to review or change a installation settings. Click Cancel to exit the wizard.	any of yo	ur	
Back 💱 Install		Can	cel

#### Windows Installation Step 03

**Warning:** If you have any problems with the installation, please disable antivirus and firewall of windows. Disabling the antivirus depends on your antivirus software. To disable the firewall, go to "Control Panel" and "Firewall of windows", then click on Turn on and turn off windows firewall and finally click on.



## 4.1.3 MAC

Attention: Pipe version for MAC is available on demand.

To install Veronte Pipe on Mac just double click on "VerontePipe\_x.x.x.dmg" (where "x.x.x" is the version number), in order to mount the image.

• • •			V	eronte	Pipe_2.7	.2		
< >	88 🔲 🖽 Kol	<b>*</b> ~	∰ <b>×</b>	₫	0		Q Search	
			Verd	ontePipe	2.7.2			+
Favorites	Name				^	Date Modified	Size	Kind
Applications	VerontePipe	_2.7.2.dn	90			10 May 2016 10:47	309,1 MB	Disk In
Dropbox								
A Google Drive								
All My Files	-							
C iCloud Drive	-							
(AirDrop								
Desktop	-							
Documents								
O Downloads								
H Movies								
🎵 Music								
Pictures								

#### Mac Installation Step 01

In the "VerontePipe" panel just follow the indications and move the Veronte Pipe application in the Applications folder to install it. The software is now ready to operate.

	VerontePipe	
	7-5	
VerontePipe	Applications	
S VerontePipe		

Mac Installation Step 02

**Warning:** If you have any problems during connection of VerontePipe, please check the firewall configuration of the application and disable it. To disable the firewall, go to "Security and Privacy" panel and be sure the program "allows incoming connections".

Deactivating the antivirus can be useful too. Disabling the antivirus depends on your antivirus software.

	Block incoming connections
S Skype	Allow incoming connections
Spotify	Allow incoming connections
Steam	Allow incoming connections
OuTorrent	Allow incoming connections
SerontePipe	Allow incoming connections
X-Plane	Allow incoming connections
Automatically allow signed soft	
Allows software signed by a valid ce network. Enable stealth mode	rtificate authority to provide services accessed from the services accessed from the services accessed from the services this computer from the services by te

# 4.1.4 Linux

Attention: Pipe version for Linux is available on demand.

To install Veronte Pipe on Linux (Ubuntu in this case) just double click on "VerontePipe\_x.x.x.deb" (where "x.x.x" is the version number), in order to open the Package Installer.

		Packa	ge Installer - vero	ontepipe – + ×
	erontepip	ies		Install Package
Description	Details	Included files	Lintian output	
Version: Maintainer Priority: Section: Size:	1.0 r: Unknov optiona unknov 422018	vn		

## Linux install step 1

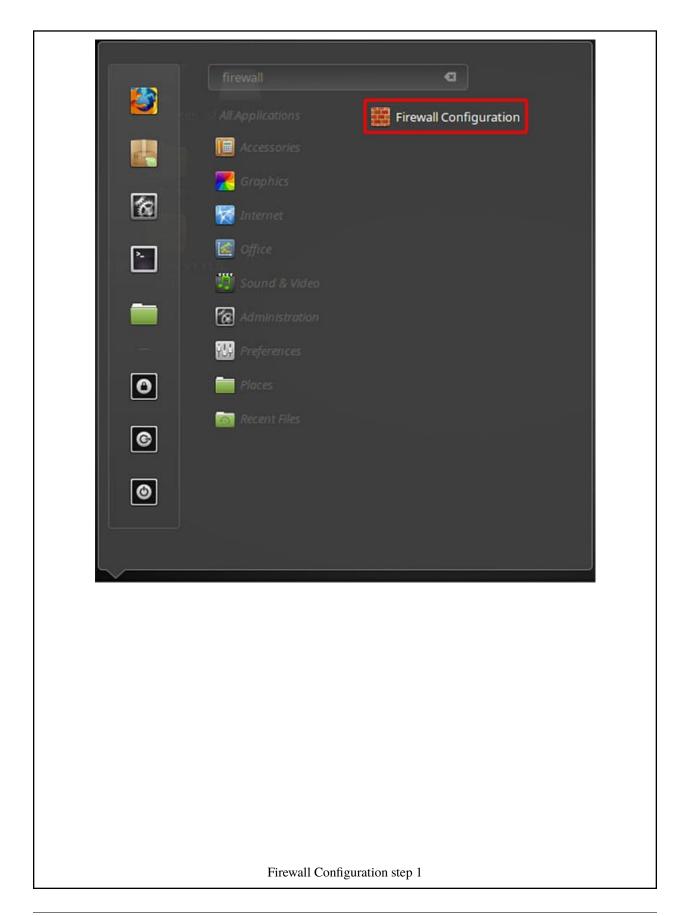
Then click on Install Package and wait the end of the installation process.

		Package Installer - verontepipe	- + ×
File Edit	Help		
Package:	verontepipe		Install Package
Status:	All dependencies		
		Package Installer - verontepipe	×
Descrip	Installation	finished	
	▶ Terminal	tePipe_v1.11.5.deb' was installed	
	Automatica	ally close after the changes have been succes	sfully applied Close
Installati	on complete		

#### Linux install step 2

**Warning:** If you have any problems during connection of VerontePipe, please check the firewall configuration of the application and disable it. To disable the firewall, go to "Firewall Configuration" panel and be sure the firewall Status is set on "Off".

Deactivating the antivirus can be useful too. Disabling the antivirus depends on your antivirus software.



	Fire	ewall – ·	+ ×
Fi	le Edit Help	Donate?	ж
	Firewall		
	Profile: Home 🔻		
	Status: OFF		
	Incoming: Allow 💌		
	Outgoing: Allow 💌		
	Rules	Report Log	
1		infort co2	
	N° Rule Name		
	+ - 0		
	Firewall disabled		
	Firewall Conf	iguration step 2	

# 4.2 Update

A setup wizard will be displayed in order to guide the user during the update process.

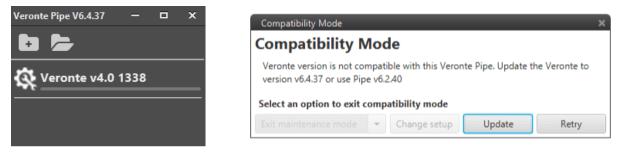
#### Warning:

- Although newer versions are usually compatible with older ones, when upgrading the system, updates must be done in the correct order. It is mandatory to update **Veronte Pipe** first, then **Veronte Onboard** and finally **Veronte on the Control Station**. Otherwise, part of the system could become unreachable.
- Never turn off Veronte during the update process. It could cause irreversible damage to the unit.
- When VerontePipe is updated be careful with managing .ver files. If the file was saved in a newer VerontePipe version, it will not be open in the actual one.

Current VerontePipe	PDI last saving	Compatibility
6.4.x	6.4.x	OK
6.4.x	6.2.x	OK
6.2.x	6.4.x	NO

When having the last version of Veronte Pipe installed in the computer, now is the time to update the software of the

autopilots. In order to do that, click on the unit you wish to update from the sidebar. Then the window shown on the right of the following figure will appear.



#### Compabtibility Mode

When clicking on Update, the next dialogue will appear on the screen.

Upgrading			×
UAV Veronte v	4.0 1338		
System Image  🗘	veronte-v6.4.28_2021-04-09_06-22-26.update	- 🖸	
Configuration	Migrate	- 6	
			Update

#### Update Veronte Autopilot

User can select:

- **System image:** With internet connection, the upgrading process will download the last version of the onboard software (in this case v6.4.28). User can also select a different system image from the PC.
- Setup: Default option of the upgrading is the migration of the Setup. By clicking on the folder icon, user can open the following window and choose a way to upload a different Setup: Template, Select from PC or from Library.

PDI Finder							×
C:\Users\jjr4\Desktop\Flight_test\6.4\FTC-9							≯
C\Users\jir4\Desktop\Flight_test\6.4\FTC-9	☆ FTC-9						
▶ 💼 GS ▶ 🖿 M600	Pdis				(		listory
	Name	Source	Veronte	Version	٥	۷	1
	FTC-9/GS	Root	Veronte Ground	6.4.29	٥	9	1
	FTC-9/M600	Root	M600	6.4.29	•	9	1
							_
							_
▼ ■ Library							
	*		<b>Ŷ</b>		1		
	Setup Not set		eration ot set		ductio lot set		
	Clear		lear		Clear		
					_		
	✓ Advanced view				IM		$\sim$
							_

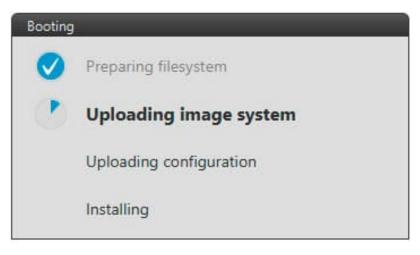
#### Veronte File Selection

The previous window shows info about Pipe version used to save the configuration.

When the booting is completely configured, the user can launch the Update by clicking on the correspondent button and waiting until the end of the process.

#### Warning:

- During the update, the system will reboot so never perform an update during an operation.
- Make sure you choose the right Veronte Update file for the selected Veronte Autopilot.



**Booting Process** 

# 4.3 Preferences

## 4.3.1 General

If you click in:



General Tool

This menu allows the user to modify the general configuration for Veronte Pipe.

Disable commit option at PDI saving			Keyboard Shortcu
loysticks	Sound		
	warning	Play	Change Default
	U1	Play	Change Default
	U2	Play	Change Default
	U3	Play	Change Default
	U4	Play	Change Default
	U5	Play	Change Default
	U6	Play	Change Default
	U7	Play	Change Default
	U8	Play	Change Default
	U9	Play	Change Default
	Reset	ADD	

Software Setup

Where we will found:

• Language: The user can choose the language that he/she wants. If Disable communications checking option is selected, degraded communications mode is disabled.

Sound Warning Play Change Default U1 Play Change Default U2 Play Change Default U3 Play Change Default U4 Play Change Default U5 Play Change Default U5 Play Change Default U6 Play Change Default U7 Play Change Default U8 Play Change Default	Disable commit option at PDI saving			Keybo	oard Shortcut
U1PlayChangeDefaultU2PlayChangeDefaultU3PlayChangeDefaultU4PlayChangeDefaultU5PlayChangeDefaultU6PlayChangeDefaultU7PlayChangeDefault	pysticks	Sound			
U2PlayChangeDefaultU3PlayChangeDefaultU4PlayChangeDefaultU5PlayChangeDefaultU6PlayChangeDefaultU7PlayChangeDefault		warning	Play	Change	Default
U3PlayChangeDefaultU4PlayChangeDefaultU5PlayChangeDefaultU6PlayChangeDefaultU7PlayChangeDefault		U1	Play	Change	Default
U4PlayChangeDefaultU5PlayChangeDefaultU6PlayChangeDefaultU7PlayChangeDefault		U2	Play	Change	Default
U5PlayChangeDefaultU6PlayChangeDefaultU7PlayChangeDefault		U3	Play	Change	Default
U6PlayChangeDefaultU7PlayChangeDefault		U4	Play	Change	Default
U7 Play Change Default		U5	Play	Change	Default
		U6	Play	Change	Default
U8 Play Change Default		U7	Play	Change	Default
		U8	Play	Change	Default
U9 Play Change Default		U9	Play	Change	Default
U9 Play Change Defa				-	
		Reset		DD	

Language

• Disable commit option at PDI saving.

Sound			
warning	Play	Change	Default
U1	Play	Change	Default
U2	Play	Change	Default
U3	Play	Change	Default
U4	Play	Change	Default
U5	Play	Change	Default
U6	Play	Change	Default
U7	Play	Change	Default
U8	Play	Change	Default
	Play	Change	Default
	U2 U3 U4 U5 U6 U7	U2PlayU3PlayU4PlayU5PlayU6PlayU7Play	U2PlayChangeU3PlayChangeU4PlayChangeU5PlayChangeU6PlayChangeU7PlayChange

Disable commit option at PDI saving

• Keyboard Shortcuts: key combination to get quicker some pipe configurations.

Disable commit option at PDI sa	ving			Keybo	pard Shortcu
loysticks		Sound			
		warning	Play	Change	Default
		U1	Play	Change	Default
		U2	Play	Change	Default
		U3	Play	Change	Default
		U4	Play	Change	Default
		U5	Play	Change	Default
		U6	Play	Change	Default
		U7	Play	Change	Default
		U8	Play	Change	Default
		U9	Play	Change	Default
		Reset	A	DD	

Keyboard Shortcuts

• **Joysticks:** this box shows you the joysticks that you have installed in your system.

Disable commit option at PDI saving			Keyb	oard Shortcut
oysticks	Sound			
	warning	Play	Change	Default
		Play	Change	Default
	U2	Play	Change	Default
	U3	Play	Change	Default
	U4	Play	Change	Default
	U5	Play	Change	Default
	U6	Play	Change	Default
	U7	Play	Change	Default
	U8	Play	Change	Default
	U9	Play	Change	Default
	Reset	A	DD	

Joysticks

- Alert audioclips: Alert Audioclips are used to manage audio files used on the application. They can be associated with system alerts on the Workspace configuration. There are nine audio files plus the alert\_audioclip.
  - To substitute an audio file for another one, the Change button displays a browser to select a mp3/wav file stored in the computer.
  - It is possible to return to the standard alert by clicking Default.

Disable commit option at PDI saving			Keyb	oard Shorte
pysticks	Sound			
	warning	Play	Change	Default
	U1	Play	Change	Default
	U2	Play	Change	Default
	U3	Play	Change	Default
	U4	Play	Change	Default
	U5	Play	Change	Default
	U6	Play	Change	Default
	U7	Play	Change	Default
	U8	Play	Change	Default
	U9	Play	Change	Default
	Reset	А	DD	

#### Alert Audioclips

To configure the alerts on a certain scenario visit Gauge Display on Workspace section.

## 4.3.2 Connections

If you click in:



Connections Tool

You can open the connections menu:

🔯 Preferences 🗱 😳 🛡 🖋 🛱	
TCP Server	Send telemetry
Port 0	Enable           Host         127.0.0.1         Port         3000         Frequency         10.0         Hz
Autodiscover COMs	
Add 👻	

#### Connections Menu

By default, Autodiscover COMs option is selected to be able to recognize Veronte Units. However, they can be added manually by unchecking this option following the steps below.

🔃 Preferences 🏟 🙆 🛡 🥓 闻	
TCP Server	Send telemetry
Enable Port C	Enable           Host         127.0.0.1           Port         3000           Frequency         10.0           Hz
Autodiscover COMs	
Serial CON DM3	

New Veronte

In case of using a different interface of connection, it may require changing some parameters.

Preferences 🏟 😳 🛡 🖋 🛱				
TCP Server	Send telemetry			
Enable Port 0	Enable Host 127.0	.0.1 Port	3000 Frequency 1	0.0 Hz
Autodiscover COMs				
Serial COM	Port	СОМЗ	-	
	Baudrate	115200 bps	•	
	Parity	None	•	
	Flow Control	None	•	
	Data Bits	8 bits	-	
	Stop Bits	1 bit	-	
Add 👻				

New Veronte Configuration

The following parameters can be edited in the menu shown above:

- Baudrate: this field specifies how fast data is sent.
- **Parity:** this field is a way of low-level error checking. It can be in odd or even.
- Flow Control RTS/CTS and XON/XOFF control can be configured if needed.
- Data Bits: this field defines the bits number of the message.
- Stop: number of the stop bit.

Туре	Bits
Start	1
Data	4-8
Parity	1-2
Stop	1-2

• TCP Server: Pipe gets information from the configured Port of the TCP (Transmission Control Protocol) Server.

Preferences 🗱 😳 🛡 🖋 🗓			
TCP Server	Send telemetry		
Enable Port 0	Enable Host 127.0.0	0.1 Port 30	00 Frequency 10.0 Hz
	11051 127.04	For So	
Autodiscover COMs			
Serial COM	Port	COM3	-
	Baudrate	115200 bps	•
	Parity	None	•
	Flow Control	None	•
	Data Bits	8 bits	-
	Stop Bits	1 bit	-
Add 👻			

### TCP Server

• Send-telemetry: Pipe sends the telemetry document through the configured parameters.

🔯 Preferences 🔅 😳 🛡 🖋 🛱			
TCP Server	Send telemetry		
Port 0	Enable Host 127.0.0	0.1 Port	3000 Frequency 10.0 Hz
Autodiscover COMs			
Serial COM	Port	СОМЗ	•
	Baudrate	115200 bps	•
	Parity	None	•
	Flow Control	None	•
	Data Bits	8 bits	•
	Stop Bits	1 bit	•
Add 👻			

Send Telemetry

# 4.3.3 Encryption

If you click in:

Preferences 🏟 🗘 🚺 Encrypt	ion in the second se

**Encryption Tool** 

Veronte Pipe contains the option to encrypt the data transmitted from the autopilots and from Pipe itself. To configure this feature go to **Preferences** (Veronte Pipe) – **Encryption**.

- 1. Select the System that will be encrypted on the left side of the menu. By default, the unit set to encrypt is Veronte Pipe.
- 2. Select an Encryption Type. There exist three different encryption types, depending on the key size: 128, 192 and 256 bits. If one of the last two is selected, an additional step is required.

Pref	ferences	<b>\$</b> 🗘 🕻	¥ 🕅							
Chan	ige end	ryption r	equires r	eboot						
5	State		Veronte			Encryption				
$\bigcirc$	🗙 M6	00				Туре		None		-
$\sim_1$	•				· .	Key		None		
						Confirm	1	AES 256		
					-		- <b>b</b>	AES 192		
								AES 128	2	 
					-		-1	M600		
					_					
					-					

Encryption Menu

<b>Warning:</b> with 192 and 256 an additional step is required. Press The Shield to open the window that provides the instructions to ensure the functioning of AES (Advanced Encryption Standard).
Cryptography Extension 🗙
Cryptography Extension
Step 1: Download Java Cryptography Extension (JCE)
Step 2: Copy content in " <path installation="">\Embention\VerontePipe\runtime\lib\security\"</path>
Step 3: Restart Veronte Pipe
Advanced Encryption Standard

- 1. Specify a Key, this will be used to encrypt the data and can be used later to get the information back to a readable format.
- 2. Press the button Change the default encryption, a pop-up window will appear.
- 3. Restart the encrypted autopilots.

Cha	nge e	encryption requ	ires reboot			
	State	Ver	onte	Encryptio	n	
$\checkmark$	8	Octocopter		Туре	1 AES 256	-
				Кеу	•••	
				Confirm	•••	
					Change the default e -Veronte Pipe -Octocopter	encryption of:
		Confirmation			×	
		Pending changes	require a restart Ver	onte 1499 for t	ake place 🥐	
		What would you like				
			Continue and restart ver	Abort w	vithout saving changes	

#### Veronte Restarting

Once autopilots are restarted they will show up in the right bar of Veronte Pipe. If both autopilot and Pipe are encrypted nothing will change in the view. If only the autopilots are encrypted (or the autopilots are connected to different encrypted Veronte Pipe), they will show up as shown in the following figure.

Veronte 255	
Both autopilots encrypted	
Ø Veronte 255	
Penguin Embention	

Only Ground autopilot encrypted

If the autopilot icon appears with the label "Veronte X" (where X is the ID of the autopilot), it is not possible accessing to its configuration and user can not use it.

#### 4.3.3.1 Remove Encryption

To remove encryption temporarily and be able to use the autopilot it is necessary to left-click on the autopilot label and insert the encryption type and password in the following window.

Encrypt		1
Encryption		
Туре	AES 128	•
Key	*******	
		Accept

Remove temporarily encryption

To remove definitely the encryption it is sufficient to go in the Encryption Panel and selecting the encryption type None. The software will ask a last time for the password and, after the autopilots restarting, the encryption will be removed.

## 4.3.4 System Units

This panel shows all the system units available for the system variables. They are arranged according to the type of variable (velocity, acceleration, temperature, etc). It can be found in **Preferences** – **Units**.

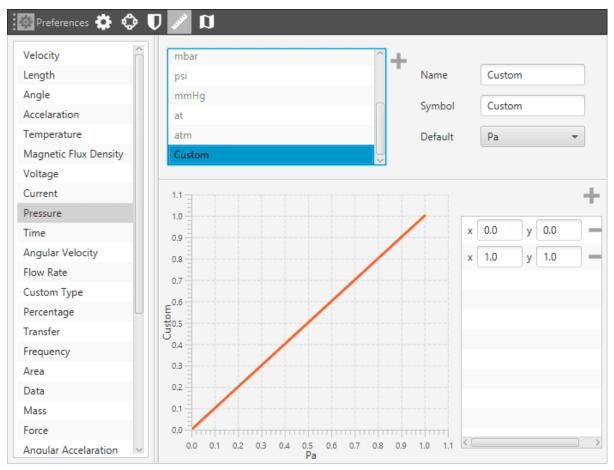
🔯 Preferences 🔅 🕻	🗘 🔽 📈 🗊			
Velocity	Pa	^ <b>+</b>		
Length	kPa		Name	
Angle	bar			
Accelaration	mbar		Symbol	
Temperature	psi		Default	Pa 👻
Magnetic Flux Density		~		
Voltage				
Current				
Pressure				
Time				
Angular Velocity				
Flow Rate				
Custom Type				
Percentage				
Transfer				
Frequency				
Area				
Data				
Mass				
Force				
Angular Accelaration	~			

System Units

Veronte Pipe works by default with units of the International System, but these ones can be changed by selecting others from the ones shown when pressing Default option.

#### 4.3.4.1 Creating Custom Units

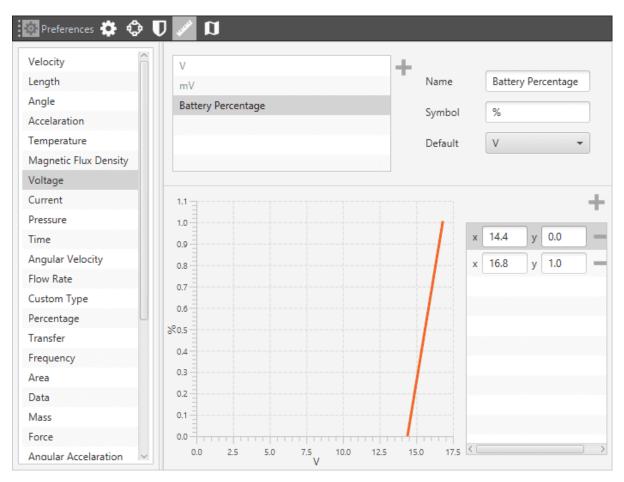
- 1. Click on "+" button, and a new variable will appear in the menu.
- 2. Introduce the conversion from the default unit to the new one. The conversion formula is created by introducing as many points as desired in the graph shown in the next figure.



#### Custom Unit Definition

An example is added to improve the understanding:

Considering the voltage of a LiPo battery, it could be useful to have a unit that indicates the remaining percentage of battery. For example, if the battery used is a 4S, the fully charged voltage is 16.8 V, while 14.4 will be the one when the battery does not provide the amount of energy needed to fly. So 16.8 V will correspond to 100% and 14.4 to 0%. Taking that into account the conversion graph will be the one shown in the next figure.



Voltage To Percentaje Conversion

**Warning:** In this panel, it can be selected the default system units. It means the first displayed unit will be the selected one, but it will be possible to change it temporarily in all Pipe windows.

#### 4.3.4.2 Units

The table below shows all the available units in VerontePipe.

Variable Type	Units
Velocity	[m/s] [kt] [km/h] [mph] [ft/s] [mm/s] [ft/m]
Length	[m] [km] [mi] [NM] [yd] [ft] [in] [cm] [mm]
Angle	rad[-;]°[-180;180] rad[0;2] °[0;360] [° · "] [° · "](N/S) [° · "](E/W)
Acceleration	$[m/s^2]$ [ft/s <sup>2</sup> ] [in/s <sup>2</sup> ] [g]
Temperature	[K] [°C] [°F]
Magnetic Flux Density	[T] [mG] [gauss] [nT]
Voltage	[V] [mV]
Current	[A] [mA]
Pressure	[Pa] [kPa] [bar] [mbar] [psi] [mmHg] [at] [atm]
Time	[s] [min] [h] [s] [ms] [Time]
Angular Velocity	[rad/s] [rad/m] [rad/h] [rps] [rpm] [rph] [°/s]

continues on next page

Variable Type	Units
Flow Rate	[m <sup>3</sup> /s] [gal/s] [gal/h] [l/s] [l/h]
Custom Type	[]
Percentage	[x1] [%]
Transfer	[pkts/s]
Frequency	[Hz] [mHz] [kHz]
Area	$[m^2] [cm^2] [mm^2] [km^2] [mile^2] [ft^2] [yd^2]$
Data	[bit] [byte] [KB] [GB] [bytes/s]
Mass	[kg] [g] [tonnes] [lbs] [oz]
Force	[N] [kN] [lbf] [pdl]
Angular Acceleration	$[rad/s^{2}] [rad/m^{2}] [rad/h^{2}] [^{\circ}/s^{2}] [^{\circ}/m^{2}] [^{\circ}/h^{2}]$
Baudrate	[Bd] [kBd] [MBd]
Pressure Variance	[Pa <sup>2</sup> ]
Magfield Variance	$[T^2]$
Velocity Variance	$[(m/s)^2] [(cm/s)^2] [(mm/s)^2]$
Numeral System	[bin] [octal] [dec] [hex]
Pressure Square Error Rate	$[Pa^2/s]$
Centimeters/Pixels	[cm/pixel]
Jerk	$[m/s^3]$
Power	[W] [kW] [Kgm/s] [erg/s] [CV]

Table 1 – continued from previous page

## 4.3.5 Map

If you click in:

Preferences 🔅	٩	U	JANKA C	Û	Мар	
					Iviap	

Map Tool

In the map menu, the user can choose the coordinate preference (from MGRS, Decimal Degrees and Degrees) and download the Terrain Height.

### 4.3.5.1 Terrain Height

Preferences 🔅 🗘	<b>U</b> # <b>I</b>	
Coordinate preference	Decimal Degrees 🗸	a)
Height preference	m	b)
Provid	lers terrain height	



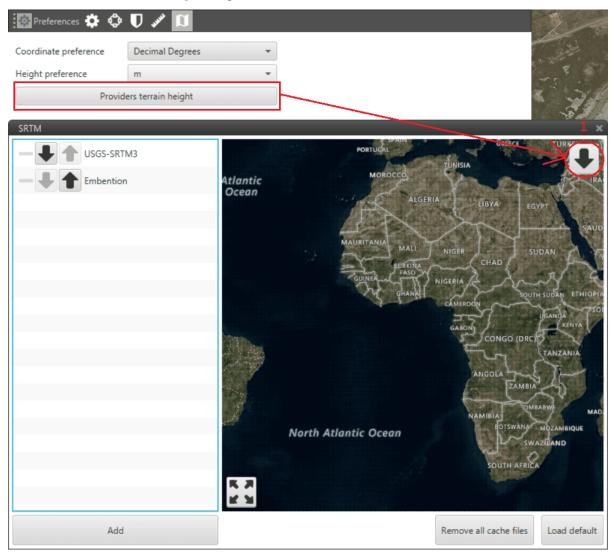
You can select the units of the coordinates clicking on **a**). You can also select the units of the height on clicking on **b**).

In order to perform the altitude estimation, Veronte installs a GIS (Geographic Information System) consisted of two meshes. When creating a mission, the terrain altitude on the mission area is automatically downloaded from the internet.

#### 4.3.5.2 Download Altitude Information

If the flight operation is carried out in an area where there is no internet connection, the altitude information can be downloaded a priori. To download the information:

1. Select **Providers terrain height** and press button **1**.



#### Terrain Height

1. Click on a quadrant to download the information of that zone into the system.

There are two providers of altitude information in Pipe:

- The first one is the **SRTM3** (shuttle radar topographic mission 3) which contains the altitude information for the territories outside the United States (the number 1 is for USA).
- The other one is a server created by **Embention** with altitude information of areas that do not appear on the SRTM such as Iceland.

### 4.3.5.3 Custom Terrain File

Pipe also provides the option of introducing a custom terrain file.

Clicking on Add appears a menu with two options to charge a terrain file in the system:

- Local: allows the user to select a file from the computer.
- **Remote:** gives the option to introduce a URL (Un\*iform Resource Identifier) of an altitude provider from both a web or FTP (File Transfer Protocol) server.

Add		×
Name		
Local	Folder	
Remote		
Туре	🖲 Web 📄 FTP	
		Save

Custom Terrain Altitude Source

This section contains all preferences settings for Veronte Pipe (software). To access them, the user has to use the Preferences Toolbar.

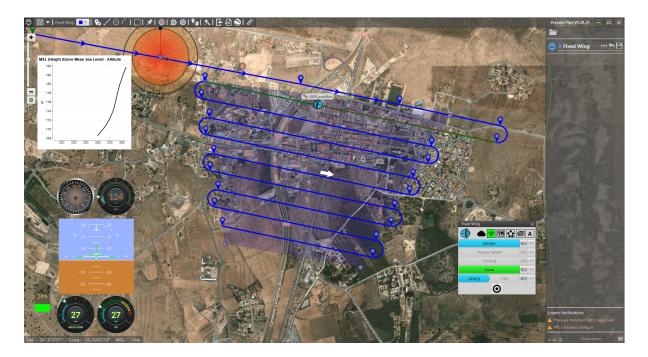
Click on (Main Menu), and then select Preferences in the pull-down menu, a new toolbar with different options will appear.



#### Preference Toolbar

The different elements of the setup toolbar are detailed in the following table.

	Item	Description
\$	General	Displays general configurable fields
¢	Connections	Open connections configuration
U	Encryption	Displays encryption configuration
JAN AND A	Units	Open system units configuration
Ø	Map	Coordinate preference and height terrain providers



#### Veronte System Overview

Veronte Pipe software is designed to operate any unmanned vehicle using Veronte as the onboard autopilot. With Veronte Pipe, users have an easy-to-use application with real-time response and telemetry with safety features.

It has been developed using software standard model of IEEE STD 830-1998, Recommended Practice for Software Requirements Specifications (SRS) and STANAG 4671 documentation, subpart about UAV Control Stations adapted to Veronte system.

Veronte Pipe includes:

- Telemetry: Real-time onboard UAV metrics, such as sensors, actuators and control states.
- **Telecommand:** Support for all synchronous operator control commands that can be sent to the flight segment, e.g. operational mode switch, mission management, payload control.
- **Mission design:** User defined, predefined mapping and drop missions configuration as well as inflight mission edit .
- **Mission analysis:** Post-flight viewer, reproduce all recorded data from a previous flights and generate plots and reports.
- Configuration: Edit vehicle settings, such as servo trim, interface/port management, modes and automations.
- Multiple Users: One or more operators can work simultaneously .

## CHAPTER

**FIVE** 

# **USERS & ACCESS LEVEL**

# 5.1 User Toolbar

The user toolbar displays the options related to the configuration of the user account.



User toolbar

•	Details	Displays configurable fields.
admin	User	Logged In user.
	Log Out	Log Out from Veronte Pipe.

# 5.2 User Manage

On the first software run, it will start with the default user:

- User: admin
- Password: admin

	TOPILOTS					
Password						
Login with VeronteCloud						
Remember me	Enter as a Guest Sign in					

#### Default user

After the first use of Veronte Pipe, it is possible to change the username and the password. Moreover, Pipe gives the option of limiting the use that each user has over the software, what could be considered as a safety measure to limit the thing that can be changed for each person according to its knowledge over the different parameters. That is done trough the permissions, where the options that can be changed by the user can be selected.

Warning: The user "admin" always will have all the permissions.

# 5.3 New User

You can create a new user and give him the permissions that you want.

Config Users		Add User	×			
dmin	Admin		~			
	Permissions	Add User	(?)			
	Export setup		2			
	V Import setup	Name user (embention				
	✓ Edit operation	Name user a embention	support			
	V Display setup					
	V Edit setup	OK	Cancel			
	✓ Change current	workspace 3				
	V Display settings	✓ Display settings of the workspace				
	✓ Edit workspace					
	V Edit mission					
	✓ Adding entries t	o the log				
	✓ Download postf	light				
	✓ Remove postflig	ht				
	✓ Telecomand					
Add	SD format					

New User

- 1. Click in "Add".
- 2. Write the new user name.
- 3. Click "Ok".
- 4. Write the password.
- 5. Click Ok.



New User Password

When the new user is created, you can give him the permissions that you want as a admin.

### CHAPTER

SIX

# WORKSPACE

# 6.1 Workspace Toolbar

Workspace settings allow the user to customize any information to be displayed on the screen for monitoring the operation. Custom workspaces can be created, set any workspace as default in order to open it automatically on system start. All these options are available in the Workspace Toolbar, which is shown on the image below.



Workspace Toolbar

	Show/Hide Workspace
2	Enable/Disable Worspace Telecommand
ø	Edit Workpace
	Many options to manage workspace

## 6.1.1 Edit Workspace

Workspace	×
Telemetry Ma	
<ul> <li>▼ [Fixed widgets]</li> <li>Wind Direction</li> <li>■ PFD</li> <li>⇒ pruebecilla</li> <li>⊘ Line of Sight</li> </ul>	
New <b>3</b> -	

'Open Details' Menu

- 1. Telemetry: Displays a list with all the displays superposed to the map (widgets).
- 2. Map: Allows to set a map or background color to the workspace.
- 3. New: Allows the addition of new displays which can be configured in Widgets and Main.

By right clicking on an item in **Telemetry** or **Map**, the following dropdown list appears:

Workspace								×
Telemetry Map								
▼ [Fixed widgets]		Name			🗞 Veronte	SELECTED-VER	ONTE	-
≍ Roll ▼ Attitude		Variable		Pitch		Unit	rad	-
Pitch		Min	0.0 r	ad Max	1.0	rad 🗸 Auto		
raw <mark>™</mark>	Move to case Hide	Gauge	式 Chart	•	Ranges			
	Clone	Enable		Time Since	Hardware Start-Up	Unit	5	•
	Change Group	Min	0.0	s Max	1.0	s 🗸 Auto		
	Remove				Ranges			
		Opacity				0		
		Pos X	50.0	Pos Y	50.0			
		Width	400	Height	300			
		Background	•	Front	-	Front 2	-	
		Time	60.0	s				
New	•							

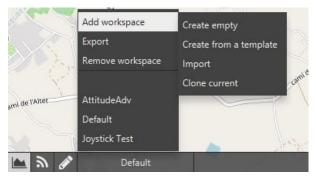
- Move to case.
- Hide: Occults the selected element.

- Copy: Stores in the clipboard the selected element.
- **Change Group:** Opens a window to type the group to place the element in. If there is no group created or the name typed does not belong to any group, this option will create one and store the element in it.
- **Remove:** Deletes the selected element.

The option highlighted in red is the option to lock the chart. If all the elements of the group are marked they will move together, if one is not marked it could be moved with respect to the other group elements.

### 6.1.2 Add workspace

By clicking on the fourth icon or space (Previously on 'Edit' icon) a dropdown list appears with the current workspaces and some options. Workspaces can be created by clicking on **Add workspace** 





The workspaces can be created from Empty, Create from template, Import or Clone current.

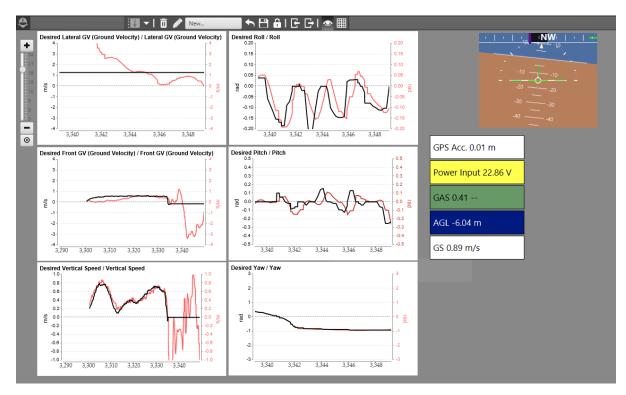
Workspaces can be modified too. The system allows the user to change the appearance and when it is completed, it can be exported.

**Warning:** Please note that Workspaces are not stored in Veronte Autopilot. Workspaces are located in the computer in which Veronte Pipe is installed.

In VerontePipe there are some templates available. When the workspace toolbar is open, the following templates can actually be opened:

- Attitude\_Adv (Advanced)
- Attitude\_PLANE
- Attitude\_VTOL
- Default
- Joystick Test
- Map
- Output Test
- Sensors
- · Stick Inputs

Following a picture of one of them:



#### Attitude Adv template

To do this is sufficient to open the toolbar, then the workspace selection and click on New.

## 6.1.3 Import/Export Workspaces

It is possible to save the current workspace on a **.wsn** file, that can be loaded later in a different configuration.

# 6.2 Map Display

## 6.2.1 Map provider

The map widget configures the background map that appears in Veronte screen. In the list shown in the following figure, it is possible to select the map provider from diverse options.

Telemetry       Map         Map tiles       Open Street Map         Background color       Google Satellite         Google Street       Bing Satellite         Bing Satellite       Bing Street         Open Street Map       Open Street Map         Open Street Map       Open Street Map         Open Street Map       Stamen terrain         Stamen Virator       Virator	Workspace			
Background color Google Satellite Google Terrain Google Street Bing Satellite Bing Street Open Street Map Cycle Open Street Map Open Sea Map Stamen terrain	Telemetry Map			
Background color Google Satellite Google Terrain Google Street Bing Satellite Bing Street Open Street Map Open Street Map Open Street Map Stamen terrain	✓ Map tiles	Open Street Map 🔹		
Google Terrain Google Street Bing Satellite Bing Street Open Street Map Cycle Open Street Map Open Sea Map Stamen terrain	Background color	Google Satellite		
Bing Satellite Bing Street Open Street Map Cycle Open Street Map Open Sea Map Stamen terrain	2	Google Terrain		
Bing Street Open Street Map Cycle Open Street Map Open Sea Map Stamen terrain		Google Street		
Open Street Map Cycle Open Street Map Open Sea Map Stamen terrain		Bing Satellite		
Open Street Map Open Sea Map Stamen terrain		Bing Street		
Open Sea Map Stamen terrain		Open Street Map Cycle		
Stamen terrain		Open Street Map		
		Open Sea Map		
Stamen Virator		Stamen terrain		
		Stamen Virator		

Custom Map Example

## 6.2.2 Custom image

Custom maps can be displayed in Veronte Pipe. It allows to include as many images as desired that will be displayed over the map.



Background Image Example

To insert an image within the map click on **New**, **Add images** and then select the desired image file. Once the image has been loaded, it is possible to configure its position and appearance in the image manager.

Workspace			×
Telemetry Map			
▼ [Fixed widgets]	Name		Load image
☆ Roll ▼ Attitude	Opacity o		Resizable image (in map)
⇔ Pitch ⇔ eee Yaw	Relative	Approach Initial 👻 😫	Preserve ratio
Add Image	Absolute	Decimal Degrees • UAV POS MAP POS	
	Latitude	0.0	
	Longitude	0.0	
	Relative	Approach Initial	EMBENTION
	Absolute	Decimal Degrees • UAV POS MAP POS	
	Latitude	0.0	
	Longitude	0.0	
New 👻			

#### Background Image Positioning and Manager

Item	Description
Name	Define widget's custom name.
Opacity	Change widget opacity.
Relative	Define image's relative position coordinates.
Absolute	Define image's absolute position coordinates (UTM, MGRS, Decimal degrees).
UAV POS	Changes image's position to the current selected UAV position.
MAP POS	Allows the user to click on the map and change image's position to the position clicked
Load image	Opens a window to select and place an image on the map.
Resizable image (in map)	When selected, allows change image dimensions.
Preserve ratio	When selected, image dimensions' ratio is conserved.

# 6.3 Widgets

### 6.3.1 Gimbal

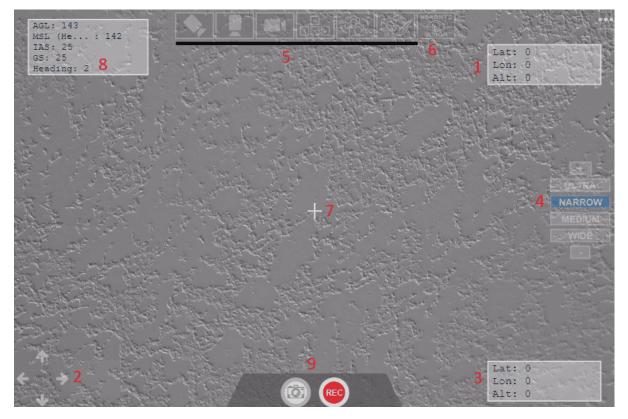
This widget allows the user to display a camera on screen and command a Gimbal if there is any device connected. The options configurable on this widget are the following ones:

- 1. **Geotagging.** Coordinates and height from mouse point selected. If Veronte Vision is in use, coordinates and height are from the tracking point.
- 2. **Pointing.** Manually move the camera through a digital stick.
- 3. Crosshair. Shows the coordinates from the picture central pixel (crosshair).
- 4. **Zoom control.** Top and bottom buttons for gradual zooming (+ and icons) and 4 predefined zoom levels: wide, medium, narrow and ultra.
- 5. Camera control. Buttons placed on the top part of the widget for:
  - Three predefined positions (45°, Zenithal, Frontal Navigation)

- Allow keyboard camera control
- Camera switch EO IR
- Colour palette switch for IR camera.
- 6. Crosshair. Show/hide, resize and colour modification.
- 7. Telemetry Overlay. Enables a screen with telemetry information into Gimbal Widget.
- 8. Record control. Photography and video recording, choosing in which folder to be stored.
- 9. Gimbal. Choose controlled Gimbal.
- 10. Camera. Choose controlled Camera.

Workspace				×
Telemetry Map				
▼ [Fixed widgets]	Name		🗞 Veronte	SELECTED-VERONTE -
☆ Time Since Hardware Start-Up	Opacity	0	GENERAL OVERLAY	TELEMETRY OVERLAY
▼ Attitude ☆  Pitch	Pos X	50.0	Geotagging 1	Uav telemetry <b>7</b>
式 📾 Yaw	Pos Y	50.0	Pointing 2	Variables Telemetry
) embention.png	Width	800	Crosshair telemetry 3	Decimals 0
	Height	600	Zoom control 4	RECORD
	Gimbal 9	No gimbal 🔹 👻	Camera control 5	Record control 8
	Camera 10	0 -	CROSSHAIR	Save Folder Change
	Center X	Time Since Hard	Show crosshair 6	
	Center Y	Time Since Hard	Size	
	SLA Model	Gimbal 30Z 🔹	Color 📃 💌	
New 🔻				

Gimbal Widget Configuration Menu



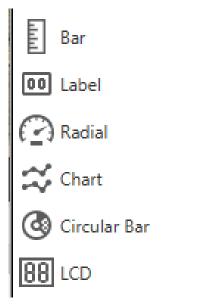
Gimbal Widget Display

## 6.3.2 Gauge Display

#### 6.3.2.1 Gauge Selection

This option is used to display a variable on the workspace. In order to display a new variable:

1. Go to **Workspace** and click on **New**.



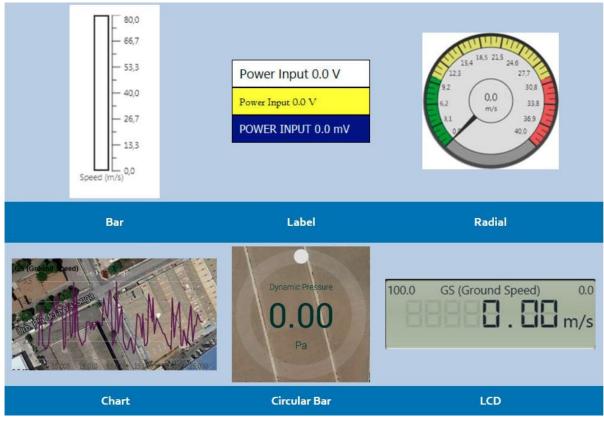
Gauge Selection Menu

2. When a gauge is selected, the system will ask for a variable to display. The variable selected can be changed easily by clicking on **Variable**, appearing then the following window.

Select variable		×
Select var	Search	
U ADC channel 1		â
U ADC channel 10		
U ADC channel 11		
U ADC channel 12		
U ADC channel 13		
U ADC channel 14		
U ADC channel 15		
U ADC channel 16		
2	Cance	el Accept

#### Variable Selection

Once the variable to display has been selected, the way it is shown in the interface is also configurable. Here are some of the different gauge types that can be chosen.



Gauge Types

## 6.3.2.2 Gauge Configuration

Each gauge type can be configured in its panel and some parameters can be changed:

Workspace								×
Telemetry Map								
▼ [Fixed widgets]	Name			🗞 Veronte	SEL	LECTED-VERO	NTE	-
I AGL (Above Ground Level) – Height	Variable	AGL (Abov	/e Ground Level)	) – Height		Unit	m	-
▼ Attitude	Gauge	00 Label 🔻		Ranges		Decimals	2	
式 📾 Yaw	Opacity				0			
) embention.png	Pos X	50.0	Pos Y	50.0				
	Width	300	Height	50				
	Background		Front	•				
	Font	System Regular			•			
	Font size	12 👻	Border					
	✓ Show title	2	Show Valu	Je		Show Uni	its	
New 👻								

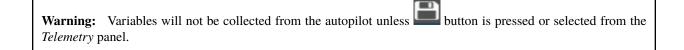
#### Gauge configuration

- Gauge name. It can be changed by typing a new one. (Orange)
- Selected Veronte. The dropdown menu allows to select another linked Veronte unit. (Blue)
  - If Selected Veronte is the option taken, the gauge will display the information corresponding to the autopilot which has been clicked on the Side Panel.
- Variable units and decimals. (Red)

**Warning:** Changing the unit of measure of the variable does not imply that the selected Veronte will gather the corresponding data in the selected unit. It only converts the unit.

- Displayed variable. (Green)
- Gauge type, dimensions and position. (Black)
  - Gauge: Allows the user to change the gauge type (Bar, Label, Radial...)
  - **Ranges:** Allows the user to define an interval by clicking on the '+' button. For this interval several customizations can be made:
    - \* Colour: Change the color of the interval which will be shown graphically in the gauge (does not apply to graph gauges)
    - \* Alarm: By clicking the bell icon an alarm can be created. For more information about alarm customization please refer to 'Alarm Creation' section.
    - \* Text: Add a text to be displayed (only in the gauge types that allow this addition of text)

One of the options that appear for all the kind of gauges is the customization of the colour according to the value of the variable shown.



#### 6.3.2.3 Alarm Creation

- 1. Select the option **Range** and a new window will be displayed.
- 2. In the new window, the user can create different ranges, each one having a certain colour and an associated alarm of the ones configured on **Pipe Configuration-Preferences-General-Alert\_Audioclips**.
- 3. Click on the Alarm icon and configure it.

Workspace						×
Telemetry Map						
▼ [Fixed widgets]	Name		% Veronte	SELECTED-VE	ERONTE	-
Ground Velocity Down	Variable	Ground Velocity I	Down	Unit	m/s	-
	Min	0.0 m/s Max	1.0 m	1/s		
	Gauge	E Bar 🔻	Pennoc	5		
	Opacity		30.0 m/	/s]-> 40.0	m/s 🔳 🔹	- 🌲
	Pos X	50.0 Pos Y	Caution			
	Scale	Medium 👻				
	✓ Scala on	the right				
		Alarm	×			
	N	✓ Actived				
		Alarm warning	•			
		Repeat 0.0	s			
		✓ Silenceable	_			
New	·	Accep	t			

Gauge – Range

**Warning:** In the case of displaying a boolean on the workspace (GNSS Navigation Down for example), in the Range menu will appear automatically the two states, each one with a colour (green, red), and also with the possibility of selecting an audio clip for each one of them.

When displaying a chart, it is useful to overlap with transparencies two or more in the same figure to observe their evolution. To do that, Pipe provides the *Change Group* option. Right clicking on the graph and selecting this item displays a window where the group name can be introduced. If two charts are in the same group, their relative position will be kept unchanged (they will move together).

Workspace									×
Telemetry Map									
[Fixed widgets]		Name	-			🗞 Veronte	SELECTED-VERG	ONTE	-
Image: Pitch Rate       Imag	Move to cas Hide Clone Change Gro Remove	;e iriable in auge	0.0 Chart 0.0 50.0 400	rad/s	Pitch Rate Max Ime Since Hard Max Pos Y Height	1.0     rac       Ranges     dware Start-Up       1.0     Ranges       50.0     300	Unit	rad/s	•
		Background Time	60.0	s	Front	•	Front 2		
New	•								

Variable - Group

The option highlighted in red is the option to lock the chart. If all the elements of the group are marked they will move together, if one is not marked it could be moved with respect to the other group elements.

## 6.3.3 Advanced Primary Flight Display (PFD)

The **primary flight display (PFD)**, also known as "artificial horizon", represents graphically the attitude of the aircraft (roll, pitch and yaw). This display is highly configurable in colours and size. It is possible to select between the 2D and 3D visualization, and also the surface deflection can be represented.

Workspace						2 1007 - 2-21	< <u>      </u>	1.1.1.1.1	I SWI I I I	<u> </u>
Telemetry Map									<u>```\``</u> '2	
▼ [Fixed widgets]	Name			% Veronte	SELECTED-VERO	NTE 👻		,20	· — <u> </u>	0
🛃 PFD	WIDGET		PFD		Surfaces	-				1. A.
	Opacity	0	Indicators		✓ Ailerons	Control Out 👻		<b>1</b> 0	1	
	Pos X	875.0	Compass		✓ Elevator	Control Out 👻	1			· .
	Pos Y	172.0	Guidance	•	✓ Rudder	Control Out 👻	-			
	Width	450	✓ Compass	Desired	<u>3D</u>		-			
	Height	450	V Pitch	Desired	Enable 30	<b>)</b>				
			✓ Roll	Desired	Waypoint	ts 📕 💌		-10		)
	Sky	•		-	Camera					
	Ground	-	Desired H	leading				-20		
	Advanced	$\checkmark$	Flight Pat	h Angle	3D Model			-20	-20	
					Mar	nage models				
New 👻								-30	-30	

#### PFD Configuration

Item	Description
Name	Define widget's custom name.
Bring to front	Places the current widget above every other display.
SELECTED-VERONTE	Dropdown menu to select which Veronte will the widget gather data from.

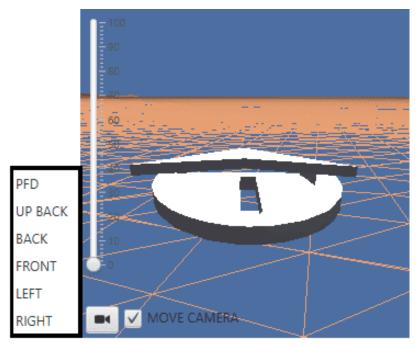
Widget	
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.
Width/Height	Define widget's width/height.
Sky/Ground	Select sky's/ground's color.
Advanced	When marked, displays all the configuration options available.

PFD	
Indicators/Compass/Guidance	Change display color of the selected feature.
Compass/Pitch/Roll	When marked, displays the selected feature.
Desired	When marked, it displays the desired Compass/Pitch/Roll, a color change option
	is available.
Desired Heading/Flight Path	When marked, displays the selected feature.
angle	

Surfaces	
Ailerons/Elevator/Rudder	When marked it displays the selected control surface, the control channel can also be
	selected.

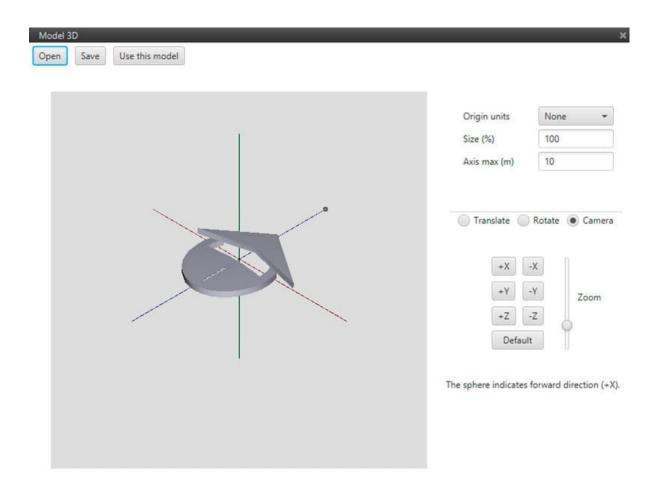
3D	
Enable 3D	When marked, it enables the 3D feature
Waypoints	Displays mission waypoints in the PFD.
Camera	Displays camera view if 'Enable 3D' feature is marked.

- By clicking the camera icon, the camera view can be selected: *PFD* (internal view at the cabin), *UP BACK*, *BACK*, *FRONT*, *LEFT*, *RIGHT*.
- When an external view is selected, it will be displayed a slide to change the distance between the camera and the aircraft, and a *MOVE CAMERA* checkbox, which allows to move around the view by dragging the mouse on the widget.



3D PDF visualization

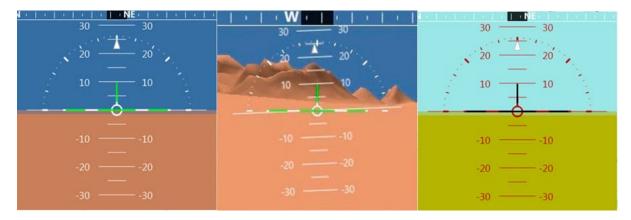
3D Model	
Manage models	Changes the 3D model display.



#### 3D Model

- Open: it allows to select an STL file to be loaded.
- Save: save user changes in an STL file.
- Use this model: select the current model to be displayed on the widget.
- **Origin units:** user can select origin file units. The model is real-scaled according to the terrain shown on the widget.
- Size: percentage scale factor.
- Axis max: axis length in meters.
- **Translate/rotate/camera:** translate and rotate modify model orientation. Camera changes the view displayed in Model 3D window. X,Y,Z buttons produce changes according to this axis. Default button resets any modification.

Some PFD display configurations are shown as an example:





## 6.3.4 Terrain

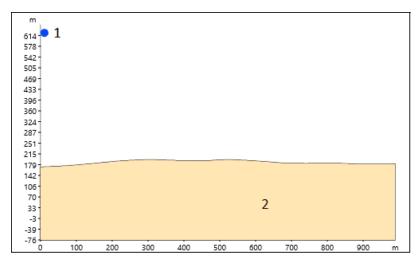
Terrain display shows the terrain profile on the platform direction. Visualization configuration options are as follows:

Workspace						×
Telemetry Map						
[Fixed widgets]	Opacity		Ground	2		
🛃 Terrain	Pos X	45.0	Uav			
	POSIA	43.0	Udv	• 1		
	Pos Y	-5.0	Distance	1000.0		
	Width	500	Orientation	Left 👻		
	Height	300	Туре	AUTO -	Min	0.0
					Max	1.0
New -						

#### Terrain Profile Configuration

In the dropdown on the top right corner, the user can select the Veronte to be used in this widget.

Item	Description
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.
Width/Height	Define widget's width/height.
Ground	Select ground's color.
Uav	Select UAV's color.
Distance	Change distance range.
Orientation	Define UAV ahead orientation (from left to right or the opposite)
Type Min/Max	Select where the program catch the variables.



Terrain Profile Widget Display

## 6.3.5 Autotune Tool

In the Workspace panel, it is possible to select the Autotune Tool. It is necessary to configure this window in order to be able to find automatically the gains of the PID controllers.

Cam							
1 PFD							
(A) Stick	ар	●●□	81 G- G- I	•			
🕼 AP		Name.				SELECTED AN	
Autotune		Opacity					
Terrain Bar		Pos X	100.0	Pos y	50.0		
00 Label							
( Radial							
😂 Chart							
Circular Bar	8						
88 LCD							
O Compass							
O Altimeter							
Nev	v •						

Autotune tool in the Workspace

When the window is opened, it is possible to select the loop for the autotuning.



Autotune loop selecting

This window shows the actual flight phase in the left bar and the control names. For each control, the available loops are showed and they are enumerated from 0 to 2 (from the intern one to the extern one). If some control loop does not have a PID controller configured, it appears with transparency and it can not be autotuned (red).



Autotune parameters

When the loop is selected, the window changes and some parameters (blue) are showed and they can be edited:

- **Time:** It is the period of time in which the Autotune is performed [s].
- Stages: The number of stages of the Fast Fourier Transform (a value between 5 and 10 is allowed).
- **Relay:** This is the amplitude of the Relay function (R). The value has to be chosen in accordance with the proportional gain in the PID of the autotuned variable.
- **Respect:** A mean value of the variable has to be selected. If the respect is select, the autotune will start from the last value of the variable. If not, the value can be edited by the user and the Autotune Relay function will start from this value and it will go from -R to R.

When all parameters are set, it is possible to click on Start and the autotuning process will begin and the blue bar will move until the end of the process. The left bar of the window allows checking the flight Phase and the selected loop.

In the section *Examples - Autotune* of this manual, an autotune example is explained in detail.

## 6.3.6 Line of Sight

Line of Sight is a widget with which the user can display a grey area around Veronte, showing the Line of Sight it has on every moment at 360°. The configurable parameters are:

- 1. Location. Choose from showing the LOS area from the UAV (checkbox) or any particular location which is fixed (menu).
- 2. Range. The radius of the area covered in meters.
- 3. **Grid resolution.** A slider that increases/decreases the number of points calculated in the grid. More points equal more resolution but more calculations as well.
- 4. **Opacity.** A slider that allows the change in LOS area opacity.

Workspace				×
Telemetry Map				
▼ [Fixed widgets]	Name		<b>%</b> Veronte	SELECTED-VERONTE -
Terrain Ine of Sight	Location	✓ Tak	e from Veronte	e0 <b>1</b>
	Relative	Approach Initial 🝷	[9]	
	Absolute	Decimal Degrees   UAV POS	MAP POS	
	Latitude	0.0		
	Longitude	0.0		
	WGS84	0.0	m	
	- MSL	0.0		
	└─ <b>▲</b> AGL	0.0	m	
	Range	1000.0 2		
	Grid Resolu			3
New	Opacity			<b>-</b> 4

Line of Sight Configuration Menu

Line of Sight Simulation

### 6.3.7 ADS-B decoder

The ADS-B Decoder widget is a visual information menu page where the user can get all ADS-B information displayed in one window while also having real-time traffics on the screen.

Workspace					×
Telemetry Map					
[Fixed widgets]	Name			% Veronte	SELECTED-VERONTE -
ADS-B Decorder	Opacity				
<ul> <li>Terrain</li> <li>Line of Sight</li> </ul>					
	Pos X	50.0	Pos Y	50.0	
New 👻					

ADS-B Decoder Menu

Item	Description
Name	Define widget's custom name.
SELECTED-VERONTE	Dropdown menu to select which Veronte will the widget gather data from.
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.

#### **ADS-B** Real Session

## 6.3.8 GNSS status

The GNSS Status widget is a visual information menu where the user can get all information from the GNSS configured in one same window. It can be chosen which GNSS is displayed:

Workspace					×
Telemetry Map					
▼ [Fixed widgets]       Image: GNSS Status       Image: GNS Status	Name Opacity Pos X GNSS	50.0	Pos Y !	<b>%</b> Veronte	SELECTED-VERONTE -
New 🔻					

#### GNSS Status Configuration Menu

Item	Description
Name	Define widget's custom name.
SELECTED-VERONTE	Dropdown menu to select which Veronte will the widget gather data from.
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.
GNSS	Select GNSS to be displayed.

GNSS Status	GNSS 2		su	RVEY IN	RTK
POSITION			VELOCITY		
Latitude	0.66915107	rad [-π,π]	East	0.39600003	m/s
Longitude	-0.00995665	rad [-π,π]	North	-0.065000005	m/s
Altitude (MSL)	125.05601	m	Down	0.062000003	m/s
<b>STATUS</b> Accuracy	63.499073	m	#SVs Used	4	]
H. Accuracy	51.786003	m	Time of Week	487146.53	s
V. Accuracy	36.747	m	PDOP	14.179999	
S. Accuracy	1.3610001	m/s		DGNS	s

#### **GNSS** Status Display

The information shown in the widget is as follows:

- GNSS 1/2. Navigation bit status (red/green).
- Survey In. RTK conditions being accomplished if green. Grey if finished or not achieved.
- RTK. Becomes green when SurveyIn bit goes grey (off) and RTK is enabled. Grey otherwise.
- DGNSS. Green when Differential Positioning is enabled (GNSS Compass). Grey if not.

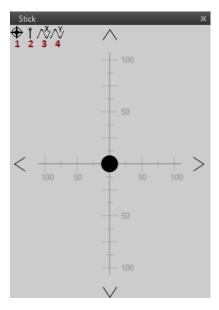
### 6.3.9 Telecommand

#### 6.3.9.1 Stick

Virtual sticks are created to simulate a radio controller that controls the channels of the aircraft directly from the computer.

In the stick display, there are four icons and their function are:

- 1. Return the stick to the centre
- 2. Activate/Deactivate the virtual stick
- 3. Move the stick in the X direction in a sinusoidal way
- 4. Move the stick in the Y direction in a sinusoidal way



Stick Display Configuration

Last two are normally used in order to test the stick or servos.

**Warning:** If the Stick is not active it will make no effect on the system. Activate it by clicking on the second icon (some waves will appear near the icon and the stick will be actived). In order to deactivate it, only click on the antenna icon one more time.

Workspace					×
Telemetry Map					
[Fixed widgets]	Name			🗞 Veronte	SELECTED-VERONTE -
((*)) Stick	Opacity				=0
	Pos X	50.0	Pos Y	50.0	
	Width	300	Height	300	
	✓ Horizon	tal Axis	✓ Vertical A	xis	Frequency (Advanced)
	Channel	1 -	Channel	2	• Min 10.0 Hz
	Axis Scale	100.0	Axis Scale	100.0	Max 10.0 Hz
	X initial:	Center 👻	Y initial:	Center	▼ Start enabled
	Endpoint		Endpoint		
	Min	0.0 ×1	Min	0.0	x1
	Max	1.0 ×1	Max	1.0	Configure Joystick
New	Return t	o initial point	Return to	o center	

#### Stick Configuration Menu

In the dropdown on the top right corner, the user can select the Veronte to be used in this widget.

Item	Description
Name	Define widget's custom name.
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.
Width/Height	Define widget's widt/height
Channel	Select which channel is controlled by each axis.
Axis Scale	Scale to show in the axis of the stick.
Endpoint Min & Max	Establish the minimum and maximum values reached by the stick.
Frequency Min	Sets the minimum quantity of messages sent when there is no movement.
Frequency Max	Sets the maximum quantity of messages that can be sent.
Return center	When it is selected the stick automatically returns to middle position on stick release.
Configure Joystick	Configure external USB joystick for camera control.

#### 6.3.9.2 Change variable

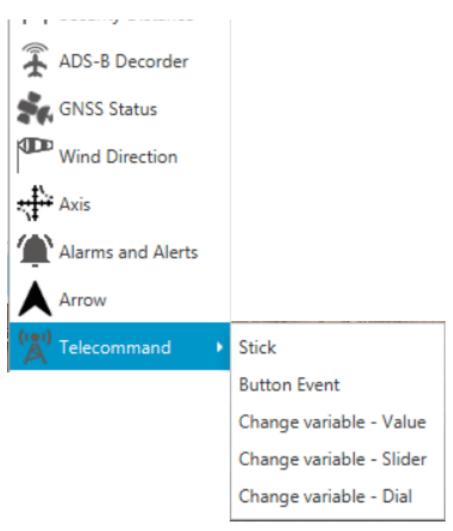
The user can choose certain variable and change its value from Workspace during a flight. There are 3 ways or widgets to implement this action:

- 1. Value
- 2. Slider
- 3. Dial

Workspace							×
Telemetry Map							
<ul> <li>[Fixed widgets]</li> </ul>	Name			<b>%</b> Veronte	SELECTED-VER	RONTE	-
((*)) Heading ((*)) Pitch Rate	Variable	IAS	(Indicated Airspe	eed)	Unit	m/s	-
((+)) IAS (Indicated Airspeed)	Opacity				0		
	Pos X	570.0	Pos Y	444.0			
	Width	300	Height	50			
			1.4		Long Ball		The generation
			1	0.0		m/s	>
			1		and a second	(a)	
			2				
			2		.5 0.4 0.5 0.	6 0.7 0.8 0.3	
			100				-
			3		$\bigcirc$		A.
New 👻				e si a	and it	Helle Spe	

#### Change variable

Veronte pipe allows the user modify some variables during a flight to test some parameters or to simulate a stick controller. Click on *New* in the widget menu and then on *Telecommand* and some options appear.



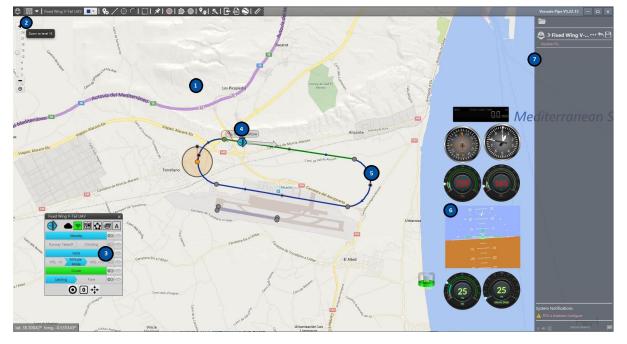
Stick Display Configuration

Veronte Pipe offers several applications to display parameters and variables in real time of the flight mission.

These are called widgets, they can be created by clicking on 'New' in Telemetry menu.

Veronte Pipe allows the user to use widgets in serveral monitors at the same time. This can be done by dragging and dropping the widget to the desired position.

# 6.4 Main Interface



Workspace on Veronte Pipe is distributed as shown in the following figure.

Workspace Main Interface

Each section has the following functions:

- 1. **Main Display:** Displays a selectable background map or a plain colour together with the most important mission data. To change it visit *Map Display*
- 2. Main Menu:
  - User: Manage user preferences.
  - Cloud: Provides access to the Cloud options.
  - Workspace: Select the way flight information is displayed.
  - Mission: Create and edit missions.
  - Log: View operation data log and introduce custom events.
  - Post Flight: Tools for recorded data analysis.
  - Preferences: Configure Pipe and Veronte autopilot.
  - License: Manage license preferences.
  - Manual: Shows help information available.
- 3. Veronte Panel: Veronte information and telecommand buttons.
- 4. Veronte Position: Veronte location on the map.
- 5. Mission: Defined mission on Veronte.
- 6. Telemetry: Configurable drag & drop flight information displays.
- 7. Side Panel: Shows linked Veronte information.

### CHAPTER

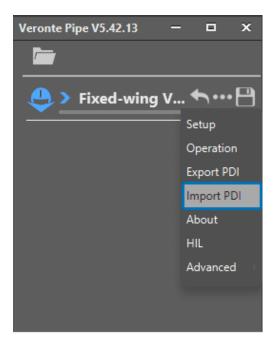
## **SEVEN**

# **VERONTE CONFIGURATION**

# 7.1 File Management

## 7.1.1 Import Configurations

In this section is explained the process to load configuration files into a Veronte Unit.



Import Configuration

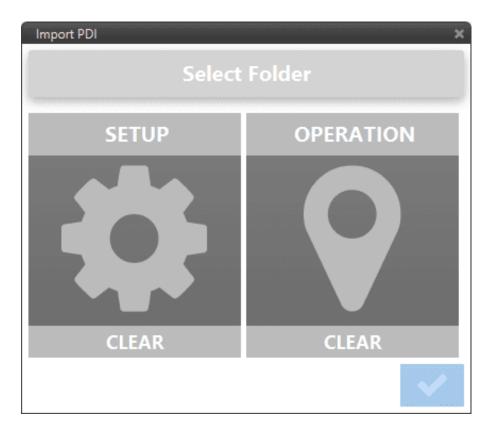
First, power the autopilot and connect it to Veronte Pipe. In the side panel, click on and then select **Import PDI**. The **Import Configuration** option displays a window used to select the file to be uploaded.

Veronte File				×
<b>5 4 7</b>		Hide u	nsupported ver	sion
Name		Library	Version	+
10.06.2020-Fixed_Wing		Pipe	v5.42.13	
10.06.2020-M400		Pipe	v5.42.13	
Prueba PIPE - Export		Pipe	v5.42.13	
	•		-	
Build from template 🔻		Folder	Lo	ad PDI

Import Configuration File Menu

There are three options within this window to select a configuration file:

- **Build from template:** By selecting this option the user can import a configuration file from a set of default configurations that can be used as a starting point. There are templates for multicopters, fixed wings, Ground station among others.
- PDI folder: By selecting PDI The user will be able to select the locations of each folder and load them.



Import a Configuration File

Load			×
D:\Users\ \Desktop\Configurations\Fixed W	/ing		>
<ul> <li>D:\Users\ \Desktop\Configurations\Fixed Wing</li> <li>.git</li> </ul>	☆ Setup		
Operation	Description	Author	Date
Production	Base configuration		06/04/2020 05:32
Setup          The setup         The setup			
			Select

#### Import a Configuration File

• Load PDI: Loads a configuration from the library.

In order to include a folder as a part of the library select **Manage Libraries** icon **b**. By including a folder to the library, any configuration files in that folder will be displayed.

VeraFile			×
	Hide	unsupported version	
Name	Library	Version	+
Libraries		Save	
Build from template 🔻	PDI Folder	Load PDI	

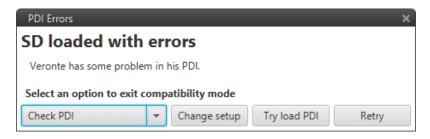
#### Library Management Menu

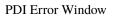
**Warning:** Each configuration in the library has a Version. It is only possible to load configuration files whose version is the same or lower than the one of the software embedded on the autopilot. As shown in the pictures above, colours are the way to show the compatibility: **Green** means fully compatible, **Yellow** means migration/PN adaptation and **Red** means not compatible.

Warning	Press the <b>Save</b> button in the right Side Panel, $\square$ , to load the configuration on the autopilot.
0	it will be only loaded to Pipe software.
Otherwise,	it will be only loaded to Fipe software.

### 7.1.1.1 Check PDI

After Importing PDI files or migrating a configuration to a newer version, Veronte might enter in "SD loaded with error" state, which is a similar state to *Maintenance Mode*. When clicking on the unit affected it can be seen the following window appearing.





The options provided to the user are "Check PDI", which generates an error display window, "Change Setup", explained below, "Try load PDI" and "Retry". When selecting "Check PDI", the system will try to report the errors. It may or may not find them:

PDI error	×
Some PDI are inconsistent	
PDI: Actmgr - List of Actions - 39 - Phase selected out of range PDI: Actmgr - List of Related Events and Actions - 22 - Period must be positive and major than 0	
	ОК

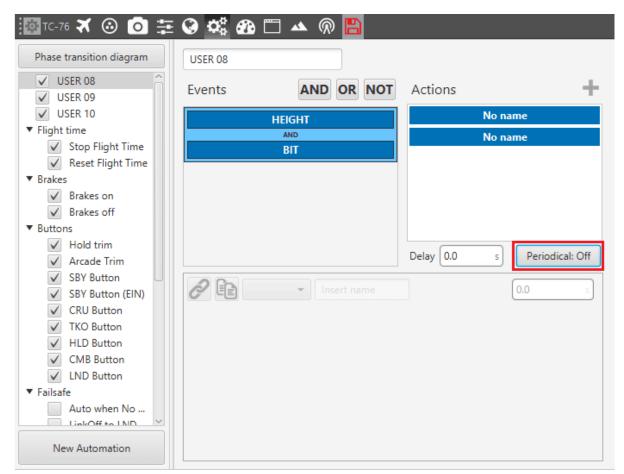
Unable to check PDI	×
Warning	
Please load other configuration or ret	try the connection

Check PDI windows

Now the user must find and correct the errors shown (or not) in the list displayed. In order to do that, click on "Try load PDI" in the PDI Error window.



Check PDI setup



In this particular example, one of the errors reported was a Period in Events/Action (Automations tab) which has been disabled.

Correction done in PDI Check

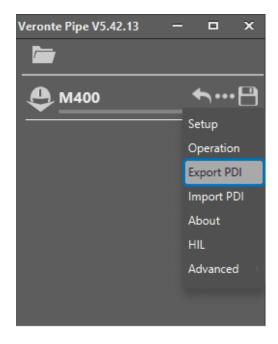
Once all reported errors have been solved, press on the Red Save button on the Setup toolbar to finish the PDI Check.

Save		×
Save and retry		?
Can you save this configuratio	n and retry synchro	onize?
	ОК	Cancel

Save Setup after PDI Check

## 7.1.2 Export Configurations

Exporting configurations or PDI files is very useful. It allows the user to share a configuration between several autopilot units or to store different missions that can be loaded when needed. Currently, two folders are exported, **Setup** and **Operation**. Each folder contains specific files with all this information. Setup holds the configuration of the aircraft or vehicle and Operation all the files related with the mission. For more details about this folders and its files, go to File Management.



#### Side Panel Option

To export a configuration, go to the side panel, click on and then click on **Export PDI**:



#### Export Configuration Menu

Once the Export PDI menu opens, the user has several options. The general workflow is to click on "Select Folder" and select a folder where the Setup and Operation ones will be created and stored. Once selected, the panels of the export menu will turn blue:

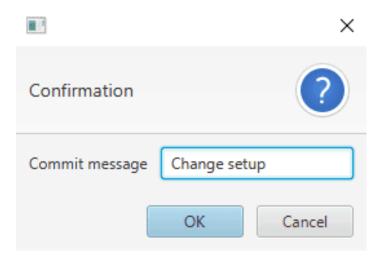


Confirmation and choosing

The user may decide not to store one of them. In that case, right-clicking on the panel, or clicking the "clear" button below it, will prevent the export of those files.

It is recommended to work with a repository for version control of the configurations so there is track of the changes done to them and the modifications go together with a commit message for later reviews.

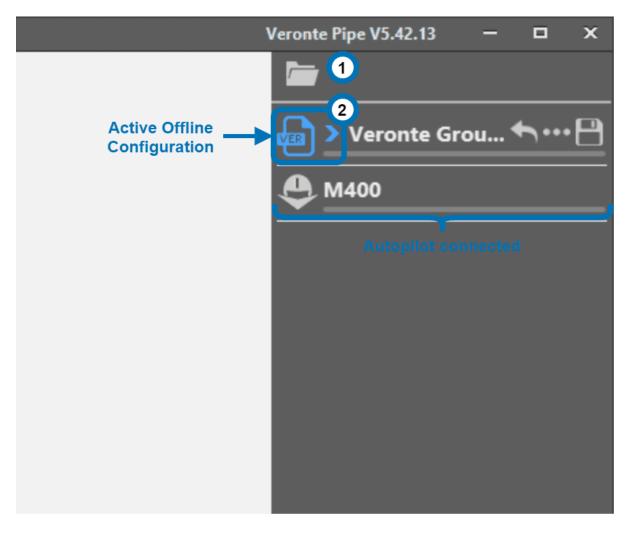
If you have a repository set up, Pipe makes version control easy. The software will detect when you are going to save changes to the repository and, automatically, a window appears to write a commit message.



Confirmation and choosing

## 7.1.3 Offline Configurations

It is possible to load and modify a configuration when an autopilot/s is not connected. That configuration file can be changed and exported, and it is also possible to overwrite it importing PDI files.



Offline Configuration

First, click on (1). The file management menu will pop up and the user can select the configuration to edit or build a new one from the templates. After uploading it, click on the configuration (2) to activate it. The icon will turn blue. Several configurations can be open simultaneously in Veronte Pipe.

The main features available when working with a configuration file are the **Mission** and **Setup** configuration menus. The user can modify them and save them.

If the user is working on a new configuration starting from a template, it is recommended to **export** the PDI files to a new folder, as explained in the previous section Export Configuration.

Once finished, this configuration file can be uploaded to the Autopilot following the steps described in the section *Import Configurations*.

## 7.1.4 Version Control

Embention offers the possibility to have a tool for version control over a customer's configuration. It is performed through the platform GitHub, where it is necessary to sign in before accessing the service. The steps to do it are:

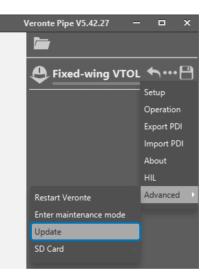
- 1. Access GitHub.
- 2. Proceed through Step 1 with user data.
- 3. In Step 2, choose Free plan and decide upon the below options
- Help me set up an organization next
   Organizations are separate from personal accounts and are best suited for businesses who need to manage permissions for many employees.
   Learn more about organizations
- Send me updates on GitHub news, offers, and events Unsubscribe anytime in your email preferences. Learn more

#### Step 2 Options

- 4. During Step 3, we recommend to "skip this step", but GitHub can be configured through these options freely.
- 5. Finally, send your Username and email of access to Embention so we can provide you with the relevant permissions for the correspondent repositories.

## 7.1.5 Update Onboard Software

To display the Update dialogue click on and choose **Advanced – Update** on the side menu.



Advanced - Update Menu

Upgrading			×
UAV Fixed-win	g VTOL		
System Image 🔹 🗘	generate-v5.42.11_2020-05-26_03-50-26.upda	- 0	
Configuration	No change	- 0	
			Update

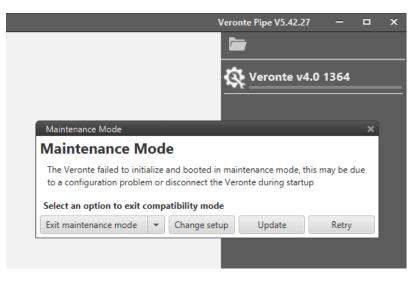
Update Veronte Autopilot

The different parameters to configure when updating the onboard software are detailed here:

- System image: here is where the version to be updated is selected. For instance, using *Pipe 5.42* the onboard version will be 5.42.X (with 'X' being the last option available). Pipe will try to download the latest version but you can manually upload the .update file if is stored in the computer by clicking on the folder icon.
- **Configuration:** this option is used to decide which configuration will be loaded when the update process ends. There are different options: "No changes" will keep the current configuration for the new version. If you want to change it, click on the folder icon. It will display the *Import Configurations* window. Select the desired configuration and press "Update".

## 7.1.6 Maintenance Mode

Whenever there is an issue with connection, powering or configuration, the unit enters in Maintenance Mode. The autopilot icon changes and the following window is displayed:



Maintenance Mode

The options available are:

- Exit Maintenance Mode. The Veronte AP tries to initialise again in order to exit Maintenance Mode. Whatever option the user chooses of the ones described below to fix the issue, this button will be the last step.
- **Change setup:** this option is used to load a configuration file into Veronte. The user has to select a configuration file, once selected, a new window will be displayed in Veronte Pipe showing the version and identification of the configuration file and the autopilot where the file is going to be loaded.

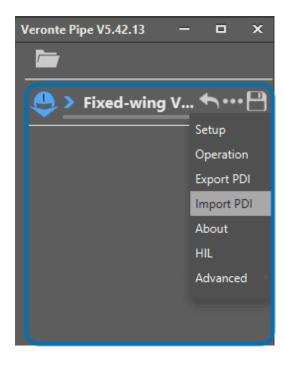


Upload Configuration - Maintenance Mode

Press "Start" and this option will upload the configuration file directly in the autopilot. Now Pipe works a tool to load the file from the computer to the autopilot and the configuration parameters will not be shown in the software window before being loaded on the autopilot.

- Update: this option allows the user to Update the Veronte Unit. This is explained in Update Onboard Software.
- **Retry:** the unit will try to boot again.

This section explains the management of configuration files. Veronte Pipe allows users to import or export configuration files and Update Veronte Units in the Side Panel.



Side Panel Options

The Setup Toolbar of Veronte Pipe contains all the parameters to configure the system, which includes the autopilots (Air and Ground) and the software (Veronte Pipe).

## 7.1.7 PDI Files

PDIs are Veronte configuration files. This files allows for modular control with improved version management. PDI files are split in two folders. Each folder hold several .xml files:

- Setup. The Setup folder contains the configuration of the aircraft or vehicle. All the control loops and their parameters, the definition of the flight phases and guidance commands, and the automations defined are stored here.
- **Operation.** This folder holds all the files related with the operations defined: waypoints, routes, operative parameters, runaways, etc.

It is recommended to work with a repository for version control so each time the user exports a configuration there is track of the changes done and the saving goes together with a commit message for later revision. Embention offers the possibility to have a tool for version control over a user's configuration. Check Version Control for more information.



PDI Files management menu

# 7.2 Setup Toolbar

## 7.2.1 Veronte

This tab consists of the identification of the autopilot, where the user can define the name of the configuration in **Vehicle Name**.

Another option available is **Encryption**, the user can click on the shield icon, see section *Encryption* for more information.

Fixed Wing V	-Tail UAV 🕺 🛞 🙆 ፰ (	<b>♀ ⊄: £8: □ ▲ Ⅲ</b> ⊘ @
Vehicle name	Fixed Wing V-Tail UAV	AES
		1. Nanoment

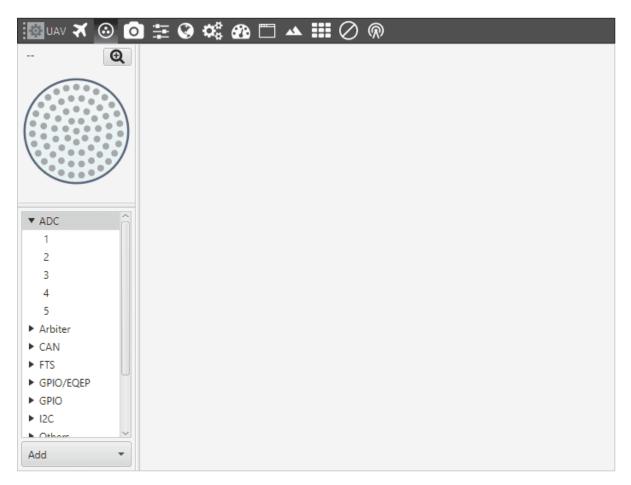
Autopilot Identification Data

## 7.2.2 Connections

## 7.2.2.1 ADC

**ADC** stands for Analog-to-Digital Converter. This connection is used by analog sensors. These sensors provide a voltage readout that needs to be converted into the actual measured vairable, e.g. temperature, fuel volume, etc.

Veronte autopilots are equipped with **5 connections** of this kind. To set them up, the user needs to go to the *Connections menu* and click on *ADC* on the left-hand side panel. Every *ADC* connection that is set requires an integer variable associated where the voltage readout will be stored. The maximum voltage of the ADC connection is 3 V.



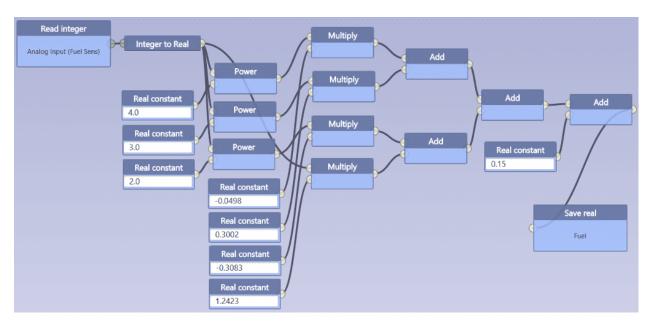
#### ADC Menu

To convert the input ADC value to the physical variable it represents the user needs to create a new program – see more information in *Blocks*.

## 7.2.2.1.1 Application example

Let us consider a Fuel Level Sensor whose datasheet provides a direct relation of the voltage readout and the fuel volume (in L) through the polynomial  $y = -0.0498x^4 + 0.3002x^3 - 0.3083x^2 + 1.2423x + 0.15$ , where y is the fuel volume and x is the voltage of the sensor.

Creating a new program in the *Blocks menu*, the above can be reproduced – see Figure below. Note that the ADC variable is first converted from integer to real, and then the polynomial is applied. The fuel remaining in the tank is saved in a *user variable*, which can be used for displaying or warning pupropses.

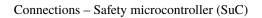


ADC conversion for a Fuel Level Sensor

## 7.2.2.2 Arbiter - SuC

Pins 45 and 46 are dedicated pins to allow the uart communication with the Safety micro Controller (SuC). This microcrollers is in charge of monitoring the state of the main microcontroller and providing the Flight Termination Signals (FTS).

Fixed Wing V-Tail UA	** 🛪 💿 💿 🏗 🚱 端 🙉 🗂 🔺 🎟 🖉
Pin: 46 🔍	
- 100 M	
► ADC ▼ Arbiter	
RX	
ТХ	
VCC	
► CAN	
► FTS	
GPIO/EQEP     GPIO	
► 12C	
► Others	
► PWM	
Sorial V	
Add	



## 7.2.2.3 CAN

Controller Area Network is a message-based protocol. Veronte includes two CAN bus connections (A-B), being both configurable.

Veronte0 🛪 🙆	ً ◙ ፰ ♀ ₡ ፼ ◻ ▲ ⅲ ⊘
Pin: 25	Baudrate 1000000.0 Bd
<b>*•</b> •••	
► ADC	
► Arbiter	
▼ CAN	
▼ A	
High	
Low B	
▶ FTS	
► GPIO/EQEP	
► GPIO	
► 12C	
<ul> <li>Others</li> </ul>	
Add 👻	

#### Connections - CAN

This connection allows the user to communicate with other devices. Each of them will be on the same bus, being possible to configure Veronte to transmit (TX) or receive (RX) data from other devices. In this menu you can only modify the Baudrate. To configure messages go to *Guidance* 

#### 7.2.2.4 GPIO/PWM

Output pins produce PWM or GPIO signals that are used to move the different servos and actuators of the platform.

#### 7.2.2.4.1 GPIO

A GPIO (General Purpose Input/Output) is a generic pin that can be configured as an input or output pin. When this option is configured as an output pin, the value sent will be different from the one sent if it was a PWM. GPIO pins admit up to 4 different states: ON (a continuous signal of value 1, made by 3.3V), OFF (a continuous signal of value 0, made by Ground), PULSE ON (a single pulse of value 1, with a width specified in seconds) and PULSE OFF (a single pulse of value 0, with a width specified in seconds). The configuration of the pin output value is done with an action *Output* in *Automations*.

Pin: 14	
	Direction GPIO as output 💌
00000	
00000	
ADC	
<ul> <li>Arbiter</li> </ul>	
► CAN	
► FTS	
GPIO/EQEP	
▼ GPIO	
11	
12	
13	
14	
15	
16	
▶ 10C V	
Add 👻	

GPIO Menu

#### 7.2.2.4.2 PWM

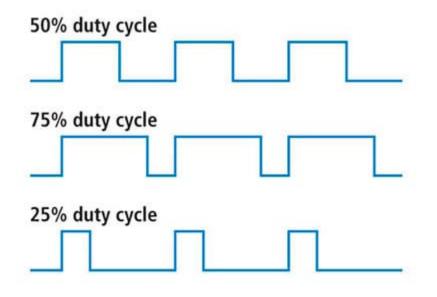
	੶  💽 🖸 ☵ 🐼 🗱 🗈	] 🏊 🏢	$\oslash$	
Pin: 1		PWM 1		
		Active	High	
		Mode	Time 💌	
	Frequency 50.0 Hz	Min	9.0E-4 s	
		Max	0.0021 s	
		Servo	Right Aileron 👻	
ADC     Arbiter	L	PWM 2		
► CAN ► FTS		Active	High	
GPIO/EQEP     GPIO		Mode	Time 🔹	
▶ 12C		Min	9.0E-4	
Others     PWM		Max	0.0021	
1		Servo	Throttle -	
2 3				
<u> </u>				
Add 🔻				

#### PWM Menu

The acronym PWM corresponds to Pulse Width Modulation. Veronte sends a pulse with a certain width that is received by the servo/actuator, and according to the width of such pulse, it changes its behaviour. A wide pulse will correspond to a big movement and a narrow one to a small movement.

The **Min** and **Max** parameters are the pulse width values that will make the servo/actuator go to its lowest and highest position. As an example let's consider the servo of an aircraft elevator, a pulse sent by Veronte of 0.9 ms will correspond with the lowest point of the servo range (-30 degrees for example). On the other hand, a pulse of 2.1 ms will make the servo go to its top position (for example 30 degrees).

The option **duty cycle** (select mode/duty cycle) is a different way of indicating the pulse width. Now the value indicated is a percentage which corresponds to the relation between the pulse width over the total period of the sent signal. So a 100% duty cycle will correspond to a signal with a constant value of 1, while a 0% duty cycle implies a constant signal with value 0. Between this two extremes, the pulse width can vary as in the examples shown in the following figure.





The option **Servo** is used to select which servo of the platform will be wired to that pin of Veronte connector, so the signal sent through that pin will go to it. The name of the "Actuator Output S" can be changed to other more identifiable according to the real actuator such as right or left aileron, see section *System Variables*.

The option **Frequency** determines the period of the pulses sent by the autopilot. The PWM is built in pairs inside the autopilot, and that is why the frequency is indicated in pairs, i.e when the frequency of PWM 1 is changed, the one of PWM 2 also changes. The following table shows the PMW pairs as configured in Veronte autopilot.

PWM Pai	rs
PWM 1	PWM 2
PWM 3	PWM 4
PWM 5	PWM 6
PWM 7	PWM 8
PWM 9	PWM 10
PWM 11	PWM 12
PWM 13	PWM 14
PWM 15	PWM 16

To sum up, a PWM is a signal which consists of a series of pulses having a width determined by a percentage over a range specified by the parameters **Min** and **Max**. On the other hand, the GPIO is a signal with a constant value (1,0) or with a single pulse (1,0).

#### 7.2.2.4.3 Add

Veronte admits up to 16 I/O PWM/GPIO signals. To configure a pin as PWM or GPIO, click on Add and select PWM or GPIO. The following windows will be displayed according to the option selected.

Connections		×
GPIO		
Connector	Changes	Pins
	GPIO 1	V PWM 1 -> GPIO 1
	GPIO 4	
	GPIO 5	
	GPIO 6	
000000	GPIO 3	
	GPIO 2	
	GPIO 7	
000000		
0 0 0 0 0		
0000		
		Change

## **GPIO** Selection

Connections		>
PWM		
Connector	Changes	Pins
	PWM 10	GPIO 10 -> PWM 10
6 6 6 6 6	PWM 8	
	PWM 14	
	PWM 12	
000000	PWM 16	
	PWM 11	
	PWM 9	
0000000	PWM 13	
000000	PWM 15	
		Change

## **PWM Selection**

As can be seen, pins are interchangeable. Once selected the desired pin, click on **Change**.

## 7.2.2.5 Serial

Two serial interfaces are available with Veronte Autopilots, RS-232 and RS-485, and more can be added by using the Can Expander Board. Each one of the serial interfaces is associated with a set of pins, which are displayed when an interface is selected.

Fixed Wing V-Tail UA	v 🛪 💿 💿 🏗	🚱 📽 🕰 🗂	▲ Ⅲ ⊘
Pin: 19 🗨	Functionality		
(•	Baudrate	115200 -	]
$\langle \cdot \cdot \cdot \rangle$	Length	8 👻	]
	Stop	1 -	]
ADC	Parity	Disabled 👻	]
► Arbiter			
► CAN			
► FTS			
► GPIO/EQEP			
► GPIO			
<ul><li>I2C</li><li>Others</li></ul>			
► PWM			
▼ Serial			
▶ 232			
▶ 485			
► USB			
Add 👻			

Connections - Serial

The following fields can be configured:

- **Baud rate:** This field specifies how fast data is sent over a serial line.
- Length: This field defines the number of data bits in each character.
- Stop: Stop bits sent at the end of every character.
- **Parity:** is a method of detecting errors in transmission. When parity is used with a serial port, an extra data bit is sent with each data character, arranged so that the number of 1 bits in each character, including the parity bit, is always odd or always even.

Туре	Start	Data	Parity	Stop
Bits	1	4-8	1-2	1-2

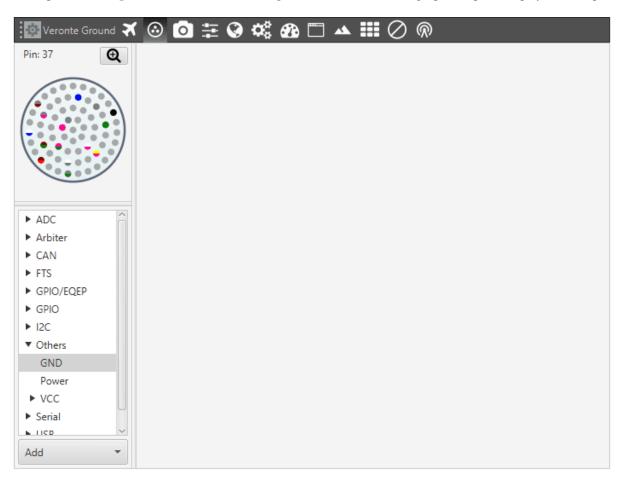
**Note:** All these settings are already specified for a given device, therefore, Veronte should match with them in order to be able to communicate.

Compatibility table:

Port name	RS-232	RS-422   RS-485				
Transfer Type	Full duplex	Full duplex   Half/Full duplex				
Maximum distance	15 meters at 9600 bps	1200 meters at 9600 bps	1200 meters at 9600 bps			
Topology	Point to point	Point to point	Multi point			
Max number of devices	1	1-10 in receive mode	32			

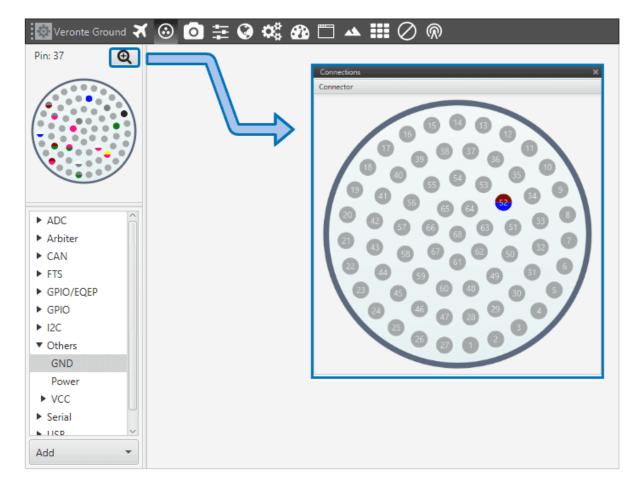
Refer to *examples* for a complete implementation of a serial device communication.

Here the user can configure the Input/Output ports of the autopilot. Veronte Autopilots have 68 pins, which are shown on the Pipe menu **Setup -> Connections** – see the Figure below. When selecting a port its pin is displayed on the panel.



#### Setup - Connections - GND Pins Displayed

To know about a particular pin's colour scheme, the user shoulg click the button on the top right corner above the 68 pin connector picture – see the Figure below.



#### Connection 68 Pin Colour Scheme

**Warning:** The colour code is referred to the single Veronte. For 4x Veronte refer to 4x Hardware Installation - *Electrical*.

Finally, depending on the configurable port selected the user will need to provide different parameters. The following table shows the type of connections available for configuration in Veronte Autopilot.

Field	Description
ADC	Analog-to-Digital Converter.
Arbiter-SuC	Safety micro controller
CAN	Configurable Controller Area Network bus A & B.
GPIO/EQEP	Enhanced Quadrature Encoder Pulse Input.
GPIO	Veronte input/output signals.
I2C	I2C (Inter-Integrated Circuit) bus.
PWM	Pulse Width Modulation configuration.
Serial	Configurable Serial ports RS232 & RS485.

Each connection is associated with a specific pin number. For more details see the section Hardware Installation - Electrical.

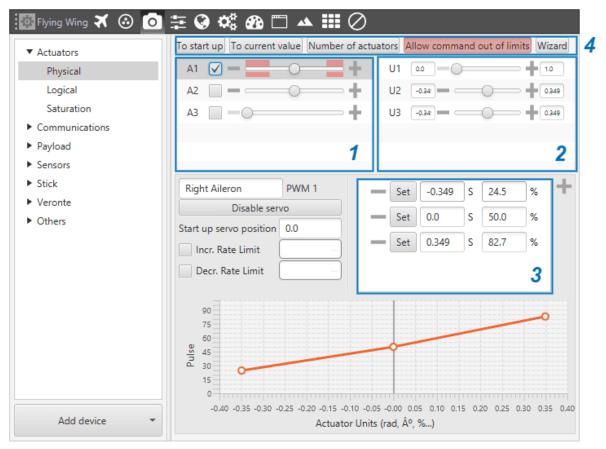
## 7.2.3 Devices

## 7.2.3.1 Actuators

### 7.2.3.1.1 Physical

## 7.2.3.1.1.1 Calibration Interface

The menu available on **Devices -> Actuators -> Physical** allows the calibration of all connected actuators. On this panel it is possible to set actuator position for each control signal/output, allowing to configure the maximum and minimum values and its **custom** performance. On the Figure below the configuration of a tailless aircraft, i.e. flying wing, is used as an example.



#### Physical Actuators Menu

The parameters of each one of the servos can be configured in two different ways: directly on the menu shown in the previous Figure, or through the *wizard button*. This last option is the recommended upon first configuration, leaving the other option for adjustments and advanced settings.

The options of the calibration menu are presented next:

- 1. Servos (actuators): this menu contains the servos of the platform. 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 (A1, A2...) is marked. The manual movement of the servos can only be done in the "Initial" phase (when there is no phase selected in Veronte Panel).
- 2. Control signals: this menu contains the variables that represent the control signals/outputs U generated by the

system. Considering the flying wing, the controls are thrusting (U1), pitching (U2) and rolling (U3), so there are 3 different controls in total. The mapping from the controls to the servo positions is indicated within the **SU matrix**, which is set in *Devices - Actuators - Logical*. When moving the scrolling bar of one of the control channels, the corresponding movement on the servos will also be represented.

- 3. Servo position PWM: this option is used to set the mapping from servo position S to PWM signal. For example, a 20° degrees deflection (0.349 rad) of the right elevon corresponds to an 82'7 % pulse to be sent to the corresponding servo. The mapping is expressed through the graph, where the user can introduce as many points as desired.
- 4. The other tools that appear on the menu are:
  - To start up: set initial values of the actuators.
  - To current value: set actuators to the current value requires the physical platform to be connected.
  - Change size actuators: change the total number of available actuators.
  - Allow command out of limits: allow out-of-limits motion for the selected actuator.
  - Wizard: explained below.
  - Disable/Enable servos: allows the user to enable or disable a configured actuator.
  - Start up servo position: sets the pulse value for the *start up configuration*.
  - Increasing/Decreasing Rate limit: sets a rate limit for increasing/decreasing motions of the servo.

The procedure to follow when configuring a servo/actuator is:

- Firstly, set the scrolling bar to its middle position.
- Secondly, click on Enable: this avoids the problem of enabling a servo when it is in an extreme position, which can produce a malfunction.
- Set the desired maximum  $S_{max}$  and minimum  $S_{min}$  values of the actuator S (a restrictive approximate value works).

Note:  $S_{max}$  and  $S_{min}$  can be chosen to match the actual physical value they represent, e.g. the angle of delfection of an aileron. But they can also be chosen not to match a physical variable, and it won't affect the autopilots behaviour as these S values are the representation of PWM signals. And the latter are the ones that correspond to an actual control surface/device movement.

Take a motor, for instance. The minimum PWM signal corresponds to a 0 rpm state, but a maximum PWM signal corresponds to finite number of rpms. In this case it's easier to assume  $S_{max} = 1$  and  $S_{min} = 0$ . The same could be done for the ailerons. If they are deflected the same amount in both directions then  $S_{max} = 1$  and  $S_{min} = -1$ .

• Finally, connect the physical actuator and adjust its minimum and maximum values.

#### 7.2.3.1.1.2 Configuration Wizard

Configuration wizard is recommended on first system configuration. It guides the user for configuring actuator limits and performance. This calibration should be performed in order to define the relationship between the autopilot output and real servo position.

In order to set servo positions, it is possible to enable servo movement from the user interface. Check the box on the left of each servo in order to enable servo movement, once enabled, servos will move according to the bar. On the bottom left part of the windows, there is the Stop PWM, with which all checkboxes are disabled.

If the user wants to finish the wizard and keep the results configured up to that point, just click on Finish on the bottom right part.

• Limits: Set maximum and minimum pulse value for the mechanical limits on the actuator.

imits											1
Actuator Output s1	0	10	20	30	40	50	60	70	90 80	90	100
Actuator Output s2	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s3	· 0	10	20	30	40	50	60	70	80	90	100
top PWM					Cance	221111	Finish	_	Previous		Next

Trim Wizard - Limits

The autopilot will never command the actuator outside these limits, preventing mechanical damages in the aircraft.

**Neutral:** Set neutral position for actuators and control channels. This position is set as a reference in the system and will remain as the default position on system startup. On the right, there is the column for U, where the neutral value for that particular control output is chosen.

Servos	U	
Actuator Output s1	Pitching	0.0
24 50 75 81.5	Thrusting	0.0
Actuator Output s2	Rolling	0.0
Actuator Output s3 0 25 50 75 100		

Trim Wizard - Trim Wizard - Neutral

• Select: Select a servo to trim. The servos are sorted depending on which is affected by each control input.

				×
Select				0
Pitching	Actuator Output s1			î
Thening	Actuator Output s2	- PWM 1		
Thrusting	Actuator Output s3	- PWM 2		
Delling	Actuator Output s1	- PWM 0		
Rolling	Actuator Output s2	- PWM 1		

Trim Wizard - Trim Wizard - Select Output

Once a servo is trimmed for a defined control channel, it will not be displayed for trim in other control channels.

• Value: Enter the maximum and minimum actuator position for the control variable. These values correspond to the components of S, for example, a maximum deflection of 20 degrees will correspond to a 75 % pulse and a minimum of -20 a 25%. These limits don't have to be the same as the mechanical limits of the actuator establish in the first screen of the wizard.

Thrusting			Set i	n neutr	al				
Actuator Out	put s3								
0	25			1 50			75		100

Trim Wizard - Trim Wizard - Min/Max Values

When the process is finished, a summary display appears, showing the user the graphs relating all the information provided, as the on the bottom part of the main display.

#### 7.2.3.1.2 Logical

#### 7.2.3.1.2.1 SU & US Matrices

SU and US are two matrices (inverse of one another, respectively) which contain the relationship between actuator outputs S and control outputs U, i.e. the influence of each control channel on each actuator output. The option of having a configurable SU matrix allows Veronte autopilots to control any type of vehicle, independently of how its control surfaces/devices are set and adjusted.

U is a vector which contains the control outputs of the platform, e.g. **pitch**, **roll**, **yaw**, **throttle**, etc. The values of U do not represent a physical variable. They are instead fictitious variables which are used in the control algorithm. What is actually applied to the system are the actuators movements, i.e. the PWM signals sent to the servos, which are mapped in the S vector – see *Devices - Actuators - Physical* for more information. The relation between S and U is essential for the right attitude control of the platform.

In order to define SU, the user needs to go to **Devices -> Actuators -> Logical** and click on *Edit* – see Figure below. A pop-up window will open containing the matrix. Control outputs U are placed on the columns and actuator outputs

S on the rows. Clicking on the '+' sign allows the user to add a new U or S, adding a new column or row will appear, respectively.

d Wing 🛪 🙆 🔼	≌ 🛛 🗱 🖾 🗖	▲ ⅲ ⊘		Edit						
ators	US Set inv(SU) Ed	it			•	•		•	•	•
iysical		_			U Control Output u1	Control Output u2	Control Output u3	Control Output u4	Control Output u5	Control Output u6
gical turation	SU Set inv(US) Ed	it		- S Right Aileron	0.0	0.0	1.0	0.0	0.0	0.0
ration unications				- Left Aileron	0.0	0.0	-1.0	0.0	0.0	0.0
				- Left Flap	0.0	0.0	0.0	0.0	1.0	0.0
				- Right Flap	0.0	0.0	0.0	0.0	1.0	0.0
			_	- H. Stabilizer	1.0	0.0	0.0	0.0	0.0	0.0
				- V. Stabilizer	0.0	0.0	0.0	1.0	0.0	0.0
				- Wheel	0.0	0.0	0.0	0.0	0.0	1.0
				- Throttle	0.0	1.0	0.0	0.0	0.0	0.0
				Throttle	0.0	1.0	+	0.0	0.0	0.0

#### SU Matrix Menu

Definition of US is also available, but it is recommended to go with the first as it is more intuitive to define. Let's comsider the SU of a fixed-wing aircraft – see the Figure below. On the S vector there are 8 entries, i.e. 8 actuators; and on the U vector there are 6 control outputs.

(U	Control Output u1	Control Output u2	Control Output u3	Control Output u4	Control Output u5	Control Output u6
Right Aileron	0.0	0.0	1.0	0.0	0.0	0.0
Left Aileron	0.0	0.0	-1.0	0.0	0.0	0.0
Left Flap	0.0	0.0	0.0	0.0	1.0	0.0
Right Flap	0.0	0.0	0.0	0.0	1.0	0.0
H. Stabilizer	1.0	0.0	0.0	0.0	0.0	0.0
V. Stabilizer	0.0	0.0	0.0	1.0	0.0	0.0
Wheel	0.0	0.0	0.0	0.0	0.0	1.0
Throttle	0.0	1.0	0.0	0.0	0.0	0.0
			+			

#### ${old SU}$ Matrix for a Fixed-Wing aircraft

As we see in the Figure above, the user defines which actuators influence which control channels. For instance, only the actuator **throttle**, e.g the engine – influences the control output  $U_2$ : **thrusting**; and only the **horizontal stabilizer** influences  $U_1$ : **pitching**.

**Warning:** Regarding the selection of the parameters of SU matrix:

The order of magnitude of the parameters should be respected at least for every row, i.e. every control channel, as long as there are no coupled control channels U.

**Note:** Good practice recommendations:

• Unitary values are recommended. Doing so, U will be equal to S. And if S has been defined according to a physical value – e.g. deflected angle, then control outputs can be easier to understand.

- The order of magnitude and the value of the SU parameters will not influence control algorithm calculations. But it will affect the control parameters, i.e. the control gains.
- It is recommended to keep the same order of magnitude for the whole matrix. That will allow an easier set up of a scaled version of the platform. Keeping the same SU and knowing the scaling factor, then the new control gains should be the old ones multiplied by that scaling factor. This practice can also be useful for transition to similar platforms.
- The SU vector should be defined accordingly in order to follow the sign convention for aerial navigation: a positive roll lowers the right wing, a positive pitch moves the nose up and a positive yaw moves the nose the right.

**Important:** Regarding *SU* parameters of opposite sign:

In the above Figure one can see that for control output  $U_3$ : **rolling**, the right aileron indicates 1 and the left aileron -1. In other words, one moves opposite to the other. But this is a mere convention. Everything depends on the ailerons PWM to servo movement curves – defined in *Devices -> Actuators -> Physical*.

Coming back to the matrix SU menu, the user should click on Apply once it has finished. A pop-up window will appear (see Figure below) warning the user about the US matrix needing to be updated: it can be automatically updated from the SU, or introduced manually. It is advised to go with the first option.

	U	Control Output u1	Control Output u2	Control Output u3	Control Output u4	Control Output u5	Control Output u6	
S Right Ailer	m	0.0	0.0	1.0	0.0	0.0	0.0	Matrix
Left Ailero	n	0.0	0.0	-1.0	0.0	0.0	0.0	
Left Flap		0.0	0.0	0.0	0.0	1.0	0.0	The size or value of the matrix SU has changed.
Right Flap		0.0	0.0	0.0	0.0	1.0	0.0	
H. Stabilize	er	1.0	0.0	0.0	0.0	0.0	0.0	The inverse matrix US has to be updated
V. Stabilize	r	0.0	0.0	0.0	1.0	0.0	0.0	Automatically calculate th Edit US
Wheel		0.0	0.0	0.0	0.0	0.0	1.0	$\mathbf{\wedge}$
Throttle	J	0.0	1.0	0.0	0.0	0.0	0.0	ור
				+				



The US matrix of the fixed-wing aircraft is shown in the Figure below:

( U	ls	Right Aileron	Left Aileron	Left Flap	Right Flap	H. Stabilizer	V. Stabilizer	Wheel	Throttle	ר
Control Output u1 - Pitching		-0.0	-0.0	-0.0	-0.0	1.0	-0.0	-0.0	-0.0	1
Control Output u2 - Thrusting		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	1.0	
Control Output u3 - Rolling		0.5	-0.5	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	
Control Output u4 - Yawing		-0.0	-0.0	-0.0	-0.0	-0.0	1.0	-0.0	-0.0	
Control Output u5 - Flaps		-7.850462E-17	1.1775693E-16	0.5	0.5	-0.0	-0.0	-0.0	-0.0	
Control Output u6 - Wheel		-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	1.0	-0.0	
					+					

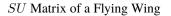


Note that the fixed-wing example shown above has only one S only. Now, some more practical examples of real configurations – with more complex SU matrices – will be presented in order to complement the above explanation.

## 7.2.3.1.2.2 SU of a Flying Wing

Flying wings are tailless aircrafts, i.e. their only control devices are ailerons and a motor. So both the longitudinal (**pitching**) and lateral (**rolling**) control of the platform have to be controlled only with the ailerons – known as elevons in this kind of configurations. Therefore, two actuator channels S (left and right ailerons) will have to incluence two control outputs U. When working like elevators, the elevons move together; when working like ailerons, one moves up as the other one moves down – this dual behaviour ir highlited in red in the Figure below.

	Ū	Control Output u1 - Thrusting	Control Output u2 - Pitching	Control Output u3 - Rolling
Right Aileron		0.0	1.0	1.0
Left Aileron		0.0	1.0	-1.0
Throttle		1.0	0.0	0.0
			+	



## 7.2.3.1.2.3 SU of a V-Tail Aircraft

The V-tail aircraft presented next has the same platform structure as the one shown above except for one difference: the tail of the aircraft is at an angle (v-shaped). That implies that **pitching** and **yawing** are controlled by two control surfaces, while for a regular congfiguration they are controlled by one separate control surface each. These control surfaces are know as ruddervators. When working like elevators, the ruddervators move together; when working like rudders, one moves up as the other one moves down – this dual behaviour ir highlited in red in the Figure below.

Regarding the rest of the actuators S, each of them only influence one single control output U- see the SU matrix below.

	-	] -		-	]	•
	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	Control Output u5 - Flaps	Control Output u6 - Wheel
S Right Aileron	0.0	0.0	1.0	0.0	0.0	0.0
Left Aileron	0.0	0.0	-1.0	0.0	0.0	0.0
Left Flap	0.0	0.0	0.0	0.0	1.0	0.0
Right Flap	0.0	0.0	0.0	0.0	1.0	0.0
Right Stabilizer	1.0	0.0	0.0	-1.0	0.0	0.0
Left Stabilizer	1.0	0.0	0.0	1.0	0.0	0.0
Wheel	0.0	0.0	0.0	0.0	0.0	1.0
Throttle	0.0	1.0	0.0	0.0	0.0	0.0
			+			
						,

SU Matrix of a V-Tail Aircraft

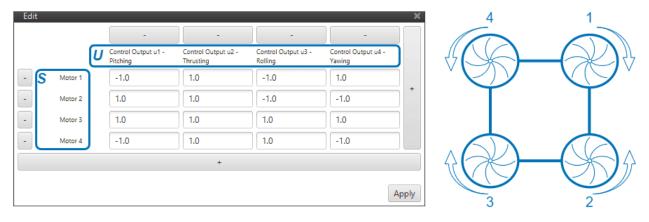
#### 7.2.3.1.2.4 SU of a Quadcopter

When it comes to a multicopter the SU matrix definition is not straightforward. Here we consider a quadcopter because it is the simplest of cases. Therefore, as its name suggests, it has 4 motors. The convention of the motor order in a quadcopter is the following: motor 1 is placed on the front right of the quadcopter, and the rest of them are placed following a clock-wise oder – see the Figure below.

When defining the SU matrix of a quadcopter with symmetrical geometry:

- Control output U: thrusting will require all 4 motors to increise their rpms the same amount.
- Control output U: **pitching** will require for motors 1 and 4 to increase their rpms one particular amount, and motors 2 and 3 to decrease their rpms that same amount.
- Control output U: rolling will require for motors 1 and 2 to increase their rpms one particular amount, and motors 3 and 4 to decrease their rpms that same amount.
- Control output U: yawing will require for motors 1 and 3 to increase their rpms one particular amount, and motors 2 and 4 to decrease their rpms that same amount.

In multicopters, specially for symmetrical geomtries, it is interesting to introduce the same influence values for the **pitching** and **rolling** control channels. That is so because when tunning the control gains (control parameters) they are usually very similar in both control channels.



#### SU Matrix of a Quadcopter

If the considered quadcopter wouldn't have symmetrical geometry, the SU matrix needs to account for the lack of symmetry. In the Figure below, one can see that motors 1 and 4 are further ahead of the center of gravity (CG) of the platform than motors 2 and 3.

For a hover maneouvre, the desired **pitching** moment is 0. Assuming the latter, i.e. the sum of all existing moments equal to 0, one finds the following relation  $T_{back} = 1.5 \cdot T_{front}$ , where T represents the force generated by the motors.

Therefore, one needs to define an influence value for the motors in the front (1 and 4) and then, multiply that same value by 1.5 for the motors in the back (2 and 3). One could choose the values 1 and 1.5, but in order for the **pitching** and **rolling** values to be similar, 0.8 and 1.2 are a better option – and they also satisfy the above relation.

Edit			-	-	-	-	×
		U	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	]
S	Motor 1	)	-0.8	1.0	-1.0	1.0	
	Motor 2		1.2	1.0	-1.0	-1.0	
	Motor 3		1.2	1.0	1.0	1.0	
	Motor 4	J	-0.8	1.0	1.0	-1.0	
				+			
							Apply

SU Matrix of a Quadcopter (non-symmetrical geometry)

## 7.2.3.1.2.5 SU of a VTOL Aircraft

Finally, a vertical take-off and landing (VTOL) aircraft configuration is covered. Main features of the aircraft are: V-shaped tail, a wing with ailerons only, one motor for plane mode, and 4 motors for quadcopter mode (VTOL). The recommended strategy for this kind of platform is to create 4 control channels U for the plane mode and 4 control channels U for the quadcopter modes.

The SU matrix of the VTOL aircraft looks like:

	Control Output u1 -	Control Output u2 -	Control Output u3 -	Control Output u4 -	Control Output u5 -	Control Output u6 -	Control Output u7 -	Control Output u8 -
- E	Pitching (P)	Rolling (P)	Yawing (P)	Pitching (Q)	Throttle (Q)	Rolling (Q)	Yawing (Q)	Throttle (P)
S Left Aileron	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Right Aileron	0.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0
Throttle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Left Elevator	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Right Elevator	1.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.0
Motor 1	0.0	0.0	0.0	-1.0	1.0	-1.0	1.0	0.0
Motor 2	0.0	0.0	0.0	1.0	1.0	-1.0	-1.0	0.0
Motor 3	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0
Motor 4	0.0	0.0	0.0	-1.0	1.0	1.0	-1.0	0.0
				+				

SU Matrix of a VTOL Aircraft

#### 7.2.3.1.3 Saturation

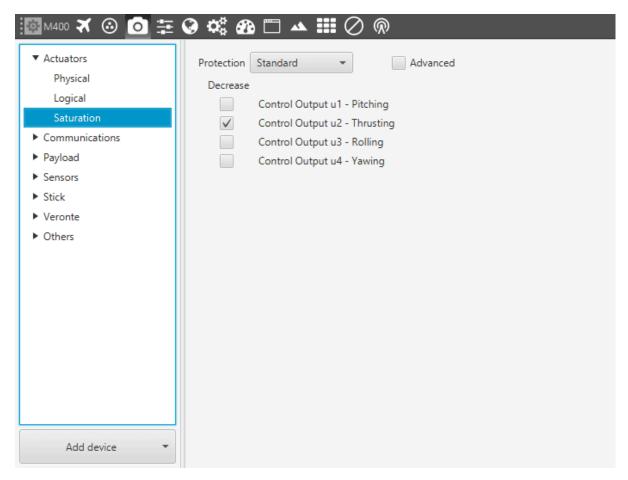
In this menu, the user can configure the behaviour of the platform when one or more of its actuators is/are in saturation state. The three options available are **Inactive** (the system does not respond to saturation), **Linear** (system affects all the actuators on the same way) and **Standard**, which can be found below.

<ul> <li>Fixed Wing V-Tail UAV</li> <li>Actuators</li> <li>Physical</li> <li>Logical</li> <li>Saturation</li> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Stick</li> <li>Veronte</li> <li>Others</li> </ul>	O Protection	Inactive Inactive Linear Standard		
Add device 🔻				

#### Saturation Option for Actuators

### 7.2.3.1.3.1 Standard Saturation

The system allows the user to choose which of the Controls is going to be affected if saturation is reached at any actuator. It can be chosen from 1 to all of them (which will be linear action).



#### Standard Saturation Menu

If clicking in the advance checkbox, a vector including all control outputs is generated, allowing for proportional control over the system when saturation happens. This tool is set for the user to have wider control over this feature if needed.

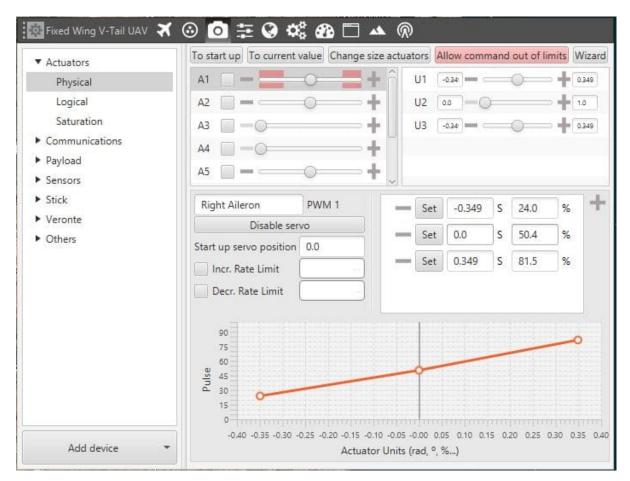
Actuators	Protection Standard -	Advanced
Physical Logical	Control Output u1 - Pitching	0.0
Saturation	Control Output u2 - Thrusting	0.0
Communications	Control Output u3 - Rolling	0.0
Payload Sensors	Control Output u4 - Yawing	0.0
Stick	Control Output u5 - Flaps	0.0
Veronte	Control Output u6 - Wheel	0.0
	saturation. For example: [0 1 0 1 ]	n in which control actions will be reduced in case of means that the control output U2 and control y. [0102], represents that control output U4 will ut U2.

Advance Standard Saturation Mode

Inside this menu, the user can access the configuration for the servos.

The first menu allows for actuators physical configuration, establishing maximum and minimum values, enabling or disabling actuators, giving them a corresponding angle associated to a pulse or using a Wizard display to do everything at once.

Note: Veronte allows configurating up to 32 actuators at the same time.



Physical Actuators Configuration

The second menu is the logical, where the US/SU matrices are configured. This defines the influence of each control channel on each control actuator.

	⊀ ⊙ <mark>⊙</mark> ≆ ♀ ≮ ∞ ⊠ ຼ ▲ @
<ul> <li>Actuators</li> <li>Physical</li> </ul>	US Set inv(SU) Edit
Logical	SU Set inv(US) Edit
Saturation	
Communications	
Payload	
Sensors	
Stick	
Veronte	
Others	
Add device	-

# Logical Actuators Configuration

The last configuration menu available is the Saturation one, where the user can choose between Saturation kind of protection and some more internal parameters.

🔤 M400 🛪 🛞 🙆 葦	o 📽 🕰 🗂 🔺 ⅲ 🖉 ด
▼ Actuators Physical	Protection Standard  Advanced Decrease
Physical Logical Saturation Communications Payload Sensors Stick Veronte Others	Decrease Control Output u1 - Pitching Control Output u2 - Thrusting Control Output u3 - Rolling Control Output u4 - Yawing
Add device 🔻	

Saturation Actuators Configuration

### 7.2.3.2 Communications

Communications menu covers the configuration for alternative communication channels, statistics and routing.

### 7.2.3.2.1 4G

Checking the **Enable** box will enable the use of 4G communication through the **Veronte LTE** Consumer/Producer in the *I/O Manager*.

### 7.2.3.2.1.1 ESIM

The embebed **ESIM** in Veronte allows the user to send and receive telemetry using a commercial data provider.

The connection between the air unit and the ground station is stablished through the Veronte Cloud server.

To connect with Veronte Cloud the following parameters have to be set:

- Host: rt.utm.systems
- **Port:** 3114

<ul> <li>Actuators</li> </ul>	🔒 🔽 Enable			
<ul> <li>Communications</li> </ul>	SIM Type	ESIM	-	
4G				
Comstats				
Iridium	Host	rt.utm.systems	Port	3114
Ports				
<ul> <li>Micro</li> </ul>				
Payload				
▼ Sensors				
Accelerometer				
Altimeter				
GNSS				
Gyroscope	and the second sec			
12C Devices				
Magnetometer				
Obstacle detection				
Pressure				
► RPM				
Speed down	~			
Add device	-			

Host and Port can be changed if the used server differs from **Veronte Cloud**, but the communication protocol does not change.

ESIM Configuration for 4G

**Note:** In order to use the embedded **SIM** card, the contract with the data supplier needs to be done through **Embention**. Please contact **sales@embention.com** for more information on availability, coverage, suppliers and prices in your country.

## 7.2.3.2.1.2 SIM

If needed it is also possible to install a custom **SIM** card on Veronte. **PIN** number and **APN** (Access Point Name) of the **SIM** card provider must be defined before enabling the 4G communication.

Warning: Introducing the wrong PIN number may block the SIM card.

**Warning:** The installation of the SIM card must be done by Embention during the production of the unit. Please make sure to indicate the interest on using a Custom SIM card when ordering new Veronte units.

<ul> <li>Actuators</li> </ul>	🔒 📝 Enable			
<ul> <li>Communications</li> </ul>	SIM Type	SIM	- APN	em
4G	-			
Comstats			PIN	0 0 0 0
Iridium	Host	rt.utm.systems	Port	3114
Ports		( <u> </u>		
<ul> <li>Micro</li> </ul>				
<ul> <li>Payload</li> </ul>				
▼ Sensors				
Accelerometer				
Altimeter				
GNSS				
<ul> <li>Gyroscope</li> </ul>				
12C Devices				
Magnetometer				
Obstacle detection				
Pressure				
► RPM				
Speed down	~			
Add device	*			

### SIM Configuration for 4G

## 7.2.3.2.2 Comstats

The Comstats feature allows Veronte to make an estimation of the overall quality of the communication channel.

Veronte will send periodically (If enabled) a message with its current communication statistics (Packets sent and received per second). Then, any other Veronte unit can receive this information and compare against its own statistics to estimate the average amount of packets lost in the communication.

The results of this estimation can be monitored in variables **2000** (**RX Packet Error Rate**) and **2001** (**TX Packet Error Rate**). These variables can be used to enable, for example, failsafe actions in case of degradation or loss of communications.

It is possible to configure the source or destination of the statistics, as well as the frequency at which the Comstats message is sent:

- **RX Auto:** Enabling this option will use the first remote AP found. If this option is disabled, the user must choose manually the address of the unit used for Comstats calculation.
- **TX:** When enabled, the unit will periodically send its Comstats message. The message can be sent to a specific unit or to all units on the network (Broadcast).

► Actuators	RX Auto	Veronte v4.5 1844 👻
<ul> <li>Communications</li> <li>4G</li> </ul>	V TX	
Comstats	Address	Broadcast 👻
Iridium	Period	0.1 s
Ports		
Micro		
Payload		
▼ Sensors		
<ul> <li>Accelerometer</li> </ul>		
Altimeter		
GNSS		
Gyroscope		
I2C Devices		
Magnetometer		
Obstacle detection		
Pressure		
► RPM		
Speed down	~	
Add device	•	

#### Comstats Configuration Menu

**Note:** Enabling Tx will enable Veronte to send its Comstats message, but in order to compute Packet Error rate it's necessary to **receive** the  $Ts_1x$  message from a different unit.

**Warning:** Packet error rate is a good indicator of the status of the communication, but it is not representative of the radiolink status. For monitoring the status of the radiolink RSSI Variables (820-822) shall be used instead. Depending on the configuration it is possible to have bad Error rates with good RSSI (overloaded radiolink) or good Error rates with bad RSSI (degraded communication with low load on radiolink). For the best results, it is recommended to use a combination of both statistics for failsafe automations.

### 7.2.3.2.3 Iridium

Checking the **Enable** box will enable the use of Iridium communication through the **Iridium** Consumer/Producer in the *I/O Manager*.

- Synchronization time: Transmission period.
- Destination address: Address of the destination Iridium module.

► Actuators	C Enabled	
<ul> <li>Communications</li> </ul>	Synchronization time	[120.0 s]
4G	Destination address	0
Comstats	bestington address	
Iridium		
Ports		
Micro		
Payload		
Sensors		
▶ Stick		
Veronte		
▶ Others		
Add device 👻		

### Iridium Configuration Menu

### 7.2.3.2.4 Ports

Ports configuration allows the user to configure which communication ports (Commgr Ports in *I/O Manager*) will be used for communication.

By using the **Route** feature, it is also possible for Veronte to act as a **Router**, redirecting any messages received (with a specific Address destination) through a specific Port.

Each of the different ports can be configured as either of the following options:

- Forward: Any messages generated by this unit (i.e. Telemetry or response messages to certain commands) will be sent through these ports.
- **Route:** Any messages received at any Commgr Port with the defined address will be re-sent through the defined port. It is possible to route several addresses through the same port, but is **not possible** to route the same address through several ports. Only the first configured port will be used. Routing also applies to messages generated by the unit for the defined address.

Note that the same Port cannot be used as Forward and Route at the same time.

It is possible to define up to 2 routing setups, which can be switched unsing the **Ports** action in the **Automations** menu. **Routing 1** will always be selected by deafult when booting Veronte.

► Actuators	Ports	$\sim 10$
<ul> <li>Communications</li> <li>4G</li> </ul>	Routing 1	î
Comstats	Forward Route	•
Iridium	- PORT 1	
Ports	- PORT 2 - UAV 40002 PORT 5	
► Micro	PORT 3	
Payload	PORT 4	
▼ Sensors		
Accelerometer		
Altimeter	Routing 2	
► GNSS	Forward Route	.
► Gyroscope		-
I2C Devices	PORT 2 UAV 2 PORT 1	
Magnetometer	PORT 4	
Obstacle detection	PORT 6	
Pressure		
► RPM		
Speed down 🗸		
Add device 🔹		~

### Ports Menu

A practical example of the use of this menu are Veronte Ground configurations. These configurations will have configured a **Routing** of Address **2** (**Pipe**) through **Port 1**. This way, any messages that are received through a Commgr Port (i.e. through Veronte LOS), will be re-routed through **Port 1** (**USB**) and received by **Pipe Software**, including any messages generated by **Veronte Ground** itself.

**Warning:** An incorrect Port configuration can disable USB communication. If this happens, Veronte will not be able to be detected through **PIPE Software**. If this is the case, please visit our Troubleshooting section on how to **recover USB communication**.

### 7.2.3.3 Payload

### 7.2.3.3.1 Camera

When adding a Device, the user can choose adding a Camera. This will create a default Camera under **Devices - Payload - Camera**.

Veronte0 🛪 🙆 🚺 🗄	፰ 🚱 🗱 🖽 🖽 🛲 💓 ⊘	
► Actuators	Default camera	Q
Communications	■ 36 mm Camera cache 1000.0	ms
▼ Payload	1 24 mm	
▼ Cameras Default camera	5784	
Gimbal/Tracker	3856	
Transponder/ADS-B	<b>9 4</b> 35 mm	
Sensors	Streaming Cam associated with gimbal	
<ul> <li>Stick</li> <li>Veronte</li> </ul>	URL	
► Others	Network caching	
	Device IP/port	
	Photogrammetry	
Add device 👻	Add Action	

Camera Menu - Configuration Parameters

- **Name**. Put a name to the camera define or use the lens on the right to choose from the predefined list of cameras. Making this will automatically establish the following values (which in other way would have to be define manually):
  - Sensor. Defines the camera sensor width and height in mm.
  - Resolution. Defines the camera resolution width and height.
  - Lens. Defines the focal length from the camera in mm.
  - Camera cache. Defines the cache time used to play the selected camera on the gimbal widget.
- **Streaming**. Section used to define a streaming service with which to configure a payload system to be able to have its video in Veronte Pipe, particularly in Workspace Gimbal widget.
  - URL. Cameras whose protocol goes through Ethernet are configured introducing its URL in this field.

If it is from a Gimbal device, it is important to be sure to configure the field *Cam associated with gimbal* if the user wants to move the Gimbal from the Widget.

- **Device**. If the Camera is a system connected directly to the computer it will be selected from here. Generally speaking, Device 0 is linked to the Screen, Device 1 to the internal camera (if portable computer).
- **Photogrammetry**. The actions undertaken in a Photogrammetry mission can be defined here, following the same possibilities as in Automations Actions. A maximum of 4 Actions can be defined.

# 7.2.3.3.1.1 Veronte Gimbal Wizard

Veronte Pipe has an option which allows the user to configure from a basic menu all needed parameters for a Veronte Gimbal (in any of its four models).

м400 🛪 💿 💽 葦	🛛 📽 🕰 🗖	<b>▲</b>	
Actuators			
Communications			
▼ Payload			
▼ Cameras			
Default camera			
Gimbal/Tracker			
Transponder/ADS-B			
Sensors			
▶ Stick			
► Veronte			
• Others			
Add device -			
Drop system			
overonte Gimbal			

Camera Menu - Veronte Gimbal Wizard

The parameters to be configured are:

- Type. Defines the Veronte Gimbal model which is being configured:
  - Veronte Gimbal
  - Veronte Gimbal SC
  - Veronte Gimbal PRO
  - Veronte Gimbal PRO SC
- **Gimbal axis type**. Defines the angles that Veronte will be controlling from the payload system from a Combination of Pan (Z axis, the same as Yaw), Tilt (Y axis, the same as Pitch) and Roll. The two options are as seen below:

- Pan & Tilt.
- Roll & Tilt.
- CAN ID. Chooses the CAN which will be configured for using the Gimbal between A and B.
- Camera URL. Set the computer IP for the wizard to create the corresponding links between Gimbal and PC.
- Automations. Defines the name of the group of automations which will be created after the Wizard.

Veronte gimbal				×
Veronte G	imbal			
Туре	Veronte Gimbal SC 🛛 👻	<u>Camera URL</u> Computer IP	@	
Gimbal axis type	Pan Tilt 🔹	Primary url	udp://@:8008	
CAN ID	B	Automations Group name	Veronte Gimbal	
			App	у

Camera Menu - Veronte Gimbal Wizard - Configuration Parameters

When clicking on apply, the wizard will automatically generate the CAN Messages, the cameras needed (either EO or IO depending on the model), the Gimbal configuration and a set of Automations for its use.

м400 🛪 💿 🔁 葦	🔇 🗱 🏠 🗔	▲ @			
► Actuators	EO Camera				Q
Communications	9,070	mm	Reserved Cam	iera Variables	
▼ Payload	\$ 9,070	mm	Command	l 1 gimbal	
▼ Cameras	▶ [1920		Command	l 2 gimbal	
EO Camera	1080		Command		
Gimbal/Tracker	€ € 4,300	mm	Command	-	
Transponder/ADS-B				_	
Sensors	✓ Streaming	✓ Ca	m associated with gimbal	1	*
▶ Stick	URL uc	dp://@:15004			
► Veronte	Device				
<ul> <li>Others</li> </ul>	Photogrammetry	/			
Add device 👻	Add Action				

#### Camera Menu - Veronte Gimbal Wizard Results

**Warning:** If the camera has not been properly configured or the user wants to delete the previous configured model there are 4 menus to clear:

- CAN A/B Telemmetry TX
- Devices Payload Cameras & Gimbal/Tracker
- Automations Group Defined

# 7.2.3.3.2 Gimbal/Tracker

This menu allows the user to configure a Gimbal Camera or a Tracker Antenna. From here the user only needs to define the movements the system has (from predefined combinations of Pan, Tilt and Roll), its logic, a distance vector and the number of systems connected (up to a maximum of 2).

Fixed Wing V-Tail UAV 🔾	🐵 💿 葦	😧 🗘 🖗	🚯 🗂 🔺			
<ul> <li>Actuators</li> </ul>	🔻 Gimbal/Tr	acker 1				+
Communications					_	
▼ Payload	Type	Pan Tilt	-			
Cameras				Base to gimbal X	0.0	
Gimbal/Tracker	Logic	Convention	al gim 🔻	Base to gimbal Y	0.0	
Transponder/ADS-B		Arcade		-		
Sensors	F	dit Rotation N	latrix	Base to gimbal Z	0.0	
Stick						
<ul> <li>Veronte</li> <li>Others</li> </ul>	Center Limi	t Yaw [0, 2pi)	0.0	Roll rate Gain	0.0	
♥ Others	Center Limi	t Pitch	0.0	Pitch rate Gain	0.0	
	Center Limi	t Roll	0.0			
	Delta Limit	Yaw (0, pi]	6.2831855			
	Delta Limit	Pitch	6.2831855			
	Delta Limit	Roll	6.2831855			
Add device 🔻						

Gimbal/Tracker Menu - Configuration Parameters

- **Type**. Defines the angles that Veronte will be controlling from the payload system from a Combination of Pan (Z axis, the same as Yaw), Tilt (Y axis, the same as Pitch) and Roll. The three options are as seen below:
  - Pan & Tilt.
  - Pan, Roll & Tilt.
  - Roll & Tilt.
- Logic. Defines the kind of payload system configured.
  - **Conventional gimbal**. This option writes over the variables Joint 1-3 Gimbal 1-3 which are used later to configure the control and stabilization of the camera from Veronte.
  - Self-stabilized gimbal. The payload system only needs movement inputs and the variables mentioned will have no output.
- **Base to gimbal Vector**. Defines the vector thats joins the Veronte Autopilot controlling the payload system and the payload system itself, in Veronte body axes.

- Arcade. Configures the Arcade control of the payload system. For a new variable to be controlled, click on the top right "+" icon.
  - Var. Displays the variable over which the Arcade control will have its effect.
  - Gain. Value which multiplies the Var. to obtain the control value.
  - **DBand X**. Creates a non-effect area in which the Joystick won't input control values. DBand X is applied to both left and right on the X axis. Value used to stop the stick from inputting control when at rest.
  - DBand Y. Same as DBand X but applied to the Y axis.
  - Control Output. Defines the value for the control output.

Var	Gain	DBand X	DBand Y	Control Output
Joint 1 of Gimbal 1	1.0	0.02	0.0	1 -

#### Gimbal/Tracker Arcade - Configuration Parameters

Any further configuration will strongly depend on the payload system selected and its control signals. Check Veronte's Gimbal manual as a reference.

### 7.2.3.3.3 Transponder

Veronte is compatible with:

- Sagetech
- uAvionix
  - Mode S Transponder ping 200Sr/200S
  - Mode S Transponder ping 20S

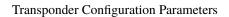
The configuration displayed below is for a Transponder.

- 1. The first step to configure it is to go to **Device Payload Transponder/ADS-B** and check the enable button. Once there, select the **Custom message** to be used for the information exchange, since it will automatically be filled with the information that the Transponder needs.
- 2. Choose the model already mentioned (uAvionix ping20S)
- 3. Switch to the desired Mode
  - **OFF:** Transponder switched off

- STANDBY: Transponder will not respond to interrogation.
- **ON:** Replies to interrogations with 4-digit squawk code.
- ALT: Replies to interrogation with altitude information.
- Enable Ident Mode: UAV identification under ATC request (only available for ON and ALT modes)
- 4. Introduce the Squawk Code provided.

There is an example configuration in the following picture from uAvionix ping 20S.

M400 🛪 💿 🧕 🗄	E 🚱 🗱 🌮 🖾 🔺	Ŵ
Actuators	← Enable	
Communications	Custom message	Custom message 1 👻
▼ Payload	Туре	uAvionix ping 20S 👻
Gimbal/Tracker		
Transponder/ADS-B	Mode	Off 👻
▼ Sensors	Call sign	
<ul> <li>Accelerometer</li> </ul>	Icao	0 hex
Altimeter	Squawk Code	0
GNSS		
<ul> <li>Gyroscope</li> </ul>	Enable ident mod	le
I2C Devices		
<ul> <li>Magnetometer</li> </ul>		
<ul> <li>Obstacle detection</li> </ul>		
Pressure		
► RPM		
Speed down		
Ultrasound		
Stick		
► Veronte	~	
Add device		



Once the transponder is configured, go to **Devices – Others – I/O Manager**. Create a bind-bidirectional communication RS232/RS485 (in the example, through RS232) and assign to it the Custom Message selected before.

-			Producer		Consumer	
Actuators	High	Q <sub>0</sub> <sup>0</sup>	USB	$\leftrightarrow$	Commgr port 1	00
Communications Payload	High	08	Veronte LOS		Commgr port 2	¢\$
Sensors	High	08	Veronte LTE	Ĩ⇔Ĩ	Commgr port 3	¢\$
Stick	High	OS	R\$232		Custom message 1	00
Veronte	High	00	RS485	$\rightarrow$	None	00
Others I/O Manager	High	08	Commgr port 1		USB	O <sup>C</sup>
Digital Input Manager	High	QS (	Commgr port 2	Ĩ↔Ĩ	Veronte LOS	03
	High	08	Commgr port 3		Veronte LTE	03
	High	00	Commgr port 4	<b>→</b>	None	¢\$
	High	Q0	Commgr port 5	$\rightarrow$	None	Q0
	High	00	Commgr port 6	$\rightarrow$	None	¢6
	High	00	Custom message 1		RS232	Q
	High	00	Custom message 2	$\rightarrow$	None	Q
	High	Q <sub>0</sub> <sup>0</sup>	Custom message 3		None	Q
	High	08	Tunnel 1		None	03

# RS232 Message Reception

Note that either RS232 or RS485 must be configured with the corresponding Baudrate from the user transponder in **Connections – Serial – 232/485**.

Veronte 1001 🗙	◎ 💿 🗄 🗞 🕯	🗱 🚯 🗀	▲ 🕅		
Pin: 19	Functionality				
(•	Baudrate	57600	-		
	Length	8	-		
	Stop	1	-		
	Parity	Disabled	-		
► ADC					
Arbiter					
► CAN					
► FTS					
► GPIO/EQEP					
► GPIO					
► I2C					
Others					
▼ Serial					
▶ 232					
▶ 485					
► USB					
Add					

RS232 Configuration Menu

## 7.2.3.3.4 ADS-B

Veronte is compatible with:

- Sagetech
- uAvionix
  - ADS-B Transceiver ping 1090/1090i
  - ADS-B Transceiver ping 2020/2020i
  - ADS-B Receiver ping Rx

The configuration displayed below is for an ADS-B.

- 1. The first step to configure it is to go to **Device Payload Transponder/ADS-B** and check the enable button. Once there, select the **Custom message** to be used for the information exchange, since it will automatically be filled with the information that the ADS-B needs.
- 2. Choose the model already mentioned (uAvionix ping20S)
- 3. Switch to the desired Mode
  - OFF: Transponder switched off
  - **STANDBY:** Transponder will not respond to interrogation.

- **ON:** Replies to interrogations with 4-digit squawk code.
- ALT: Replies to interrogation with altitude information.
- 1090ES: ADS-B transmit is always enabled when a 6-digit ICAO code is entered.
- Enable Ident Mode: UAV identification under ATC request (only available for ON and ALT modes)
- 4. Introduce the Squawk Code provided.
- 5. Enable reception.

There is an example configuration in the following picture from uAvionix ping 1090/1090i.

м400 🛪 🙆 흐 🛱	E 🤪 🗱 🍪 🗂 🔺	$\bigcirc$
Actuators	V Enable	
Communications	Custom message	Custom message 2 🔹
▼ Payload	Туре	uAvionix ping 1090i 👻
Gimbal/Tracker		
Transponder/ADS-B	Mode	Off 👻
▼ Sensors	Call sign	
<ul> <li>Accelerometer</li> </ul>	Icao	0 hex
Altimeter	Several Code	0
► GNSS	Squawk Code	0
Gyroscope	Enable ident mode	e
I2C Devices	Enable reception	
Magnetometer	Remember to activate	the refresh time in the obstacle
Obstacle detection	detection tab	
Pressure		
► RPM		
Speed down		
Ultrasound		
Stick		
► Veronte ~		
Add device 👻		

**ADS-B** Configuration Parameters

The last step you need to do is to enable the External Object Detection in Devices - Sensors - Obstacle Detection.

100 🛪 💿 🔁 🏗	🛛 🗱 🖽 🗔 🔺 🕅
Actuators	✓ Enable
► Communications	Refresh time 2.0 s
▶ Payload	
▼ Sensors	
<ul> <li>Accelerometer</li> </ul>	
Altimeter	
► GPS	
Gyroscope	
I2C Devices	
Magnetometer	
<ul> <li>Obstacle detection</li> </ul>	
External	
Obsens	
Range sensors	
Pressure	
► RPM	
Speed down	
Ultrasound	
► Stick 🗸	
Add device 🔻	

### External Obstacle Detection Menu

Once the transponder is configured, go to **Devices – Others – I/O Manager**. Create a bind-bidirectional communication RS232/RS485 (in the example, through RS232) and assign to it the Custom Message selected before.

			Producer		Consumer	
Actuators	High	Q0	USB	$\leftrightarrow$	Commgr port 1	00
Communications	High	Q <sup>0</sup>	Veronte LOS	Ĩ⇔Ĩ	Commgr port 2	¢\$
Payload Sensors		08		ī⇔ī		00
Stick	High		Veronte LTE		Commgr port 3	
Veronte	High	00	RS232	<b>→</b>	Custom message 1	00
Others	High	00	RS485	$\rightarrow$	None	
I/O Manager	High	00	Commgr port 1		USB	00
Digital Input Manager	High	00	Commgr port 2		Veronte LOS	Q <sup>0</sup>
	High	Q0	Commgr port 3		Veronte LTE	Q0
	High	00	Commgr port 4		None	¢°
	High	00	Commgr port 5	$\rightarrow$	None	00
	High	00	Commgr port 6	$\rightarrow$	None	Q0
	High	00	Custom message 1		RS232	00
	High	00	Custom message 2	$\rightarrow$	None	00
	High	$\dot{\mathbf{Q}}^{\diamond}_{\diamond}$	Custom message 3	$\rightarrow$	None	00
	High	Q0	Tunnel 1		None	00

Transponder Configuration - Serial Communication

Note that either RS232 or RS485 must be configured with the corresponding Baudrate from the user transponder in **Connections – Serial – 232/485**.

Veronte 1001 🛪	🛛 🖸 🗄 🕄 K	🗶 🙆 🗀	▲ 🕅		
Pin: 19	Functionality				
	Baudrate	57600	-		
$\langle \cdot \cdot \cdot \rangle$	Length	8	-		
	Stop	1	•		
	Parity	Disabled	-		
► ADC					
► Arbiter					
► CAN					
► FTS					
► GPIO/EQEP					
► GPIO					
▶ I2C					
▶ Others					
▼ Serial					
▶ 232					
▶ 485					
► USB					
Add 👻					
10.0101010010101010101010101010101010					

Transponder Configuration - Serial Configuration

In order to see the information from the ADS-B, aside from having visual objects on the screen, the user can use a Widget (refer to Workspace – ADS-B Decoder)

The following menu displays the possible Payload that can be configured with Veronte. Each window will allow the user to configure different parameters from the available variety of payloads.

🔯 M400 🛪 🛞 🙆 葦	Q 🗱 🔁 🗆 🔺
<ul> <li>Actuators</li> </ul>	
<ul> <li>Communications</li> </ul>	
▼ Payload	
Gimbal/Tracker	
Transponder/ADS-B	
Sensors	
▶ Stick	
▶ Veronte	
<ul> <li>Others</li> </ul>	
Add device 🔻	

Payload Menu

### 7.2.3.4 Sensors

## 7.2.3.4.1 Accelerometer

Veronte incorporates two Inertial Measurement Units (IMUs) that allows the Veronte System to measure different variables and that are the main navigation data source. From the IMU, the user can configure the Accelerometer and Gyroscope. The first one is explained below.

The user can choose between 3 types of source for the accelerometer.

- Integer var sensor 1-2. Veronte uses a integer value provided by an external sensor.
- Decimal var sensor 1-2. Veronte uses a decimal value provided by an external sensor.
- Internal 1-2 (Main/Secondary). Veronte uses the internal sensor.

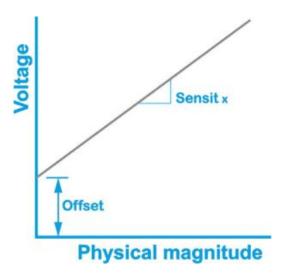
# 7.2.3.4.1.1 Integer var sensor

In this menu it is possible to configure integer variables provided by an external sensor.

M400 🛪 🛞 🧿 葦	🚱 🗱 🌇 🗂 🔺 🕅	
<ul> <li>Actuators</li> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> <li>Configuration</li> <li>Altimeter</li> <li>GNSS</li> </ul>	<ul> <li>O - Integer var sensor 1</li> <li>O - Integer var sensor 2</li> <li>2 - Decimal var sensor 1</li> <li>3 - Decimal var sensor 2</li> <li>4 - Internal 1</li> <li>5 - Internal 2</li> </ul>	Edit Rotation Matrix         X Axis       Zero       Signed $V_0 + V_1 \cdot X^1$ $\checkmark$ $\checkmark$ $V_0$ $V_1$ $\bullet$ $V_0$ $V_1$ $\bullet$ Y 0 $V_1$ $\bullet$ Y Axis $\bullet$ $\bullet$
<ul> <li>Gyroscope         <ul> <li>I2C Devices</li> <li>Magnetometer</li> <li>Obstacle detection</li> <li>Pressure</li> <li>RPM</li> <li>Speed down</li> <li>Ultrasound</li> <li>Stick</li> <li>Veronte</li> <li>Others</li> </ul> </li> </ul>		Zero       Signed $V_0 + V_1 \cdot X^1 + V_2 \cdot X^2$ • $V_0$ $V_1$ $V_2$ $0.0$ $0.0$ Z Axis       User Variable 01 (Unsigned Integer - 16       Signed         0       •       •
Hou defice	< >	<>

Integer var Accelerometer Menu - Configuration Parameters

When Integer var sensor 1 or 2 are selected, the previous panel will be shown. In this panel, the user selects the variable that has been stored in a user variable (Green Box) and the operations that will be carried on (Red Box). It is possible to use the signal through a linear or quadratic relation. The following image shows an example of a linear relation.



Linear relation of 2 Variables

The process of configuration has to be done using **Custom Messages**. This is to be configured in **Devices - Others - Digital - I/O Manager**. The configuration will depends on the device in use and its communication protocol.

## 7.2.3.4.1.2 Decimal var sensor

In this menu, the user selects real variables for each axis (X,Y,Z), these do not requiere a signal treatment. The process of configuration is similar to the one carried out when configuring a Integer Variable.

M400 🛪 🛞 🧰 \Xi	🚱 📽 🕰 🗂 🔺 🕅	)
Actuators     Communications	0 - Integer var sensor 1 1 - Integer var sensor 2	Edit Rotation Matrix
<ul> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> </ul>	<ul> <li>2 - Decimal var sensor 1</li> <li>3 - Decimal var sensor 2</li> <li>4 - Internal 1</li> </ul>	X     User Variable 01 (Real - 32 bits)       Y     User Variable 02 (Real - 32 bits)
Configuration Altimeter GNSS Gyroscope I2C Devices Magnetometer Obstacle detection Pressure RPM Speed down Ultrasound Stick Veronte Others	5 - Internal 2	Z User Variable 03 (Real - 32 bits)
Add device 👻	<>	

Decimal var Accelerometer Menu - Configuration Parameters

# 7.2.3.4.1.3 Internal

This last menu available displays the posible parameters that can be configured for the internal Accelerometer.

🔟 M400 🛪 💿 🧿 葦 😵 🗱 🖽 🗖	▲ @
Actuators     O - Integer val	Edit Kotation Matrix
<ul> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> <li>Configuration</li> <li>Altimeter</li> <li>GNSS</li> <li>Gyroscope</li> <li>I2C Devices</li> <li>Magnetometer</li> <li>Obstacle detection</li> <li>Pressure</li> <li>RPM</li> <li>Speed down</li> <li>Ultrasound</li> <li>I - Integer val</li> <li>2 - Decimal val</li> <li>3 - Decimal val</li> <li>3 - Decimal val</li> <li>3 - Decimal val</li> <li>5 - Internal 1</li> <li>5 - Internal 2</li> </ul>	sensor 2 r sensor 1 Accelerometer
Stick     Veronte     Others     Add device	

#### Accelerometer Menu - Configuration Parameters

**Warning:** Edit Rotation Matrix brings the position of the accelerometer inside the Veronte Autopilot, it must **NOT** be changed under any circumstance.

In this menu it is possible to set different options regarding range and filters from the accelerometer. The parameters that can be modified are:

- **Range**. Sets the maximum range of performance, high ranges implies less precision while small ranges might mean the system saturates. Values allowed are 2g, 4g, 8g and 16g.
- Antialiasing filter bandwith. It is the bandwidth of the antialiasing low pass filter. The options available are 50Hz, 100Hz, 200Hz and 400Hz, the greater the value selected the worse the filtering will be.
- Enable digital filter. Enables a low pass filter which its cutoff frequency is configured from the options 16.65Hz, 66.6Hz, 133.2Hz and 740.0Hz. This is a hardware filter, included directly in the Accelerometer.
- **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**, applied after the hardware filter from the point before.

## 7.2.3.4.2 Altimeter

The following figure shows the configuration menu for an external altimeter like LIDAR, Sonar, etc.

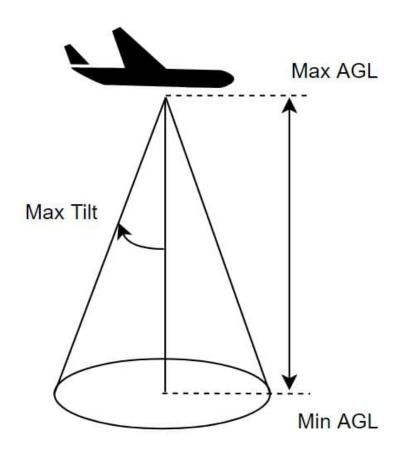
Veronte Air 🛪 🙆 🧿	≆ 🛛 端 🙆 🗂 🔺 ⅲ ⊘
► Actuators	C Enable Altimeter
Communications	Sensor Type Distance 👻
Payload	
▼ Sensors	Min time diff to allow preload
<ul> <li>Accelerometer</li> </ul>	X (0.0 m)
Altimeter	Position of altimeter (Body frame) Y 0.0 m
► GNSS	z 0.0 m
Gyroscope	2 0.0 m
I2C Devices	✓ Enable tilt limit         10.0         ° [-180,180]
Magnetometer	Input Variable Lidar 1 Distance
Obstacle detection	
Pressure	✓ Enable sensor limits ( 0.05 m , 40.0 m )
► RPM	Sensor variance (m²) 0.01 🔅
Speed down	
Ultrasound	Maximum variance 1.0
► Stick	Minimum variance 0.01
▶ Veronte	Time to reset variance
▶ Others	
	τ (filter constant)
Add device 🔹	

Altimeter Menu - Configuration Parameters

- Sensor Type. This drop-down list allows the user to choose between two possible configurations:
  - AGL. AGL stands for Height Above Ground Level. This options is intended for use with altimeters that
    do not depend on the inclination of the platform (e.g. barometric) or when this inclination is or will be
    negligible.
  - **Distance**. It is meant to be used with radar altimeter or Lidar systems. The distance to the ground (or to a certain object of interest) is corrected taking into account the inclination angles and, also, the X, Y and Z offset between the altimeter position and the origin of the body frame.
- Min time diff to allow preload. Establishes the maximum frequency at which this sensor values will enter the Navigation filter. I.e. if it is executed at 50 Hz and we set (as in the picture 0.1 s) 10 Hz, there will be loops when the value is the one stored before.
- **Position of altimeter (Body frame)**. Parameter to indicate the distance from the altimeter to the centre of gravity of the platform. This is used to take into account the weight of the altimeter in the aircraft control.
- Enable tilt limit: The altimeter is normally installed in a fixed position having a constant direction with respect to the platform. Taking a LIDAR as an example, it is used to measure altitude so it has to point towards the ground, in a direction parallel to the Z body axis. When the vehicle is not level on its X or Y axis (has a pitch or roll angle different from zero), the LIDAR will not point in a direction perpendicular to the ground, and the measurement taken will not be the real altitude of the aircraft. This option is a safe condition to discard the measure of an altimeter when its tilt angle exceeds a certain value.

- Sensor variance. It is a measurement related to sensor error, whose units are squared meters. It indicates the weight that this measure will have in the sensor fusion algorithm that combines the information of different sensors to generate an altitude estimation.
- Input Variable. Input variable to which the parameters defined here will be applied.
- Enable sensor limits. It is the range in which the sensor measurement is taken to be processed by Veronte Pipe. Any outer value will be discarded by the system.

The following figure shows a diagram with the values of maximum and minimum sensor limits altitude, and the maximum tilt angle.



Altimeter Menu - Sensor Limits

- Maximum variance: Maximum variance applied to the measurement after measurement lost.
- Minimum variance: Minimum variance applied to the measurement after recovering from a measurement lost.
- Time to reset variance: Time before considering measurement lost.
- Tau (Filter constant): Smoothing parameter for the transition from maximum to minimum variance.

Common implementations of lidar can be found in *Lidar Integration*.

# 7.2.3.4.3 GNSS

# 7.2.3.4.3.1 GNSS 1 & 2 Configuration

# 7.2.3.4.3.2 Configuration

This menu contains the parameters needed to configure the GNSS receiver 1-2 located in Veronte Autopilot.

🔯 Veronte0 🛪 🐵 💽 葦 😵 🗱 🔁 🔺 🏭 ⊘			
► Actuators	Configuration SBAS Message rate EKF N	lavigation Advanced	
► Communications	GNSS	Survey In	
▶ Payload	14 A. (025	Enabled	
▼ Sensors	Meas Rate 0.25 s	Minimum duration 0.0 s	
Accelerometer	Precise Point Positioning		
Altimeter		Position accuracy limit 0.0 m	
▼ GNSS			
GNSS 1 Configuration	Protocols		
GNSS 2 Configuration	Mask in	Mask out	
GNSS Compass			
GPS External	✓ ublox	✓ ublox	
NTRIP	nmea rtcm	nmea rtcm3	
► Gyroscope	rtcm3	nems	
I2C Devices	- Items		
Magnetometer			
Obstacle detection			
Pressure			
► RPM	Distance to the center of mass in aircraft body frame		
$\langle $	X Y	Z	
Add device 👻	Vector 0.0 m 0.0 m 0	.0 m	

#### GNSS - Configuration Menu

The following parameters are configurable in this menu:

- GNSS. Data values that can be configured.
  - Meas Rate. Defines the minimum time between data acquisition.
  - **Precise Point Positioning (PPP)**. This option is a global precise positioning service, PPP is able to provide position solutions at centimetre to decimetre level after a few minutes with unobstructed sky view.
- **Survey in**. Determines a stationary receiver's position by building a weighted mean of all valid 3D position solutions. This mode should be activated in a Veronte Ground to enable GNSS Differential mode and send corrections to Veronte Air. Two requirements for stopping the procedure must be specified. Survey in procedure will end when both requirements are met.
  - Minimum duration. Defines a minimum amount of observation time regardless of the actual number of valid fixes that were used for the position calculation. Reasonable values range from one day for high

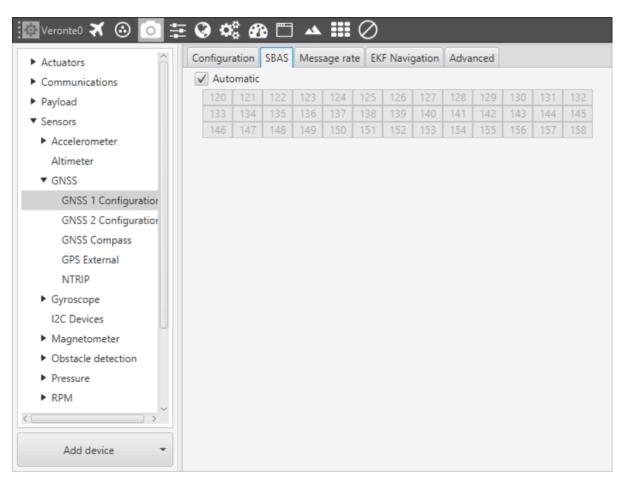
accuracy requirements to a few minutes for coarse position determination

- Position accuracy limit. Defines a limit on the spread of positions that contribute to the calculated mean.
- **Protocols**. Allows the user to select the different comunication protocols as input or output. One port can handle several protocols at the same time (e.g. NMEA and UBX).
  - Protocols will be changed when using the GNSS Compass Wizard (see in Devices GNSS GNSS Compass).
- **Distance to center of mass**. It is used to set the relative distance to the center of mass from the GNSS antenna in aircraft body axis. This parameter has to be set correctly in order to get a correct value when using GNSS Compass.

More information about protocols and configuration can be found here .

### 7.2.3.4.3.3 SBAS

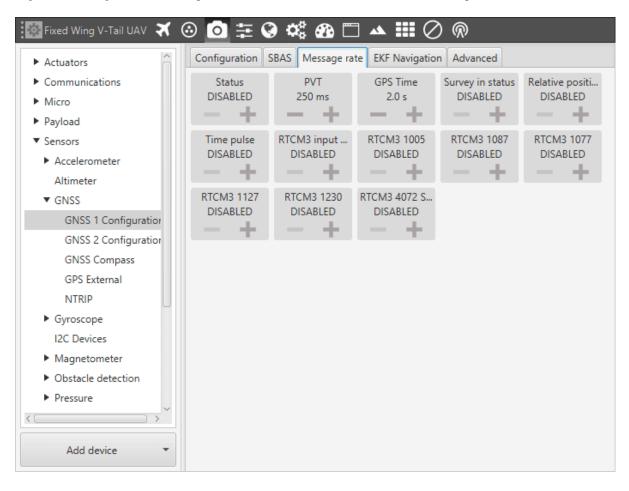
**SBAS** stands for Satellite Based Augmentation System. It is a set of geostationary satellites that are used to check the status of the signals sent by the GPS Satellites, and to improve the tracking via the correction of atmospheric disturbations, orbit deviations, clock errors and so on. In Veronte Pipe, it is possible to select the satellites that will be used for this purpose (selecting the number that appears in the table of the following figure), or make the software to automatically choose them according to the location of the platform.



GNSS - SBAS Menu

# 7.2.3.4.3.4 Message Rate

The **Message rate** options are used to set the time between the messages received at the autopilot. Each one of the different messages can be configured separately: ECEF (earth centred, earth fixed reference system), LLH (latitude, longitude and height), Speed, GPS Time, SV Status (state of the GPS satellite) and so on. This messages will be changed when using the GNSS Compass Wizard (see in Devices - GNSS - GNSS Compass).



GNSS - Message Rate

For information about RTCM 3 message list can be found here .

# 7.2.3.4.3.5 Estimation Error

🔯 Veronte0 🛪 💿 💽 🗄	E 😧 📽 🌮 🖾 🔺			
Actuators	Configuration SBAS Messa	age rate EKF Navig	ation Adva	nced
Communications	Enable GNSS in EKF Naviga	ation		
Payload	Use position measures in the attitude calculation			
▼ Sensors	Use speed measures in attitude calculation			
Accelerometer				
Altimeter	Square error on strong acceleration for position 20.0 m <sup>2</sup>			
▼ GNSS	Square error on strong acceleration for speed 20.0 (m/s) <sup>2</sup>			
GNSS 1 Configuration	Acceleration 30.0 m/s <sup>2</sup>			
GNSS 2 Configuration	Duration of effect (disappears linearly with time) 2.5 s			
GNSS Compass				
GPS External	Square error Use receiver value			
NTRIP				if present
► Gyroscope	GNSS North Position	10.0	m².	$\checkmark$
I2C Devices	GNSS East Position	10.0	m²	$\checkmark$
Magnetometer	GNSS Down Position	10.0	m²	$\checkmark$
Obstacle detection	GNSS North Velocity	0.1	(m/s) <sup>2</sup>	$\checkmark$
Pressure	GNSS East Velocity	0.1		$\checkmark$
► RPM			(m/s)*	
× ×	GNSS Down Velocity	0.1	(m/s) <sup>2</sup>	$\checkmark$
Add device 👻				

#### GNSS - Estimation Error

- **Enable check**: Enables/Disables the usage GNSS solution in the Extended Kalman Filter. Veronte will keep receiving GNSS information from that module, but it will not be considered.
- Use position measures in the attitude calculation: When enabled, the position data from the GNSS solution is considered for the attitude estimation.
- Use speed measures in the attitude calculation: When enabled, the speed data from the GNSS solution is considered for the attitude estimation.

The variances considered in the EKF for the GNSS solution are by default the values provided by the GNSS receiver but can be modified for more complex scenarios.

- GNSS North Position: Variance for the North component of the position solution.
- GNSS East Position: Variance for the East component of the position solution.
- GNSS Down Position: Variance for the Down component of the position solution.
- GNSS North Velocity: Variance for the North component of the velocity solution.
- GNSS East Velocity: Variance for the East component of the velocity solution.
- GNSS Down Velocity: Variance for the Down component of the velocity solution.

Under strong accelerations the information provided by the GNSS does not represent the fast change of position and velocity therefore different variance must be considedred in the EKF.

- Square error on strong acceleration for position: Under a strong acceleration the variance for the position solution it is changed to the specified value.
- Square error on strong acceleration for speed: Under a strong acceleration the variance for the speed solution it is changed to the specified value.
- Acceleration: Threshold definition. When this threshold is exceeded, strong acceleration variances are considered.
- Duration of effect: Time needed to restore the default variances of the GNSS solution .

## 7.2.3.4.3.6 Advanced

Veronte0 🛪 🛞 💽 🛱	: 🛛 🗱 🙆 🗂 🔺 🏭 🤇	$\diamond$
Actuators	Configuration SBAS Message rate	EKF Navigation Advanced
Communications		
Payload	Minimum satellites number	4
▼ Sensors	Maximum satellites number	20
Accelerometer	Minimum satellite Elevation	5.0
Altimeter		
▼ GNSS	PDOP Mask	25.0
GNSS 1 Configuration	TDOP Mask	100.0
GNSS 2 Configuration	P Acc Mask	100.0 m
GNSS Compass		
GPS External	T Acc Mask	100.0 m
NTRIP		
► Gyroscope	Dynamic model Airbone 4G	-
I2C Devices		
Magnetometer		
Obstacle detection		
Pressure		
► RPM		
<>		
Add device 👻		

### GNSS - Estimation Error

Warning: Modifying these parameters can cause problems during the acquisition of GNSS positioning.

- Minimum satellites number: Minimum number of satellites needed to have position fixed.
- Maximum satellites number: Maximum number of satellites needed to have position fixed

- Minimum satellite elevation: Minimum elevation of a satellite to be considered. Value in degrees.
- **PDOP mask**: Maximum Position dilution of precision to consider the solution.
- **TDOP mask**: Maximum Time dilution of precision to consider the solution.
- P Acc mask: Maximum Position accuracy to consider the solution.
- T Acc mask: Maximum Time accuracy to consider the solution.

### Dynamic Model

The embedded receiver supports different dynamic platform models to adjust the GNSS navigation engine to the expected application environment. The settings improve the receiver's interpretation of the measurements and thus provide a more accurate position output. Setting the receiver to an unsuitable platform model for the given application environment is likely to result in a loss of receiver performance and position accuracy.

Platform	Description
Portable	Applications with low acceleration.
Stationary	Stationary applications. Velocity restricted to 0 m/s. Zero dynamics assumed
Pedestrian	Applications with low acceleration and speed. Low acceleration assumed.
Automotive	Used for applications with equivalent dynamics to those of a car. Low vertical acceleration assumed.
Sea	Recommended for applications at sea, with zero vertical velocity. Zero vertical velocity assumed. Sea
	level assumed.
Airborne	Used for applications with a higher dynamic range and greater vertical acceleration than a car.
1G	
Airborne	Recommended for typical airborne environments.
2G	
Airborne	Recommended for extremely dynamic environments.
4G	

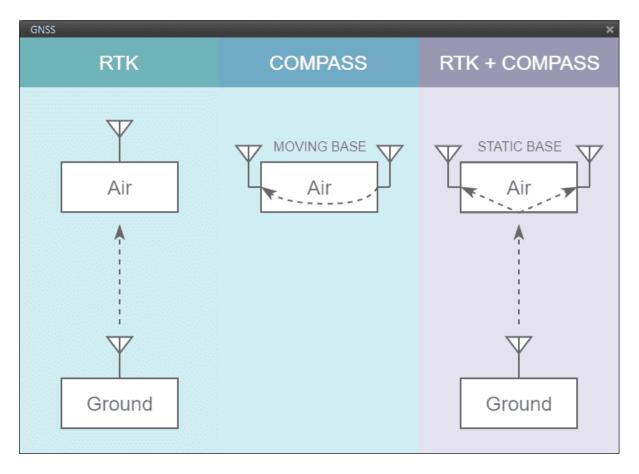
### 7.2.3.4.3.7 GNSS Compass

GNSS Compass menu allows the user to access to the RTK - Compass Wizard (an interface which helps the user configuring everything related to RTK - GNSS Compass) and some other parameters which could be changed afterwards or if the user has knowledge enough.

Versati SIL 🛪 🛞 💽 🛱	E 🥝 🗱 🍪 🗂 🔺	
Actuators	🌮 RTK - Compass Wizard	
Communications		
▶ Payload	GNSS compass configuration	
▼ Sensors	Enable	
Accelerometer	DGNSS type	Rover with moving base -
Altimeter		
▼ GNSS	Base source	GPS 2
GNSS 1 Configuration	Use user variance	
GNSS 2 Configuration	User variance	(4.0 m <sup>2</sup> )
GNSS Compass		
GPS External	3D	
NTRIP		
Gyroscope		
I2C Devices		
Magnetometer		
Obstacle detection		
Pressure		
► RPM		
$\langle $		
Add device 👻		

# GNSS Compass - Configuration Menu

By clicking on RTK - Compass Wizard button, the user will access the configuration menu where three options will be displayed.



GNSS Compass - RTK & Compass Wizard

- **RTK**. Stands for Real Time Kinematics and it is a satellite navigation technique used to **enhance the precision** of position data derived from satellite-based positioning systems. It requires from **2 GNSS receivers** placed **in different autopilots** to work.
- Compass. The GNSS compass provides accurate dual antenna GNSS based heading that is not subject to magnetic interference. It requires from 2 GNSS receivers placed in the same autopilot to work.
- **RTK + Compass**. A hybrid combination where both tool are employed at the same time in a system where the **AIR unit** must have **2 GNSS receivers** and the **GND**, at least, **must have 1**.

When accessing the GNSS Compass feature, the user will be asked which configuration is preferred in accordance to the function of each receiver:

- GNSS 1 Base and GNSS 2 Rover.
- GNSS 1 Rover and GNSS 2 Base.

I GNSS		×
Select the function of eac	h GPS	?
GNSS1 Base, GNSS	GNSS1 Rover, GNS	Cancel

GNSS Compass - Compass Base/Rover

**Warning:** It's possible that Compass options are blocked in Wizard if the position of GNSS antennas is not defined. To avoid this problem, change the distance to the center of mass in aircraft body frame in Devices/Sensors/GNSS.

These same parameters can be manually changed afterwars in GNSS Compass Configuration. After using the wizard, the Enable check will be marked. The options enabled this way are:

- **DGNSS Type**. Where the option available are "Rover with moving base" and "Rover with rover (static base)". The first option references to GNSS Compass, while the second is used in RTK with Compass. Consider the parameter established will be the one coming from the Wizard configuration.
- Base source. Where option are GPS 1 or 2.

To configure the rest of parameters in Compass mode, user has to modify the GNSS configuration and message rate. First, set the MEAS rate to 0.5. Then configure the protocols. Rtcm3 is enabled in *mask in* for the GNSS configured as rover, and in the *mask out* for the GNSS base. The message rates are different in each GNSS. The essential messages are shown below:

Configuration	SBAS Message ra	te EKF Navigation	n Advanced	BASE
Status	PVT	GPS Time	Survey in status	Relative positi
500 ms	500 ms	4.0 s	DISABLED	DISABLED
Time pulse	RTCM3 input	RTCM3 1005	RTCM3 1087	RTCM3 1077
DISABLED	DISABLED	DISABLED	500 ms	500 ms
RTCM3 1127 DISABLED	RTCM3 1230 1.0 s	RTCM3 4072 S 500 ms		

Configuration S	SBAS Message ra	te EKF Navigation	n Advanced	ROVER
Status	PVT	GPS Time	Survey in status	Relative positi
500 ms	500 ms	4.0 s	DISABLED	500 ms
Time pulse	RTCM3 input	RTCM3 1005	RTCM3 1087	RTCM3 1077
DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
RTCM3 1127 DISABLED	RTCM3 1230 DISABLED	RTCM3 4072 S DISABLED		

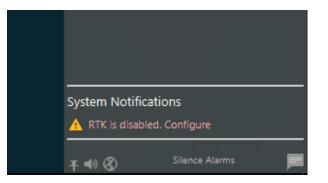
GNSS Compass - Compass Message Rate

In the I/O Manager menu (Devices - Others), base GNSS (producer) sends RTCM information to rover GNSS (consumer).

GNSS 2 Configuration	Configu Priority	ration	Producer		Consumer	
GNSS Compass GPS External	High	$Q_0^0$	Commgr port 3		Veronte LTE	¢,
NTRIP	High	00	Commgr port 4	$\rightarrow$	None	0
<ul> <li>Gyroscope</li> </ul>	High	00	Commgr port 5	$\rightarrow$	None	Q <sup>0</sup>
I2C Devices	High	00	Commgr port 6	$\rightarrow$	None	08
Magnetometer     Obstacle detection	High	00	RS custom message 1	-	None	08
Pressure	High	00	RS custom message 2	$\rightarrow$	None	¢\$
▶ RPM	High	00	RS custom message 3	$\rightarrow$	None	Q.
Speed down Ultrasound	High	00	Tunnel 1	-	None	08
• Stick	High	00	Tunnel 2	$\rightarrow$	None	0
Veronte	High	00	Tunnel 3	<b>→</b>	None	08
Others	High	00	GPS 1 RTCM	$\rightarrow$	GPS 2 RTCM	03
CAN Config	High	00	GPS 2 RTCM	$\rightarrow$	None	03
Digital Input Manager 🗸	High	00	External magnetometer	<b>→</b>	None	08
) >	High	Q <sup>0</sup>	External ultrasound	<b>→</b>	None	08
Add device 🔻	High	Q <sup>0</sup>	Y1 splitter A	-	None	08

GNSS Compass - Compass I/O Manager

The RTK - Compass Wizard does also appear as a red notification on the bottom right side of Veronte Pipe.



**GNSS** Compass - Configuration Notification

By clicking on it, the Wizard will ask the user which AP is the AIR unit and which one is the GND (in case RTK functionality is expected) and afterwards, the GNSS Compass wizard will be displayed and use in the same way.

## 7.2.3.4.3.8 RTK Configuration

Apart from the wizard option, it is possible to configure RTK following the next guide. First, it is needed to configure Ground Station setup. Ground station has two GNSS ports. User can choose one of them to carry out the RTK technique (Using Wizard tool the first GNSS is chosen by default). The main parameters are shown in the picture below.

Veronte Ground 🛪 🙆 🚺	〕፰��ぱぬ㎝ – ▲ Ⅲ (	0
► Actuators	Configuration SBAS Message rate EKF N	lavigation Advanced
► Communications	GNSS	Survey In
Payload     Sensors     Accelerometer     Altimeter     GNSS	Meas Rate 0.5 s	Image: Second state     Second state       Minimum duration     300.0 s       Position accuracy limit     3.0 m
GNSS 1 Configuration	Protocols	
GNSS 2 Configuration GNSS Compass GPS External NTRIP Gyroscope I2C Devices Magnetometer Obstacle detection Pressure	Mask in ✓ ublox nmea rtcm rtcm3	Mask out ✓ ublox ☐ nmea ✓ rtcm3
► RPM	Distance to the center of mass in aircraft boo	ly frame
Add device	X Y Vector 0.0 m 0.0 m 0.	Z .0 m

GNSS Compass - RTK configuration (Ground Unit)

- Meas Rate: measurement rate. The optimal is fixed in 0.5.
- **Protocols**: rtcm3 has to be enabled in Mask out.
- **Survey in**: to configure the **minimum** 'Survey In' accuracy and for how long the accuracy needs to be held within this range in order to enable the RTK feature.

Then, the following messages need to be configured in the 'Message Rate' tab. They are properly selected in the next picture.

Veronte Ground 🛪 🙆	] 🗄 🚱 🗱	🛾 🔁 🖾	. Ⅲ ⊘		
► Actuators	Configuration S	BAS Message ra	te EKF Navigatio	n Advanced	
<ul> <li>Communications</li> <li>Payload</li> </ul>	Status 500 ms	PVT 500 ms	GPS Time 4.0 s	Survey in status 500 ms	Relative positi DISABLED
Sensors     Accelerometer     Altimeter	Time pulse DISABLED	RTCM3 input DISABLED	RTCM3 1005 500 ms	RTCM3 1087 500 ms	RTCM3 1077 500 ms
<ul> <li>GNSS</li> <li>GNSS 1 Configuration</li> <li>GNSS 2 Configuration</li> <li>GNSS Compass</li> <li>GPS External</li> <li>NTRIP</li> <li>Gyroscope</li> </ul>	RTCM3 1127 DISABLED	RTCM3 1230 1.0 s	RTCM3 4072 S DISABLED		
I2C Devices  Magnetometer  Obstacle detection  Pressure  RPM  <					
Add device 👻					

GNSS Compass - RTK Message Rate (Ground Unit)

Finally, go to the I/O Manager, and add a message by a tunnel with RTCM information. This will be sent to AIR UNIT to correct their GNSS measurements and improve their accuracy.

GNSS 2 Configuration	Configu	ration							
GNSS 2 configuration	Priority High	5,65	Producer Commgr port 4		Consumer KS232	54 <sub>0</sub>	~		
GPS External	High	08	Commar port 5	$\rightarrow$	None	00			
NTRIP		Q <sup>0</sup>	Commgr port 6	$\rightarrow$	None	00			
Gyroscope	High		<u> </u>						
I2C Devices	High	$Q_0^0$	RS custom message 1	$\rightarrow$	None	<b>Q</b> <sup>0</sup>			
<ul> <li>Magnetometer</li> </ul>	High	$Q_0^0$	RS custom message 2	$\rightarrow$	None	00			
Obstacle detection	High	00	RS custom message 3	$\rightarrow$	None	03			
Pressure		00	Tunnel 1	$\rightarrow$	None	00			
▶ RPM	High				None				
Speed down	High	$Q_0^0$	Tunnel 2	$\rightarrow$	None	00			
Ultrasound	High	$Q_0^0$	Tunnel 3	$\rightarrow$	None	08			
Stick	High	Q <sup>0</sup>	GPS 1 RTCM	i→i	None	00			
/eronte							Veronte ID	Broadcast	
Others	High	00	GPS 2 RTCM	$\rightarrow$	Tunnel 1	00			
I/O Manager	High	$Q_0^0$	External magnetometer	$\rightarrow$	None	00	Parser	RTCM3	
CAN Config	High	Q <sup>0</sup>	External ultrasound	i → i	None	00	Destination tunnel	Tunnel producer 1	-
Digital Input Manager									
>	High	00	Y1 splitter A	$\rightarrow$	None	00	Time between messages	s 1.5	

GNSS Compass - RTK I/O Manager (Ground Unit)

Now, it's time to configure the AIR Unit. Meas Rate to 0.5, and rtcm3 enabled in *Mask in* (Protocols). The message rate has to be configured as follows:

Versati SIL 🛪 🛞 💽 🗄	= 🛛 📽 🙆	) 🗂 🔺 🎞	$\oslash$		
► Actuators	Configuration 9	SBAS Message ra	te EKF Navigatio	n Advanced	
<ul> <li>Communications</li> <li>Payload</li> <li>Sensors</li> </ul>	Status 500 ms	PVT 500 ms RTCM3 input	GPS Time 4.0 s	Survey in status DISABLED	Relative positi DISABLED
<ul> <li>Accelerometer</li> <li>Altimeter</li> <li>GNSS</li> </ul>	Time pulse DISABLED	DISABLED	DISABLED	DISABLED	
GNSS 1 Configuration GNSS 2 Configuration GNSS Compass GPS External NTRIP Gyroscope I2C Devices Magnetometer Obstacle detection Pressure RPM	RTCM3 1127 DISABLED	RTCM3 1230 DISABLED	RTCM3 4072 S DISABLED		
Add device					

GNSS Compass - RTK Message Rate (Air Unit)

The last step consists of configuring I/O Manager to receive RTCM message sent by the tunnel (Ground unit). If user wants to receive position corrections in both GNSS devices the tunnel has to be splitted in 2 channel (1). Then, user has to link these splitted channels to GPS RTCM (2).

GNSS 2 Configuration	Configu	Configuration									
GNSS Compass	Priority		Producer		Consumer						
GPS External	High	${\mathfrak Q}^0_0$	RS custom message 1	$\rightarrow$	None	00					
NTRIP	🔲 High	$Q_0^0$	RS custom message 2	$\rightarrow$	None	\$¢					
<ul> <li>Gyroscope</li> </ul>	High	$\dot{Q}^0_0$	RS custom message 3	$\rightarrow$	None	¢\$					
I2C Devices Magnetometer	High	$\dot{Q}^0_0$	Tunnel 1	$\rightarrow$	Y1 splitter						
<ul> <li>Obstacle detection</li> </ul>	High	00	Tunnel 2	$\rightarrow$	None	00					
Pressure	High	Q°	Tunnel 3	$\rightarrow$	None	00					
<ul> <li>RPM</li> <li>Speed down</li> </ul>	High	00	GPS 1 RTCM	$\rightarrow$	None	00					
Ultrasound	High	08	GPS 2 RTCM	$\rightarrow$	None	08					
Stick	High	00	External magnetometer	$\rightarrow$	None	08					
Veronte     Others	High	$\langle Q^0_0 \rangle$	External ultrasound	$\rightarrow$	None	¢00					
I/O Manager	High	00	Y1 splitter A	$\rightarrow$	GPS 1 RTCM						
CAN Config	High	08	Y1 splitter B	$\rightarrow$	GPS 2 RTCM	2					
Digital Input Manager	High	00	Y2 splitter A	$\rightarrow$	None	00					
	High	-08	Y2 splitter B	$\rightarrow$	None	¢6					
Add device	High	108	Y3 splitter A	$\rightarrow$	None	02					

GNSS Compass - RTK I/O Manager (Air Unit)

# 7.2.3.4.3.9 GNSS External

If the reception of GNSS information is done through an external system, the user must configure it in this menu, so that system can be included in the navigation filters. After properly configuring the communication protocol on the corresponding channel (RS 232, RS485, CAN...) the GNSS External variables of interest must be filled in this interface:

## 7.2.3.4.3.10 Configuration

Veronte0 🛪 🐼 💽 🛱	E 🚱 🗱 🚳 🗂 🔺 🎚		
Actuators	Configuration EKF Navigation		
▶ Communications	✓ Enable		
Payload	Period	0.25	s
▼ Sensors			
Accelerometer	Fix bit	BIT Dummy Er	ror
Altimeter	Time of week	Rvar Disable	d
▼ GNSS	GPS week	Rvar Disable	d
GNSS 1 Configuration			
GNSS 2 Configuration	<ul> <li>Enable position</li> </ul>	GPS position	Value used when invali
GNSS Compass		Horizontal position error	2.0 m
GPS External			
NTRIP		Vertical position error	5.0 m
Gyroscope			
I2C Devices	✓ Enable velocity	Horizontal velocity error	1.0 m/s
<ul> <li>Magnetometer</li> </ul>			
<ul> <li>Obstacle detection</li> </ul>		Vertical velocity	1.0 m/s
Pressure	Velocity north	Velocity east	Velocity down
► RPM	Rvar Disabled	Rvar Disabled	Rvar Disabled
< <u> </u>		X Y	Z
Add device 👻	Distance to mass center 0.0	m 0.0	m 0.0 m

#### **GNSS** External - Configuration Menu

Check GNSS External device communication protocol before filling this menu.

The user should create a Custom Message according to the communication protocol used by the external sensor, so that its readings are stored in system variables. Then, the user can select this variables to configure the following parameters:

- **Period**. Defines the period of incoming information from the external system.
- Fix bit. Data provided by the external device which is important to know the status of the positioning.
- Time of week. Variable extracted from the communication protocol defining the time of the week.
- GPS Week. Variable extracted from the communication protocol defining the week.
- **GPS Position**. Variable defining latitude, longitude and height from GNSS. Usually Moving Object variables are used in Pipe.
- Horizontal/Vertical Position Error. Defined by the GNSS External device provider.
- Velocity north/east/down. Variables extracted from the communication protocol defining GNSS velocity measured.
- Horizontal/Vertical velocity error. Defined by the GNSS External device provider.

• **Distance to mass center**. Define the distance between the uav mass center and the position of the external GNSS antenna.

### 7.2.3.4.3.11 NMEA Parser

Another way to add an external GNSS device is to use the **NMEA Parser** Consumer (*I/O Manager*). This consumer allows to receive NMEA 0183 messages and parses them directly. The NMEA Parser configuration menu includes the following parameters:

- Time out. Defines the period of incoming information from the external system.
- **Feature**. Variable extracted from the message defining the GNSS position. Usually Moving Object variables are used in Pipe.
- Utc. Variable extracted from the message defining the UTC.
- Fix. Data provided by the external device which is important to know the status of the positioning.

Once the NMEA message has been parsed, the variables used for **Fix** and **Feature** can be selected in the GPS External configuration menu as **Fix Bit** and **GPS Position**. The variable used for **Utc** can be selected in the GPS External configuration menu as **Time of week**. The other parameters of the GPS External configuration must be defined according to their definitions shown above.

Communications	Configu	ration						
Micro	Priority		Producer		Consumer	1		
Payload	V High	00	Veronte LOS	$\leftrightarrow$	Commgr port 2			
Sensors	🖌 High	Q0	Veronte LTE	]↔[	Commgr port 3	00		
Stick	High	00	RS232	$\rightarrow$	NMEA parser	¢.	Time out	0.5
Veronte	High	02	RS485		None	QC 1	Feature	Moving Object 00
Others I/O Manager	✓ High		Commgr port 1	i ↔	USB	08	reature	Moving Object 00
CAN Config	V High	00	Commgr port 2	Ì↔Ĩ	Veronte LOS	00	Utc	Rvar Disabled
Digital Input Manager	V High	00	Commgr port 3	Ī↔Ī	Veronte LTE	Q0	Fix	BIT Dummy Error
	High	00	Commgr port 4		RS232			
	High	00	Commgr port 5	$\rightarrow$	None	Q0		
	High	00	Commgr port 6	$\rightarrow$	None	Q0		
	High	00	RS custom message 1	$\rightarrow$	None	Q0		
	High	00	RS custom message 2	$\rightarrow$	None	Q0		
	High	$Q_0^0$	RS custom message 3	$\rightarrow$	None	Q0		
	High	00	Tunnel 1	$\rightarrow$	None	00		

NMEA Parser - Configuration Menu

## 7.2.3.4.3.12 Estimation Error

See section Setup - Devices - Sensors - GNSS - GNSS 1 & 2 Configuration.

### 7.2.3.4.3.13 NTRIP

RTCM functionality provides precise positioning trough NTRIP (Networked Transport of RTCM via Internet Protocol). This protocol is a standard for streaming differential GPS (DGPS) data over the Internet.

#### 7.2.3.4.3.14 Registration

RTCM activation requires from a previous registration in one of the NTRIP stream providers available. Select the stream provider according to the location of your operation. Some examples of NTRIP providers are IGS.IP or EUREF.

Once registered, you will receive the following data from the NTRIP provider: URL, Port, User, Password

### 7.2.3.4.3.15 Configuration

In order to activate precise positioning functionality in Veronte, NTRIP user data must be loaded in THE Veronte Autopilot. Go to the Setup menu in the Veronte Autopilot unit (Setup - Devices - Sensors - GNSS - NTRIP) and follow these steps:

- 1. Enable NTRIP
- 2. Enter NTRIP server data and user as follows

м400 🛪 💿 🧰 葦	I 🗘 🖉	s 🗂 🔺 🖗		
► Actuators	V Enable			
Communications	URL	193.145.206.163	Port	2101
Payload	User	USER	Ĩ	
▼ Sensors	Deer			
Accelerometer	Pass	•••••		
Altimeter	Stream	VRSRTCM23	Q	
▼ GNSS	Time	300.0 s		
GNSS 1 Configuration				
GNSS 2 Configuration				
GNSS Compass				
GPS External				
NTRIP				
Gyroscope				
I2C Devices				
Magnetometer				
Obstacle detection				
Pressure				
► RPM				
< > ~				
Add device 👻				

NTRIP - Configuration Menu

- 1. Click on the Lens Icon for connecting to the server
- 2. From the displayed list select the desired stream and click on select.

Ntrip mount		×
✓ RED VRS RTCM 2.3	Туре	STR
RED VRS RTCM 3.0	Mountpoint	VRSRTCM23
Alcoi RTCM 2.3	Identifier	RED VRS RTCM 2.3
Alcoi RTCM 3.0	Format	RTCM 2.3
Borriana RTCM 3.0	Details	1(1),3(10),18(1),19(1)
✓ Borriana RTCM 2.3	Carrier	2 CDS - CLONASS
✓ Torrevieja RTCM 2.3	Navigation system	erva
Torrevieja RTCM 3.0	Country	ESP
✓ Denia RTCM 2.3	Latitude	0.00
✓ ALAC RTCM 2.3	Longitude	0.00
ALAC RTCM 3.0	NMEA	1
	Solution	1
Ayora RTCM 2.3	Generator	Trimble GPSNet
Ayora RTCM 3.0	Encryption	none
✓ Valencia-IGN RTCM 2.3	Authentication	-
Valencia-IGN RTCM 3.0	Fee	N
RED RTCM 3.1 NETWORK-MAC	Bit rate	0
PEÑISCOLA RTCM 2.3		
RED_CMR1	r	Select

### NTRIP - Stream List

## Warning:

- The system is compatible with RTCM protocol 2.3. Compatible streams are marked with **Check**. It is recommended to select a virtual stream covering the area of operation.
- RTCM positioning requires an internet connection.

In this menu the user can modify all parameters which are relevant to GNSS sensors.

🖸 Fixed Wing 🛪 🙆 🙍	= 🛛 端 🏖	) 🗂 🔺 🕅	
► Actuators			
Communications			
▶ Payload			
▼ Sensors			
<ul> <li>Accelerometer</li> </ul>			
Altimeter			
▼ GNSS			
GNSS 1 Configuration			
GNSS 2 Configuration			
GNSS Compass			
GPS External			
NTRIP			
<ul> <li>Gyroscope</li> </ul>			
I2C Devices			
<ul> <li>Magnetometer</li> </ul>			
Obstacle detection			
Pressure			
► RPM			
<>			
Add device 🔹			

#### GNSS - Options available

Veronte has embedded 2 GNSS modules which are configured through GNSS 1-2 Configuration tabs. They can be configured as well for precision acolications, such as RTK (high precision with correction from a base) or GNSS Compass (Compass information from differential positioning). External positioning such as GPS External or NTRIP have their own configuration tab as well.

### 7.2.3.4.4 Gyroscope

The gyroscope from the IMU can be configured as explained in the menus shown below.

The user can choose between 3 types of source for the gyroscope.

- Integer var sensor 1-2. Veronte uses a integer value provided by an external sensor.
- Decimal var sensor 1-2. Veronte uses a decimal value provided by an external sensor.
- Internal 1-2 (Main/Secondary). Veronte uses the internal sensor.

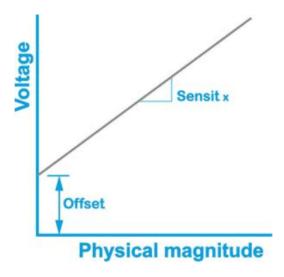
## 7.2.3.4.4.1 Integer var sensor

In this menu it is possible to configure integer variables provided by an external sensor.

м400 🛪 💿 🚊	E 🚱 🗱 🎛 🗂 🔺 🛞	
► Actuators	0 - Integer var sensor 1	Edit Rotation Matrix
<ul> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Accelerometer Configuration Altimeter</li> <li>GNSS</li> </ul>	<ul> <li>1 - Integer var sensor 2</li> <li>2 - Decimal var sensor 1</li> <li>3 - Decimal var sensor 2</li> <li>4 - Internal 1</li> <li>5 - Internal 2</li> </ul>	X Axis Zero Signec $V_0 + V_1 \cdot X^1$ $V_0$ $V_1$ 0.0 $0.0Y Axis$
<ul> <li>▼ Gyroscope</li> <li>Configuration</li> <li>I2C Devices</li> </ul>		Zero Signec
<ul> <li>Magnetometer</li> <li>Obstacle detection</li> </ul>		V <sub>0</sub> V <sub>1</sub> V <sub>2</sub> 0.0 0.0 0.0
Pressure     RPM     Speed down		Z Axis User Variable 01 (Unsigned Integer - 16 Signec
Ultrasound  Stick Veronte	~	
Add device	•	< >

Integer var Gyroscope Menu - Configuration Parameters

When Integer var sensor 1 or 2 are selected, the previous panel will be shown. In this panel, the user selects the variable that has been stored in a user variable (Green Box) and the operations that will be carried on (Red Box). It is possible to use the signal through a linear or quadratic relation. The following image shows an example of a linear relation.



Linear relation of 2 Variables

The process of configuration has to be done using **Custom Messages**. This is to be configured in *Devices - Others - Digital - I/O Manager*. The configuration will depends on the device in use and its communication protocol.

### 7.2.3.4.4.2 Decimal var sensor

In this menu, the user selects real variables for each axis (X,Y,Z), these do not requiere a signal treatment. The process of configuration is similar to the one carried out when configuring a Integer Variable.

	E 🚱 🗱 🕰 🖾 🔺 🖗		
Actuators	0 - Integer var sensor 1		Edit Rotation Matrix
Communications	1 - Integer var sensor 2		
Payload	2 - Decimal var sensor 1	X	User Variable 07 (Real - 32 bits)
▼ Sensors	3 - Decimal var sensor 2	Y	User Variable 05 (Real - 32 bits)
▼ Accelerometer	4 - Internal 1		
Configuration	5 - Internal 2	Z	User Variable 06 (Real - 32 bits)
Altimeter			
GNSS			
▼ Gyroscope			
Configuration			
I2C Devices			
<ul> <li>Magnetometer</li> </ul>			
Obstacle detection			
Pressure			
► RPM			
Speed down			
Ultrasound			
► Stick			
► Veronte ~			
Add device 👻			

Decimal var Gyroscope Menu - Configuration Parameters

## 7.2.3.4.4.3 Internal

This last menu available displays the posible parameters that can be configured for the internal Gyroscope.

Veronte0 🛪 🛞 🚺 🛱	: 🛛 🗱 🌮 🖾 🗄	
Actuators     Communications	0 - Integer var sensor 1 1 - Integer var sensor 2	Edit Rotation Matrix
Payload     Sensors     Accelerometer	<ul> <li>2 - Decimal var sensor 1</li> <li>3 - Decimal var sensor 2</li> <li>4 - Main Gyroscope</li> </ul>	Gyroscope Range 2000 °/s 👻
Altimeter GNSS GNSS 1 Configuratior GNSS 2 Configuratior GNSS Compass	5 - Secondary Gyroscope	Pro Enable low pass filter Low pass filter 304.2 Hz
GPS External NTRIP		Digital Filter
Configuration I2C Devices Magnetometer Obstacle detection		
Pressure     Add device		

### Gyroscope Menu - Configuration Parameters

**Warning:** Edit Rotation Matrix brings the position of the gyroscope inside the Veronte Autopilot, it must NOT be changed under any circumstance.

In this menu it is possible to set different options regarding range and filters from the gyroscope. The parameters that can be modified are:

- **Range**. Sets the maximum range of performance, high ranges implies less precision while small ranges might mean the system saturates. Values allowed are 125°/s, 250°/s, 500°/s, 1000°/s and 2000°/s.
- **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

## 7.2.3.4.5 I2C Devices

**Warning:** Be aware that custom messages are not available for I2C. Only the devices listed below can be integrated with Veronte Autopilot using the I2C interface.

The I2C bus allows the connection of several devices with different addresses to the same line via master-slave communication. At this moment, Veronte supports the following devices:

- Garmin LIDAR-Lite v3. Optical distance measurement sensor with a range of 5cm to 40m.
- SF11 Lidar. Long range laser altimeter. Supported SF11/B and SF11/C with a maximum range of 50m and 120m respectively.
- Magnetometer LIS3MDL. Three-axis magnetic sensor with a very small package.
- Magnetometer HSCDTD008A. Three-axis terrestrial magnetism sensor of the digital output.

### 7.2.3.4.5.1 Lidar Devices

Both Lidar must be configured in *I2C Devices* menu. In our case, Veronte allows up to 5 Lidar devices to be connected to the system at the same time.

The configuration menu can be seen below:

Actuators	Lidar I2C					
Communications	✓ Enable Lidar 1	Garmin Lida 🝷	Address	0	dec	Digital filter
Payload		Garmin Lidar Lite v3		-		
Sensors	Enable Lidar 2		dress	0	dec	Digital filter
<ul> <li>Accelerometer</li> </ul>		SF11 Lidar		_		
Altimeter	Enable Lidar 3	Garmin Lida 👻	Address	0	dec	Digital filter
GNSS						
Gyroscope	Enable Lidar 4	Garmin Lida 🔻	Address	0	dec	Digital filter
I2C Devices	Enable Lidar 5	Garmin Lida 👻	Address	0	dec	Digital filter
Magnetometer	Enable Lidar 5		Address	Ľ		Digital inter
Obstacle detection						
Pressure						
► RPM						
Speed down						
Ultrasound						
Stick						
Veronte						
Others						

#### I2C - Configuration Menu

After enabling the needed number of Lidar devices, configurable parameters are:

- Type of Lidar. Veronte is compatible with Garmin Lidar Lite v3 and SF11 Lidar.
- Address. With an accepted value between 16 239, this is the origin address from the Lidar being configured.
- **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

The Lidar number need to be kept in order to properly configure the Altimeter menu afterwards in Setup - Devices - Sensors - *Altimeter*.

### 7.2.3.4.5.2 Magnetometer Devices

The magnetometers are configured in Setup - Devices - Sensors - *Magnetometer*. It is **very important** to know that **address cannot be chosen in the software** and must be as follows:

- Magnetometer LIS3MDL: 0x1C.
- Magnetometer HSCDTD008A: 0x0C.

In order to select a magnetometer connected by I2C bus, the user simply has to select it in the configuration menu (see the figure below):

мбоо 🛪 💿 💽 葦	🔮 🗱 🕾 🗂	1 🔺 🖉 🏢	
► Communications	Use three axis		
► Micro	Navigation		
Payload	Custom setting	-	
▼ Sensors		(105.40	
Accelerometer	Square error	1.0E-10 T <sup>2</sup>	
Altimeter	Decimation	10	
► GNSS	0 - Integer var	censor 1	
Gyroscope	1 - Integer var		Edit Rotation Matrix
I2C Devices	2 - Decimal va		Digital Filter
<ul> <li>Magnetometer</li> </ul>	3 - Decimal va		5
Calibration	4 - Internal	r sensor z	
Configuration	5 - External HM	482200	
Obstacle detection	6 - External LIS		
Pressure	7 - External HS		
► RPM			
Speed down	8 - Internal MM	VIC5883MA	
Terrain settings			
Ultrasound			
► Stick ~			
Add device 👻			

#### I2C - Magnetometer Configuration

Once the magnetometer is chosen, the user can modify the following parameters:

- **Rotation matrix**. It must be modified in the case that the axes of the magnetometer do not coincide with those of the aircraft.
- **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

#### 7.2.3.4.6 Magnetometer

#### 7.2.3.4.6.1 Calibration

Magnetometer calibration should be performed once Veronte has been installed on the platform so the magnetic field during the operation is similar to the one measured during the calibration. Hard calibration includes distorsions created by objetcs that produce a magnetic field (theses objetcs are the uav or their components). Soft calibration also includes the alterations in the existing magnetic field.

Fixed Wing V-Tail UAV	★ ③ 💽 ☵ 🚱 🦚 🕮 🖾 🔺 🎟 ⊘
• Раушац	Bard Iron Soft Iron Regression
Cameras	
Gimbal/Tracker	See computed matrix
Transponder/ADS-B	Use temperature
▼ Sensors	bias_x 3.6037568E-4 k_x 0.8845785
<ul> <li>Accelerometer</li> </ul>	bias_y 2.4615135E-4 k_y 0.29632095
Configuration	
Altimeter	bias_z -2.2604801E-5 k_z 0.2756723
GNSS	
Gyroscope	
I2C Devices	Start calibration
<ul> <li>Magnetometer</li> </ul>	Start cambration
Calibration	
Configuration	
<ul> <li>Obstacle detection</li> </ul>	
Pressure	
► RPM	
Speed down	
Ultrasound	
Add device	•

#### Magnetometer - Calibration Menu

In order to start calibration, press on the **Start Calibration** button so the system can capture magnetometer data. During the calibration, the system must be oriented in all possible directions so enough data can be captured. Once enough data has been captured, **Compute Data** sets the calibration.

The procedure for acquiring enough data for performing the calibration is:

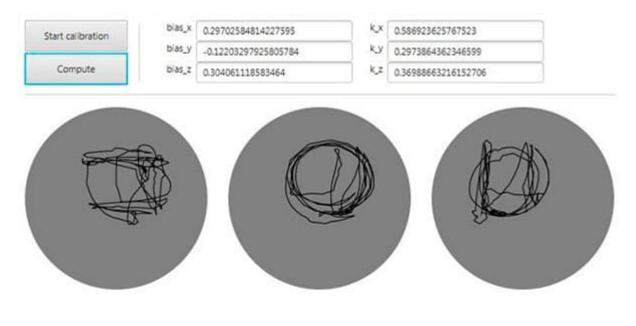
1. Rotate Veronte around one of its axis (e.g. the x-axis) and make at least three turns around this axis.

- 2. Repeat the same process for another of its axis (e.g. y-axis).
- 3. Finish the calibration by repeating this process for the remaining axis (e.g. z-axis).

The different rotations that Veronte must be subjected can be visualized in the figure below.

#### Magnetometer - Calibration Procedure

Once three circles have been drawn on the screen, captured data will be enough for saving the calibration data. The following image shows an example of the calibration result:



Precalibrate:	×	0.16959064	Y	-0.39181286	z	0.14473684	
Actual calibrate:	×	0.16959064	Y	-0.39181286	z	0.14473684	
New calibrate:	x	0.09799161	Y	-0.3247512	z	0.5023342	



#### 7.2.3.4.6.2 Configuration

Veronte incorporates an internal magnetometer that allows the Veronte System to measure the magnetic field.

The user can choose between 4 types of source for the accelerometer.

- Integer var sensor 1-2. Veronte uses a integer value provided by a no-integrated external sensor.
- Decimal var sensor 1-2. Veronte uses a decimal value provided by a no-integrated external sensor.
- Internal Veronte uses the internal sensor.
- External HMR2300/LIS3MDL/HSCDTD008A. Veronte uses the information from one of the compatible external magnetometers.

There are 3 parameters that are configured independently from the Magnetometer selected. These are the one in the Navigation section: - **State**. User can choose from **Disabled** for magnetometer not entering the Navigation filters (not being used but not turning it off) or **Custom settings**, which will take into account all the following parameters. - **Square error**. Means the influence of the parameter on the Navigation filters. The greater the less effect it will have. - **Decimation**. Defines the bunch of data from which 1 value will be stored. For example, if decimation is 10, every 10 measurements 1 will be taken into account. This procedure is used to reduce the number of samples.

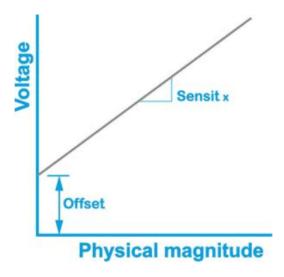
### 7.2.3.4.6.3 Integer var sensor

In this menu it is possible to configure integer variables provided by an external sensor.

м400 🛪 💿 🧰 葦	🚱 🗱 🕰 🗂 🔺	$\sim$
► Actuators	Use three axis	
► Communications	Navigation	
Payload	Custom setting	•
▼ Sensors		10 72
Accelerometer	Square error 1.0E	-10 T <sup>2</sup>
Altimeter	Decimation 10	
► GNSS	0 - Integer var sense	or 1
Gyroscope	1 - Integer var sense	Edit Rotation Matrix
I2C Devices	<ul> <li>2 - Decimal var sens</li> </ul>	
<ul> <li>Magnetometer</li> </ul>	3 - Decimal var sens	
Calibration	4 - Internal	
Configuration	5 - External HMR23	0 *
Obstacle detection		
► Pressure	6 - External LIS3MD	L
► RPM		Y Axis
Speed down		Zero Signed
Ultrasound		
► Stick		0 🗸
► Veronte 🗸		
Add device 🔻		Z Axis

Integer var Magnetometer Menu - Configuration Parameters

When Integer var sensor 1 or 2 are selected, the previous panel will be shown. In this panel, the user selects the variable that has been stored in a user variable (Green Box) and the operations that will be carried on (Red Box). It is possible to use the signal through a linear or quadratic relation. The following image shows an example of a linear relation.



Linear relation of 2 Variables

The process of configuration has to be done using **Custom Messages**. This is to be configured in *Devices - Others - Digital - I/O Manager*. The configuration will depends on the device in use and its communication protocol.

### 7.2.3.4.6.4 Decimal var sensor

In this menu, the user selects real variables for each axis (X,Y,Z), these do not requiere a signal treatment. The process of configuration is similar to the one carried out when configuring a Integer Variable.

🔤 M400 🛪 💿 🧕 葦	🚱 🗱 🖽 🗔 🔺 🖗
► Actuators	Use three axis
<ul> <li>Communications</li> <li>Payload</li> </ul>	Navigation
<ul> <li>Sensors</li> <li>Accelerometer</li> <li>Altimeter</li> </ul>	Custom setting     Image: Custom setting       Square error     1.0E-10       Decimation     10
<ul> <li>GNSS</li> <li>Gyroscope         <ul> <li>I2C Devices</li> <li>Magnetometer</li> <li>Calibration</li> </ul> </li> </ul>	0 - Integer var sensor 1       Edit Rotation Matrix         1 - Integer var sensor 2       Edit Rotation Matrix         2 - Decimal var sensor 1       X         3 - Decimal var sensor 2       Y         4 - Internal       Y
Configuration  Configuration  Configuration  Ressure  RPM Speed down	5 - External HMR2300     Z     User Variable 03 (Real - 32 bits)       6 - External LIS3MDL
Ultrasound   Stick  Veronte  Add device	

Decimal var Magnetometer Menu - Configuration Parameters

## 7.2.3.4.6.5 Internal

This menu available displays the posible parameters that can be configured for the internal Magnetometer.

M400 🛪 📀 🙆 葦	🕲 🗱 🖽 🗂 🔺 🕅
Actuators	Use three axis
Communications	Navigation
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Custom setting -
<ul> <li>Accelerometer</li> </ul>	Square error
Altimeter	Decimation 10
<ul> <li>GNSS</li> <li>Gyroscope</li> </ul>	0 - Integer var sensor 1 Edit Rotation Matrix
I2C Devices	1 - Integer var sensor 2 2 - Decimal var sensor 1 Digital Filter
<ul> <li>Magnetometer</li> <li>Calibration</li> </ul>	3 - Decimal var sensor 2
Configuration	<ul> <li>4 - Internal</li> </ul>
Obstacle detection	5 - External HMR2300
► Pressure	6 - External LIS3MDL
► RPM	
Speed down	
Ultrasound	
Stick	
► Veronte ~	
Add device 👻	

#### Internal var Magnetometer Menu - Configuration Parameters

**Warning:** Edit Rotation Matrix brings the position of the magnetometer inside the Veronte Autopilot, it must **NOT** be changed under any circumstance.

In this menu it is possible to set different options regarding filters.

• **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

#### 7.2.3.4.6.6 External

Veronte has been designed to have compatibility with the external magnetometers HMR200 and LIS3MDL. The first one has no filters configurable, only the option Edit Rotation Matrix to set the orientation of it.

The LIS3MDL option is the sensor Veronte has inside it, but mounted externally to avoid the possible interferences from being close to ekectronic components. It has de Edit Rotation Matrix and the Digital Filter.

On the other hand, the connection to the serial port is configured in Devices - Others - I/O Manager

Sensors ^			Producer		Consumer	
Accelerometer	High	Q <sub>0</sub>	USB		Commgr port 1	<b>Q</b> <sup>0</sup>
Altimeter	High	00	Veronte LOS		Commgr port 2	Q <sup>0</sup>
GNSS	High	08	Veronte LTE	Ĩ⇔Ì	Commgr port 3	03
▶ Gyroscope	High	00	RS232		External magnetometer	¢.
I2C Devices Magnetometer	High	Q <sup>o</sup>	RS485	$\rightarrow$	None	00
Calibration	High	¢\$	Commgr port 1		USB	
Configuration	High	08	Commgr port 2		Veronte LOS	03
Obstacle detection     Pressure	High	QS (	Commgr port 3		Veronte LTE	
► RPM	High	08	Commgr port 4	$\rightarrow$	None	¢\$
Speed down Ultrasound	High	00	Commgr port 5	$\rightarrow$	None	08
Stick	High	00	Commgr port 6	$\rightarrow$	None	0
Veronte	High	00	Custom message 1	$\rightarrow$	None	03
Others I/O Manager	High	\$000 C	Custom message 2	$\rightarrow$	None	
Digital Input Manager	High	0°	Custom message 3	$\rightarrow$	None	
- 18	High	00	Tunnel 1	$\rightarrow$	None	03

External Magnetometer - Channel Configuration

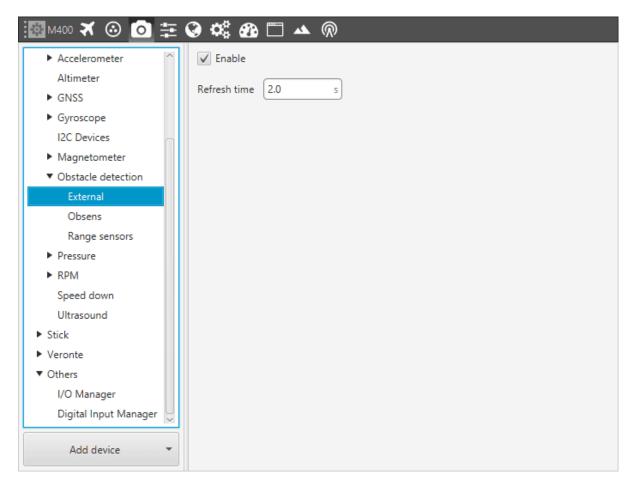
### 7.2.3.4.7 Obstacle Detection

Obstacle detection allows the creation of obstacles that the platform will consider for its Navigation. It could be an external source of obstacles or the sensors connected to Veronte with the selection of the sensors range.

### 7.2.3.4.7.1 External

If a user connects an Obstacle provider system to Veronte, it has to be enabled from this menu.

The **Refresh time** is the time it takes Veronte to check again the obstacle status from the external device. This is used to know when an obstacle has disappear from range or a new obstacle is inside it.



#### Obstacle Detection - External

### 7.2.3.4.7.2 Obsens

This panel contains the configuration menu to set the obstacles creation.

M400 🛪 💿 🙍 葦	🚱 🗱 🆽 🗂 🔺 🕅	
Accelerometer     Altimeter	Mode	Cir2d 🗸
► GNSS	Number of obstacles	64
Gyroscope	Type of obstacles generated	2D 🔹
I2C Devices	Distance parameter for obstacles generated	0.0 m
<ul> <li>Magnetometer</li> <li>Obstacle detection</li> </ul>	Time constant for field filter	0.2 s
External	Wrapper to ignore measures bassed on elevation	1:
Obsens	Min 0.0	
Range sensors	Max 0.0	
Pressure		
► RPM		
Speed down		
Ultrasound		
▶ Stick		
Veronte		
▼ Others		
I/O Manager		
Digital Input Manager 💛		
Add device 👻		

#### Obstacle Detection - Obsens

In this panel, it can be configured the following Obsens parameters:

- Mode: Cir2d (circular 2 dimensions), Raw and off mode can be selected.
  - **Raw**. The sensors create the obstacle where it is located. At next step, if the obstacle is not present, the area is cleared.
  - Cir2d. Allows to input the number of divisions the area around the platform will have (considering a circular area). If one area is blocked due to an obstacle presence, even the sensors lost that obstacle, the area will remain blocked until enough distance has been reached.
  - Off. The obstacle detection is not enabled.
- Type of obstacles generated. 2D or 3D obstacles can be generated.
- Distance parameter for obstacle generated. Defines de radius of the obstacles generated with Obsens.
- Time constant for field filter. Filter applied to smooth the transition when obstacles are affecting the control.
- Wrapper. A minimum and a maximum elevation wrapper can be activated in order to limit the obstacle generation in a limited cone angle.

When configuring this sensor, obstacles will be created automatically, working similarly to the ones created in the mission toolbar.

## 7.2.3.4.7.3 Range sensors

The following figure shows the menu to configure the sensors which are used during the obstacle detection.

1111111111111	😧 📽 🙆 🛙	<b>□ ▲</b>			
Accelerometer ^	Range sensors				
Altimeter	Sensor 1				-
► GNSS	Туре	Axis body 👻			
Gyroscope	Sensed	Constant value: 0.0	VO	Constant value: 0.0	
I2C Devices	Valid	Constant value: 0.0	V1	Constant value: 0.0	
<ul> <li>Magnetometer</li> </ul>	Valid			Constant value, 0.0	
<ul> <li>Obstacle detection</li> </ul>	OOR	Constant value: 0.0	V2	Constant value: 0.0	
External	Sensor 2				
Obsens	Туре	Axis body 🔹			
Range sensors	Sensed	Constant value: 0.0	VO	Constant value: 0.0	
Pressure					
► RPM	Valid	Constant value: 0.0	V1	Constant value: 0.0	
Speed down	OOR	Constant value: 0.0	V2	Constant value: 0.0	
Ultrasound					
▶ Stick					
Veronte					
▼ Others					
I/O Manager					
Digital Input Manager Ų					
Add device 🔹					

#### **Obstacle Detection - Range Sensors**

In this menu can be configured the following parameters:

- **Type**. Allows the user to select the kind of orientation which will be used: Axis body, Angles body or Angles NED
- V0, V1,V2. Once an orientation is selected, it is possible to edit where the sensor is pointing to by editing these values.
- Sensed. To select the variable which is measured.
- Valid. Usually sensors incorporates a varible to know if the data measured is valid. If that variable has been stored, it is possible to select it.
- OOR. Allows the user to select the variable that indicates if the data measured is out of range.

### 7.2.3.4.8 Pressure

### 7.2.3.4.8.1 Dynamic

This menu allows the user to configure a dynamic pressure sensor input in Veronte.

## 7.2.3.4.8.2 Sensor

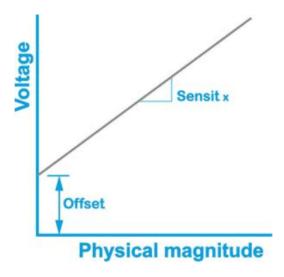
### 7.2.3.4.8.3 Integer var sensor

In this menu it is possible to configure integer variables provided by an external sensor.

M400 🛪 🙆 🧿	E 🚱 🗱 🏧 🗂 🔺 🖗	
► GNSS	Sensor Navigation	
Gyroscope	0 - Integer var sensor 1     Axis	
I2C Devices	1 - Integer var sensor 2	ned
Magnetometer	2 - Decimal var sensor 1	
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2 V <sub>0</sub> + V <sub>1</sub> · X <sup>1</sup>	•
External	4 - Internal Vo V1	
Obsens	0.0 0.0	
Range sensors		
▼ Pressure		
Dynamic		
Static		
► RPM		
Speed down		
Ultrasound		
▶ Stick		
Veronte		
▼ Others		
I/O Manager		
Digital Input Manager		
Add device		

Integer var Dynamic Pressure Menu - Configuration Parameters

When Integer var sensor 1 or 2 are selected, the previous panel will be shown. In this panel, the user selects the variable that has been stored in a user variable (Green Box) and the operations that will be carried on (Red Box). It is possible to use the signal through a linear or quadratic relation. The following image shows an example of a linear relation.



Linear relation of 2 Variables

The process of configuration has to be done using **Custom Messages**. This is to be configured in *Devices - Others - Digital - I/O Manager*. The configuration will depends on the device in use and its communication protocol.

### 7.2.3.4.8.4 Decimal var sensor

In this menu, the user selects a real variable, this does not requiere a signal treatment. The process of configuration is similar to the one carried out when configuring a Integer Variable.

м400 🛪 💿 🙍 葦	🚱 🗱 🕰 🗂 🔺 🕅	
► GNSS	Sensor Navigation	
► Gyroscope	0 - Integer var sensor 1	Variable
I2C Devices	1 - Integer var sensor 2	User Variable 10 (Real - 32 bits)
Magnetometer	2 - Decimal var sensor 1	
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2	
External	🔵 4 - Internal	
Obsens		
Range sensors		
▼ Pressure		
Dynamic		
Static		
► RPM		
Speed down		
Ultrasound		
► Stick		
► Veronte		
▼ Others		
I/O Manager		
Digital Input Manager 🜷		
Add device 🔹		

Decimal var Dynamic Pressure Menu - Configuration Parameters

# 7.2.3.4.8.5 Internal

This menu displays the posible parameters that can be configured for the internal Dynamic Pressure sensor.

🔯 M400 🛪 🛞 🙆 葦	🚱 🗱 🌇 🖾 🕷		
► GNSS	Sensor Navigation		
Gyroscope	0 - Integer var sensor 1	Sensor filter	
I2C Devices	1 - Integer var sensor 2		
Magnetometer	2 - Decimal var sensor 1	Digital filter	5.0 Hz
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2		
External	4 - Internal		
Obsens			
Range sensors			
▼ Pressure			
Dynamic			
Static			
► RPM			
Speed down			
Ultrasound			
Stick			
▶ Veronte			
▼ Others			
I/O Manager			
Digital Input Manager 💛			
Add device 👻			

Internal Dynamic Pressure Menu - Configuration Parameters

In this menu it is possible to set different options regarding filters.

• **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

### 7.2.3.4.8.6 Navigation

This menu allows the user to configure the navigation parameters from a dynamic pressure sensor input in Veronte.

- 🔝 M400 🛪 🐵 🙆 🏣 (	🔾 🗱 🔁 🗠 🖗				
► GNSS	Sensor Navigation				
Gyroscope	Custom setting	-			
I2C Devices					
Magnetometer	Square error	100.0		Pa <sup>2</sup>	
<ul> <li>Obstacle detection</li> </ul>	Decimation	10			
External	Minimum pressure	1.0			
Obsens	Willing pressure	1.0			
Range sensors	Pitot Orientation (X,Y,Z)	1.0	0.0	0.0	
▼ Pressure					
Dynamic					
Static					
► RPM					
Speed down					
Ultrasound					
► Stick					
▶ Veronte					
▼ Others					
I/O Manager					
Digital Input Manager 🔍					
Add device 👻					

Dynamic Pressure Menu - Navigation Configuration Parameters

- **Enable**. Choose the dynamic sensor pressure use on the system. Values from the sensor will be received, but they will not enter the Navigation Filter.
- Square Error. Sensor error square, which defined the weight if the measurement into the Navigation filter.
- **Decimation**. Defines the bunch of data from which 1 value will be stored. For example, if decimation is 10, every 10 measurements 1 will be taken into account. This procedure is used to reduce the number of samples.
- Minimum pressure. Minimum pressure readable from the sensor.
- Pitot Orientation. Vector defining the Pitot orientation on the platform.

## 7.2.3.4.8.7 Static

This menu allows the user to configure a static pressure sensor input in Veronte.

### 7.2.3.4.8.8 Sensor

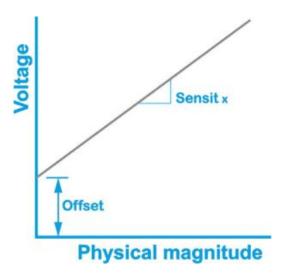
### 7.2.3.4.8.9 Integer var sensor

In this menu it is possible to configure integer variables provided by an external sensor.

м400 🛪 🛞 🧕 🗄	E 🚱 🗱 🎛 🖾 🔺 🖗	
► GNSS	Sensor Navigation Ground effect	
Gyroscope	0 - Integer var sensor 1     Axis	
I2C Devices	1 - Integer var sensor 2 User Variable 100 (Unsigned Integer - 1	Signed
Magnetometer	2 - Decimal var sensor 1	- gives
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2	-
External	4 - Internal Sensor (HSC)	
Obsens	5 - Internal Sensor (MS56) 0.0 0.0 0.0	
Range sensors		
▼ Pressure		
Dynamic		
Static		
► RPM		
Speed down		
Ultrasound		
► Stick		
▶ Veronte		
▼ Others		
I/O Manager		
Digital Input Manager 🖕		
Add device 👻		

Integer var Static Pressure Menu - Configuration Parameters

When Integer var sensor 1 or 2 are selected, the previous panel will be shown. In this panel, the user selects the variable that has been stored in a user variable (Green Box) and the operations that will be carried on (Red Box). It is possible to use the signal through a linear or quadratic relation. The following image shows an example of a linear relation.



Linear relation of 2 Variables

The process of configuration has to be done using **Custom Messages**. This is to be configured in *Devices - Others - Digital - I/O Manager*. The configuration will depends on the device in use and its communication protocol.

## 7.2.3.4.8.10 Decimal var sensor

In this menu, the user selects a real variable, this does not requiere a signal treatment. The process of configuration is similar to the one carried out when configuring a Integer Variable.

🔟 M400 🛪 🛞 🙆 葦	🛛 🗱 🌇 🗖 🔺 🖗	
► GNSS	Sensor Navigation Ground et	ffect
Gyroscope	0 - Integer var sensor 1	Variable
I2C Devices	1 - Integer var sensor 2	User Variable 100 (Real - 32 bits)
Magnetometer	2 - Decimal var sensor 1	
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2	
External	4 - Internal Sensor (HSC)	
Obsens	5 - Internal Sensor (MS56)	
Range sensors		
▼ Pressure		
Dynamic		
Static		
► RPM		
Speed down		
Ultrasound		
► Stick		
► Veronte		
▼ Others		
I/O Manager		
Digital Input Manager 🜷		
Add device 👻	< () >	

Decimal var Static Pressure Menu - Configuration Parameters

## 7.2.3.4.8.11 Internal

This menu displays the posible parameters that can be configured for the one of the internal Static Pressure sensors.

Veronte has embedded 3 digital static pressure sensors: the **DPS310** (only avaiable in Veronte 4.5 hardware version), the **MS56** and the **HSC**. See more information on the pressure ports in *Connector Layout*.

м400 🛪 💿 🔁 葦	🚱 🗱 🌇 🖾 🕷			
► GNSS	Sensor Navigation Ground eff	ect		
Gyroscope	0 - Integer var sensor 1	✓ Sensor filter		
I2C Devices	1 - Integer var sensor 2	V Sensor Inter		
Magnetometer	2 - Decimal var sensor 1	Digital filter	5.0	Hz
<ul> <li>Obstacle detection</li> </ul>	3 - Decimal var sensor 2			
External	4 - Internal Sensor (HSC)			
Obsens	5 - Internal Sensor (MS56)			
Range sensors				
▼ Pressure				
Dynamic				
Static				
► RPM				
Speed down				
Ultrasound				
► Stick				
► Veronte				
▼ Others				
I/O Manager				
Digital Input Manager 🜷				
Add device 🔹	<			

Internal Static Pressure Menu - Configuration Parameters

In this menu it is possible to set different options regarding filters.

• **Digital filter**. Enables a low pass filter which its cutoff frequency is configured manually, allowing the user to input any desired value in Hz. It is a **software filter**.

## 7.2.3.4.8.12 Navigation

This menu allows the user to configure the navigation parameters from a static pressure sensor input in Veronte.

🔯 M400 🛪 💿 🧰 🗄	🛛 📽 🗱 🗔	▲ ®
► GNSS	Sensor Navigation	Ground effect
Gyroscope     I2C Devices	Variance rate limit	
Magnetometer	Max falling rate	-9900.0 Pa <sup>2</sup> /s
<ul> <li>Obstacle detection</li> </ul>	Max rising rate	0.0 Pa <sup>2</sup> /s
External	Navigation	
Obsens Range sensors	Custom setting	-
▼ Pressure	Square error	100.0 Pa <sup>2</sup>
Dynamic	Decimation	10
Static		
► RPM	<ul> <li>Export atmosphere</li> </ul>	ic correction
Speed down	Send to	Broadcast
Ultrasound		
► Stick	Period	60.0 s
► Veronte	Altitude	Computed -
▼ Others	Annude	Computed
I/O Manager	MSL	0.0 m 🏶
Digital Input Manager 🕌	OAT	288.15 K
Add device 👻		

Static Pressure Menu - Navigation Configuration Parameters

- Variance rate limit. Defines the maximum falling and/or rising rate from the system.
- Navigation.
  - Enable. Choose the static sensor pressure use on the system. Values from the sensor will be received, but they will not enter the Navigation Filter.
  - Square Error. Sensor error square, which defined the weight if the measurement into the Navigation filter.
  - Decimation. Defines the bunch of data from which 1 value will be stored. For example, if decimation is 10, every 10 measurements 1 will be taken into account. This procedure is used to reduce the number of samples.
- Export atmospheric correction. This feature allows, in a standard GND-AIR configuration, to send continuously information regarding configured platform static pressure to the desired platform. The parameters that need to be configured are:
  - Send to. Points where the correction will be sent. It can be another Veronte Unit (*Name-of-platform* (*Veronte SN*)), Broadcast or Pipe Fixed.
  - Period. Period of time spent between sending each correction.
  - Altitude. Can be computed by the system or input by the user manually if known.
  - MSL. Option enabled from the previous field. Can be input manually or by a system variable.
  - OAT. Outside Atmospheric Temperature, to be defined by the user.

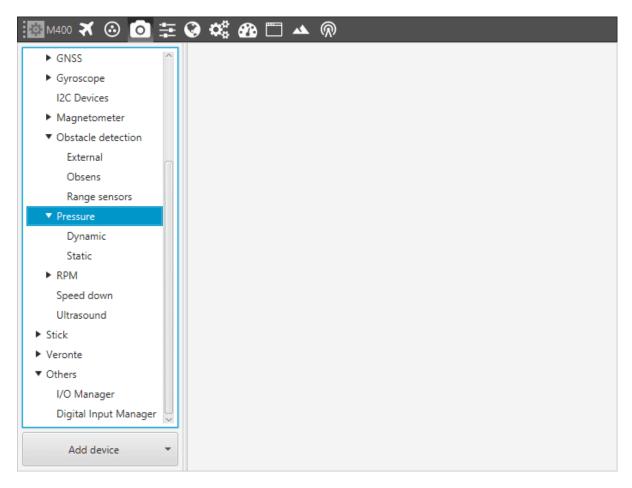
#### 7.2.3.4.8.13 Ground Effect

Veronte is configured to apply a correction to the Ground Effect for landing purposes, which needs to be configured here.

- Square error. Values which authomatically calculated from Navigation Square Error (see previous tab).
- Altitude correction threshold. The user has to define an Altitude Difference for the system to apply the Grouund Effect. While landing, the aircraft will feel a decrease in the static pressure due to the Ground Effect, and this pressure difference (transformed into meters) is the Threshold that can be configured here. If set to 0, whenever Ground Effect is enabled, it will make its effect.

Note: Ground effect is configured as an Action in the Automations Tab.

In this menu the user can modify all parameters which are relevant to Pressure sensors.



#### Pressure - Options available

Veronte has three pressure input lines, two for static pressure to determine the absolute pressure and one for pitot in order to determine the dynamic pressure.

# 7.2.3.4.9 RPM

Users can connect in Devices - Other - Digital Input Manager up to 6 RPM signal.

The following menu allows the user to configure these sensors.

🔟 M400 🛪 🛞 🧕 葦 🕻	ə 🗱 🗛 🗂 🔺		
Altimeter			
► GNSS	Units	6.2831855	Custom 👻
Gyroscope			
I2C Devices	✓ Average filter (Measures)	5	
Magnetometer	Minimum pulse	2.0E-4	s
Obstacle detection			
Pressure	Maximum time without capture	0.5	s
▼ RPM			
RPM 1			
RPM 2			
RPM 3			
RPM 4			
RPM 5			
RPM 6			
Speed down			
Ultrasound			
▶ Stick			
▶ Veronte			
► Others			
Add device 🔹			

#### **RPM** - Menu Parameters

- Units. Sensor conversion factor. It can be Custom, Radians per pulse, Pulse per cycle.
- Average filter (Measures). It is a filter to avoid voltage spikes.
- Minimum pulse. Minimum time to detect a lap.
- Maximum time without capture. The maximum period of time allowed without capturing.

## 7.2.3.4.10 Speed Down

The speed down sensor measures the velocity in the Z axis of the platform. Works in the same way as the altimeter, but in this case, instead of a position reading, the magnitude measured is velocity.

M400 🛪 🛞 🙆 葦	Q 🗱 🕰 🗔 🔺		
► Actuators	✓ Enable Speed down		
<ul> <li>Communications</li> <li>Payload</li> </ul>	Sensor variance ((m/s)²)	0.0	
▼ Sensors	Input Variable	Rvar Disabled	
Accelerometer	Enable tilt limit		
Altimeter	Max tilt	0.0 rad [-π,π]	1
<ul> <li>GNSS</li> <li>Gyroscope</li> </ul>	Enable speed limits		
I2C Devices	Min speed down	0.0 m/s	
Magnetometer	Max speed down	0.0 m/s	ĺ.
<ul> <li>Obstacle detection</li> </ul>			
Pressure			
► RPM			
Speed down			
Ultrasound			
► Stick			
► Veronte			
▼ Others			
I/O Manager 🗸 🗸			
Add device 👻			

Speed Down - Menu Parameters

- Sensor variance. Variance of the error of the sensor in meters per second squared.
- Input variable. It indicates the variable that contains the information from the sensor.
- **Tilt limits**. The sensor measures the variable in a direction perpendicular to the longitudinal axis of the platform, so when it is tilted the reading will not be reliable. This option allows the definition of a tilt limit, so that if the limit is reached, the sensor reading will be discarded.
- Speed limits. Defines the limits of the speed measured by the sensor.

### 7.2.3.4.11 Ultrasounds

An ultrasound sensors computes Veronte position by measuring the time the signal sent out takes to return. The following panel allows the user to configure this sensor. This panel is used to configure an **Internest** system with Veronte Autopilot.

# 7.2.3.4.11.1 Sensor

In this menu the user is allowed to choose which Internest version is to be used, its range and the rotation matrix:

- Version. To be chosen between Internest Base and Internest Explorer.
- Range. Defines de distances at which Internest values will start to be valid.
- Sensor to base rotation matrix. Matrix to rotate the system and make it coincident with the Veronte Autopilot.

м400 🛪 🙆 🙆	E 🚱 🗱 🍘 🗂 🔺	
► Actuators	Sensor Base Transmitter Navigation	
Communications	Version Base 👻	
Payload	Range 15.0 m	
▼ Sensors		
<ul> <li>Accelerometer</li> </ul>	Sensor to base rotation matrix	
Altimeter		
► GNSS		
<ul> <li>Gyroscope</li> </ul>		
I2C Devices		
Magnetometer		
Obstacle detection		
Pressure		
► RPM		
Speed down		
Ultrasound		
▶ Stick		
Veronte		
▼ Others		
I/O Manager	~	
Add device		

Ultrasound - Sensor Menu

# 7.2.3.4.11.2 Base

In the base menu the information *Sniffered* from the Base system is placed.

- Rotation. Input the 3 navigation angles from the Base platform.
- **Position**. Define it as Relative to Moving Object, which is the Base position sniffered.

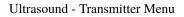
🔝 M400 🛪 📀 🙆 🏣 I	I 🗘 🖓	
<ul> <li>Actuators</li> </ul>	Sensor Base	Transmitter Navigation
Communications	Rotation	
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Base yaw	Sniffer Yaw
Accelerometer	Base pitch	Sniffer Pitch
Altimeter ► GNSS	Base roll	Sniffer Roll
<ul> <li>Gyroscope</li> <li>I2C Devices</li> </ul>	Position	
Magnetometer	<ul> <li>Relative</li> </ul>	Moving Object 01 -
<ul> <li>Obstacle detection</li> </ul>	Absolute	Decimal Degrees   UAV POS MAP POS
Pressure     RPM	North	10746.974609375 m
Speed down	East	-8720.189453125 m
Ultrasound	Down	-182.66500854492188 m
► Stick		0.0 m
<ul> <li>Veronte</li> <li>Others</li> </ul>		0.0 m
Add device 🔹		

Ultrasound - Base Menu

# 7.2.3.4.11.3 Transmitter

Defines the distance between the Internest system and the mass center from the platform.

🔣 M400 🛪 🛞 🙆 🛱	E 🚱 🗱 🖽 🗂 🔺	
Actuators	Sensor Base Transmitter Navigation	
Communications	Distance to mass center	
Payload		
▼ Sensors	X Y Z	
<ul> <li>Accelerometer</li> </ul>	Vector 0.0 0.0 0.0	
Altimeter		
► GNSS		
Gyroscope		
I2C Devices		
Magnetometer		
Obstacle detection		
Pressure		
► RPM		
Speed down		
Ultrasound		
► Stick		
► Veronte		
▼ Others		
I/O Manager 🗸		
Add device 👻		



# 7.2.3.4.11.4 Navigation

It has two checks configurable, one for enabling/disabling the Internest effect in navigation and a second one to use the error computed by the sensors if it affects the navigation.

м400 🛪 🛞 🧰 葦	🚱 🗱 🍘 🗂 🔺
Actuators	Sensor Base Transmitter Navigation
Communications	Enable
Payload	
▼ Sensors	✓ Use error computed by sensor
<ul> <li>Accelerometer</li> </ul>	
Altimeter	
► GNSS	
<ul> <li>Gyroscope</li> </ul>	
I2C Devices	
Magnetometer	
Obstacle detection	
Pressure	
► RPM	
Speed down	
Ultrasound	
Stick	
► Veronte	
▼ Others	
I/O Manager 🗸 🗸	
Add device 👻	

#### Ultrasound - Navigation Menu

Sensors section permits to configure any sensor connected or internal from Veronte.

Accelerometer	Configure the accelerometer parameters
Altimeter	Enable the Altimeter into navigation if a sensor is connected to Veronte
GNSS	Configure GNSS receivers, RTK, Compass, External source and NTRIP
Gyroscope	Configure the gyroscope parameters
I2C devices	Configure Lidar sensors connected through I2C
Magnetometer	Configure the internal magnetometer or an external one
Obstacle Detection	Enables the obstacle detection and configured it
Pressure	Menu including both dynamic and static pressure configurations
RPM	Configure RPM sensors parameters
Speed Down	Enable the navigation using a Speed down sensor
Ultrasound	Menu to configure Internest with Veronte

# 7.2.3.5 Stick Configuration

### 7.2.3.5.1 Arcade trim

The arcade trim is used to set the zero-stick position for the Arcade Mode.

In such mode, when obtaining the *Control output* U from *Stick input* R the final value is not the one that enters the navigation algorithm. The variable that is otherwise employed is D, called "*Stick input d*", which is computed as  $D = U - U_0$ , being  $U_0$  the arcade trim. In this way, when the sticks are trimmed at a certain position, the movement from that point will be the value of R that - after transformations - will generate the U.

The values of the trim vector  $U_0$  can be introduced in **Devices - Actuators - Stick - Arcade trim** as shown in the figure below.

M400 🛪 🛞 🚺	🛛 📽 🕰	
▼ Gyroscope ^	Stick projecte	d to control channels, used for neutral arcade command
Configuration	Channel 1	0.525519
I2C Devices	Channel 2	0.49890113
<ul> <li>Magnetometer</li> <li>Obstacle detection</li> </ul>	Channel 3	0.5206349
Pressure	Channel 4	-0.523077
► RPM	Channel 5	0.0
Speed down	Channel 6	0.0
Ultrasound Stick	Channel 7	0.0
Arcade trim	Channel 8	0.0
<ul> <li>Local sources</li> </ul>	Channel 9	0.0
Transmitter 1	Channel 10	0.0
Transmitter 2 Virtual Stick	Channel 11	0.0
Test Stick	Channel 12	0.0
Stick	Channel 13	0.0
Veronte	Channel 14	0.0
► Others	Channel 15	0.0
Add device 👻	Channel 16	0.0

Stick Arcade Trim - Configuration Parameters

Another way to perform the arcade trim is to create the automation as described in *Automations - Actions - Arcade trim*. Once that is done, it is sufficient to move the stick main levers to their center position and to click on the *Trim Arcade button*. Then wait for 2-3 seconds and return the levers to their default positions.

**Warning:** The Arcade mode has to be trimmed before flight. If not trimmed, the zero level will be different from the desired one.

#### 7.2.3.5.2 Local Sources

#### 7.2.3.5.2.1 Transmitter

The wired connected transmitters are configured through the following menus.

### 7.2.3.5.2.2 PPM

This tab provides the options to configure a Pulse Postion Modulation (PPM) radio controller to control the platform fitted with the autopilot.

м400 🛪 💿 🖸 葦	😧 🗱 🅰 🗂	1 🔺 🏭 ⊘ ด		
► Actuators	PPM Exponential	Trim Output		
Communications	Brand Futaba	▼ Model 8J/10J/	12K/14SG 🝷 Char	nnels 8 👻
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Pulse polarity	Positive  Negative	Sync time	0.004 s
▼ Stick	Min pulse	2.5E-4 s	Max pulse	5.0E-4 s
Arcade trim    Local sources	Position			
Transmitter 1	Min accepted	8.0E-4 s	Max accepted	0.0022 s
Transmitter 2	Min value encoded	9.0E-4 s	Max value encoded	0.0021 s
Transmitter 3 Transmitter 4	Min channels	7	Max channels	8
Virtual Stick	Channel (DISABLE	DEnabledFilter) 1 2	3 4 5 6 7 8 9	10 11 12 13 14 15 16
Test Stick	Non linear low pas	is filter		
Stick  Veronte	Min delta	0.0	Max delta	1000.0
<ul> <li>Veronte</li> <li>Others</li> </ul>	Min delta alpha	1.0	Max delta alpha	0.02
Add device 👻				

Stick Transmitter - PPM Configuration Parameters

• **Brand, Model & Channels**. Veronte Pipe has been configured to provide the user with the expected parameters to configure different transmitters models:

– Futaba.

- \* Model 8J/10J/12K/14SG with 8 channels.
- \* Model 12K/14SG with 12 channels.
- \* Model T18SZ with 8 channels.

– Jeti.

- \* DC 16 / DC 24 with 16 channels.
- FrSky.
  - \* Taranis 9XD with 8 channels.
  - \* X12S with 8 channels.
- Polarity. Indicates the pulse polarity. The image below shows a positive signal.
- Sync time. Minimum time on the PPM output till the next frame. It tells the receiver to reset its channel counter.
- **Minimum/Maximum pulse**. Pulse length, it depends on the system and it is a constant value (usually 0.2-0.5 ms).
- **Position Minimum/Maximum accepted**. Pulse length accepted for each channel. Standard for R/C servos uses a pulse of 1 ms for the maximum position at one end, 1.5 ms for the midpoint and 2 ms for the maximum position at the opposite end.
- **Minimum/Maximum encoded**. If there is noise and the signal is varying around the minimum/maximum values accepted, Veronte will encode those values to the ones set here. For instance, a pulse length between 0.8-0.9 ms will be considered as one of 0.9 ms.
- **Channels**. Sets the number of channels accepted (minimun and maximun). Besides, it is possible to Disable/Enable/Filter each channel individually.
- Non linear low pass filter. Default parameters are recommended.

When some data is out of the established ranges, Veronte will discard that frame to avoid a possible malfunction. The next image clarifies the parameters introduced previously.

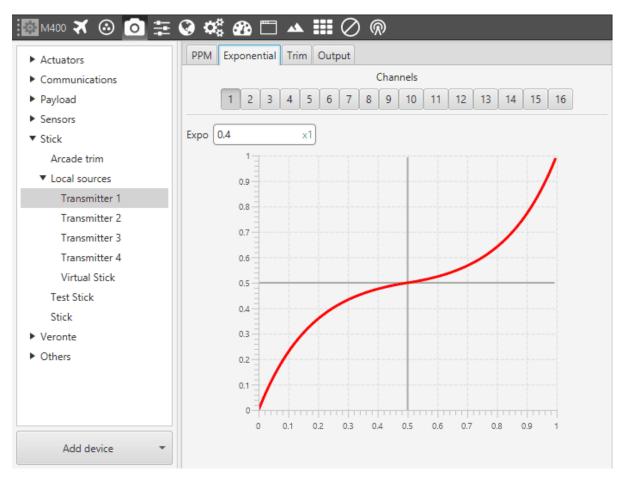
м400 🛪 💿 🧰 葦	I I I I I I I I I I I I I I I I I I I	ð 🗂 🔺	▶ Ⅲ 🤅	$\mathbb{R}$				
<ul> <li>Actuators</li> </ul>	PPM Expo	nential Tri	im Output					
Communications				Wiza	rd trim			
Payload								
Sensors	✓ Advance	ed						Reset
▼ Stick		Trim	Range	Neutral		Trim	Range	Neutral
Arcade trim	Channel 1	0.0	0.7	Zero	Channel 9	0.0	0.7	Zero
<ul> <li>Local sources</li> <li>Transmitter 1</li> </ul>	Channel 2	0.0	0.7	Zero	Channel 10	0.0	0.7	Zero
Transmitter 2	Channel 3	0.0	0.7	Zero	Channel 11	0.0	0.7	Zero
Transmitter 3	Channel 4	0.0	0.7	Zero	Channel 12	0.0	0.7	Zero
Transmitter 4 Virtual Stick	Channel 5	0.0	0.7	Zero	Channel 13	0.0	0.7	Zero
Test Stick	Channel 6	0.0	0.7	Zero	Channel 14	0.0	0.7	Zero
Stick	Channel 7	0.0	0.7	Zero	Channel 15	0.0	0.7	Zero
► Veronte	Channel 8	0.0	0.7	Zero	Channel 16	0.0	0.7	Zero
Others								
Add device 👻								

Transmitter - PPM Signal

# 7.2.3.5.2.3 Exponential

The second tab in allows the user to define an exponential stick response for every channel.

Allowed inputs go from 0 to 1 and there is a graph showing the generated response curve, as can be seen in the following figure.



Transmitter - Exponential

## 7.2.3.5.2.4 Trim

The third tab available is the Trim option. On the upper part, there is a *Wizard trim button*. The latter will guide the user through some pop-up windows.

🖾 M400 🛪 💿 🖸 🏗	o 🕫 e	م 🗀 🖌	▶ Ⅲ 🤇	୭ ଲ					
<ul> <li>Actuators</li> </ul>	PPM Expo	onential Tr	im Output	t					
Communications				Wiza	rd trim				
Payload									<b>D</b>
Sensors	✓ Advanc	ed							Reset
▼ Stick		Trim	Range	Neutral		Trim	F	Range	Neutral
Arcade trim	Channel 1	0.0	0.7	Zero	Channel 9	0.0	] [0.1	7	Zero
▼ Local sources Transmitter 1	Channel 2	0.0	0.7	Zero	Channel 10	0.0	] [0.:	7	Zero
Transmitter 2	Channel 3	0.0	0.7	Zero	Channel 11	0.0	0.:	7	Zero
Transmitter 3	Channel 4	0.0	0.7	Zero	Channel 12	0.0	0.1	7	Zero
Transmitter 4 Virtual Stick	Channel 5	0.0	0.7	Zero	Channel 13	0.0	0.1	7	Zero
Test Stick	Channel 6	0.0	0.7	Zero	Channel 14	0.0	0.1	7	Zero
Stick	Channel 7	0.0	0.7	Zero	Channel 15	0.0	0.1	7	Zero
<ul> <li>Veronte</li> <li>Others</li> </ul>	Channel 8	0.0	0.7	Zero	Channel 16	0.0	0.1	7	Zero
Add device 👻									

#### Transmitter - Trim

If that option is not chosen, the user can toggle the Advanced option and set the expected trim values manually. The user should have a deep knowledge on its transmitter if this option is selected. Finally, on the right hand side, the *Reset button* puts every parameter back to 0.

#### 7.2.3.5.2.5 Output

Lastly there is the Output tab. Once the stick has been configured, the commands that arrive at the ground autopilot have to be sent to the air one. Here the user sets the receiving port and process the incoming commands.

🔤 M400 🛪 🛞 🙆 \Xi	🛛 🗱 🕰 🗖 🔺 🏭 🖉 🖗
<ul> <li>Actuators</li> </ul>	PPM Exponential Trim Output
Communications	Enable Initial Channel at destination 1 Port 0
Payload	
Sensors	UAV M400 (Vero V Min period 0.0 s Delta 0
▼ Stick	Max period 0.0 s
Arcade trim	
▼ Local sources	r
Transmitter 1	Enable Initial Channel at destination 1 Port 0
Transmitter 2 Transmitter 3	
Transmitter 4	Remote UAV Thin period 0.0 s Delta 0
Virtual Stick	Max period 0.0 s
Test Stick	
Stick	
► Veronte	
► Others	
Add device 👻	

#### Transmitter - Output

Once enable is flagged, the user indicates to which channel of the air autopilot (**AIR**) will be sent the first channel received in the ground segment (**GND**). The channels arrive at the platform in order and without spaces between them i.e, if at the **GND** channels 1,2,3,4 and 6 are enabled, the **AIR** will recieve channels 1,2,3,4 and 5. Therefore channel 6 of the stick will be channel 5 in the **AIR** configuration.

The option remote allows the delivery of the commands to the platform by indicating the address of the UAV. There is also the option *Broadcast*, where the commands are sent to all the air autopilots linked to the **GND**).

#### 7.2.3.5.2.6 Virtual Stick

If the information of a stick is received through a different channel than PPM, the user can create a virtual stick to process that information and input it to the system.

In order to do so, enable the Virtual Stick, place the variables containing the stick information and configure the update frequency required.

The tabs Exponential, Trim and Output are the same as the Transmitter ones, so refer to *Transmitter* for more information.

🔯 M400 🛪 🛞 🙆 葦	😧 🗱 🌇 📥 🏭 🖉 🙊
► Actuators	Input Variable Exponential Trim Output
Communications	Enable Virtual Stick
<ul> <li>Payload</li> <li>Sensors</li> <li>Stick         <ul> <li>Arcade trim</li> <li>Local sources</li> <li>Transmitter 1</li> </ul> </li> </ul>	Input Variable  Update Period User Variable 02 (Real - 3 User Variable 03 (Real - 3
Transmitter 2 Transmitter 3 Transmitter 4 Virtual Stick	
Test Stick Stick ▶ Veronte ▶ Others	
Add device 👻	

#### Virtual Stick - Configuration Parameters

This part of the configuration toolbar allows the user to set **up to four transmitters** and **one virtual stick**. The autopilot's capabilities allows it to receive information from four different transmitters at the same time plus transforming some values into a virtual stick.

The content presented in the next two sections covers:

- Setting of the transmitter's parameters.
- Definition of exponential response-curves for the desired channels.
- Trimming of the channels' neutral position.
- Setting of the data receiving port on the autopilot.
- Definition of a virtual stick.

### 7.2.3.5.3 Test Stick

This menu is used to generate stick inputs that are introduced in the system. This is a way to check how the system behaves when a stick commands enters in the autopilot. For each channel, the user can set a continuos movement formed for example by a sine wave, spike-like function or a rectangular function. There are a set of parameters to be modified for the signals.

M400 🛪 🛞 🙆 葦	🛛 🗱 🌇 🗖 🔺 🏭 🖉 🖗	
<ul> <li>Actuators</li> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Stick         <ul> <li>Arcade trim</li> <li>Local sources</li> <li>Transmitter 1</li> <li>Transmitter 2</li> <li>Transmitter 3</li> <li>Transmitter 4</li> </ul> </li> </ul>	Channels Channel 1 Channel 2 Channel 3 Channel 4 Channel 5 Channel 6 Channel 7 Channel 8 Channel 9	Minimun 30 % Maximun 68 % Period 10.0 s
Virtual Stick Test Stick Stick Veronte Others		

Test Stick - Configuration Parameters

- Minimum & Maximum: limit values that will be sent to the system for the stick test.
- **Period**: function period.
- Show on the checklist: configured parameters can be shown on the checklist in order to test the system prior to change flight phase more information on *Checklists*. To activate the automatic movement, activate the virtual stick configured see *Workspace Widgets Stick*.

**Warning:** This test should be performed carefully if control surfaces/devices are engaged because the stick input should be carefully defined.

# 7.2.3.5.4 Stick

The following content will help the user to configure the stick parameters for manual and arcade modes – more information about these modes in *Modes*.

The movement that the pilot makes on the stick produces variations on a vector called R of length n, where n goes from 1 to the total number of employed transmitter channels. The values reached by the components of R are limited between 0 and 1. These stick movements need to be processed to produce the input signals that will go into the control algorithm, in the case of arcade mode; or directly into the servos for manual mode.

The process begins by mapping each one of the sticks inputs to PWM signals into a vector called Y of length m, where m goes from 1 to the total number of actuators. The full definition of Y is  $Y = YR \cdot R + Y_0$ , where :

- **YR** is a matrix that transforms raw stick inputs R to PWM sigals Y.
- Y<sub>0</sub> is an offset vector, which corrects the Y vector.

The above parameters are defined at beginning of the **Stick** menu (as seen in the Figure below). There is a *Wizard Stick* button that sets YR and  $Y_0$ , which has a dedicated section below.

🔯 M400 🛪 🛞 🙆 葦	😧 📽 🖾 🔺 🏭 🖉 🖗
<ul> <li>Actuators</li> </ul>	YR Raw channels to servo transformation matrix
Communications	Y <sub>0</sub> Offset after applying transformation to servos
Payload	Wizard Stick
Sensors	
▼ Stick	Mask servos 1 2 3 4
Arcade trim	
Local sources	Stick reception timeout 0.25 s
Test Stick	Priority table 0 Priority table 1
Stick	
Veronte	● 0 UAV Local    Port 0 Time 0.2    On Overwrite
<ul> <li>Others</li> </ul>	↑ 1 UAV Pipe fixed ▼ Port 0 Time 0.2 V On Overwrite X
	Add
Add device 👻	

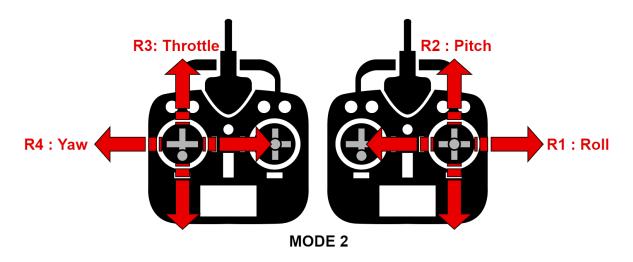
#### Stick - Configuration Parameters

Let's consider a quadocopter. With such platform applying thrust produces an increase in the rotation speed of the four engines, and only one stick channel (throttle) is required to achieve that. So here the mapping will be that an increase in one component of R has to produce an increase in four components of Y. Doing the same with the rest of stick channels (pitch, yaw, roll) will generate matrix YR:

	R	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing
Motor 1		-1.0	1.0	-1.0	1.0
Motor 2		1.0	1.0	-1.0	-1.0
Motor 3		1.0	1.0	1.0	1.0
Motor 4		-1.0	1.0	1.0	-1.0
			+		

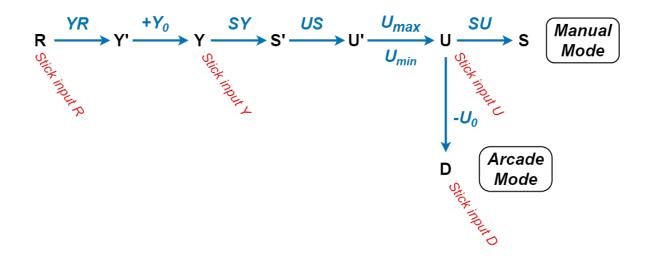
Stick - YR Matrix for a Quadcopter

Keep in mind that each stick channel (throttle, roll, yaw, pitch, etc) depends on the *mode* of the transmitter, i.e. the sticks' physical layout. There are 4 different modes and there is no prevailing type, it really depends on the pilot. In the following Figure a **Mode 2** channel layout is depicted:



Stick - Channels Layout

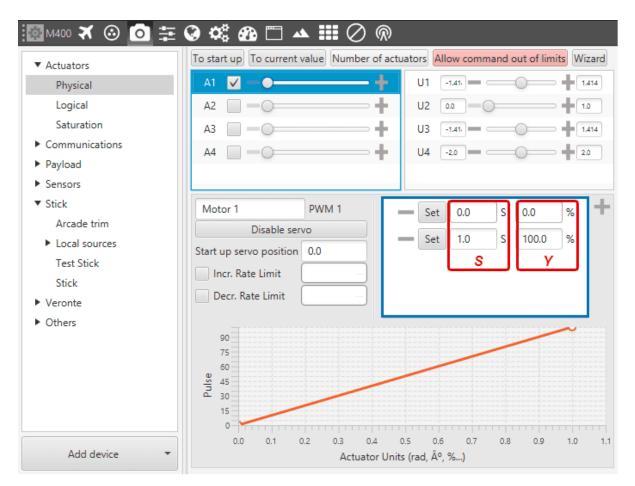
The offset  $Y_0$  is calculated by setting R and Y with a specific value. Take the neutral position of a quadcopter: the sticks are  $R_{neut} = [0.5; 0.5; 0; 0.5]$  (the third value is 0 as it corresponds to the neutral position of channel 3, i.e. the throttle) and the actuators PWM signals  $Y_{neut} = [0; 0; 0; 0]$ . Then, the solution for the offset vector will be:  $Y_0 = Y_{neut} - YR \cdot R_{neut}$ . The neutral position information will be asked when using the *Wizard Stick button*.



Stick - Transformation Diagram

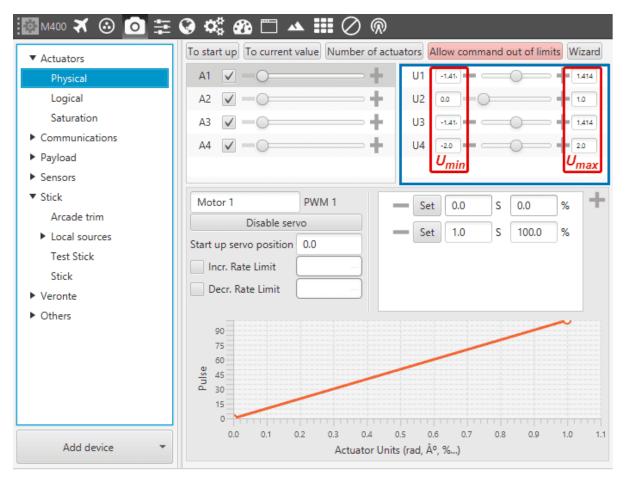
The above diagram depicts the whole transformation process of the incoming raw input R vector. It also shows in red the naming of some important variables in Veronte Pipe. Step by step, the process is:

- 1. From R one gets Y' using YR, as defined above.
- 2. From Y' one gets Y adding  $Y_0$ .
- 3. From Y, using the trim of the servos, one gets the actuator output S'. PWM to actuator output mapping SY is defined in *Devices Actuators Physical*. The mapping consists in a piecewise-linear function relating each actuator output S to a certain amount of PWM signal S:



Linear Mapping SY of a quadcopter engine

- 4. From S', using the logical transformation matrix US (defined in **Devices ->** Actuators -> Logical), one gets U'.
- 5. From U', and delimiting its values if they are higher or lower than the limit values  $U_{max}$  and  $U_{min}$ , one gets U. The limit values of U are found in *Devices - Actuators - Physical*.



Limit values of U

- 6. From U, substracting the arcade trim of the transmitter  $U_0$  one gets vector D, which goes into the guidance control of the modes where arcade mode is enabled. More information on the arcade trim on *Devices Stick Arcatedtrim*.
- 7. Lastly, if manual mode is selected, one last transformation is required. From U, applying SU, one gets the final S: actuator outputs.

## 7.2.3.5.4.1 Wizard Stick

To make use of this assitant tool, logical matrices US and SU must have been defined, otherwise it will not work.

When clicking on the button (see Figure below), the user is asked to associate each control output U of the platform with a stick channel R. Doing so, matrix YR is automatically calculated.

Chann	el order			R Stick inputs		s Actuator outputs
Use ✓	Invert	Control Output u1 - Pitching Control Output u2 - Thrusting	Stick Channel	r2 0	1	Servo 1
$\mathbf{V}$		Control Output u2 - Anissing Control Output u3 - Rolling Control Output u4 - Yawing	1 4	Value 0.0 r3		Value 0.0 Servo 2
				Value 0.0 r1		Value 0.0 Servo 3
Conf	igure Neu	trals	Accept	Get of Telemetry		Default Values

Stick - Wizard Stick Configuration Parameters

In addition, to obtain  $Y_0$  the user needs to click on *Configure Neutrals* – otherwise it is considered as  $Y_0 = 0$ . There, the neutral values of the actuator outputs  $S_{neut}$  (i.e. servo positions, engine rpms, etc) and the neutral values of the stick  $R_{neut}$  can be introduced manually. If *Default Values* button is clicked,  $S_{neut}$  is taken from *Devices* - *Actuators* – *Physical*, where its start-up position is defined.

If *Get of Telemetry* is clicked,  $R_{neut}$  is taken from the connected transmitter. The user should move the sticks to their netural position and then click on the button. Finally, to exit the assistant tool click on *Accept*.

Note: The assistant tool might not work for some configurations, such as hybrid platforms.

For those platforms where a same channel is used both for the plane and the quadcopter configuration, the stick configuration has to be done manually.

## 7.2.3.5.4.2 Mask Servos

This option is used to select which servos will "listen" to the commands sent by the stick. If the servo is selected (green box), it means the servo will be moved upon stick command. On the other side, if a servo is not selected (grey box), it will ignore the commands sent from the stick.

🔛 M400 🛪 💿 🧰 葦	🔮 🗱 🖽 🗔 🔺 🏭 🖉 🙊
<ul> <li>Actuators</li> </ul>	Raw channels to servo transformation matrix
Communications	Offset after applying transformation to servos
Payload	Wizard Stick
Sensors	
▼ Stick	Mask servos 1 2 3 4
Arcade trim	
Local sources	Stick reception timeout 0.25 s
Test Stick	Priority table 0 Priority table 1
Stick	
► Veronte	● ● UAV Local    Port 0 Time 0.2    On Overwrite
► Others	1 UAV Pipe fixed - Port 0 Time 0.2 On Overwrite X
	Add
Add device 🔻	

Stick - Mask Servos

7.2.3.5.4.3	Transmitter	Inputs
-------------	-------------	--------

🖾 M400 🛪 🛞 🙆 葦	🚱 🗱 🖽 🞞 🖉 🖗
<ul> <li>Actuators</li> </ul>	Raw channels to servo transformation matrix
Communications	Offset after applying transformation to servos
Payload	Wizard Stick
Sensors	
▼ Stick	Mask servos 1 2 3 4
Arcade trim	
Local sources	Stick reception timeout 0.25 s
Test Stick	Priority table 0 Priority table 1
Stick	◆ 0 ◆ UAV Local    Port 0 Time 0.2    On Overwrite
<ul> <li>Veronte</li> </ul>	
Others	↑     1     UAV     Pipe fixed     ▼     Port     0     Time     0.2     ✓     On     Overwrite     X
	Add
Add device 👻	

Stick - Transmitter Inputs

It is possible to set multiple transmitter inputs with the respective priority, from top to bottom.

- UAV: defines the source of where the stick information is taken from. *Local* represents the actual selected autopilot (i.e. the transmitter is connected to it); *Pipe fixed* means the information is coming from the virtual stick; *Broadcast* means the information comes from all linked autopilots; and one particular autopilot, which needs to be visible in Pipe.
- **Port**: from each source it is possible to have more than one stick information, e.g. two transmitters can be connected to the same autopilot. The port is an identifier to distinguish them.
- **Time**: defines the time to consider the source inactive. Therefore the incoming stick information will be always the one from the source with higher priority and active. Once it is considered inactive the following active source will send its stick information.
- **ON**: enables the source.
- Overwrite: if marked, the stick information will be overwritten by this source when it becomes the active source.

In this section, the stick configuration on Veronte Pipe is explained. The next table details what is going to be covered:

Arcade trim	Neutral position value for the sticks
Local sources	External transmitter configuration (up to 2) and 1 virtual stick
Test Stick	Testing of the transmitter configured channels
Stick	Configuration of the stick matrices, offsets and transmitter priority

All these menus help the user in configuring the transformation of stick inputs into control outputs. Summarized, the following process is followed:

- Stick inputs R are named "Stick input  $r_n$ ", where n goes from 1 to the maximum number of employed channels of the transmitter. R values go through the YR transformation matrix (see **Devices -> Stick ->** Stick menu), which converts raw stick iputs to servo PWM signals. And become Y, which is named "Stick input  $y_m$ ", where m goes from 1 to the total number of actuators of hte platform.
- Y PWM signals are corrected by adding an offset matrix Y<sub>0</sub>. After that, Y values are converted into S values, known as "Actuator outputs S<sub>m</sub>". The transformation is performed according to the relation defined in Devices
   Actuators -> Physical for each actuator.
- S values then go through the matrix US, defined in **Devices** -> Actuators -> Logical, and become U, the "Control outputs  $U_n$ ".

Note: If the YR matrix has not been properly defined, Y values will be greater than 1 but the actuator output will have the maximum S available.

A broader and more detailed explanation of the above can be found in *Stick*.

# 7.2.3.6 Others

## 7.2.3.6.1 Can Configuration

## 7.2.3.6.1.1 Configuration

This menu allows the configuration of communications between different devices.

Communications	Priority		Custom Message 1 Custon Producer	n Message	2 Mailboxes Consumer	
Micro	High	00	Serial to CAN 1	$\rightarrow$	None	
Payload Sensors	High	00	Serial to CAN 2	i → i	None	
Stick	High	00	Serial to CAN 3	$\rightarrow$	None	
Veronte	✓ High	- ma - 000	CAN custom message 1	Ì→Ì	Output filter 3	
Others	✓ High	40 Q0	CAN custom message 2		Output filter 4	
I/O Manager CAN Config	High	00	Input filter 1		None	
Digital Input Manager	High	₩0 \$	Input filter 2	i → i	None	
	High	00	Input filter 3	Ì→[	Custom message 1	
	High	00	Input filter 4	Ì→Ì	Custom message 2	
	High	08	CAN unwrapper 1	→	None	
	High	00	CAN unwrapper 2	I→I	None	
	High	$Q_0^\circ$	CAN GPIO remote 1	I→	None	
	High	$Q_0^{\circ}$	CAN GPIO remote 2	→	None	

#### CAN configuration

Attention: Make sure that the mask is set properly to be able to receive the desired CAN messages.

On the one hand, Veronte has the producers shown below:

- Serial to CAN: Serial messages over CAN output and it has to be connected to I/O Manager consumer. ID can be configured in the settings button.
- CAN custom message: CAN custom messages transmission.
- Input filter: CAN input filters. A mask can be set to filter messages in the settings button. Those CAN messages received in one filter can no longer be received in subsequent filters.
- CAN unwrapper: CAN messages over serial output and it has to be connected to I/O Manager consumer.
- CAN GPIO remote: CAN messages from GPIO peripherals such as CEX and Arbiter.

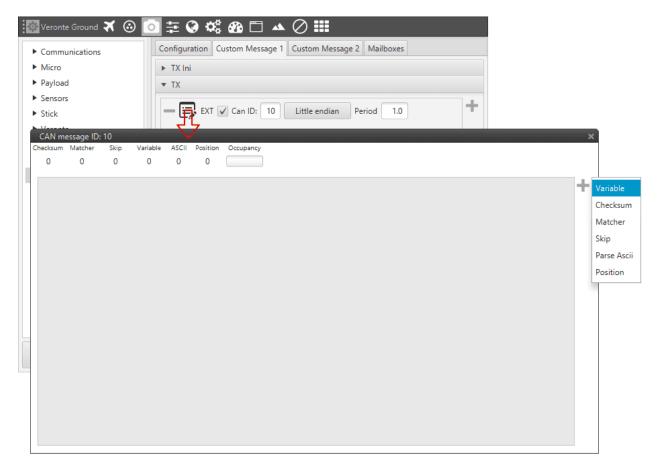
On the other hand, the consumers are the following:

- CAN to serial: Serial messages over CAN output and it has to be connected to I/O Manager producer.
- Custom message: CAN custom messages reception.
- Output filter: CAN output filters. CAN bus can be selected in settings button.
- CAN wrapper: CAN messages over serial output and it has to be connected to I/O Manager producer.

# 7.2.3.6.1.2 CAN Telemetry

# 7.2.3.6.1.3 Custom Messages

When using and configuring custom messages, the following types of elements can be defined within.



Telemetry Panel

## 7.2.3.6.1.4 Variable

Used to store certain bits in a system variable (RX) or to send a certain variable (TX).

CAN mess				Cil Desiries	2						×
Checksum M	0				Occupancy						
- 🗐		Static	Pressure								+
	Variabl	le		Compressio	n	Decimals	Encode/Decode	Encode Min Max	Decode Min Max		
	Static Pre	ess	Uncompr	ess	-	0	1	0.0 0.0	00	)	
										,	

#### Variable Configuration Menu

- Type of Compression. The first step is to configure which kind of compression will be used for this variable.
  - Uncompressed: the variable is taken in its full length, with no value modification.
  - Compressed:
    - \* **Compress (Bits signed)**: specify the number of bits to be compressed to (negative values accpeted). It is necessary that the user configures Encode/Decode options.
    - \* **Compress (Bits unsigned)**: specify the number of bits to be compressed to (no negative values accepted). It is necessary that the user configures Encode/Decode options.
    - \* **Compress (Decimals)**: the variable is compressed according to the number of decimals specified and the range specified (max and min values). The resultant compression (number of bits) follows the relation  $(max min) \cdot 10^{decimals}$  which yields the encoding of the maximum value of the range (and the number of bits necessary for that). The range needs to be specified on the **Encode Min/Max** field.

	User Variable 02 (Real - 32 bits)						
Variable	Compression	Decimals	Encode/Decode	End	:ode	De	code
variable	Compression	Declinais	Encode/Decode	Min	Max	Min	Max
User Variabl	Compress - Decimals 🔹 👻	2	1	-500.0	500.0	0	0
	# (	decima	ls	rai	nge		

#### **Compress Decimal Selection**

• **Encode/Decode**: these values are used to apply a scaling factor after the transformation from binary to decimal value, or before the transformation from decimal to binary value.

In the example shown below, a real user variable (32 bits) is being used to receive data from an external device. This data corresponds to the heading angle of the aircraft (which goes from 0 to 359 degrees). The device is sending this

information in a 16-bit data frame and the angle value times 100 (hence why the **Decode** section goes from 0 to 35900). This needs to be saved in Veronte in the user variable in the range 0 to 359 (**Encode**).

- 🗊 🗇 🕇	REF_HDG_VALUE							
Variable	Compression		Decimals	Encode/Decode	En Min	code Max	De Min	code Max
REF_HDG_V	Compress - Bits Unigned	*	16	1	0.0	359.0	0	35900



## 7.2.3.6.1.5 Checksum

Sometimes, control codes are needed for preventing random errors in transmission, where a bits frame is operated and the result is sent to the receiver to check it. To do so the CheckSum option is used.

CAN n	nessage ID: '													×
Checksum	n Matcher		Variable			Occupancy								
1	0	0	0	0	0									
		•												1.0
- [		🕂 CR	C (crc16v	eronte)	)									+
	Туре	e	Bits	E	Indianness		Crc - Preset	в	ackFrom	BackTo	Polynomial StartValue	Final XOR R.	n R. OutSum8	
	Polynomia	il 👻	16	Mi	xed	• crc	16veronte	•	2	0	40961 23073	0		

#### CheckSum

- Back From: Indicates that the CRC will be computed from the indicated byte (inclusive).
- Back To: Indicates that the CRC will be computed to the indicated byte (exclusive).

**Note:** Byte 0 it is referred to the first byte of the Checksum block. i.e for a message with 6 bytes where 2 bytes are the CRC. Back from = 4 and Back To = 0

- Endianness: Indicates how the bytes that it contains are read:
  - Big endian: Set the value from left to right
  - Little endian: Set the value from right to left
  - Mixed endian: For some special devices.

- Type: User can choose the type of CRC that will be applied.
- CRC type.
  - Polynomial. Select from a list of predefined Embention Veronte CRC. Last option is Custom, where fields as nº Bits, Polynomial, Start Value, Final Xor, Reflect In and Out can be defined. Check Polynomial CRC online for more information.
  - Module. Applies Module CRC.
  - Mavlink. EMbention has implemented the Mavlink checksum, used only for Mavlink protocol communications.
- Sum 8. The Sum 8 checksum is the 8 bit modulo 256 checksum. It consists of adding all bytes to take only the less significa
  - SUM = Sum on all bytes
  - CHECKSUM = MOD(SUM,256)

#### 7.2.3.6.1.6 Matcher

This option is used to send a constant value through the bus in TX or wait for a particular value in RX.

	essage ID:		Madabla	4000	<b>B</b> iti	2
necksum 0	Matcher 1	Skip 0	Variable 0	ASCII 0	Position 0	Occupancy
- 6	, O	+ №	latcher x9			
	Value	Bits			Mask	
9		8	255			dec
<						

#### Matcher

- Nº Bits: number of bits in which the matcher is performed.
- Value: sent/received value for the above nº of bits.
- Mask: it is automatically set when the n<sup>o</sup> of bits is assigned.

For example, a matcher of 8 bits with a value of 9 will be reading/sending: 0000 1001.

## 7.2.3.6.1.7 Skip

This option is used to discard a certain number of bits from the message (the maximum number of bits that can be skipped with a single "Skip" are 32). This tool can be used when there are variables incoming that are from no interest for the user, not loading unnecessary information into the system.

# 7.2.3.6.1.8 Parse ASCII

Parsing ASCII is used when the protocol required is of this kind. Only for RX. The variable set at the top is where the ASCII will be saved.

ASCII protocol is used for transforming a character array into decimal values. For such task, the user needs to define the number of characters in the integer and the decimal parts, as well as defining which is the division character. See how to introduce all this information in the picture below.

ſ		essage ID						×
4		Matcher		Variable			Occupancy	
	0	0	0	0	1	0		
	—	ļ	) 💠 Pa	arse ASCII				+
			Variable	e (	Char in ir	nter part	Char in decimal part Division char	
			IAS (Indic	at 1			0 .	

Parse ASCII Menu

## 7.2.3.6.1.9 Position

Position is used to input/output a data set with a particular format. When created, the user can only choose from Moving Object variables.

The window display below is the configurable menu, where it can be chosen between degrees and radians as units. The information stored is the WGS84 coordinates in the following order: Latitude, Longitude and Height. All of them are stored with double precision.

	message ID:						×
	m Matcher	Skip	Variable			n Occupancy	
0	0	0	0	0	1		
		•					$\left  + \right $
	I, O	<b>₩</b>	loving Ob	ject 01			Ξ.
		F	eature		Units	Factor	
		Mov	ing Obj	De	g	• 0.017453292519943295	

#### Position Menu

On the custom message tabs, the user chooses the variables to be sent/received over the CAN buses. The following elements can be configured:

- **TX Ini:** used to configure transmitted messages that are only sent once at the beginning of the operation (sent when the autopilot boots up). They can be used to initialize some devices.
- **TX:** used to configure transmitted messages.
- **RX:** used to configure the reception messages (where they are stored).

Veronte Ground 🛪 🙆	፩፰፡፡ 🖓 📽 🕰 🗖 🔺 🖉 🏛
► Communications	Configuration Custom Message 1 Custom Message 2 Mailboxes
Micro	► TX Ini
Payload	► TX
Sensors	▶ RX
► Stick	
► Veronte	
▼ Others	
I/O Manager	
CAN Config	
Digital Input Manager	
Add device 🔹	

CAN – Telemetry

Veronte Ground 🛪 🙆	፩፰ ፡፡ 🚱 🐗 🙆 🖽 🔺 🖉 🎟
► Communications	Configuration Custom Message 1 Custom Message 2 Mailboxes
► Micro	► TX Ini
Payload	▼ TX
Sensors	
Stick	EXT Can ID: 10 Little endian Period 1.0
Veronte	2 1
▼ Others	
I/O Manager	
CAN Config	
Digital Input Manager	► RX
Add device 🔻	

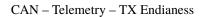
# 7.2.3.6.1.10 TX Messages

# CAN – Telemetry - TX

In order to add a new custom message the user needs to press "+" and a new element will be added into the panel.

- **EXT:** enables the frame format with a 29-bit identifier.
- ID: 11 or 29-bits (Extended) ID used to identify TX messages. The value set has to be decimal format.
- Period: time in seconds between TX messages delivery.
- **Button 1:** open a new window to configure the endianness of the message, which indicates how the bytes that it contains are sent/read:
  - Big endian: set the value from left to right
  - Little endian: set the value from right to left
  - Mixed endian: custom endiannes.

Veronte Ground 🛪 🙆	፰ ፡♀ 🗱 🙆 🖽 🔺 ⊘ ⅲ	
► Communications	Configuration Custom Message 1 Custom Message 2 Mailboxes	
► Micro	► TX Ini	
Payload	▼ TX	
Sensors	Big endian	
► Stick		
▶ Veronte	Little endian	
▼ Others	Custom	
I/O Manager	Endianness Little endian	-
CAN Config	Disaster Laure Links	
Digital Input Manager	Bit order Low to high	*
	► RX	
Add device 👻		



• Button 2: displays the menu to configure how the bits/bytes of the message are divided and sent.

There are six different elements that can be added when setting up a custom message: *Variable, Checksum, Matcher, Skip, Parce Ascii* and *Position*. This is covered in section *Custom Messages*.

The **maximum capacity** of a CAN message is 64 bits (8 bytes), so to send more information it must be divided into several messages.

## 7.2.3.6.1.11 RX Messages

The procedure is similar to the one followed in TX messages.

Veronte Ground 🛪 🙆	፰��₡∞□ ▲ ⊘Ⅲ
► Communications	Configuration Custom Message 1 Custom Message 2 Mailboxes
► Micro	► TX Ini
Payload	▶ TX
Sensors	▼ RX
► Stick	
▶ Veronte	EXT Can ID: 10 Little endian Period 1.0 Bit ID: 0
▼ Others	
I/O Manager	
CAN Config	
Digital Input Manager	
Add device 👻	

### CAN - Telemetry - RX

The custom message needs to have the expected ID with which the external device/sensor is going to be sending information.

Attention: It is important to configure a mailbox for every single reception ID. See *Mailboxes* for more information.

The custom message structure needs to match the reception data-format. User variables (real - 32 bits, integer - 16 bits or boolean - 1 bit) need to be used to store that data.

Unlike TX messages there are two additional variables per message, **Bit ID** and **Period**. The user bit selected in **Bit ID** box will be true if the message is being received correctly. **Period** is the time between receptions to consider that it is not being received correctly. For example, if period is set to 1s and it passes more than 1s since the last reception, the bit ID will be set to false.

Warning: Pay attention that the user bit selected in **Bit ID** is not in use for another task.

# 7.2.3.6.1.12 Mailboxes

Here the user can modify the mailboxes from the CAN bus.

When Veronte is going to receive data on the CAN Bus, it is mandatory to configure a certain number of mailboxes. In order to add a mailbox one needs to click on (1).

🔯 Veronte Ground 🛪 🙆 🚺	•] ‡	Q	) 🗘 🖓	🗂 🔺	$\oslash$		
▶ Communications	Confi	gurat	tion Custom	Message 1	Custom N	lessage 2 Mailboxes	
Micro	CAN	A C	AN B				
Payload	Γ						
Sensors	Units	; ID	DEC 💌	Units	Mask BIN	-	
Stick	Mailla	over	reserved RX1	Mailb	oxes availab	ula 21	
Veronte		oxes					_ <b>(</b>
▼ Others	#		Mailboxes	Extended	ID	Mask	- T
I/O Manager	1		1		10	1111111111	
CAN Config							
Digital Input Manager							
Add device 👻	1						

### CAN - Mailboxes

Mailboxes are required to store the data received until Veronte reads it and it is **necessary at least one mailbox** per RX message. Veronte allows up to 32 mailboxes. The options available when adding a new mailbox are:

- Mailboxes: number of mailboxes assigned to that ID.
- Extended: select this option for 29-bit IDs.
- **ID:** 11 or 29-bits (Extended) ID used to identify RX messages. The value set can be defined in decimal, hexadecimal or binary form.
- Mask: This filter is configured for reception messages; received data will be stored on mailboxes where message ID coincides with mailbox ID. Mask adds some flexibility on the reception, when comparing message with mailbox data, only the value of binary digits configured as 1 on the mask will be taken into account. (e.g, for a configuration MASK: **11** 000 and ID:**10** 110 all incoming messages addressed to **10** XXX will be received in this mailbox).

Warning: If any mailbox is full and another message arrives, the new message is discarded.

A Controller Area Network (CAN Bus) is a robust vehicle bus standard widely used in the aviation sector. Veronte is fitted with two CAN buses that can be configured independently.

The structure of a CAN message can be seen in the following image:



CAN message structure

Only the ID is introduced in the system, the rest of the message layout is already coded. The data field is the one build by the user to send, and parsed when received.

The baud rate of both CAN buses can be configured in Setup - Connections - CAN.

# 7.2.3.6.2 I/O Manager

### 7.2.3.6.2.1 Serial Custom Messages

It is possible to configure the messages sent/received through the serial port and its conversion to system variables by selecting the option Custom message and configuring the I/O port.

Actuators	Configur	ration				
Communications	Priority		Producer		Consumer	
Payload	High	00	USB	$\leftrightarrow$	Commgr port 1	0
Sensors	High	$Q_0^0$	Veronte LOS	→	Commgr port 2	
Stick	High	00	Veronte LTE	$\leftrightarrow$	Commgr port 3	0
Veronte Others	High	$Q^0_0$	RS232	$\rightarrow$	RS custom message 1	0
I/O Manager	High	$Q^0_0$	RS485	$\rightarrow$	Commgr port 5	
CAN Config	High	$Q^0_0$	Commgr port 1	$\leftrightarrow$	USB	0
Digital Input Manager	High	$\dot{\Omega}^0_0$	Commgr port 2	Ī↔Ī	Veronte LOS	
	High	$Q^0_0$	Commgr port 3	↔	Veronte LTE	
	High	$Q^0_0$	Commgr port 4	<b>→</b>	RS232	
	High	$Q_0^0$	Commgr port 5	$\rightarrow$	None	
	High	$Q^0_0$	Commgr port 6	$\rightarrow$	None	
	High	$\mathbf{Q}_0^0$	RS custom message 1	$\rightarrow$	None	0
	🗌 High	$\mathbf{Q}_0^0$	RS custom message 2	<b>→</b>	RS485	0
	High	$\mathbf{Q}_{0}^{0}$	RS custom message 3	$\rightarrow$	None	
Add device 👻	High	$\dot{Q}^{0}_{0}$	Tunnel 1	$\rightarrow$	None	03

## XPC Unit8 Panel - Custom Message

In the image above can be seen two possible configurations using a Custom Message. The first one is configured to receive a determined message from a RS-232 serial port and the second is used to send a Custom Message through a RS-485 serial port. It is possible to use the same Custom Message for both tasks if Bind Bidirectional is used (the arrow indicates this). Custom Message configuration is covered in section *Custom Messages*.

The options available when configuring a custom message are:

- Period: this option has a dual role depending on if it is used to transmit or receive data.
  - For transmitting, it is the inverse of the send frequency.
  - For receiving, it is the time Veronte wait for the message.
- Endianness: depending on the order in which the device issue the message, it is possible to select:
  - **Big endian:** set the value from left to right
  - Little endian: set the value from right to left
  - Mixed endian: Any devices have this format. If you need to configure, please contact us.

The following type of messages are available to configure a structure: Variable, Checksum, Matcher and Skip.

Before configuring any message, user has to know the structure it has to have according to the device that is connected to the port. Each device may have a different message structure when it sends or receives information.

# 7.2.3.6.2.2 Message received

In this section is shown a possible structure when receiving a message.

[Consumer] RS custom message 1									>
- 🗊 🗍 Little endian	Big endian		Checksum 0	Matcher 1	Skip 0	Variable 2	ASCII 0	Position 0	Occupancy
User Variable User Variabl Uncor	Endianness	Little endian   Low to high	ode/Decode	Er Min	Max Max	Min	Decode Mao	٤	<b>+</b>
0 0 0	02 (Unsigned Integ		icode/Decode	Er Min	icode Max	[ Min	Decode Max	¢	
User Variabl Uncon	npress	• 0 0		0.0	65535	.] [0			>

Custom Messages Configuration Menu

- 1. Select the desired I/O port and then select Custom Message.
- 2. Configure the custom message. Press **the configuration button** and another window will be displayed. In this window press "+" to add a message (system variables or ADSB Vehicle), when it is already added, select an **Endianness** and set a value for **Period**.
- 3. Create the message structure by adding fields to it. In this example, the structure of the message received consists of a Matcher (to identify the message) and two **User Variable** (where the information is storaged).
- 4. Check the number of bits of each element. User has to know previouly the structure of the message received and its size, each element has to configured according to that.

### 7.2.3.6.2.3 Tunnel

It is possible to configure a Tunnel which is a bidirectional bridge between Veronte Units that communicate to each other sharing information about an external device connected to the Serial or Digital port.

Imagine that we would like to have a button connected to the air autopilot to launch a parachute. It is not possible to physically connect the button because the air autopilot is in the flying platform, so we need a different option. Here is where the tunnel becomes useful. We could connect the button throught the Serial or Digital port to the Ground Autopilot, and then with the tunnel send the signal to the air one. With this configuration it would be like if the button were physically connected to the aircraft.

Let's consider the following image.

Actuators	Configu	ration							
Communications	Priority		Producer		Consumer				
Payload	High	00	USB	$\leftrightarrow$	Commgr port 1	00	â		
Sensors	High	00	Veronte LOS	↔	Commgr port 2	Q <sub>0</sub> <sup>0</sup>			
Stick	High	08	Veronte LTE	$\leftrightarrow$	Commgr port 3	00			
Veronte	High	08	RS232	<b>→</b>	Tunnel 1	Q0	Veronte ID	Veronte0 (Veronte v4.0	1
Others I/O Manager	High	00	RS485	]→[	Commgr port 5	¢\$	Parser	No protocol	•
CAN Config	High	00	Commgr port 1	↔	USB	Q <sup>0</sup>	Destination tunnel	Tunnel producer 1	
Digital Input Manager	High	$Q_0^0$	Commgr port 2	↔	Veronte LOS	Q <sub>0</sub>	Time between messages	0.01	_
	High	$Q_0^0$	Commgr port 3	$\leftrightarrow$	Veronte LTE	Q <sub>0</sub> <sup>0</sup>	Bytes to send	22	by
	High	00	Commgr port 4	$\rightarrow$	RS232	00			
	High	$Q_0^0$	Commgr port 5	$\rightarrow$	None	$Q_0^0$			
	High	$Q_0^0$	Commgr port 6	$\rightarrow$	None	Q0			
	High	$Q^0_0$	RS custom message 1	$\rightarrow$	None	Q <sub>0</sub> <sup>0</sup>			
	High	$Q^0_0$	RS custom message 2	$\rightarrow$	RS485	Q <sub>0</sub> <sup>0</sup>			
	High	$\mathbf{Q}_0^0$	RS custom message 3	$\rightarrow$	None	Q <sub>0</sub> <sup>0</sup>			
Add device 👻	High	00	Tunnel 1	$\rightarrow$	None	Q0			

### XPC Uint8 Configuration Menu

In the image above there is a device connected to the SCID Connector 232 (Producer) and there is a Tunnel (Consumer) which sends that information to other Veronte with a determined ID. On the other hand, Veronte Air has to be configured to receive the signal sent by other device. In that case the Producer will be Tunnel and Consumer will be the port or destination tunnel where the device is connected.

The option available when configuring Tunnel as Consumer are:

- Veronte ID: identifies the Autopilot which will receive the information.
- Parser: chooses protocol to parse message data.
- Destination tunnel: number of port is used to avoid mistakes and identify a Tunnel when using more than one.
- Time between messages.
- Bytes to send: sets the message size to send.

When configuring the unit that receives the information, only is necessary to configure the "Consumer" of that a information, generally a serial port.

In this panel the user can stablish the relationship between a determined signal with a I/O port. This allows users to configure an external sensors, messages between Veronte Units (Tunnel) and custom messages.

Actuators	Configura	tion				
Communications	Priority		Producer		Consumer	
Payload	High	Q <sub>0</sub> <sup>0</sup>	USB	$\leftrightarrow$	Commgr port 1	0
Sensors	High	$Q_0^0$	Veronte LOS	$\rightarrow$	Commgr port 2	
Stick	High	Q <sub>0</sub> <sup>0</sup>	Veronte LTE	$\leftrightarrow$	Commgr port 3	03
Veronte Others	High	Q0	RS232	$\leftrightarrow$	Commgr port 4	0
I/O Manager	High	$Q_0^0$	RS485		Commgr port 5	0
CAN Config	High	Q0	Commgr port 1	↔	USB	0
Digital Input Manager	High	Q00	Commgr port 2		Veronte LOS	0
	High	Q0	Commgr port 3		Veronte LTE	
	High	Q0	Commgr port 4	$\rightarrow$	RS232	0
	High	$\dot{\Omega}^0_0$	Commgr port 5		RS485	Q.
	High	Q0	Commgr port 6	$\rightarrow$	None	0
	High 🗌	$\dot{\Omega}^{0}_{0}$	RS custom message 1	$\rightarrow$	None	0
	High -	<b>Q</b> 0	RS custom message 2	$\rightarrow$	None	0
	High	Q <sub>0</sub> <sup>0</sup>	RS custom message 3	$\rightarrow$	None	0
Add device 👻	High	00	Tunnel 1	$\rightarrow$	None	-03

### XPC Uint8 Configuration Menu

Firstly, users have to configure the **Producer** selecting the I/O port or information to use. Later, users have to configure the Consumer by clicking on an element, a new window will be displayed to select an item. The relationship between them can be unidirectional (Blind) or bidirectional (Blind Bidirectional), the last enables a port to receive or send information.

The following I/O ports are available:

Field	Description
USB	USB Port
SCIB	Radio
SCIA	4G Connection
SCID	Serial Port 232
SCIC	Serial Port 485
Commgr port	COM Manager Port

It is worth noting that only SCID/SCIC ports can be used to configure an element, the other ports have to be maintained by default.

Finally, it is possible to configure the next elements:

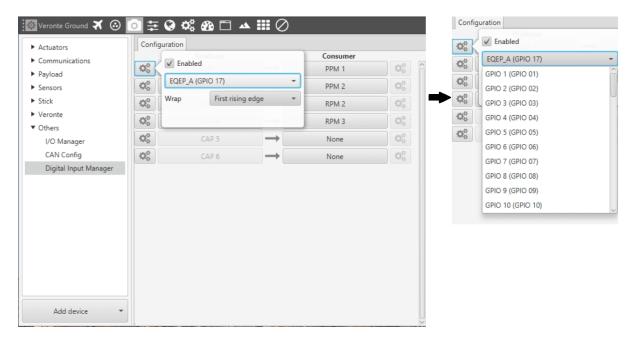
Field	Description
Tunnel	Creates a bidirectional brigde between two devices, see section <i>Tunnel</i>
Custom Message	This allows user to send/receiver a custom message.see section Custom Messages
GPS RTCM	Differential GPS.
Magneto	External magnetometer sensor, see section Magnetometer
Ultrasound	External ultrasound sensor, see section Ultrasounds
Splitter	Used to split a signal into 2.
NMEA Parser	NMEA 0183 messages parser, see section GNSS External

More information about each element can be found in the links provided before.

# 7.2.3.6.3 Digital Input Manager

Pins 1-8 and 10-16 can work as Digital Input or Output as well as PWM. In order to configure some custom sensors such as a Stick PPM, RPM Sensor or a Pulse Sensor Enhanced Quadrature Encoder Pulse Inputs (EQEP) pins are reserved, which correspond to pins 55-58. These pins can also be used as Digital I/O.

Sensors using a Digital In are configured in this menu.



#### XPC CAP Configuration Menu

The process to configure a device can be done as follows:

- Select a **Producer**.
- Click on a button to select the type of **Consumer**, it is possible to choose among a Stick PPM, RPM Sensor or Pulse Sensor.
- Configure the **Producer**, press on the configuration button and a new po-up window will show.
- In the pop-up window is possible to select the pin where the device is connected. Pins available are **GPIO** 1 to 16, and **EQEP** A, B, S and I. When using the harness provided by Embention the transmitter Digital Input is connected to the pin 55 (EQEP\_A) with pin 49 as Ground.

• Wrap options allows to configure how the information is treated: for example if it will read the first rising edge or the first falling one. Clicking on the arrows it can be configured as desired.

**Warning:** Do not use EQEP\_B to readd PPM, RPM or Pulse with Veronte units of Hardware version 4.5 or lower. It can only be used as digital I/O.

For more information on the stick configuration and how to set the RPMs correctly, visit : Stick and RPM.

This section of the manual contains the information about external sensors/devices configuration. These devices are configured on the different ports available in Veronte (CAN buses, Serial buses, digital I/O, etc):

Port / Manager	Description
CAN Configuration	Configuration of the two CAN buses (A and B)
I/O Manager	Configuration of serial ports, LOS & BLOS connection, and others.
Digital Input Manager	Configuration of PPM signals, pulses or rpm sensors.

As Custom Messages need to be defined for both serial and CAN communication, there will be a section after the CAN Configuration and I/O Manager sections.

Devices Panel permits to configure any device (payload, sensors...) connected to Veronte and the internal Veronte ones.

Туре	Description
Actuators	To configure the actuators limits, their logic and saturation
Communications	4G, Comstats and Iridium configurations
Payload	Menus for different Cameras/Transponder configurations
Sensors	To set sensor device
Stick	To configure Stick
Veronte	To set the orientation and mass centre of the aircraft
Others	To set other devices and I/O signals

# 7.2.4 Control

# 7.2.4.1 Phases

# 7.2.4.1.1 Guidance

# 7.2.4.1.1.1 Guidance Variables

The guidances contained within Veronte generate a series of variables that are later used in the control system as the input of the PIDs. In the Hold guidance is the user the one that selects the desired variables to be generated. These variable can be added by clicking on the "+" button, there are different variables to select. Generally, variables named as Desired are used in this Guidance.

Select	t variable			×
Selec	ct var	Desired		
R	Desired Forward Load Fact Unit:	tor - X Body	y Axis	^
R	Desired Front GV (Ground Unit: m/s	Velocity)		
R	Desired GS (Ground Speed Unit: m/s	4)		
R	Desired Heading Unit: rad [-π,π]			
R	Desired IAS (Indicated Airs Unit: m/s	speed)		
R	Desired Lateral GV (Groun Unit: m/s	d Velocity)		
R	<b>Desired</b> Latitude Unit: rad [-π,π]			
R	<b>Desired</b> Longitude Unit: rad [-π,π]			~
			Cancel	Accept

Variables Selection

After that these variables are used in the Control Loops.

# 7.2.4.1.1.2 Taxi

Taxi guidance is used to create a linear path along the runway that is followed by the aircraft. This command is normally used in the take-off phase, where the airplane is wanted to keep the direction of the runway while is accelerating until the lift-off point.

Fixed Wing V-Tail UAV 🔾	😔 💿 🗄	I I I I I I I I I I I I I I I I I I I	) 🖽 🔺 🖽 🖉	)	
▼ Phases	Guidance Arc	ade TC Pannel	Automations		
0 Standby	Taxi		<b>^</b>	Name	Flare
1 Climbing	Hold		+		
2 Flare			×		
3 Hold			*		
4 Cruise	Set speed				~
5 Landing			(		
6 Runway Takeoff	Cruise		1.0 m/s	¢.	
7 Altitude Mode	Way	point reach	1.0 m/s	÷.	
8 MSL +10	Туре		IAS	*	
9 MSL -10	Decelera	ation	5.0	m/s²	
Runway			(		
Envelope	Guidance c	ontrol ?			
Modes		Туре	Scheduling variable		
Arcade axis	Horizontal		<ul> <li>Zero</li> </ul>		
	nonzontar		200		
	Vertical	PID	• Zero		
	Runway Runw	vay 1 👻	Advanced		
	End point				- %
Add 👻	Direction	R	unway Direction		- 9 <u>.</u> -

### TAXI Guidance

- Set height mode: the height mode indicates how the aircraft will perform the route. Height mode in Taxi guidance is fixed to 2.5D type. This means that vertical flight is not allowed, so horizontal guidance has priority over vertical guidance.
- Arcade position/speed transition In Arcade mode the trajectory generated (*position*) is not followed and instead the aircraft moves according to the commanded *speed*. The *horizontal* and *vertical speed* parameters serve as the upper-thresholds for when the aircraft's guidance should be *position-based*, even in Arcade mode. This parameters are mainly useful for platforms like multicopters.
- Set speed: this option sets the speed that the vehicle will have during this phase. It can be IAS (indicated airspeed) or Speed (Ground Speed). Normally, IAS is used for airplanes and Speed for multicopters. The option Waypoint reach is used to indicate the speed at which the platform will reach the waypoints, so it will travel along the path with the speed indicated in the option Cruise, then it will decelerate or accelerate to the speed indicated in Waypoint Reach and then it will go back to the cruise speed.
- **Guidance control:** vertical and horizontal PIDs (with constants gains or variable that control this phase (see *Blocks*).
- **Runway:** here it is selected a runway previously configured, see section *Runway*. Besides, it is possible to use the advanced mode and select a different end point or direction.

# 7.2.4.1.1.3 VTOL

VTOL guidance (vertical take-off and landing) is used in multicopters for the take-off and landing operations. This guidance consists on the creation of a vertical line that starts at the point where the platform enters in this guidance.

Veronte0 🛪 🙆 🧿	🖸 😧 🔇 📑	🕉 🗂 🔺	▶ Ⅲ ⊘	)			
▼ Phases	Guidance Arc	ade TC Pann	el Automati	ons			
0 Standby	Taxi		1	N	ame	Runway Takeoff	F
1 Climbing	Hold		+				
2 Flare	VTol		×				
3 Hold			4				
4 Cruise		1. A A.		/ she			<u>^</u>
5 Landing	Way	point reach	5.0	m/s			
6 Runway Takeoff	Туре		Ground S	Speed 🔻			
7 Altitude Mode	Deceler	ation	5.0	m/s <sup>2</sup>			
8 MSL +10							
9 MSL -10	Guidance c	ontrol ?					
► Runway		Туре	Schedul	ing variable			
Envelope	Horizontal	PID	•	Zero			
Modes					_		
Arcade axis	Vertical	PID	•	Zero			
	Туре		Straight	•			
	Extend		None	-			
	Safe		0.0	m 🗘	R	lelative 👻	
Add 👻	Touch		Runway To	ouch Point		- <sup>0</sup> 0	$\sim$

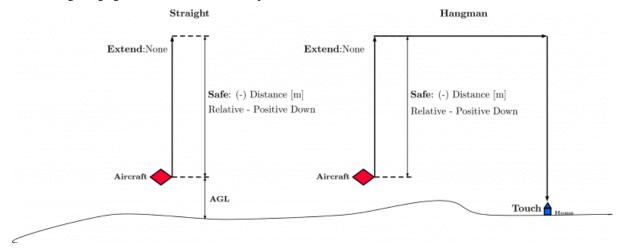
### VTOL Guidance

- Set height mode. Height mode indicates how the aircraft will perform the route. Height mode in VTOL guidance is fixed to 3D type. This means that vertical flight is allowed, so both horizontal and vertical guidance have the same priority level.
- Arcade position/speed transition In Arcade mode the trajectory generated (*position*) is not followed and instead the aircraft moves according to the commanded *speed*. The *horizontal* and *vertical speed* parameters serve as the upper-thresholds for when the aircraft's guidance should be *position-based*, even in Arcade mode. This parameters are mainly useful for platforms like multicopters.
- Set Speed: this option sets the desired aircraft speed during the manoeuvre.
  - Cruise: sets the velocity modulus of the commanded velocity.
  - **Waypoint reach** indicates the speed at which the platform will reach the waypoints of the path, i.e. it will travel along the path with the speed indicated in the option *Cruise* and then it will decelerate or accelerate to the speed indicated in here.
  - **Defined speed type** can be IAS (indicated airspeed) or Ground speed. Normally, IAS is used for airplanes and Ground speed for multicopters.
  - Deceleration: maximum allowed acceleration/deceleration to meet the desired velocity.

- **Guidance control:** vertical and horizontal PIDs (with constant gains or variable gains based on a schedule or a table) that control this phase. The structure of PID is explained in *Blocks*.
- **Type:** this parameters are used to indicate the route followed by the multicoter during the take-off and landing. The path Straight consists on a vertical line from the point where the vehicle enters in this phase. In the case of a take-off, the line goes from the ground to an altitude indicated by the user. The second option, Hangman, the path consists on a vertical and horizontal line.
  - Extend: when Up or Down are selected, the value set in Safe will be discard, and the platform will ascend or descend, until a next change.
  - Safe: this parameter defines the altitude the aircraft reach, it can be Relative (starting from the initial point of the route current platform position) or an Absolute altitude (MSL,AGL or WGS84). As an example, in a take-off operation, an altitude of -10000 meters can be indicated as the final point of the route, so it is sure that the multicopter will keep climbing until another phase is commended (via automation or manually). The same procedure is done in the landing, indicating a big relative distance (for example 100 meters from the starting point), so it is sure that the vehicle reaches the ground, and an automation is set to stop the platform when it touches the surface.
  - Touch: additional parameter to be configured when the type Hangman is selected. It defines a point that the aircraft has to reach. For instance, after go Up/Down the value set, the aircraft will perform an horizontal movement according to the point defined. Finally, when the aircraft is over the point, it will descend till reach that point. Usually, this option is used when there are obstacles in the area and by performing this movement the platform can avoid them and land safely.

**Note:** when the option relative is selected, a positive value will made the aircraft descend. Therefore, this value is Positive down.

The following image gives an overview of some parameters introduced:



Parameters Overview

# 7.2.4.1.1.4 Guidance-generated Variables

VTOL guidance generates a vertical straight trajectory. It also generates a set of variables which can be used in the control loops. The list of variables is the following:

- Desired position.
- Track position.
- Track state (current patch, last patch).
- Desired latitude, desired longitude, desired WGS84, desired MSL, desired AGL.
- Desired velocity.
- Desired front groundspeed, desired lateral groundspeed, desired velocity down.
- Desired tangential acceleration.
- Desired IAS.
- Guidance north error.
- Guidance east error.
- Guidance down error.
- Desired body velocities.
- Desired velocities north, east, down.
- Desired heading, FPA and bank.
- Route-guidance distance tangential component.
- Route-guidance distance horizontal component.
- Route-guidance distance perpendicular component.

# 7.2.4.1.1.5 Climb

Climb guidance is used to make the aircraft climb from the start of the phase to another altitude. Commonly, this guidance is used after the take-off to fly from the ground to cruise altitude through a loiter point, but it can be employed for other purposes.

Fixed Wing V-Tail UAV 🛪	💿 🖸 🗄 🚱 🗱	ช 🗂 🔺 🏭 ⊘	
▼ Phases	Guidance Arcade TC Pan	nel Automations	
0 Standby	Climbing	Name Climbi	na
1 Climbing		+	5
2 Flare		×	
3 Hold		*	
4 Cruise		•	\$
5 Landing		101	
6 Runway Takeoff	Section	0	] (1)
7 Altitude Mode			
8 MSL +10	Set height mode	2.5D 👻	) ②
9 MSL -10	Arcade position/speed to	ansition	
Runway	Horizontal	1.0 m/s	
Envelope	Vertical		3
Modes	vertical	1.0 m/s	)
Arcade axis	Set speed		
	Cruise	20.0 m/s	
	Waypoint reach	20.0 m/s	
			4
	Туре	IAS 🔹	
	Deceleration	0.5 m/s <sup>2</sup>	
	Axes controller		
	Туре	Scheduling variable	
	Horizontal PID	- Zero	5
			Ŭ
	Vertical PID	- Zero 🧳	)
	Runway Runway 1 👻	Advanced	
	Loiter point	Runway Loiter 🔹 🗞	
	Direction	Runway Direction	6
		Namely Direction	
	Loiter pos is center		
	Taxi extension	[1800.0 m]	
	Horizontal distance (dxy)	1800.0 m 🌣	
	Radius head turn (R3)	250.0 m 🔅	7
	Radius loiter (R1)	[250.0 m] 🗱	
Add 👻	Flight path angle	0.1 rad [-π,π]	

**Climbing Guidance Parameters** 

The climbing path is automatically generated and is not directly shown to the user until the aircraft enters this phase. This is due to the algorithm recalculating the path each time to take into account the aircraft's actual flight conditions

and the user's indicated parameters. Below, the parameters shown above are going to be described. Later, a brief description of the algorithm and its behavior in different possible situations will be presented:

- 1. Section. This option allows the user to select the first path to be flown by the aircraft in cruise mode. Section selection is disabled in this mode. As already said, in this phase the path can not be directly indicated by the user as it is done in cruise mode (see *Mission menu* for more details).
- 2. Set height mode. Height mode indicates how the aircraft will perform the route. Height mode in Climb guidance is fixed to 2.5D type. In 2.5D, the aircraft will fly from current altitude at a desired flight path angle, FPA. Go below for more information about this topic.
- 3. Arcade position/speed transition In Arcade mode the trajectory generated (*position*) is not followed and instead the aircraft moves according to the commanded *speed*. The *horizontal* and *vertical speed* parameters serve as the upper-thresholds for when the aircraft's guidance should be *position-based*, even in Arcade mode. This parameters are mainly useful for platforms like multicopters.
- 4. Set speed: this option sets the desired aircraft speed during the manoeuvre.
  - **Cruise**: Cruise Lets the user set the velocity modulus of the guidance. This velocity can be slightly modified by the autopilot control algorithms.
  - **Waypoint reach** indicates the speed at which the platform will reach the waypoints of the path, i.e. it will travel along the path with the speed indicated in the option *Cruise* and then it will decelerate or accelerate to the speed indicated.
  - **Defined speed** can be IAS (indicated airspeed) or Ground speed. Normally, IAS is used for airplanes and Ground speed for multicopters.
  - Deceleration: maximum allowed acceleration/deceleration to meet the desired velocity.
- 5. **Guidance control:** Horizontal and Vertical PIDs controllers to guarantee stability of guidance loop are defined here. Their purpose are to adjust the platform's actual trajectory to the desired one. When clicking on *Horizontal* or *Vertical*, a pop-up window will appear where the control parameters should be introduced for more information on the latter subject check *Blocks*.
- 6. Loiter and runway position: By default, loiter and runway positions and direction are defined in *Runway* menu and the user selects the runaway. However, this parameters can by modified clicking on "Advanced". Then, the

Runway Runway 1 👻	Advanced		
Loiter point	Runway Loiter	*	S
Direction	Runway Direction	•	S
✓ Loiter pos is center			
Runway Runway 1 🛛 👻	Advanced		
Runway Runway 1 -	Advanced	0000	•
		0000 ° [0,360]	0 0

Runway and loiter position options and alternative configurations

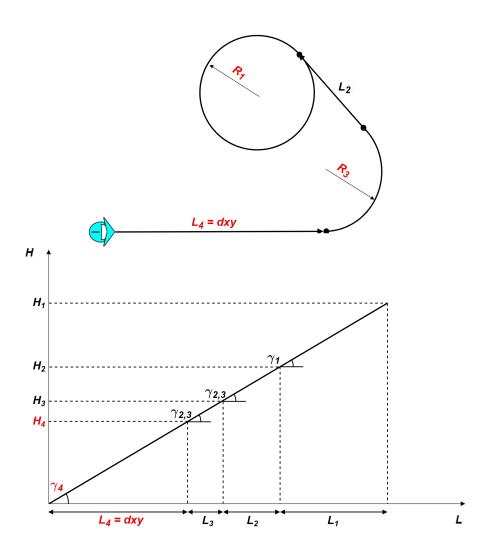
user can choose between the two available option definitions by clicking on

• Loiter point: defines the loiter point. By default, this point is the runaway's loiter. But the user can select in the drop-down list any other previously defined point. This includes waypoints defined in Mission, among many others. Alternately, the user can manually define the Loiter point.

Relative		-	9	[9]
Absolute	Decimal Degrees	*	UAV POS	MAP POS
Latitude	0.0			
Longitude	0.0			
WGS84	0.0			m
MSL	0.0			m
				m
>	e 104	14	Cancel	Accept

Loiter Point Selection Menu

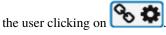
- **Runway direction**: defines the runway direction. Again, by default, is the same as the selected runaway. It can be also chosen from a list of options including runway direction, tailwind direction, etc. Alternately, it can also be defined as an angle with respect to the magnetic north.
- If the box **Loiter pos is center** is ticked, the defined loiter point will be the center of the loiter circular trajectory. In case of not, the circular loiter trajectory will pass through that point.



Climb route top and front views with parameter identification

- 7. **Route:** here is where the user can set some of the the climbing path parameters (those highlighted in red on the above diagram). First, the user defined parameters are described and, after, some considerations about the climb algorithm behavior will be explained:
  - Taxi extension: this parameter does not apply to this algorithm.
  - Horizontal extension (dxy): absolute ground distance of the first path,  $L_4$ : from the star of the climb to the start of the turn that faces the loiter path. This distance will remain fix always and it will also fix  $L_4$  path's final point height,  $H_4$ . More information below.
  - Radius Head Turn (R3): radius of the turn to head the platform towards the loiter.
  - Radius loiter (R1): radius of the ascending helix path to reach the loiter height.
  - Flight Path Angle. The *FPA* is the angle at which the aircraft will climb. Before the algorithm execution, all Flight Path Angles,  $\gamma_i$ , are equal:  $FPA = \gamma_4 = \gamma_{2,3} = \gamma_1$ . The algorithm can modify  $\gamma_{2,3}$  and  $\gamma_1$ . In that case, the Flight Path Angle option will serve as the upper threshold.

Each one of this parameters can be disabled, enabled or linked to an Operation Guidance defined by



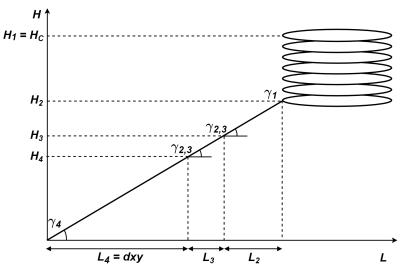
#### 7.2.4.1.1.6 Climbing guidance parameters behavior

The climbing track is not fix, the algorithm recalculates the paths each time to take into account the aircraft position and the user's parameters. The trajectory usually has 4 paths, excluding the final loiter path:

- · General trajectory description:
  - $L_4$  is the first path. The user can set the horizontal length, dxy, the direction (in Runway direction) and the path's final point height,  $H_4$  with the defined Flight Path Angle. This is very relevant, as seen later. The path length can not be zero.

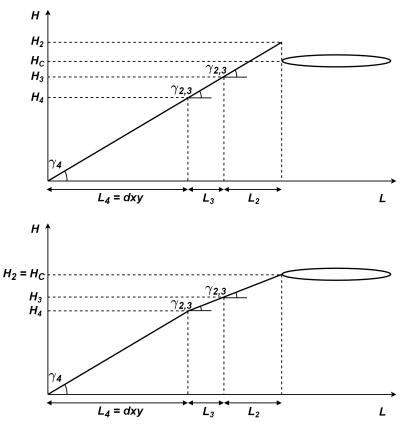
$$\gamma_4 = FPA$$
$$H_4 = dxy * \tan(\gamma_4)$$

- $L_3$ : Circular turn to head the platform towards the loiter. The user can set the radius,  $R_3$ . Is possible to set this path to zero and disabled it clicking on 3. The FPA,  $\gamma_{2,3}$ , can be modified by the algorithm.
- $L_2$ : Straight path that reaches the climbing loiter point. This path is completely automatic generated. Its FPA,  $\gamma_{2,3}$ , can be modified by the algorithm.
- $L_1$ : Ascending helix path to reach the loiter height. The user can set the radius,  $R_1$ .
- Loiter height effect: Loiter height's,  $H_c$ , modifies the algorithm general behavior. Depending on whether  $H_c$  is bigger or smaller than  $H_2$  or smaller than  $H_4$  the algorithm will modify some parameters, in particular the flight path angles:
  - 1.  $H_2 < H_c$ . Is the general case. In this situation, no corrections will be applied as shown below and  $\gamma_{2,3} = \gamma_1 = FPA.$



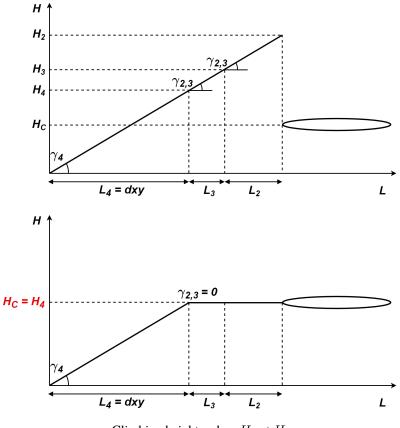
Climbing heights when  $H_2 < H_c$ 

2.  $H_4 < H_c < H_2$ : In this case, the algorithm will compute a new  $\gamma_{2,3}$  to avoid surpassing the loiter's height and  $\gamma_1$  will be zero.



Climbing heights when  $H_4 < H_c < H_2$ 

3.  $H_c < H_4$ : In this case, the algorithm will force  $H_c = H_4$ . So  $H_4$  will be the new loiter height keeping  $\gamma_4 = FPA$  and the other flight paths angles equal to zero,  $\gamma_{2,3} = \gamma_1 = 0$ .



Climbing heights when  $H_c < H_4$ 

# 7.2.4.1.1.7 Guidance-generated Variables

Climbing guidance generates a three-dimensional trajectory, as well as a set of variables which can be used in the control loops.

The list of variables is the following:

- Desired position.
- Track position.
- Track state (current patch, last patch).
- Desired latitude, desired longitude, desired WGS84, desired MSL, desired AGL.
- Desired velocity.
- Desired front groundspeed, desired lateral groundspeed, desired velocity down.
- Desired tangential acceleration.
- Desired IAS.
- Guidance north error.
- Guidance east error.
- Guidance down error.
- Desired body velocities.

- Desired velocities north, east, down.
- Desired heading, FPA and bank.
- Route-guidance distance tangential component.
- Route-guidance distance horizontal component.
- Route-guidance distance perpendicular component.

# 7.2.4.1.1.8 Cruise

This phase is used to make the aircraft follow a position-based route created by the user in the Mission menu. This is the principal use of this guidance algorithm, but it can also be used to make the aircraft go to a certain location (e.g waypoint) without indicating the full route, thus being a guidance used to command a movement by position. All the parameters that define the cruise guidance are detailed.

🖾 🛪 💿 🖬	🎯 🗱 🌮 🗠		
	Guidance Arcade TC Pann		
	Cruise	Nai	me
		<b>.</b>	
		×	
		•	
	Section	6	
	Set height mode	2.5D 👻	2
	Arcade position/speed trar	nsition	
	Horizontal	1.0 m/s	3
U	Vertical	1.0 m/s	$\sim$
	Set speed		(
	Cruise	33.3 m/s	
	Waypoint reach	33.3 m/s	(4)
<	Туре	IAS 👻	
Add	Deceleration	2.0 m/s <sup>2</sup>	
Add	<u> </u>		

Cruise Guidance Menu (I)

1. Section. This option allows the user to select the first path to be flown to. The user should first enable this option,

click on with the click on the desired waypoint to bo the first-of-the-route.

- 2. Set height mode. Height mode indicates how the aircraft will perform the route whein it comes to the waypoints' altitude. There are three possible height modes:
  - **2D mode:** if this mode it is selected, the platform will follow the predifined route without taking into account the altitude of the waypoints, it will keep the altitude that it has at the moment it enters in the cruise guidance.

- 2.5D mode: the vehicle will follow a 3D trajectory that connects both waypoints. However, it will give priority to horizontal guidance. Veronte will try to adjust its position and altitude to the path (both horizontally and vertically), but if for any reason it cannot reach the altitude of the final waypoint, it will considered that it has been reached if its position matches the position of the waypoint.
- 3D mode: the vehicle will follow a 3D trajectory that connects both waypoints. In this case, horizontal and vertical guidance have the same priority level. This means that Veronte will not consider that a waypoint has been reached until its position and altitude match the waypoint's ones. As this type of guidance may result in a vertical flight, it is reserved for multicopters or hybrid platforms.
- 3. Arcade position/speed transition In Arcade mode the trajectory generated (*position*) is not followed and instead the aircraft moves according to the commanded speed. The horizontal and vertical speed parameters serve as the upper-thresholds for when the aircraft's guidance should be *position-based*, even in Arcade mode. This parameters are mainly useful for platforms like multicopters.

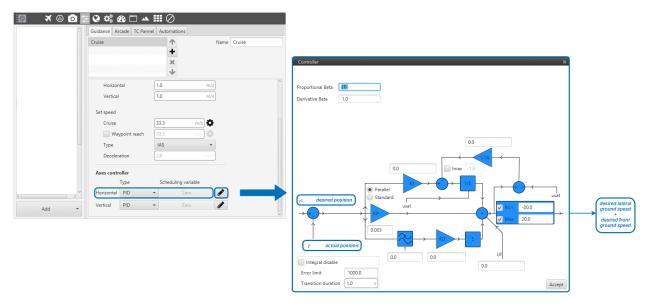
# 4. Set speed: this option sets the desired aircraft speed during the manoeuvre.

- Cruise: sets the velocity modulus of the commanded velocity.
- Waypoint reach indicates the speed at which the platform will reach the waypoints of the path, i.e. it will travel along the path with the speed indicated in the option *Cruise* and then it will decelerate or accelerate to the speed indicated in here.
- Defined speed type can be IAS (indicated airspeed) or Ground speed. Normally, IAS is used for airplanes and Ground speed for multicopters.

🔟 🛪 💿 🖸	- 🛛 📽 🍪 🗖 🔺	
Â	Guidance Arcade TC Pann	el Automations
	Cruise	Name Name
		×
		*
	Horizontal	1.0 m/s
	Vertical	1.0 m/s
	Set speed	
	Cruise	33.3 m/s 🌣
	Waypoint reach	33.3 m/s
	Туре	IAS 👻
	Deceleration	2.0 m/s <sup>2</sup>
	Axes controller	
	Туре	Scheduling variable
		- Zero 🖋 (5)
<	Horizontal PID	- Zero 🖋 (5)

### Cruise Guidance Menu (II)

5. Guidance control: a horizontal and vertical position PID controller is defined here. Its purpose is to adjust the platform's actual trajectory to the desired one. When clicking on *Horizontal* or *Vertical*, a pop-up window will open where the control gains should be introduced - for more information on the latter subject check the Blocks. In the horizontal-position PID (see image below), North-East current position of the aircraft is compared to the desired position. The output of the PID controller is going to be a ground speed in the North-East plane, which translates into a desired lateral and front ground speeds in body axes. The same logic applies for the vertical-position PID.



#### Horizontal Position PID

# 7.2.4.1.1.9 Guidance-generated Variables

Cruise guidance generates a three-dimensional trajectory, as well as a set of variables which can be used in the control loops.

The list of variables is the following:

- Desired position.
- Track position.
- Track state (current patch, last patch).
- Desired latitude, desired longitude, desired WGS84, desired MSL, desired AGL.
- · Desired velocity.
- Desired front groundspeed, desired lateral groundspeed, desired velocity down.
- Desired tangential acceleration.
- Desired IAS.
- Guidance north error.
- Guidance east error.
- Guidance down error.
- Desired body velocities.
- Desired velocities north, east, down.
- Desired heading, FPA and bank.
- Route-guidance distance tangential component.

- Route-guidance distance horizontal component.
- Route-guidance distance perpendicular component.

# 7.2.4.1.1.10 Hold

Hold guidance algorithm allows the user to introduce a desired variable value that has to be followed or held by the platform. It differs from the other guidances where the user sets a path to follow and the aircraft follows the track commanding the desired heading, velocities, etcétera, which is determined by the control algorithm. Here, the aircraft will hold a velocity (IAS,TAS,...), a heading, a flight path angle, a roll, pitch and yaw angle, ... or a constant distance to a moving Object of Interest, for example.

Fixed-wing VTOL 🛪 🙆	🖸 📰 🚱 端 🙉 🗂 🔺 🎟 🖉
▼ Phases	Guidance Arcade TC Pannel Automations
0 Standby	Hold Name Standby
1 Takeoff (Q)	+
2 Stabilize (Q)	×
3 Landing (Q)	<b>v</b>
4 Plane to Quad	
5 Hover - Align (Q)	Desired Pitch
6 Flare (P)	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
7 Cruise (P)	
8 Climbing (P)	Constant value: 0.0 π 0.0 Constant value: 0.0 π
9 Approach (P)	Desired Roll
10 Pre-Takeoff (Q)	
11 Quad to Plane	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
13 Stabilize (P)	Constant value: 0.0 π 0.0 Constant value: 0.0 π
14 Return to Home (C	Desired Yaw
Runway	
Envelope	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Modes	Constant value: 0.0 π 0.0 Yaw
Δrcade avis ✓	
Add 👻	

#### Hold Guidance Example in Standby phase

There are 4 ways in Pipe to determine how the variable is introduced in the controller in a Hold Guidance:

- None. A simple value is specified. As soon as the aircraft enters in the phase that has this hold guidance, the desired variable will take the value specified in this option. It is possible to define a constant value for the desired variable, or take the value that another variable has at the instant when the aircraft enters in that phase. Lets see some examples:
  - To make the aircraft keep the heading that it has when changing phase, select Desired Heading as the hold variable, and choose heading. This is useful, for example, when the aircraft looses GNSS signal. You can set an automation that jumps to this phase to hold the flight path.

Desired Heading				
None	Time (Ramp time)	Slope (Ramp rate)	Ewma (TAU)	
Cons	tant value: 0.0 π	0.0	Heading	

### Hold Heading

 Hold is also useful in the Standby phase to check the correct setting of the servos of the aircraft. During this phase, if this is configured, the user can manually move the aircraft and the autopilot will try to counteract this change of attitude commanding movement to the corresponding servos:

	Des	ired Pitch			
None     Cons	Time (Ramp time) tant value: 0.0 π	O.0 Slope (Ramp rate)	Ewma (TAU) Constant value: 0.0 π		
	Des	ired Roll			
None Cons	Time (Ramp time) tant value: 0.0 π	O.0	Onstant value: 0.0 π		
Desired Yaw					
None     Cons	Time (Ramp time) tant value: 0.0 π	O.0 Slope (Ramp rate)	Ewma (TAU) Yaw		

Standby phase Hold guidance

- Another common application of this Hold guidance is the *Arcade Mode* for multicopters. Multicopters need assistance to fly as they are inherently unstable. Here are presented two strategies: hold attitude or hold position.
  - \* **Hold attitude** will correct the angles of the multicopter to keep it stable when the stick is released, but the aircraft will continue moving due to inertia.

	Desi	ired Pitch	)—
None Cons	Time (Ramp time)	Slope (Ramp rate)         Ewma (TAI           0.0         Constant value: 0.0	-
	Des	ired Roll	)—
	Time (Ramp time)	Slope (Ramp rate) Ewma (TA) 0,0 Constant value: 0.0	
	Desired Down (	GV (Ground Velocity)	)-
None Const	Time (Ramp time) Time: 0.0 m/s	Slope (Ramp rate) Ewma (TA)	

Hold multicopter attitude

\* To **hold aircraft's position**, a good strategy is to set a Velocity Hold (or VHold). This adds another layer to the control algorithms. Setting velocities to zero will stop the vehicle in place when the stick is released.

	Desired Dowing	GV (Ground Velocity	
None	Time (Ramp time)	Slope (Ramp rate)	Ewma (TAU)
Const	ant value: 0.0 m/s	0.0	onstant value: 0.0 m/s
	Desired Lateral	GV (Ground Velocit	y)
None	Time (Ramp time)	Slope (Ramp rate)	Ewma (TAU)
Const	ant value: 0.0 m/s	0.0	onstant value: 0.0 m/s
	Desired Front (	GV (Ground Velocity	)
None	Time (Ramp time)	Slope (Ramp rate)	Ewma (TAU)
	ant value: 0.0 m/s	0.0	onstant value: 0.0 m/s

Hold multicopter position

..note: This Hold guidances examples lack of Yaw control as it is included in the phase with other guidance control.

- **Time (Ramp Time)**. In this case the desired variable introduced in the controller will take first the value (or the variable) introduced. After a certain time established, the variable will reach the value indicated.
- Slope (Ramp Rate). The same as before, but now instead of the time between the two values of the ramp, the slope of the linear ramp can be indicated.
- Ewma (TAU). The variation between the start and final values is exponential.

These type of transitions are useful to avoid sending aggressive control commands to the aircraft that can damage the structure or set the aircraft in a compromising situation. For example, this can be used in the flare maneuver before the aircraft's touchdown during landing. The aircraft, which is flying at a very low speed height must reduce its vertical down velocity. A time ramp can be set to reduce it from the actual velocity at which the plane enters this phase to the desired one.

### 7.2.4.1.1.11 Landing

Landing guidance is used to generate the flying path the aircraft will follow when landing on a certain runway. The generated path is not directly indicated by the user as in the cruise guidance (which is defined in the *Mission menu*), instead a trajectory is generated based on the parameters detailed later in this section. Below, find all the information to be defined by the user accompanied by the corresponding Figures showing the location of these parameters on the menu.

Veronte0 🛪 🙆 🙆 📑	Q 🗱 🙆 🗂 🔺		
▼ Phases (	Guidance Arcade TC Pannel	Automations	
0 Standby	Landing	↑ Na	me Landing
1 Climbing		+	
2 Flare		×	
3 Hold		4	
4 Cruise		V	^
5 Landing			
6 Runway Takeoff	Section	0	
7 Altitude Mode			
8 MSL +10	Set height mode	2.5D 👻	1
9 MSL -10	Arcade position/speed trans	ition	
Runway			2
► Envelope	Horizontal	1.0 m/s	2
Modes	Vertical	1.0 m/s	
Arcade axis			
	Set speed		
	Cruise	22.0 m/s	
	Waypoint reach	22.0 m/s	3
	Туре	IAS 👻	
Add 👻	Deceleration	0.5 m/s <sup>2</sup>	

Landing Guidance menu (I)

#### 1. Set height mode: the height mode indicates how the aircraft will perform the landing path. The only one available for land

- 2.5D mode: the vehicle goes from the altitude at which it enters the phase with landing guidance to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points) with a flight path angle, giving priority to horizontal over vertical guidance.
- 2. Arcade position/speed transition: if Arcade mode is configured, then the trajectory generated (*position*) is not followed and instead the aircraft moves according to the commanded *speed*. The parameters here (*horizontal* and *vertical speed*) serve as an upper-threshold for when the aircraft's guidance should be *position-based*, even in Arcade mode. This parameters are mainly useful for platforms like multicopters.
- 3. Set speed: this option sets the speed that the vehicle will have during the landing manoeuvre.
  - In *Cruise* the user sets the velocity modulus.
  - The option *Waypoint reach* is used to indicate the speed at which the platform will reach the waypoints, i.e. it will travel along the path with the speed indicated in the option *Cruise* and then it will decelerate or accelerate to the speed indicated in *Waypoint reach*.
  - The defined speed can be IAS (indicated airspeed) or Ground speed. Normally, IAS is used for airplanes and Ground speed for multicopters.
  - Deceleration: maximum allowed acceleration/deceleration in order to meet the desired velocity.

Veronte0 🛪 🙆 🧿	🗄 🚱 🗱 🖽 🗂 -	▲ Ⅲ ⊘		
▼ Phases	Guidance Arcade TC Pan	nel Automations		
0 Standby	Landing	<b>^</b>	Name Landing	
1 Climbing		+		
2 Flare		×		
3 Hold		~		
4 Cruise		W		
5 Landing	Horizontal PID	▼ Zero		
6 Runway Takeoff	Vertical PID	- Zero	4	
7 Altitude Mode	Vertical	2210	<b>G</b>	
8 MSL +10 Runway Runway 1 - Advanced				
9 MSL -10				
Runway	Touch point	Runway Touch Point	• <b>%</b> 5	
Envelope	Loiter point	Runway Loiter	~ ° °	
Modes	Direction	Runway Direction	~ °o	
Arcade axis				
	Taxi extension	400.0	m 🗘	
	Horizontal distance (dxy)	400.0	m 🌣 6	
	Radius head turn (R3)	250.0	m 🗘	
Add 👻	Radius loiter (R1)	250.0	m 🌣	

Landing Guidance menu (II)

- 4. **Guidance control:** a horizontal and vertical PID controller is defined here. Its purpose is to adjust the platform's actual trajectory to the desired one. When clicking on *Horizontal* or *Vertical*, a pop-up window will open where the control parameters should be introduced for more information on the latter subject check the *Blocks*.
- 5. Loiter and runway position: here the user defines the loiter and runway positions. The default option is to have the have the loiter and runway positions defined in *Runway*. If the *Advanced* option is chosen, then the user needs

to define three parameters. By clicking on to different options will be displayed:

- *Touchpoint*: defines the touchpoint of the runway. This point can be defined by introducing its latitude, longitude and altitude; or else it can be chosen from a list of options that includes the waypoints defined in Mission, among many others.
- *Loiter point*: defines the loiter point. This point can be defined by introducing its latitude, longitude and altitude; or else it can be chosen from a list of options that includes the waypoints defined in Mission, among many others.
- *Runway direction*: defines the runway direction. I can be defined as an angle with respect to the magnetic north; or else it can be chosen from a list of options like runway direction, tailwind direction, etc.

If the box *Loiter pos is center* is ticked the defined loiter point will be the center of the loiter circular trajectory. On the contrary, the loiter trajectory can pass throught that point.

- 6. **Trajectory distances**: here the user defines some of the trajectory distances. This distances match the trajectory patches lengths L or are proportional to them. See the explanation below for more information on every patch.
  - *Radius loiter R1*: radius of the descending loiter for the aircraft to reach an altitude suitable to perform the landing manoeuvre  $(L_1 \propto \pi R_1)$ .
  - Radius Head Turn R3: radius of the last turn in order to face the runway direction ( $L_3 \propto \pi R_3$ ).

- *Horizontal extension (dxy)*: distance before the head of the runway. At the end of this length, touchdown is expected.
- Taxi extension: distance from touchdown to where the aircraft is brought to a full stop.

Some patches don't have an associated user-defined distance, and are automatically calculated by the landing guidance algorithm: they depend on some of the above distances and other parameters defined below.

Veronte0 🛪 🙆 💿	- 😯 端 🕰 🗀	▲ Ⅲ ⊘			
▼ Phases	Guidance Arcade TC Pa	nnel Automations			
0 Standby 1 Climbing	Landing	<b>^</b>	Name	Landing	
2 Flare 3 Hold 4 Cruise		*			
5 Landing 6 Runway Takeoff	Radius head turn (R3)	250.0	m	•	1
7 Altitude Mode 8 MSL +10	Radius loiter (R1) Flight path angle	250.0	m	\$	
9 MSL -10	Initial	0.0	rad [-π,π]	<b>\$</b>	
<ul> <li>Runway</li> <li>Envelope</li> </ul>	Loiter	-0.08726646	rad [-π,π]	. /	
Modes	Aim	-0.08726646	rad [-π,π]		
Arcade axis	DXY Velocities	-0.08726646	rad [-π,π]	\$	
	Initial	22.0	m/s	\$	
	Loiter	22.0	m/s		
	Aim	22.0	m/s		
Add 👻	DXY	22.0	m/s	\$ <b>\$</b>	-

Landing Guidance menu (III)

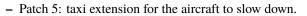
- 7. **Trajectory flight path angles**: here the user defines the desired trajectory flight path angles for each of the patches of the trajectory. See the explanation below for more information on every patch.
  - *Initial*: desired flight path angle  $\gamma_0$  of patch 0.
  - *Loiter*: desired flight path angle  $\gamma_1$  of patch 1.
  - *Aim*: desired flight path angle  $\gamma_{2,3}$  of patches 2 and 3.
  - *DXY*: desired flight path angle  $\gamma_4$  of patch 4.
- 8. **Trajectory velocitites**: here the user defines the desired trajectory velocities for each of the patches of the trajectory. See the explanation below for more information on every patch.
  - *Initial*: desired velocity  $v_0$  of patch 0.
  - *Loiter*: desired velocity  $v_1$  of patch 1.
  - *Aim*: desired velocity  $v_{2,3}$  of patches 2 and 3.
  - *DXY*: desired velocity  $v_4$  of patch 4.

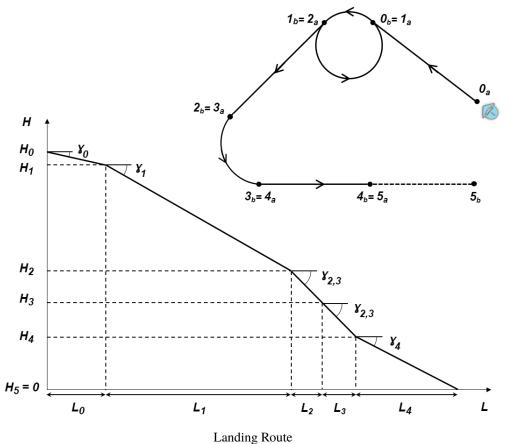
The generated trajectory of the landing guidance defines the route that the aircraft follows from the point when the phase with this guidance is entered, to the point where it touches the ground – see the Figure below. The landing route has two parts, being decomposed into 6 patches.

- First part: descending loiter used to descend from the cruise altitude to an altitude where the heading manoeuvre towards
  - Patch 0: this patch is generated from the point the landing phase is entered to where the loiter is located. Variables that influence this patch are  $\gamma_0$ ,  $v_0$ , altitudes  $H_0$  and  $H_1$ , and *Loiter point* position.
  - Patch 1: the patch length  $(L_1)$  will depend on the amount of loops on the loiter. The latter can go from 0 to more than 1 loop, depending on the altitude necessary to descend/ascend. Variables that influence this patch are  $\gamma_1$ ,  $v_1$ , altitudes  $H_1$  and  $H_2$ , and *Radius loiter R1*.

The loiter exiting point altitude is computed so that patches 2 to 5 can be performed following their desired v and  $\gamma$ . So it exists the possibility of starting the landing manoeuvre at a lower altitude thant the exiting point of the loiter. In that case, the loiter would be used to ascend. If the aircraft starts the landing phase at an altitude similar to the one of the loiter (defined in point 6), then the loiter patch is simplified into a turn – during the turn the altitude can still be adjusted, and the turn's length will depend on the latter.

- Second part: final approach of the landing, which consists on turning, facing the runway and touchdown.
  - Patch 2: patches 3 and 4 need to matcht the distances defined above. Patch number 2 will conect the exit of the loiter patch with the beginning of patch 3. Variables that influence this patch are  $\gamma_{2,3}$ ,  $v_{2,3}$ , altitudes  $H_2$  and  $H_3$ , and *Loiter point* and *Touchpoint* positions.
  - Patch 3: turning of the aircraft to face the runway. Variables that influence this patch are  $\gamma_{2,3}$ ,  $v_{2,3}$ , altitudes  $H_3$  and  $H_4$ , and *Radius Head Turn R3*.
  - Patch 4: at the end of the patch the aircraft lands. Variables that influence this patch are  $\gamma_4$ ,  $v_4$ , altitude  $H_4$ , and *Horizontal extension (dxy)*.





# 7.2.4.1.1.12 Guidance-generated Variables

Landing guidance generates a three-dimensional trajectory, as well as a set of variables which can be used in te control guidance. The list of variables is the following:

- Desired position.
- Track position.
- Track state (current patch, last patch).
- Desired latitude, desired longitude, desired WGS84, desired MSL, desired AGL.
- Desired velocity.
- Desired front groundspeed, desired lateral groundspeed, desired velocity down.
- Desired tangential acceleration.
- Desired IAS.
- Guidance north error.
- Guidance east error.
- Guidance down error.
- Desired body velocities.
- Desired velocities north, east, down.
- Desired heading, FPA and bank.
- Route-guidance distance tangential component.
- Route-guidance distance horizontal component.
- Route-guidance distance perpendicular component.

# 7.2.4.1.1.13 Yaw

Yaw guidance is used in multicopters to indicate the behaviour of the platform in the yaw axis. This option is normally used during the cruise phase of the multicopters, because the route can be carried out with the aircraft without rotating in the yaw axis, or rotate it to point its longitudinal axis parelel to the path.

Veronte0 🛪 🙆 👩	i 😧 🗱 🚯			
▼ Phases	Guidance Arcade	TC Pannel Automatio	ns	
0 Standby	Тахі	1	Name	Runway Takeoff
1 Climbing	Hold	+		
2 Flare	Yaw	×		
3 Hold	•			
4 Cruise		W		<u>^</u>
5 Landing	Mode	current	-	ñ
6 Runway Takeoff	Limit rate	current		
7 Altitude Mode	_	fixed		
8 MSL +10	Yaw	heading	~ ~0	
9 MSL -10		position		
Runway	Relative A	oproach Initial *	► 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Envelope				
Modes	Absolute	cimal Degrees 🔹	UAV POS MAP POS	
Arcade axis	Latitude 0.0			
	Longitude 0.0			
	WGS84 0.0		m	
	- MSL 0.0		m	
Add 👻	AGL 0.0		m	~

### Yaw Guidance

The modes available in the yaw guidance are:

- **Current:** the multicopter will keep the yaw angle it has when entering in the phase that contains this guidance. Desired Yaw = Current Yaw
- Fixed: the yaw is kept at a constant value indicated by the user.
- **Heading:** Heading represents velocity vector direction and, when it is very small, its estimation is more complex and direction is changing constantly. Because of this, the approximation Yaw = Heading is introduced when the estimated velocity is near 0.
- **Position:** the yaw of the multicopter will be rotated so its longitudinal axis is always focusing a point defined by the user in the menu shown in the previous figure (absolute or relative).

It's posible to fix a limit in the yaw rate and a constant value(depending on the selected mode).

### 7.2.4.1.1.14 Rendezvous

Rendezvous guidance is used to create a meeting point where the Air unit will approach a second unit (either Air or Ground) within a determined offset. This guidance updates constantly the vehicle attitude in order to track, with the shortest path, the position of the second unit (named as Ground hereafter). This guidance works for both static and moving Ground. Rendezvous navigation is ready for taking Internest input to improve the precision from its guidance, being the most suitable kind for Internest integration.

Phases	Guidance Arcade TC Pannel	Automations		
0 Standby	Taxi	1	Name	Runway Takeoff
1 Climbing	Hold	+		
2 Flare	Yaw	×		
3 Hold	Rendezvous	*		
4 Cruise				
5 Landing 6 Runway Takeoff	Section	0	52	
7 Altitude Mode				
8 MSL +10	Set height mode	2.5D	•	
9 MSL -10	Arcade position/speed tra	nsition		
Runway	Horizontal	1.0	m/s	
Envelope     Modes	Vertical	1.0	m/s	
Arcade axis	Set speed			
	Cruise	5.0	m/s 🎝	
	Waypoint reach	5.0	inis 🔅	
	Туре	Ground Speed	*	
Add 👻	Deceleration	5.0	m/s <sup>1</sup>	

Rendezvous Guidance – Menu 1

• Set height mode: the height mode indicates how the aircraft will perform the route. 2D height mode is not allowed in this

- 2.5D mode: the vehicle will follow a 3D trajectory that connects both waypoints. However, it will give priority to horizontal guidance. Veronte will try to adjust its position and altitude to the path (both horizontally and vertically), but if for any reason it cannot reach the altitude of the final waypoint, it will considered that it has been reached if its position matches the position of the waypoint.
- 3D mode: the vehicle will follow a 3D trajectory that connects both waypoints. In this case, horizontal and vertical guidance have the same priority level. This means that Veronte will not consider that a waypoint has been reached until its position and altitude match the waypoint's ones. As this type of guidance may result in a vertical flight, it is reserved for multicopters or hybrid platforms.
- Set speed: this option sets the speed that the vehicle will have during the phase. It could be IAS (indicated airspeed) or Speed (Ground Speed). Normally, the IAS is used for airplanes and the Speed for multicopters. The option Waypoint reach is used to indicate the speed at which the platform will reach the waypoints, so it will

Phases	Guidance Arcade	TC Panne	I Automati	ons			
0 Standby	Taxi		1		Name	Runway Ta	keoff
1 Climbing	Hold		+				
2 Flare	Yaw		×				
3 Hold 4 Cruise	Rendezvous		4				
4 Cruise 5 Landing	Тур	pe	Schedu	iling variable	ı.		
6 Runway Takeoff	Horizontal	ID	•	Zero	ø	]	
7 Altitude Mode 8 MSL +10	Vertical PID		•	• Zero		)	
9 MSL -10 Runway			х		γ	Z	
Envelope	Rendezvous relative position		0.0	m) 0.0	m	0.0	m
Modes	Docking relative p	osition	0.0	m) 0.0	m	0.0	m
Arcade axis	Base yaw	Constant value: 0.0					
	Base pitch		Constant value: 0.0				
		Constant value: 0.0					
	Base roll						

travel along the path with the speed indicated in the option Cruise, then it will decelerate or accelerate to the speed indicated in Waypoint Reach and then it will go back to the cruise speed.

Rendezvous Guidance – Menu 2

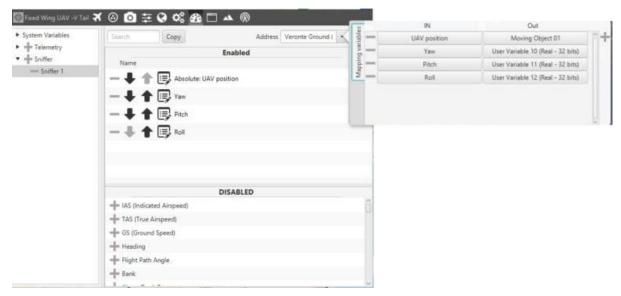
- Guidance control (Horizontal and Vertical): configuration of the PIDs from the system for both axes (see *Blocks*).
- Docking base: defines the position of the GNSS antenna connected to Veronte Ground.
- **Base yaw, pitch & roll:** defines the attitude from the base body. These values affect the navigation by orienting the Air unit to be equal to the attitude from the Ground one. To be configured with telemetry (example below).

In order to configure the Moving Object which is assigned to Docking Base and the Base attitude, the next procedure must be followed.

<ul> <li>System Variables</li> </ul>	Search Copy Frequency 2.0 Hz Address Fixed Wing UAV	*				
<ul> <li>Telemetry</li> <li>Data link to Pipe</li> </ul>	Enabled					
🛑 Data link to Veronte	Name					
Onboard Log	- + Absolute: UAV position					
User Log	- 🗣 🛧 🕞 Yaw					
Fast Log	- 🗣 🛧 🗊 Pitch					
<ul> <li>Sniffer</li> <li>Sniffer 1</li> </ul>						
Shiffer 1	- 🕂 🕇 🗊 Roll					
	DISABLED					
	IAS (Indicated Airspeed)					
	TAS (True Airspeed)					
	GS (Ground Speed)					
	Heading					
	Flight Path Angle					
	Bank					

Ground Telemetry

In the Ground unit, go to Variables Telemetry – Data link to Veronte and add the variables Absolute: UAV position, Yaw, Pitch & Roll. A recommended frequency is 10 Hz. On address, point to the Air Unit (it is needed to have both units connected through the radio in order to be able to see them on the menu).



Air Sniffer

For the Air unit, go to Sniffer - Add a new Sniffer and configure the same Variables (keeping the same order) than in the Ground unit (in this case Absolute: UAV position, Yaw, Pitch & Roll). Address the Ground unit and in the gear next to it, configure the 4 incoming variables as System Variables. Assign UAV Position to Moving Object and the 3 variables from attitude to 3 different User Variables (keeping the same order as well).

In order to be able to see the Moving Object position in Pipe interface, go to Air unit configuration ref Variables – Telemetry – Data Link to Pipe and add Moving Object to the list of variables.

- **Docking relative position:** 3D point used to configure the offset for the approaching vehicle to the Docking base. This will be the difference from GNSS position that defines the landing point.
- **Rendezvous relative position:** 3D point used to configure the meeting point for the Air Veronte. This point will be tracked by the vehicle and, once reached, it will start travelling to Docking relative position. For VTOL, X and Y components must be equal. For both Docking and Rendezvous the axes are set according to Veronte orientation.

When defining a guidance system, we refer to a set of commands sent to the platform controller in order to make it carry out a certain task. This task could be follow a line, climb, land, hold one of its states at a certain value and so on.

In Veronte Pipe, it is possible to combine a series of guidances to create custom flight phases that will make the aircraft perform in a given way. For example, to create a Take Off phase, the guidances to be included could be a **Runway**, which defines a line over the runway to make the aircraft follow it, and a **Hold** that will keep the roll and pitch angle at zero to keep the aircraft level when it is accelerating on the runway.

Each Guidance contains a different set of parameters to be configured. All of them are presented as follows and its parameters are explained in detail.

Value	Description
Taxi	Creates a linear path along the runway that is followed by the aircraft.
VTOL	Vertical take-off and landing.
Climb	Makes the aircraft climb from the start of the phase to another altitude.
Hold	Introduces in the control system a desired variable with a value especified by the user.
Cruise	Makes the aircraft follow a determined route created by the user.
Landing	Creates the route that the airplane will follow to land.
Yaw	Indicates the behaviour of the platform in the yaw axis.

**Note:** in section *Configurations* there are some examples of how to combine these guidances to create phases for common platforms (Plane, Quadcopter, etc.).

## 7.2.4.1.2 Arcade

## 7.2.4.1.2.1 Arcade Mode Settings

The arcade mode could be considered as an aided manual control where the pilot sends a control command and not a PWN signal for the actuators. This control command is used by the Hold or Yaw guidance algorithm to provide the input for the controller. So, in this case, is not directly the autopilot which generates the PID inputs, but an optimal combination of its commands and the ones from the pilot.

🔯 🕑 Penguin Embention 🛪	' 💿 🖸 🗄 😵 📽 🕯	🏠 🛅 🔺 CfgMgr StepMgr
▼ Phases Standby	Guidance Loop Arcade TC	C Pannel Gain DBand
Climbing Hold	- Desired Pitch	-1.0 0.0 Max 0 Integral +
Cruise	Desired Roll	1.0 0.0 Max 0 Integral
Landing Runway Takeoff	- Desired Yaw	2.0 0.02 Max 0 V Integral
<ul> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> <li>Arcade axis</li> </ul>		
Add 👻		

### Arcade Configuration Menu

Considering that the pilot's stick can reach values approximately between 0 and 1, the **gain** is applied to the stick position before entering into the controller so the complete range of the controlled variable is covered.

The **DBand** option (Dead Band) creates a zone where the movement of the stick is not sent to the system, that is used because of the noise present on the stick position. So if the pilot has the stick in the neutral position, the actual value would be 0.001 for example and not zero. If the dead band is set to +-0.01, that command will not be sent to the system avoiding then a possible malfunction.

Finally, when the **integral** option is marked the variable increases continuously on joystick hold, and when is unchecked the control variable is reset after joystick release.

The Arcade mode has to be trimmed before the flight and each time the radio controller is changed. For more info about the Trim Arcade process, please visit section *Arcade Trim*.

### 7.2.4.1.3 TC Panel

This menu sets the variables that will be accessible during the flight from the Veronte Panel. Considering as an example a typical navigation phase, the parameters that can be changed from the TC Panel appear in the following figure. In recent versions of Veronte pipe, the most of theses variables are managed by Workspace widgets.

💽 Veronte0 🛪 💿 👩 🔻 Phases	Guidance Arcade TC Pannel Automations
	Guidance Arcade To Painter Automations
0 Standby	
1 Climbing	Desired Roll
2 Flare	Desired Roll rad
3 Hold	0 rad [-π,π]
4 Cruise	0 rad [-π,π]
5 Landing	
6 Runway Takeoff	
7 Altitude Mode	Min 0.0 Max 1.0 rad 🔗
8 MSL +10	
9 MSL -10	
Runway	
<ul> <li>Envelope</li> </ul>	
Modes	
Arcade axis	
	<u> </u>
Add 🔫	·

### TC Panel

- Number 1 is the button used to add a variable to the TC Panel of a phase (the "-" button is used to remove an element).
- Number 2 indicates the TC Panel page where the current element is being added. Pipe allows user to set more than one page in order to arrange all the variables in an easily accessible way.

## 7.2.4.1.3.1 Cruise Guidance

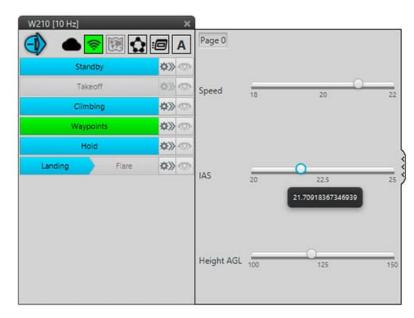
In addition, if the Guidance of the phase is Cruise, the TC Panel can also hold the option of creating different types of interactions with the UAV:

• Desired variable change: Speed, Speed IAS, Height AGL, Height MSL, Height WGS 84.

The variable changing allows the user to modify the desired variable in real time during the flight. In the configuration of the TC Panel, a maximum and a minimum of the variable has to be set (red box).

Veronte0 🛪 💿 🧿	🗄 🚱 📽 🚱 🗔 🗚		
▼ Phases Veronte	Guidance Arcade TC Panne	Automations	
0 Standby			
1 Climbing	Speed	Page 0 +	â
2 Flare		Speed m/s	
3 Hold		Min 0.0 Max 1.0 m/s	
4 Cruise	Height MSL		
5 Landing 6 Runway Takeoff	Height AGL	Speed IAS m/s Min 0.0 Max 1.0 m/s 0.5	
7 Altitude Mode		Height WGS84 m	
8 MSL +10		O Min 0.0 Max 1.0 m 📣	
9 MSL -10			
<ul> <li>Runway</li> <li>Envelope</li> </ul>			
Modes			
Arcade axis			
Add 👻		<	

### TC Panel variables change set



TC Panel during Waypoint phase (Variables)

## 7.2.4.1.4 Automations

The last tab in phases menu is Automations. Here, we can find the automations that take part in each flight phase. From this menu you can modify or create new automatations. Another option is clicking on in the set-up toolbar (the

this menu you can modify or create new automatations. Another option is clicking on **main** in the set-up toolbar (the changes are update in both menus). For more information, see *Automations*.

Veronte0 🛪 🙆 🧿	🗄 🔇 端 🙆 🗂 🔺 🏭 🖉		
▼ Phases	Guidance Arcade TC Pannel Automations		
0 Standby	CMB to CRU		
1 Climbing			
2 Flare	3 - CMB to CRU	Actions	n fra
3 Hold	4 - LND Button		5 - CRU
4 Cruise	5 - CRU Button		
5 Landing	7 - SBY Button		
6 Runway Takeoff	17 - Reset Flight Time		
7 Altitude Mode			
8 MSL +10	New Automation	Delay 0.0	s Periodical: Off
9 MSL -10		Delay 0.0	
Runway	Insert name		0.0 s
Envelope			
Modes			
Arcade axis			
Add 👻			
Add			

#### Automations

The **Phases** menu contains the guidance and control commands used to rule the vehicle. It is possible to create different phases, each one of them with a series of guidance commands and with different control systems. Commonly, the phases correspond with different stages of the flight operation, for example, in an airplane the phases could be: Standby, Take Off, Climb, Cruise and Land. So it is clear from that in each one of them the commands generated to control the vehicle have to be different.

🔅 🙀 Fixed Wing V-Tail UAV 🛪	🐵 🧿 🚟 🚱 🗱 🖓 🗂 🔺 🏭 🖉
▼ Phases	Guidance Arcade TC Pannel Automations
0 Standby	Name No name
1 Climbing	+ 2
2 Flare	×
3 Hold	3
4 Cruise	
5 Landing	
6 Runway Takeoff	Guidance X
7 Altitude Mode	
8 MSL +10	Confirmation
9 MSL -10	
10 No name	Add Cruise
Runway	
Envelope	OK Cancel
Modes	
Arcade axis	
1	
Add 👻	

Control Phases Configuration Menu

When pulling down the phases option, the different phases created appear.

- To create a new phase click on Add, and select Phase (1). The new phase appears by default with the label No Name and with any guidance defined.
- Pressing the Add button (2), a new Guidance is added to the current phase. The section *Guidance* contains the information about all the guidances available on Pipe.
- Lastly, the button (3) is used to order the guidances when there is more than one of the same type.

Arcade refers to the aided mode of controlling a platform, where the control system aids the pilot to improve the piloting experience. All the information about this option is available in section *Arcade*.

The TC Panel tab is used to include in Veronte Panel a series of variable to be changed in real time (while the platform is flying). Refer to *TC Panel* for more information about this.

Finally, Automations includes automatic changes or action buttons that can occur in each phase. In *Automations* there is more information about this.

## 7.2.4.2 Runway

## 7.2.4.2.1 Runway

This menu allows the user to configure a **Runway** and **Spot** which are used during the **Phases** configuration. It is possible to configure more than one previously.

🔯 🕑 Penguin Embention 🛪	🐵 🧿 🚟 🔇 🗱 🌇 🗂 🔺 CfgMgr StepMgr	
<ul> <li>Phases</li> <li>▼ Runway</li> </ul>	Select airport	
Runway 1 Spot 1 Envelope		
Smooth Modes Arcade axis	Lat: 38.2798         Lon: -0.5413         Lat: 38.2845         Lon: -0.5750           Margin         0.3         x1         Margin         0.3         x1	
	Loiter position Lat: 38.2798 Lon: -0.5413 Alarms	
Add 👻		

### Runway Configuration Menu

- Margin: percentage of the runway distance at which the airplane will try to touch the ground.
- Loiter position: this option defines the loiter point of reference (Runway Loiter) and the altitude that the aircraft will reach during the climb.
- Alarms: When an alarm is selected, e.g fuel lost. The aircraft will perform the actions associated to that alarm in the selected runway.

Veronte Pipe incorporates a database with different Airports. When the option **Select Airport** is selected the following panel is displayed.

				Add new							
	ID	LE	HE	Airport	Country	Region	LE Lon	LE Lat	HE Lon	HE Lat	
☆ 🖉 🗙	ETEU	08	26	[Duplicate] Giebelstadt Army Air Field	DE	DE-BY	9.95201	49.6461	9.98092	49.6501	
☆ <b>@ ×</b>	RKSG	14	32	A 511 Airport	KR	KR-41	127.021	36.9697	127.042	36.9548	
☆ <i>⊘</i> ×	EKYT	08L	26R	Aalborg Airport	DK	DK-81	9.83338	57.0937	9.87687	57.0965	
☆ <b>/ ×</b>	EKYT	08R	26L	Aalborg Airport	DK	DK-81	9.83547	57.0919	9.87724	57.0946	
☆ <i>⊘</i> ×	EDPA	09L	27R	Aalen-Heidenheim/Elchingen Airport	DE	DE-BW	10.2582	48.7778	10.2711	48.7779	
☆ <i>⊘</i> ×	EKAH	10L	28R	Aarhus Airport	DK	DK-82	10.5978	56.3074	10.6419	56.303	
☆ <i>⊘</i> ×	EKAH	10R	28L	Aarhus Airport	DK	DK-82	10.5976	56.3055	10.6405	56.3012	
☆ <b>/ ×</b>	EKVH	11	29	Aars Airport	DK	DK-81	9.44926	56.8485	9.46796	56.8453	
☆ <i>⊘</i> ×	EFAA	14	24	Aavahelukka Airport	FI	FI-LL	23.9657	67.6066	23.9791	67.6009	
☆ <b>/ ×</b>	OIAA	14L	32R	Abadan Airport	IR	IR-10	48.2291	30.3713	48.2427	30.3547	
☆ <i>⊘</i> ×	OIAA	14R	32L	Abadan Airport	IR	IR-10	48.2213	30.3787	48.24	30.3559	
☆ <b>/ ×</b>	UNAA	02R	20L	Abakan Airport	RU	RU-KK	91.3747	53.7268	91.3955	53.7532	
☆ <i>⊘</i> ×	HADR	15	33	Aba Tenna Dejazmach Yilma International Airport	ET	ET-DD	41.8485	9.63576	41.8598	9.61433	
☆ <i>⊘</i> ×	LFOI	02	20	Abbeville-Buigny-Saint-Maclou Airport	FR	FR-S	1.82865	50.1383	1.83513	50.1487	
A	Kona		22	ALL THOUSE AND STATES	110	110.1.4	03.0071	20.0021	03.0014	20.0004	

#### Aiport Selectiong Menu

Once the user selects the desired airport, the different coordinates will be introduced automatically. In addition, the direction of the runway is asked.

Confirmation	×
Confirmation	?
Selects the direction	
	HE (26R) LE (08L)

#### **Runway Confirmation**

On the other hand, it is possible to introduce the coordinates manually and the direction of the runway can be changed in the configuration menu by pressing 1.

# 7.2.4.2.2 Spot

This option reffers to a kind of runway where a initial point and its azimuth is defined by **Select airport** option or the user information. Besides, it is necessary to define a **Delta** angle as is shown in the image. The aircraft will land or take off using the best orientation computed inside the area limited by the parameters introduced.

🔣 🖸 Penguin Embention 🛪	🛛 💿 🗄	🛛 📽 🆓 🗔	🔺 CfgMgr StepMgr	
▶ Phases	Select airport			
▼ Runway			Azimuth	
Runway 1			4.8884273	rad [-π,π]
Spot 1				
Envelope			Delta	
Smooth	Lat: 38.2	798 Lon: -0.5413	0.0	rad [-π,π]
Modes			×	
Arcade axis				
	_			
	Loiter position	Lat: 38.	2798 Lon: -0.5413	
	Alarms			
				+
Add 👻				

Spot Configuration Menu

## 7.2.4.3 Envelope

Menu to configure the flight envelope of the aircraft. Here the limits that will not be exceeded during the operation are set.

Versati SIL 🛪 🙆	) 🧿 🔚 🚱 🗱 🚳 🗂	▲ Ⅲ ⊘	
▶ Phases	Envelope Acceleration limit	t	
Runway			
<ul> <li>Envelope</li> </ul>	1 Stall speed	2 Minimum ground speed	
Envelope 1	Min 18.0		ī/s
Modes			=
Arcade axis	Max 30.0		1/5
	3 Vertical speed	Фгра	
	✓ Min -2.0	m/s Min 0.0 rad [-π,	πl
	✓ Max 2.0	m/s Max 0.0 rad [-π,	,al
	Actuators limits		
Add			

#### Envelope

- 1. **Stall speed:** limit for the indicated airspeed (IAS). The value indicated here has effect over the "Cruise" guidance, but is overrided if there is a Hold command on the IAS, so the user must be careful with the velocity commands. Besides, there is an option name as stall speed max that refers to the limit the uav shouldn't exceed.
- 2. **Ground speed:** minimum and maximum ground speed of the platform. In case of strong wind, these parameters set the minimum GS that the aircraft can reach, for lower values than this one the thrust will be automatically increased to gain speed and avoid a point where the platform is stopped in the air.
- 3. Vertical Speed: similar to the previous limit. It sets the minimum and maximun value for the vertical speed of the platform.
- 4. FPA: maximum and minimum values for the flight path angle (angle of climb or descent).
- 5. **VTOL**: If this option is enabled, when the vehicle reaches the last waypoint of its route (and it is an open path), a hover is done instead of a loiter point.

It's possible to insert multiple envelopes (useful for hybrid configurations). The change between envelopes can be performed using *Automations*.

Versati SIL 🛪 🙆 🧿	i 🗄 🚱 🗱 🕰 🗂 4	▲ Ⅲ ⊘	
▶ Phases	Envelope Acceleration limit		
Runway	VTOL		
▼ Envelope	Stall speed	Minimum ground speed	
Envelope 1 Envelope 2	✓ Min 0.5	m/s Min 0.0	m/s
Modes	✓ Max 3.0	m/s Max 0.0	m/s
Arcade axis	Vertical speed	FPA	
	✓ Min 0.0	m/s Min 0.0 rad [	[-π,π]
	✓ Max 2.0	m/s Max 0.0 rad [	[-π,π]
	Actuators limits		
Add 👻			

Multiple envelope configuration

In the second tab there are more options to fix the limits (rising and falling) of acceleration and jerk in SI units.

Acceleration limits are applied in any phase with position guidance. They modify the desired velocity. The algorithm compares the current desired velocity with thatstored in previous step. There are six values to define. The configurable options in this menu are:

- 1. Enable/Disable the acceleration limit.
- 2. Type : User can choose between cartesian frame o spherical frame.
- 3. **Rising limit** : The limit for acceleration. If desired velocity has the same sign as in the previous step, and it's is lower (in absolute value) this limit is applied. For example, if a multicopter is fliving in negative X direction, and it has to increase desired velocity in same direction this limit will be applied.
- 4. Falling limit : The limit for deceleration. In the case rising limit is not used.
- 5. Axes : In cartesian mode they reference body frame (Longitudinal X, lateral Y, and Bottom Z). In spherical type, the algorithm internally applies limits in module, inclination and azimuth to maintain the limits set by the user in body frame (body frame limits will be turn into spherical limits). The user also can selected directly **angular rates** option (6) which allows him set limits in Heading rate and Flight Paht angles rates.

Versati SIL 🛪 🙆 🚺	o 😤 🚱 🗱 🖾	▲ Ⅲ ⊘		
▶ Phases	Envelope Acceleration lim	it <b>2</b>	0	
Runway	Acceleration limit Type		<ul> <li>6</li> <li>✓ Angular ra</li> </ul>	tes
▼ Envelope	Rising limit 3		alling limit (4)	
Envelope 1	✓ Longitudinal axis 4.0		<ul> <li>Longitudinal axis</li> </ul>	4.0 m/s <sup>2</sup>
Envelope 2 Modes	5 Heading rate	) rad/s	✓ Heading rate	4.0 rad/s
Arcade axis	FPA rate 1.0	) rad/s	✓ FPA rate	1.0 rad/s
	Jerk limit			
	Rising limit	F	alling limit	
	✓ Longitudinal axis 3.0	) m/s3	<ul> <li>Longitudinal axis</li> </ul>	3.0 m/s3
	✓ Lateral axis 3.0	) m/s3	✓ Lateral axis	3.0 m/s3
	Bottom axis 0.8	m/s3	✓ Bottom axis	0.8 m/s3
Add	•			

### Acceleration limit (Spherical frame)

The second derivative of velocity (jerk) imposes another limit in acceleration. It modifies the behaviour of the vehicle. Depending on values, it's possible to get more smoothness during guidance. Algorithm ensures that when desired velocity is reached the acceleration value is near 0. As acceleration limits, user can set 6 values (3 for rising limit and 3 for failing limit).

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► Phases	Envelope Acceleration limit
Runway Envelope	Acceleration limit Type Cartesian Body
Envelope 1	Rising limit Falling limit
Envelope 2	✓ Longitudinal axis 4.0 m/s <sup>2</sup> ✓ Longitudinal axis 4.0 m/s <sup>2</sup>
Modes	✓ Lateral axis     4.0     m/s <sup>2</sup> ✓ Lateral axis     4.0     m/s <sup>2</sup>
Arcade axis	✓ Bottom axis         1.0         m/s²         ✓ Bottom axis         1.0         m/s²
	Jerk limit
	Rising limit Falling limit
	✓ Longitudinal axis 3.0 m/s3 ✓ Longitudinal axis 3.0 m/s3
	✓ Lateral axis         3.0         m/s3         ✓ Lateral axis         3.0         m/s3
	✓ Bottom axis         0.8         m/s3         ✓ Bottom axis         0.8         m/s3
Add 👻	

Acceleration limit (Cartesian frame)

The effects of these limitations are explained below.

First, the acceleration limits are disabled. The stick that controls Thrust is moved and desired velocity change according to this stick command. In Desired velocity chart we can see this effect and in bottom acceleration chart is shown how acceleration is not limited (hight values reached).

## Only velocity limit (Thrust)

Now, a limit in acceleration bottom axis is set to 0.1. Now the desired speed grows with a lower slope due to the imposed limitation. Also in the acceleration bottom chart we can see how the value oscillates within the imposed limit.

### Acceleration limit (Thrust)

To compare acceleration and jerk, roll axis is chosen. In the first gif below only the first limit is applied.

### Acceleration limit (Cartesian frame)

When the jerk limit is also enabled we can see how acceleration (in Y Body axis) does not show peaks, and changes in desired velocity are smoother.

Acceleration limit (Cartesian frame)

### 7.2.4.4 Modes

The flight modes determine who is in charge of controlling each one of the aircraft control channels. There are 5 different control modes and it is possible to combine them to create custom flight modes.

		Pitching	Thrustin	Rolling (	Yawing (	Pitching	Thrustin	Rolling (	Yawing (
-	Auto A	auto	auto	auto	auto	auto	auto	auto	auto
-[	Manual	rc	rc	rc	rc	auto	auto	auto	auto
-	G-Arcade G	auto	auto	auto	auto	arc	arc	arc	arc
-	Semi-Arcade S	auto	auto	auto	auto	arc	rc	arc	arc
				Ad	id				

#### Modes editing panel

The options available are:

- Automatic: the control channel is controlled totally by the autopilot.
- **RC:** the control is totally carried out manually. The movements on the pilot stick imply directly movements on the servo linked to that control channel.
- ARC: the autopilot aids the radio controller during the flight, i.e it could be considered as a mix between automatic and manual. The movements on the pilot stick are the input values on the control system, so the pilot commands a desired pitch, roll, IAS, heading and so on, and is the control system who is in charge of making the platform follow those commands.
- **Mix:** in this mode, it is possible to select in which step of the controller will enter the pilot command. For example, the pitching of an aircraft is commonly controlled with 3 PID being: flight path angle, pitch and pitch rate. In the arcade mode the pilot command will be a desired flight path angle that enters as input of the whole control system, but in the Mix mode is possible to select where we want the command to enter, so the pilot command could be pitch (entering in the second PID directly) or pitch rate (entering directly on the third PID). The control system will take this input as a disturbance that it wants to discard because the final objective is to match the input of the first PID (a desired flight path angle in this case), so the Mix mode can be used to make small corrections when the aircraft is following a route for example, where we want it to move slightly towards a certain direction by introducing a value directly on the roll PID. The following figure shows how to select the Mix mode and the parameters that have to be configured: the variable to control (Desired Pitch in this case) and the gain applied on the stick command (it goes from -0.5 to 0.5 so in this case, a gain of 1 implies a Desired Pitch that can go from -0.5 rad to 0.5 rad).

🔯 🕑 Penguin Embention 놧	🕻 🛪 💿 🧰	= (	) 🗘 🖉	ð 🗂 🔺				
► Phases			Pitching	Thrusting	Rolling	Yawing	Flaps	ν
► Runway	Auto	Α	auto	auto	auto	auto	auto	
Envelope Smooth	- G-Arcade	G	arc		are	arc		
Modes	- MIX	X	mix 🌣	Assist	De	sired Pitch		
Arcade axis	- Manual	Μ	rc	Gain 1	.0			
				Ad	d			
Add 👻	K							>

#### MIX Mode

• Autotune: this mode has to be select when the user wants to find control gains automatically.

It is every common to find an automatic mode where all the dynamics are controlled by the autopilot. Likewise, the manual mode is completely controlled by the remote controller ( $\mathbf{rc}$ ). To change any of this options, click on the cell you would like to change and the next option will be set.

### 7.2.4.5 Arcade Axis

The Arcade Axis menu enables the option of changing the center of the system axes. This option is useful, for example, when the pilot wants all movement to be made with respect him (Ground axes). In this way, if the pilot command a turn right, the aircraft will turn to the right of the pilot, instead the right of the aircraft (Body axes).

🔯 🕑 Penguin Embention 🗙	🛪 💿 💿 語	Q 🗱 🚱 🗂 🔺	
Phases	Reference	Offset	
<ul> <li>Runway</li> <li>Envelope</li> </ul>	Body	▼ 0.0	rad [-π,π] Edit point
Smooth			
Modes			
Arcade axis			
Add 🗸			

### Arcade Axis Configuration Menu

It is possible to add as many axes system as desired, being able to choose between the following types:

- **Body:** fix the axes in the UAV. It is standard for the pilot.
- Ground: fix the axes in the Veronte GND.
- **Point:** fix the axes in a point that user defines.

An automation can be used to select an Arcade Axis in flight, see section Select Arcade Axis.

In this panel all the parameters related to the control of the platform can be found. There are 5 sections, each one showing a different menu of configuration.

Veronte0 🛪 🙆 🧿	🗄 😧 端 🚳 🗂	▲ ⅲ ⊘	
Phases			
Runway			
Envelope			
Modes			
Arcade axis			
Add 👻			
Add			

### Control Configuration Menu

- **Phases:** in this section are created the Flight Phases that will control the aircraft at different satages of the operation. This section includes the Guiadances that are necessary, the type of Control used for each phase, the Arcade configuration when is used and the TC Panel for configuring in-flight parameters.
- Runway: this section allows user to configure a Runway or Spot used during the flight operation.
- Envelope: here are definied the flight limits, stall speed and the maximum climb and descent angles.
- **Modes:** allows the creation of custom flight modes, where each one of the control channels can be assigned a mode individually.
- Arcade Axis: this option is used to create axis systems referred to a certain point or direction.

# 7.2.5 Navigation

## 7.2.5.1 Wind Estimation

From the Navigation window can be configured the parameters that affects the wind estimation algorithm.

✓ Acceleration	Intensity
	Estimation
	Uncertainty

Wind estimation parameters

For proper estimation, the system needs to gather as much information of the wind as possible so missions with a trajectory involving changes on the of directions will result in better wind estimation compared with a straight trajectory mission.

Wind Estimat	tion					×
🖌 Enable						
Process noise	covariance matrix		Initialization			
1.0E-4	0.0	0.0	Initial state e	stimate		
0.0	1.0E-4	0.0	0.0	0.0	0.0	
0.0	0.0	1.0E-4	Initial error o	ovariance matrix		
0.0	0.0	1.02-4	1.0	0.0	0.0	
			0.0	1.0	0.0	
			0.0	0.0	1.0	
Apply change	es					

Wind Estimation (Process covariance matrix, Init state estimate, Init error covariance matrix)

The computed result is displayed in the variables: Wind Velocity Down, Wind Velocity East, Wind Velocity North.

Warning: The values that appear here should only be changed by advanced users.

This menu contains the parameters used in the Kalman Filter algorithm to fuse the information provided by the different sensors. This data is used in the navigation system to generate the commands sent to the aircraft.

State Vector		Navigati	on Internal	*	
GPS ok time to resto	re restricted mask	Accelero	meter		
5.0	s)	Qnfb	12.0	12.0	12.0
0	Speed		4.0E-5	4.0E-5	4.0E-5
	Attitude Bias Accelerometer	Gyrosco	pe		
	Bias Gyroscope	Qnwb	0.12	0.12	0.12
Wind		Qdwb	4.0E-6	4.0E-6	4.0E-6
Acceleration	Intensity	Qdem			
E	stimation	Value	Irregular	•	
U	ncertainty	Angular	speed estimation	filter	
Attitude		Custom			
Magnetometer	D 👻	1.0			
Filter parameters		-1.0			
Beta 0.025 rad	/s Initial 10.0 rad/s				
Zeta 0.003 rad/	s <sup>2</sup> Initial 0.0 rad/s <sup>2</sup>				
Advanced	Steps 50				
E annound an			ADD		

#### Navigation Parameters

Veronte integrates a navigation system which can operate with GPS and without GPS coverage. In the navigation with GPS, the system uses it to make the aircraft fly a route or towards a certain waypoint. It is possible to control the aircraft position (longitude and latitude) and the altitude. This is the navigation used by default, the one that the system uses when everything is working properly.

In case the GPS signal is lost, the navigation can easly measures the attitude angles with a greater precision than using a simple IMU. With these measures, it is possible for the system to control the pitch, roll and yaw and then keep a safe attitude when the GPS signal is lost, avoiding any possible malfunction. It is recommended to create an automation to change to a phase where the attitude angles are controlled, in the case of a loss of GPS signal. For more information visit *Automations*.

**Note:** the yaw can be measured in the navigation without GPS only if the magnetometer is activated in the navigation window.

**Warning:** The values that appear here should only be changed by advanced users. If you are not familiar with the Kalman Filter algorithm and Sensor Fusion do not change the default parameters.

# 7.2.6 Automations

## 7.2.6.1 Events

# 7.2.6.1.1 Alarm

This kind of automation allows the user to add any system bit. Depending on the mode in which it is configured, it will be triggered in one way or another.

м600 🛪 💿 ᄒ 葦	😧 📫 🏠 🗂	▲ ⊘ ⅲ		
✓ 30 - LINK off ✓ 31 - Link on	No name			
<ul> <li>33 - Landing to SBY</li> <li>✓ 36 - RTH (tko save)</li> </ul>	Events	AND OR NOT	Actions	+
<ul> <li>✓ 37 - RTH to Landing (</li> <li>✓ 32 - Save tko point</li> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - RDZ Button</li> <li>✓ 17 - No name</li> <li>✓ Stick</li> <li>✓ 13 - Hold Phase (Ar</li> </ul>	80 - N	lo name	32 - No Delay 0.0 s	name Periodical: Off
<ul> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl</li> </ul>	Type Fail one	No name	Compliance time	0.0 s
<ul> <li>▼ Transitions</li> <li>21 - TKO to HVR tra</li> <li>24 - SBY to AUTO</li> <li>24 - SBY to AUTO</li> <li>19 - Takeoff vertica</li> <li>25 - Hover HERE ( H</li> <li>22 - RTH</li> </ul>	<ul> <li>System Error</li> <li>Position not fix</li> </ul>	ed		+
New Automation 🔻				

Event - Alarm

The two possible modes are the following:

- Fail one: it is triggered when one of the bits is set to false.
- All ok: it is triggered when all bits are set to true.

A common alarm event is the **Position not fixed** in fail one mode, which is triggered when there is not GPS signal in the autopilot.

## 7.2.6.1.2 Button

✓ 30 - Link on         ✓ 31 - Link on         33 - Landing to SBY         ✓ 36 - RTH (tko save)         ✓ 37 - RTH to Landing (         ✓ 32 - Save tko point         ✓ 38 - Inside Cylinder         ✓ 40 - Attitude Limits         ✓ 41 - RDZ Button         ✓ 11 - No name         Stick         ✓ 13 - Hold Phase (Ar         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD w         Transitions	nts 80 - N	AND OR NOT o name	Actions 32 - Delay 0.0	- No name	F.		
✓ 36 - RTH (tko save)         ✓ 37 - RTH to Landing (         ✓ 32 - Save tko point         ✓ 38 - Inside Cylinder         ✓ 39 - Outside Cylinder         ✓ 40 - Attitude Limits         ✓ 41 - RDZ Button         ✓ 17 - No name         Stick         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD wl	80 - N	o name	32 -	- No name			
✓ 36 - RTH (tko save)         ✓ 37 - RTH to Landing (         ✓ 32 - Save tko point         ✓ 38 - Inside Cylinder         ✓ 39 - Outside Cylinder         ✓ 40 - Attitude Limits         ✓ 41 - RDZ Button         ✓ 17 - No name         Stick         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD wl	80 - N	o name	32 -	- No name			
<ul> <li>✓ 32 - Save tko point</li> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - RDZ Button</li> <li>✓ 17 - No name</li> <li>Stick</li> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl</li> <li>Icon</li> </ul>					f		
✓ 38 - Inside Cylinder         ✓ 39 - Outside Cylinder         ✓ 40 - Attitude Limits         ✓ 41 - RDZ Button         ✓ 17 - No name         Stick         ✓ 13 - Hold Phase (Ar)         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD wl	Button		Delay 0.0	s Periodical: Off	f		
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - RDZ Button</li> <li>✓ 17 - No name</li> <li>Stick</li> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD will Icon</li> </ul>	Button		Delay 0.0	s Periodical: Off	f		
<ul> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - RDZ Button</li> <li>✓ 17 - No name</li> <li>Stick</li> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl Icon</li> </ul>	Button		Delay 0.0	s Periodical: Off	f		
✓ 41 - RDZ Button         ✓ 17 - No name         Stick         ✓ 13 - Hold Phase (Ar         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD wl	Button		Delay 0.0	s Periodical: Off	f		
<ul> <li>✓ 17 - No name</li> <li>Stick</li> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl Icon</li> </ul>	Button		Delay 0.0	s Periodical: Of	f		
Stick V 13 - Hold Phase (Ar V 11 - Auto Mode V 34 - Arm Sequence V 12 - Manual Mode V 35 - Arcade/HLD wl Icon	Button		Delay 0.0	s Periodical: Off	f		
<ul> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl</li> <li>Icon</li> </ul>	Button		Delay 0.0	s Periodical: Off	f		
<ul> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wl</li> <li>Icon</li> </ul>	Button		Delay 0.0	s Periodical: Off	f		
✓ 34 - Arm Sequence       ✓ 12 - Manual Mode       ✓ 35 - Arcade/HLD wl	Button			s Periodical. On	•		
✓ 12 - Manual Mode       ✓ 35 - Arcade/HLD wl	Button						
✓ 35 - Arcade/HLD wl Icon	CE Button		Compliance t	time 0.0			
Con reon		* No name	Compliance				
		Time Control 1	Confir	mation			
ransitions	0						
✓ 21 - TKO to HVR tra							
✓ 24 - SBY to AUTO Rang	ige variable	PWM7 GPIO Off					
✓ 19 - Takeoff vertica	ige colors	Catalanana	0.0	>	0.5		
✓ 25 - Hover HERE ( F	ige colors	Set color ranges					
22 - RTH			0.5	>	1.0		
>							
w Automation 👻 This	s button will be di	splayed on Veronte Pan	el				

This option creates a button that will trigger the event when it is clicked.

#### Event - Button

- **Range variable** and **range colors** options are used to make the button change its color according to the value of a variable. To do that, select a variable and then indicate as many points as desired, each one with its corresponding value and color.
- **Confirmation** option will display a pop-up window that asks for confirmation after pushing the button, so it is a safety measure.
- **Time Control** option is used to trigger the action when the button is being pushed during the time specified in this option.

If a button event triggers and action that consists of a change to a determined phase, the button will be the one of the Veronte Panel with the name of that phase on it. If the button event is linked to a different action (servo movement, variable...), it will appear in the lower part of Veronte Panel with the Icon selected by the user.

### 7.2.6.1.3 Mode

The event is triggered when the aircraft is in one of the modes selected.

1600 🛪 💿 ᄒ 🏗	😵 端 🕸	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name		71 - No name	30 - No	name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	2 🗈 M	ode 🔻 No name	Compliance time	0.0 s
▼ Stick				
✓ 13 - Hold Phase (Ar	Auto		G-Arcade	
✓ 11 - Auto Mode			Semiarcade	
✓ 34 - Arm Sequence ✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD w				
▼ Transitions				
✓ 21 - TKO to HVR tra				
New Automation 🔹				

Event - Mode

These modes have been created previously. See section *Modes*, for more information about creating modes. A **Compliance time** can be set for this kind of event.

### 7.2.6.1.4 Phase

The event is triggered when the aircraft is in the phases selected by clicking on the "+" button, not in all of them at the same time, being in one of them is enough to trigger the action.

м600 🛪 💿 🔁	🔇 🔅 🌮 🗂	▲ ⊘ ⅲ		
✓ 30 - LINK off ✓ 31 - Link on	No name			
33 - Landing to SBY ✓ 36 - RTH (tko save)	Events	AND OR NOT	Actions	+
✓ 37 - RTH to Landing (	79 -	No name	32 - No	name
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder				
✓ 40 - Attitude Limits				
🖌 41 - RDZ Button				
✓ 17 - No name				
▼ Stick				
🗸 13 - Hold Phase (Ar			Delay 0.0 s	Periodical: Off
✓ 11 - Auto Mode			,	
✓ 34 - Arm Sequence	Phase	<ul> <li>No name</li> </ul>	Compliance time	0.0 s
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl	Standby		and an	
▼ Transitions	Cruise			
✓ 21 - TKO to HVR tra				
✓ 24 - SBY to AUTO				
✓ 19 - Takeoff vertica				
✓ 25 - Hover HERE ( F				
22 - RTH				
New Automation 💌				

Event-Phase

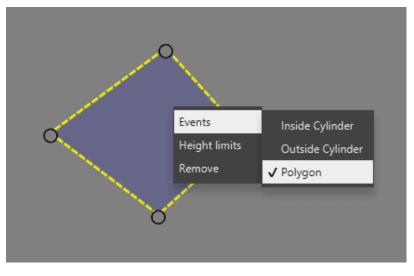
# 7.2.6.1.5 Polygon

The event is triggered when the aircraft is inside or outside a polygon defined in the Mission menu.

м600 🛪 💿 🔁	🔇 端 🕰 🖺	1 🔺 🖉 🏢		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	
<ul> <li>29 - No name</li> <li>30 - LINK off</li> <li>31 - Link on</li> <li>33 - Landing to SBY</li> <li>36 - RTH (tko save)</li> <li>37 - RTH to Landing (</li> <li>32 - Save tko point</li> <li>38 - Inside Cylinder</li> </ul>	71	- Polygon	30 -	No name
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> </ul>			Delay 0.0	s Periodical: Off
✓ 41 - No name ▼ Stick	Poly	<ul> <li>Polygon</li> </ul>	Compliance t	time 0.0 s
✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode	Туре	Inside	•	
✓ 34 - Arm Sequence       ✓ 12 - Manual Mode       ✓ 35 - Arcade/HLD wl       ▼ Transitions       ✓ 21 - TKO to HVR trave       ✓ New Automation	Object of interest	UAV position	•	

Event - Polygon

- When the event has been labeled ("Event Name (Polygon)" in this case) and saved, it is then possible to link it to a polygon drawn on the map in the *Mission menu*.
- Right-clicking on the polygon will open a menu, and in *Events* will appear all the polygon-type events defined on the system. Click on it to link the polygon and the event.



Event - Polygon Selection

**Object of interest** allows the user to select which object is the one that should fulfill the event.

An example about using this automation can be found in *Circular Area*.

### 7.2.6.1.6 Route

This event is related with the waypoints defined by the user in the *Mission menu* and the marks defined in *Mission setup*.

100 🛪 📀 💿 🏗	😧 🖧 🏖	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	T Actions	-
✓ 29 - No name		71 - No name	30 - N	o name
30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits				Periodical Off
✓ 41 - No name		oute 👻 No name	Compliance time	e [00 ]
▼ Stick		No name		
✓ 13 - Hold Phase (Ar			<b>101</b>	
🖌 11 - Auto Mode	Activation	Mark achieved 🔹	Select Mark	
✓ 34 - Arm Sequence		Flying to waypoint	Selected Marks	
✓ 12 - Manual Mode	<b>U</b>	Mark achieved		
✓ 35 - Arcade/HLD wl				
▼ Transitions				
🗸 21 - TKO to HVR tra				
	Waypoints a	ffected will be available on m	ission edition	
New Automation 💌				

Event - Route

There are two modes in the event type.

- Mark achieved: triggers the action when the vehicle has reached the selected mark.
- Flying to waypoint: triggers the action when the platform is flying towards that waypoint (is the next waypoint of the route).

Clicking on **Select Mark/Waypoint** allows the selection of the mark/waypoint among the ones created by the user. It is possible to change the appearance of the waypoint to an image selected in the **icon** option, so the user can identify easily the waypoint linked to that automation.

# 7.2.6.1.7 Timer

This event will check the status of the timer selected in the menu. That timer should have been configured before on the action side of another automation ref (Action type *Periodical*).

1 🐼 🛪 🐼 🧰	🔇 📽 🕰 🗂	A 🖉 🎞		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	
✓ 29 - No name	71 -	No name	30 - 1	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	Periodical: Off
✓ 40 - Attitude Limits			-	
✓ 41 - No name	A E Timer	<ul> <li>No name</li> </ul>	Compliance tir	me 0.0 s
▼ Stick				
✓ 13 - Hold Phase (Ar	Timer 1 -	•		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence ✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD w				
▼ Transitions				
✓ 21 - TKO to HVR tra				
New Automation 👻	Event triggered pe	riodically based on selected	d Timer. See timer act	ion for timer options.

#### Event - Timer

For example: if it is desired to take a photo 10 seconds after the takeoff, one automation should have the event of Phase take off, with the correspondent *Periodical* action that will start a timer that lasts 10 seconds. Then with another automation, indicating in the event the timer created, an action is created to take a photo when the timer event is triggered. In Timer is selected the number that identifies the timer that is evaluated in this event.

## 7.2.6.1.8 Variable

мбоо 🛪 💿 💿 葦	😧 端 🙆 (	≞ ▲ ⊘ ⅲ		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	7	1 - No name	30 - No	name
30 - LINK off				
🗸 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	🖉 🗈 Vari	ia 💌 No name	Compliance time	0.0 s
▼ Stick				
✓ 13 - Hold Phase (Ar	Variable	IAS (Indicated Airspeed)		
✓ 11 - Auto Mode ✓ 34 - Arm Sequence	Max 2	0.0	🜣	
✓ 12 - Manual Mode	Min 5	.0	<b>\$</b>	
✓ 35 - Arcade/HLD wl	Invert range 🗸	7		
▼ Transitions	interendinge V			
21 - TKO to HVR tra	Min			Max
New Automation 💌	Event triggere	d on blue area		

This event is triggered when a variable selected is between a range established.

Event - Variable

- The variable to be evaluated is selected on Variable.
- **Max-Min:** maximum and minimum values of the threshold are established here. Custom threshold can be established by clicking on the gear icon.
- The option **invert range** will change the interval (the blue area will be gray, and the gray one will be blue).

As an example consider the event of the figure. With that parameters, the event is triggered when the IAS is between 5 and 20 meters per second. If the **invert range** option is unchecked, the event will be triggered when the IAS is lower that 5 m/s or greater than 20 m/s.

An event is something that has to be accomplished to trigger the actions. All the events can be combined to create a custom event, using the boolean operations provided by the software (AND,OR, NOT).

When entering a new Event or Action it is possible to choose from one of the previously created on the system or to create a new one.

1600 🛪 💿 🔁 🏗	E 🚱 💁 🖽 🗂 🔺 🖉 🎟	
✓ 30 - LINK off ✓ 31 - Link on	Outside Cylinder	
33 - Landing to SBY ✓ 36 - RTH (tko save)	Events 1 AND OR NOT Actions	+
<ul> <li>✓ 37 - RTH to Landing (</li> <li>✓ 32 - Save tko point</li> </ul>	19 - Flight Phases     28 - BITCylinder = 0       AND     67 - Outside Cylinder	
<ul> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - RDZ Button</li> </ul>	Remove Add	
▼ Stick ▼ 13 - Hold Phase (Ar ▼ 11 - Auto Mode ▼ 34 - Arm Sequence	Wrap in     And       Unwrap     Or       Not     Delay     0.0     s     Period	dical: Off
✓ 12 - Manual Mode ✓ 35 - Arcade/HLD wl	Outside Cylinder Compliance time 0.0	S
<ul> <li>▼ Transitions</li> <li>✓ 21 - TKO to HVR tra</li> </ul>	Type •	
✓ 24 - SBY to AUTO ✓ 19 - Takeoff vertica ✓ 25 - Hover HERE ( H ✓ 22 - RTH ✓ 23 - Hover HERE (H ✓ New Automation	Object of interest UAV position -	

Automations Panel – Events

When there is only one event, clicking on the boolean command (1) will create another event linked to the other one according to that operation. Right-clicking on an event and selecting **Wrap in** allows the creation of an operation as if it was inside brackets, i.e it will be evaluated first. Let's consider the following event group as an example.

AND Event2 OR NOT Event3		Event1	
OR NOT		AND	
NOT		Event2	
	8	OR	
Event3		NOT	
		Event3	
	ļ		

Events

The first operation that is evaluated is the NOT, then the OR between Event2 and the result of the NOT, and finally the AND between Event1 and the result of the OR.

The following table depicts the meaning of each one of the boolean operators.

Logics	Description
AND	All events grouped on an AND should be accomplished simultaneously in order to activate the automation.
OR	One of the events in the group should be accomplished for activating the automation.
NOT	The event will be active meanwhile the event or event group is not accomplished.

When creating a new event, it possible to select different types of events, these are explained in the next sections.

## 7.2.6.2 Actions

## 7.2.6.2.1 Atmosphere Calibration

This action allows the atmosphere calibration in the same way as shown in Quick Commands.

м600 🛪 💿 💿 🏗	🔇 🖾 🚱 🗂 🗚			
✓ 30 - LINK off ✓ 31 - Link on	No name			
33 - Landing to SBY ✓ 36 - RTH (tko save)	Events	AND OR NOT	Actions	+
✓ 37 - RTH to Landing (	71 - No n	ame	30 - N	No name
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder				
✓ 40 - Attitude Limits				
✓ 41 - No name				
▼ Stick				
✓ 13 - Hold Phase (Ar				
✓ 11 - Auto Mode			Delay 0.0 s	Periodical: Off
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode	Atm	No name		
✓ 35 - Arcade/HLD wl				
▼ Transitions	Altitude	0.0	m	<b>\$</b>
✓ 21 - TKO to HVR tra				-
✓ 24 - SBY to AUTO	✓ Use current pressure			
✓ 19 - Takeoff vertica	T			
✓ 25 - Hover HERE ( H	Time to acquire mea	n 0.0	s	
22 - RTH	Static pressure	0.0	Pa	
23 - Hover HERE (H	Static pressure	0.0		
New Automation 👻	Temperature (OAT)	288.16	K	

Action – Atmosphere Calibration

The following options can be configured:

- Altitude: actual MSL altitude.
- User current pressure: if this box is ticket, static pressure is read from the static pressure sensor during the specified time. Otherwise, actual static pressure should be specified manually.

• Temperature (OAT): outside air temperature.

## 7.2.6.2.2 Change Active Sensor

This option allows the change of the actual sensor used as accelerometer, gyroscope, magnetometer, static pressure and dynamic pressure; between the internal and external ones.

м600 🛪 💿 🔁 葦	🚱 📽 🕮 🗂	▲ ⊘ ⅲ		
✓ 30 - LINK off ✓ 31 - Link on	No name			
33 - Landing to SBY ✓ 36 - RTH (tko save)	Events	AND OR NOT	Actions	- -
✓ 37 - RTH to Landing (	71 - N	o name	<b>30</b> -	- No name
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder				
✓ 40 - Attitude Limits				
✓ 41 - No name				
▼ Stick				
✓ 13 - Hold Phase (Ar				
🖌 11 - Auto Mode			Delay 0.0	s Periodical: Off
🖌 34 - Arm Sequence				
✓ 12 - Manual Mode	Chan	<ul> <li>No name</li> </ul>		
✓ 35 - Arcade/HLD wl				
▼ Transitions	Accelerometer	Static pres	ssure	
🖌 21 - TKO to HVR tra	Gyroscope	🔵 Dynamic p	oressure	
✓ 24 - SBY to AUTO	Magnetometer			
✓ 19 - Takeoff vertica	Magnetometer			
✓ 25 - Hover HERE ( F	Type 4 - Main Acc	elerometer	-	
22 - RTH				
🖌 23 - Hover HERE (H 🗸				
New Automation 🔹				

Action - Change Active Sensor

### 7.2.6.2.3 Command Block

This action allows the user to configure gimbal control or trim the radio controller.

### 7.2.6.2.3.1 Gimbal

Note: This action is disabled by default when Veronte is started. To activate it, the user have to run the action.

When this action is triggered, the gimbal control is enabled. There are several control modes that are explained below.

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17 - GE ON	No name	
27 - Activate GE on Ta 28 - Deactivate GE on	Events AND OR NOT Actions	+
<ul> <li>29 - No name</li> <li>30 - LINK off</li> <li>31 - Link on</li> <li>33 - Landing to SBY</li> <li>36 - RTH (tko save)</li> <li>37 - RTH to Landing (</li> <li>32 - Save tko point</li> </ul>	71 - No name 30 - No	name
<ul> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - No name</li> </ul>	Delay 0.0 s	Periodical: Off
▼ Stick ▼ 13 - Hold Phase (Ar ▼ 11 - Auto Mode	Block type Gimbal  Block 0	
<ul> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD w</li> </ul>	<ul> <li>Delta</li> <li>Vector Body</li> <li>Custom Axis Arcade axis 1 </li> </ul>	- °o
▼ Transitions	Azimuth $0.0$ $rad [-\pi,\pi]$ ManualElevation $0.0$ $rad [-\pi,\pi]$	
New Automation 🔻		

Action - Gimbal

- Delta: control using NED axis, defining the initial position through azimuth and elevation.
- Vector body: this control uses aircraft body axis. The initial position is defined through roll and tilt.
- Custom Axis: in this case the axis should have been defined in Arcade Axis.
- Location: the gimbal will point towards the projection on the ground at the specified point.
- Manual: gimbal control is done externally, e.g. via VCP commands.

# 7.2.6.2.3.2 ArcTrim

м600 🛪 💿 🧿 葦	😧 🛸 🕰 🕻	∃ 🔺 ⊘ 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71	- No name	3	80 - No name
30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name ▼ Stick	Com	🔻 No name		
✓ Suck ✓ 13 - Hold Phase (Ar	Block type ArcT	rim 🔻 Block 2	•	
✓ 11 - Auto Mode	and the second second			
✓ 34 - Arm Sequence	Update the a	rcade trim values		
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl	Save the arca	ade trim values calculated		
<ul> <li>Transitions</li> </ul>				
🗸 21 - TKO to HVR tra				
New Automation 👻				

This action trims the radio controller, i.e sets as zero the current sticks positions.

Action – Arcade Trim

- **Update the arcade trim values:** if this option si checked, the stick is trimmed but not saved in the configuration. This means that if Veronte is restarted the trimming is lost.
- Save the arcade trim values calculated: trim values are stored for future flights.

## 7.2.6.2.4 Custom CAN TX

When this action is triggered, a previously configured CAN message is sent through the CAN bus. The message has to be configured in *Custom messagess section*.

м600 🛪 💿 🔁 🏥	🚱 😳 🚯 [	≞ ▲ ⊘ ☷		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	- -
✓ 29 - No name	7	1 - No name		30 - No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	🖉 🗈 Cus	t 🔻 No name	7	
▼ Stick				
✓ 13 - Hold Phase (Ar	Producer	CAN custom message 1	-	
✓ 11 - Auto Mode	0	es 0		
✓ 34 - Arm Sequence	Custom message		•	
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
21 - TKO to HVR tra				
New Automation 🔻				

Action – Custom CAN TX

The two parameters to configure in this action are:

- Producer: where is located the custom message: CAN custom message 1 or 2.
- Custom message: the one that will be sent.

# 7.2.6.2.5 Custom Serial TX

When this action is triggered, a previously configured serial message is sent through the serial port (RS232 or RS485). The message has to be configured in *Custom messagess section*.

м600 🛪 📀 💿 葦	😧 端 🕰 🛙	∃ 🔺 ⊘ 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71	- No name	30	- No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	Cust.	🔻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Producer	RS custom message 1	-	
✓ 11 - Auto Mode		1		
✓ 34 - Arm Sequence	Custom message	Message 1	-	
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
21 - TKO to HVR tra				
New Automation 🔻				

Action - Custom Serial TX

The two parameters to configure in this action are:

- Producer: where is located the custom message: RS custom message 1, 2 or 3.
- Custom message: the one that will be sent.

## 7.2.6.2.6 DEM Calibration

This option allows the calibration of the digital elevation model by setting the actual AGL value in the same way as shown in *Quick Commands*.

🔤 мбоо 🛪 💿 💿 葦	🔇 端 🕰 🗂	▲ ⊘ Ⅲ		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71 -	No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	O E DEM	<ul> <li>No name</li> </ul>		
▼ Stick				
✓ 13 - Hold Phase (Ar	AGL expected 0.	0 m		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
✓ 21 - TKO to HVR tra				
New Automation 👻				

Action – DEM Calibration

## 7.2.6.2.7 Enable/Disable Wind Estimation

Note: This action is disabled by default when Veronte is started. To activate it, the user have to run the action.

This action allows the user to enable or disable the wind estimation. Besides, an initial wind vector can be set to a faster convergence of the estimation.

1600 🛪 📀 🧿 葦	🔇 😳 🚯	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
28 - Deactivate GE on ✓ 29 - No name ✓ 30 - LINK off ✓ 31 - Link on 33 - Landing to SBY ✓ 36 - RTH (tko save) ✓ 37 - RTH to Landing ( ✓ 32 - Save tko point ✓ 38 - Inside Cylinder ✓ 39 - Outside Cylinder ✓ 40 - Attitude Limits ✓ 41 - No name ▼ Stick		71 - No name	30 - Delay 0.0	No name
✓ 13 - Hold Phase (Ar         ✓ 11 - Auto Mode         ✓ 34 - Arm Sequence         ✓ 12 - Manual Mode         ✓ 35 - Arcade/HLD wl         ▼ Transitions         ✓ 21 - TKO to HVR trave         ✓ New Automation	<ul> <li>✓ Enable Win</li> <li>Initial Vector</li> <li>North</li> <li>East</li> <li>Down</li> </ul>	0.0     0.0       0.0     0.0	m/s m/s m/s	

Action - Enable/Disable Wind Estimation

### 7.2.6.2.8 Entrance EKF

This action modify the entrances to the Kalman filter. It can be configured so that a sensor enter or exits the Kalman filter.

100 🛪 📀 💿 葦	🔇 🔅 🕰	] 🔺 (	⊘ Ⅲ			
17 - GE ON	No name					
20 - GE OFF 27 - Activate GE on Ta	Events	AND	OR NO	<b>T</b> Actions		+
28 - Deactivate GE on ✓ 29 - No name	71	- No name			30 - No	o name
✓ 30 - LINK off						
✓ 31 - Link on						
33 - Landing to SBY						
✓ 36 - RTH (tko save)						
✓ 37 - RTH to Landing (						
✓ 32 - Save tko point						
▼ 38 - Inside Cylinder						
✓ 39 - Outside Cylinder				Delay 0.0	s	Periodical: Off
✓ 40 - Attitude Limits				Delay 0.0		Periodical. Off
✓ 41 - No name	P Entra		No name			
▼ Stick			to name			
✓ 13 - Hold Phase (Ar		Apply En	able/Disable		Apply	Enable/Disable
✓ 11 - Auto Mode	GNSS 1		$\checkmark$	Magnetometer		$\checkmark$
✓ 34 - Arm Sequence				-		
✓ 12 - Manual Mode	GNSS 2		$\checkmark$	Static pressure		$\checkmark$
✓ 35 - Arcade/HLD wl	GNSS External		$\checkmark$	Altimeter		$\checkmark$
▼ Transitions	Internest		$\checkmark$	Speed Down		$\checkmark$
✓ 21 - TKO to HVR tra	GPS Compass		$\checkmark$	Terrain		$\checkmark$
	2.2.30110035					
New Automation 🔹						

#### Action - Entrance EKF

Only those sensors that have their apply box checked are modified. Once this box is checked, the enable or disable box of the Kalman filter can be accessed.

### 7.2.6.2.9 Envelope

This action is used to change the envelope during the flight mission. Envelopes are created in the Control Menu, see section *Envelope*.

м600 🛪 📀 💿 葦	🔇 端 🕰 🖺	∃ 🔺 ⊘ 🏛		
17 - GE ON	No name			
27 - Activate GE on Ta	Events	AND OR NOT	Actions	+
28 - Deactivate GE on 29 - No name	71 -	- No name	30 - N	lo name
<ul> <li>✓ 30 - LINK off</li> <li>✓ 31 - Link on</li> </ul>				
33 - Landing to SBY ✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
<ul> <li>✓ 32 - Save tko point</li> <li>✓ 38 - Inside Cylinder</li> </ul>				
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> </ul>			Delay 0.0 s	Periodical: Off
✓ 41 - No name ▼ Stick	P E Envel	🔹 No name		
✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode	Select Envelop	e 1 👻		
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode ✓ 35 - Arcade/HLD wl				
<ul> <li>▼ Transitions</li> <li>✓ 21 - TKO to HVR trage</li> </ul>				
New Automation 🔹				

#### Action - Envelope

This is useful with a hybrid platform, being possible to change the envelope when the aircraft changes its configuration. Envelopes are selected from those created previously.

### 7.2.6.2.10 FTS Activation

Note: This action is useful for 4xVeronte. In 1xVeronte this action will have no effect.

This action activate the flight termination system (FTS) bit useful for arbitration.

м600 🛪 📀 💿 葦	😵 端 🕰 🗂	🔺 🖉 🏢		
17 - GE ON	No name			
20 - GE OFF				
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
28 - Deactivate GE on ✓ 29 - No name	71 -	No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A 🕞 FTS	<ul> <li>No name</li> </ul>		
▼ Stick				
✓ 13 - Hold Phase (Ar	✓ FTS Activation	l.		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl ▼ Transitions				
✓ Transitions ✓ 21 - TKO to HVR tragent				
New Automation 👻				

Action – FTS Activation

When two or more autopilots activate their FTS the arbiter can activate a safe system such as a parachute.

### 7.2.6.2.11 Feature

When this action is triggered, a position is stored in the desired variable. This position can be absolute or relative (in the figure below the current position of the aircraft would be saved):

м600 🛪 🙆 🧰 🏣	😵 📫 🍄 🗂	▲ ⊘ Ⅲ						
17 - GE ON	Save tko point							
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions		+			
✓       29 - No name         ✓       30 - LINK off         ✓       31 - Link on         33 - Landing to SBY       ✓         ✓       36 - RTH (tko save)         ✓       37 - RTH to Landing (         ✓       32 - Save tko point         ✓       38 - Inside Cylinder         ✓       39 - Outside Cylinder         ✓       40 - Attitude Limits         ✓       41 - No name		nase TKO	Delay 0.0	24 - save tko s Periodical:	Off			
▼ Stick	Peat	▼ save tko				11434 52		MAI
✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode	Value	N: 0.000000 m, E:	0.000000 m, D:	0.000000 m	Relative	UAV position	. 9	
✓ 34 - Arm Sequence	Save value in	Inflight Re	eference Point (	0	Absolute	Decimal Degrees	<b>UAV POS</b>	MAP POS
✓ 12 - Manual Mode					North	0.0		m
✓ 35 - Arcade/HLD wl	Type Fixed	*			East	0.0		m
▼ Transitions		Value used when inva	alid ID is tried		Last	0.0		
					Down	0.0		m
New Automation 👻						0.0		m
						0.0		m

#### Action – Feature

Besides, there are two types of features:

- Fixed: once the point has been generated it remains fixed.
- No change: if the point has been created relative, it remains relative all the time.

### 7.2.6.2.12 Format SD

**Warning:** This action will have irreversible effects on your Veronte. Formatting the SD card will delete important and mandatory files for the correct functioning of Veronte. In order to recover a formatted Veronte the customer should contact with Embention support.

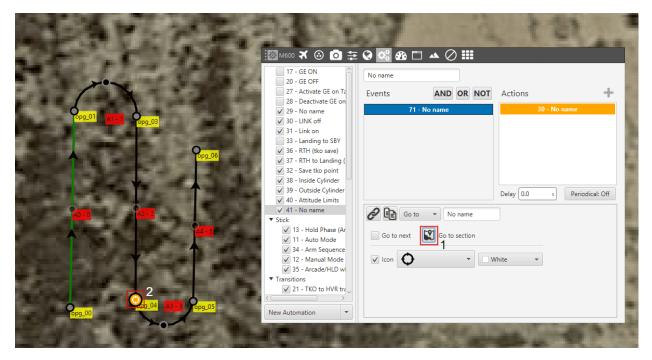
This action will format the SD card, deleting the configuration and flight logs from it.

100 🛪 💿 🔁	😧 😳 🚯	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name		71 - No name	30 - No	o name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
▼ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits			Delay 0.0 S	Periodical: Off
✓ 41 - No name		orm 👻 No name	7	
▼ Stick		No name		
✓ 13 - Hold Phase (Ar				
✓ 11 - Auto Mode	<b>Λ</b>	Caution		
✓ 34 - Arm Sequence	∣ /ı∖	Using this action will form	at Varanta's momeny. T	his may says the
🖌 12 - Manual Mode	/:\	loose of important data.	at veronte's memory. I	his may cause the
✓ 35 - Arcade/HLD wl		-		
▼ Transitions		Use this action just if you	are sure, once the SL	) is formatted
🖌 21 - TKO to HVR tra		ther is no way back.		
< >				
New Automation 👻				

Action - Format SD

# 7.2.6.2.13 Go To

This action is used to make the aircraft go to a path (or waypoint if it is alone) of the route created by the user with the *Mission toolbar*.



Action - Go To

• Clicking in 1 allows the user to select a waypoint on the map (2 for example).

Once the action is triggered, the vehicle will go to that patch (or waypoint). If the patch is on a route, the vehicle will follow the selected patch and then it will continue the route going to its adjacent. On the other hand, if the option **Go to next** is selected, once the event is accomplished the aircraft will forget about the current path that is following and it will go to the next one. If the event happens again it will "jump" another patch and go to the following.

For example, considering the route that appears in the previous figure, if the automation **Go to next** is triggered by a button, when the aircraft is in the first patch (the one that starts on the green waypoint) and the button is pressed it will go to the next curved patch. If the button is pressed again before reaching that patch, the aircraft will go to the next straight line (parallel to the first one) without going over the curved patch.

It is possible to change the appearance of the waypoint to an image selected in the **icon** option, so the user can identify easily the waypoint linked to that automation.

### 7.2.6.2.14 Ground Effect

Note: This action is disabled by default when Veronte is started. To activate it, the user have to run the action.

This action activate the groun effect compensations previously configured in Static pressure sensor.

м600 🛪 💿 🔁 葦	😧 🖧 🕰 (	□ ▲ ⊘ Ⅲ			
17 - GE ON	No name				
20 - GE OFF					
27 - Activate GE on Ta	Events	AND OR NOT	Actions		-
28 - Deactivate GE on	7	4 No 2000		30 - No name	
✓ 29 - No name	/	1 - No name	_	SU - No name	
30 - LINK off					
✓ 31 - Link on					
33 - Landing to SBY					
✓ 36 - RTH (tko save)					
✓ 37 - RTH to Landing (					
✓ 32 - Save tko point					
✓ 38 - Inside Cylinder					
✓ 39 - Outside Cylinder			Delay 0.0	s Periodica	I: Off
✓ 40 - Attitude Limits					
✓ 41 - No name		ou 👻 No name			
▼ Stick		······			
✓ 13 - Hold Phase (Ar	Ground effect				
✓ 11 - Auto Mode	Enable stat	tic pressure square error comp	pensation		
✓ 34 - Arm Sequence	Enable stat	tic pressure correction compe	nsation		
✓ 12 - Manual Mode					
✓ 35 - Arcade/HLD wl					
<ul> <li>Transitions</li> </ul>					
🗸 21 - TKO to HVR tra					
New Automation 👻					

Action - Ground Effect

There are two types of ground effect compensation:

- Enable static pressure square error compensation: compensations in the pressure square error when Veronte is close to the ground.
- Enable static pressure correction compensation: compensation in the pressure reading from the table configured in *Static pressure sensor*.

### 7.2.6.2.15 Mode

The flight mode is changed to the one specified in this option.

100 🛪 💿 🧿 \Xi	😧 端 🕰 🛙	∃ ▲ ⊘ ⅲ		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71	- No name	30 - N	o name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A E Mod	e 👻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Change to 🛛 🗚	uto 👻		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
21 - TKO to HVR tra				
New Automation 🔻				

#### Action - Mode

These modes have been created previously. See *Modes section* for more information about creating modes.

### 7.2.6.2.16 Navigation

This action is used to change the navigation mode used by the aircraft. By default, the UAV uses a sensor fusion Internal algorithm, but for example, if the GPS falls, this algorithm produces bad results so it would be convenient to change to another type if that happens (External). The navigation without GPS will make the aircraft fly stable but it will not be possible to command a path to follow during that time, so it can be used as a safety mode to avoid a malfunction of the system when the GPS signal is lost.

🔯 мбоо 🛪 📀 💿 葦	😵 📽 🖾	▲ ⊘ ⅲ		
17 - GE ON	No name			
20 - GE OFF 27 - Activate GE on Ta	Events	AND OR NOT	Actions	-
28 - Deactivate GE on	Events		Actions	Т
✓ 29 - No name	71 - 1	No name	3	0 - No name
30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits			_	
✓ 41 - No name	Navi	<ul> <li>No name</li> </ul>		
▼ Stick				
✓ 13 - Hold Phase (Ar	Type Internal	•		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence ✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
21 - TKO to HVR tra				
New Automation 👻				

Action - Navigation

The options available are:

- Internal: uses internal data for navigation. Data (position, attitude, etc.) is processed into Veronte Unit from sensor measures.
- External VCP: uses external data for navigation. Data (position, attitude, etc.) is provided by Veronte Communication Protocol (VCP).
- External Var: uses external data for navigation. Data (position, attitude, etc.) is provided by Var.
- Vectornav VN-300: uses external data for navigation. Data (position, attitude, etc.) is provided by Vectornav VN-300.

### 7.2.6.2.17 Obstacle Avoidance

Note: This action is disabled by default when Veronte is started. To activate it, the user have to run the action.

This action enables the obstacle avoidance predefined in Obstacle Detection.

100 🛪 📀 💿 葦	😧 端 🕰 🛙	∃ 🔺 ⊘ 🎟		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
28 - Deactivate GE on ✓ 29 - No name ✓ 30 - LINK off ✓ 31 - Link on 33 - Landing to SBY ✓ 36 - RTH (tko save) ✓ 37 - RTH to Landing ( ✓ 32 - Save tko point ✓ 38 - Inside Cylinder ✓ 39 - Outside Cylinder ✓ 40 - Attitude Limits ✓ 41 - No name ✓ Stick ✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode ✓ 34 - Arm Sequence ✓ 12 - Manual Mode ✓ 35 - Arcade/HLD wl ✓ Transitions ✓ 21 - TKO to HVR travelet	71	nap	30 - Delay 0.0	s Periodical: Off
New Automation				

Action – Obstacle Avoidance

Three types of obstacles can be enabled:

- **Designated on map:** those obstacles that appears on the map, both obstacle zones and aircraft received by ADS-B.
- Range sensor: obstacles defined in Range sensors section.
- Detection sensor: obstacles defined in Obsens section.

### 7.2.6.2.18 Output

This action is used to set an output value in a GPIO pin. The output pin should have been configured as GPIO (visit section *GPIO*).

100 🛪 💿 🧰 葦	😧 端 🕰 🗂	▲ ⊘ Ⅲ			
✓ 37 - RTH to Landing ( ^ ✓ 32 - Save tko point	No name				
<ul> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> </ul>	Events	AND OR NOT	Actions		+
✓ 40 - Attitude Limits	71 - N	lo name		30 - No name	
✓ 41 - No name ▼ Stick					
✓ 13 - Hold Phase (Ar					
✓ 11 - Auto Mode					
✓ 34 - Arm Sequence					
🖌 12 - Manual Mode					
✓ 35 - Arcade/HLD wl					
<ul> <li>Transitions</li> </ul>			Delay 0.0	s Period	dical: Off
✓ 21 - TKO to HVR tra			·		
✓ 24 - SBY to AUTO	Output	<ul> <li>No name</li> </ul>			
✓ 19 - Takeoff vertica					
✓ 25 - Hover HERE ( H 22 - RTH	GPIO 7	-			
✓ 23 - Hover HERE (H	04 0.	Pulse On 🔵 Pulse Off			
18 - LND at Home	Off On ●	Puise On Puise Off	_		
▼ Buttons	Time 0.0	2			
🗸 0 - To SBY					
🗸 7 - SBY Button 🗸					
New Automation 👻					

Action - Output

There are four possible output signals:

- Off: provides continuous 0V output.
- **On**: provides continuous 3.3V output.
- Pulse ON: provides 3.3V for the specified time and after that 0V.
- Pulse OFF: provides 0V for the specified time and after that 3.3V.

### 7.2.6.2.19 Periodical

мбоо 🛪 💿 💿 葦	😧 端 🚯	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name		71 - No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	Pe Pe	rio 🝷 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Timer 1	•		
✓ 11 - Auto Mode	Dura Dura	Stop		
✓ 34 - Arm Sequence	Run Run	Stop		
✓ 12 - Manual Mode	Reset			
✓ 35 - Arcade/HLD wl ▼ Transitions	Tuno	Time 🔻		
✓ Transitions ✓ 21 - TKO to HVR tragentiations	🗸 Туре	Time v		
	✓ Mode	Fixed peri • Period	0.0	s
New Automation 💌				

This action is used to set a timer during a flight operation.

Action - Periodical

The first parameter is an identifier for the timer, so it can be used in an event for another automation. In order to explain the other parameters of the timer action, a set of examples will be detailed, each of them with different options.

- **Run + Distance/Time + Continuous:** when the action is triggered, the timer will be started and will measure distance/time from that instant until the moment when the autopilot is turned off (or until another automation acts on the same timer).
- **Run + Distance/Time + Fixed Delay/Period:** once the action has been triggered, the timer will start to measure a distance/time. Each time the value indicated in Period is reached, the event linked to this timer will be triggered. For example, if the user wants to take a photo each 25 meters, the timer should have Distance in the Type option and 25 meters in Period, then in another automation, an event of type Timer is created, so each time the timer reaches 25 meters the event will be triggered and the action will be carried out
- Distance + Vector: the distance is measured in the direction indicated by the vector.
- Stop: the timer will be stopped. Another automation should be created to run it again.
- **Reset:** when this action is active, the timer is reset to zero before starting to measure. If the reset is used with Stop, the timer will be stopped and set back to zero.

The difference between fixed delay and fixed period has been explained in Automations.

# 7.2.6.2.20 Phases

The flight phase is changed to the one selected in this action.

мбоо 🛪 💿 💿 葦	🔇 🔅 🚯	🗀 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	
✓ 29 - No name	7	'1 - No name	30 - 1	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A Pha	ase 👻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Change to	Takeoff 🔹		
✓ 11 - Auto Mode	- L			
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
✓ 21 - TKO to HVR tra				
New Automation 👻				

Action – Phases

# 7.2.6.2.21 Ports

This action allows the user to switch between two pre-set configurations defined in Ports.

100 🛪 📀 🧿 \Xi	😵 🐝 🕰 🗂	▲ ⊘ 🛄		
17 - GE ON	No name			
27 - Activate GE on Ta	Events	AND OR NOT	Actions	
28 - Deactivate GE on 29 - No name	71 - 1	No name	30 - N	lo name
<ul> <li>✓ 30 - LINK off</li> <li>✓ 31 - Link on</li> </ul>				
33 - Landing to SBY ✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing ( ✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> </ul>			Delay 0.0 s	Periodical: Off
<ul> <li>✓ 41 - No name</li> <li>▼ Stick</li> </ul>	Ports	▼ No name		
✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode	Select Routing 1	-		
✓ 34 - Arm Sequence ✓ 12 - Manual Mode	Routing 1 Routing 2	1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -		
✓ 35 - Arcade/HLD wl	Rodding 2			
21 - TKO to HVR tra				
New Automation				

Action - Ports

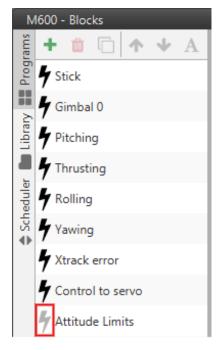
# 7.2.6.2.22 Run Block Program

When this action is triggered, the block program specified in the "Execute" label is executed.

100 🛪 📀 🧿 葦	😧 端 🗗	) 🗂 🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
<ul> <li>29 - No name</li> <li>30 - LINK off</li> <li>31 - Link on</li> <li>33 - Landing to SBY</li> <li>36 - RTH (tko save)</li> <li>37 - RTH to Landing (</li> <li>32 - Save tko point</li> <li>38 - Inside Cylinder</li> </ul>		71 - No name	30	- No name
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - No name</li> <li>✓ Stick</li> </ul>	8 B	Run 🔻 No name	Delay 0.0	s Periodical: Off
<ul> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> <li>✓ 35 - Arcade/HLD wi</li> <li>✓ Transitions</li> <li>✓ 21 - TKO to HVR trave</li> </ul>	Execute	Attitude Limits	<b>*</b>	
New Automation				

Action - Run Block Program

This action can run those programs that have the lightning icon in grey colour as those programs with the lightning icon in black color run continously.



Action – Lightning Icon

# 7.2.6.2.23 Safety Bits

This action selects a predefined safety bits list which must have been previously configured.

1 💿 🐼 🛪 😳	😧 端 🚯	□ ▲ ⊘ Ⅲ		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	7	1 - No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A E Saf	et 👻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Select bit list	List A 👻		
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence		List A		
✓ 12 - Manual Mode		List B		
✓ 35 - Arcade/HLD wl		List C		
▼ Transitions		Character and the second se		
21 - TKO to HVR tra				
New Automation 🔹				

Action - Safety Bits

# 7.2.6.2.24 Select Arcade Axis

The axes system of the aircraft is changed to one that has been previously created in the Arcade Axis option inside the Control Panel, see section *Arcade Axis* 

м600 🛪 💿 흐 🏥	😧 端 🚯 🛛	□ ▲ ⊘ Ⅲ		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	-
✓ 29 - No name	7	'1 - No name	30 - N	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A E Sel	ec 👻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Arcade axis sele	ection		
✓ 11 - Auto Mode	Body - Of	fset: 0.0		
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
✓ 21 - TKO to HVR tra				
New Automation 👻				

Action - Select Arcade Axis

# 7.2.6.2.25 Stick Priority

The stick priority table is changed to one that has been previously created in Stick Configuration inside the Devices menu, see section *Stick*. By default priority table 0 is selected when Veronte starts.

м600 🛪 💿 🔁 葦	📀 端 🍄 🗂	🔺 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	-
✓ 29 - No name	71 -	No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	Stick	<ul> <li>No name</li> </ul>		
▼ Stick				
✓ 13 - Hold Phase (Ar	Priority table 0			
✓ 11 - Auto Mode	Priority table 1			
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
21 - TKO to HVR tra				
New Automation 👻				

Action - Stick Priority

### 7.2.6.2.26 Terrain Obstacle

This option is used to make the aircraft climb when is reaching an altitude of zero meters, for example, when flying towards a mountain. This option is not activated all the time because it will not allow the aircraft to land.

1600 🛪 💿 🔁 🏗	🔇 端 🚳 🕻	⊐ ▲ ⊘ ☷		
17 - GE ON	No name			
20 - GE OFF 27 - Activate GE on Ta	Et.		A	
28 - Deactivate GE on	Events	AND OR NOT	Actions	т
✓ 29 - No name	71	- No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder ✓ 40 - Attitude Limits			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
▼ Stick	C E Terr	a 🔻 No name		
✓ 13 - Hold Phase (Ar	Enable	•		
🗸 11 - Auto Mode	chable	· ·		
✓ 34 - Arm Sequence	Distance	0.0	m 🔂	
🖌 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
▼ Transitions				
V 21 - TKO to HVR tra				
New Automation 🔹				

Action – Terrain Obstacle

• **Distance:** establish how the aircraft will climb, it can be said to be a repulsion value. High values made the platform ascent quickly. This effect is more noticeable when the aircraft is close to the ground.

### 7.2.6.2.27 Track

This action is used to configure a hover/loiter route (depending if it is a multicopter or an airplane) for the platform. Besides, there exists an option to follow a moving object.

1600 🛪 📀 💿 葦	: 🔇 📽 🖾 🔺 🖉 🏭
17 - GE ON	No name
27 - Activate GE on Ta 28 - Deactivate GE on	Events AND OR NOT Actions +
<ul> <li>29 - No name</li> <li>30 - LINK off</li> <li>31 - Link on</li> <li>33 - Landing to SBY</li> <li>36 - RTH (tko save)</li> <li>37 - RTH to Landing (</li> <li>32 - Save tko point</li> <li>38 - Inside Cylinder</li> </ul>	71 - No name     30 - No name
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - No name</li> <li>✓ Stick</li> <li>✓ 13 - Hold Phase (Ar</li> <li>✓ 11 - Auto Mode</li> </ul>	Delay 0.0 s Periodical: Off
✓ 34 - Arm Sequence       ✓ 12 - Manual Mode       ✓ 35 - Arcade/HLD wl       ▼ Transitions       ✓ 21 - TKO to HVR trave       ✓ New Automation	Location Current Lat: 0.000000 Lon: 0.000000 Direct Loiter Auto Hover Distance 0.0 m

Action - Track

There are our different options for the Track action, selecting **Disabled** no action will have effect on the guidance. The others are explained below.

### 7.2.6.2.27.1 Position

The aircraft will loiter/hover in a selected point.

- Selecting **Current** will make the platform to hover over the position that the vehicle has when this action is triggered, or loiter around that point in a circular route with a radius indicated in **Distance**.
- It is also possible to select the direction of the loiter (Auto, Clockwise and Anticlockwise).
- On the other hand, the box (Longitude, Latitude) in the figure allows the user to select the point where the hover/loiter will be performed.

# 7.2.6.2.27.2 Follow Leader

The platform (Multicopter) will follow an moving object.

м600 🛪 💿 흐 葦	😧 📽 🕰 🕻	⊐ ▲ ⊘ ☷		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71	- No name	30 - No	name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0 s	Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	🖉 🖹 Trac	k 👻 No name		
▼ Stick				
✓ 13 - Hold Phase (Ar	Follow Leader	✓ Leader	Moving Object 00	
✓ 11 - Auto Mode				
✓ 34 - Arm Sequence	Distance to l	eader 15.0	🛱	
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl	Distance bet	ween points 2.0	m 💭	
<ul> <li>▼ Transitions</li> <li>✓ 21 - TKO to HVR tra</li> </ul>	Offset	Body   NED		
	North 0.0	m East 0.0 m	n Down 0.0 m	
New Automation 🔹				

#### Follow Leader

- Leader: here is selected the moving object i.e, the object to follow.
- Distance to leader: distance to leader over trajectory.
- Distance between points: leader route is generated by points separated by the distance specified here.
- Offset: user can establish offset parameters related to trajectory in Body or NED coordinates.

To configure correctly this automation, user has to follow the next steps:

- Configure Telemetry Air and Ground.
- Configure the automation as desired.

# 7.2.6.2.28 User Log

An entry is added to the log on board.

м600 🛪 🙆 ᄒ 🏗	🚱 端 🚯	🗂 🔺 🖉 🏭		
17 - GE ON	No name			
20 - GE OFF 27 - Activate GE on Ta	Events	AND OR NOT	Actions	+
28 - Deactivate GE on ✓ 29 - No name		71 - No name	30 - 1	No name
✓ 30 - LINK off ✓ 31 - Link on				
33 - Landing to SBY ✓ 36 - RTH (tko save)				
<ul> <li>✓ 37 - RTH to Landing (</li> <li>✓ 32 - Save tko point</li> </ul>				
<ul> <li>✓ 38 - Inside Cylinder</li> <li>✓ 39 - Outside Cylinder</li> </ul>			Delay 0.0	s Periodical: Off
<ul> <li>✓ 40 - Attitude Limits</li> <li>✓ 41 - No name</li> </ul>		er 🔻 No name		
▼ Stick ✓ 13 - Hold Phase (Ar	Add entry to th	e log on board		
✓ 11 - Auto Mode ✓ 34 - Arm Sequence				
✓ 12 - Manual Mode ✓ 35 - Arcade/HLD wl				
<ul> <li>▼ Transitions</li> <li>✓ 21 - TKO to HVR trage</li> </ul>				
New Automation				

Action – User Log

## 7.2.6.2.29 Variable

Allows the user to select a variable and save it in an user variable.

1600 🛪 💿 🔁 🏗	😧 🔅 🏖	∃ 🏊 🖉 🏭		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
<ul> <li>29 - No name</li> <li>30 - LINK off</li> <li>31 - Link on</li> <li>33 - Landing to SBY</li> <li>36 - RTH (tko save)</li> <li>37 - RTH to Landing (</li> <li>32 - Save tko point</li> <li>38 - Inside Cylinder</li> <li>39 - Outside Cylinder</li> <li>40 - Attitude Limits</li> </ul>	71	- No name	30 - N Delay 0.0 s	o name
✓ 41 - No name ▼ Stick	🔗 🖹 Varia	a 🔻 No name		
✓ 13 - Hold Phase (Ar ✓ 11 - Auto Mode	Value	Cons	tant value: 0.0	
✓ 34 - Arm Sequence       ✓ 34 - Arm Sequence       ✓ 12 - Manual Mode       ✓ 35 - Arcade/HLD wl       ▼ Transitions       ✓ 21 - TKO to HVR trave       ✓ New Automation	Save value in	User Variab	ole 01 (Real - 32 bits)	

Action – Variable

### 7.2.6.2.30 Yaw

When this action is triggered the actual yaw can be commanded. This action is useful when flying without a magnetometer, as the user can stablish the current yaw value when it is known.

м600 🛪 💿 🔁 葦	😧 📫 🍪 🕻	⊐ ▲ ⊘ ☷		
17 - GE ON	No name			
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND OR NOT	Actions	+
✓ 29 - No name	71	- No name	30 -	No name
✓ 30 - LINK off				
✓ 31 - Link on				
33 - Landing to SBY				
✓ 36 - RTH (tko save)				
✓ 37 - RTH to Landing (				
✓ 32 - Save tko point				
✓ 38 - Inside Cylinder				
✓ 39 - Outside Cylinder			Delay 0.0	s Periodical: Off
✓ 40 - Attitude Limits				
✓ 41 - No name	A 🕞 Yaw	<ul> <li>No name</li> </ul>	7	
▼ Stick				
✓ 13 - Hold Phase (Ar		Constant value: 0.0		
✓ 11 - Auto Mode				, 
✓ 34 - Arm Sequence				
✓ 12 - Manual Mode				
✓ 35 - Arcade/HLD wl				
<ul> <li>Transitions</li> </ul>				
🗸 21 - TKO to HVR tra				
New Automation 👻				

#### Action - Yaw

The Actions box contains all the actions that will be performed when the event (or group of events) has been accomplished.

To create a new action press . When entering a new Event or Action it is possible to choose from one of the previously created on the system or to create a new one.

छ мбоо 🛪 💿 🧿 🏣	😧 😳 🕰	) 🗂 🔺 🖉				
17 - GE ON	No name					
27 - Activate GE on Ta 28 - Deactivate GE on	Events	AND	NOT	Actions		-
✓ 29 - No name		71 - No name				
✓ 30 - LINK off						
✓ 31 - Link on						
33 - Landing to SBY ✓ 36 - RTH (tko save)						
✓ 37 - RTH to Landing (						
✓ 32 - Save tko point						
✓ 38 - Inside Cylinder						
✓ 39 - Outside Cylinder				Delay 0.0	s Perio	dical: Off
✓ 40 - Attitude Limits						
🖌 41 - No name	2 B	▼ Inser			0.0	s
▼ Stick						
✓ 13 - Hold Phase (Ar						
✓ 11 - Auto Mode						
✓ 34 - Arm Sequence ✓ 12 - Manual Mode						
✓ 35 - Arcade/HLD wl						
▼ Transitions						
21 - TKO to HVR tra						
New Automation						

#### Automations Panel – Actions

When creating a new action, it possible to select different types of actions, these are explained in the next sections.

Automations are actions that are carried out when a combination of events happen, i.e when the events are accomplished the action are done. An example of what an automation could be a change of phase when reaching a certain altitude and speed, moving a servo when a button is clicked and many other possible combinations. In this section all the possible events and action will be explained in detail, so the user can combine them to create the automations that best suit their needs.

The following figure shows the layout of the automations menu, with a column for the events and another for the actions linked to these events.

1600 🛪 💿 💼 🏣	🚱 🚅 🚜 🗂 🔺 🖉 🏢	
✓ 31 - Link on 33 - Landing to SBY	RTH to Landing (inflight point)	
✓ 36 - RTH (tko save) ✓ 37 - RTH to Landing (	Events AND OR NOT Actions	+
✓ 32 - Save tko point ✓ 38 - Inside Cylinder	54 - DV<0.08 26 - To LDN	
<ul> <li>✓ 39 - Outside Cylinder</li> <li>✓ 40 - Attitude Limits</li> </ul>	55 - V<0.08	
▼ Stick	58 - RTH compliance	
✓ 11 - Auto Mode		
<ul> <li>✓ 34 - Arm Sequence</li> <li>✓ 12 - Manual Mode</li> </ul>	Delay 0.0 s Perio	dical: Off
▼ 35 - Arcade/HLD w Transitions	Varia V<0.08 Compliance time 0.0	s
<ul> <li>✓ 21 - TKO to HVR tra</li> <li>✓ 24 - SBY to AUTO</li> </ul>	Variable Velocity	
<ul> <li>✓ 19 - Takeoff vertica</li> <li>✓ 25 - Hover HERE ( H</li> </ul>	✓ Max 0.08 🌣	
22 - RTH ✓ 23 - Hover HERE (H	Min 0.0 🗱	
■ 18 - LND at Home ▼ Buttons	Invert range 🗸	
New Automation	Min Ma Event triggered on blue area	×

#### Automation Display

Automations (red) are a combination of events (blue) and actions (green). All actions will be performed on event or an event combination triggering. There a are some parameters that can be configured in the events and actions menu and which are applicable independently of the type of event/action configured (black).

- Delay: time between the triggering of the event and the beginning of the action.
- **Compliance Time:** is a value related to the automations. Indicates how much time the event has to be accomplished in order to trigger the action. For example, if an event is to be above 100 meters and the value of Time is 3 seconds, the platform has to be above 100 meters during at least 3 second to trigger the action.
- **Periodical:** this menu is used to configure actions to take place periodically during the time that the events are active.

<ul> <li>Enabled</li> </ul>						
Туре	distance	*	Vector	0.0	0.0	0.0
Mode	Fixed del		Period	-1.0		m

#### Automation Selection

The action can be configured to take place each certain distance or time. When using distance, the option Vector makes it possible to measure that distance along a direction specified by that vector. The two modes available for both time and distance are fixed delay and period. In order to explain the difference between them, the following figure is presented as an aid to the user.



#### Automation Selection

Let's consider that the system evaluates the automations each second (black line), and the automation that contains the periodical option is wanted to execute each 1.5 seconds (red line). In that case, the first action will be triggered at the second 1.5 but will be evaluated at second 2. The second time that the action is evaluated will depend on the mode: if fixed delay is selected, the evaluation of the action will be done 1.5 seconds after it was evaluated the first time, so that will be at second 3.5. On the other hand, if the mode is fixed period, the action will be evaluated 1.5 seconds after the first triggering (not evaluation) so that would be at the second 3. In the real praxis, the evaluation time for the automation is much lower than 1 second so the difference between the modes is much smaller.

Finally, automations can be grouped

### 7.2.6.3 Other Options

To create a new automation press **New Automation**, a new window will be displayed, users can select a previous one (if exists) or **Create new**.

Right-clicking on an automation makes it possible to **Remove** it or to **Clone** it. When a clone of an automation is created, the changes made in the event panel will be applied to the other one and vice versa, while the actions can be different in each automation.

Automations also can be grouped by right-clicking in an automation and selecting the option **Change Group**. When a group is created, the rest of automations that the user wants to add to the group can be done by drag and drop.

Common configuration options are:

Buttor	Description
Q	Select an action or event from the available in the system. When modifying an action or event it will be modified in all automations where it is in use.
	Clone an existing action or event creating a new one with same parameters configured on the start point.

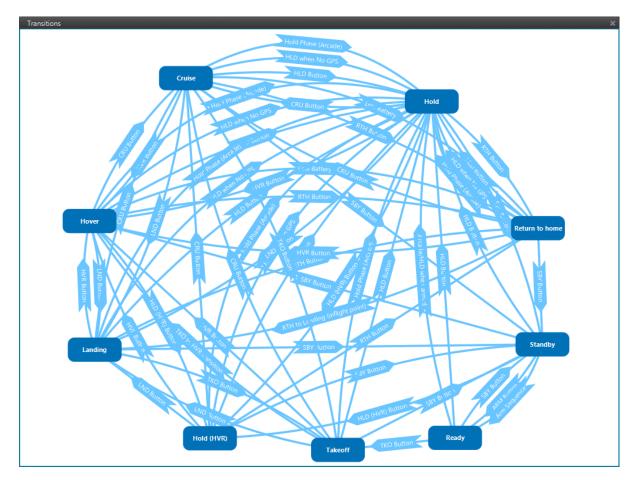
By pressing the drop down list next to New Automation button two additional options can be found.

м600 🛪 💿 💿 葦	😧 端 🕰 🗂	▲ ⊘ ⅲ		
✓ 24 - SBY to AUTO ✓ 19 - Takeoff vertica	Auto when No Stick			
✓ 25 - Hover HERE ( ŀ	Events	AND OR NOT	Actions	+
22 - RTH	20 - St	ick Error	9 - Al	ло
✓ 23 - Hover HERE (H	20 50			
■ 18 - LND at Home ▼ Buttons				
✓ 0 - To SBY ✓ 7 - SBY Button				
✓ 7 - SBY Button				
✓ 3 - HVR Button				
✓ 4 - LND Button				
✓ 4 - LND Button				
✓ 6 - TKO Button			Delay 0.0 s	Periodical: Off
✓ 26 - ARM Button				
✓ 16 - HLD (HVR) But	Alarm	<ul> <li>Stick Error</li> </ul>	✓ Compliance time	2.0 s
✓ 1 - HLD Button	Type Fail one	-		
✓ 15 - Arcade Trim	The randice			
▼ Failsafe		ted		+
✓ 10 - Auto when No				
✓ 14 - Low Battery				
8 - LinkOff to FTLP				
9 - HLD when No G				
< >				
New Automation				
Show phase transition diagram				
Delete unused events and action	s			

### Automation Drop Down List

**Delete unused events and actions** option deletes those events or actions that has been created but are not in use in any automation.

**Show phase transition diagram** option generates a diagram in which the phase changes through the different automations can be visualized. An example of such diagrams is shown in the figure below.



Phase Diagram

# 7.2.7 Variables

# 7.2.7.1 System Variables

### 7.2.7.1.1 Names

This menu is used to set a custom name for one of the system variables.

- 1. Click on the **Custom Name** cell of the desired variable and **introduce the new name** for it.
- 2. When the name is introduced press Enter to store the name on the system.
- 3. Press **Save** to save all changes.

enguin Embention 🛪 💿 🧿 🗄	E 🚱 🗱 🕾 🖽	▲ ⊘ Ⅲ		
ystem Variables				
Names 🗡	Use Default name	Custom name	Show unit	Init value(SI)
Telemetry	Actuator Output s1	Right Aileron	Custom Ty	
niffer 🗸	Actuator Output s2	Left Aileron	Custom Ty	
$\checkmark$	Actuator Output s3	Left Flap	Custom Ty	
	Actuator Output s4	Right Flap	Custom Ty	
	Actuator Output s5	Right Stabilizer	Custom Ty	
$\checkmark$	Actuator Output s6	Left Stabilizer	Custom Ty	
$\checkmark$	Actuator Output s7	Wheel	Custom Ty	
$\checkmark$	Actuator Output s8	Throttle	Custom Ty	
	Actuator Output s9	Landing Gear	Custom Ty	
	Actuator Mode		Unitless	
$\checkmark$	Actuator Output s10		Custom Ty	
	Actuator Output s11		Custom Ty	
$\checkmark$	Actuator Output s12		Custom Ty	
	Actuator Output s13		Custom Ty	

#### Variable Name Customization

Name	Туре	Size
U	Unsigned int	16
R	Float	32
В	Bit	1

Besides changing their name, the user can also configure the measurement units of the variables, as well as the initial value (expressed in SI units) they will have each time the system (re)starts, using the **Show Units** and the **Initial Value** (SI) cells.

### 7.2.7.2 Telemetry

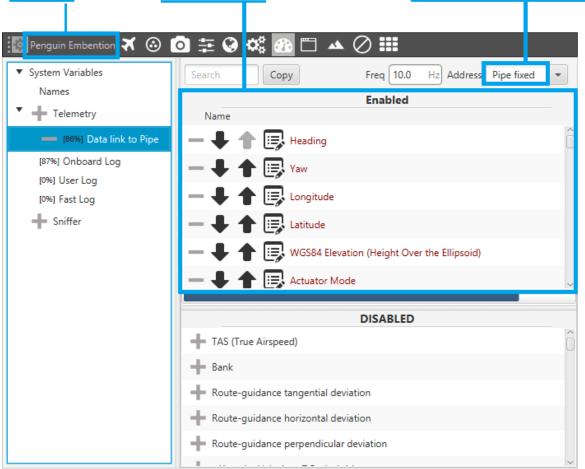
Telemetry controls permit to configure data to be stored or transmitted on the system. There are 4 main items that can be configured within this panel:

Туре	Description
Data Link	Configures the variables to send throughout the data link channel.
Onboard	Sets the variables to be stored on system Log. (on Veronte SD Card)
Log	
User Log	User Log for custom applications.
Fast Log	Saves data at the maximum frequency available on the system. Recording time depends on the selected variables.

Configuration display permits to enable the desired variables for each telemetry file and to set the maximum and minimum values together with precision for each one.

### 7.2.7.2.1 Data Link

The Data Link contains the variables sent between Veronte Units and Veronte Pipe. By default, the system provides one Data Link that represents the connection between the air autopilot and the software (Pipe). Veronte Air sends the variables to Veronte Ground, being processed when they arrive there by Veronte Pipe. The variables indicated in red in a Data Link to Pipe are required for correct operation of Pipe.



# <u>Veronte will send all these variables</u> to the Veronte with the corresponding Address

#### Telemetry Configuration Menu

Pipe permits the creation of more Data Links too. The user has to configure which unit sends the information and which receives it and the sending rate. As an example, another possible data link could be set between the Air and Ground autopilots directly (without Pipe) and used to send the position of the UAV to the Ground autopilot for the configuration of a tracker. This Data Link example is presented in the following figure.

Penguin Embention 🛪 🙆 🕻	◙ ፰ Q 📽 🕼 🗂 🔺 ⊘ ⅲ
<ul> <li>System Variables</li> </ul>	Copy Freq 10.0 Hz Address Veronte v4.
Names	Enabled
Telemetry	Name
[86%] Data link to Pipe	- 🗣 🛖 🕞 Latitude
5 Data link to Veronte	- 🗣 👚 🕞 Longitude
[87%] Onboard Log [0%] User Log	— 📕 🛧 🕞 AGL (Above Ground Level) – Height
[0%] Fast Log	
Sniffer	
	DISABLED
	IAS (Indicated Airspeed)
	TAS (True Airspeed)
	GS (Ground Speed)
	Heading
	Flight Path Angle
< [ >	· · · · · · · · · · · · · · · · · · ·

Data Link (Ground/Air)

The autopilot **Penguin Embention** will send the Latitude, Longitude and AGL to the autopilot with address **Veronte v4.0 1085**. The sending rate of these data links can be modified by the user. In this example, the sending rate is 10 Hz. The unit that receives the telemetry has to configure its sniffer in order to store the data.

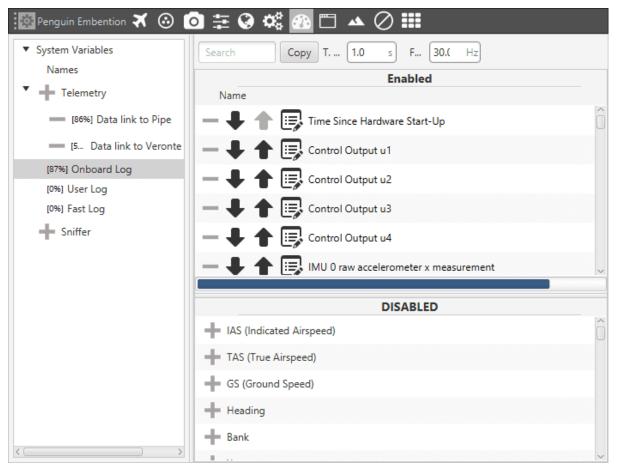
There is a special address called Broadcast. This means that every Veronte could receive the information of this data link (if they are configured to do so).

**Warning:** If the number of variables enabled for telemetry communication are higher than the maximum supported by the system, the latest variables will not be sent, so they will display a zero value if shown in the workspace.

**Note:** It is possible to create more than one data link associated to the same receiver address, and they can also have different sending rates. It could be useful in case one of the data links is almost full.

## 7.2.7.2.2 Onboard Log

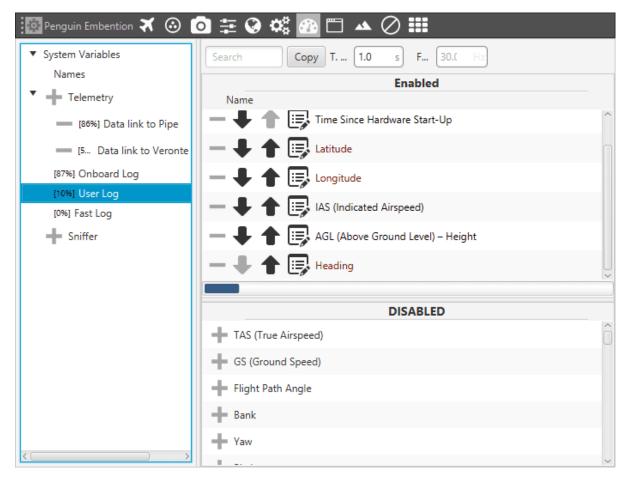
The Onboard Log determines the variables that are being stored on the autopilot SD Card. In this case, there are not sending/receiving units, so the only thing to configure here is the list of variables that will be saved on the autopilot internal memory for a further download and processing, as well as the writing frequency (30 Hz in the example of the image below).



Onboard Log

# 7.2.7.2.3 User Log

The user log contains the variables that are stored according to an automation created by the user. Considering an example, in a photogrammetry mission it is important to record the aircraft location when the photo is taken, so a user log could be used to record a certain set of variables (position, speed, direction...) each time a photo is taken.



User Log

In order to create a User Log action where an entry is added to the log when a certain set of events are accomplished check *Automations*.

## 7.2.7.2.4 Fast Log

The fast log store the specified variables at the maximum rate available on the system. This tool could be used to save information in an operation that happens extremely fast, such as missile launching. The time that this logging process lasts depends on the number of variables being saved.

When a variable is enabled in the Fast Log, a new button will appear in the Veronte Panel. The user must click on it when he wants to activate the fast log tool.

Mentor [9 Hz]		×
	· 🕅 🟠	:0 A
Stand	by	<b>\$</b>
Takeo	off	\$>> (C)
Climbi	ing	\$>> (©
Waypoints		\$>> ©
Hold	ł	\$>> @
Landing	Flare	\$>> ©
CheckList: Check pressure Check propeller Check MANUAL Configure calibre	is tight enoug controls (serv	os & mot

### Fast Log button

The downloading of the information of an operation depends on how it has been stored, i.e depends on the type of log (data link, onboard, user or fast). Visit section 10 of the manual to see the information related to the postflight tools contained in Veronte Pipe.

## 7.2.7.2.5 Compressing options

Veronte includes some compression tools that may be useful for increasing the amount of information transmitted in a certain bandwith or stored in a log. Each variable can be compressed separately in each log.

Penguin Embention 🛪 🙆	◙ ≑ Q 📽 🜇 🗖 🔺 ⊘ ⅲ
<ul> <li>System Variables</li> </ul>	Copy Freq 10.0 Hz Address Veronte v4.
Names	Enabled
Telemetry	Name
(86%) Data link to Pipe	- 🖶 🛖 🕞 Latitude
[5 Data link to Veronte	- 🗣 🛧 🔜 Longitude
[87%] Onboard Log [0%] User Log	- I AGL (Above Ground Level) - Height
[0%] Fast Log	
Sniffer	
	DISABLED
	IAS (Indicated Airspeed)
	TAS (True Airspeed)
	GS (Ground Speed)
	Heading
	Flight Path Angle
< >	· · · · · · · · · · · · · · · · · · ·

Compression options icon

There are different types of compression available:

Type Variable	-		
	Latitude		
Uncompressed     Compress			
Compress (Dec			
Compress (Bits unsigned)			
Encode			
Min	0		
Max	0		
Decode			
Min	0		
Max	0		
Encode / Decode	1.0		

Compression options

- Uncompressed: the variable is taken in its full length, with no value modification.
- **Compress (Bits signed)**: specify the number of bits to be compressed to (negative values accepted). It is necessary that the user configures Encode/Decode options.
- **Compress (Bits unsigned)**: specify the number of bits to be compressed to (no negative values accepted). It is necessary that the user configures Encode/Decode options.
- Compress (Decimals): the variable is compressed according to the number of decimals specified and the range specified (max and min values). The resultant compression (number of bits) follows the relation  $(max min) \cdot 10^{decimals}$  which yields the encoding of the maximum value of the range (and the number of bits necessary for that). The range needs to be specified on the Encode Min/Max field.
- **Encode/Decode**: these values are used to apply a scaling factor after the transformation from binary to decimal value, or before the transformation from decimal to binary value.

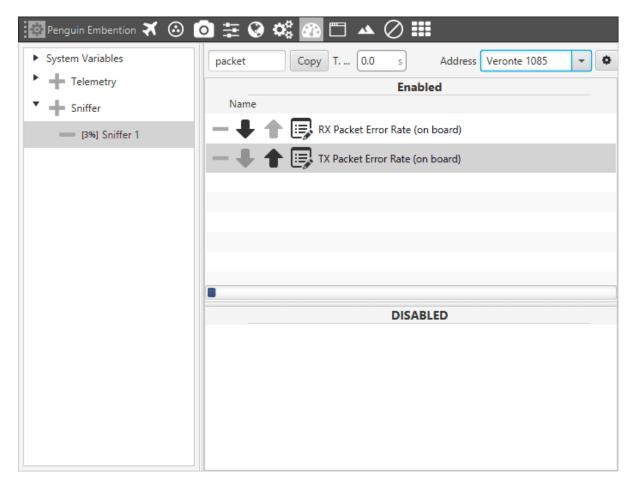
In the example shown below, the Heading variable with 3 decimals will be compressed, so instead of using 32 bits, it will only require 19 bits.

Type	Variable	-
	Heading	
O U	ncompressed	
0 C	ompress	
• C	ompress (Decimals)	]
) C	ompress (Bits signed)	3
0 C	ompress (Bits unsigned)	
Enco	de	
Mi	n aw Measure 0	
Ma	ix en Measure 359.999	
Deco	dev Measure Z	
e Mi	Deration) of	
Ma	<b>x</b> 0	
Enco	de / Decode	1.0

Compression example

## 7.2.7.3 Sniffer

This menu is used to establish a telemetry communication between two autopilots. The autopilot being configured will "listen" the variables indicated in the window **Enabled**, from another autopilot whose address is indicated in **Address**. The sniffer is commonly used to make the aircraft listen the position of the ground station and the link quality.



### Sniffer Configuration Menu

The source UAV, in this case, is the ground station (1085), which communicates to the Air UAV its position and some variables related to link quality (Rx and Tx Packet Error Rates). In **Mapping Variables** (Select **Configure**), the ones send by the ground UAV are indicated in the columm **IN**, and they are stored in the variables indicated in **Out** for its later use by the air autopilot.

The sniffer is configured so that the air autopilot has information about the state of the communications, and it could perform an action when the link is lost. The aerial platform also receives information about the ground station position, so it can perform a mission in relation to that point.

8	IN Color Color	Out	
riable	RX Packet Error Rate (on board)	Rx Ground	- A-
Mapping variables	TX Packet Error Rate (on board)	Tx Ground	
ppin	UAV position	Ground Position	
Map			
			~(

### Mapping Variables

The Veronte Unit that sends the data has to be configured as well, in the Telemetry Panel. That unit will send telemetry through a Data Link.

## 7.2.7.4 List of Variables

**Warning:** Bit Variables displayed on Labels (see ref Workspace – Gauge Display) will be shown as Red/Green depending on its state. Red stands for 0 and Green for 1, changing the name displayed accordingly to the BIT value.

## 7.2.7.4.1 32 VAR

0         IAS (Indicated Air Speed)         m/s         Pitot-static measurement speed           1         TAS (True Air Speed)         m/s         Speed relative to the armass in which the vehicle is moving (           3         Heading         rad         Direction in which the vehicle velocity vector is pointing           3         Heading         rad         Angle between velocity vector and local horizontal line           5         Bank         rad         Angle around the Vertical axis of the vehicle           7         Pitch         rad         Angle around the Transverse axis of the vehicle           8         Roll         rad         Angle around the Transverse axis of the vehicle           9         Route-guidance tangential deviation         m         Tangencial distance to the desired position (guidance)           10         Route-guidance perpendicular deviation         m         Perpendicular distance to the desired position (guidance)           11         Route-guidance perpendicular deviation         m         Perpendicular distance to the desired position (guidance)           12         p (Angular Velocity - Y Body Axis)         rad/s         Angular velocity around longitudinal axis           13         q (Angular Velocity - Y Body Axis         m/s <sup>2</sup> Acceleration in the X-axis           16         Right Acceleration - X Body Axis	ID	Name	Units/Values	Description
1       TAS (True Air Speed)       m/s       Speed relative to the airmass in which the vehicle is moving (         2       GS (Ground Speed)       m/s       Horizontal speed, relative to the ground         3       Heading       rad       Direction in which the vehicle velocity vector is pointing         4       Flight Path Angle       rad       Angle between velocity vector and local horizontal line         5       Bank       rad       Angle around the Vertical axis of the vehicle         6       Yaw       rad       Angle around the Vertical axis of the vehicle         7       Pitch       rad       Angle around the Vertical axis of the vehicle         8       Roll       rad       Angle around the Vertical axis of the vehicle         9       Route-guidance tangential deviation       m       Tangencial distance to the desired position (guidance)         11       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around longitudinal axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around longitudinal axis         14       r (Angular Velocity - Z Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         15	0	IAS (Indicated Air Speed)		•
2         GS (Ground Speed)         m/s         Horizontal speed, relative to the ground           3         Heading         rad         Direction in which the vehicle velocity vector is pointing           4         Flight Path Angle         rad         Angle between velocity vector and local horizontal line           5         Bank         rad         Angle around the Vehicle vehicle component           6         Yaw         rad         Angle around the Vertical axis of the vehicle           7         Pitch         rad         Angle around the Vertical axis of the vehicle           8         Roll         rad         Angle around the Unstructural axis of the vehicle           9         Route-guidance tangential deviation         m         Tangencial distance to the desired position (guidance)           10         Route-guidance perpendicular deviation         m         Perpendicular distance to the desired position (guidance)           11         Route-guidance borizontal deviation         m         Perpendicular distance to the desired position (guidance)           12         p (Angular Velocity - X Body Axis)         rad/s         Angular velocity around longitudinal axis           13         q (Angular Velocity - Z Body Axis)         rad/s         Angular velocity around lateral axis           14         r (Angular Velocity - Z Body Axis)         <	1		m/s	Speed relative to the airmass in which the vehicle is moving (
4       Flight Path Angle       rad       Angle between velocity vector and local horizontal line         5       Bank       rad       Velocity vector lateral component         6       Yaw       rad       Angle around the Vertical axis of the vehicle         7       Pitch       rad       Angle around the Congritudinal axis of the vehicle         8       Roll       rad       Angle around the Longritudinal axis of the vehicle         9       Route-guidance tangential deviation       m       Targencial distance to the desired position (guidance)         10       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         11       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around lateral axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         15       Forward Acceleration - X Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         17       Bottom Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Z-axis	2		m/s	
4       Flight Path Angle       rad       Angle between velocity vector and local horizontal line         5       Bank       rad       Velocity vector lateral component         6       Yaw       rad       Angle around the Vertical axis of the vehicle         7       Pitch       rad       Angle around the Congritudinal axis of the vehicle         8       Roll       rad       Angle around the Longritudinal axis of the vehicle         9       Route-guidance tangential deviation       m       Targencial distance to the desired position (guidance)         10       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         11       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around lateral axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         15       Forward Acceleration - X Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         17       Bottom Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Z-axis	3	Heading	rad	Direction in which the vehicle velocity vector is pointing
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8       Roll       rad       Angle around the Longitudinal axis of the vehicle         9       Route-guidance tangential deviation       m       Tangencial distance to the desired position (guidance)         10       Route-guidance horizontal deviation       m       Horizontal distance to the desired position (guidance)         11       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around lateral axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around lateral axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         15       Forward Acceleration - X Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         16       Right Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Y-axis         17       Bottom Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Y-axis         18       RPM       rad/s (RDS)       Revolutions per minute configurable for external sensor         19       Front GV (Ground Velocity)       m/s       GV vector Y component         21       Velocity       m/s       Velocity vector module         22	6	Yaw	rad	Angle around the Vertical axis of the vehicle
9       Route-guidance tangential deviation       m       Tangencial distance to the desired position (guidance)         10       Route-guidance horizontal deviation       m       Horizontal distance to the desired position (guidance)         11       Route-guidance horizontal deviation       m       Perpendicular distance to the desired position (guidance)         11       Route-guidance horizontal deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around longitudinal axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         15       Forward Acceleration – X Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         16       Right Acceleration – Z Body Axis       m/s <sup>2</sup> Acceleration in the Z-axis         18       RPM       rad/s (RDS)       Revolutions per minute configurable for external sensor         19       Front GV (Ground Velocity)       m/s       GV vector X component         20       Lateral GV (Ground Velocity)       m/s       GV vector Modula         21       Velocity vector module       Coroce in X body axis       customTyp	7	Pitch	rad	Angle around the Transverse axis of the vehicle
10       Route-guidance horizontal deviation       m       Horizontal distance to the desired position (guidance)         11       Route-guidance perpendicular deviation       m       Perpendicular distance to the desired position (guidance)         12       p (Angular Velocity - X Body Axis)       rad/s       Angular velocity around lateral axis         13       q (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around lateral axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         14       r (Angular Velocity - Z Body Axis)       rad/s       Angular velocity around vertical axis         15       Forward Acceleration - X Body Axis       m/s <sup>2</sup> Acceleration in the X-axis         16       Right Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Z-axis         17       Bottom Acceleration - Z Body Axis       m/s <sup>2</sup> Acceleration in the Z-axis         18       RPM       rad/s (RDS)       Revolutions per minute configurable for external sensor         19       Front GV (Ground Velocity)       m/s       GV vector X component         20       Lateral GV (Ground Velocity)       m/s       Velocity vector module         22       Forward Load Factor - X Body Axis       customType       G-force in X body axis	8	Roll	rad	Angle around the Longitudinal axis of the vehicle
11Route-guidance perpendicular deviationmPerpendicular distance to the desired position (guidance)12 $p$ (Angular Velocity - X Body Axis)rad/sAngular velocity around longitudinal axis13q (Angular Velocity - Z Body Axis)rad/sAngular velocity around lateral axis14r (Angular Velocity - Z Body Axis)rad/sAngular velocity around lateral axis15Forward Acceleration - X Body Axism/s²Acceleration in the X-axis16Right Acceleration - Z Body Axism/s²Acceleration in the Y-axis17Bottom Acceleration - Z Body Axism/s²Acceleration in the Z-axis18RPMrad/s (RDS)Revolutions per minute configurable for external sensor19Front GV (Ground Velocity)m/sGV vector X component20Lateral GV (Ground Velocity)m/sCytoer or y component21Velocitym/sVelocity vector module22Forward Load Factor - X Body AxiscustomTypeG-force in X body axis23Right Load Factor - Z Body AxiscustomTypeG-force in X body axis24Bottom Load Factor - Z Body AxiscustomTypeG-force in X body axis25Tangential Accelerationm/s²Acceleration for tangential direction26Co-yawradAcrobatic Pitch with Body X' axis pointing to X29Co-pitchradAcrobatic Pitch with Body X' axis pointing to -Z30Co-orollradAcceleration around the longitudinal axis31Angular Acceleration - X Bod	9	Route-guidance tangential deviation	m	Tangencial distance to the desired position (guidance)
12p (Angular Velocity - X Body Axis)rad/sAngular velocity around longitudinal axis13q (Angular Velocity - Y Body Axis)rad/sAngular velocity around lateral axis14r (Angular Velocity - Z Body Axis)rad/sAngular velocity around vertical axis15Forward Acceleration - X Body Axism/s²Acceleration in the X-axis16Right Acceleration - Y Body Axism/s²Acceleration in the X-axis17Bottom Acceleration - Z Body Axism/s²Acceleration in the Z-axis18RPMrad/s (RDS)Revolutions per minute configurable for external sensor19Front GV (Ground Velocity)m/sGV vector X component20Lateral GV (Ground Velocity)m/sGV vector Y component21Velocitym/sVelocity vector module22Forward Load Factor - X Body AxiscustomTypeG-force in X body axis23Right Load Factor - Z Body AxiscustomTypeG-force in X body axis24Bottom Load Factor - Z Body AxiscustomTypeG-force in X body axis25Tangential Accelerationm/s²Absolute acceleration for tangential direction28Co-pitchradAcrobatic Yaw with Body Z' axis pointing to X29Co-pitchradAcrobatic Roll with Y' keeping same as Y31Angular Acceleration - X Body Axisrad/s²Acceleration around the lateral axis32Angular Acceleration - Z Body Axisrad/s²Acceleration around the longitudinal axis33Angular Acceleratio	10	Route-guidance horizontal deviation	m	Horizontal distance to the desired position (guidance)
13q (Angular Velocity - Y Body Axis)rad/sAngular velocity around lateral axis14r (Angular Velocity - Z Body Axis)rad/sAngular velocity around vertical axis15Forward Acceleration - X Body Axis $m/s^2$ Acceleration in the X-axis16Right Acceleration - Z Body Axis $m/s^2$ Acceleration in the Y-axis17Bottom Acceleration - Z Body Axis $m/s^2$ Acceleration in the Y-axis18RPMrad/s (RDS)Revolutions per minute configurable for external sensor19Front GV (Ground Velocity) $m/s$ GV vector X component20Lateral GV (Ground Velocity) $m/s$ GV vector Y component21Velocity $m/s$ Velocity vector module22Forward Load Factor - X Body AxiscustomTypeG-force in X body axis23Right Load Factor - Z Body AxiscustomTypeG-force in Y body axis24Bottom Load Factor - Z Body AxiscustomTypeG-force in Z body axis25Tangential Acceleration $m/s^2$ Absolute acceleration for tangential direction28Co-yawradAcrobatic Yaw with Body Z' axis pointing to X29Co-pitchradAcceleration around the longitudinal axis31Angular Acceleration - Z Body Axisrad/s²Acceleration around the longitudinal axis32Angular Acceleration - X Body Axisrad/s²Acceleration around the longitudinal axis33Angular Acceleration - Z Body Axisrad/s²Acceleration around the longitudinal axis34	11		m	Perpendicular distance to the desired position (guidance)
14r (Angular Velocity - Z Body Axis)rad/sAngular velocity around vertical axis15Forward Acceleration - X Body Axis $m/s^2$ Acceleration in the X-axis16Right Acceleration - Z Body Axis $m/s^2$ Acceleration in the X-axis17Bottom Acceleration - Z Body Axis $m/s^2$ Acceleration in the Y-axis18RPM $rad/s$ (RDS)Revolutions per minute configurable for external sensor19Front GV (Ground Velocity) $m/s$ GV vector X component20Lateral GV (Ground Velocity) $m/s$ GV vector Y component21Velocity $m/s$ customType23Right Load Factor - X Body AxiscustomType24Bottom Load Factor - Z Body AxiscustomType25Tangential Acceleration $m/s^2$ 26Absolute acceleration for tangential direction28Co-yawrad29Co-gitchrad20Co-rollrad21Acrobatic Roll with Body Z' axis pointing to X22O-rollrad23Right Load Factor - Z Body Axis24Bottom Load Factor - Z Body Axis25Tangential Acceleration26Co-yaw27Absolute acceleration for tangential direction28Co-yaw29Co-roll29Co-roll31Angular Acceleration - X Body Axis32Angular Acceleration - Y Body Axis33Angular Acceleration - Z Body Axis34Body to NED quaternio	12		rad/s	Angular velocity around longitudinal axis
15Forward Acceleration – X Body Axis $m/s^2$ Acceleration in the X-axis16Right Acceleration – Y Body Axis $m/s^2$ Acceleration in the Y-axis17Bottom Acceleration – Z Body Axis $m/s^2$ Acceleration in the Z-axis18RPMrad/s (RDS)Revolutions per minute configurable for external sensor19Front GV (Ground Velocity) $m/s$ GV vector X component20Lateral GV (Ground Velocity) $m/s$ GV vector Y component21Velocity $m/s$ Velocity vector module22Forward Load Factor – X Body AxiscustomTypeG-force in X body axis23Right Load Factor – Z Body AxiscustomTypeG-force in X body axis24Bottom Load Factor – Z Body AxiscustomTypeG-force in Z body axis25Tangential Acceleration $m/s^2$ Absolute acceleration for tangential direction28Co-yawradAcrobatic Pitch with Body Z' axis pointing to X29Co-rollradAcrobatic Roll with Y' keeping same as Y31Angular Acceleration - X Body Axisrad/s²Acceleration around the longitudinal axis32Angular Acceleration - Z Body Axisrad/s²Acceleration around the vertical axis33Angular Acceleration - Z Body Axisrad/s²Acceleration around the longitudinal axis34Body to NED quaternion qscustomTypeFirst component of body to NED orientation quaternion35Body to NED quaternion qscustomTypeFirst component of body to NED orientation quaternion <td>13</td> <td>q (Angular Velocity - Y Body Axis)</td> <td>rad/s</td> <td>Angular velocity around lateral axis</td>	13	q (Angular Velocity - Y Body Axis)	rad/s	Angular velocity around lateral axis
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42SCI-A Rx rate (4G)bytes/s4G link reception byte rate43SCI-A Tx rate (4G)bytes/s4G link transmission byte rate			• •	
43     SCI-A Tx rate (4G)       43     bytes/s       46     link transmission byte rate				
44     SCI-B Rx rate (LOS)     bytes/s     Radio link reception byte rate				
	44	SCI-B Rx rate (LOS)	bytes/s	Radio link reception byte rate

			Table 1 – continued from previous page
ID	Name	Units/Values	Description
45	SCI-B Tx rate (LOS)	bytes/s	Radio link transmission byte rate
46	SCI-C Rx rate (RS485)	bytes/s	RS485 communication reception byte rate
47	SCI-C Tx rate (RS485)	bytes/s	RS485 communication transmission byte rate
48	SCI-D Rx rate (RS232)	bytes/s	RS232 communication reception byte rate
49	SCI-D Tx rate (RS232)	bytes/s	RS232 communication transmission byte rate
50	CAN-A Tx rate	pkts/s	CAN-A transmission packet rate
51	CAN-B Tx rate	pkts/s	CAN-B transmission packet rate
52	CAN-A Tx skip rate	pkts/s	CAN-A messages delayed because no mailbox is available for
53	CAN-B Tx skip rate	pkts/s	CAN-B messages delayed because no mailbox is available for
56	Yaw rate	rad/s	Rate of change of the yaw angle
57	Pitch rate	rad/s	Rate of change of the pitch angle
58	Roll rate	rad/s	Rate of change of the roll angle
100	Desired IAS (Indicated Air Speed)	m/s	Commanded IAS from guidance
101	Desired TAS (True Air Speed)	m/s	Commanded TAS from guidance
102	Desired GS (Ground Speed)	m/s	Commanded GS from guidance
103	Desired Heading	rad	Commanded Heading from guidance
104	Desired Flight Path Angle	rad	Commanded Flight Path Angle from guidance
105	Desired Bank	rad	Commanded Bank from guidance
106	Desired Yaw	rad	Commanded Yaw from guidance
107	Desired Pitch	rad	Commanded Pitch from guidance
108	Desired Roll	rad	Commanded Roll from guidance
112	Desired p (Angular Velocity - X Body Axis)	rad/s	Commanded angular velocity around longitudinal axis
113	Desired q (Angular Velocity - Y Body Axis)	rad/s	Commanded angular velocity around lateral axis
114	Desired r (Angular Velocity - Z Body Axis)	rad/s	Commanded angular velocity around vertical axis
115	Desired Foward Acceleration – X Body Axis	m/s <sup>2</sup>	Commanded Forward Acceleration from guidance
116	Desired Right Acceleration – Y Body Axis	m/s <sup>2</sup>	Commanded Right Acceleration from guidance
117	Desired Bottom Acceleration – Z Body Axis	m/s <sup>2</sup>	Commanded Bottom Acceleration from guidance
118	Desired RPM	rad/s	Commanded RPM from guidance
119	Desired Front GV (Ground Velocity)	m/s	Commanded Front GV from guidance
120	Desired Lateral GV (Ground Velocity)	m/s	Commanded Lateral GV from guidance
121	Desired Velocity	m/s	Commanded Velocity from guidance
122	Desired Forward Load Factor – X Body Axis	customType	Commanded Forward Load Factor from guidance
123	Desired Right Load Factor – Y Body Axis	customType	Commanded Right Load Factor from guidance
124	Desired Bottom Load Factor – Z Body Axis	customType	Commanded Bottom Load Facto from guidance
125	Desired Tangential Acceleration	m/s <sup>2</sup>	Commanded Tangential Acceleration from guidance
126	Energy Rate Error	customType	Rate of change of the Total System Energy
127	Energy Distribution Error	customType	Distribution of system energy between kinetical and geopoten
128	Desired co-yaw	rad	Commanded co-yaw from guidance
129	Desired co-pitch	rad	Commanded co-pitch from guidance
130	Desired co-roll	rad	Commanded co-roll from guidance

201Desired East GV (Ground Velocity)m/sCommanded East (NED Coordinates system) GV from g202Desired Down GV (Ground Velocity)m/sCommanded Down (NED Coordinates system) GV from203Desired 2D MSL (Heigh Above Mean Sea Level)mCommanded MSL from guidance in 2D height mode204Desired 2D AGL (Above Ground Level) – HeightmCommanded AGL from guidance in 2D height mode				
202Desired Down GV (Ground Velocity)m/sCommanded Down (NED Coordinates system) GV from203Desired 2D MSL (Heigh Above Mean Sea Level)mCommanded MSL from guidance in 2D height mode204Desired 2D AGL (Above Ground Level) – HeightmCommanded AGL from guidance in 2D height mode205Desired 2D WGS84 Elevation (Height Over The Ellipsoid)mCommanded WGS84 Elevation from guidance in 2D height	200	Desired North GV (Ground Velocity)	m/s	Commanded North (NED Coordinates system) GV from
203Desired 2D MSL (Heigh Above Mean Sea Level)mCommanded MSL from guidance in 2D height mode204Desired 2D AGL (Above Ground Level) – HeightmCommanded AGL from guidance in 2D height mode205Desired 2D WGS84 Elevation (Height Over The Ellipsoid)mCommanded WGS84 Elevation from guidance in 2D height	201	Desired East GV (Ground Velocity)	m/s	Commanded East (NED Coordinates system) GV from g
204Desired 2D AGL (Above Ground Level) – HeightmCommanded AGL from guidance in 2D height mode205Desired 2D WGS84 Elevation (Height Over The Ellipsoid)mCommanded WGS84 Elevation from guidance in 2D height	202	Desired Down GV (Ground Velocity)	m/s	Commanded Down (NED Coordinates system) GV from
205       Desired 2D WGS84 Elevation (Height Over The Ellipsoid)       m       Commanded WGS84 Elevation from guidance in 2D height Over The Ellipsoid)	203	Desired 2D MSL (Heigh Above Mean Sea Level)	m	Commanded MSL from guidance in 2D height mode
	204	Desired 2D AGL (Above Ground Level) – Height	m	Commanded AGL from guidance in 2D height mode
206   Desired Longitude   rad   Commanded Longitude from guidance	205	Desired 2D WGS84 Elevation (Height Over The Ellipsoid)	m	Commanded WGS84 Elevation from guidance in 2D heig
	206	Desired Longitude	rad	Commanded Longitude from guidance

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Table 2 – continued from previous page
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207	Desired Latitude	rad	Commanded Latitude from guidance
208	Desired WGS84 Elevation (Height Over The Ellipsoid)	m	Commanded WGS84 Elevation from guidance
209	Desired MSL (Height Above Mean Sea Level) – Altitude	m	Commanded MSL Altitude from guidance
210	Desired AGL (Above Ground Level) – Height	m	Commanded AGL Altitude from guidance
250	Guidance north position error	m	Difference from Desired and actual north position
251	Guidance east position error	m	Difference from Desired and actual east position
252	Guidance down position error	m	Difference from Desired and actual down position
253	Guidance PID north desired velocity	m/s	Difference from Desired and actual PID north velocity
254	Guidance PID east desired velocity	m/s	Difference from Desired and actual PID east velocity
255	Guidance PID down desired velocity	m/s	Difference from Desired and actual PID down velocity
256	Desired velocity X body axis	m/s	Commanded velocity in X-axis from guidance
257	Desired velocity Y body axis	m/s	Commanded velocity in Y-axis from guidance
258	Desired velocity Z body axis	m/s	Commanded velocity in Z-axis from guidance
259	External yaw	rad	Yaw from external navigation source
260	External pitch	rad	Pitch from external navigation source
261	External roll	rad	Roll from external navigation source
262	External Roll Rate	rad/s	Roll rate from external navigation source
263	External Pitch Rate	rad/s	Pitch rate from external navigation source
264	External Yaw Rate	rad/s	Yaw rate from external navigation source
265	External Velocity North	m/s	Velocity North from external navigation source
266	External Velocity East	m/s	Velocity East from external navigation source
267	External Velocity Down	m/s	Velocity Down from external navigation source
268	External acceleration x body axis	m/s <sup>2</sup>	Acceleration x body axis from external navigation source
269	External acceleration y body axis	m/s <sup>2</sup>	Acceleration y body axis from external navigation source
270	External acceleration z body axis	m/s <sup>2</sup>	Acceleration z body axis from external navigation source
271	External GPS Time of Week	S	GNSS Time of week from external navigation source
300	Time since Hardware Start-Up	S	Time spent since power-on of the system
301	Used Memory Space	byte	SD used memory space
302	Free Memory Space	byte	SD free memory space
303	Dynamic Pressure	Pa	Physical measurement from Pitot (dynamic preassure)
304	Static Pressure	Pa	Physical measurement from Pitot (static preassure)
305	Internal Temperature	K	Physical measurement from internal sensors
306	External Temperature	K	Physical measurement from Veronte sensors
307	Accelerometer – X Body Axis	m/s <sup>2</sup>	Accelerometer measurement for X axis
308	Accelerometer – Y Body Axis	m/s <sup>2</sup>	Accelerometer measurement for Y axis
309	Accelerometer – Z Body Axis	m/s <sup>2</sup>	Accelerometer measurement for Z axis
310	Gyroscope – X Body Axis	rad/s	Gyroscope measurement for X axis
311	Gyroscope – Y Body Axis	rad/s	Gyroscope measurement for Y axis
312	Gyroscope – Z Body Axis	rad/s	Gyroscope measurement for Z axis
313	Magnetometer – X Body Axis	Т	Magnetometer measurement for X axis
314	Magnetometer – Y Body Axis	Т	Magnetometer measurement for Y axis
315	Magnetometer – Z Body Axis	Т	Magnetometer measurement for Z axis
322	Internal magnetometer raw X in SI	Т	Magnetometer raw measurement for X axis
323	Internal magnetometer raw Y in SI	Т	Magnetometer raw measurement for Y axis
324	Internal magnetometer raw Z in SI	Т	Magnetometer raw measurement for Z axis
325	Internal magnetometer temperature	K	Magnetometer temperature
326	External LIS3MDL magnetometer raw X in SI	Т	LIS3MDL external Magnetometer raw measurement for 2
327	External LIS3MDL magnetometer raw Y in SI	Т	LIS3MDL external Magnetometer raw measurement for
328	External LIS3MDL magnetometer raw Z in SI	Т	LIS3MDL external Magnetometer raw measurement for
329	External LIS3MDL magnetometer temperature	K	LIS3MDL external Magnetometer temperature

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330	IMU 0 raw accelerometer x measurement	m/s <sup>2</sup>	IMU 0 raw accelerometer x measurement
331	IMU 0 raw accelerometer y measurement	m/s <sup>2</sup>	IMU 0 raw accelerometer y measurement
332	IMU 0 raw accelerometer z measurement	m/s <sup>2</sup>	IMU 0 raw accelerometer z measurement
333	IMU 0 raw gyroscope x measurement	rad/s	IMU 0 raw gyroscope x measurement
334	IMU 0 raw gyroscope y measurement	rad/s	IMU 0 raw gyroscope y measurement
335	IMU 0 raw gyroscope z measurement	rad/s	IMU 0 raw gyroscope z measurement
336	IMU 0 temperature measurement	K	IMU 0 temperature measurement
337	IMU 1 raw accelerometer x measurement	m/s <sup>2</sup>	IMU 1 raw accelerometer x measurement
338	IMU 1 raw accelerometer y measurement	m/s <sup>2</sup>	IMU 1 raw accelerometer y measurement
339	IMU 1 raw accelerometer z measurement	m/s <sup>2</sup>	IMU 1 raw accelerometer z measurement
340	IMU 1 raw gyroscope x measurement	rad/s	IMU 1 raw gyroscope x measurement
341	IMU 1 raw gyroscope y measurement	rad/s	IMU 1 raw gyroscope y measurement
342	IMU 1 raw gyroscope z measurement	rad/s	IMU 1 raw gyroscope z measurement
343	IMU 1 temperature measurement	K	IMU 1 temperature measurement
344	Static pressure sensor (MS56) raw measurement	Pa	Static pressure sensor MS56 raw measurement
345	Static pressure sensor (MS56) temperature	K	Static pressure sensor MS56 temperature
346	Dynamic pressure sensor raw measurement	Pa	Dynamic pressure sensor raw measurement
347	Dynamic pressure sensor temperature	K	Dynamic pressure sensor temperature
348	Static pressure sensor (HSC) raw measurement	Pa	Static pressure sensor 0 raw measurement
349	Static pressure sensor (HSC) temperature	K	Static pressure sensor 0 temperature
350	Vectornav Message Frequency	Hz	Frequency at which external navigation source VectorNav
351	Vectornav Raw Acc x measurement	m/s <sup>2</sup>	Raw accelerometer X measurement from external navigation
352	Vectornav Raw Acc y measurement	m/s <sup>2</sup>	Raw accelerometer Y measurement from external navigation
353	Vectornav Raw Acc z measurement	m/s <sup>2</sup>	Raw accelerometer Z measurement from external navigat
354	Vectornav Raw Gyr x measurement	m/s <sup>2</sup>	Raw gyroscope X measurement from external navigation
355	Vectornav Raw Gyr y measurement	m/s <sup>2</sup>	Raw gyroscope Y measurement from external navigation
356	Vectornav Raw Gyr z measurement	m/s <sup>2</sup>	Raw gyroscope Z measurement from external navigation
357	External HSC magnetometer raw X in SI	Т	HSCDTD008A external Magnetometer raw measuremen
358	External HSC magnetometer raw Y in SI	Т	HSCDTD008A external Magnetometer raw measuremen
359	External HSC magnetometer raw Z in SI	Т	HSCDTD008A external Magnetometer raw measuremen
360	External HSC magnetometer temperature	K	HSCDTD008A external Magnetometer temperature
361	IMU 2 raw accelerometer x measurement	m/s <sup>2</sup>	IMU 2 raw accelerometer x measurement
362	IMU 2 raw accelerometer y measurement	m/s <sup>2</sup>	IMU 2 raw accelerometer y measurement
363	IMU 2 raw accelerometer z measurement	m/s <sup>2</sup>	IMU 2 raw accelerometer z measurement
364	IMU 2 raw gyroscope x measurement	rad/s	IMU 2 raw gyroscope x measurement
365	IMU 2 raw gyroscope y measurement	rad/s	IMU 2 raw gyroscope y measurement
366	IMU 2 raw gyroscope z measurement	rad/s	IMU 2 raw gyroscope z measurement
367	IMU 2 temperature measurement	K	IMU 2 temperature measurement
368	Static pressure sensor (DPS310) raw measurement	Pa	Static pressure sensor DPS310 raw measurement
369	Static pressure sensor (DPS310) temperature	K	Static pressure sensor DPS310 temperature
370	Magnetometer 4 raw measure X converted to SI	Т	Magnetometer 4 raw measurement for X axis converted t
371	Magnetometer 4 raw measure Y converted to SI	Т	Magnetometer 4 raw measurement for Y axis converted t
372	Magnetometer 4 raw measure Z converted to SI	Т	Magnetometer 4 raw measurement for Z axis converted to
373	Magnetometer 4 temperature	K	Magnetometer 4 temperature
400	Power Input	V	Power received by Veronte
401	Power Comicro 3.3V	V	Power received by Veronte through 3.3V port
402	Power 5V	V	Power received by Veronte through 5V port
403	SUC Power Input	V	Power received by Veronte SUC
404	Power 3.6V	V	Power received by Veronte through 3.6V port
405	CPU Temperature	K	Internal computer temperature
		I	* *

Table 2 – continued from previous page

500	Longitude	rad	East-West geographic coordinate
500	Latitude	rad	North-South geographic coordinate
502	WGS84 Elevation (Height Over the Ellipsoid)	m	Elevation over WGS84 reference frame
502	MSL (Height Above Mean Sea Level) – Altitude	m	Altitude over the Mean Sea Level
503	AGL (Above Ground Level) – Height	m	Height Above Ground Level – Dependent on extern
505	Ground Velocity North	m/s	Ground Velocity component in the North direction (
506	Ground Velocity East	m/s	Ground Velocity component in the North direction ( Ground Velocity component in the East direction (N
507	Ground Velocity Down	m/s	Ground Velocity component in the resultant axis fro
508	Sensor IAS (Indicated Air Speed)	m/s	Pitot-static measurement speed
509	Angle of Attack – AoA		Angle between reference body line and flow direction
510	Sideslip	rad	
	1	rad	Angle between the flow direction vector and the lon
600-603	Temperature 1-4	K	Variables to be configured with external Temperatur
650	Gimbal command yaw	customType	Yaw sent to the gimbal
651	Gimbal command pitch	customType	Pitch sent to the gimbal
652	Gimbal stick yaw	customType	Yaw received from the joystick controlling the gimb
653	Gimbal stick pitch	customType	Pitch received from the joystick controlling the gim
654	Gimbal pitch correction 1	customType	Correction calculated by the gimbal for the pitch co
655	Gimbal pitch correction 2	customType	Correction calculated by the gimbal for the pitch co
656	Gimbal old joint 1	customType	Auxiliar variable for Gimbal control configuration
657	Gimbal old joint 2	customType	Auxiliar variable for Gimbal control configuration
658	Cos (gimbal yaw)	customType	Auxiliar variable for Gimbal control configuration
659	Sin (gimbal yaw)	customType	Auxiliar variable for Gimbal control configuration
660	Gimbal yaw rad	customType	Auxiliar variable for Gimbal control configuration
661	Veronte Gimbal yaw output	customType	Yaw value the gimbal is outputting
662	Veronte Gimbal pitch output	customType	Pitch value the gimbal is outputting
663	Gimbal phi(z)	customType	Auxiliar variable for Gimbal control configuration
664	Gimbal theta(y)	customType	Auxiliar variable for Gimbal control configuration
665	Gimbal psi(x)	customType	Auxiliar variable for Gimbal control configuration
666	Veronte Gimbal roll output	customType	Roll value the gimbal is outputting
700-705	RPM 1-6	rad/s	RPM associated to pulse captured 1-6
750	Selected controller time step	S	PID selected time step
751	Selected controller derivative filtered error	customType	PID selected derivative filtered error
752	Selected controller proportional action	customType	PID selected proportional action
753	Selected controller derivative action	customType	PID selected derivative action
754	Selected controller integral input	customType	PID selected integral input
755	Selected controller integral action	customType	PID selected integral action
756	Selected controller anti-windup input	customType	PID selected anti-windup input
757	Selected controller derivative error	customType	PID selected derivative error
800-815	PWM 1-16	customType	Pulse Width Modulation signal
900-915	Stick Input r1 – r16	customType	Raw stick measurement
1000-1031	Stick Input y1 – y32	customType	Servo position commanded from stick
1050-1069	Control Output u1-20 before servo saturation	customType	Commanded control output before saturation correc
1100-1104	Lidar 1-5 Distances	m	Variable configurable for Lidar distances
1105-1109	External range sensor 1-5 measurements	m	Variable configurable for external range sensors
1200	Route-Guidance Distance	customType	Shortest distance to desired path (perpendicular dist
1201	Radar AGL (Above Ground Level) – Height	m	Radar altimeter measure
1202	Radar Speed Down	m/s	Radar speed
	-	rad	Relative vector rotation when using Follow Route
	External Rotation for Follow Route	lau	Relative vector rotation when using romow Rome
1202 1203 1204	External Rotation for Follow Route Time to Impact with Obstacles	s s	Time calculated with Distance to Obstacle and trave

1320-1321	ADC 3.3V input 1-2	V	CEX ADC 3.3 V inputs
1322-1323	ADC 5.0V input 1-2	V	CEX ADC 5.0 V inputs
1324-1325	ADC 12.0V input 1-2	V	CEX ADC 12.0 V inputs
1326-1327	ADC 36.0V input 1-2	V	CEX ADC 36.0 V inputs
1328-1329	ADC vIn 1-2	V	CEX External power supplies
1330	PCB Temperature	K	CEX PCB Temperature (from ADC input)
1350-1356	4XV ADC1-6 converted value	V	4xVeronte ADC 1-6 converted value
1357-1359	4XV internal ADC7-9 converted value	V	4xVeronte ADC 7-9 converted value
1360	4XV Vcc for arbiter	V	4xVeronte Arbiter power supply
1361-1362	4XV Vcc A-B 3.3V	V	4xVeronte Redundant power supplies
1363-1365	4XV Vcc 1-3	V	4xVeronte Autopilots power supplies
1366-1368	4XV Autopilot 0-1 Score	customType	4xVeronte Autopilots scores
1369	4XV Autopilot External score	decimal	4xVeronte External autopilot score

# Table 3 – continued from previous page

1400	Velocity – X Body Axis	m/s	Velocity vector X componen
1401	Velocity – Y Body Axis	m/s	Velocity vector Y componen
1402	Velocity – Z Body Axis	m/s	Velocity vector Z component
1403	Estimated Dynamic Pressure	Pa	Dynamic pressure sensor rav
1404	Barometric Pressure at Sea Level (QNH)	Pa	Introduced value for QNH
1450-1453	Captured pulse 1-4	customType	Input values from pulses
1490	Internest raw x distance	m	Raw measurements for X-ax
1491	Internest raw y distance	m	Raw measurements for Y-axi
1492	Internest raw z distance	m	Raw measurements for Z-axi
1493	Internest raw angle	rad	Raw measurements for intern
1494	Internest raw xy standard deviation	m	Raw measurements for XY a
1495	Internest raw z standard deviation	m	Raw measurements for Z-axi
1496	Internest raw angle standard deviation	rad	Raw measurements for intern
1497	Internest position update frequency	Hz	Frequency at which Interest
1500	GNSS1 Time of Week	S	Data from GNSS1 module:
1501	GNSS1 ECEF Position X	m	Data from GNSS1 module: 1
1502	GNSS1 ECEF Position Y	m	Data from GNSS1 module: 1
1503	GNSS1 ECEF Position Z	m	Data from GNSS1 module: 1
1504	GNSS1 Longitude	rad	Data from GNSS1 module: 1
1505	GNSS1 Latitude	rad	Data from GNSS1 module: 1
1506	GNSS1 Height Above Ellipsoid (WGS84)	m	Data from GNSS1 module: 1
1507	GNSS1 Mean Sea Level (MSL)	m	Data from GNSS1 module: 1
1508	GNSS1 Above Ground Level (AGL)	m	Data from GNSS1 module: A
1509	GNSS1 PDOP (Dilution of Precision of Position)	customType	Data from GNSS1 module: 1
1510	GNSS1 Accuracy	m	Data from GNSS1 module: A
1511	GNSS1 Horizontal Accuracy Estimate	m	Data from GNSS1 module: 1
1512	GNSS1 Vertical Accuracy Estimate	m	Data from GNSS1 module:
1513	GNSS1 Velocity North	m/s	Data from GNSS1 module:
1514	GNSS1 Velocity East	m/s	Data from GNSS1 module:
1515	GNSS1 Velocity Down	m/s	Data from GNSS1 module:
1516	GNSS1 Speed Accuracy Estimate	m/s	Data from GNSS1 module: \$
1517	GNSS1 Related Base Longitude	rad	Data from GNSS1 module: 1
1518	GNSS1 Related Base Latitude	rad	Data from GNSS1 module: 1
1519	GNSS1 Related Base WGS84 Altitude	m	Data from GNSS1 module: 1
1520	GNSS1 Related Base to Rover Azimuth	rad	Data from GNSS1 module: 1

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1521	GNSS1 Related Base to Rover Elevation	rad	Data from GNSS1 module:
1522	GNSS1 Related Base to Rover Distance	m	Data from GNSS1 module:
1523	GNSS1 Related Base to Rover Accuracy	m	Data from GNSS1 module:
1524	GNSS1 Survey in Accuracy	m	Data from GNSS1 module:
1525	GNSS1 Related Base to Rover North	m	Data from GNSS1 module:
1526	GNSS1 Related Base to Rover East	m	Data from GNSS1 module:
1527	GNSS1 Related Base to Rover Down	m	Data from GNSS1 module:
1528	GNSS1 Position Frequency	Hz	Data from GNSS1 module:
1600	GNSS2 Time of Week	S	Data from GNSS2 module: '
1601	GNSS2 ECEF Position X	m	Data from GNSS2 module:
1602	GNSS2 ECEF Position Y	m	Data from GNSS2 module:
1603	GNSS2 ECEF Position Z	m	Data from GNSS2 module:
1604	GNSS2 Longitude	rad	Data from GNSS2 module:
1605	GNSS2 Latitude	rad	Data from GNSS2 module:
1606	GNSS2 Height Above Ellipsoid (WGS84)	m	Data from GNSS2 module:
1607	GNSS2 Mean Sea Level (MSL)	m	Data from GNSS2 module:
1608	GNSS2 Above Ground Level (AGL)	m	Data from GNSS2 module:
1609	GNSS2 PDOP (Dilution of Precision of Position)	customType	Data from GNSS2 module:
1610	GNSS2 Accuracy	m	Data from GNSS2 module:
1611	GNSS2 Horizontal Accuracy Estimate	m	Data from GNSS2 module:
1612	GNSS2 Vertical Accuracy Estimate	m	Data from GNSS2 module:
1613	GNSS2 Velocity North	m/s	Data from GNSS2 module:
1614	GNSS2 Velocity East	m/s	Data from GNSS2 module:
1615	GNSS2 Velocity Down	m/s	Data from GNSS2 module:
1616	GNSS2 Speed Accuracy Estimate	m/s	Data from GNSS2 module: S
1617	GNSS2 Related Base Longitude	rad	Data from GNSS2 module:
1618	GNSS2 Related Base Latitude	rad	Data from GNSS2 module:
1619	GNSS2 Related Base WGS84 Altitude	m	Data from GNSS2 module:
1620	GNSS2 Related Base to Rover Azimuth	rad	Data from GNSS2 module:
1621	GNSS2 Related Base to Rover Elevation	rad	Data from GNSS2 module:
1622	GNSS2 Related Base to Rover Distance	m	Data from GNSS2 module:
1623	GNSS2 Related Base to Rover Accuracy	m	Data from GNSS2 module:
1624	GNSS2 Survey in Accuracy	m	Data from GNSS2 module:
1625	GNSS2 Related Base to Rover North	m	Data from GNSS2 module:
1626	GNSS2 Related Base to Rover East	m	Data from GNSS2 module:
1627	GNSS2 Related Base to Rover Down	m	Data from GNSS2 module:
1528	GNSS2 Position Frequency	Hz	Data from GNSS2 module:
1700-1731	Actuator Output s1 – s32	customType	Configurable variable from a
1800-1895	Distance, azimuth and elevation to Object of Interest 1-32	m, rad and m (respectively)	Spherical coordinates to Ob
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2000	RX Packet Error Rate (on board)	decimal	Value relating RX p
2001	TX Packet Error Rate (on board)	decimal	Value relating TX p
2002	Computed RX pkt/s used for RX PER	messages	Packages per second
2003	Remote RX pkt/s used for TX PER	messages	Same as Computed
2004	Computed TX pkt/s used for TX PER	messages	Packages per second
2005	Remote TX pkt/s used for RX PER	messages	Same as Computed
2019	Stick RX rate	Hz	Stick messages rece
2020	Position fix Time	S	Time spend with GN
2040	Tunnel producer receive frequency 1	Hz	Frequency at which

Table	5 –	continued	from	previous	page
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			5 – continued from previous page
2041	Tunnel producer receive frequency 2	Hz	Frequency at which
2042	Tunnel producer receive frequency 3	Hz	Frequency at which
2043	Tunnel consumer send frequency 1	Hz	Frequency at which
2044	Tunnel consumer send frequency 2	Hz	Frequency at which
2045	Tunnel consumer send frequency 3	Hz	Frequency at which
2046	Max duration of step in CIO	8	Longest time durati
2047	Acquisition task timestep	8	Average period for e
2048	Acquisition task maximum timestep	S	Maximum period for
2049	Cross core message queue CPU ratio	percentage	% of time of CPU t
2050	Acquisition task average CPU ratio	percentage	Average % of time
2051	Acquisition task maximum CPU ratio	percentage	Maximum % of tim
2052	Acquisition task average time	S	Average time acquis
2053	Acquisition task maximum time	8	Maximum time acq
2054	CIO Max time	8	Maximum time in a
2055	CIO average time	8	Average time in acq
2094	GNC task average CPU ratio	percentage	Average % of time
2095	GNC task maximum CPU ratio	percentage	Maximum % of tim
2096	GNC task average time	s	Average time spent
2097	GNC task maximum time	S	Maximum time spe
2098	GNC task maximum timestep	S	Maximum execution
2099	Max duration of step in GNC	S	Maximum duration
2100	Gyroscope Based on Accelerometer – X Body Axis	rad/s	Gyroscope measure
2101	Gyroscope Based on Accelerometer – Y Body Axis	rad/s	Gyroscope measure
2102	Gyroscope Based on Accelerometer – Z Body Axis	rad/s	Gyroscope measure
2103	Acceleration North	m/s <sup>2</sup>	Acceleration in the
2104	Acceleration East	m/s <sup>2</sup>	Acceleration in the
2105	Acceleration Down	m/s <sup>2</sup>	Acceleration in the
2112	Estimated Dem	m	Altitude given by th
2200	Curve Length Covered	m	Total distance from
2201	Curve Length	m	Total distance from
2202	Curve Length Pending	m	Total distance from
2203	Curve Parameter Covered	customType	Total amount from
2204	Curve Parameter Range	customType	Total distance from
2205	Curve Parameter Pending	customType	Total distance from
2250-2259	Reserved 1-10	customType	System reserved var
2300-2302	Joint 1-3 of Gimbal 1	rad	Variables for Gimba
2303-2305	Joint 1-3 of Gimbal 2	rad	Variables for Gimba
2303-2305	Joint 1-3 of Gimbal 2	rad	Variables for Gimba
2330	VMC control loop period	S	Veronte Motor Con
2331	VMC control loop maximum period	S	Veronte Motor Con
2332	VMC control loop duration	S	Veronte Motor Con
2333	VMC control loop maximum duration	S	Veronte Motor Con
2334	VMC control CPU usage ratio	percentage	Veronte Motor Con
2335	VMC control loop maximum CPU usage ratio	percentage	Veronte Motor Con
2336-2338	VMC U-W phase current	customType	Veronte Motor Con
2339	VMC electrical angle	rad	Veronte Motor Con
2340	VMC mechanical angle	rad	Veronte Motor Con
2341	VMC mechanical angular speed	rad/s	Veronte Motor Con
2342	VMC desired mechanical angle	rad	Veronte Motor Con
2343	VMC position controller output	rad/s	Veronte Motor Con
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2344	VMC desired mechanical angular speed	rad/s	Veronte Motor Cont
2345	VMC desired mechanical angular speed after limiter	rad/s	Veronte Motor Con
2346	VMC speed controller output	customType	Veronte Motor Con
2347-2348	VMC clarke alpha-beta current	customType	Veronte Motor Cont
2349-2350	VMC park direct-quadrature current	customType	Veronte Motor Cont
2351-2352	VMC desired park direct-quadrature current	customType	Veronte Motor Cont
2353-2354	VMC park direct-quadrature current controller output	customType	Veronte Motor Cont
2355-2356		park controller output   customType   V	eronte Motor Controll
	beta current from park controller outp		
2357-2358	VMC desired clarke alpha-beta current	customType	Veronte Motor Cont
2359-2361	VMC U-W phase space vector generator output	customType	Veronte Motor Cont
2362-2364	VMC U-W phase PWM output	percentage	Veronte Motor Cont
2365	VMC encoder raw angle	rad	Veronte Motor Cont
2366	VMC stepper output frequency	Hz	Veronte Motor Cont
2367	VMC mechanical angle error	rad	Veronte Motor Cont
2368-2370	VMC U-W phase BEMF	V	Veronte Motor Cont
2400-2419	Control Output u1-20	customType	Control output 1-20
2500-2519	Stick Input u1-u20	customType	Intermediate values
2600-2619	Stick Input d1-d20	customType	Intermediate values
2700-2731	Operation Guidance 1-32	customType	Configurable values
2800	Wind Velocity North	m/s	Wind velocity vecto
2801	Wind Velocity East	m/s	Wind velocity vecto
2802	Wind Velocity Down	m/s	Wind velocity vecto
2803	Wind Velocity North Estimation Covariance	m/s	Wind velocity vecto
2804	Cross North-East Wind Velocity Estimation Covariance	m/s	Wind velocity vecto
2805	Wind Velocity Estimation Uncertainty (Element 2-0)	m/s	2-0 element from co
2806	Wind Velocity Estimation Uncertainty (Element 0-1)	m/s	0-1 element from co
2807	Wind Velocity Estimation Uncertainty (Element 1-1)	m/s	1-1 element from co
2808	Wind Velocity Estimation Uncertainty (Element 2-1)	m/s	2-1 element from co
2809	Wind Velocity Estimation Uncertainty (Element 0-2)	m/s	0-2 element from co
2810	Wind Velocity Estimation Uncertainty (Element 1-2)	m/s	1-2 element from co
2811	Wind Velocity Estimation Uncertainty (Element 2-2)	m/s	2-2 element from co
2812	Wind Azimuth Angle	deg	Wind estimated azir
2813	Wind Velocity in North-East plane	m/s	Wind velocity vecto
2900	MSL Right from Actual QNH and Pressure Measurement	m	Mean Sea Level obt
2901	MSL for ISA and Pressure Measurement	m	Mean Sea Level cal
2902	Time Since Entering Current Phase	S	Time-lapse consider
2903	GNC Timestep	S	Task execution perio
2904	Total Flight Time	S	Time-lapse since the
2905	Total Flight Distance	m	Distance covered by
2906	Reception Frequency of Simulated Navigation Data	Hz	Frequency at which
2907	Reception Frequency of External Navigation Data	Hz	Frequency at which
2908-2927	Time Spent Within Phase 1-20	S	Time-lapse spent by
3000-3031	Simulation Variable 1-32	customType	Variables used for S
3100-3399	User Variable 1-300	customType	Free variables for th
4100	Zero	customType	Constant value 0
4101	Rvar disabled	customType	Disabled variable

## 7.2.7.4.2 BIT

ID	Name	Units/Values	Description
0-2	Initialisation values	-	Bit for fail, ok and license – 0 for error, 1 for run
3	System Not Ready to Start	_	System is ready to start operating $-0$ for not real
4	No Writing Telemetry	_	Telemetry is properly sending/receiving – 0 for
5	Reserved	_	Reserved variable
6	File System Error	_	System file manager is working – 0 for error, 1 f
7	System Error	_	System is working – 0 for error, 1 for running
8	Memory Allocation	_	Memory allocation is working – 0 for error, 1 for
9	PDI Error	_	PDI files are working – 0 for error, 1 for running
10	CIO Low or C2 Error	_	All threads running at specified frequencies $-0$
11	PDI Version Not Compatible	_	PDI files compatible with current version $-0$ fo
12	System Power Up Bit Error	_	Power up Built in Test result $- 0$ for fail, 1 for ol
13	Reset and Write Disabled	_	When true, indicates that reset and non-operation
14-15	FTS-1-2 Feedback (V4.5)	_	Flight Termination System feedback – 0 for error
16-17	Stack Core 1-2 Usage Fail	_	Stack CPU 1-2 usage - 0 for fail, 1 for ok
20	4XV System		4xVeronte system wide bit (Arbiter OK) - 0 for
20	4XV System Power up Bit		4x Veronte system wide bit (Atbiter OK) – 0 for f 4x Veronte power up Built in Test result – 0 for f
22	4XV PDI		4x Veronte PDI files are working – 0 for error, 1
23	4XV Memory Allocation		4x Veronte Memory allocation is working $-0$ for
24-25	4XV CAN-A-B Bus Off		4x Veronte CAN A-B bus is working $-0$ for error
26	4XV C1 Arbiter		4xVeronte CP1 Main Task – 0 for error, 1 for ru
27	4XV Acquisition Arbiter		4x Veronte Cer i Wain Task $=$ 0 for error, i for ta 4x Veronte Acquisition task in real time $=$ 0 for e
28	4XV Power A		4x Veronte Power A Status - 0 for error, 1 for run
28	4XV Not in Maintenance Mode		4x Veronte Arbiter in Maintenance Mode – 0 for
30-32	4XV Alive 0-2		4x Veronte Autopilot 0-2 Alive – 0 for false, 1 fo
33	4XV Alive 3 External		4x Veronte External Autopilot $0.2$ Airve $-0$ for false, 1 fe
34-36	4XV Ready 0-2		4x Veronte External Autopilot $-0$ for false, 1 f
37	4XV Ready 3 External		4x Veronte External Autophot 0-2 Ready $-$ 0 for false, 1 f 4xVeronte External Autophot Ready $-$ 0 for false
38	4XV Arbitrating		4x Veronte External Autophot Ready $= 0$ for false, 1 for true
39	4XV File Open Error		4x Veronte Arbiter Ready – 0 for raise, 1 for the $4x$ Veronte System file manager is working – 0 f
40	4XV PDI Version Not Compatible	-	4x Veronte PDI files compatible with current ver
40	4XV FDI Version Not Compatible 4XV Stack Usage Fail	-	4x Veronte FDT mes comparible with current ver 4x Veronte Stack CPU usage - 0 for fail, 1 for ok
41 42-46	4XV PWM1-5 GPIO Off	-	4x Veronte GPIO/PWM 1-5 Read Value - 0 for f
42-40 50	Sensors error	-	Selected sensors are working - 0 for error, 1 for
51	Sensors-Main IMU	-	0 for not enable, 1 for enable
52		-	
<u>52</u> 53	Sensors-Secondary IMU		0 for not enable, 1 for enable
	Sensors-Magnetometer		Internal magnetometer $-0$ for not enable, 1 for $-0$
54	Sensors-External magnetometer (HMR2300)		HMR2300 External magnetometer $-0$ for not e
55	Sensors-External Magnetometer (LIS3MDL)	-	LIS3MDL External magnetometer $-0$ for not en
56	Sensors-Static pressure (HSC)	-	HSC Static Pressure Sensor – 0 for not enable, 1
57	Sensors-Static pressure (MS56)	-	MS56 Static Pressure Sensor – 0 for not enable,
58	Sensors-Dynamic pressure (HSC)	-	HSC Dynamic Pressure Sensor $-0$ for not enable
59	Sensors-External I2C devices	-	0 for not enable, 1 for enable
60-64	Sensors-External I2C 0-4	-	External communication I2C – 0 for not enable,
65-72	SCI A-D Transmitting-Receiving	-	SCI A-D Transmitting-Receiving during last ch
73-74	CAN A-B Error	_	CAN A-B Bus communication – 0 for error, 1 fo
75-76	CAN A-B Warning	-	CAN A-B deteriorated (but still working) - 0 for
77	Vectornav GPS fix	-	Vectornav GPS fix state - 0 for error, 1 for runni

Table 6 – continued from previous page

		ble 6 – continued from previous page
	Units/Values	Description
	_	Vectornav IMU state - 0 for error, 1 for running
	-	Vectornav Magentometer and Pressure sensors s
	-	Vectornav GPS state - 0 for error, 1 for running
	-	Vectornav navigation state - 0 for error, 1 for run
	-	External Magnetometer HSCDTD008A state - 0
	-	IMU BMI088 state - 0 for error, 1 for running
	-	Static preassure sensor DPS310 state - 0 for error
	-	Magnetometer MMC5883MA state - 0 for error
Position not Fixed	-	GNSS data reception $-0$ for not receiving, 1 for
Out of Georeferenced Area	-	0 for being outside a Georeferenced area, 1 for b
CAN A-B Receiving	-	CAN A or B communication – 0 for not receivir
Stick PPM 1-2 detection	-	Stick PPM (1 or 2) – 0 for not detecting, 1 for detecting, $1$
Magnetic Field Out of Bounds	-	0 for Magnetic Field Out of Bounds, 1 for Magn
	-	INS Navigation state - 0 for off, 1 for on
Stick PPM 3-4 detection	-	Stick PPM (3 or 4) – 0 for not detecting, 1 for detecting, $1$
Stick Not Detected	_	Stick signal detected $-0$ for not detecting, 1 for
	_	CAN A or B communication $-0$ for not transmi
	_	Iridium ready state – 0 for not ready, 1 for ready
	_	Cholesky Inverse Error in Kalman filter - 0 for e
	_	Matrix inversion error in Kalman filter - 0 for er
	_	Radar Altimeter State – 0 for error, 1 for running
	_	Main or SuC Power State – 0 for error, 1 for run
		Pulse 1-4 signal detected $-0$ for not detecting, 1
		4xVeronte Arbiter Power State $-0$ for error, 1 for
		4xVeronte Redundant Power State $-0$ for error,
		4x Veronte Autopilots Power State - 0 for error,
		Extended Kalman Filter Navigation State – 0 for
		External VCP State – 0 for error, 1 for running
		External Navigation State – 0 for error, 1 for run
		Kind of attitude calculation – 0 for external, 1 for
		System Bit
		FTS Activation Bit - 0 for not activated, 1 for ac
		0 for error, 1 for running
		0 for error, 1 for running
<u> </u>		(Differential) GNSS1 Navigation, Input, Survey
		Moving Baseline Mode - 0 for deactivated, 1 for
	-	4xVeronte Arbiter custom message timeout - 0 f
-		(Differential) GNSS2 Navigation, Input, Survey
		Moving Baseline Mode - 0 for deactivated, 1 for
_		-
		Jetibox is communicating properly - 0 for error,
1 1		0 for CPU main task error, 1 for CPU main task
1	-	0 for GNC Step Missed, 1 for GNC Task ok
		0 for Acquisition Step Missed, 1 for Acquisition
		0 for Acquisition Task overload, 1 for Acquisitio
		System bits
	-	Veronte Motor Controller stepper inversion - 0 f
	-	Veronte Motor Controller PWM driver input err
-	_	Ground effect compensation effect $-0$ for disable
Ground effect compensation measurement disabled	-	Ground effect compensation effect – 0 for disable
	CAN A-B Receiving Stick PPM 1-2 detection Magnetic Field Out of Bounds INSS Navigation Off Stick PPM 3-4 detection	NameUnits/ValuesVectornav IMU Error-Vectornav Mag/Press Error-Vectornav OPS Error-Sensor External Magnetometer (HSCDTD008A)-Sensor Static Preassure 2 (DPS310)-Magnetometer 4 (MMC5883MA)-Position not Fixed-Out of Georeferenced Area-CAN A-B Receiving-Stick PPM 1-2 detection-Magnetic Field Out of Bounds-INSS Navigation Off-Stick PPM 3-4 detection-Stick Not Detected-CAN A-B Transmitting-Iridium Ready-EKF: Cholesky Inverse Error-EKF: Condition Number Error-Radar Altimeter CAN-RX Error-Main-SuC Power Error-Pulse 1-4 Not Detected-4XV Vcc A-B Error-4XV Vcc A-B Error-4XV Vcc Vc-1-3 Error-EKF: Navigation State-External VCP Navigation Error-External VCP Navigation Error-External VCP Navigation Error-External Attitude-Reserved Off-FTS Activation (V4.5)-Internest ultrasound position status-ORSS1 Not Moving Baseline Mode-JogNSS1 Not Moving Baseline Mode-JogNSS2 Not Moving Baseline Mode-JogNSS2 Not Moving Baseline Mode-JogNSS2 Not Moving Baseline Mode-CI Low Frequency-GNC Step

		Tac	ne o – continued nom previous page
ID	Name	Units/Values	Description
600	Wind Estimation Off	-	Wind estimation - 0 for disabled, 1 for enabled
700-731	Servo 1-32 Of	-	Servos state – 0 for saturated, 1 for Ok
800-815	PWM1-16 GPIO Off	-	PWM GPIO 1-16 communication Sate – 0 for O
816-819	EQEP A-D Off	-	Input/Output State – 0 for Off, 1 for On
820-822	RSSI LED 1-3 Off	_	Received Signal Strength Indicator led state – 0 f
900-931	Virtual GPIO 1-32 Off	_	Virtual GPIO 1-32 - 0 for Off, 1 for On
1000-1009	Simulation BIT 1-10 State	_	Variables used for Simulation data $-0$ for error,
1010-1113	Custom Msg 0-103 Rx Error	_	Custom message timeout - 0 for error, 1 for ok
1120-1121	Entrance EKF GNSS0-1 Off	_	GNSS1-2 information considered in EKF Naviga
1122	Entrance EKF GNSS EXT Off	_	External GNSS information considered in EKF N
1123	Entrance EKF Internest Off	_	Internest information considered in EKF Navigat
1124	Entrance EKF GPSCOMPASS Off	_	GNSS Compass information considered in EKF
1125	Entrance EKF Magnetometer Off	_	Magnetometer information considered in EKF N
1126	Entrance EKF Static Press Off	_	Static Pressure sensor information considered in
1127	Entrance EKF Altimeter Off	_	Altimeter information considered in EKF Naviga
1128	Entrance EKF Radar-Altimeter Off	_	Radar Altimeter information considered in EKF
1129	Entrance EKF DEM Off	_	DEM information considered in EKF Navigation
1180-1181	Sniffer Msg 0-1 Rx Error	_	Error in received sniffer message - 0 for error, 1
1200-1499	User BIT 1-300	_	Free bits for the user to use $-0$ for error, 1 for ru
2200	BIT Dummy	-	Bit for configurable checks $-0$ for error, 1 for run

# Table 6 – continued from previous page

## 7.2.7.4.3 16 VAR

ID	Name	Units/Values	Description
0	Actuator mode	-	Index pointing to the flight mode in use
1	Phase identifier	-	Index pointing to the active phase
2-18	ADC Channel 1-17	-	Internal ADC 1, 7-8 ADC 1-5
19	Current envelope	-	Index pointing to the envelope in use
20	Counter for C2 system BIT	-	Index for number of cycles from Core 2
50	PDI Error Source	-	Index for error source identification
55	4XV Veronte Selected	-	4xVeronte selected autopilot
56	4XV Config manager status	-	4xVeronte Configuration manager status (flash,
57	4XV File System Status	-	4xVeronte State error for DFS2 file system
58-59	4XV CAN to Serial 0-1 frames dropped	-	4xVeronte Lost messages during CAN to Serial
60-69	4XV Internal ADC Channel 1-10	-	4xVeronte ADC Converters input signals
70	4XV VCC arbiter	-	4xVeronte Arbiter power supply
71-72	4XV VCC A-B	-	4xVeronte Redundant power supplies
73-75	4XV VCC 1-3	-	4xVeronte Autopilots power supplies
80	Detour calculation identifier	-	Index for a route change
90	Version Major	-	Major software version
91	Version Minor	-	Minor software version
92	Version Revision	-	Revision software version
95	UAV Address	-	UAV address
96	File system status	-	State error for DFS2 FS
100	GNSS1 Number of Satellites Used in Solution	-	Number of Satellites Used in Solution
101-112	GNSS1 rejected/accepted RTCM	-	Number of RTCM rejected by wrong CRC/corr
113	GNSS1 rejected RTCM unknown type	-	Number of RTCM unknown rejected by wrong

	· • •		continued from previous page
ID	Name	Units/Values	Description
114	GNSS1 week	_	GNSS1 week
150	GNSS2 Number of Satellites Used in Solution	-	Number of Satellites Used in Solution
151-162	GNSS2 rejected/accepted RTCM	-	Number of RTCM rejected by wrong CRC/corr
163	GNSS2 rejected RTCM unknown type	-	Number of RTCM unknown rejected by wrong
164	GNSS2 week	-	GNSS2 week
200	Radar Altimeter State	-	Index for the radar altimeter state
201	Current Section	-	Index showing section
202	Last Achieved Section	-	Index showing sections achieved
203	Track Stage	-	Index showed when a route change happens
204	Current patchset ID	-	Index showing the patchset
303-305	HMR2300 Magnetometer Raw Measurement X-Y-Z	-	External HMR2300 Magnetometer Raw Measu
310-311	Iridium sent-received	-	Number of packets succesfully sent/received
398	VectorNav Mode	-	Index showing external source VectorNav mode
399	Identifier of max duration step in acquisition	-	Identifier of maximum duration step in acquisit
400	Internest raw status	-	Internest raw status
401	Navigation source	-	Index pointing to the primary navigation source
402	Raw position source identifier	-	GPS identifier selected as main
403-410	Sensor selection	-	Static & Dynamic Pressure, Primary accelerom
425	Identifier of max duration step in GNC	-	Step with maximum duration
426	Group of user bits selected for CBIT	-	Step with maximum duration
450-453	CAN A-B Tx-Rx errors	-	CAN A-B communication errors in transmissio
454-456	CAN to Serial 1-3 frames dropped	-	Lost messages during CAN to Serial transformation
460-461	First-Last file Periodic log	-	First-Last file of the periodic log
462-463	First-Last file Event log	-	First-Last file of the event log
464-465	First-Last file Fast log	-	First-Last file of the fast log
490	Number of moving objects detected	-	Number of moving objects detected
491-492	Veronte static cfg CRC (no Op.) of files	-	Veronte static cfg CRC (no Op.) of files - High
493-494	Veronte static cfg CRC (no Op.) of memory	-	Veronte static cfg CRC (no Op.) of memory - H
495-496	Global configuration state (crc) files-memory	-	Global configuration state (crc) files-memory -
497	Config manager status (flash/sd/maintenance m.)	-	Config manager status
498-499	Global configuration state (crc) files-memory	-	Global configuration state (crc) files-memory
500	Transponder sequence number	-	Value of the transponder sequence number
501	System Reserved	-	System variables not configurable
550-555	Reserved 1-8	-	System reserved variables
600-615	PPM channel 0-15 output	-	CEX PPM channel outputs
900-909	Simulation variables	-	Variables used for Simulation data
1000-1299	User Variables	-	Free variables for the user to use
2000	Uvar Disabled	-	Disabled variable
2001	Zero	-	Uvar with constant 0 value

Table 7 – continued from previous page

The following figure shows the menu to manage the variables in the system.

🔯 🕑 Penguin Embention 🔆	🗙 💿 🕻	) 🗄 🔇 🗄	¢\$ 🙆 🗂 🔺		
<ul> <li>System Variables</li> <li>Telemetry</li> </ul>		Сору	Frequency (Hz)	Address	
Sniffer	Super high High Low				and an and a second
	Idle None Other				~
		Out		Name	

### Variables Configuration Menu

The three options available on the Variables menu are:

Value	Description
System	In this menu, the user can find the name of all system variables, as well as their units and initial
Variables	values
Telemetry	In this menu, the user can set the priority of the system variables to be saved and sent
Sniffer	Option used to configure what messages user wants to receive

# 7.2.8 Panel

In this menu the user can customize how the phases will look in Veronte Panel, create checklists for each phase, create manual check boxes for particular phase changes and configure some notifications that will appear behind the Veronte Unit (Side Panel) upon activation.

### 7.2.8.1 Sort Phases

The first menu gives the option to arrange the phases that will appear on the panel. Just dragging a phase and moving it wherever is desired will change its location in the panel. More than one phase can be arranged in the same line.

📴 🕑 Penguin Embention 💥	★ ⊙ 🖸 ☵ 🚱 端 🏤 🗖 🔺
Sort Phases Checklist Confirmation Notifications	Standby   Runway Takeoff   Climbing   Cruise   Landing   Flare

Phases Disposition

## 7.2.8.2 Checklists

This feature is used to make sure that some requirements have been accomplished, for example, prior to a phase change or to avoid a possible malfunction.

In this menu, the checklist that will appear in the Panel is configured. In (1), the user will find all the phases configured for the operation. In each one of them, new elements for the checklist can be added with the button **Add** (2). The user can modify the checklist order of the phase by selecting and dragging elements in the list to the desired position.

The configurable parameters for each element are:

- Name: the name that will identify the element.
- Type: the element chosen from the checklist can be one of the following types.
  - None: any action is performed, been just a check for the user to do something external to Pipe
  - Calibrate: the user can request the calibration of the atmosphere model, the DEM or other internal sensors.
  - Command: send to the UAV a position, a yaw angle or the wind velocity in the three axes.

- In Range Check: Allows checking if a variable is between the range selected.
- Atmosphere: set the atmosphere parameters (temperature...).
- Automation: selection between a set of automations, in order to only activate one of them for the phase that the aircraft is entering in.

0			Veronte Pipe V5.42.13 🛛 🗖 🗙
Fixed Wing V-Tail UAV	🛪 💿 🧰 😨 🛱 🖾 🖾	▲ Ⅲ ⊘	
Sort Phases	Standby	<u>(1)</u>	
Checklist		Name	Veronte Ground
Confirmation	Sensors OK	New Element	Fixed Wing V-Tail UAV
Notifications	Stick OK		Servio 5 Satured
	Link Quality	Automation   Required for phase change	Fixed Wing V-Tail UAV
	Calibrate Atmosphere	Required for phase change	🤌 🌰 🛜 🕅 🏚 🗖 A
	Batery/Fuel OK	Show only once	
	Actuators OK		Standby
	CG Position OK		Runway Takeoff Climbing
	Mission OK		
	Terrain Mesh OK	Automation	×
	Automations OK	SBY Button (EIN)	No group
	New Element	CMB Button	▼ Option 1
		TKO to CMB	LND Button
		CMB to CRU	CMB to CRU
		LND Button	▼ Option 2
		CRU Button	CRU Button
		TKO Button	▼ Option 3
		SBY Button	SBY Button
		Auto when No Stick	Add group
	Add		Click and drag
			co create new
		Arcade Trim	
		LND to FLARE	
		Reset Flight Time	
		Brakes off	
		FLARE to SRV	
			Accept
	lat.	38.34298° long0.499711° MSL 28	🖬 🕂 🐗 🛞 Silence Alarms 📕
			THE REPORT OF A LARMS
📐 🔊 🖋 Empty fo	or Manual		

### **Checklist Elements**

Click and drag the automations into "Add group" to create a new selection. It is possible to have more than one option.

For example, the following figure shows a window with an automation selection on the checklist. The user has to select between two automations previously included in a group. Once one of them is selected, the other one will be automatically deactivated:

<b>\$</b>		Veronte Pipe V5.42.13	- 🗆 X
+			
		😃 > м600	←…₽
		M600	×
15			🖹 🏠 🖅 🗛
		Standby	•
6		Ready	•
•		Takeoff	•
0		Hold	VHold 👁
Che	ckList ×	Hover	•
Link		Cruise	•
۲	RTH to Land	Return to Home	Landing 💿
۲	Hover HERE	CheckList:	
	Cancel Accept		
	,	System Notifications	
		🔥 RTK is disabled. Configu	re
	lat. 38.35846° long0.514559° MSL 77m	平 🕫 🔇 Silence	e Alarms 🗾
🖿 🔊 🖋 Empty for Manual			

Checklist Verification

- Required for phase change: the element must be checked to go to another phase.
- Show only once: the check will only appear the first time its phase is executed.

Sort Phases	Standby	News
Checklist Confirmation Notifications	Standby Mode AUTO and check control in SBY Check mission (First and last waypoint) Check Veronte battery V(>15V) Arm catapult	<ul> <li>Name</li> <li>Arm catapult</li> <li>None</li> <li>Required for phase change</li> <li>Show only once</li> </ul>
	Add	

**Checklist Configuration** 

## 7.2.8.3 Confirmation

This menu manages the "Disable/Enable telecommand" confirmation message that appear when the radio link button is pressed in Veronte Panel. It is a safety system to avoid pressing this button by mistake.

🔯 🖸 Penguin Embention 💥	★ ⊙ 🖸 🗄 😌 🗱 🕮 🛄 🔺
Sort Phases Checklist	Ask for confirmation before running
Confirmation	Disable/enable telecommand
Notifications	

### Panel Confirmation

For the other custom buttons added by the user in the Veronte panel, the confirmation option is alos available. When configuring the Button event, the system provides a check to include a confirmation when selecting that option. For more information check *Automations*).

When the user is trying to activate an action (previously selected), Veronte Pipe will show a warning message like the following, asking us confirmation:

\$			Veronte Pipe V5.42.13	- 🗆 X
мбоо 🛪 💿 💿 🗄	፰ 🎯 端 ፼월 🗖 🔺 ⅲ 🖉		<b>F</b>	
Sort Phases	Ask for confirmation before running		色 > м600	<b>←</b> …₽
Checklist	Disable/enable telecommand			
Notifications				
			M600	×
	Warning	×	b}> <b>●</b> ≋®	🖲 📩 🗐 A
	Warning		Standby	•
			Ready	
	Are you sure you want to run this action?	,	Takeoff	0
	Y	es No	Hold	VHold
			Hover	0
			Cruise	0
			Return to Home	Landing 🔿
			CheckList:	Ì
			Actuators OK	
			CG Position OK Mission OK	
			Terrain Mesh OK	
			Automations OK Sensors OK	
			Batery/Fuel OK	
			Stick OK	
			Link Quality	
	lat. 38.35765° long0.496621°	MSL 64m	Calibrate Atmosphere	
Empty for N	formal		平 📢 🔇 Silenc	e Alarms 📕

Confirmation – Example

## 7.2.8.4 Notifications

This menu is used to select which notifications will appear in the Side Panel and the way in which the user wants to hide them. There are three options:

- Mouse confirmation It is necessary to pass with the mouse on notifications in order to hide them.
- Auto-hide Notification will auto hide in few seconds.
- No show The notifications will not show up.

ecklist nfirmation stifications	Position not fixed No Writing Telemetry File System Error Out of Georefenced Area Power A Error Servo 1 Satured Servo 2 Satured Servo 3 Satured	Mouse confirmation  Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation Mouse confirmation		Sta	ed Area y to Start	, , , , , , , , , , , , , , , , , , ,
nfirmation	File System Error Out of Georefenced Area Power A Error Servo 1 Satured Servo 2 Satured Servo 3 Satured	Mouse confirmation       •         Mouse confirmation       •		Out of Georefend Power A Error System Not Ready Stick Not Detected M600	ed Area y to Start d	
	Out of Georefenced Area Power A Error Servo 1 Satured Servo 2 Satured Servo 3 Satured	Mouse confirmation       •		Power A Error System Not Ready Stick Not Detected M600	y to Start d	
	Power A Error Servo 1 Satured Servo 2 Satured Servo 3 Satured	Mouse confirmation     •       Mouse confirmation     •       Mouse confirmation     •       Mouse confirmation     •		M600 D	d <b>?</b> 🕅 🟠 🛙	
	Servo 1 Satured Servo 2 Satured Servo 3 Satured	Mouse confirmation Mouse confirmation Mouse confirmation		Sta		
-	Servo 2 Satured Servo 3 Satured	Mouse confirmation  Mouse confirmation		Sta		
-	Servo 3 Satured	Mouse confirmation 👻		Sta		
-					andoy	
	Servo 4 Satured	Maria				
		Mouse confirmation 👻			eady	
	Servo 5 Satured	Mouse confirmation 🔹			ikeoff	
-	<ul> <li>Servo 6 Satured</li> </ul>	Mouse confirmation 🔹		Hold	VHold	
-	Servo 7 Satured	Mouse confirmation 👻			lover	
-	Servo 8 Satured	Mouse confirmation 👻		C	ruise	<
-	<ul> <li>System Not Ready to Start</li> </ul>	Mouse confirmation 👻		Return to Home	Landing	<
	<ul> <li>Stick Not Detected</li> </ul>	Mouse confirmation 👻			$\odot$	
				CheckList: Actuators OK		
				CG Position OK		
				Mission OK Terrain Mesh O	12	
				Automations O		
				Sensors OK		
				Batery/Fuel OK		
				Stick OK		
				Link Quality		
				Calibrate Atmos	sphere	
	lat. 3	8.35926° long0.4	96278° MSL	63m ∓ +% ⊗	Silence Alarms	

Panel - Notifications

Besides the notifications that appear by default on this menu, it is possible to include some other system alarms or even custom ones created by the user. Click on "+" to display a pop-up window that allows the selection of a new variable. The window will allow the user to select any BIT variable of the system, including all the custom User BITs. See *variables* and *list of variables* for more information.

It is also possible to delete the notifications shown by default, click on the "-" button at the left side of any notification to remove it from the error list.

In the following table, it will be described the error types of the notification panel.

Notification	Cause	Possible solution
Position	The system is not connected to	Check the GPS signal in the area and the GPS antenna
not fixed	GPS signal	connection
No writing	System is not writing telemetry in	Check the Air micro SD. It could be corrupted or without
telemetry	the onboard log	memory available
File	System has one or more corrupted	Try to repeat the operation or check the micro SD files
system	files	
error		
Out of	The GPS position is out of	Go to Terrain Profile in Mission Panel and move manually
georeference	dthe areas with terrain altitude	Coarse and Fine areas or choose Auto to make the system doing
area	information	it automatically and save
Power A	Comicro (pin 48) power supply	Go to "Electrical" section of the manual to check admitted
error	out of range	voltages
Servo X	The servo number X is actually	Check the servos panel to set the moving range
satured	satured	
System not	No GPS connection/Licence	See "GPS navigation down"/Update the licence expiration
ready to	expired	
start		
Task X real	System is not able to complete all	Check system variables in Variables Panel and move the
time error	tasks: 1 means High level,5 means	operations to a lower level
	Low level	
Stick Not	The stick is not connected to	Check radio signal and stick connection (in case of HIL
Detected	autopilot	simulation it will be simulated)
Sensors	Sensor malfunction	
Error		
PDI Error	Some PDI files are inconsistent	Review errors or import files again

**Warning:** In some cases, it will be necessary to restart the autopilot once the solution of one of this problems has been applied ("Out of georeferenced area" for example).

# 7.2.9 HIL

Professional Hardware In the Loop (HIL) Simulator package is a powerful tool for Veronte Autopilot integration, development and operator training; permitting to extensively operate the system in a safe environment, prior to conducting real flight operations

There are 2 configuration items on Veronte Pipe, one relating communications between the application and the X-Plane simulator and another one refereeing the autopilot configuration. Users can find the complete process including X-Plane settings in *Professional HIL*.

### 7.2.9.1 Autopilot Configuration

HIL simulation tab is available within Veronte Autopilot setup toolbar. The user can link the variables on Veronte Autopilot with the corresponding ones in X-Plane simulator.

🔯 🕑 Penguin Embention 💥	* 💿 🖸 🗄 🚱 🗱 🚳	) 🛅 🔺 CfgMgr Ste	pMgr
DISABLED		To XPlane	
Throttle 01	Throttle 00	Control	Output u2
Throttle 02		Offset	0.0
Throttle 03	Aileron		
Throttle 04	— Rudder	Conversion Factor	1.0
Throttle 05	- Flap handle		
Throttle 06	- Plap handle		
Throttle 07			
RPM 1			
RPM 2			
Aileron 1 Left 00			
Aileron 1 Right 00		To Veronte	
Aileron 1 Left 01		Sele	ect var
Aileron 1 Right 01		Offset	
Aileron 1 Left 02		с. т. <b>г</b> . г	
Aileron 1 Right 02		Conversion Factor	
Aileron 1 Left 03			
Aileron 1 Right 03			
Aileron 2 Left 00			
Aileron 2 Right 00			
Aileron 2 Left 01			
A1 0.01 14.04			

Veronte Pipe - HIL Setup

In this panel, X-Plane variables are available on the left side (**Disables**). In addition, it can be seen two section more **To XPlane** and **To Veronte**.

In order to configure the simulation variables, users have to:

1. Enable the ones that have been configured in the aircraft model (**Plane Marker**). Just drag and drop them into **To Xplane** section.

**Warning:** Always make sure that surfaces are moving in the right direction and with the correct deflection angle.

To avoid mistakes is possible to set a positive fixed deflection (Control Tab) in Standby phase for all surfaces and control surface deflections in the X-Plane model.

Surface control variables are of two types:

- Radians measure (variables with numbers)
- Degrees measure (variables with no numbers)

2. Once X-Plane variables have been enabled, select the actuator variable (Control Output) that matches with the ones in Veronte autopilot. A new window will be displayed for each variable.

Select variable		×
Select var		
U ADC Channel 1		Ô
U ADC Channel 10		
U ADC Channel 11		
U ADC Channel 12		
U ADC Channel 13		
U ADC Channel 14		
U ADC Channel 15		~
	Cancel	Accent

HIL Panel

3. Set a **Conversion Factor** or **Offset**, if it is necessary. Conversion factor multiplies the Veronte output signal and can be used in case units on Veronte and the X-Plane simulator do not match (Surfaces in X-Plane move normally in a [-1,1] range). The following operation allows to converting an angle [deg] measure to the X-Plane form:

(Angle + Offset) Conv.Factor = ...

When Angle and Offset are measured in [rad] and the Conversion factor is a constant (normally it can be calculated as 1/(deflection angle in [rad]).

In the case of [rad] measures, the Conversion factor must be set in 57,29578 ([deg]-[rad] conv. factor).

Finally, it is necessary to configure the communication between Veronte Pipe and X-Plane, see section below.

### 7.2.9.2 Adding New variable

When there is any varible that doesn't appear in Veronte Pipe, it is possible to add a new one and linked it with the one correspondent in X-Plane. To do this, user have to edit the file "XplaneDATAGroupConfig.xml".

This file contains the following information:

```
    <DATAGroup name="controls">

            <Entries>
            <Entries>
            <DATA name="elv" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="0" message="11" nameUI="Elevator"/>
            <DATA name="ail" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="1" message="11" nameUI="Aileron"/>
            <DATA name="rud" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="11" nameUI="Aileron"/>
            <DATA name="rud" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="11" nameUI="Rudder"/>
            <DATA name="srvAil1L0" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="0" message="70" nameUI="Aileron 1 Left 00"/>
            <DATA name="srvAil1R0" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="1" message="70" nameUI="Aileron 1 Left 00"/>
            <DATA name="srvAil1R0" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="1" message="70" nameUI="Aileron 1 Left 00"/>
            <DATA name="srvAil1R0" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="1" message="70" nameUI="Aileron 1 Right 00"/>
            <DATA name="srvAil1L1" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="1" message="70" nameUI="Aileron 1 Right 00"/>
            <DATA name="srvAil1L1" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="70" nameUI="Aileron 1 Right 00"/>
            <DATA name="srvAil1L1" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="70"</li>
            <DATA name="srvAil1L1" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="70"</li>
            <DATA name="srvAil1L1" desc="" convertTo="" unit="" xplaneName="" readOnly="false" parameter="2" message="70"</li
```

#### XplaneDATAGroupConfig.xml

- Data name: variable's name in X-Plane.
- Parameter and message: these values must be set correctly to link the variables.

• nameUI: variable's name in Veronte Pipe. User can type the name that will appear in the list.

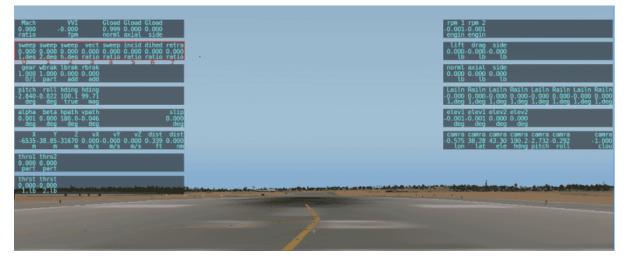
Consider the following example that explains how to add a new variable. Imagine you have a wing with variable incidence (configurable in Plane Maker) and this parameter doesn't appear in Veronte Pipe.

First, user have to check the variable's name, parameter and message in X-Plane. Open X-Plane and go to Setting/Data Input & Output.

×	Data Input & Output		
Data Set Data See Dataref-Out	Flight-Test	enable: 👿 internet 🛛 👿 disk file	
0	33    starter timeout      34    engine power      35    S      36    engine torque      37    S	70    71    71    71    71    71    71    71    71    71    71    71    71    71    71    71    72    72    72    72    74   <	
4 👿 🗖 🕅 Mach, VVI, G-load	38 📄 📄 📄 prop RPM 39 📄 📄 📄 prop pitch	75 📄 📄 📄 defs: rudders 76 📄 📄 📄 defs: yaw-brakes	
5 atmosphere: weather 6 atmosphere: aircraft 7 a system pressures	40	77	
8  9  9  9  9  9  9  9  9  9  9  9  9  9	43 A MP 44 A EPR 45 A FF	79       79       70 <td< td=""></td<>	
10 📄 📄 📄 art stab ail/elv/rud 11 📄 🗖 🛃 flight con ail/elv/rud	46 📄 📄 📄 ITT 47 📄 📄 📄 EGT 48 📄 📄 📄 CHT	82 82 82 82 82 82 82 82 82 82 82 82 82 8	
12       Image: Second structure         13       Image: Second structure         14       Image: Second structure         14       Image: Second structure	49 di pressure 50 di di contractori temp 51 di di di temp 51 di di di temp	84       9	

### Data Input & Output

The message is the number that appears next to each variable. In this case, the data related to a wing with variable incidence is "wing sweep/thrust vect" (see X-Plane manual), so message has to be set with 12. Variable's name and parameter can be found in the following image:



### X-Plane

Variables's name is **incid** and parameter is **5**. To find out the parameter's number, user have to count starting from "0" and the left. Once all data is known, it is possible to edit the .xml file and add the new variable with a text editor. The result is shown in the following image:

<datagroup name="controls"></datagroup>	
- <entries></entries>	
<data "="" and="" convertto="" desc="" message="11" name="elv" nameui="Elevi&lt;br&gt;convertTo=" parameter="0" readonly="false" second="" second<="" td="" the="" unit="" xplanename=""><td>tor"/&gt;</td></data>	tor"/>
<data convertto="" desc="" message="11" name="ail" nameui="Ailer&lt;/td&gt;&lt;td&gt;n" parameter="1" readonly="false" unit="" xplanename=""></data>	
_ <data <="" convertto="" desc="" message="11" name="rud" nameui="Rud" p="" parameter="2" readonly="false" unit="" xplanename=""></data>	ler"/>
<data convertto="" desc="" message="12" name="incid" nameui="Ca&lt;/td&gt;&lt;td&gt;nard" parameter="5" readonly="false" unit="" xplanename=""></data>	

### XplaneDATAGroupConfig.xml

The nameUI has been set as **Canard** and this will be displayed in the variables list. Now, user can simulate this variable in X-Plane from Veronte Pipe.

## 7.2.9.3 Veronte Pipe communications

In order to start the simulation, select the HIL option (1) on the Veronte Unit, this is available on the side menu. Popup screen will be displayed (2) for selecting the type of simulation and configuring the parameters.



Veronte Pipe - HIL Communications

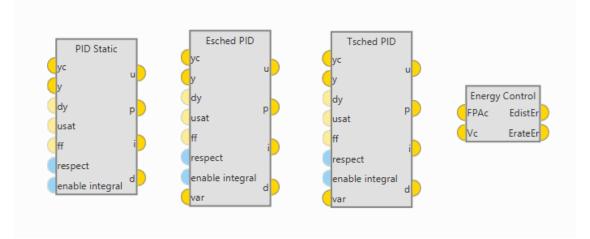
Changing the default values is only recommended for advanced users. Press start in order to start the data transfer between X-Plane and Veronte Autopilot.

**Warning:** The simulation must be started when the aircraft is in the Initial phase (the one that gets in once is powered). In this phase the X-Plane will simulate the GPS signal to locate the autopilot in the place indicated by the airport on X-Plane.

# 7.2.10 Programs

## 7.2.10.1 Control Blocks

Control blocks are those related to the creation of control loops:



Control Blocks

### **PID blocks**

PID blocks allow the user to build a PID controller.

The PID mathematical implementation in **Veronte** is the following:

$$C = Kp + \frac{1}{Ti}IF(z) + \frac{Td}{\tau + DF(z)}$$

PID Model

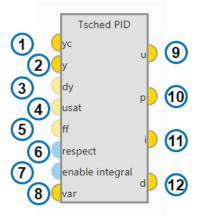
Where:

$$DF(z) = T_s \frac{z}{z-1}$$

$$IF(z)=rac{T_s}{2}rac{z+1}{z-1}$$

$$LPF(s) = rac{1}{ au s + 1}$$

#### Inputs and outputs

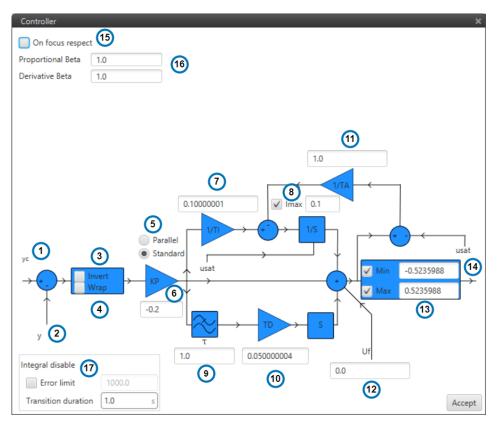


#### PID Block

- 1. yc: Target value, desired state that the controlled variable must acquire.
- 2. y: Closed loop feedback, current value for the controlled variable.
- 3. **dy (optional):** Time derivative for feedback. If provided, this value will replace discrete derivative of y in the derivative term calculation.
- 4. usat (optional): initial output value. Needed for the 'respect' feature.
- 5. ff (optional): feedforward value. Offset applied at PID output.
- 6. **respect** (optional): enable/disable the respect feature. Default is configured in the PID menu.
- 7. enable integral (optional): enable/disable intergal term. Default is enabled.
- 8. var (only scheduling blocks): scaling variable for gain scheduling.
- 9. u: pid output
- 10. **p:** proportional term
- 11. i: integral term
- 12. d: derivative term

### Configuration

Double click on a PID block to open its configuration menu



#### PID Configuration

- 1. yc: Input variable.
- 2. y: Feedback variable.
- 3. invert: Apply a -1 gain .
- 4. wrap: Perform a [-pi,pi] wrap.
- 5. **parallel/standard:** In *parallel* mode, PID gains are independent. In *standard* mode, I & D gains are scaled by P gain.
- 6. KP: Proportional gain.
- 7. 1/TI: Integral gain.
- 8. **Imax:** Maximum value for integral term. Value must be possitive and the limit applied is symmetrical ([-Imax,Imax]).
- 9. tau: Time constant for the derivative term first order LPF.
- 10. **TD:** Derivative gain.
- 11. **TA:** Anti-windup gain. Recommended value around x10 KI. Unloads integral term if output is saturated.
- 12. Uf: Output offset. Feedforward value is also applied at this point.
- 13. Min/Max: Output limits.
- 14. **u:** PID output.
- 15. **On focus respect:** If respect is enabled, when the PID is first executed, an initial I value will be applied so that **'u' = 'usat'** for the first iteration.

- 16. **Proportional/Derivative Beta: yc** scaling for proportional and derivative terms. Unless necessary, value should always be **1**.
- 17. Integral disable: disables integral term if (yc y) > Error limit.

**Tip:** Remember to always use **'wrap'** for direction controllers, such as 'Heading' or 'Yaw' PIDs. This will allow the UAV to always turn in the right direction.

**Danger:** Applying changes to ANY **Program** will **RESET** all PIDs **Integral** terms. Make sure that this is not dangerous to your operation or make a proper use of the '**Respect**' feature if you are planning to make **in-flight** program changes.

### Scheduling

Schedulling allows to adapt PID gains and parameters depending on flight conditions:

### **Proportional Scheduling**

**ESched** block allows to scale **KP** gain using an external variable. This control block works in Standard mode, so integral and derivative gains are changed in the same proportion.

On focus respe	:t	Var	
Proportional Beta	1.0		
Derivative Beta	1.0	KP1	0.0
Inverse	•	v1	0.0
		Min	0.0
		Max	0.0

	Result (Kp)
Inverse	$Kp_i \frac{V}{V_i}$
Proportional	$Kp_i \frac{V_i}{V}$
Quadratic	$Kp_i \frac{V_i^2}{V^2}$

PID Proportional Scheduler

Min and Max values make reference to the Scaling Variable.

If the variable is out of bounds the value of Kp for the closest limit will be applied.

### **Table Scheduling**

TSched block allows to scale most PID parameters using an external variable.

		KP	KD	τ	KI	TA	Uf	Imax	BetaP	BetaD
-	• 0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
-	2.0	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
-	3.0	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
-	4.0	7.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
-	s.0	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
-	6.0	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-1.0000	1.0000	1.0000
÷	•									

## PID Table Scheduler

If the variable is out of bounds the values for the closest point will be applied.

Values between points are linearly interpolated.

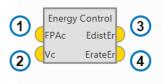
#### **Total Energy Control**

Total Energy Control is a strategy for the control of Fixed Wing aircrafts.

The aim of this strategy is to decouple **speed** and **altitude** controls.

The **Total Energy Control** block will provide two errors that must be minimized in order toobtain the desired speed and flight path:

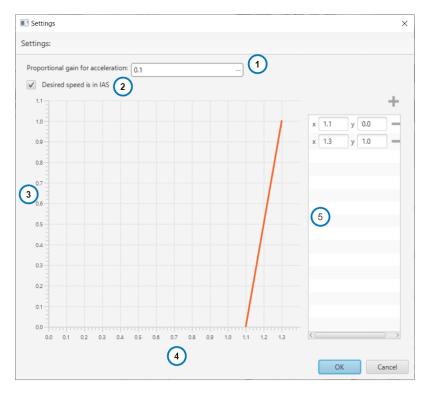
- **Energy Distribution Error**: Distribution of sistem energy between kinetical and geopotential energy. This error should be minimized using the **Elevator**.
- Energy Rate Error: Rate of change of the Total System Energy. This error should be minimized using Throttle.



Energy Control Block

- 1. FPAc: Desired Flight Path Angle.
- 2. Vc: Desired Speed.
- 3. EdistEr: Error in the required Energy Distribution.
- 4. ErateEr: Error in the required Energy rate.

Some parameters of the Energy algorithm can be modified by *Double clicking* on the block:

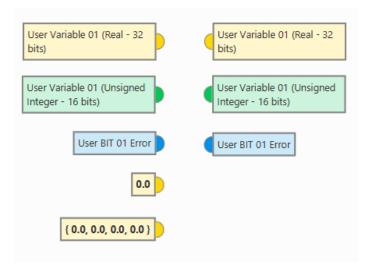


Energy Control Menu

- 1. **Proportional Gain for Acceleration**: in short, its an indication of how aggresive the algorithm is when trying to gain speed. The higher the value, the faster the algorithm will try to 'dive' in order to gain speed. A typical recommended value is around 0.1. Higher values are only recommended for fast maneuvering platforms.
- IAS/GS: If checked, the block will use variable '0 IAS (Indicated Airspeed)'. If unchecked, variable '2 - GS (Ground speed)' will be used as a reference instead. Use of Ground Speed is not recommended unless Airspeed measurement is not available.
- 3. **Stall correction coefficient**: If 1, energy control is balanced for altitude and speed. If 0 only speed control is taken into account.
- 4. Speed/Stall ratio: Ratio between current speed and minimum speed.
- 5. **Stall correction interpolation function**: Define how the relation function between the stall correction coefficient and the Speed/Stall ratio.

**Note:** The Stall correction coefficient is a **Safety** tool that can be used to sacrifice altitude control in order to improve speed control when speed gets close to the minimum speed selected in the *Envelope* 

#### 7.2.10.2 Data Source/Sink Blocks



#### Source/Sink Blocks

### Source Blocks

Source blocks allow to import into the program any variable available in the system.

Additionally the Const Real/Vector allows to create a constant variable or vector.

### Sink Blocks

Sink blocks allow to overwrite any variable in the system.

Variables that can be written using **Sink blocks** are:

- User Variables
- Desired variables (Variables whose name starts with 'Desired')

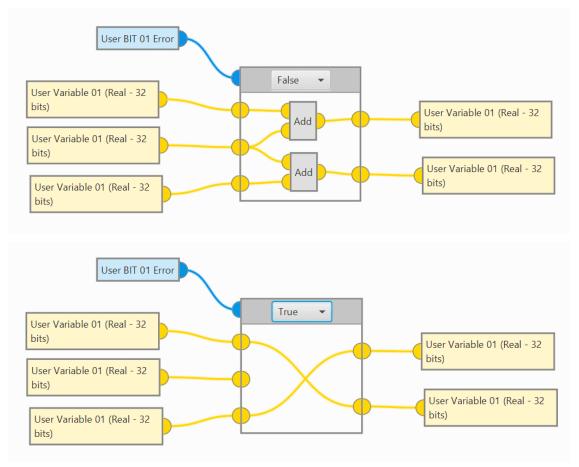
**Note:** Desired variables are naturally written by Veronte *Guidances*. If an active **Guidance** is writting a certain **Desired** variable, writting it with a **Sink** block should be avoided.

**Warning:** Using Sink blocks to overwrite **System Variables** usually results in the change not taking effect, but in some cases could end up causing Veronte to malfunction.

Avoid using Sink blocks to write any variable that does not belong to one of the groups listed above.

## 7.2.10.3 Execution Flow Blocks

**Execution Flow** blocks allow to switch sections of a program during its execution among a set of pre-configured options.





*Right click* **inside** a **Switch block** in order to create a new block.

Drag into a Switch block to create Inputs and Outputs. To remove them, right click and select Remove Input/Output

**Note:** The size of a switch block depends on the blocks it contains. A switch block will always have the size of the **biggest** of its existing cases.

### **Switch Blocks**

If/Else

Choose between two cases based on the state of a boolean variable.

4	False	•

### If/Else Switch

#### Integer case

Choose a case based on the value of an integer variable.



Integer Switch

Right click the Case Block to access Case configuration options

- Add Case: Create a new empty case.
- Copy Case: Create a copy of the current case.
- Delete Case: Delete the current case.
- Add Entry: Add a new entry to the current case. An entry is a condition under which the case will be selected. The same entry can on only be in one case at a time. Adding an entry that already exists will move said entry to the current case.
- Delete Entry: Remove an entry from the current case.
- Set as Default case: the Default case will be executed whenever the switch condition does not match any of the existing entries.

#### Phase case

Same as Integer case, but using Flight Phases as the switch condition.

Default case: Manual	Ŧ

Phase Switch

Warning: Case Blocks will report a 'PDI ERROR' if they don't have at least 2 cases with entries.

## **On Focus**



## On Focus Block

The **On Focus** block outputs a boolean value, which is only **True** the first time the block is executed.

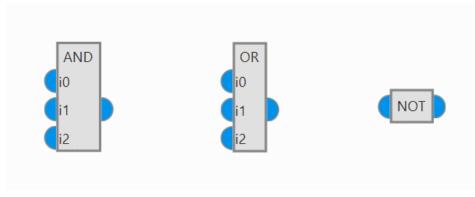
If used inside a Switch Block, the value will be True each time the case is selected.

On Focus can be used to trigger actions or initialize variables whenever a case is switched.

The following example would initialize User Variable 01 to 7 whenever Landing phase is selected:

## On Focus Example

## 7.2.10.4 Logic Blocks



### Logic Blocks

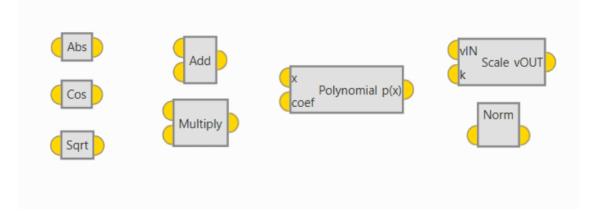
Logic gates for operating with boolean variables:

- AND Gate
- OR Gate
- NOT Gate

AND and OR number of inputs is configurable.

## 7.2.10.5 Math Blocks

Math blocks allow to perform a wide variety of mathematical operations.





### 1R -> 1R

1-input 1-output blocks

- Abs: returns absolute value of the input.
- Sin: returns the sine of an angle (in *rad*).
- **Cos**: returns the cosine of an angle (in *rad*).
- **Tan**: returns the tangent of an angle (in *rad*).
- Arcsin: inverse function of the sine. It returns an angle (in *rad*).
- Arccos: inverse function of the cosine. It returns an angle (in rad).
- Arctan: inverse function of the tangent. It returns an angle (in rad).
- **Sqrt**: returns the square root of the input.
- Exp: returns e powered to the input.
- Log: returns the natural logarithm of the input.
- Ceil: returns the input, rounded up.
- Floor: returns the input, rounded down.
- [pi,-pi]Unwrap: return the unwrap of the input. That is, if a jump higher than  $\pi$  is detected, an offset of  $(-)2\pi$  is added to the result.
- [pi,-pi]Wrap: returns an angle (in *rad*) wrapped between  $\pi$  and  $-\pi$ .
- [0,2pi]Wrap: returns an angle (in *rad*) wrapped between 0 and  $2\pi$ .

#### 2R -> 1R

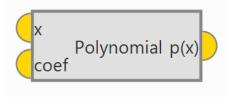
2-input 1-output blocks

- Add: returns the sum of the inputs.
- Substract: returns the substraction of the inputs.
- Multiply: returns the product of the inputs.

- **Divide**: returns the division of the inputs.
- **Power**: returns *input 1* to the power of *input 2*.
- Max: returns highest of the inputs.
- Min: returns the lowest of the inputs.
- Remainder: returns the remainder of the division of the inputs.
- Atan2: variation of the *atan* function, that allows to avoid .

#### Polynomial

Returns the value of the polinomial defined by the coefficients *coef* for the value of *x*.



Polynomial Block

#### Vectors

Perform operations with vectors

- Add: return the sum of the input vectors.
- Add elements: returns the sum of input vector components.
- Bundle: returns a vector whose components are the inputs to the block.
- Dot product: returns the dot product of the input vectors.
- **Linear transformation**: returns the input vector multiplied by the transformation matrix. In order to edit the transformation matrix, double click on the block.

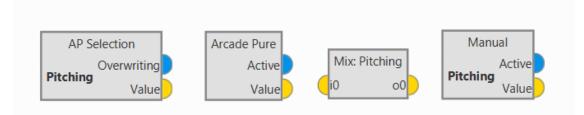
Linear Transformati	on	Ed	it -	-	-	×
{1.0,0.0,0.0		•	1.0	0.0	0.0	
0.0,1.0,0.0 0.0,0.0,1.0	Сору	-	0.0	1.0	0.0	+
	Remove block	-	0.0	0.0	1.0	
	Change matrix values			+		
	4					Apply

Linear Transformation Block

• Multiply elements: returns the product of the vector input components.

- Norm: returns the norm of the input vector.
- Max: returns the value and position of the highest component of the input vector.
- Min: returns the value and position of the lowest component of the input vector.
- Scale: returns vector *vIN* multiplied by scalar *k*.
- **Split**: returns ech of the components of the input vector. The number of outputs must match the input vector length.
- **azeld** -> **xyz** / **xyz** -> **azeld**: transform from spherical coordinates (*azeld*) to cartesian coordinates (*xyz*) and viceversa. Input must be 3*x*1.
- Body -> NED / NED -> body: rotate from body axis NED axis and viceversa. Input must be 3x1.

### 7.2.10.6 Mode/AP Selection Blocks





#### **AP** selection

The AP selection block is meant to be used along 4xVeronte, but can also have other aplications.

An AP Selection block must be linked to one of the Control loops.

Whenever the current autopilot is selected, **Overwriting** will be **False**, and **Value** will be equal to the value of the control loop.

If the current autopilot is **not selected**, then **Overwriting** will be **True** and **Value** will be equal to the control loop from the **seleted autopilot**.

#### Arcade

The arcade block allows the user to detect if the selected channel is in 'arcade' mode. This block include the following output and configurable parameters:

#### • Outputs:

Active: BIT status that is HIGH when the mode is arcade and the stick is sending a command.

**Value:** will output the Arcade value for the selected channel. It is obtained as a result of applying the gain to the stick input d. For more information about the different stick inputs see *Stick* 

#### • Parameters:

- 1. Channel: control output controlled by this block. It selects the stick input d used to calculate the output.
- 2. Gain: the output value is the result of multiply the stick input d by this gain.

- 3. Dead band: creates a zone where the movement of the stick is not sent to the system.
- 4. Stick zero: output value when the value os the stick input d is 0.
- 5. Add configuration: add a new group of phases affected by this block.
- 6. Delete a group of phases.
- 7. Add a phase to a group.

All these parameters are shown in the image below:

		×
Channel	Control Output u4 🝷 1	6
Phases — Hold + 7	2 Gain         5.0            3 Dead band         0.02            4 Stick zero         0.02	
Phases VHold Hover +	Gain         3.0            Dead band         0.02            Stick zero         0.0	)
	Add configuration 5	~
	Add conliguration	

Parameters Arcade block

There are three similar Arcade blocks:

#### Pure

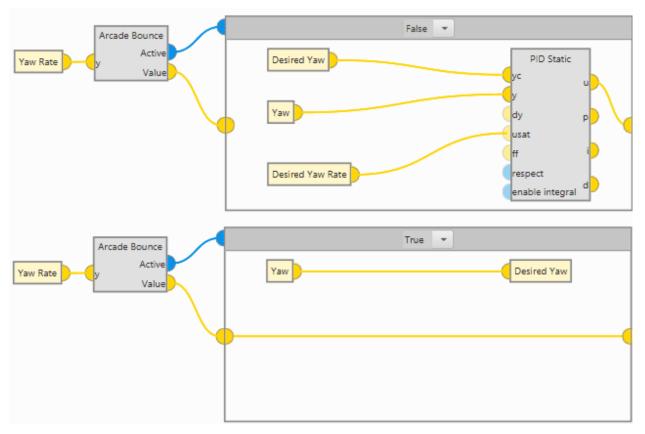
Normal arcade mode. Its parameters are those explained previously.

#### Bounce

Arcade will be also activate after applying a command, when the value of the **input** (y) changes its sign (value closest to 0) in order to modify the desired value to avoid a bounce in this variable. Normally, the value to enter is the derivate of the output variable.

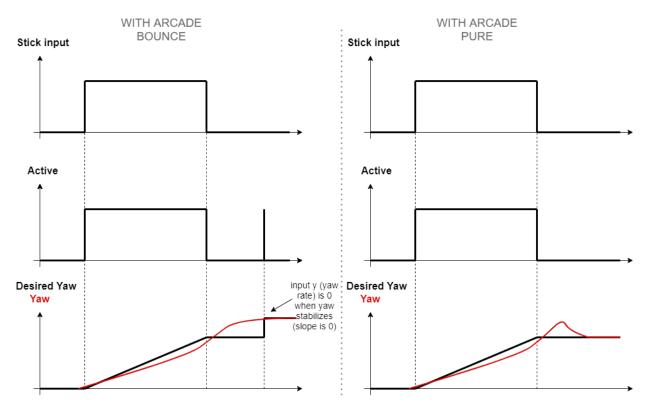
In the picture below there is an example controlling the yaw: when the stick in its zero position, the command sent is 0, the status of Active BIT is FALSE (low level), and the desired yaw is the last yaw saved when the status was TRUE (high level). However, the platform can still have a yaw rate and in a normal arcade block it could experiment this bounce. Therefore, when the yaw rate is close to 0 (changes its sign), this BIT is TRUE again (in spite of not being commanding a new yaw rate with the stick), and the desired yaw is updating with the current yaw.

#### Extended



Similar to Bounce. In this case Arcade will stay activated if **input** (y) is higher than the defined threshold.

Arcade bounce block example I



Arcade bounce block example II

#### Mix

Mix allows to apply a variable offset over the input using one of the stick channels.

## Manual

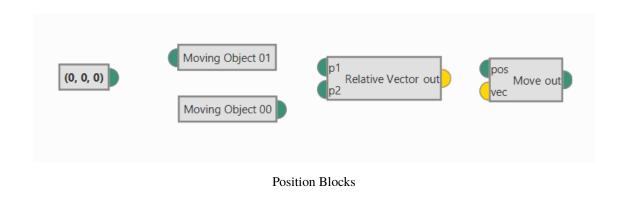
The manual block allows the user to detect if the selected channel is in 'RC' mode.

Value will output the Stick value for the selected channel.

## 7.2.10.7 Position Blocks

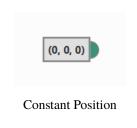
**Position** blocks allow to operate with position variables.

Note: In Veronte position variables are also refered to as Features.



#### **Const Position**

Create a constant position.



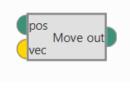
## **Read/Write Feature**

Import or export an existing feature.

Moving Object 00	Moving Object 01
positio	on Blocks

#### Move

Displace a position *pos* based on an input vector *vec*. Input vector must be a 3x1 vector in meters and NED axis.



position Blocks

## **Relative vector**

Calculate the relative vector from p1 to p2.



position Blocks

## 7.2.10.8 Signal Blocks

Signal Blocks include fucntions for processing and filter signals, control inputs and outputs, etc.



Signal Blocks

## **3D Table Interpolation**

Returns the value obtained by interpolating the configured table with the input variables. First input represents *rows*, second input represents *columns*.

If out of range, the value for the closest limit will be taken.



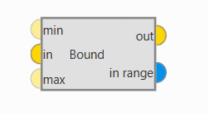
Table Interpolation

**Note: IIR Block** will return an error if the *row* or *column* values are not sorted from lowest to highest. In order to solve this, just click on the **Sort** button.

## Bound

Returns the input *in*. If the input is out of range, the **limit** is returned instead. If limits are not defined, they are asumed to be **infinity**.

In range will be true if the input is within the limits and false if it is not.

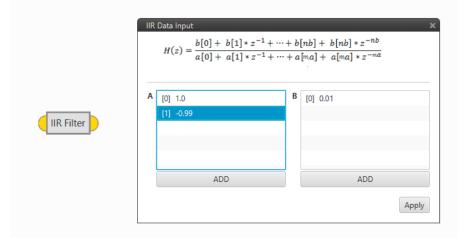




**Tip:** Use the **Bound** block to monitor that critical parameters inside your system are within operational limits (i.e. voltage levels). If **not OK**, **in range** can be used to activate an alarm.

### **IIR Filter**

Allows the user to define an IIR Filter



IIR Filter Block

## **Rate Limiter**

Returns the *Current* input signal, but limiting its maximum rate of change.

The limits are defined in Input units/s.

If the rate of change of the input is higher than the maximum, the output will try to converge to the input, but respecting the imposed maximum rate of change.

The first time the block is executed the output will be equal to *Init*.

	Settings		
	Settings:		
Rate limiter	Min :	0.0	
Current	Max :	1.0	
		ОК	ancel

Rate limiter Block

**Tip:** The **Rate limiter** block can be used to avoid steps and instant spikes in the control signals, effectively reducing control noise and smoothing the flight.

#### Ramp

The Ramp block will ramp up to the defined value, starting from the *Input*, and respecting the **Delay** and **Ramp Time** parameters.

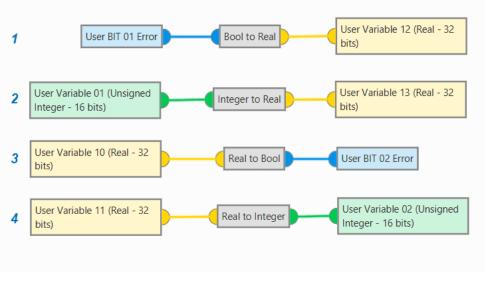
	Output transition from output value when phase starts to a new fixed value	
		0.0
Ramp		



### 7.2.10.9 Type Casting Blocks

These blocks allow to change from one data type to another. There are four different blocks available:

- 1. Bool to real: it transforms a boolean variable to a real variable.
- 2. Integer to real: it transforms an integer variable to a real variable.
- 3. **Real to bool**: it transforms a real variable to a boolean variable. Any number but 0 will be transformed to **true**; the rest (negative numbers included) will yield **false**.
- 4. Real to integer: it transforms a real variable to an integer variable.

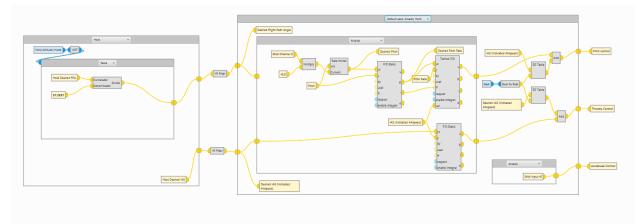


Type Castings Blocks

Programs are the core of Veronte Autopilot.

A **Program** is a custom algorithm executed by Veronte. While their main purpose is the control of the aircraft, **Programs** can be used to develop a wide variety of applications, from simple math operations to complex estimation filters.

Programs provide the user with a block programming interface that Veronte will then execute at core frequency:



Block Program Example

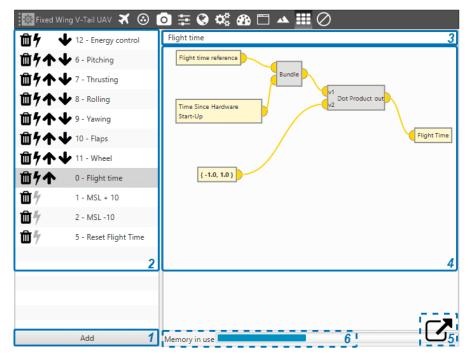
The different types of blocks available in Veronte Programs are:

- **Control**: control-related blocks (simple PID, scheduling PID,...).
- **Data source/sink**: Input/Output blocks. **Programs** can have access to any variable available within Veronte system. Results can then be stored in Custom variables for display, use as a different program input, feedback,...
- **Execution flow**: programming-like blocks for operation flow control. These blocks allow to alter parts of a program depending on a condition (If-Else, Integer Case, Phase Case,...)
- Logic: logical gates to operate with boolean variables.
- Math: mathematical blocks, which include a variety of mathematical operators: basic (sum, multiply, square root,...), trigonometric (sine,cosine,tangent,...), vectors (norm, dot product, rotations,...).

- Mode/AP selection: blocks that allow to interact with flight modes and redundancy (4x Veronte).
- **Positions**: blocks for operating with position-type variables (create psotition, read position, relative position,...).
- Signals: blocks for signal processing (IIR filter, rate limiter,...)
- **Type casting**: blocks for variable conversion (Real to BIT, Integer to real,...)

## **Block Program Interface**

Accessible from the *Setup* menu, allows for the creation and edition of block programs:



Programs Menu

- 1. Add a new empty **Block Program**
- 2. Program list. From here programs can be selected for edition or deleted. Clicking on will delete an existing **Program**.
- 3. Program name.
- 4. Program definition.
- 5. 'Pop up' the program edition window. This allows the user to have a clearer view of the operation while editing.
- 6. Estimation of the remaining memory available. If no more memory is available, no new blocks will be allowed to be created. The allocated memory for each block depends on the block type.

### Execution

The icon indicates that the program will be executed periodically, **at core frequency**.

Use to determine execution order of existing programs. **Programs** are executed from top to bottom.

Clicking on will toggle execution mode. Inactive blocks will not execute periodically, but can be executed using *Run Program Actions*.

**Danger:** Applying changes to programs during an operation can cause changes in the beahvior of some blocks.

For example, the Integral terms in *PID Blocks* will be reset.

Applying changes during an operation is **highly unrecommended**. If done, please make sure that operational safety is not compromised.

#### Blocks

*Right click* on the edition screen to open the block list. Select a block to import it into the program.

Click and drag on blocks to re-locate them:

### Adding Blocks

Double click on a block to open its configuration menu.

Block inputs and outputs use a colour code in order to indicate variable types:

- BIT Boolean variables
  16-bit Integer variables
  32-bit Real variables. Connectors can also be Arrays of real variables.
- Desition variables

An input and an output can be connected directly using the mouse:

### Linking Blocks

An input and output with different variable types cannot be connected without a Type Cast.

All inputs of each block must be connected, otherwise Veronte will report an error.

An exception to this rule are translucid inputs , which are optional. These inputs will have a default value if not linked.

Outputs do not need to be linked.

## 7.2.11 Block PDIFs

**Block PDIFs** avoid the user changing certains parameters, settings or programs of Veronte. It is shown in the picture below:

Terrain Settings	No block	•
Georef (Ref0, Rerrain, Dem, Geoid) Configura	No block	
PPM Stick 1 Configuration	Block in normal mode	
PPM Stick 2 Configuration	Block in maintenance mode Block always	
RPM Stick Configuration	No block	*
Polygon Manager	No block	•
Magfield Configuration	No block	•
Arcade Axis Set of Options	No block	•
Arcade Stick Trim Values	No block	•
Frequencies	No block	•
Actuator Configuration	No block	•

## Block PDIFs

You can choose when theses options are disabled (in normal mode, in maintentance mode or always).

To display Veronte Setup Toolbar, when the autopilot is connected or an offline configuration is opened, in the side panel, click on and then click Setup. This toolbar allows the user to modify the main features of the Veronte Units.



# 🔯 Veronte0 🛪 💿 🧰 😨 🥵 🥵 🖽 🔺 🏭 ⊘

## Setup Toolbar

The different elements of the setup toolbar are detailed in the following table.

Icon	Item	Description
×	Veronte	Introduce Veronte information.
$\odot$	Connections	Configure I/O connections on Veronte.
0	Devices	Configure any connected devices: servo, radio, camera
	Control	Introduce control variables and phase configuration.
Ø	Navigation	Configure navigation parameters on the system.
$\mathbf{o}_{\mathbf{o}}^{\mathbf{o}}$	Automation	Configure automatic actions on event detection (go home, change phase).
<b>6</b> 20	Variables	Customize variable names and traffic: log, telemetry
	Panel	Configure Veronte Panel layout.
<b>~</b>	HIL	Configure parameters for Xplane Simulator.
===	Programs	Customize algorithms executed by Veronte.
$\oslash$	Block PDIFs	Block user control in PDI configuration.

Each option will be explained in detail in the next sections.

# 7.3 Installation

The menu found in **Devices -> Veronte -> Attitude** (see the Figure below) allows the user to define the orientation of the autopilot with respect to the platform once it is installed. Aircraft axes are defined according to international aviation convention. Veronte axes are drawn on the autopilot's external case as defined in the *Hardware Installation*.

Fixed Wing V-Tail UAV 🛪 🤇	◙ 💁 ☵ 🚱 端 🙉 🗂 🔺 🎟 ⊘	
► Actuators	Distance to the center of mass in aircraft body frame	
Communications		
Payload	X Y Z	
Sensors	Autopilot 0.0 m 0.0 m 0.0 m	1
▶ Stick		
▼ Veronte	Orientation	
Attitude		
Safety Bits	Advanced	2
► Others		
	×	
	6 8	
	z	
Add device 👻		

Veronte Attitude Menu

The menu consists in:

1. Distance to the center of mass in aircraft body frame.

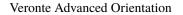
The autopilot's distance to the centre of mass must be defined. This distance is entered in meters and accordingly to aircraft axes. This information is used to take into account the moment produced by the weight of the autopilot.

2. Orientation.

It is not compulsory to install the autopilot aligned with the aircraft axes. In order to indicate the autopilot's relative position inside the platform, select the advanced option. A matrix relating vehicle axes and autopilot axes is needed to be filled in.

The case of a non-orthogonal installation can be covered. If a simple rotation is introduced, for example, the autopilot's case having its x axis directed to the right wing (y- vehicle) the matrix should be completed as follows:

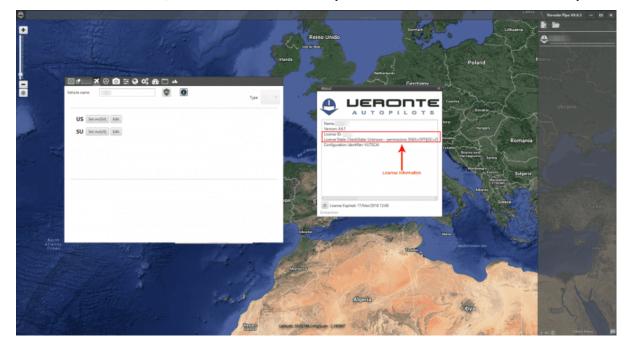
	vanced				
Y - Vehicle -1 0 0.0 Y - Boar	X - Vehicle	0	1	0.0	X - Board
	Y - Vehicle	-1	0	0.0	Y - Board
Z - Vehicle 0.0 0.0 1.0 Z - Boan					Z - Board



# 7.4 License & Safe Mode

## 7.4.1 License

To access the License you have to open setup, then select Veronte and click on  $\square$ . In this tab you can check you License of your Veronte. You will have a different License Id for each Veronte (so, License Id Veronte Air is different from License Id Veronte GND). To renovate Veronte License, you must connect Veronte to Internet biweekly.



License

The license panel is useful to check the following information:

	AU			TE TS		
Name: M40						
Version: 2.1	V=1,MCU=0] 1.5					
	er: V300M32P					
	4134325344384 te: CheckState: L				UTC-ONI	
LICENSE STA	te, enectotate, c	nknown - pen	Inssions toc.		Therond	

#### License panel

The panel is useful to check the following information:

- 1. UAV name
- 2. UAV Address
- 3. Software Version
- 4. Autopilot Part Number
- 5. Software version
- 6. License ID
- 7. License State (red)
  - GC: Guidance and Control
  - NAV: Navigation
  - TC: Transmission (RC)
- 8. License Expiration Date and Time (blue)

The license state shows the possible action for the selected autopilot (ON=Active, OFF=Not Active). The Ground Autopilot license state for a normal configuration is **ON: OFF: ON**. The Air state is **ON: ON: ON**.

## 7.4.2 Safe Mode

The safe mode is used to avoid malfunctioning when the autopilot is trying to charge a corrupt file.

When Veronte is trying to charge a configuration file in its SD card and there is some problem, the safe mode avoids that the autopilot tries to charge the corrupt file again and again entering then in a loop that would not allow communicating with it. Instead of that, the system charges a default configuration stored in its flash memory and enters in what is called the safe mode, allowing the operator to change the configuration and send it again to Veronte.

It is also possible to force the enter in the safe mode by turning the autopilot off and on quickly. Safe mode displays the following window.



Safe Mode

It is possible to **Change setup** and select the configuration file which will be loaded on the autopilot. When a file is selected, a new window will be displayed in Veronte Pipe showing the version and identification of the configuration file and the autopilot where the file is going to be loaded.



Upload Configuration - Safe Mode

With this tool, the configuration file is loaded directly on the autopilot. Now Pipe is only a tool to load the file from the computer to the autopilot and the configuration parameters will not be shown in the software window before being loaded on the autopilot.

The other option available allow the user update the Veronte Unit, this is explained in Update Onboard Software.

# 7.5 Veronte LOS (Line Of Sight)

This panel allows the user to easily access to the Pipe Terminal and modify the desired radio module settings. In the case of Veronte 4.0 and 4.5, they are integrated with Microhard Pico Series internal radio modules and their configuration can be modified by using the Microhard Setup Helper.

Veronte Pipe V6.2.51 -	- 0	×
😃 м400		••
	Setup	
	Opera	on
	Export	DI
	Import	PDI
	About	
	HIL	ļ
Restart Veronte	Advand	ced 🔹
Pipe Terminal		J
Enter maintenance mode		
Update		
SD Card		

## Veronte Pipe Terminal Setup

In order to start the configuration, the user should open the Setup by clicking on **basis**, then on Advanced and finally on Pipe Terminal. After this, the following window will show up.

	×
> Welcome to Pipe Terminal Manager	
What you need to know about the process:	
1. Your Veronte unit must be in INI phase	
2. You must to connected to to your Veronte unit via USB.	
3. Interrupting the process may brint your Veronte unit to a corrupted status.	
4. Once the process is done. Your Veronte unit will be restarted.	
Agree	



		×
> Welcome to Pipe Terminal Manager		
What you need to know about the process:		
1. Your Veronte unit must be in INI phase		
2. You must to connected to to your Veronte unit via USB.		
3. Interrupting the process may brint your Veronte unit to a corrupted status.		
4. Once the process is done. Your Veronte unit will be restarted.		
	Veronte LOS 🔹	Launch
	Veronte LOS	
	RS232	
	RS485	

### Serial selection

Veronte Pipe is able to automatically set up the required tunnel over LOS, RS232 or RS485 depending on the user configuration and needs. In case of internal radio module configuration, the LOS option must be selected. If some external module is plugged over some external serial port, then RS232 or RS485 option must be used.

Once the process is launched, the Tunnel Console shows up.

Tunnel C	onsole					×
Veronte	ID: 1120	Tunnel Pip	e:	0	Tunnel Veron	nte: 0
						Â
						~
	Display	ASCII -	Clea	r	Pause 🗸	Show sended Msgs
Message	2					
						<b>C C</b>
R						
Send	ASCII 👻	End (	Of Line EOL	-		Send

#### Tunnel Console

This console allows the user to communicate with the desired device (internal LOS or external device) by configuring the listed parameters:

- **Display:** Data can be displayed in Ascii or Hexa format.
- Clear: Clears the last console data.
- Pause: When the data stream is running, it is possible to pause it by enable this option.
- Show sent messages: If enabled, the sent messages are shown in the console.
- Message: Message content.
- Microhard setup helper: Check the related sub-section below.
- Send: Data sent in Ascii or Hexa format.
- End Of Line: Message "End of line" configuration.
- Send: Sending button. When clicked, the current message is sent.

# 7.5.1 Microhard setup helper

The **Microhard setup helper** can be used in order to easily configure the Microhard internal modules. In order to do this, the user should click on the dedicated button and the Wizard will automatically start the radio searching.

Tunnel Console			×
Veronte ID: 1120	Tunnel Pipe:	0 Tunne	el Veronte: 0
Waiting response. Waiting response. Waiting response. Waiting response. Waiting response. Waiting response. ***> AT&V AT&V p2400 Microhard S v1.027 Jul 14 201 S/N: 025-1026227 MAC: 00:00:00:00: E1 DCD &C1 DTR Operating Mode Wireless Link Rat Unit Address Output Power(dBm) Packet Retransmis Repeat Interval Roaming RSSI from Downlin Destination Addres Protocol Type Fast Sync Timeout FEC Mode Compatible _21 at OK	<pre></pre>	DSR &S1 Serial Baud Rate Network Address Static Mask Data Format Packet Retry Limit Character Timeout RSSI from Uplink,dBm Network Type Serial Channel Mode Sync Mode Address Tag Sync timeout	S102=1 S104=1 S104=1 S107=**** S110=1 S213=5 S116=10 S123=N/A S133=1 S142=0 S153=0 S153=0 S248=512
D	splay ASCII 👻	Clear Pause	Show sended Msgs
Message			
Send ASCII	• End Of Lin	e EOL 🔻	Send

#### Terminal Console - Radio found

Once the radio is found, its model is shown in the upper-left corner of the window and the configured parameters in the console. The following Wizard menu is displayed.

Radio Wizard						×
Radio model P2400		Licens	ed band configu	ration		
Radio configuration		Lice	nsed Band Frequ	ency	430.0	Hz
		Frequ	ency hopping tal	ble		
Out power	30 dBm (1W) 👻					
Address	Master -					
Connection	pp 👻					
Connection						
Network address	1					
Packet retransmission	2 0-254					
Commands		V Lin	k values from Ta	ble1 to Tab	le0	
AT&F6	<u>^</u>					
ATS108=30						
ATS104=1						
ATS105=1						
ATS102=1 ATS113=2						
ATS103=5						
AT&W						
ΔΤΔ	~					
Reset					Send m	nessage

#### Radio Panel

These parameters have to be set accordingly to the radio module installed in Veronte.

- **Radio Module:** Each Veronte has only one of the following radio modules P400, P900 and P2400. Select here the radio module installed.
- Output power: Sets the available power output.
- Connection: Point to Point or Point Multi Point. By default all units are paired with PP connection.
- Address: Master or Slave . Select the role for each Veronte by selectig Master or Slave. By default the air unit is defined as Slave and ground units as master.
- Network address: the network address is a number that must be equal between Verontes using the same network.
- Packet retransmission: Each data pack is sent as much times as defined here.

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

The commands can be also manually sent. For advanced Microhard configuration, please check the specific radio module User Manual here.

Once the configuration is sent, the console is closed and the **Close & Restart** button appears. By clicking this button, the user can exit the configuration process and the Veronte unit is restarted. The Microhard radio module is now configured.

	×
> Welcome to Pipe Terminal Manager	
What you need to know about the process:	
1. Your Veronte unit must be in INI phase	
2. You must to connected to to your Veronte unit via USB.	
3. Interrupting the process may brint your Veronte unit to a corrupted status.	
4. Once the process is done. Your Veronte unit will be restarted.	
Close & Restart Veronte LOS 👻 Launch	

Veronte Pipe Terminal closing and Veronte restart

# 7.6 Overview

In this section, it is explained how to configure Veronte Units using Veronte Pipe. Each feature available is described in detail in following sub-sections.

Firstly, the user will find how to manage configuration files: import, export, update, etc. Later, this manual will focus on the setup toolbar, this allows the user to change the main settings of the Veronte Units according to the aircraft (Control Loops, Installation, etc.) and mission (Phases, Guidance, etc.) to perform.

Finally, the manual explains how to check Veronte's license, where the user can see the license ID and its status.

# 7.7 Side Panel Options

The Side Panel allows the user to manage Veronte Units and Configuration files. In this panel each item is displayed, when an autopilot is connected it will appear automatically. The following image shows both items and the options available.



Side Panel Options

Item	Description
Setup	Displays the setup toolbar
Operation	Displays the operation toolbar
Set	Choose one operation to be loaded
Operation	
Export	Export configuration on Veronte to disk in .ver or PDI files
Import	Import a configuration from disk
About	Displays information on Veronte SN, License and Status (only available for connected Veronte configurations)
HIL	Hardware in the loop simulation
Advanced	Update Veronte Unit and Reboot it

The next table gives a brief overview of each option.

## CHAPTER

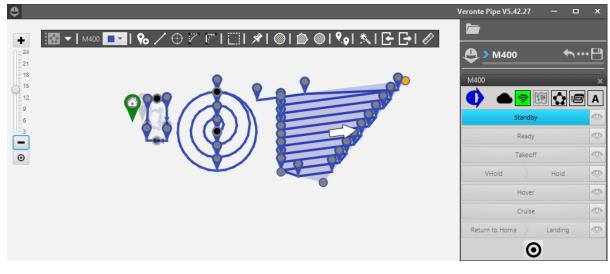
# EIGHT

# **MISSION**

# 8.1 Setup

## 8.1.1 Introduction

A Mission can be configured making use of the Mission Menu. Missions can be created and managed though the Mission menu. First, make sure the autopilot unit where the mission has to be upload is selected, i.e. the Air unit. Right after, the aircraft trajectory can be drawn using the graphical tool of this menu, along with other auxiliary elements such as polygons, event markers or obstacles markings.



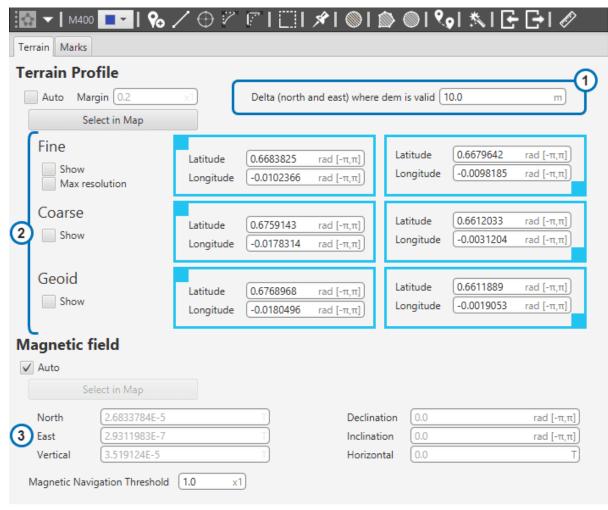
Mission Setup Examples

The user can manage two or more missions simultaneously open in Pipe, but be careful not to mix configurations. The paths created will be directly linked to the Cruise guidance mode, so each time the aircraft is in a phase with cruise guidance, it will start to follow the track created with the mission menu.

# 8.1.2 Terrain profile and magnetic field

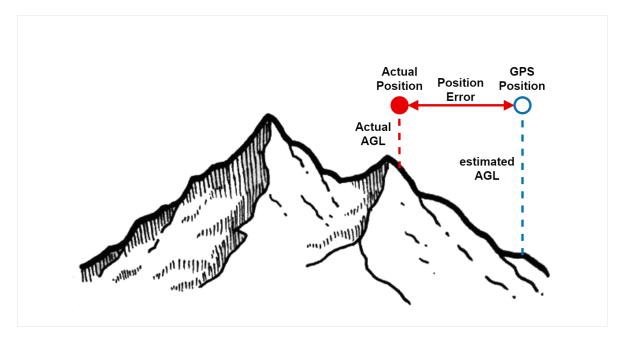
Before starting the configuration of a new mission, the terrain profile and the magnetic field, Magfield, have to be set.

Click on Open details button, **button**, to access the settings.



Terrain profile and magnetic field settings

1. **Delta parameter**: The distance to the ground (AGL) may be measured through two or more systems. Usually, an altimeter like a LIDAR in conjunction with the GPS signal and the meshes information are used. During flight, it is possible that the GPS position error is large enough that the height provided by the meshes does not correspond with the actual position. In order to avoid problems, the Delta parameter can be defined. This parameter defines a circumference radius where both systems will be used. If the estimated position error is bigger than the delta parameter, only LIDAR data will be used.



Delta Parameter

- 2. Meshes of terrestrial mode: three different are established: Fine, Coarse and Geoid.
  - Fine: Is the smaller mesh. Contains detailed information about terrain altitude.
  - Coarse: Medium mesh with not so much detail.
  - Geoid: World mesh which provides the geoid altitude.

<b>e</b>		Veronte Pipe V5.42.27 —	□ ×
24	•	😃 > м400	<b>∽</b> ⊟
18	· · · · · · · · · · · · · · · · · · ·	M400	×
12		🜓 🌰 🛜 🕅 🛕	:@ A
9		Standby	•
		Ready	•
Θ	· · · · · · · · · · · · · · · · · · ·	Takeoff VHold Hold	
		VHold Hold Hover	
		Cruise	0
		Return to Home Landin	ng 👁
		Θ	

Fine and Coarse meshes setup

If "Auto" is enabled, the system will automatically place and adjust the meshes to optimal start dimensions. The user can modify them manually, also. First, deselect the "Auto" option. The coordinates of each upper left corner and lower right corner of the meshes' rectangle can be introduced. Also, they can be set by hand by clicking and dragging the meshes and its edges around the map. In order to do that, click on "Show" to display the meshes on the screen.

In general, increasing meshes size will mean lower area definition. And greater resolutions smaller meshes, because it implies heavier data files.

"Margin" is the percentage at which the system will recalculate the mission if the route is displaced. In other words, if the mission is displaced 60% out of the area (Coarse or Fine) and the margin is set to 80%, the mission will be not recalculated. If the mission is 81% (or more) away from the previous one, the system will recalculate the mission. A low level (or zero) margin means more terrain profile precision but the system will have to recalculate the meshes more times (or each time) when the mission is modified.

3. **Magnetic vector**: the magnetic vector of the mission's area should be introduced. As far as the Magfield is concerned, it is recommended to select the "Auto" option to take the magnetic declination information of the mission area.

**Warning:** Check that meshes position are over the mission area before flying, especially if carrying out an operation in mountainous terrain.

## 8.1.3 Marks

Marks are an important feature to Pipe and the missions. Marks can trigger actions when the aircraft passes through them. Actions can be configured in the *Automations Menu*.

There are two possible options to add a new mark. One is through the "Event Mark" button on the Mission toolbar

, which allows the user to create a new mark on a **route** track directly or attached to an individual waypoint, or

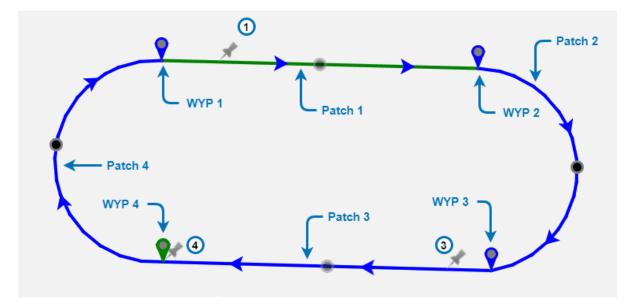
via the Marks flange on the Open Details by clicking on "+" at the upper right corner of the table. In both cases, all the marks created will appear on this menu:

Terrain Marks	<mark>-   % / ⊕ /″ /″  </mark>	<u>[]</u>   ≉ ©  <b>⊘</b>	©  <b>?₀</b>  ≛	.  E E   🖉
Patches	Patch	Туре	Value	6
Route	Route 1	Referred to start	1074.692	
Route	Route 3	Referred to start	865.56433	
Route	Route 4	Referred to start	0.0	
Approach	<b>,</b> L4	Referred to start	50.0	
Approach				
Climbing				
Route				
Taxi				
VTol				
Rendezvous				

Marks Menu and Guidance's patch selection

There are several options to configure the Marks:

- **Patches**: by double-clicking on "Route", a dropdown list allows the user to select different flight phases where the marks will be placed: Approach, Climbing, route... Except for Route patches, the rest of the phases are generated when the user, or an automation, activates them. As the user can not select this patches, they do not already exits, this option will create the mark automatically in the patch selected.
- **Patch**: Most Flight phases have predefined patches with specific names. The user can select where the mark will be placed on those patches. At the end of this section there is a table that summarizes available options. For more information about them, check the *Control menu* in Setup Toolbar.
- Type: right now the only possible option is "Referred to Start" of the selected patch.
- Value: Mark's distance to the start of the patch.



#### **Route Patches**

At the examples above there are four marks created. Three are attached to different route patches: 1,3 and 4. Route 1 and Route 3 marks were added by hand. Route 4 mark was introduced using this menu and is overlapping with waypoint 4 (value equals zero). Last mark was added to the approach L4 patch. This mark could be linked to an automation that deploys landing flaps, for example.

Approach	L0/A1/L2/A3/L4/L5
Climbing	L4/A3/L2/A1
Route	512 patches
Taxi	Taxi1/Taxi2
VTol	VTol1/VTol2/VTol3
Rendezvous	Rendezvous1/Rendezvous2/Rendezvous3

# 8.2 Tools

### 8.2.1 New Waypoint



#### New Waypoint Tool

Use the New Waypoint tool and press on the map for creating a waypoint. For moving waypoints, simply drag it to the desired position. If user wants to manually change the coordinates of the waypoint, it is possible to click twice the waypoint and the following display will appear for entering custom parameters. In order to only check them, a resume display can be obtained by simply passing mouse on the point.

Longitud	Operation C	ustom Point 04		×
<ul> <li>Absolute Decimal Degrees UAV POS MAP POS</li> <li>Latitude 38.28887891032879</li> <li>Longitude -0.48371747150403627</li> <li>WGS84 80.35568237304688 m</li> <li>MSL 30.01545225969066 m</li> <li>Latitude Longitude</li> <li>AGL 30.01545225969066 m</li> </ul>	Relative	-	<b>e</b> [9]	
Longitude -0.48371747150403627 WGS84 80.35568237304688 m MSL 30.01545225969066 m ▲ AGL 30.01545225969066 m AGL 30.01545225969066 m	Absolute	Decimal Degrees 🔹		
WGS84 80.35568237304688 m MSL 30.01545225969066 m ▲ AGL 30.01545225969066 m Latitude Latitude Longitude Altitude	Latitude	38.28887891032879		
MSL 30.01545225969066 m ▲ AGL 30.01545225969066 m AGL 30.01545225969066 m	Longitude	-0.48371747150403627		
AGL 30.01545225969066 m Latitude Longitude	WGS84	80.35568237304688	m	
Longitude	- MSL	30.01545225969066	m	
Altitude	LA AGL	30.01545225969066	m	
Events Actions Altitude				
	Events	Actions		Altitude
			Cancel	

Waypoint Settings

There exist two way of defining the position of a waypoint:

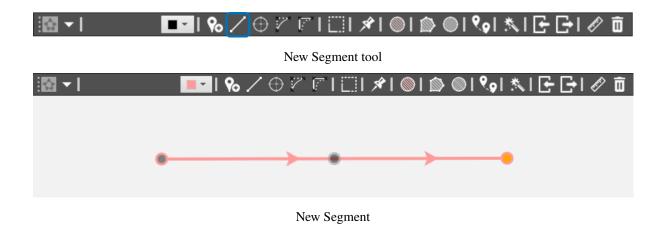
- Absolute: the coordinates of the waypoint are indicated trough the latitude, longitude and altitude (being possible to define this last one with respect to the ellipsoid, WGS84, to the sea level, MSL or to the ground, AGL). To introduce the point coordinates the user can select 3 and click on the map, introducing later the altitude manually, or press 2 that allows selecting the current position of the air or ground autopilot as the waypoint coordinates.
- **Relative:** in this case, the position of the waypoint is relative to another point. That point could be any platform fitted with a Veronte autopilot. It is possible to select up any waypoint, home or the UAV. It is common to select a waypoint with reference to the position of the ground station. In order to link an object of interest with the position of the ground autopilot please go to section *Sniffer*.

The other two windows that appear on the waypoint menu are related with the automations of the system. There will appear all the events and actions related with the mission waypoints (Route, Track, Go To), so it is possible to indicate which waypoints will trigger the event or perform the action. To have a deep understanding on the system automations visit *Automations*.

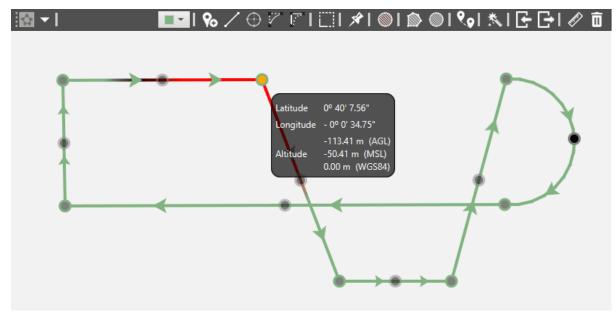
If you click the right button of the mouse yo can:

- Change the name of the waypoint
- · Remove the waypoint
- Set the waypoint as start of the route

## 8.2.2 Segment



To create a new segment, click on first. Then, select in the map the point where you want the segment to start. To finish the track click first the left button and then the right button. You can concatenate two or more segments clicking on several points in the maps with the left button, as you can see in the picture below:



Concatenated Segments with one waypoint below ground level

To delete a segment, remove one of the waypoints of its extremes. You can modify the concatenated segments moving the waypoint between them or create circular paths clicking and dragging the middle point of the path.

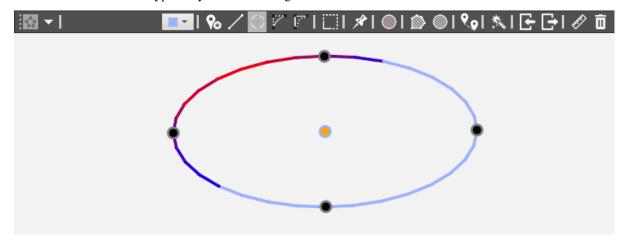
**Warning:** When you create a segment, you have to be careful with the height of the waypoints. **Please, remember to check their altitude.** If some of them are under the ground altitude indicated by the meshes, the segment will change its colors to red. To resolve this, change the altitude of the waypoints clicking on them twice.

## 8.2.3 New Orbit



New Orbit Tool

This tool allows the user to create a new orbit on the map. First, select a point on the map which will be the center of the new orbit. To move the orbit, drag the center point to the desired position. It is also possible to set the precise coordinates of the central waypoint by double-clicking on it.



New Orbit, transformed to an ellipse and partially below ground level

The initial circular orbit can be converted to an ellipse modifying the length of the axes the extremes. Click and drag on any of the four points to your preferences

To delete a orbit, remove the central waypoint.

**Warning:** When creating a orbit, **be careful with its altitude and the ground level** (all the points of the orbit will be at the same altitude), if any part of orbit is below the terrain level indicated by the meshes, it will be coloured in red. Please, modify the altitude of the waypoint by clicking twice on the central waypoint.

## 8.2.4 Intersect Lines

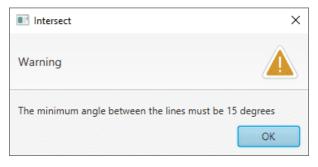


#### Intersect Lines Tool

This tool eliminates circular paths between linear paths by extending them until they intersect. To apply it, select the tool first. Then, click on the circular path you want to delete. Intersect Lines performs well reversing the fly-by tool:

#### Intersect Lines example

The angle between linear paths must be greater than 15 degrees to correctly undo the turn. In case the angle is smaller, a warning window will pop up. This feature prevents the creation of very long linear paths that intersect in the infinity.



Warning Message

Warning: Always check the altitude of the waypoint at the intersection

## 8.2.5 Fly By



Fly-By tool

This tool has been developed to improve turns of fixed-wings aircrafts. To explain better the utility of the tool we will use this example:

### Fly-By example

To configure a Fly-By waypoint click on the tool's icon. Once it is selected, click on a waypoint. A new window will pop up asking to introduce the desired turn radius. When the radius is introduced the route will change and now the aircraft won't fly over the waypoint.

## 8.2.6 Multiple Choice



Multiple Choice Tool

Multiple Choice allows to move mission's path from one place on the map to another. Select the tool and create a rectangle by clicking and dragging until the waypoints you want to move fall into it. With the points selected, click and drag the selected path to the desired location. After that, click again in the tool's icon to deselect.

The tool can be used to remove multiple waypoints or paths too. This action can be performed by right-clicking on one of selected waypoints and clicking on Remove.

Drag and delete example

It is also possible to rotate the selection by clicking on the arrow symbol and dragging it.

Rotation example

**Warning:** Always remember to check the altitude of the waypoints by double clicking on them or in Operation menu, in the Waypoints tab.

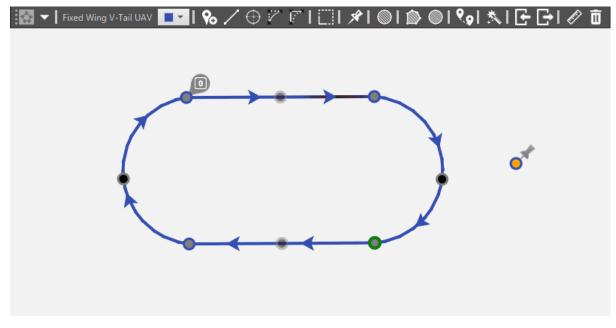
## 8.2.7 Event Mark



Event Mark Tool

This tool allows to set an Event Mark over a track or attached to a waypoint. Marks are useful to start automations. When the aircraft flies over it, an event is triggered and it can be used as a condition to start a set of actions: add a lap to a counter, payload launch, take a photo, start video recording,...

To add an Event Mark, select the tool and click on the desired path point or waypoint. Initially, new marks appear as a pushpin. If you link an action to one of them, it will show the icon selected to this action.



Event Mark examples

To access the properties of the mark, make double click on it:

Event		×
Туре	Referred to start	•
Distance	0.0	m
Associated ev	ents	
29 - Res	et Time button	
		_
		Accept

### Event Mark properties

- **Type**. Allows the user to select the type of mark reference. Right now all the marks are "Referred to start", that means the position of the mark is relative to the starting point of the path in which the mark is. I
- **Distance**. Is the horizontal distance along the path to the starting waypoint. If the mark is attached to a waypoint, distance will be zero.
- Associated Events: List of events that can be linked to the mark.

**Remember to save the changes to make them effective.** After saving, all the marks created will appear in the Marks tab of the Open Details menu:

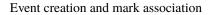
rrain Marks	ing V-Tail UAV 💶 🖠 伦 🖊			
 Patches	Patch	Туре	Value	+
 Route	Route 7	Referred to start	0.0	
 Route	Route 10	Referred to start	0.0	

Marks List

### 8.2.7.1 Event creation and association

For this example we have created a new automation, Reset Flight Time, and created and associated an event to the mark in route 7 to trigger it:

Fixed Wing V-Tail UAV 🛪	🕺 ই 🙆	📽 🗂 🕰		
<ul> <li>✓ 8 - Reset Flight Time</li> <li>✓ Transitions</li> </ul>	Reset Flight Time			$\searrow$
2 - TKO to CMB	Events	AND OR NOT	Actions	+
<ul> <li>✓ 3 - CMB to CRU</li> <li>✓ 16 - LND to FLARE</li> </ul>	21 - R	eset Mark	20 - Update time reference	e
19 - FLARE to SBY				
▼ ALT mode				
2210				
▼ Flight time				
✓ 28 - Stop Flight Tir ▼ Brakes				
✓ 27 - Brakes on			Delay 0.0 s Periodica	al: Off
✓ 18 - Brakes off ▼ Failsafe			2	_
✓ 10 - Auto when Nc	Route	▼ Reset Mark	Compliance time 0.0	
▼ Stick	Activation Mar	k achieved	X Add marks	-4
21 - Arcade Mode		5	Selected Marks	
12 - Manual Mode		White 👻		+
▼ Buttons				
🗸 15 - Arcade Trim 🗸		l	<	Σ
	Waypoints affecte	d will be available on miss	sion edition	
New Automation				

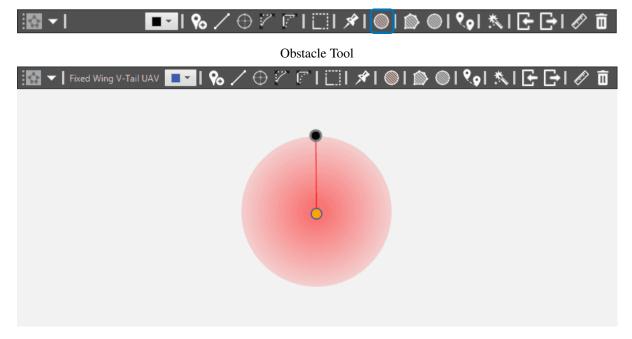


Clicking in Setup, in the subsection of automations, you can enter in the automations menu tab to link one event to one mark following the next steps:

- 1. **New Automation**. The first step is to choose or create a new automation. In this example we have created a new one: Reset Flight Time. After its creation, a list with events will show up. We select "New Event
- 2. Route. . We have changed its name to "Reset Mark" and selected the "Route" type in the drop down list.
- 3. Activation. In the drop-down list menu, we select "Mark Achieved".
- 4. Add/Selected Marks. Click on  $\bigotimes$ , or  $\bigotimes$ , to select a mark in the map. We've selected the mark in Route 7. The user can select multiple marks for the same event. All the marks associated to this event will appear in this list. This is useful if some action needs to be repeated several times during a mission, for example taking photos at the desired locations or dropping payloads.
- 5. **Icon and color**. The final step is changing the icon and color of the mark to remember easily the automation linked to the mark. We have selected a zero icon, as it can be seen in previous photos. This step is optional but highly recommendable.

Remember to save the changes to make them effective.

## 8.2.8 Obstacles



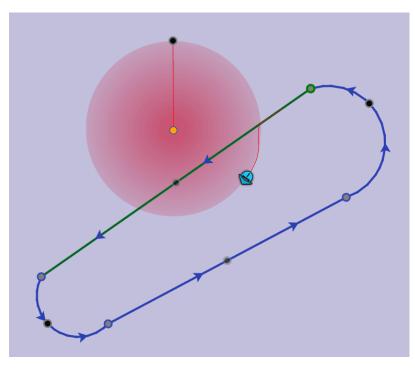
### Obstacle

This tool permits to set an exclusion area on the map that can not be crossed by the RPAS. To change the area position, drag its central waypoint to the desired position. The radius can be extended or contracted directly by dragging the point in its circumference. It is also possible to set the coordinates of the central waypoint by double-clicking on it.

Main functions of the tool:

- Avoid collisions with obstacles as for example buildings, trees or antenna towers.
- Avoid flying restricted access areas.

This area is a repulsion potential field for the aircraft, so depending on the moving speed, the plane will cross the black line (high speed) or it will remain completely out of the red zone.



Obstacle avoidance

What can happen with high speed aircrafts (Airplanes) ? Its possible that because their velocity, the RPAS will sign in the obstacle area, but immediately it will apply the corrections to leave of the obstacle area and return to the path. The solutions for this problem its configure a bigger obstacle area in order to avoid the physical obstacle

What can happen with mow speed aircrafts (Multirotor)? It can happen that a multirotor enter in a obstacle area (staying very near of its center), in this moment *Ground Speed Vector* and *Field Repulsion Vector* have the same direction but reverse sign. This phenomenon causes a conflict and until the directions are sufficiently different to allow the multirotor moving, it will stay in an indecision situation. To solve this problem you can configure the obstacle area letting the obstacle center away from the route line.

There are some options available for each obstacle. To access them right-click on the center waypoint of the obstacle.

- Set 3D: this option enables the aircraft to avoid an obstacle passing over it, taking account the height of the obstacle. The height can be edited as any waypoint, to access into the configuration menu double-click on it.
- Set 2D: this option only takes account 2 dimensions for the obstacle. So, the platform won't be able to avoid the obstacle passing over it
- **Remove:** deletes the selected obstacle.

## 8.2.9 New Polygon



#### New Polygon Tool

This tool is used to determinate an area in which an action is wanted to be performed. The way of working is very similar to Event Mark.

New Polygon

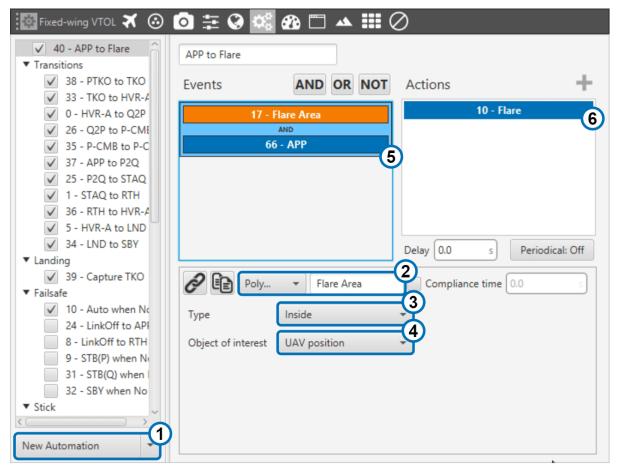
When the aircraft enters or leaves the polygon an event may be triggered and it can be used to start an automation.

To easy understand this tool, lets do an example with the action Landing to flare.

**Note:** *Landing to flare* is a maneuver made by an aircraft just before the touchdown. It Consists on a rise of the nose to decelerate the descent rate and set a proper attitude before touching the ground.

Following the same steps as in the Event Marks, we have created a new automation, "APP to Flare", and a new event, "Flare Area". Its purpose is to automatically change from the Approach maneuver (APP) to Flare before touchdown. To avoid problems, we have added as an additional condition that the plane should be in the Approach phase to trigger this automation:

The steps followed to configure this automations were:



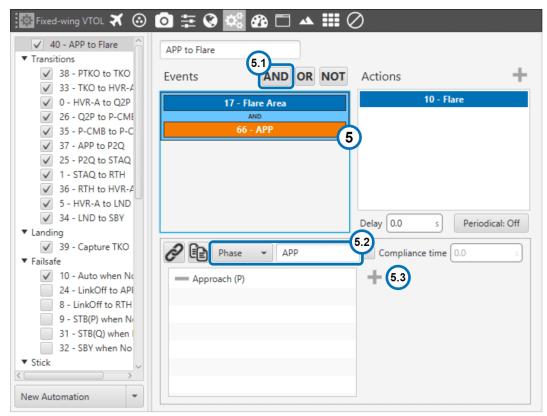
#### Flare Event Example

- 1. New Automation. First, create a new automation and change its name to "APP to flare".
- 2. Event Type. Then, select the "Polygon" event type in the drop-down list and change its name to "Flare Area".
- 3. Type. The Polygon event type can be defined as:
  - Inside polygon. The event will be carried out when the aircraft enters in the polygon.
  - Outside polygon. The event will be carried out when the aircraft leaves the polygon.

Select "Inside".

4. **Object of interest**: UAV position.

5. **Extra condition**. As previously said, to avoid problems another condition has to be meet to trigger the automation. The plane must be in the Approach phase:



- 1. Add Event. Click on the "AND" button. An Event list Menu will pop-up,select a "Create Event".
- 2. Event Type. Select "Phase" in the drop-down list. Change its name to "APP" (approach).
- 3. Add Phase. Click on the cross at the right of the list, search the "Approach" phase (the phase would have been previously created in the Control tab of the Setup menu. Check *Phases* for more information).
- 6. New Action. To end this automation, add a new action:

Fixed-wing VTOL 🛪 🙆	◙ ≆ ⊗	🔹 🚯 🗂	▲ Ⅲ (	$\oslash$	
✓ 40 - APP to Flare Transitions	APP to Flare				
<ul> <li>✓ 38 - PTKO to TKO</li> <li>✓ 33 - TKO to HVR-4</li> </ul>	Events	AND	OR NOT	Actions	6.1 +
<ul> <li>✓ 0 - HVR-A to Q2P</li> <li>✓ 26 - Q2P to P-CME</li> </ul>		17 - Flare Area AND			10 - Flare
<ul> <li>✓ 35 - P-CMB to P-C</li> <li>✓ 37 - APP to P2Q</li> </ul>		66 - APP			
<ul> <li>✓ 25 - P2Q to STAQ</li> <li>✓ 1 - STAQ to RTH</li> </ul>					
<ul> <li>✓ 36 - RTH to HVR-4</li> <li>✓ 5 - HVR-A to LND</li> </ul>					
✓ 34 - LND to SBY ▼ Landing				Delay 0.0	s Periodical: Off
<ul> <li>✓ 39 - Capture TKO</li> <li>✓ Failsafe</li> </ul>	8 🖻 P	hase 👻 Fla		6.2	
<ul> <li>10 - Auto when Nc</li> <li>24 - LinkOff to API</li> </ul>	Change to	Flare (P)		9	
8 - LinkOff to RTH 9 - STB(P) when N					
31 - STB(Q) when I 32 - SBY when No					
▼ Stick ~					
New Automation 👻					

- 1. Add Action. Pressing the cross icon and "Create New" phase (if it doesn't already exists).
- 2. Action Type. Select "Phase" in the dropdown list.
- 3. **Change to**. And select the "Flare" phase. This phase would have been previously created in the Phase menu.
- 7. Link Polygon to event. Finally, after the event creation, press the save button. Then, right click on the polygon and choose *Events > Name of the event*, to link the polygon to the new event.



## 8.2.10 Circular Area



#### Circular Area Tool

This tool is used to determinate an area in which an action is wanted to be performed. The way of working is the same as New polygon and very similar to Event Mark.

#### Circular Area

When the aircraft enters or leaves the circular area, an event is triggered and it can be used to start an automation.

Check Event Mark or New Polygon to learn how to create a Polygon Event.

To access the parameters, right button click on the circle:

- Events. Enter the Events tab to assign previously created events to the circular area.
- Set Radius. To accurately set the radius of the circle. You can also set the radius clicking and dragging the outer point.
- **Height Limits**. Yu can set the upper and lower heights of the circle volume. By default, circular areas have infinite lower and upper boundaries.

Height limi	ts		×
Lower	100000.0	m 🛟	MSL 👻
🔲 Upper	100000.0	m 🛟	MSL 👻
			Apply

#### Circle Heights

• Remove. Deletes the Circular Area.

### 8.2.11 References



#### References Tools Symbol

This tool has a wide range of capabilities, it is used to set references during the creation of a mission. Once selected, click on the map and a new window will be displayed to select the type of reference.

Select variable		×
Select var Filter -		
F 8192 - UAV position		<b>^</b>
F 8194 - Desired position		
F 8196 - Track position		
F 28672 - Moving Object 01		
F 28673 - Moving Object 02		
F 28674 - Moving Object 03		
F 28675 - Moving Object 04		
F 28676 - Moving Object 05		~
	Cancel	Accept

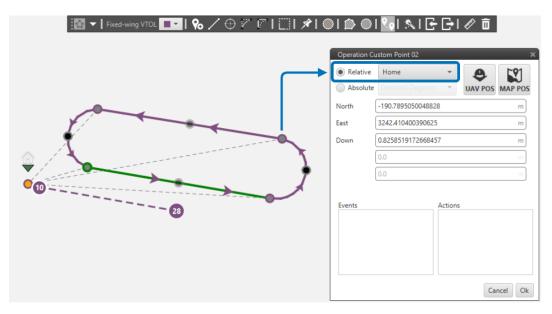
#### List of References

In this list is possible to select between 4 types of elements:

- **Home:** select a waypoint as Home. For example, it can be used to made a multicopter return to that point using the VTol guidance.
- UAV position: waypoint(s) can be linked to this reference and they will move relative to this reference.
- **Moving Object:** it works in the same way that UAV position, but now it is possible to use any moving object. They have to be configured and associated to a Moving Object in the sniffer. You can create until 32 moving objects.
- **Desired position:** it allows to define a fixed reference (it can be moved on the map, but not automatically). This reference can be used when there are a huge number of points. If users refer each point to a reference, user only has to move the reference to move all points or to perform a Phase (if it has the option) in a determined point.

How to add a reference:

- 1. Select Reference on the Mission Toolbar and click on New Reference.
- 2. Click on the desired position on the map and select the type of element.
- 3. Double-click on a waypoint to acces its properties. Select the Relative drop-down list and then select the element of interest.



Waypoint Reference

4. Finally, set the relative position of the waypoint, this can be done introducing offsets or just moving the waypoint onto the desired place. A dashed line will appear to indicate that the waypoint is linked correctly.

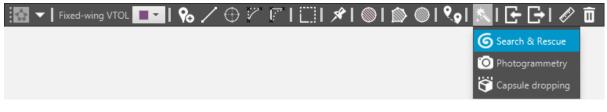
## 8.2.12 Mapping

	G-G- ∥	Π
6	Search & Rescue	
0	Photogrammetry	
<b>Ö</b>	Capsule dropping	

Mapping Tool Symbol

The Mapping tab includes a series of missions automatically generated from a set of parameters introduced by the user. So far, Veronte Pipe includes the following mission wizards:

### 8.2.12.1 Search & Rescue



### Search & Rescue

**Search & Rescue** mission draws a spiral that can cover the target area. The spiral can be modified using the two blackgray points or opening the Search & Rescue Menu (double click on the route waypoints) and changing parameters:

- Radius: spiral maximum radius.
- **Rounds:** the number of spiral rounds.

- Altitude: altitude of the waypoints. It can be expressed in AGL, MSL or WGS84.
- Angle: inclination angle of the spiral axes on the map.
- Length: length of the entire route.
- Rotation: you can choose between clock-wise or counter clock-wise.

Search & Rescue Example

### 8.2.12.2 Photogrammetry

🔣 🔻 🛛 Fixed-wing VTOL 🔳 🕇 🛛 💸	📌 I 🔘 I 🏠 🌒 🍫	📉 I 🕒 🗗 🖉 🖻
		6 Search & Rescue
		O Photogrammetry
		Capsule dropping

#### Photogrammetry

This tool allows users to draw a polygon on the map and configure camera parameters to automatically generate a mapping mission. Photogrammetry can be set from the mission tab by clicking on the Mapping icon and selecting photogrammetry from the list.

#### Photogrammetry Example

The process to configure a *Photogrammetry* mission:

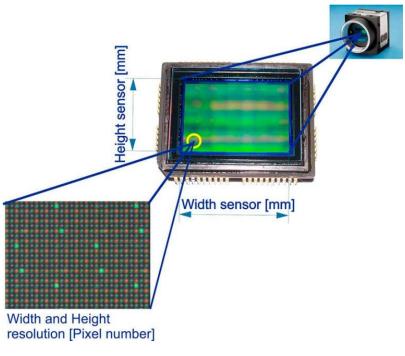
- 1. **Draw the polygon** in which the drone will cover flying. If no camera is configured, a new window will appear when you close the polygon.
- 2. **Camera specifications**. Define the camera (or select it from the database included in Veronte Pipe by clicking on the hand lens icon). Veronte can stream the video signal selecting the Streaming option. If the camera is associated with a gimbal, it can also be defined here.

Create camera			×
Default camera			Q
36	mm	Camera cache	1000.0 ms
1 24	mm		
5784			
3856			
<b>9 1</b> 35	mm		
Streaming	Cam associa	ted with gimbal	~
URL			
Device	-	Network caching	
Device		IP/port	
Photogrammetry			
Action 0			
Add Action			
Add Action			
			Accept

### Camera Configuration

Five parameters appear below the camera name:

- Width Sensor in millimeters.
- Height Sensor in millimeters.
- Width resolution in pixels.
- Height resolution in pixels.
- Focal length.



Sensor Parameters

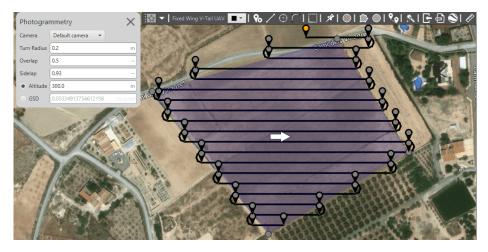
Photogrammetry actions can be also added here.

3. **Photogrammetry configuration**. When your camera is created, it is time to configure your Photogrammetry process.

Photogrammetry 🛛 🗙				
Camera	Default camera 🔹			
Turn Radius	0.0	m		
Overlap	0.5 T			
Sidelap	0.5			
Altitude	300.0	m		
GSD	0.05334913754612158	cm/pixel		

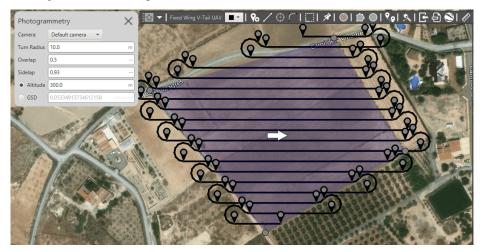
#### Photogrammetry Configuration

- Camera. Select which camera you are using in the process.
- **Turn radius**. radius of the route turns. Depending on this value and the distance between passes, there are three cases for this part of the route (the radius has to be established according to the minimum reacheable by the platform):
  - **Radius 0**, there are not curves between passes, but straight lines. This option is used with multicopters, which are able tor perform this kind of paths.
  - Radius is smaller than half the distance between passes (R<d/2). Pipe generates a semicircle with the diameter equal to the distance between parallel tracks.



Smaller Radius

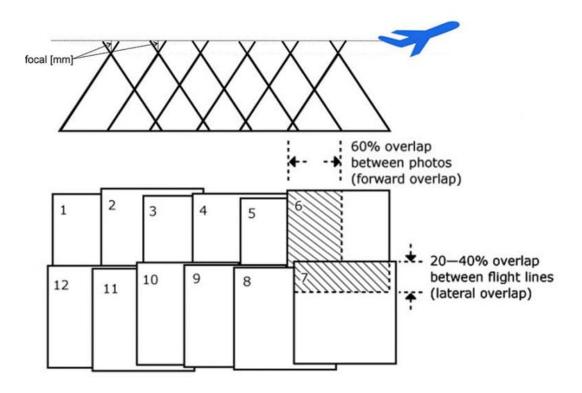
- Radius bigger than half the distance between phases (R>d/2). The path between straight lines is made up of two curves and a line.



**Bigger Radius** 

- **Overlap**. Desired overlap of the photos in the route direction. Its effect will be evident in the photos period changes.
- **Sidelap**. Desired photos overlap in the different passes. Increasing this value will reduce the distance between the passes.
- Altitude. Waypoints altitude in AGL.
- **GSD**. Ground Sampling Distance in photogrammetry is the distance between two consecutive pixel centres measured on the ground.
- **Main Direction of the mission** In the mission creation, at the centre of the created polygon, an steerable white arrow is present. When the arrow is turned, the mission will turn its main direction consequently. this is useful to avoid excessive wind exposition, for example.

The following image represents the mapping configuration variables in Veronte Pipe:



Overlap and Sidelap

4. When defining a Photogrammetry mission **an automation will be created automatically**. To complete the mission, in the lower part of the previous menu the option Photogrammetry has to be selected and the user must define the action that will be carried out, in this case taking a photo. The action (usually Output) has to be defined according to the hardware configuration on board. Once completed all the configuration, the automation will be created, by default its name is Mapping mission as showed in the two pictures below.

Fixed Wing V-Tail UAV 🔾	🐵 🧰 😜 🥸 🗱 🖾 🔺	
Phase transition diagram	Mapping mission	
<ul> <li>✓ 7 - SBY Button</li> <li>✓ 15 - Arcade Trim</li> <li>✓ 23 - HLD Button</li> <li>✓ 24 - ALT Button</li> <li>✓ 29 - Hold trim</li> <li>✓ Failsafe</li> <li>8 - LinkOff to LND</li> <li>9 - HLD when No (</li> </ul>	Events AND OR NOT Actions 90 - Inside polygon mapping	15 - Photo
<ul> <li>✓ 10 - Auto when No</li> <li>14 - Low Battery</li> <li>▼ Stick</li> <li>✓ 11 - Auto Mode</li> <li>✓ 12 - Manual Mode</li> <li>✓ 21 - Arcade Mode</li> </ul>	Delay 0.0	s Periodical: On
<ul> <li>✓ 2 - TKO to CMB</li> <li>✓ 3 - CMB to CRU</li> </ul>	Type Inside 👻	
<ul> <li>✓ 13 - When Event Mai</li> <li>✓ 16 - LND to FLARE</li> <li>✓ 19 - FLARE to SBY</li> <li>20 - CRU to LND</li> <li>✓ ✓ ✓ 26 - Mapping miss ×</li> </ul>	Object of interest UAV position -	
New Automation		

Mapping Automation Event

This automation tool offers you define automation as:

- Inside area: the event will be carried out when the aircraft enter in the area.
- **Outside area:** the event will be carried out when the aircraft leave the area.

Object of interest defines the object that have to enter or leave the area.

Fixed-wing VTOL 🛪 🙆	o 🗄 🗞 🔿	🚯 🗂 🔺	<b>III</b> (	0		
✓ ♂ 41 - Mapping miss ✓ 40 - APP to Flare	Mapping mission					
<ul> <li>Transitions</li> <li>38 - PTKO to TKO</li> </ul>	Events	AND OR	ΝΟΤ	Actions		+
✓ 33 - TKO to HVR-4	42 - Inside	polygon mapping			21 - Photo	
✓ 0 - HVR-A to Q2P						
✓ 26 - Q2P to P-CME						
✓ 35 - P-CMB to P-C						
✓ 37 - APP to P2Q						
✓ 25 - P2Q to STAQ						
✓ 1 - STAQ to RTH						
✓ 36 - RTH to HVR-A						
5 - HVR-A to LND				Delay 0.0	s Pe	riodical: On
✓ 34 - LND to SBY				-		
▼ Landing	🖉 📳 User.	👻 Photo				
✓ 39 - Capture TKO						
▼ Failsafe	Add entry to the lo	og on board				
✓ 10 - Auto when No						
24 - LinkOff to API						
8 - LinkOff to RTH						
9 - STB(P) when N						
31 - STB(Q) when I						
32 - SBY when No						
New Automation 🔹						

Mapping Automation Action

The action is carried out periodically in order to cover all the required area. Hence, the Period is computed in accordance with this and the camera specifications.

The configuration of the Photogrammetry mission is now complete. If the user wants to modify it, it can be done by changing the automation, the mission or the camera settings. The created camera can be found in the Devices panel as showed in the following figure.

It is also possible to configure a camera previously and select it after during the mission creation. How to add a new camera and configure it, is explained in *Camera* section.

### 8.2.12.3 Capsule Dropping



#### Capsule Dropping

This tool can be used when the user wants to create automatically a mission which has the scope of periodically dropping payload when the platform is following the route.

To do this, open the Capsule Dropping tool from the Mission toolbar. The configuration of this kind of mission is exactly the same of the Photogrammetry but menu and automation are different.

The process to configure a *Capsule Dropping* mission:

1. Clicking on the map, draw the polygon which indicates the zone the drone will cover with its flight. When you close the polygon, a new window will display.

Create camera		×
Default drop system		
Action 0	Output	Z
	Acce	pt

### Capsule Dropping Configuration

2. When your camera is created, it is time to configure the Capsule Dropping process.

The routes can be modified by changing the parameters in the menu which shows up when a waypoint of the mapping mission is clicked. The following parameters can be set:

- Drop: the Dropping system can be configured in the tool menu and switched from this list.
- **Turn Radius:** radius of the route turns. In this case, the default configuration has the turn radius set to 0, but the effect of this parameter on the curve form is the same as in the case of photogrammetry mission.
- AGL: waypoints Above Ground Level altitude.
- Distance: distance between two parallel routes of the mission.
- **Period:** dropping period in [s].

· <b>·</b> • • •	Fixed-wing VTOL 📃 🛛 🖡 🏑	/ 🕀 🗸	🖋 I 🄘 I	I 🔊 🚳 I	<b>९</b> ०। १९।	<u></u> [-] - [-] ∉	Ø 🖬
Capsule [	Dropping 🗙						
Drop	Default drop system 💌						
Turn Radius	30.0 r	ı					
AGL	200.0 r	ı					
Distance	70.0 r	ı)					
Period	35.0 r	ı					

Capsule Dropping Configuration

3. As in the photogrammetry case, when the mission is defined, the previous menu will show up allowing the user to define the Capsule Dropping mission actions. The automation is then created as showed in the following image.

Fixed-wing VTOL 🛪 🙆	o 🗄 🛇 🖸	🛛 🕰 🗂 -	• • • •	0		
12 - Arcade Mode	Drop mission					
✓ 13 - Arcade Mode ✓ 22 - Manual Mode		(				
✓ 22 - Manual Mode	Events	AND	NOT	Actions		<b>T</b>
▼ Envelope	42 - Insid	le polygon dro	р		21 - Drop	
🗸 28 - Envelope - Qι						
🗸 29 - Envelope - Tra						
🖌 27 - Envelope - Pla						
▼ Buttons						
7 - SBY Button						
2 - STB (Q) Button						
✓ 3 - HVR Button						
✓ 4 - LND Button				Delay 0.0	s Pe	riodical: On
14 - RTH Button						
6 - TKO Button	Outp	ut 👻 Drop				
✓ 16 - CRU Button						
✓ 17 - APP Button	GPIO 11	-				
✓ 18 - CMB Button						
✓ 19 - Pre-TKO Butto	Off On	Pulse On (	Pulse Off			
✓ 20 - Q2P Button				L L		
21 - P2Q Button	Time 0.0		5	5		
✓ 30 - STB (P) Buttor						
✓ C 41 - Drop mission ↓						
New Automation						

#### Capsule Dropping Automation Event

4. The configuration of the Capsule Dropping mission is now complete. If the user wants to modify it, it can be done by changing the automation, the mission or the dropping system settings. The created dropping device can be found in the Devices panel as showed in the following figure.

Fixed Wing V-Tail UAV 🛪	💿 🖸 🗄 🚱 📽 (	86 🗂 🔺
Fixed Wing V-Tail UAV Actuators Physical Logical Saturation Communications Payload Sensors Stick Veronte Veronte Others Dop System I/O Manager CAN Config Digital Input Manager	<ul> <li>Default drop system</li> <li>Action 0</li> </ul>	Output     GPIO 11     Off   On   Pulse On    Pulse Off Time   0.0   S
Add device	Add Action	

#### Capsule Dropping device

It is possible to create a Drop System before the mission and select it after, this can be done at the Devices panel.

## 8.2.13 Import Route



Import Route Tool

Veronte Pipe has integrated the possibility to import routes from an external source software in NMEA RTE/WPL format, that is Route (RTE) or Waypoint (WPL) format.

NMEA is a communication standard developed by the *National Marine Electronics Association*. For example, GPS receiver communication is defined within this specification. Most computer programs that provide real time position information understand and expect data to be in NMEA format. NMEA handles different standard format data sentences for multiple purposes including Routes definitions and waypoints positioning.

If you click in:

🔣 👻   Fixed-wing VTOL 📃 🖌   🇞 🖊 🕀	~	🖈   ⊚   🏠 ⊚   🍫   🏷	E E I Ø ā
			Import from NMEA RTE/WPL Format
	_		

Import NMEA Protocol

The next window will appear:

NMEA Import Route Configuration					
Enable TCP server					
Recive Port		50000			
Radius	0.0	m			
Prolongation distance	0.0	m			

#### NMEA Import Route Configuration

In this window you can configure the data reception via TCP connection. First, open a server socket. This socket must have the same address as the external software. Pipe will expect that the input format follows the MNEA RTE/WPL format to correctly display all the info.

## 8.2.14 Export Route



### Export Route Tool

Pipe software allows to export the mission in two different ways: KML and Google Earth files.

### 8.2.14.1 KML



Export to KML

This tool facilitates to export the mission in KML format.

KML, *Keyhole Markup Language*, is a code language, based in XML, used to represent geographical data in three dimensions.

### 8.2.14.2 Google Earth

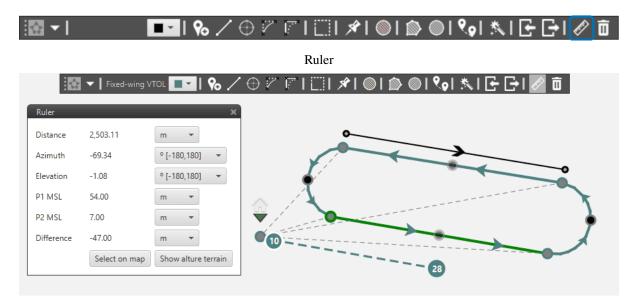


#### Google Earth Tool

This tool allows to export the mission to Google Earth, it can be very useful depending the objective of the mission.



Veronte Mission in Google Earth



## 8.2.15 Ruler

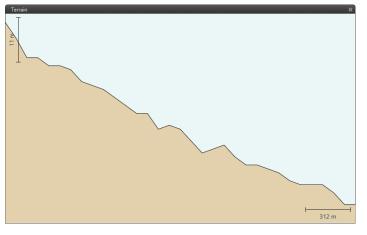
#### Ruler Example

Using the ruler, you can measure:

- Distance: distance between two points.
- Azimuth: angle of the segment with the North.
- Elevation: shows you the angle of the segment respect to a horizontal plane.
- P1/P2 MSL: altitude respect to the the Main Sea Level of the points P1 and P2.
- Difference: height difference of the points P1 and P2.

You can choose the units of the measures.

- Select on Map. Restarts the measurement.
- Show alture terrain. Shows the terrain profile between the ruler points



Terrain Profile

## 8.2.16 Remove unused points



#### **Remove Unused Points**

This tool allows to clean the map of the mission of unused points. Those points can appear after paths modifications. This tool searches unconnected points with no dependencies and deletes them from the workspace.

This section of the manual contains the information about the different tools available in Veronte Pipe to create the map elements used during the mission. Some of those are: waypoints, lines, circles and so on.

In order to activate the mission tools bar, a Veronte unit or a configuration has to be select in the right menu. Once selected, the toolbar will be activated with its corresponding name.

\$		Veronte Pipe V5.42.27	- 0	×
User				
Cloud			~	
✓ Mission	!छ ▾   ⋈∞ ■▾   % / ⊕ ♡ ☞   ♡  ጶ   ◎   ◎ ●   �   Ҟ   ि ि   ⊘	Fixed Wing V		
Log		📠 м600		
Post Flight		<u> </u>		<u> </u>
Preferences		🐣 > м400	<u> </u>	• 💾
License				
Manual				
0				

Mission Menu Access

The common way to work with Veronte is to create missions. Missions can be created and managed though the Mission

menu. To access this menu, click on at the upper left corner and select **Mission** in the pull-down menu. The Mission toolbar will appear as shown at the image below:

\$		Veronte Pipe V5.42.27	- 0	×
User				
Cloud ✓ Mission	▾   ┉∞ ■▾   % / ↔ ♡ ▷   ◯   ᢞ   ◎   ⋒ ◎   ९० ! Ҟ   ि    ৶	Fixed Wing V-	Tail UAV	
Log		🔊 м600		
Post Flight		<u> </u>		
Preferences		😃 > М400	<u> </u>	•••••
License				
Manual				
0				

Mission toolbar menu access

The mission toolbar provides graphical tools to create the path that the aircraft follows while it is in **cruise phase**. Multiple missions can be created for different purposes. The missions generated are stored into the **Autopilot Air unit** and into the **Operation** folder of the PDI configuration files when exported.

Next, a detailed description of the toolbar is given. And an example of how to set up a mission will be given in the following section.

# 8.3 Toolbar



#### Mission toolbar

The controls found in the toolbar are detailed in the following table.

Icon	Item	Description
	Open Detail	Displays Terrain and Marks configuration.
•	Colours	Line colour.
%	New Waypoint	Add new waypoint on click position.
	Segment	Add a straight line.
$\oplus$	New Orbit	Add a orbit.
V.	Fly By	Tool to adapt straight path corners into turns.
	Intersect Lines	Undoes the Fly-by command.
	Multiple Choice	Selection tool.
Å	Event Mark	Add a mark to trigger an event.
	Obstacle	Add an obstacle signal the aircraft has to avoid.
	New Polygon	Draw areas on the map for association with polygon events.
	Circular Area	Draw a circular area on the map. For association with polygon events.
<b>९</b> .0	References	Create points of reference.
*	Mapping	Predefined tasks helper: Search & Rescue, Photogrametry,
G	Import Route	Import NMEA route configuration.
G	Export Route	Export to a .kml or a .csv file the route created.
<b>E</b>	Ruler	Measure on map.
Ō	Remove Unused Points	Removes unused points

### CHAPTER

## NINE

# **OPERATION**

# 9.1 Map

The map is always displayed on the background and provides visual information about the area.

If known, the position and direction of any connected units will also be plotted on the map automatically.

There are several provider and map type options. Choose the one that fits better the nature of the mission. It is also possible to use **Custom Maps**.

Veronte Pipe automatically downloads map information when needed. This information gets stored on the computer, and will then be accessible without the need of an internet connection.

Downloaded map tiles are stored under the following route: C:\Users\<Your User>\AppData\Roaming\ VerontePipe\cache\map

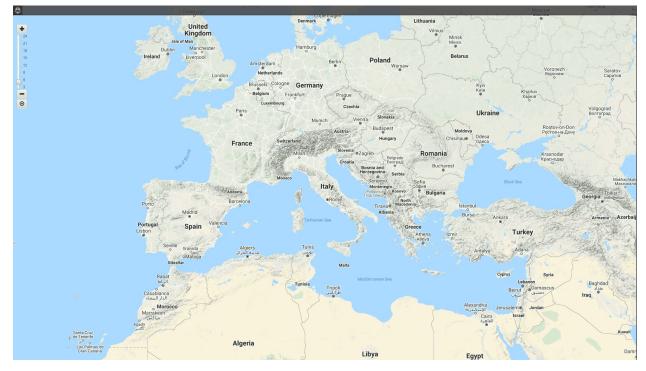
For more information on how to configure the different map options, please visit the Workspace section.

**Warning:** Veronte Pipe can only download map information using Internet access. If there is no internet access available during your operation, make sure to download any map tiles that may be needed preemptively.

Each zoom level in Veronte Pipe counts as an independent map tyle. When downloading map information, make sure that any relevant zoom levels are also downloaded.



Satellite Map



Terrain Map



Street Map

# 9.2 Telemetry

Telemetry involves any data that is received from the UAV in order to monitor the status of the mission.

Aside from position, which is always displayed, a typical operating workspace may include:



Example of telemetry setup with Veronte

- 1. Attitude and heading: Allows to know the status of the aircraft in the air. In case of External pilot takeover out of line-of-sight, it can work as a reference for flying if no other references are available.
- 2. **Battery/Fuel/Flight time**: Indication of the remaining energy resources. Indicates the operator the remaining operation time.
- 3. GPS data: Includes GPS status (GPS Ok/No OK), accuracy and satellite coverage.
- 4. Wind information: Wind direction and intensity.
- 5. Speed information: Airspeed and grounspeed.
- 6. Alarms & Warnings: Any alarms from the system that the operator should pay attention to.
- 7. Altitude information: Including different reference systems such as MSL and AGL.
- 8. Actuator information: Position of each of the system actuators.

Other relevant telemetry data could include:

- Link status
- Payload status
- Engine telemetry: RPM, temperature

Veronte Pipe workspace is fully configurable, and has a wide variety of widgets available to help the user build an operation screen that meets its requirements. For more information about how to build a workspace please visit the *Workspace* section.

**Tip:** It is recommended that the operating workspace includes only information relevant to the current mission, avoiding any irrelevant data on screen.

**Warning:** The fact that a certain variable is displayed on the workspace does not guarantee that the value is being received. Some widgets will warn you whenever the displayed variable is not being updated, but others may not.

Make sure to always verify that all relevant data is correctly included in the telemetry vector.

Different missions may require different workspaces. For instance, in the early stages of development, the most common type of mission is a Tuning mission, where different parameters of the system are adjusted in order to find the propper values or validate a new set of parameters.

In this type of mission, it is common to have more crowded workspaces like the one displayed below:



Example of tuning setup with Veronte

**Tip:** Make sure to take advantage of the workspace CASES and GROUPS to hide an show certain widgets only when they are relevant. With the CASE feature, this can even be done automatically!

# 9.3 Operation Parameters

Operation parameters are configurable values, postitions and directions that can vary depending on the mission.

Examples of operation parameters can be:

- Mission duration
- Cruise speed
- Flight level

- Takeoff and landing direction
- Home point
- Start of route

The main advantage of Operation parameters is that there is no need to access **Veronte configuration** in order to change them. This way, the Operator is able to modify certain parameters without the need of having access to the whole configuration.

Defined operation parameters will be saved into Veronte configuration, and will be kept even if the system is rebooted.

**Operation Parameters Example** 

#### How to use operation parameters

Operation parameters are created whenever one of the following actions is performed while building a Veronte configuration:

• An **Operation Guidance** or **User direction** variable is used at any point within the configuration (e.g. in control

clicking on or in Blocks menu)

- A Waypoint on the map is given a 'Name'.
- A specific **Waypoint** is assigned to the **Guidance** of one of the **Phases**.

Whenever one of the above cases is true, a new field will appear in the **Operations menu**.

The Operations menu for each unit can be accessed from its respective dropdown list on the top-right corner of the screen:

🔯 Veronte0 🔀 😣 🛙 🏛	🕒 Veronte0	<b>+</b>
C	▲ Incomplete operation	Setup
		Operation
		Export PDI
Landing speed 22.0		Import PDI About
FPA		HIL
		Advanced
Landing Approach FPA -5.0 Landing Final FPA -3.0		
Landing Initial FPA -5.0		
ADD GROUP		
	10	
	rbanovas	
	CALLY IN THE	

#### Operation Menu

After that, the values for these parameters can be defined using this menu. Remember that, in order to apply the new

parameters, it is necessary to save 🕒 the configuration.

If any of these parameters is not defined at any moment, the user will receive an **Operation Incomplete** warning message. Clicking this message will also open the Operation menu.



Parameter not defined warning

**Warning:** Although it is possible to modify Operation Parameters during the flight, this practice is not recommended.

Whenever changing values during an operation, make sure that no potential risk to flight safety is involved.

#### Example

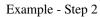
Lets say it is required to define Flight path angles for the different Landing segments from the Operation menu. The **First step** should be going to the **Landing Phase Guidance**, and define these parameters as **Operation Guidance** variables.

Flight path angle			
Initial	Operation Guidance 04	*	ବ୍ତ
Loiter	Operation Guidance 05	*	ବ୍ତ
Aim	Operation Guidance 06	*	ବ୍ତ
DXY	0.0	rad [-π,π]	\$

Example - Step 1

Now, the selected values will appear on the Operation menu.

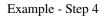
Operations				×
				۲
Cruise speed	30.0	 Landing speed	22.0	
Operation Guidance 03				
ADD GROUP				



Operation Guidance variables can be directly renamed from the Operation Menu.

Veronte0 👩 这   🛍	
C	
	•
Operation Guidance 04	
Change name     Change magnitude     Change magnitude      Change magnitude	
ADD GROUP	
Example - Step 3	
Finally, giving values to each of the parameters and saving will apply the changes.	

Veronte0 🔝 🙎 🛚 🛍	Ĭ			
ď				
				۲
Landing speed	22.0			
FPA				• •
Landing Approach FPA	-5.0	Landing Final FPA	-3.0	
Landing Initial FPA	-5.0	-		
ADD GROUP				



# 9.4 Mission

Even though it is recommended that the mission is already defined before the operation starts, it is possible to load a new mission or modify the current mission before and during the operation.

Within the Operation menu, the **Waypoint** tab can be accessed. In here it is possible to find a list of all elements that belong to the current mission, including **Waypoints**, **Polygons** and **Obstacles**.

	Fixed-Wing VT		21	۳ ۵								
	aypoints 4		0.0	Set heig								
#					Longitude	MSL	Relative	Events	Position		Delete	
3	Operation Cus			8.29944	-0.573740	249.595	Absolute	0 events 🚯	0		0	
2	Operation Cus			8.28975	-0.575885	249.604	Absolute	0 events 🛈	0		0	
1	Operation Cus			8.28489	-0.539879	199.627	Absolute	0 events 🚯	0	<b>S</b>	0	
0	Operation Cus	tom Point (	0 3	8.29516	-0.538034	149.983	Absolute	0 events 🛈	8	San P	Θ	
Ob	ostacles 이	30.	0	Set heigh	nt MSL	•						
								D 1 4				Delete
	# La	titude	Longi	tude	MSL	Radius	Mode	Relative	Positi	on	Edit	Delete
Pol	# La	titude	Longi	tude	MSL		Mode tent in table		Positi	on	Edit	Jack
Pol	lygons 0		Longi		MSL Points				Positi	on	Edit	Jack

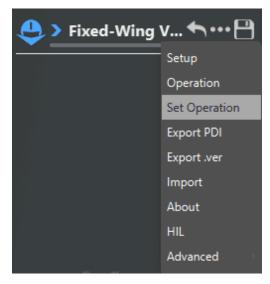
#### **Mission Elements**

From here each of the elements can be monitored and their status can be checked or modified. The following fields can be found in this menu:

- Name: Element Identifier. Changing the name of any of the waypoints will turn them into operation parameters and also display their name on the map.
- Latitude, Longitude and MSL: Element coordinates.
- **Relative**: 'Absolute' means that the position of the element is fixed, while 'Relative' indicates its position is relative to the position of another element and it may vary during the operation.
- Events: List of any events that are linked to the position of this element, such as triggers for automatic actions.
- **Position**: Clicking here will center the element on the map.
- Edit: open the edition menu for this element. It is also possible to modify the altitude of all of the listed elements at the same time by using the **Set height** feature on the top of each list.
- Delete: remove this operatioon element.

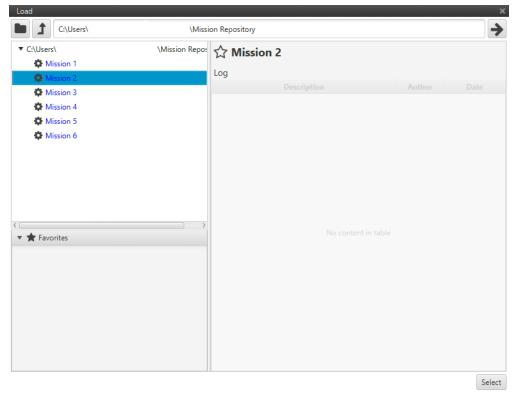
## 9.4.1 Loading a new mission

Using the feature Set Operation it is possible to replace the current mission by another one that was previously exported.





This allows the user to build a mission library that can then be used to load an operation from a set of pre-defined missions.



Operation Library

## 9.4.2 Modifying the current mission

The current mission can be modified at any point using the options described above, or by means of the Mission Building

Tools *mission*, and then clicking on the Save 🕒 button.

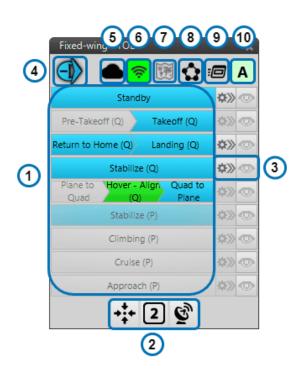
It is also possible to make temporary changes to the current mission by using *Detour commands*.

## 9.5 Commands

## 9.5.1 Veronte Panel

**Veronte Panel** is the main tool for operating Veronte. It includes all basic commands and information needed during a standard mission.

**Note:** Closing the Veronte Panel will hide it for the current workspace. In order to display it again, double click on the unit you want Veronte Panel displayed for.



Veronte Panel

#### 1. Phase selection:

Display of the existing flight phases. The colour code indicates which phase is currently selected, and also the different phase transitions available.

• Green: This is the phase currently selected.

- Blue: This phase can be accessed from the curent phase.
- **Blue (Translucid)**: This phase can be accessed from the current phase, but only through an *Automation*
- Grey: This phase cannot be accessed from the current phase.

The distribution of phases on the Veronte Panel can be edited in the *Panel* Menu.

Note: If no phase is highlighted in Green, then the selected unit is currently in INITIAL Phase

#### 2. Command Buttons:

Command buttons can be used to manually trigger certain actions, that can be programmed using *Automations* 

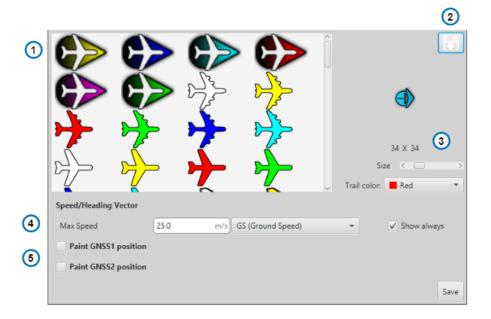
#### 3. Guidance options:

Allow the user to interact with phase Guidances

- The **Gear** button allows to make changes to the guidance of the **Current phase**. These changes will only last for the duration of current phase and will dissappear upon phase switch.
- The eye button allows displaying on the map the route for each phase, even if the phase is not currently selected.

#### 4. UAV Icon:

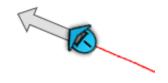
This is the icon that will be used to represent this units' position on the map. Clicking on it will open the icon menu:



#### Icon Menu

- 1. Icon List: List of available icons
- 2. Import Icon: Import a custom icon to veronte Pipe
- 3. Icon customization: Choose icon size and the colour of the movement trail

4. Speed display: Allows to display an arrow indicating speed direction and magnitude



#### Speed arrow

5. GNSS Position: Display raw GNSS positions on the map.

#### 5. Veronte Cloud:

Indicator of Cloud connection status.

#### 6. Radiolink status:

Indicator of radiolink status. The colour of the inclusion represents quality of the link, with **green** representing a good link connection, then changing to yellow-orange-red as the quality gets worse.

Clicking on the icon will disable all telecommands to the unit

#### 7. Center on map:

Center the map on the unit position

#### 8. Mission Edit menu:

Quick access to the mission menu

#### 9. Quick Commands:

Open the quick command list.



#### Quick Commands

#### 10. Flight Mode:

Displays the current selected flight mode. Clicking on it allows to manually change the selected mode.

When a stick is correctly detected, the icon will have a green background . Otherwise, it will be



## 9.5.2 Quick Commands

Quick commands are common actions that are performed during a standard operation and are alredy predefined. This way, there is no need of modifying the configuration or building a specific *Automation*.

Note: Some of the following quick commands can also be triggered automatically using Automations.

#### **Panel Quick Commands**

These actions can be accessed from the specific drop-down list located on the Veronte Panel.

• Calibrate IMU:

Correct any biases on the IMU calibration, including mounting offsets.

Calibrate IMU			×
Calibrate automatically			
Calibration time 3.0			
✓ Save			
Yaw *	0.0	rad [-π,π]	
✓ Pitch *	0.0	rad [-π,π]	
✓ Roll *	0.0	rad [-π,π]	
✓ Overwrite gyroscope calibra	ation		
Overwrite Partial accelerom	eter rotation		
✓ Overwrite Full acceleration	rotation		
Overwrite accelerometer bi	as		
See Accelerometer Rotation	n Matrix		
Set calibration values (Ad	lvanced)		
		Reset calibration	Calibrate

#### IMU Calibration

There are three calibration options available in the automatic calibration:

- **Overwrite Partial accelerometer rotation**: only calibrates pitch and roll angles. The autopilot must be horizontal during the calibration process:

Calibration Wizard 🛛 🗙
Calibration Matrix set up.
Your Veronte must be horizontal while measurements
are collected.
Wait a few seconds.
50%



- **Overwrite Full accelerometer rotation**: calibrates pitch, roll and yaw angles and it needs to take measurements in two orientations. During the first measurement the autopilot must be horizontal:

Calibration Wizard 🛛 🗙
Calibration Matrix set up.
Your Veronte must be horizontal while measurements
are collected.
Wait a few seconds.
Done
Step 2. Choose a rotation axis for the second
measurement, rotate around that axis and keep
Veronte still while taking measurements.
Pitch positive  Continue

IMU Full accelerometer rotation first measurement

The second measurement requires to rotate the autopilot around the selected axis. The options are: pitch positive, pitch negative, roll positive, roll negative. The autopilot must be turned **more than 10 degrees** in the selected axis.

Calibration Wizard						
Calibration Matrix set up.						
Your Veronte must be horizontal while measurements						
are collected.						
Wait a few seconds.						
Step 2. Choose a rotation	n axis for the second					
measurement, rotate arc	ound that axis and keep					
Veronte still while taking	measurements.					
Dis L St	0.5					
Pitch positive 🔹	Continue					
Pitch positive						
Pitch negative						
Roll positive						
Roll negative						

IMU Full accelerometer rotation second measurement

- **Overwrite accelerometer bias**: calibrates the accelerometer bias in each axis. The autopilot must be horizontal during the calibration process.

It is also possible to input calibration values manually if known:

Calibrate IMU			×
Calibrate automatic	ally		
Calibration time 3.0			
✓ Save			
Yaw *	0.0	ra	d [-π,π]
✓ Pitch *	0.0	ra	d [-π,π]
✓ Roll *	0.0	ra	d [-π,π]
✓ Overwrite gyroscop	e calibration		
Overwrite Partial ac	celerometer rotation	1	
Overwrite Full acce	leration rotation		
Overwrite acceleror	meter bias		
See Accelerometer	Rotation Matrix		
	1 (A.1 D		
Set calibration va	alues (Advanced)		
Accelerometer 1	Bias	Scale	Variance
Accelerometer 2	x QQ		
Accelerometer 3	X 0.0	0.0	0.0
Accelerometer 4	Y 0.0	0.0	0.0
Accelerometer 5	-		
Accelerometer 6 🗸	Z 0.0	0.0	0.0
		Res	et calibration Save

#### IMU Advanced Calibration

#### • Calibrate Magnetometer:

Perform magnetometer calibration. Both Soft and Hard Iron calibrations are available. Soft Iron calibration will perform Hard Iron calibration also.

**Tip:** To achieve the best calibration, try to perform the calibration under operational conditions, including nominal currents and other magnetic disturbance sources that may be present during the operation

Calibrate Magnetometer					
		— M	agnetome	ter	
	$\bigcirc$	Hard Iro	n	Soft Iron	
bias_x	0.0	]	1.0	0.0	0.0
bias_y	0.0	Gain	0.0	1.0	0.0
bias_z	0.0	]	0.0	0.0	1.0
Calibrate Reset calibration Save calibration					

## Magnetometer Calibration

## • Calibrate Static Pressure:

Calibration for the static pressure calculation.

Calibrate Static Press	sure	×
✓ Save		
Calibration time	3.0	s
Calibrate static	pressure	
bias	0.0	
Scale factor	0.0	
Pabs *	101325.0	Pa
Reset calibration	C	alibrate

#### Static Pressure Calibration

• Calibrate Dynamic pressure:

Calibration for Airspeed calculation

Calibrate Dynamic Pres	isure X
Save	
Calibration time	3.0 s
Calibrate dynami	ic pressure
bias	0.0
Scale factor	0.0
Reset calibration	Calibrate

Dynamic Pressure Calibration

**Warning:** Dynamic pressure calibration is very sensitive to pressure disturbances. Make sure that the pressure intake is not disturbed while performing this calibration.

#### • Calibrate Atmosphere:

Calibration for MSL calculation with barometric pressure. Both QNH and QFE options are available. Static pressure can be selected from the autopilot measurement or it can be written by the user if known.

Calibrate Atmosphere	×
Autopilot (QFE) 🔹	
Time to acquire mean	3.0 s
Temperature (OAT)	288.0 K
Altitude (MSL)	0.0 m
QFE	1001.71 mbar
✓ Take AP's pressure	
	Cancel Accept

#### Atmosphere Calibration

#### • Calibrate DEM:

Calibrate any offset that the current terrain model may have for your current position.

Warning:	Always perform this action on the ground, unless an accurate estimation of current
AGL is avai	lable

Calibate DEM	×
AGL expected 0.0	m
	Cancel Accept

#### **DEM** Calibration

#### • Command Position:

Allows to manually modify the Position Navigation state.

**Warning:** If there is any absolute positioning sensor active (i.e. GNSS), this command will not work since it will be automatically overrided.

Command Po	osition	×
Relative	Approach Initial 🔹 🔒	21
Absolute		P POS
Latitude	0.0	
Longitude	0.0	
WGS84	0.0	m
— MSL	0.0	m
L <b>▲</b> AGL	0.0	m
	Cancel	Accept

## **Command Position**

#### • Command Yaw:

Allows to manually modify the Yaw Navigation state.

**Warning:** If there is any Yaw sensor active (i.e. Magnetometer), this command will not work since it will be automatically overrided.

Comma	and Yaw		×
Yawing	0.0		rad [-π,π]
		Cancel	Accept

Command Yaw

#### • Enter Wind Information:

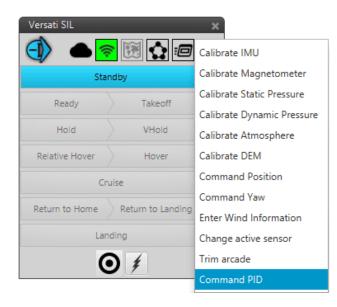
Enter initial values for wind state and start wind estimation algorithm.

Enable/Disab	ole Wind Estimation	×		
C Enable Wind Estimation				
Initial Vector	Initial Vector			
North	0.0	m/s		
East	0.0	m/s		
Down	0.0	m/s		
		Send		

Wind Parameters

#### • Command PID:

Allows to modify PID gains during operation.



#### PID Command

Click on Command PID, a new window will show up. Then select a valid PID block from the tree (they are shown in green). This tree represents how control blocks are organised in Programs.

Select Block	×
20 - Pitching	Read: Control Output u1
21 - Thrusting	Read: Pitch Rate
22 - Rolling	Read: Pitch
23 - Yawing	Read: Desired Pitch Rate
0 - Distance to Desired I	<ul> <li>Phase switch between several batches of blocks</li> </ul>
1 - Yaw	▼ Default case: Hold
24 - Objects of Interest	Read: Desired Pitch
2 - Attitude Limits	<ul> <li>VHold, Hover, Cruise, Landing, Takeoff, Returr</li> </ul>
	Read: Desired Front GV (Ground Velocity)
	Read: Front GV (Ground Velocity)
	Read: Desired Pitch
	PID Static
	PID Static
	Write: Desired Pitch Rate
	Write: Desired Pitch
	Tsched PID
	Write: Control Output u1 before servo saturation
< >	< >
	Select

## Select PID

Behind this window there is another where users can modify the values of PID gains and type (standard or parallel). Here, users can either increase or decrease each of the gains P/I/D or N(derivative filter)/Imax. Modifying and clicking on **send**, updates the values of your vehicle. Clicking on **Change block** returns to the previous menu where you have to select again a new 'green' block.

**Warning:** All changes applied are volatile and will be lost after the system is reset. After the desired values are found, the save button must be clicked but restart is required.

PID command		×
Parallel		
Standard		B
₽	-0.11	)→
· <b>+</b>	-0.04	<b>)→</b>
▷ ←	-0.07	)→
N <b>4</b>	0.1	)→
🔲 Imax 🗲	0.0	)→
Change block		1

PID parameters

#### Change Active Sensor:

Allows to change one of the currently selected sensors.

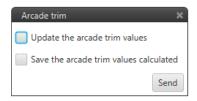
**Warning:** Remeber that these changes are volatile. After the system is restarted, the selected sensor set will be the one defined on the configuration

Chang	ge active sensor		×
💿 Ac	celerometer	Static pressure	
Gy Gy	/roscope	Dynamic pressure	
<u>М</u>	agnetometer		
Туре	0 - Integer var sens	or 1 👻	
			Send

#### Calibrate IMU

#### • Trim Arcade:

Calibrate current stick for arcade commands





#### **Detour Quick Commands:**

The following commands are only accessible if the current phase has an active *Cruise* Guidance. They allow to make temporary changes to the execution of the current mission.

• Fly to Hover:

Create a volatile waypoint and change the current route. The created reference will dissappear whenever this command is overrided.

#### Fly to Hover

#### • Fly to Loiter:

Create a volatile loiter and change the current route. The created reference will dissappear whenever this command is overrided.

#### Fly to Loiter

## • Fly to Waypoint:

Fly to an existing Waypoint. If the Waypint belongs to a mission, the UAV will continue that mission after thewaypoint is reached.

Fly to Waypoint

## 9.5.3 Additional Commands

Other available commands are:

• Custom & Automatic Commands:

By using *Automations*, the user is able to define any kind of command using the *actions* available in Veronte.

These commands can be triggered manually (buttons on Veronte Panel, physical switches, external devices, etc) or automatically (i.e. deploy a parachute if IAS is below stall speed).

• Stick commands:

Sticks and Flight boxes allow the configuration of **manual flight modes**. By using custom commands it is also possible to map additional actions to switches on the manual control devices, such as landing gear/flap position, lighting toggle, Auto/Manual toggle, parachute deployment, etc.

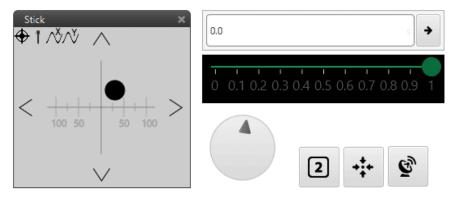




Stick commands

#### • Workspace Command Widgets:

Command widgets allow to update the values of certain variables in Veronte, that can then be used in flight modes and phases (i.e. desired speed, desired altitude...)



Workspace commands

#### • VCP Commands:

VCP stands for **Veronte Control Protocol**. By using VCP, it is possible to send commands to Veronte without the need of using Veronte Pipe.

VCP is designed for those users that wish to develop their own software applications, either to use them along Veronte Pipe or even replace it completely.

If you are interested in the use of VCP, please contact support@embention.com for more information.

A command involves any external action that causes a change on the system during the operation.

**Note:** Commands will never modify the autopilot's current configuration: the changes are volatile, and will dissapear once the system is rebooted. On the other hand, sensor calibration can be changed with these commands and will be a permanent change.

Usual sources of commands are:

- Operator/Internal Pilot: phase changes, panel buttons, etc.
- External Pilot: override autonomous command, manual controls, etc.
- Automatic actions: triggered upon phase change, upon mode change, etc.
- Payloads: payload activation under certain circumstances.

The different command types available can be classified into:

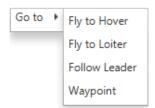
• Veronte Panel: this pannel is the basic Operator tool, and includes the use of Phase buttons and Command buttons. These commands can be triggered with a single click, and/or automatically.

Fixed-wing VTOL	×
ي 😥 💌 🍖 🌰	<b>a</b>
Standby	<b>\$</b> }
Pre-Takeoff (Q) Takeoff (Q)	¢»
Return to Home (Q) Landing (Q)	<b>\$</b>
Stabilize (Q)	<b>\$</b>
Plane to Hover - Align Quad to Quad (Q) Plane	♦≫
Stabilize (P)	♦≫
Climbing (P)	<b>\$</b>
Cruise (P)	<b>\$</b>
Approach (P)	<b>\$</b>
+‡+ 2 🔮	

#### Veronte Panel

• Quick commands: these commands are also triggered by the operator, but usually require a couple more steps.

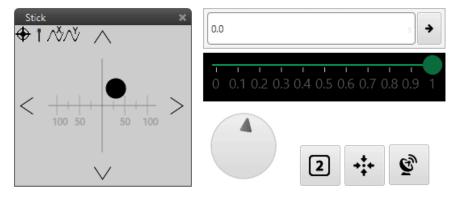
They can be accessed by either clicking the button on the Panel, or by right clicking on the map. Examples of quick commands are internal sensor calibrations and mission detours.



Calibrate Static Pres	sure X
Save	
Calibration time	3.0 s
Calibrate stati	c pressure
bias	0.0
Scale factor	0.0
Pabs *	101325.0 Pa
Reset calibration	Calibrate

#### Quick commands

• Additional commands: virtual sticks, external flight computers, command widgets, VCP messages, etc.



Additional commands

# 9.6 Log Report

The Log feature in Pipe allows the user to create mission reports, that contain basic information (like mission duration, UAV ID, configuration name, date, etc.) and any relevant events, along with a timestamp.

If you are interested in logging of variables for post-flight analysis, please visit the Post Flight section.

The log menu can be accessed from the drop down list on the top left of the screen:



By default, Pipe starts logging when started, and will save the log when closed. It is also possible to stop/pause the log recording using the buttons.

No	Time	Uav	Board	State	Event
13	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Servo 8 Ok
14	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: System Not Re
15	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: GNC task ok
16	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Acquisition Tas
17	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Stick Not Dete
18	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Stick PPM 1 de
19	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Sensors Ok
20	13:14:23	Veronte	0:00:08.6		Uav Fixed-wing VTOL: Magnetic field
21	13:14:23	Veronte	0:00:08.6		Link OK
22	13:14:23	Veronte	0:00:08.6		FSM initial state
23	13:14:23	Veronte	0:00:08.6		Auto

#### Pipe Log

By default, Pipe registers the following events:

- Phase and Mode changes
- Position Fix
- File System OK
- Out of georeferenced area
- Power OK
- Servo 1-8 Saturation
- System Ready to start
- GNC step lost
- Acquisition step lost
- Stick not detected
- PPM not detected
- · Sensors error
- Link Error

It is possible to add entries to the log manually. They will be registered with the appropriate timestamp.

24	13:28:46	USER	0:14:31.5	Internal Pilot ready for operation	Ŷ
<					

#### User Entry

Once the mission is complete, clicking on the button will generate the document. Additional data can be included when generating the document, such as the pilot identifier, weather conditions, extra comments,...

Create PDF					×
Pilot					٦
Reference					1
Clouds	▼ Rain	*	Wind	•	
Description					
Comments					
Path C:/Use	rs/Embention	/AppData/	/Roamir		
✓ Open PD	F after creatin	g		Create	

#### Generate Log

Once all units are set up and the mission has been loaded, the system is ready to fly.

Before starting the operation, it is very important to check that the operator(s) will have access on the screen to all the information and commands that will be needed during the flight.

Below can be observed an example of an operation setup with Veronte Pipe:



Example of an Operation with Veronte

- 1. **Map:** Map of the area.
- 2. UAV Position: Position of the UAV on the map.
- 3. Mission: Configured mission.
- 4. **Telemetry:** All relevant information that must be monitored during the operation.
- 5. Veronte Panel: Command pannel. Includes all basic commands including phase changes, command buttons and quick commands.
- 6. Connected units: All units connected to the ground station are shown on the right hand side of the screen.

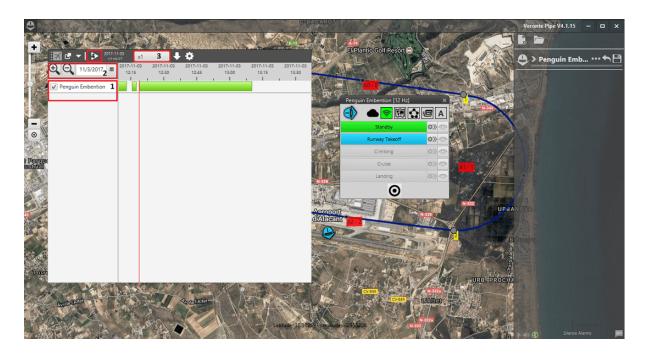
## CHAPTER

# POST FLIGHT

The post flight menu allows the user to check all the information stored during a flight operation. There exist different options to display the telemetry of a certain operation, and they are presented in this section.

To access the menu, click on (Main Menu), and then select Post Flight in the pull-down menu.

# 10.1 Tour Play



## Post Flight Panel

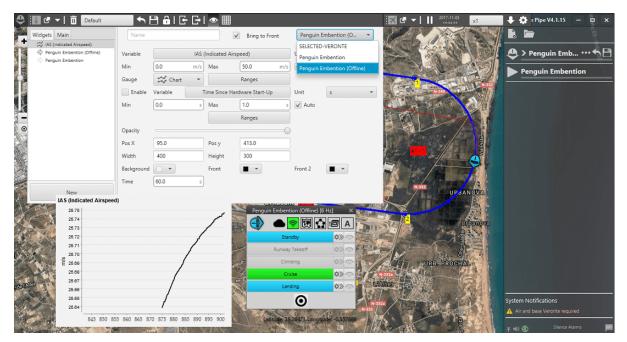
When opening the post flight menu, there are a series of options to configure in order to display the tour:

- 1. The autopilot, whose information wants to be played on the tour, has to be selected among the ones that appear on the list on the left side.
- 2. The user here can select the date of the flight that is going to be replayed.
- 3. The speed of the tour can be configured in this option (x1 means normal speed).

4. The play button starts the tour.

When clicking the play button, a new autopilot will appear in the right sidebar with the name of the unit plus Offline. As it can be seen in the previous figure, a new Veronte Panel appears on the screen showing the phase changes as they occurred in the real operation.

Regarding the telemetry, all the variables that were in the Telemetry Link during the real flight can be displayed in the tour.



#### Workspace Panel

For example, to display the IAS that the aircraft had during the flight played, just select the offline autopilot in the pull-down menu, and the gauge will show the indicated airspeed of that operation.

**Warning:** If a variable was not in the telemetry link during a flight, it can not be later shown in the tour of that flight.

# 10.2 Data Export

The telemetry generated during an operation is stored in different ways (see section *Telemetry*). According to how each one of the telemetry variables has been stored (data link, onboard log, user log and fast log) it has to be downloaded in a different way.

## 10.2.1 Data link

The information obtained directly from the **Data Link** is saved at the "appdata" folder of the operative system. This data is the telemetry sent by the air autopilot to Veronte Pipe, so it is stored in the computer that has the software installed. The exact path (in version 4.X) to obtain it is:

C:\Users\<Username>\AppData\Roaming\VerontePipe\<Veronte Pipe version>\session

In the folder that appears in this route, there are several folders each one corresponding to one operation. To identify the desired one check the date on the folder name. In order to play a tour of a flight in a different computer, just copy the folder to the same route in the other computer and the information will appear in the post flight menu as was explained in the previous section.

It is also possible to download the information of the Data Link for post-processing purposes. Right-clicking on the green bar of the desired flight will open a menu where it is possible to download that information in:

- CSV file This file uses ";" for data separation and "," for decimal indication.
- KLM file It can be opened using Google Earth and allows to check the aircraft route in 3D.

2017-11 12-25-	-03 52 x1	+	<b>.</b>			
€ € 11/3/2017	2017-11-03 12:15	2017-11-03 12:30 	2017-11-03 12:45	2017-11-03 13:00	13:15	2017-11-03 13:30
Penguin Embention						

## Post-flight data export

When downloading a CSV file, Pipe provides the user with an option to automatically name the photos taken during a photogrammetry mission.

Export CSV		×
✓ Add photo n	ame	
Folder	] -	
First file	+	
Sort by	🔘 File name 💮 Date file	
		Accept

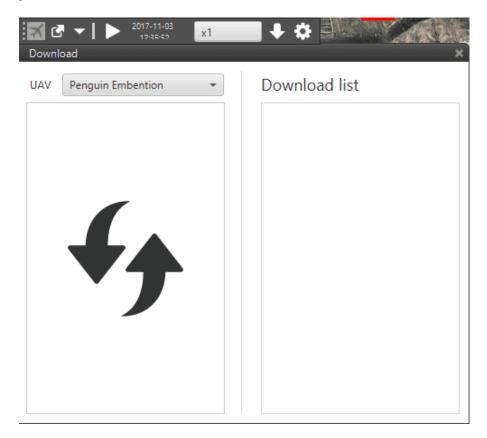
## Export CSV

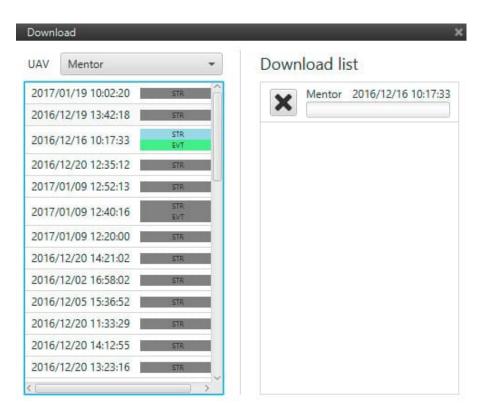
The button Folder allows the selection of the folder that contains the photos taken during the mission. Then, in First file will appear all the files of that folder and the user has to select the file that corresponds to the first photo. Finally,

Pipe permits to sort the photo files by name or date.

## 10.2.2 LOG

The data of the other three type of logs is stored in the SD Card of the air autopilot, so it has to be downloaded to the computer in order to obtain it. To do this, it's sufficient to open Postflight bar and click on the down-directed arrow, then select the Veronte unit for data downloading and refresh the page in order to choose the flight files to be download (checking the flight date and time).





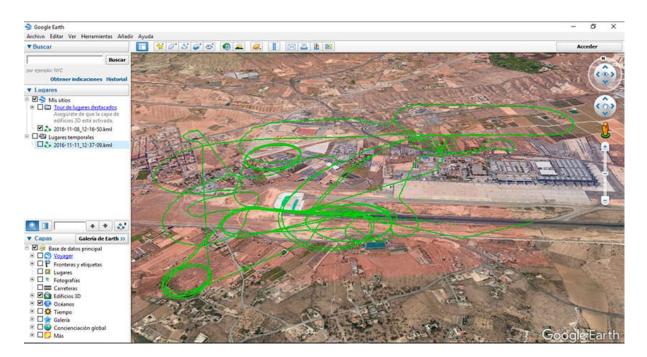
Data Export

The bar STR corresponds with the information of the Onboard Log and EVT is for the User Log. Once the file has been downloaded, the bar will turn green and right-clicking over it (SRT or EVT) will allow the user to download a CSV file with that information.

The following two images show a .CSV and a .KML files opened respectively with Microsoft Excel and Google Earth.

RCHI		INSERTAR	DISEÑO D	E PÁGINA FÓRMUL	AS DATOS	REVISAR VISTA	Team	-			
Pega	Cali		- 11 - A*	∧* ≡ ≡ <b>≡ ⊗</b> •		% 000 🕎 Dar form	condicional * ato como tabla * celda *	Eliminar •	∑ - A Z · Crdenar y e - filtrar -	Buscar y seleccionar *	
ortap	apeles 🗔	Fuer	nte	rs Alineación	5 Núm	ero ra E	stilos	Celdas	Modifi	car	^
P528	365 -	$\times$	/ fx 3	935193750000							v
- 11	J	к	L	м	N	0	P	Q	R	S	IP
2852	GS - Ground	Longitude	Latitude	Magnetometer - Y	AGL-Height	WGS84 Elevation	GPS ECEF Positio	on Z Heading	Yaw	Pitch	F
2853	0.000000	-0.009955	0.669152	0.008506	15.839.272	157.641.953	3.935.194.250	.000 2.915.3	98 2.915.398	-0.010472	C
854	0.099976	-0.009955	0.669152	-0.101984	15.780.312	157.583.496	3.935.194.250	.000 2.911.2	09 2.911.209	-0.010472	C
2855	0.099976	-0.009955	0.669152	-0.002543	15.735.466	157.538.986	3.935.194.250	.000 2.917.4	93 2.917.493	-0.010472	¢
856	0.099976	-0.009955	0.669152	-0.107508	15.769.096	157.572.784	3.935.194.250	.000 2.921.6	81 2.921.681	-0.011519	C
857	0.000000	-0.009955	0.669152	-0.101984	15.829.353	157.632.874	3.935.194.250	.000 2.922.7	28 2.922.728	-0.013614	C
858	0.000000	-0.009955	0.669152	-0.096459	15.765.465	157.569.153	3.935.194.250	.000 2.923.7	76 2.923.776	-0.013614	C
859	0.099976	-0.009955	0.669152	-0.090935	15.718.254	157.522.095	3.935.194.250	.000 2.920.6	34 2.920.634	-0.013614	C
860	0.000000	-0.009955	0.669152	-0.107508	15.758.446	157.562.958	3.935.194.250	.000 2.923.7	76 2.923.776	-0.011519	C
861	0.099976	-0.009955	0.669152	-0.113033	15.678.627	157.483.475	3.935.194.250	.000 2.931.1	06 2.931.106	-0.011519	C
862	0.000000	-0.009955	0.669152	-0.107508	15.722.450	157.527.466	3.935.194.250	.000 2.925.8	70 2.925.870	-0.013614	¢
863	0.099976	-0.009955	0.669152	-0.008067	15.675.270	157.480.453	3.935.194.250	.000 2.929.0	12 2.929.012	-0.013614	C
864	0.000000	-0.009955	0.669152	-0.101984	15.716.087	157.521.271	3.935.193.750	.000 2.932.1	53 2.932.153	-0.013614	C
865	0.099976	-0.009955	0.669152	-0.101984	15.652.443	157.457.794	3.935.193.750	.000 2.923.7	76 2.923.776	-0.013614	C
	0.000000	0 000055	0 660153	0.000025	15 700 004	157 517 005	2 025 102 750	000 2 027 0	A 2 027 064	0.012614	1

Post flight in Microsoft Excel (.csv)



Post flight in Google Earth (.kml)

### CHAPTER

## **ELEVEN**

## SIMULATION

## **11.1 Professional HIL**

(11.1)

### 11.1.1 Mounting

#### 11.1.1.1 Cable Connection

Package content includes the following cable. One connector must be connected to Veronte Autopilot and the other one to the CS Cable or the Aircraft connector in case of HIL Simulation using the complete platform system.

 $\alpha$ 



HIL Simulator Cable

#### 11.1.1.2 Veronte Pipe Configuration

There are 2 configuration items on Veronte Pipe, one relating communications between the application and the X-Plane simulator and another one refereeing the autopilot configuration.

Veronte Pipe acts as a "bridge" between Veronte Autopilot and XPlane. Hence, these are the variables that the Autopilot receives from Pipe and how they are processed:

- Heading, pitch, roll: received in [deg], converted to [rad]
- Roll rate, pitch rate, yaw rate: received in [rad/s]
- Longitude, latitude: received in [deg], converted to [rad]
- Height: received MSL height in [ft], converted to ellipsoidal height in [m]

 $H_{ellipsoidal} = Ellipsoid(lon, lat) + h_{MSL}$ 

- X velocity, Y velocity, Z velocity: received in [m/s]
- Accelerations (G-loads): received in g's, converted to [m/s<sup>2</sup>]
- Incidence angle (Alpha) and sideslip angle (Beta): received in [deg], converted to [rad]
- Indicated Air Speed: received in [kts], converted to [m/s] and projected to body axes

$$IAS_{BA} = IAS_{WA}cos(\alpha)cos(\beta)$$

• Height above ground level: received in [ft], converted to [m]

On the other hand, as it is explained in the following section, Veronte Pipe sends XPlane the commands received from the Autopilot according the variables of the aircraft configuration in XPlane.

#### 11.1.1.3 Autopilot Configuration

HIL simulation tab is available within Veronte Autopilot setup toolbar. The user can link the variables on Veronte Autopilot with the corresponding ones in X-Plane simulator.

🔯 🕑 Penguin Embention 💥	* 💿 🖸 🗄 🚱 🗱 🗗	🛅 🟊 CfgMgr StepMgr
DISABLED		To XPlane
Throttle 01	- Throttle 00	Control Output u2
Throttle 02	Elevator	Offset 0.0
Throttle 03	- Aileron	
Throttle 04	Rudder	Conversion Factor 1.0
Throttle 05	- Flap handle	
Throttle 06	- hap handle	
Throttle 07		
RPM 1		
RPM 2	-	
Aileron 1 Left 00		
Aileron 1 Right 00		To Veronte
Aileron 1 Left 01		Select var
Aileron 1 Right 01		Offset
Aileron 1 Left 02		
Aileron 1 Right 02		Conversion Factor
Aileron 1 Left 03		
Aileron 1 Right 03		
Aileron 2 Left 00		
Aileron 2 Right 00		
Aileron 2 Left 01		
A1 2.01 17.04		

Veronte Pipe – HIL Setup

In this panel, X-Plane variables are available on the left side (Disables). In addition, it can be seen two section more To XPlane and To Veronte.

In order to configure the simulation variables, users have to:

1. Enable the ones that have been configured in the aircraft model (Plane Marker). Just drag and drop them into To Xplane section.

**Warning:** Always make sure that surfaces are moving in the right direction and with the correct deflection angle.

To avoid mistakes is possible to set a positive fixed deflection (Control Tab) in Standby phase for all surfaces and control surface deflections in the X-Plane model.

Surface control variables are of two types:

- Radians measure (variables with numbers)
- Degrees measure (variables with no numbers)
- 2. Once X-Plane variables have been enabled, select the actuator variable (Control Output) that matches with the ones in Veronte autopilot. A new window will be displayed for each variable.

Select variable	×
Select var	
U ADC Channel 1	Î
U ADC Channel 10	
U ADC Channel 11	
U ADC Channel 12	
U ADC Channel 13	
U ADC Channel 14	
U ADC Channel 15	~
	Cancel Accept

3. Set a Conversion Factor or Offset, if it is necessary. Conversion factor multiplies the Veronte output signal and can be used in case units on Veronte and the X-Plane simulator do not match (Surfaces in X-Plane move normally in a [0,1] range). The following operation allows to converting an angle [deg] measure to the X-Plane form:

(Angle + Offset) Conv.Factor = ...

When Angle and Offset are measured in [rad] and the Conversion factor is a constant (normally it can be calculated as 1/(deflection angle in [rad]).

In the case of [rad] measures, the Conversion factor must be set in 57,29578 ([deg]-[rad] conv. factor).

Finally, it is necessary to configure the communication between Veronte Pipe and X-Plane, see section below.

#### 11.1.1.4 Veronte Pipe Communications

In order to start the simulation, select the HIL option (1) on the Veronte Unit, this is available on the side menu. Popup screen will be displayed (2) for selecting the kind of simulation and configuring the parameters.



Veronte Pipe - HIL Communications

Changing the default values is only recommended for advanced users. Press start in order to start the data transfer between X-Plane and Veronte Autopilot.

**Warning:** The simulation must be started when the aircraft is in the Initial phase (the one that gets in once is powered). In this phase the X-Plane will simulate the GPS signal to locate the autopilot in the place indicated by the airport on X-Plane.

### 11.1.2 X-Plane 10 Settings

#### 11.1.2.1 X-Plane 10 Configuration

X-Plane 10 demo version can be downloaded from this link.

X-Plane 10 communications settings must be edited in order to have communication with Veronte system. Follow the next steps in order to make a proper configuration.

For low-performance computers, it may be needed to reduce the graphics quality on the simulator, as described below.

#### 11.1.2.1.1 Aircraft Model Installation

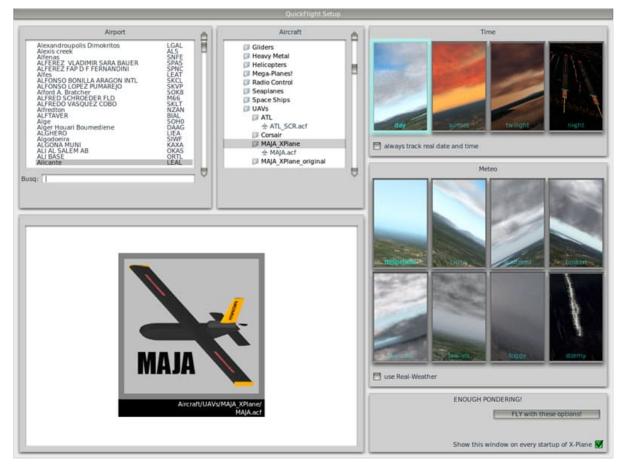
X-Plane 10 simulator is compatible with a wide variety of platforms: airplane, helicopter, multicopter, surface vehicle.... In order to create the platform model, Plane Maker tool provided by X-Plane 10 must be used.

Once the aircraft model has been created, it can be integrated on the X-Plane 10 simulator by following next steps:

- Copy the model folder to the "Aircraft" folder within the X-Plane 10 installation directory.
- Copy the content in the "Airfoils" folder, available on the aircraft model folder, to the "Airfoils" directory within the X-Plane 10 installation directory.

#### 11.1.2.1.2 X-Plane 10 Setup

On X-Plane 10 execution, **Quick Flight Setup** window will be displayed; select which aircraft to use, the starting airport and weather conditions to be simulated during the flight.



#### Quick Flight Setup

Data transmission settings must be edited on the settings tab. Select the input and output data option and edit the UDP speed. This speed must be set to **50/s**.



#### X-Plane 10 Setup

K Entrada y salida de datos				
Configurar Ver datos Prueba de v	uele	Habilitar: 👿 Internet 🛛 👿 Arch. disc	co 👿 Grafico 🛛 📄 Pantalla de la cabina ciear al	
0 0 0 0 0 frame rate	33 🗖 🗖 🗖 🖬 starter timeout	70 📄 🗖 🗑 😿 defs: allerons 1	106 🗖 🗖 🗖 switches 1:electrical	
1 8 8 8 times	34 🗄 🖶 📑 engine power	71 🗧 🗖 🗖 defs: allerons 2	107 🗖 🗖 🗖 switches 2:EFIS	
2 2 2 3 3 1 1 1 sim stats	35 🖻 🗖 🗖 🚮 engine thrust	72 🗖 🗖 🗖 defs: roll spoilers 1	108 🗖 🗖 🗖 switches 3:AP/f-dir/HUD	
	36 🗖 🗖 🗖 engine torque	73 🗖 🗖 🗖 defs: roll spollers 2	109 🗖 🗖 🗖 switches 4:anti-ice	
3 🖸 🗖 🗹 🗖 speeds	37 🗖 🗖 🛃 engine RPM	74 🔲 🗖 🗑 😿 defs: elevators	110 🗖 🗖 🗖 5 interruptores:anti hielo/	
4 👿 🗖 🗖 👿 Mach, VVI, G-load	38 🗖 🗖 🗖 🗖 prop RPM	75 🗖 🗖 🗖 defs: rudders	111	
	39 C C C prop pitch	76 C C C defs: yaw-brakes	112 C C Switches 7:misc	
5 5 6 6 atmosphere: weather	40 C C propwash/jetwash	77		
6 👿 🗖 🗖 🗖 atmosphere: aircraft	41 0000 N1		113	
7 PPP system pressures	42 0000 N2	78 C C TOTAL vert thrust vects	114 C C C annunciators: general	
	43 8 8 8 8 MP	79 79 70 TOTAL lat thrust vects	115 annunciators: engine	
8 8 8 8 9 joystick all/elv/rud		80 🗖 🗖 🗖 🗖 pitch cyclic disc tilts		
9 9 9 9 9 9 other flight controls		81 C C C roll cyclic disc tilts	116 C C autopilot arms	
10 1 art stab all/elv/rud		82 8 8 9 pitch cyclic flapping	117	
11 C C flight con all/elv/rud		83 P P P roll cyclic flapping	118	
12 C C C Wing sweep/thrust vect	49	84 PPP arnd effect lift, wings	119 🗖 🗖 🗖 🗖 weapon status	
13	50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	85 C C C grind effect drag, wings	120 C C C pressurization status	
14 C C gear/brakes	51 C C C fuel pressure	86 C C C grind effect wash, wings		
	52 CORPT	87	122888 radar status	
15 🗖 🗖 🗖 angular moments	53 F F F battery amperage	88 C C C grind effect drag, stabs	123 C C C hydraulic status	
16 M C C angular velocities	54 PPP battery voltage	89 C C C grind effect wash, stabs		
17 M C M pitch, roll, headings	34 C C C D Dattery votage	90 PPP grind effect lift, props	125 C C C C C C C C C C C C C C C C C C C	
18 C AoA, side-slip, paths	55 PPP elec fuel pump on/off	91	126 C C C icing status 2	
19 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	56 C C C C C C C C C C C C C C C C C C C	91 C C C gind effect drag, props	120	
ta 🖸 🖸 🖸 🖸 inba profinia		92 EEE wing lift	128 C C C filte-plan legs	
			120 C C C nite-plan legs	
20 🛃 📄 🦳 lat, lon, altitude	58 C C generator on/off	93 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9		
21 😿 🛅 🗭 🗭 loc, vel, dist traveled	59	94 B B B stab lift	129	
	60 A FADEC on/off	95 🗐 🗖 🗖 stab drag	130 🗋 📄 👿 camera location	
22 🗍 📄 📄 all planes: lat	61 🖪 🗖 🗖 igniter on/off		131	
23 C all planes: Ion		96 COM 1/2 frequency		
24 🗇 🗖 🖶 all planes: alt	62 6 62 fuel weights	97 B B NAV 1/2 frequency	132	
	63 🗖 🗖 🗖 payload weights and CG	98 8 8 8 8 NAV 1/2 085	133 C C Cruise stats	
25 🔲 🗖 🛃 throttle command	and the second second second second	99 9 NAV 1 deflections	Cabina durante el vuelo Visualización gráfica en 'Ver Dat Archivo en disco 'data.txt'	
26 🖸 🗖 🗖 throttle actual	64 🔲 🗖 🛃 🛃 aero forces	100 C NAV 2 deflections	Archivo en disco 'data.txt'	
27 C P Pluma-norm-beta-revers	65 🖸 🗖 🕅 👿 engine forces	101 🗖 🗖 🗖 ADF 1/2 status	Internet a traves de UDP	
28 C prop setting	66 🖪 🗖 🗖 landing gear vert force	102 🖸 🗖 🗖 DME status	Velocidad 2.0.0 Ine	
29 🖸 🗖 🗖 mixture setting	67 🗖 🗖 🗖 landing gear deployment	103 🗖 🗖 🗖 GPS status	Detalle: Trotores	
30 🗖 🗖 🗖 carb heat setting		104	Detalle: 🗇 helices	
31 🗄 🖶 🖶 cowi flap setting	68 📑 📑 📑 IIft over drag & coeffs	105 🗖 🗖 🗖 MARKER status	Detalle: alas Velocidad 10.0 /sec	
32 📑 📑 📑 magneto setting	69 🖪 🗖 🗖 prop efficiency		detail: 📑 stabs & misc 0000	

#### X-Plane 10 Input and Output Data

#### gSide Y acceleration – Body axis 16 Angular Velocities pitchRate Pitch Rate rollRate Roll Rate

23 yawRate Yaw Rate 17 Pitch, Roll, Headings pitch Pitch roll Roll	
32 headingTrue Yaw         18 AoA, side-slip, paths alpha used for IAS         beta used for IAS         20 lat,lon, altitude lat Latitude         lon Longitude	

I

48 altMs1 Mean sea level

### 48 altAgl Above ground level 21 loc, vec, dist traveled Vx X velocity – Body Axis Vy Y velocity – Body Axis

59 Vz Z velocity – Body Axis 11.1. Professional HIL

On the **settings** tab, enter into the **network configuration** and select the **data** menu. There user must edit the IP configuration as follows:

- IP: 127.0.0.1 49005
- Check the IP of data receiver option
- Uncheck the IP of Flir Imagery receiver

×		×
Multijugador Extern Visual Instructor	IPhone/IPad Distos	
	tern navegar, mylaar ei correo electronico, etc. Si la denee poede ejecular el navegador de internet para probar la conexion. 21 a contribuación. 0.0.1 0.0 seconds ago, and the send was successful.	
-		_
	IP para salida de datos Conecte este equipo a otro con un cable de ethernet. Si liene datos seleccionados para que vayan a internet en la pantalia COMFIGURAR SALUDA DE DATOS, se iran a esta direccion. iUse estos datos UDP para enviar lo que se le ocurra!	
	127.0.0.1       49005       IP of data receiver (set output options in Data Output screen)         IP of FLIR imagery receiver (for different apps that receive X-Plane imagery)	
	Puertos UDP	
	we receive on 49000 is the default	
	we send on 49001 is the default	
	port that we 49002 is send to iPad on 000000 the default	

#### X-Plane 10 Network Configuration

On **settings** tab, **General options and warnings**, set the flight models per frame to a minimum of 3. It is needed for small aircraft simulation within X-Plane 10. If your model is vibrating in XPlane 10 you can increase this value but higher PC performances are required.

X Operaciones y	advertencias X				
ldio	ma				
⊖ English ⊖ Français ⊖ Deutsch	<ul> <li>Русский</li> <li>Português</li> <li>Italiano</li> <li>Пава</li> <li>Въраñol</li> </ul>				
Modelo	de vuelo				
flight models 2 is OK for most situations, more may be needed for per frame 9 very fast, light, small aircraft or low framerate!					
Inicio          Iniciar vuelo con los motores funcionando         Iniciar cada vuelo en rampa         Guardar preferencias	Advertencias          Advertencia instalacion incompleta paisaje         Advertencia velocidad baja de fotograma         Advertencias de peligro en texto				
Dano          Quitar superf. vuelo a una sobrevelocidad         Quitar superficies vuelo en sobregravedad         Quitar flaps en over-Vfe         Quitar compuertas tren aterr. over-Vle         Reinicie en impacto fuerte	Datos Cargar datos de red en log.txt dump un-translated language-file strings to 'Untranslated Strings.txt'				

X-Plane 10 General Options and Warnings

#### 11.1.2.2 Low Performance Computer Configuration

In case of using a low performance computer with the HIL Simulator the simulation reliability can decrease. In this case, it is recommended to reduce the graphic quality on the X-Plane 10 simulator.

On the settings tab, enter the graphics option menu and press on set all rendering options for maximum speed.

	de textura		lock to monitor	the frame-rate)
at this resolution	on animetros por defecto del monitor (only a screen	oplies if the full- button is checked)	gamma	2.2 (takes effect on restart)
		COSAS PARA DIBUJAR		
draw view indicator	draw forest fires and balloons	sparse  in number of trees	m	distance
dim under high G- load or hypoxia	draw birds and deer in nice weather	too many  number of objects		fronte  airport detail
draw hi-res planet textures from orbit	draw aircraft carriers and frigates	default . number of roads		shadow detail
E runways follow terrain contours	Borealis	Siberia Winter   number of cars		simm : water reflection detail
	EFECTOS ESPECIALES		)(	DETALLE DE NUBE
J-D bump-maps	draw per pixel lighting	aliasing	41	N: some.
gritty detail textures	HDR rendering			number of cloud putfs
draw volumetric fog		nivel de filtro anisotrópico		
		ESPECIALES DE VISUALIZACIÓN		
para paisaje en red	(grados) Campo lateral 0 6 0.0 0 (g)	display IOS and cockpit on two monitors	O cylinder projection	<ul> <li>ir por defecto a la visualización del pane</li> </ul>
0000	*****	FOV (campo de vista) vertical no proporcional	O dome projection	O Vista no-HUD a pantal completa por defecto
para paisaje en red 0 0 0.0	(grados)			O bloquear a la visualización del pane
ensación del alabeo para paísaje en red	(grados) lateral 0.0 0 (screen offset 0000 ratio)		set all re	idering options for maximum speed
	mparation 17X 650/PCIe/SSE2 4.4.0			

X-Plane 10 Graphics Option

### 11.1.3 X-Plane 11 Settings

#### 11.1.3.1 X-Plane 11 Configuration

Since now, Veronte system is compatible with X-Plane 11 for HIL simulation. The demo version of the program can be downloaded from this link.

X-Plane 11 communications settings must be edited in order to have communication with Veronte 4 system. Follow the next steps in order to make a proper configuration.

For low-performance computers, it may be needed to reduce the graphics quality on the simulator, as described below.

#### 11.1.3.1.1 Aircraft Model Installation

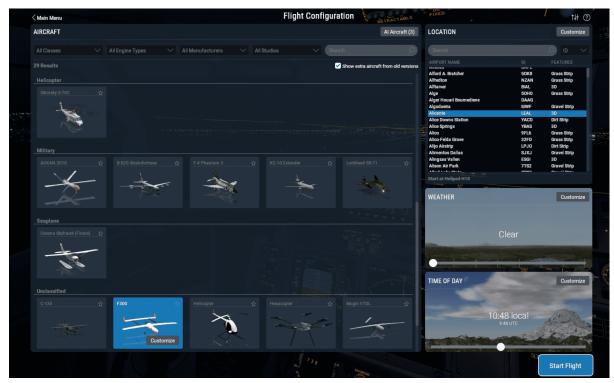
X-Plane 11 simulator is compatible with a wide variety of platforms: airplane, helicopter, multicopter, surface vehicle.... In order to create the platform model, **Plane Maker** tool provided by X-Plane 11 must be used.

Once the aircraft model has been created, it can be integrated on the X-Plane 11 simulator by following next steps:

- Copy the model folder to the "Aircraft" folder within the X-Plane 11 installation directory.
- Copy the content in the "Airfoils" folder, available on the aircraft model folder, to the "Airfoils" directory within the X-Plane 11 installation directory.

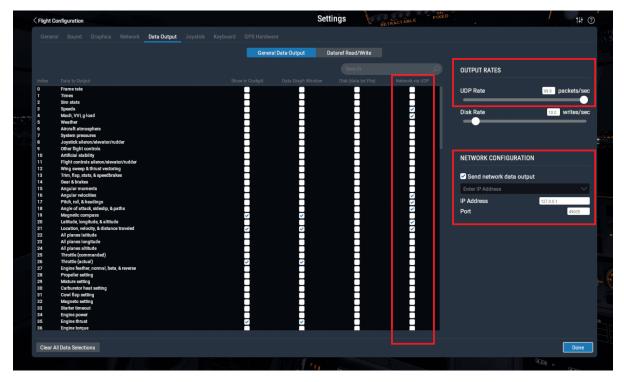
#### 11.1.3.1.2 X-Plane 11 Setup

On X-Plane 11 execution, **Quick Flight Setup** window will be displayed; select which aircraft to use, the starting airport and weather conditions to be simulated during the flight.



Quick Flight Setup

Data transmission settings must be edited on the **Data Output** tab. Select all the variables in order to be sent through the UDP Network and set the UDP rate at maximum speed. The network configuration must be configured as shown in the following picture.



X-Plane 11 I/O configuration

### 11.1.4 Operation

Once the hardware has been connected and Veronte Pipe and X-Plane have been configured, operation can starts and the system can be operated as if it was on a real flight.



#### M400 Flight Simulation

When the X-Plane model is uploaded, GPS is simulated and the UAV must be visible on VerontePipe map. With GPS signal it is possible to pass the system to Standby phase and to start flight. X-Plane flight starts from an airport; a custom airport must be defined for simulating out of available airports.

+ 4 2 2 4			XPlane	-	*	
15	0 1	80 - 0 <sup>4</sup>	Type simulation	1446	1012	
	0		UAV Frequency	50		
0	REAL PROPERTY AND INCOMENTS	-2. 81-1	IP Recive Port	49005	1	
	Contract of		Send Port	49000		
Ent	All and	an Taiget A	and the second of the second o	STOP		

#### Start GPS simulation

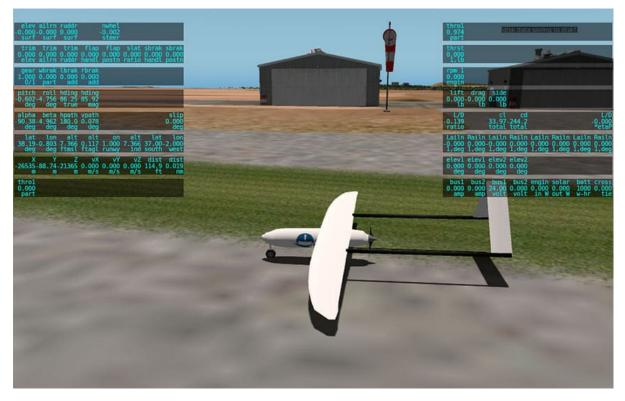
Moreover, it is possible to create a new airport. In order to do that, the user should follow the X-Plane tutorial presented in the next link . Once the aircraft has taken off from the airport on X-Plane the automatic control will start and the aircraft will fly to the defined mission on Veronte Pipe.

**Warning:** The flight is simulated in all real case aspects. Always make sure that the mission is well configurated and check the terrain profile is in the correct position.

The operator can fly the system as on real flight, being compatible with main Veronte features: real-time mission edit, in-flight automatic to manual control, flight data recording... Sometimes is possible, during an edition saving, that the simulation fails because the simulation link suffers a little interruption (this fact does not exist in real flights).

When using the HIL simulator connected to the platform, control actuators will move as if it were flying. In order to avoid damaging the system or personnel, make sure that the motor is disconnected and there is no shock risk due to the actuators movement.

**Warning:** Always make sure that motor has been disconnected before starting a simulation. Otherwise the motor will run as if it were flying.



#### HIL Simulation

Veronte HIL simulator integrates Veronte Autopilot control system within the X-Plane simulator for highly realistic simulation within a safe environment.

Professional Hardware In the Loop (HIL) Simulator package is a powerful tool for Veronte Autopilot integration, development and operator training; permitting to extensively operate the system in a safe environment, prior to conducting real flight operations. Veronte HIL Simulator has been designed for accomplishing with requirements of most demanding unmanned system operators. Some of the main uses of the simulator are:

- Pilot training.
- Veronte configuration for unmanned platform control.
- PID setting.
- Mission configuration.
- Aircraft performance validation.

## 11.2 SIL Simulink

A software in the loop simulation consists of a Simulink model that simulates the behaviour of the system formed by the autopilot and a vehicle, without having the physical devices connected to the computer, in contrast to the HIL which has both the autopilot and (optionally) vehicle connected to the PC. This option has several advantages when it is compared with a HIL setup:

- Complete simulations without any hardware.
- Possibility of using your own vehicle model: no need to stick to XPlane models. You can add as much physics/complexity as desired.
- Possibility of simulating different kinds of sensors even if they are not fitted in Veronte.

- All results can be exported/visualized to MATLAB workspace simultaneously.
- Veronte Block runs faster than real time, allowing the user to execute a series of simulations in a short time.
- Light computational load.

#### 11.2.1 Requisites

The following MATLAB Toolboxes are needed for a full explotation of Veronte SIL capacities:

- MATLAB + Simulink (basic package).
- Aerospace toolbox: contains sensor blocks, flight instruments and environment blocks.
- Simulink Real-Time: contains useful blocks to be used with buses: UDP/RS232/CAN...

In addition, it is required to install and select Microsoft Visual Studio 2015 (or later) as your MEX compiler.

- 1. First, get Microsoft Visual Studio from here.
- 2. Follow the onscreen steps, please make sure that C++ tools are selected (they may appear as an optional item).
- 3. When finished, select it as your default MEX compiler by typing in MATLAB console mex -setup c++.
- 4. If everything is correct, it should be configured as shown:

MEX configured to use 'Microsoft Visual C++ 2015' for C++ language compilation.

Warning: The MATLAB C and Fortran API has changed to support MATLAB variables with more than 2^32-1 elements. You will be required

variables with more than 2^32-1 elements. You will be required to update your code to utilize the new API. You can find more information about this at: https://www.mathworks.com/help/matlab/matlab\_external/upgrading-mex-files-to-use-64-bit-api.html

To choose a different C++ compiler, select one from the following:

MinGW64 Compiler (C++) mex -setup:'C:\Program Files\MATLAB\R2018a\bin\win64\mexopts\mingw64\_g++.xml' C++ MinGW64 Compiler with Windows 10 SDK or later (C++) mex -setup:'C:\Program Files\MATLAB\R2018a\bin\win64\mexopts\mingw64\_g++\_sdkl0+.xml' C++ Microsoft Visual C++ 2015 mex -setup:C:\Users\mfg\AppData\Roaming\MathWorks\MATLAB\R2018a\mex\_C++\_win64.xml C++

Visual C++ 2015 Selected as Compiler for MEX functions.

### 11.2.2 Autopilot Simulation

The autopilot is implemented in Simulink with an S-Function. This kind of block takes a C, C++, Fortran or even Matlab code, and implements it in a block containing a certain number of inputs and outputs. A typical Veronte s-function is shown below.

_		
		Control Outputs
<b>_</b>		Servos
Static Pressure 1		Position
Static Pressure 2		Heights
Static Pressure 3		Velocities
Dynamic Pressure		IAS TAS GS
IMU1		IAS IAS GS
IMU2		MSL.
IMU3		Angle of Attack / Sideslip
Magnetometer 1		q_infinity
Magnetometer 2		IAS RAW
Magnetometer 3		
Magnetometer 4		Tangential Acceleration
GNSS1		Body Velocities
GNSS2		Angular Velocity
Relative Position 1		Angular Acceleration
Relative Position 2		Acceleration NED
GPS Time		
Lidar 1		Velocities NED
Lidar 2	Inlined C++ S-Function	Angles
Lidar 3		Co-Angles
Lidar 4		Aerodynamic Angles
Lidar 5		Acceleration Body
ID Bit Vars		Load factor
ID UVars		scia_data
ID Real Vars		scia_length
ADCs		scib_data
scia_data		ecih length
scia_length		scib_length
scib_data		scic_data
scib_length		scic_length
scic_data		scid_data
scic_length		scid_length
scid_data		usb_data
scid_length		
usb_data		usb_length
unth lamath		uvar_values
usb_length		bvar_values
		rvar_values

### S-Function containing the autopilot embedded code

Inputs are described in the next table:

PIN	Signal Type	Description	Form	Size	Units	
1	Input	Static Pressure 1	[pressure_measur temperature]	erænt;sensor	Pa / K	
2	Input	Static Pressure 2	[pressure_measur temperature]	en2æn1t;sensor	Pa / K	
3	Input	Static Pressure 3	[pressure_measur temperature]	en2æn1t;sensor	Pa / K	
4	Input	Dynamic Pressure	[pressure_measur temperature]	enænt;sensor	Pa / K	
5	Input	IMU 1	[acc_x;acc_y;acc_ temperature]	z7 <b>gylr_</b> x;gyr_y;gyr_	z <b>ısıd∕ıs</b> \$∂ı/m/s/K	
6	Input	IMU 2	[acc_x;acc_y;acc_ temperature]	z7gylr_x;gyr_y;gyr_	z <b>,sa∕n</b> §∂r/m/s/K	
7	Input	IMU 3	[acc_x;acc_y;acc_ temperature]	z7gylr_x;gyr_y;gyr_		
8	Input	Magnetometer 1	[mag_x;mag_y;m temperature]	-	Т	
9	Input	Magnetometer 2	[mag_x;mag_y;m temperature]	-	Т	
10	Input	Magnetometer 3	[mag_x;mag_y;m temperature]	-	Т	
11	Input	Magnetometer 4	[mag_x;mag_y;m temperature]	-	Т	
12	Input	GNSS 1			n <b>dety</b> h;*v <u>1</u> 0a\$t;/v <u>m</u> ahow / mm/s	
13	Input	GNSS 2			n <b>dets</b> h;*v <u>1</u> 0a\$t;/v <u>m</u> ahow / mm/s	
14	Input	Relative Position 1			cæ <u>n</u> y;,d <b>iista</b> nče <u>0</u> 2;;xl_a	
15	Input	Relative Position 2	[1;x_rel;y_rel;z_r	el <b>;tf)x</b> thnce_x;distan	cæ <u>n</u> y;diistančel <u>0</u> 2;xl_a	iccu;y_accu;z_acc
16	Input	GPS Time	[week_number;se	conds_of_week]	• / s	
17	Input	Lidar 1	[lidar_measureme	nt]x1	cm	
18	Input	Lidar 2	[lidar_measureme	nt]x1	cm	
19	Input	Lidar 3	[lidar_measureme	nt]x1	cm	
20	Input	Lidar 4	[lidar_measureme	nt]x1	cm	
21	Input	Lidar 5	[lidar_measureme	nt]x1	cm	
22	Input	ID Bit Var	[Var_IDs]	50x1	m	
23	Input	ID Unsigned Var	[Var_IDs]	50x1	m	
24	Input	ID Real Var	[Var_IDs]	50x1	m	
25	Input	ADCs	[adc(1-17)]	17x1	•	

continues on next page

PIN	Signal Type	Description	Form	Size	Units
26	Input	SCIA Data	[serial_data]	1024x1	•
27	Input	SCIA Length	[serial_length]	1x1	•
28	Input	SCIB Data	[serial_data]	1024x1	•
29	Input	SCIB Length	[serial_length]	1x1	•
30	Input	SCIC Data	[serial_data]	1024x1	•
31	Input	SCIC Length	[serial_length]	1x1	•
32	Input	SCID Data	[serial_data]	1024x1	•
33	Input	SCID Length	[serial_length]	1x1	•
34	Input	USB Data	[serial_data]	1024x1	•
35	Input	USB Length	[serial_length]	1x1	•

Table 1 – continued from previous page

Outputs are the following:

PIN	Signal Type	Description	Form   Size		Units
1	Output	Control Outputs	[control_outputs(1-20)]   20x1		
					•
2	Output	Servo Values	[servos(1-32)]	32x1	
					•
3	Output	Position	[lat;lon;alt]	3x1	rad / m
4	Output	Heights	[msl,agl]	2x1	m
5	Output	Velocities	[longitudinal_v;la	teBadlv;velocity(mo	dunhe?)]
6	Output	IAS TAS GS	[ias,tas,gs]	3x1	m/s
7	Output	MSL	[msl_from_qnh;m	sl2_xfilom_ISA]	m
8	Output	Angle of Attack	[angle_of_attack;	siæslip]	rad
		/ Sideslip			
9	Output	Q_Infinty	[dynamic_pressur	e]1x1	Ра
10	Output	IAS RAW	[ias_raw]	1x1	m/s

continues on next page

PIN	Signal Type	Description	d from previous page Form   Size Units			
11	Output	Tangential	[tangential_accele	ration	m/s^2	
	Curput	Acceleration				
12	Input	Body Velocities	[lon_v;lat_v;verti	caBxvIl	m/s	
13	Output	Angular	[roll_rate;pitch_rate]		rad/s	
_		Velocities	,r	, , , ]		
14	Output	Angular	[acc z axis;acc y	<b>axi</b> s;acc_x_axis]	rad/^2	
	1	Acceleration				
15	Output	Acceleration NED	[acc_north;acc_ea	ast3adc_down]	m/s^2	
16	Output	Velocity NED	[v_north;v_east;v	dowIn]	m/s	
17	Output	Angles	[Yaw;Pitch;Roll]	3x1	rad	
18	Output	Co-Angles	[co-Yaw;co- Pitch;co-Roll]	3x1	rad	
19	Output	Aerodynamic Angles	[heading,flight_pa	atl <b>it,bå</b> nk_angle]	rad	
20	Output	Acceleration Body	[acc_x,acc_y;acc_	z}x1	m/s^2	
21	Output	Load factor	[nx;ny;nz]	3x1	•	
22	Output	SCIA Data	[serial_data]	1024x1	•	
23	Output	SCIA Length	[serial_length]	1x1		
					•	
24	Output	SCIB Data	[serial_data]	1024x1	•	
25	Output	SCIB Length	[serial_length]	1x1	•	
26				1024.1		
26	Output	SCIC Data	[serial_data]	1024x1	•	
27	Output	SCIC Length	[serial_length]	1x1	•	
28	Output	SCID Data	[serial_data]	1024x1		
					•	
29	Output	SCID Length	[serial_length]	1x1	•	
30	Output	USB Data	[serial_data]	1024x1	•	

Table 2 – continued from previous page

continues on next page

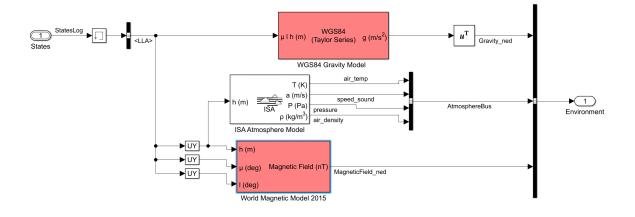
PIN	Signal Type	Description	Form   Size		Units
31	Output	USB Length	[serial_length])	1x1	•
32	Output	Unsigned Variables	[selected variables(1- 50)]	50x1	•
33	Output	Bit Variables	[selected variables(1- 50)]	50x1	•
34	Output	Real Variables	[selected variables(1- 50)]	50x1	•

Table 2 – continued from previous page

### **11.2.3 Sensors Simulation & Input Examples**

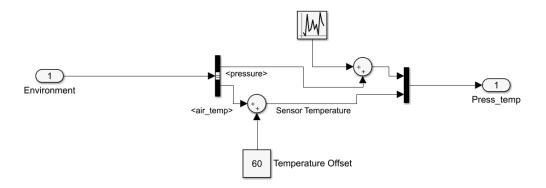
This section aims to ilustrate how to implement the inputs described in the previous section. The structures that are shown here are orientative and, of course, can be adapted by the user.

A basic subsystem that must be built in every flight simulation is an environment model. This model, groups the atmospherical properties and it changes according to different variables as well as the magnetic field at certain coordinates on earth. This block will be the basis of most the sensors that will be shown later on:



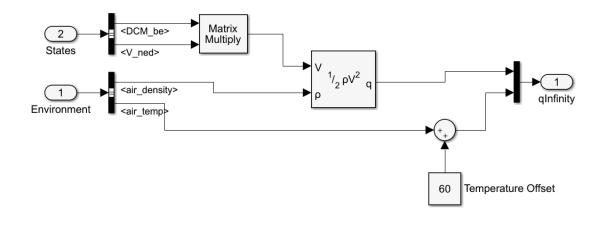


The static pressure sensor block can be easily derived by taking the pressure from the environment model. The only parameter that must be added is the temperature of the sensor (in this case is the OAT + 60):



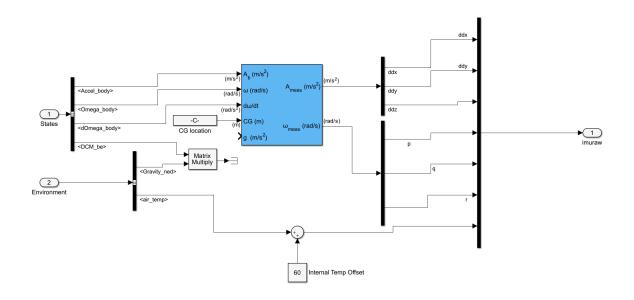
Static Pressure Example Block

The dynamic pressure input can be also obtained by using the standard dynamic pressure simulink block. The inputs are the speed (body axis) and the density:





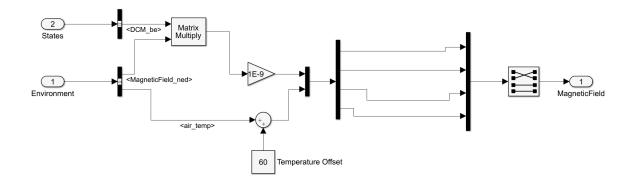
There is also a dedicated simulink block in the aerospace blockset that models a set of accelerometers and gyroscopes. The inputs of this block are the acceleration and angular velocities coming out of dynamics of the vehicle.



#### IMU Example Block

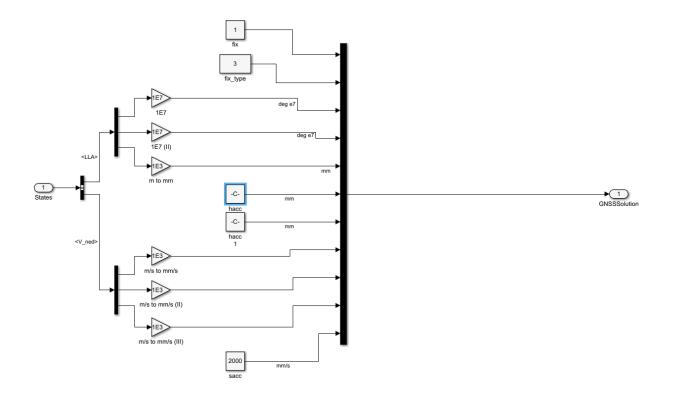
Warning: Do not connect the gravity port to the IMU block.

The magnetometer block is simply a rotated environment magnetic field where the temperature of sensor has been added (same as before OAT + 60). The reason why there is a selector crossing the signals is because there is a rotation matrix pre-configured in each PDI (the real magnetometer is not aligned with the autopilot axis):

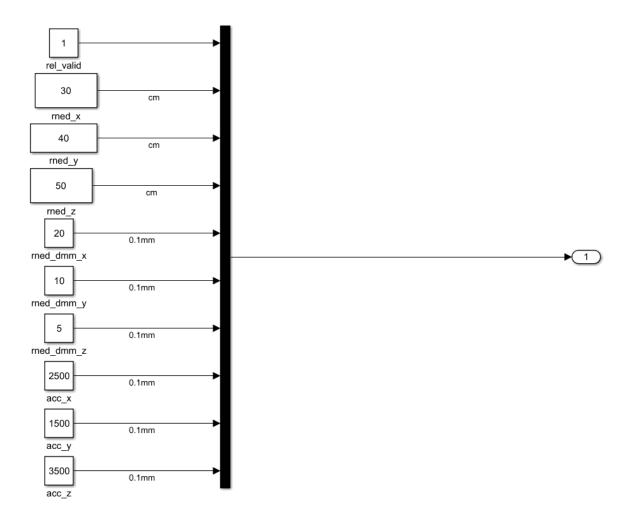


#### Magnetometer Example Block

The GNSS receiver and the relative position input (RTK) are only a multiplexor that creates an array. The position and the velocity are outputs of the vehicle model:

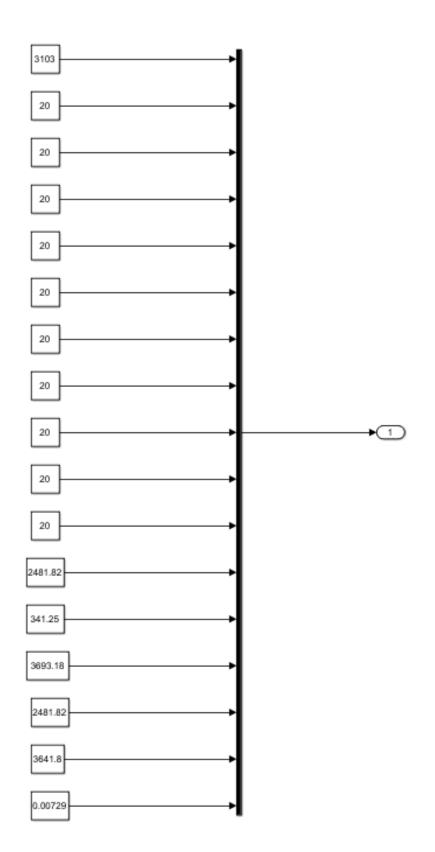


GNSS Receiver Example Block



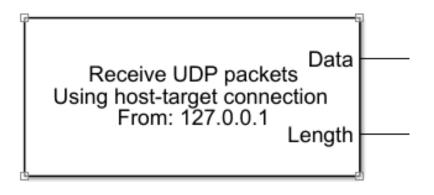


The analogue inputs follow the same reasoning, the user must add the desired values to the mux:



ADCs Example Block

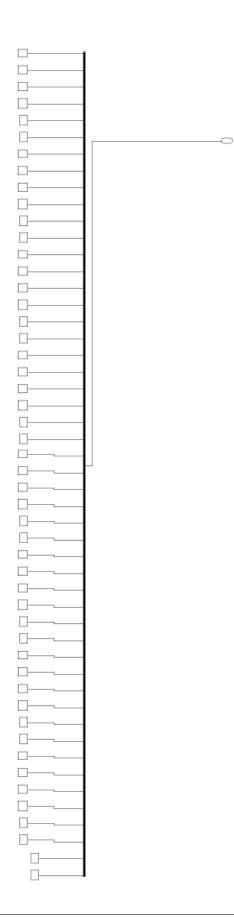
Veronte can manage input and output serial ports as explained *here*. An easy way to create serial frames (data en length wires) is by using the simulink UDP block. Therefore, the data coming in to veronte should be sent though UDP (if this approach is taken):



SCI Example Block

### 11.2.4 Monitoring Telemetry with Simulink

As explained before, there are three inputs specially dedicated to select custom telemetry (pins 22,23 and 24). The input structure of those is fixed and must be of size 50, as illustrasted here:



Telemetry ID Mux

The ID of each variable vailable in Veronte can be easily found in Veronte Pipe by adding a new workspace widget. The ID is labelled right before the variable name:

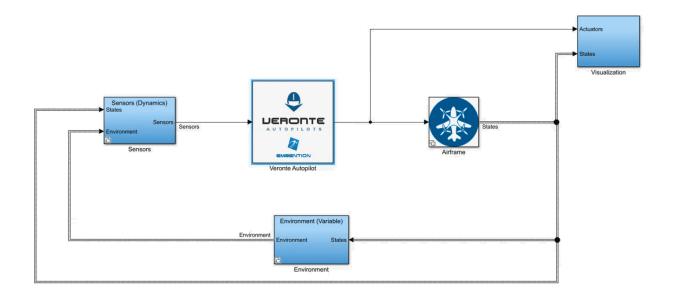
Select variable	×
Select var Filter - Searc	h
0 - IAS (Indicated Airspeed) • Unit: m/s	Ô
R 1 - TAS (True Airspeed) Unit: m/s	
R 2 - GS (Ground Speed) Unit: m/s	
R <sup>3</sup> - Heading ❶ Unit: rad [-π,π]	
R 4 - Flight Path Angle O Unit: rad [-π,π]	
5 - Bank                 ① Unit: rad [-π,π]	
R 6 - Yaw O Unit: rad [-π,π]	
R 7 - Pitch ❶ Unit: rad [-π,π]	~
	Cancel Accept

#### ID indicator

Lastly, to see their values, just place a scope connected to the matching output (pins 32, 33 or 34).

### 11.2.5 Complete Simulation

After setting the main blocks, the result should look like this:



Complete Setup Example

The main systems are:

- Veronte Autopilot: It contains our flight control software.
- Airframe: a model of the flight dynamics.
- Environment: a model of the atmosphere, magnetic field, WGS84...
- Sensors: it contains individual blocks of all the sensors that veronte needs as input.
- Visualization: It contains, scopes, flight instruments...

The time step should be set to 0.0002 as shown in the next figure in order to guarantee a good GNC/Adquisition frequency:

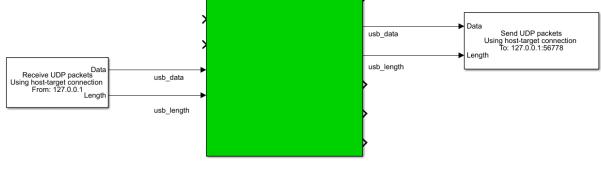
Configuration Parameters:	/Configuration (Active)	-		×		
<b>Q</b> Search						
Solver Data Import/Export Math and Data Types	Simulation time			^		
	Start time: 0 Stop time: TFinal					
<ul> <li>Diagnostics Hardware Implementation</li> </ul>	Solver selection					
Model Referencing Simulation Target	Type: Variable-step					
Code Generation	▼ Solver details					
<ul> <li>Coverage</li> <li>HDL Code Generation</li> </ul>	Max step size: 0.0002 Relative tolerance: 1e-3					
	Min step size: auto Absolute tolerance: auto					
	Initial step size: auto					
	Shape preservation:         Disable All           Number of consecutive min steps:         1		•			
	Zero-crossing options					
	Zero-crossing control: Use local settings   Algorithm: Nonadaptive		•			
	Time tolerance: 10*128*eps Signal threshold: auto		- 1			
	Number of consecutive zero crossings: 1000					
	Tasking and sample time options					
	Automatically handle rate transition for data transfer					
	Higher priority value indicates higher task priority					
				~		
	OK Ca	ancel Help		pply		

Time step settings

### 11.2.6 Connecting Simulink & Veronte Pipe

Our Software-in-the-loop simulator can be connected and used alonside Veronte Pipe software. To do it. Follow this steps:

- 1. Add a UDP serial communication block and connect it to USB data and length.
- 2. Add a second UDP serial communication block and connect it to the USB output of veronte.





3. Configure your destination port.

Block Parameters: UDP Send	×				
UDP Send					
Send data over UDP network to a remote device. Send to 255.255.255 for broadcast.					
'Local IP address' applies only when the block executes on a target computer.					
Parameters					
Local IP address:					
Use host-target connection					
Local port: 56777					
To IP address: 127.0.0.1					
To port: 56778					
Sample time (-1 for inherited): -1					
OK Cancel Help Apply	/				

#### Destination UDP Port

4. Set an ethernet network in Preferences as shown using the destination port selected before.

Preferences 🏟 😳 🛡 💉 🕅				
TCP Server	Send telemetry			
Enable Port 3000	Enable           Host         127.0.0.1           Port         3000           Frequency         10.0           Hz			
Autodiscover COMs				
Ethernet	Multicast IP 239.0.0.1 Port 56778 Network Interface Qualcomm Atheros AR8171/8175 PCI-E Gigabit Ethe •			
	Local IP Address 0.0.0.0 Local Subnet Mask 0.0.0.0			
Add 👻				

Destination UDP Port (Pipe)

### 11.2.7 Dealing with PDI files

PDI are uploaded exactly the same way that would be uploaded to a physical autopilot. Once connected to Veronte Pipe, a *virtual* autopilot will be detected in safe mode, then these steps can be followed.

Warning:	Restart functionalities	do no restart	the simulation	and must be done	manually.

Veronte S-function deals with a direct copy of the binary files of a veronte autopilot, if a manual setup is needed, these files will be found in the same folder as the simulink block in a subfolder called *mmc*:

- mmc
   flightController.slx
   flightControlSystem.slx
   reset\_SIL.m
   Veronte\_SIL.cpp
   Veronte\_SIL.m
  - Meronte\_SIL.mexw64
  - Veronte\_SIL.mexw64.pdb

Folder structure (matlab)

# 11.3 3D Simulation



#### Veronte 3D Simulation

Veronte PFD works using a flight simulator for representing the worldwide geographical scenarios: *lands, seas, mountains, cities, airports, airfields, heliports, etc...* In addition, unlike other 3D PFDs an internet connection is not necessary so it can be operated from any location and environment without any delays in scenario loading.

This feature displays a 3D view of the aircraft which is being piloted, while it permits to use it as a 3D PFD (Primary Flight Display) when using the 1st camera view. This system permits to display custom aircraft models in the virtual

environment. Planemaker tool is available for creating custom models, thereby the operator can see in the interface aircraft model which is being flown.

Video: Veronte Situational Awareness for UAVs.

# **11.3.1 Veronte Pipe Configuration**

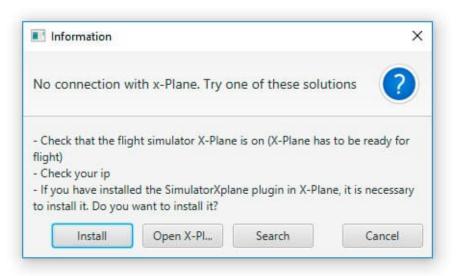
To configure the 3D Simulation in Veronte Pipe it is necessary to complete some steps. First of all, the user must connect Veronte Autopilots to the PC and run Veronte Pipe and XPlane simulator.

When the system is ready, it is possible to open the XPlane connection on Pipe following the path Setup > XPlane. In this panel, the user must select the Real 3-D View from the menu, complete the editable fields as described in section *Mounting* and configure X-Plane following the same section.

Type simulation	Real 3-D View -
UAV	Mentor
Frequency	50
IP	127.0.0.1
Recive Port	49005
Send Port	49000

Veronte 3D Simulation

When the connection with XPlane is not possible, an information window shows up. In order to admit the input connection, XPlane requires a plugin installation. By clicking on "Install", it is possible to select the XPlane folder on the PC in order to install it.



← → × ↑ 📥 > Este	equipo > DATA (D:) >	v ⊙	Buscar en DATA	(D:) P
Organizar 👻 Nueva car	peta			BE • ()
Img Manual 🔷	Nombre	Fe	cha de modifica	Tipo
Mentor	Program Files (x86)	04	/01/2017 14:38	Carpeta de archiv
	Users	18	/04/2016 12:00	Carpeta de archiv
Chebrive	VerontePipe2.6.2	05	/09/2016 9:43	Carpeta de archiv
Este equipo	VerontePipe2.7.4	06	/10/2016 12:08	Carpeta de archiv
🕹 Descargas	VerontePipe2.8.5	07	/09/2016 16:31	Carpeta de archiv
Documentos	VerontePipe2.9.5	12	/01/2017 14:10	Carpeta de archiv
Escritorio	VerontePipe2.10.1	09	/09/2016 9:50	Carpeta de archiv
F Imágenes	VerontePipe2.11.1	05	/10/2016 12:35	Carpeta de archiv
h Música	VerontePipe2.11.2	01	/12/2016 15:34	Carpeta de archiv
	VerontePipe2.12	30	/11/2016 17:23	Carpeta de archiv
Vídeos	VerontePipe2.12.5	13	/01/2017 10:36	Carpeta de archiv
" OS (C:)	XPlane	26	/08/2016 10:39	Carpeta de archiv
DATA (D:) 🗸 🗸	<			>
Carpet	a: XPlane			
		Sala	ccionar carpeta	Cancelar

Plugin installation request

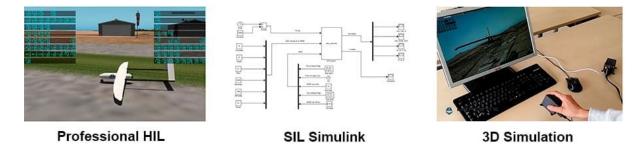
#### X-Plane folder selection

When the XPlane connection is correctly configured, it is possible to click on "Start" in the XPlane connection panel and the 3D Simulation will start. XPlane will take position on the map and attiude datas from Veronte Pipe and will reproduce the aircraft movement in the simulation environment following the real one.

When the flight is over and the simulation is not required, in order to stop the connection with XPlane, it is sufficient to open the XPlane connection panel and click on "Stop".

Type simulation	Real 3-D View 👻
UAV	Mentor
Frequency	50
IP	127.0.0.1
Recive Port	49005
Send Port	49000

Stop XPlane connection



This section of the manual presents the three possible ways to simulate using Veronte System:

- Hardware In the Loop simulation (HIL): This kind of simulation shows Veronte Pipe software performing as it does during a real operation. Meanwhile running the simulation Veronte Autopilot "thinks" it is flying, taking simulator input as real sensor data. The whole flight is controlled by Veronte Autopilot in the virtual environment, making it the perfect tool for vehicle development and for training in the use of Veronte Autopilot.
- Software In the Loop simulation (SIL): The software in the loop simulation consists in the creation of a Simulink model that simulates the behaviour of the system formed by the autopilot and platform, without having the physical devices connected to the computer, in contrast to the HIL which has both the autopilot and platform connected to the PC. The SIL allows the user to simulate faster than real time, which allows the user to simulate a system several times.
- **3-D Simulation:** When Veronte Air is flying, it is possible to connect the system with X-Plane simulator through the 3-D Simulator. In this way, the user can see a virtual reproduction of the flight in real time and use it in a FPV-like mode.

# CHAPTER

# TWELVE

# **EXAMPLES**

# 12.1 4G Communication

# 12.1.1 4G Communication with Veronte Autopilot

Embention integrates its own Veronte Autopilot with a cloud service that allows the user controlling its own platform around the world with real time telemetry.

## 1. Add an Autopilot to cloud

Enter to cloud.

Please sign in		
User Email		
Password		
 Remember me		
Sign in		
Login problems?		
Register		

## Login

Sign in or create an account to be able to access to the cloud services . From your personal space the user is able to add new Veronte Autopilots by clicking on the top right corner.

Ueronte Cloud Dashboard	Autopilots	1 ~
Autopilots list		•
1 <b>025</b> V4 1025	Version: Unknown Last connection: Unknown	
<b>1043</b> V4 1043	Version: Last connection: Unknown	

#### Autopilots List

Introduce the information required in the list and a new autopilot will show up on the previous list.

# Add new autopilot to your list

	ID of the autopilot
	Registration code
•	Custom name

🕇 Add Autopilot	
Cancel	

Add new Autopilot

Contact support@embention.com for further details

### 2. Activate 4G Communication in Veronte Autopilot

In order to activate 4G communications open the 'Set up' menu and select 'Devices'. By default the 4G communication is disabled. Select ESIM or SIM accordingly to your set up.

#### ESIM

For all Veronte Autopilots with ESIM activated the following fields should be filled.

- Host: cloud.embention.com
- Port: 3114

×

Embention 🛪 🙆 🤇	े ≅ 📀 🕯	🛱 🚳 🗔 🔺 🔶		
Actuators	✓ Enable			
<ul> <li>Communications</li> </ul>	SIM Type	ESIM		
4G				
Payload				
Sensors	Host	cloud.embention.com	Port	3114
Stick				
▶ Veronte				
▶ Others				
Add device 🔻				

ESIM

#### SIM

For Veronte Autopilots with a physical SIM card installed in Embention facilities the following parameters have to be set up:

- Host: cloud.embention.com
- Port: 3114
- APN: APN given by the 4G provider.
- PIN: PIN code of the SIM card installed. It should be defined before enabling the communication.

Embention 🛪 🙆 🖸	) ≑ 🛛 🗘	🕏 🕰 🗖 🔺 🤶	
► Actuators	✓ Enable		
<ul> <li>Communications</li> </ul>	SIM Type	SIM 👻	APN em
4G			
Payload			PIN 0 0 0 0
Sensors	Host	cloud.embention.com	Port 3114
Stick			
Veronte			
Others			
Add device 💌			



### 3. Add a Veronte Autopilot from cloud

Open Veronte Pipe and Select the Cloud menu. The user will be requested to enter its own cloud account:

Email	
user@domain.com	
Password	
Password	
✓ Remember me	
Login	🔵 Register
Le	ogin



All veronte autopilots registered in Veronte Clould will appear showing the **Name**, **Version** and **Last** connection information.

🔅 🔂 Cloud 🛆	
VeronteCloud	(Logout) 15/05/2018 13:28:58 Disconnect
1025	Version: 5.1.0 Last connection: 10/05/2018 13:16:27 🐼 🎧 😱 🚺
> <b>1043</b>	Version: 4.12.3 Last connection: 11/05/2018 09:35:38 🐼 🎧 😱 🛈

Cloud

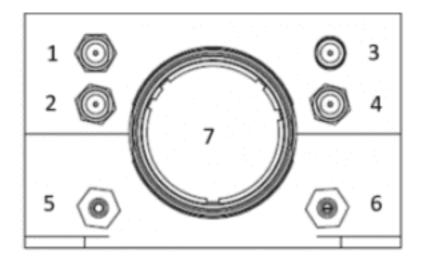
When a Veronte is **ONLINE** the user is able to download the information of the cloud by clicking  $\bigcirc$ 

1043	Version: 4.12.3	
1043	Last connection: Online	

A new Veronte will appear in Pipe with exactly the same capabilities compared with a veronte connected by USB.

# 4. Antenna Connection

Connect the 4G antenna in 3 (SSMA connector).



Antenna Connector

# 5. XPC UINT8 Configuration

Check SCIA-Sara configuration match the following scheme:

		Producer		Consumer	
Actuators Communications	<b>Q</b> <sup>o</sup>	USB	$\rightarrow$	Commgr port 1	Q0
Payload	¢¢	SCIB	$\leftrightarrow$	Commgr port 2	Q
Sensors	Q0	SCIA - Sara		Commgr port 3	00
Stick		SCID - Connector 232		None	Q.
Veronte Others		SCIC - Connector 485	$\rightarrow$	None	0
XPC Uint8		Commgr port 1		USB	00
XPC CAP	¢8	Commgr port 2		SCIB	00
	¢8	Commgr port 3		SCIA - Sara	00
	Ø8	Commgr port 4		None	0
	¢¢	Commgr port 5	$\rightarrow$	None	0
	Q0	Commgr port 6	$\rightarrow$	None	00
	Ø0	Custom message 1	$\rightarrow$	None	0
	Ø0	Custom message 2	<b>→</b>	None	08
	Ø0	Custom message 3	$\rightarrow$	None	08
Add device		Tunnel 1	$\rightarrow$	None	Q.
Add device		Tunnal 2		None	86

XPC Uint8

# **12.2 Configurations**

# **12.2.1 Plataform Configurations**

## 12.2.1.1 Fixed Wing-Mentor

### 12.2.1.1.1 Servo Configuration

Once the Autopilot has been installed and connected according to the guidelines that appear in the section *Hardware Installation*, the first step of the configuration process is the adjustment and trimming of the servos. The next list contains the instructions to follow in order to trim the platform servos.

1. Set which servo number will have each one of the controls. **Mentor** has a conventional aircraft configuration, so there are five controls: elevator, two ailerons, rudder and throttle. Each one of these controls is assigned to a value of the "Actuator Output" vector (s) according to the pin where it is connected. It is possible to assign any value to any control, i.e the control connected to Pin1 can be s1, s2, s3, s4 or s5.

🔯 🕑 Penguin Embention 🛪	💿 💿 葦 🚱 🗱 🙆 🛽	🗂 🔺 CfgMgr	StepMgr	
	Γ	PWM 1		
		✓ Active High		
		Mode	time 👻	
	Frequency 50.0 Hz	Min	9.0E-4 s	
		Max	0.0021 s	
► Others		Servo	Actuator Output s1 👻	
▼ PWM			Actuator Output s1	
1		PWM 2	Actuator Output s2	
2		✓ Active High	Actuator Output s3	
3			Actuator Output s4	
4		Mode	Actuator Output s5	
5		Min	Actuator Output s6	
7		Max	Actuator Output s7	
8			Actuator Output s8	
9		Servo	None	
Serial				
► USB				
Add 👻				

Actuator Output

- Right Aileron: Actuator Output s1
- Elevator: Actuator Output s2
- Throttle: Actuator Output s3
- Rudder: Actuator Output s4
- Left Aileron: Actuator Output s5

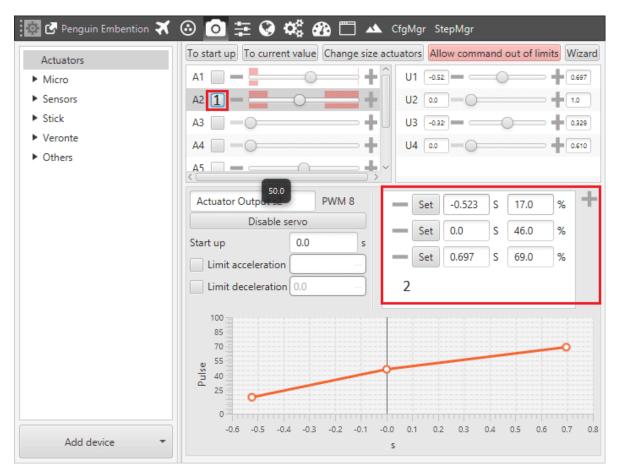
**Note:** Name **Actuator Output s** can be changed to other more identifiable according to the real actuator such as right or left aileron, see section *System Variables*.

2. With the five controls now having a value of the S vector, the SU matrix can now be edited. Here the user configures the relation between the controller outputs ("u") and the servo movements ("s"). In the case of **Mentor**, each control channel is related with only one servo: the pitching with the elevator, the rolling with the ailerons, the yawing with the rudder and the thrusting with the throttle, so the SU matrix will be as follows, taking into account which s corresponds which control according to the connections.

name Penguin E	mbention	AES	Ð	r StepMgr	Туре
S Set inv(SU) Ed	t				
U Set inv(US) Ed	it				
Edit					×
	-	-	-	-	
	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	
- Actuator Output s1					
Actuator Output s1     Actuator Output s2	Pitching	Thrusting	Rolling	Yawing	+
	Pitching 0.0	Thrusting 0.0	Rolling 1.0	Yawing 0.0	+
Actuator Output s2	Pitching 0.0 1.0	Thrusting           0.0           0.0	Rolling 1.0 0.0	Yawing 0.0 0.0 0.0	+
Actuator Output s2     Actuator Output s3	Pitching 0.0 1.0 0.0	Thrusting           0.0           0.0           1.0	Rolling	Yawing 0.0 0.0 0.0 0.0 0.0	

#### SU Matrix Configuration

- Pitching (u1): Actuator Output s2 (Elevator)
- Thrusting (u2): Actuator Output s3 (Throttle)
- Rolling (u3): Actuator Output s1 and s5 (Ailerons)
- Yawing (u4): Actuator Output s4 (Rudder)
- 3. Finally, the servo position has to be linked with a real variable, for example, the angle of the control surface or the throttle level. Besides, here are set the physical limits of the servo in the case when it is not possible for it to move in the full range (0-100%).



#### Servos Configuration

Servos can be moved from the actuators menu when being in INI phase (no phase in green in Veronte Panel).

- When 1 is marked, the slide bar allows the movement of that servo.
- The curve points are added in **2**.

Let's consider the elevator  $(s_2, A_2)$  as an example. In Mentor, the elevator can not be moved totally down because it hits the landing gear, and neither totally up because it hits the rudder. Taking note of the pulse value at this points, the limits of the servo are obtained: 17% and 69% in the example of the previous figure. Measuring also the surface deflection at those points (-0.523 and 0.697 radians) the servo curve is totally defined (including also the point where the deflection is zero).

# 12.2.1.1.2 Mission Phases

In this section, it will be explained how to configure a whole mission for an airplane, in this case, **Mentor**. The typical phases will be detailed and the guidance for each one of them will be presented.

# 12.2.1.1.2.1 Takeoff

The takeoff phase will be the one where the aircraft goes from the initial to the lift off point.

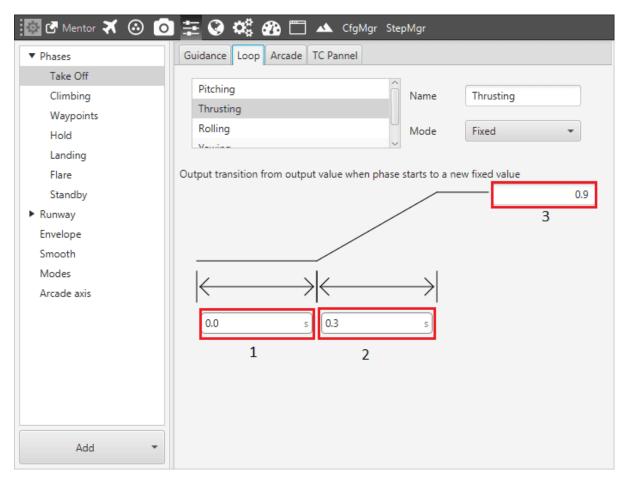
🔯 🛃 Mentor 🛪 🙆 🧿	\Xi 🚱 🗱 🚰 📥 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Take Off	Hold Name Take Off
Climbing	+
Waypoints	×
Hold	•
Landing	
Flare	Pitch —
Standby	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Runway	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad
Envelope Smooth	
Modes	Roll
Arcade axis	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
	Yaw
	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
Add 🔻	

Take Off Phase - Guidance

The guidance for this phase will be a **Hold** of three variables:

- Pitch and Roll Angle: kept at 0 [rad].
- Yaw Angle: kept at the value that the aircraft has when is set on the runway i.e, the variable selected will be Yaw.

Regarding the control loop, there are PIDs in the pitch, roll and yaw control channels, while the throttle has a ramp as defined in the following figure.



Take Off Phase - Loop

- 1. Here the initial value is set, in this case 0 because the aircraft starts from a standing point.
- 2. Time of transtion, 0.3 seconds, the throttle is increased from the initial to the final value.
- 3. Final value, 0.9.

# 12.2.1.1.2.2 Climbing

The climbing phase is used to make the airplane reach the cruise altitude after the takeoff.

🔣 🕑 Mentor 🛪 🙆 🧿	I 🗄 🛛 🗱 🕰 🗖	] 🔺 CfgMgr StepMg	gr	
▼ Phases	Guidance Loop Arcade	TC Pannel		
Take Off	Climbing	1	Name Climbing	1
Climbing		+		
Waypoints		×		
Hold		*		
Landing				
Flare	Hover gain			
Standby				
Runway	Horizontal	0.0		
Envelope	Vertical	0.0		
Smooth	Runway Runway 1 💌	Advanced		
Modes				
Arcade axis	Loiter point	Ref Runway Loite		
	Direction	✓ Ref Runway Direc	ction •	
	Flight-path angle	Ref 0.17	rad [-π,π]	
	Horizontal distance (dxy)	Ref 200.0	m	
	Radius head turn (R3)	Ref 500.0	m	
	Radius loiter (R1)	Ref 500.0	m	
Add 👻	✓ Loiter pos is center			

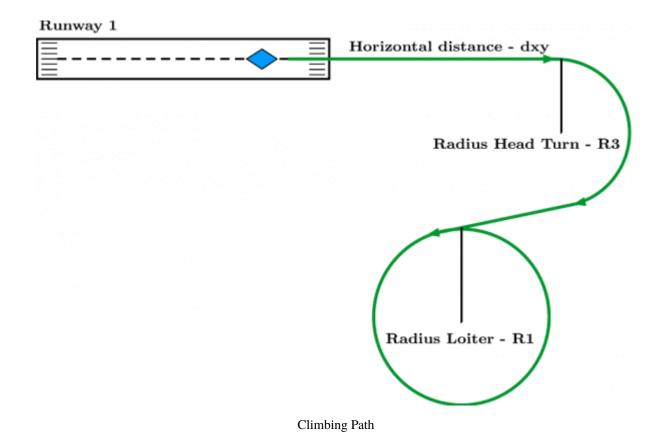
Climbing Phase - Guidance

This fase consists of Climbing Guidance:

- Line attraction: value related to how strongly the aircraft tries to reach a path (climb path in this case). This value is commonly between 20 and 40 for airplanes.
- Set speed: speed that will have the airplane during the climb, 15 [m/s].

In this phase, the aircraft reaches the mission altitude by performing a spiral route. In order to determine the correct path, these parameters must be set:

- Runway: here is selected the runway which previously has been edited in its configuration menu.
- Flight Path Angle: angle at which the aircraft will climb, 0.17.
- Horizontal Distance: is the distance from the point where the aircraft enters in the phase which contains the climbing guidance, to the start of the circular climbing path, 200 [m].
- Radius Head Turn R3: radius of the turn made to head the airplane towards the loiter direction, 500 [m].
- Radius Loiter R1: radius of the loiter ascending made by the aircraft to reach an altitude suitable, 500 [m].



# 12.2.1.1.2.3 Cruise

The cruise phase is where the aircraft follows a route marked by a set of waypoints, which are defined by the user in the **Mission** menu.

🔣 🕑 Mentor 🛪 🙆 🧿	I 🗄 🛛 🗱 🚳 🗖	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade	TC Pannel	
Take Off	Cruise	<b>^</b>	Name Waypoints
Climbing		+	
Waypoints		×	
Hold		4	
Landing			~
Flare	Line attraction	40	
Standby	Patch	0	<b>C</b> 91
Runway	- dech		
Envelope	Acceleration proportional	0.0	
Smooth	Set height mode	2.5D -	
Modes			
Arcade axis	Set limit acceleration		
	Acceleration	0.0 m/s <sup>2</sup>	
	Deceleration	0.0 m/s <sup>2</sup>	
	Deceleration	000	)
	Set speed		U
	Cruise	150	
	Cruise	15.0 m/s	
Add 👻	Waypoint reach	0.0 m/s	
			~

Cruise Phase – Guidance

This fase consists of a Cruise Guidance. Parameters set here are the same as the ones from the climbing phase.

- Line attraction: 40.
- Set Speed: 15 [m/s].

In this guidance, there is an option related to the gains used to recover the hover point in an multicopter, **Hover Gain**. In this case, the platform configured is an airplane, so this option will not be used.

**Warning:** When using the Cruise phase, the aircraft will automatically follow the waypoint route. An automation has to be created to make the platform perform in a different way.

# 12.2.1.1.2.4 Hold

ases	Guidance Loop	Arcade TC Pannel		
Take Off	Hold	1	Name	Hold
Climbing		+		
Waypoints		×		
Hold		*		
Landing		W		
Flare		Pitch		. +
Standby				
inway		lime (Ramp time) Slope (Ramp		
velope	Constant valu	e: 0.0 rad 0.0	Constant value: 0.0 rad	
nooth		Roll		
odes		KOI		_
cade axis	None     I	lime (Ramp time) 🛛 🔘 Slope (Ramp	rate) 💮 Ewma (TAU)	_
	Constant valu	ue: 0.0 rad 0.0	Constant value: 0.0 rad	
		IAS (Indicated Airspeed)		-
	None	lime (Ramp time) 🛛 🔘 Slope (Ramp	rate) 💿 Ewma (TAU)	
	Constant valu	ie: 0.0 m/s 0.0	Constant value: 0.0 m/s	

This phase is used to keep the aircraft at a constant heading, for example, when the radio connection is lost.

#### Hold Phase - Guidance

When this phase is active, the aircraft flies in a straight line, until another phase is commanded.

• Pitch, Roll and IAS: kept at a constant value 0.

# 12.2.1.1.2.5 Landing

This phase is used to make the aircraft land at a certain airport. When the flight altitude is too big, this phase contains the parameters which define the route performed by the platform to descent until an altitude where it can line up with the runway.

🔯 🗹 Mentor 🛪 🙆 🧿	I 🗄 🏵 端 🕰 🗖	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade	TC Pannel	
Take Off	Landing	1	Name Landing
Climbing		+	
Waypoints		×	
Hold		*	
Landing	Horizontal	0.0	^
Flare	Vertical	0.0	
Standby		0.0	
<ul> <li>Runway</li> <li>Envelope</li> </ul>	LoiForce		
Smooth	Runway Runway 1 🔹	Advanced	
Modes	Touch point	Ref Runway Touch Point	-
Arcade axis	Loiter point	✓ Ref Runway Loiter	<b>•</b>
	Direction	Ref Runway Direction	*
	Flight-path angle	Ref -0.14	rad [-π,π]
	Horizontal distance (dxy)	Ref 275.0	m
	Radius head turn (R3)	Ref 80.0	m
	Radius loiter (R1)	Ref 100.0	m
Add 👻	✓ Loiter pos is center		~

Landing Phase – Guidance

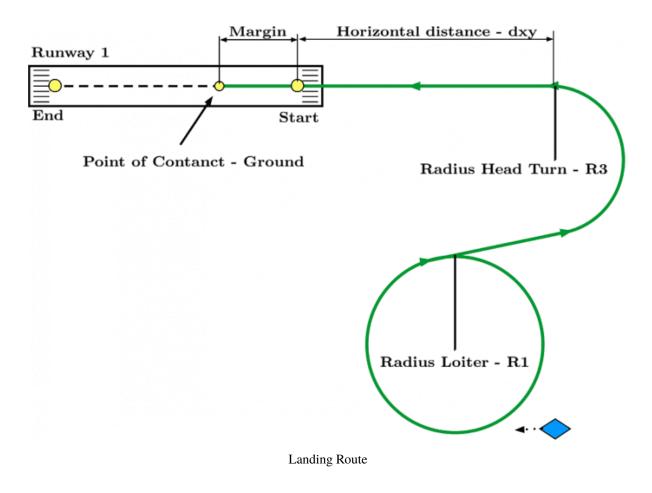
The guidance to be configured is Landing:

- Line Attraction: 20.
- Set Speed–Cruise: 14 [m/s].

Finally, the following parameters define the path during this phase.

- Runway: here is selected the runway which previously has been edited in its configuration menu.
- Flight Path Angle: angle at which the aircraft will descend, -0.14 [rad].
- Horizontal Distance: is the distance from the point where the aircraft enters in the phase which contains the climbing guidance, to the start of the circular climbing path, 275 [m].
- Radius Head Turn R3: radius of the turn made to head the airplane towards the runway direction, 80 [m].
- **Radius loiter R1:** radius of the loiter descending made by the aircraft to reach an altitude suitable to perform the landing manoeuvre, 100 [m].

The route of this phase is shown in the following figure, where each one of the parameters that define it are defined.



#### 12.2.1.1.2.6 Flare

The flare is a maneuver made by an aircraft just before the touchdown. Consists on a rise of the nose to decelerate the descent rate and set a proper attitude before touching the ground.

🔯 🕑 Mentor 🛪 🙆 🧿	፰ 🔇 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Take Off Climbing Waypoints Hold Landing Flare Standby	Hold Name Flare Name Flare
<ul> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> </ul>	None     Time (kamp time)     Slope (kamp rate)     Ewma (IAU)       Constant value: 0.0 rad     0.0     Constant value: 0.0 rad
Arcade axis	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)     Constant value: 0.0 rad     0.0     Constant value: 0.0 rad
Add 👻	

#### Flare Phase – Guidance

Considering what is wanted in this phase, the guidance to command is a Hold.

• Roll – Pitch Angle: kept at a constant value 0 [rad].

Regarding the thrust in this phase, the engines are shut off, so the mode of the controller is off.

#### 12.2.1.1.3 Automations

Automations are the mechanisms used to perform an action when some event is triggered. These actions could be a change from one phase to another, taking a photo, dropping a payload and so on. In this section, the conventional automations used in a flight of the Mentor airplane will be detailed.

The first automations to be created are the ones linked to the buttons of Veronte Panel. When clicking one of these buttons the phase is changed to the one shown on the button label.

🔯 🛃 Mentor 🛪 🙆 🧿	🛿 🏗 🚱 🥵 🛅 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	TKO Button Max 0	
SBY Button CRU Button	Events AND OR NOT Actions	alla i
<ul> <li>TKO Button</li> <li>CMB Button</li> <li>LND Button</li> <li>Failsafe</li> <li>Stick</li> <li>Transitions</li> <li>Arcade Trim</li> <li>When Event Mark</li> <li>LND to Flare</li> </ul>	TKO Button       TKO         AND       TKO Phases         Delay       0.0         Periodical         Image       TKO Button         Time       0.0         Image       Rvar Disabled	0
New Automation	This button will be displayed on Veronte Panel	

#### Automation Panel

Normally, besides the button event, a safety condition is added to the automation, which consists on letting only the system to change to a phase when being in a certain set of phases. For example, only change to cruise when being in climbing or change to landing when being in cruise or climbing. It is only necessary to create an AND condition with the phases to change from. In the previous figure, the automation is the change to takeoff when clicking on Veronte panel, being on Standby. This process is repeated for the rest of phases.

# 12.2.1.1.3.1 Takeoff to Climb

The change from the take off to the climbing phase occurs when the IAS of Mentor on the runway is greater than 8 m/s. There are two events to be configured:

- **Variable:** IAS > 8 [m/s].
- Phases: Standby.

🔯 🛃 Mentor 🛪 🙆 🧿	i 🗄 🚱 📽 🙆 🗖 4	🔺 CfgMgr StepM	1gr	
▼ Buttons	TKO to CMB	Max 0		
SBY Button (EIN) SBY Button	Events AN	D OR NOT	Actions	+
TKO Button CMB Button LND Button	IAS>8 AND TKO Phase		CM	IB
<ul> <li>Failsafe</li> <li>Auto when No Stick</li> <li>LinkOff to LND</li> <li>HLD when No GPS</li> <li>Low Battery</li> <li>Stick</li> <li>Auto Mode</li> <li>Manual Mode (Arc</li> <li>Transitions</li> <li>TKO to CMB</li> </ul>	Variable	▼ IAS>8 Indicated Airspeed)	Delay 0.0	Periodical: Off
<ul> <li>CMB to CRU</li> <li>Arcade Trim</li> <li>When Event Mark</li> <li>LND to Flare</li> <li>No name</li> </ul>	Max Min 8 Invert range 🗸			
New Automation	Min Event triggered on blue are	ta		Max

Take off to Climb - Automation

The action will be a change of Phase:

• Phase: Climbing.

# 12.2.1.1.3.2 Climbing to Cruise

When a certain altitude is reached, Mentor changes to the Cruise phase where it starts to follow the path determined by the user. As a safety condition, the change will only happen when having a speed greater than 6 meters per second. There are three events to be configured:

- **Variable:** AGL > 90 [m].
- **Variable:** IAS > 6 [m/s].
- Phases: Climbing.

🔯 🕑 Mentor 🛪 🙆 🧿	) 🌐 🥹 😂 🛱	🏠 🛅 🔺 CfgMgr Ste	pMgr	
▼ Buttons ✓ SBY Button (EIN)	CMB to CRU	Max 0		
✓ SBY Button ✓ CRU Button	Events	AND OR NOT	Actions	+
<ul> <li>TKO Button</li> <li>CMB Button</li> <li>LND Button</li> <li>Failsafe</li> <li>Stick</li> <li>Transitions</li> <li>TKO to CMB</li> </ul>		AGL>90 AND CMB Phase AND IAS > 6		CRU
CMB to CRU  Arcade Trim  When Event Mark			Delay 0.0	Periodical: Off
✓ LND to Flare	Variable Max Min Invert range	able  IAS > IAS (Indicated Airspee) 6 V		Time 0.0
New Automation	Event triggered	l on blue area		

to Cruise - Automation

Finally, the action will be a change of Phase:

• Phase: Cruise.

## 12.2.1.1.3.3 Radio Error

When the radio connection from the ground station to Mentor is lost, the aircraft is forced to change to auto mode and land. It is necessary to configure two events:

- Variable: TX or RX error (TX /RX Packet Error Rate (on board)), greater than 0.
- Phases: Climbing or Cruise.

🔯 🕑 Mentor 🛪 🙆 🧿	) 🏛 🚱 🛱 🤅	🏠 🛅 🔺 CfgMgr Ste	epMgr	
▼ Buttons ✓ SBY Button (EIN) ✓ SBY Button	LinkOff to LND	Max 0	Actions	+
CRU Button KO Button CMB Button		TX Error OR		LND
LND Button     Failsafe     Auto when No Stick     LinkOff to LND	F	RX Error AND light Phases		
HLD when No GPS				
<ul> <li>Transitions</li> <li>Arcade Trim</li> <li>When Event Mark</li> </ul>	🖉 🖹 Vari	iable 👻 TX Er	Delay 0.0	Periodical: Off
✓ LND to Flare	Variable Max	TX Packet Error Rate (on b	board)	
	Min Invert range			
New Automation	Min Event triggered	d on blue area		Max

Radio Error - Automation

Two actions are configured:

- Phase: Landing.
- Mode: Auto.

When the value of the flag that evaluates the TX or RX error ("TX Packet Error Rate (on board") has a value greater than 0.8, being the aircraft in climb or cruise phases, it is forced to land. The value 0.8 means that 80 percent of the packets send trough the radio link have been lost.

#### 12.2.1.1.3.4 Low Battery

When the battery is below a certain level (15.2 Volts in this case), and the aircraft is in climb or cruise, it is automatically commanded to land. The events to configure are:

- Variable: Power Input < 15.2 [V].
- Phases: Climbing or Cruise.

🔯 🕑 Mentor 🛪 🙆 🧿	) 🏛 🥹 📽 6	🏠 🛅 🔺 CfgMgr Ste	pMgr	
▼ Buttons	Low Battery	Max 0		
SBY Button (EIN) SBY Button CRU Button	Events	AND OR NOT	Actions	+
✓ TKO Button	Powe	r Input < 15.2V		LND
CMB Button		AND On Phase		AUTO
✓ LND Button ▼ Failsafe				
Auto when No Stick				
HLD when No GPS				
Low Battery				
► Stick			Delay 0.0	Periodical: Off
Transitions				
Arcade Trim     When Event Mark	🖉 🖹 Vari	able 🔻 Powe	r Input < 15.2V	<b>Time</b> -1.0
✓ LND to Flare	Variable	Power Input		
	Max			
	Min	15.2		
	Invert range			
				Max
	Min			IVIAX
New Automation	Event triggered	d on blue area		

Low Battery – Automation

Two actions are configured:

- Phase: Landing.
- Mode: Auto.

#### 12.2.1.1.3.5 Landing to Flare

The change from the landing to flare phase is triggered when the aircraft is above the runway and about to touch the ground. This idea is implemented with a set of three events:

- AGL: the aircraft is below a certain altitude, in this case, 8 meters.
- Inside Polygon: Mentor enters in a polygon defined in the map on the runway head.
- Landing Phase: the aircraft is landing phase.

🔯 🕑 Mentor 🛪 🙆 🧿	) 🏛 🥹 📽 d	🥻 🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	LND to Flare	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
<ul> <li>✓ CKO Button</li> <li>✓ TKO Button</li> <li>✓ CMB Button</li> <li>✓ LND Button</li> <li>✓ Failsafe</li> <li>Auto when No Stick</li> <li>LinkOff to LND</li> <li>HLD when No GPS</li> </ul>		ide Polygon AND AGL < 8 AND Phase LND		Flare
Low Battery  Stick  Auto Mode  Manual Mode (Arcad  Transitions  KOB to CRU  LND to Flare  Arcade Trim	Variable Max Min	able  AGL (Above Ground Level)		Periodical: Off
When Event Mark	Invert range Min Event triggered	I on blue area		Max

#### Landing to Flare

When these events are fulfilled, Mentor enters in the Flare phase and lands.

#### 12.2.1.1.3.6 Stick Auto

This automation changes the control mode according to the command sent by the radio controller. Only an event is necessary:

• Variable: Stick Input rX, greater than 0.75.

🔯 🛃 Mentor 🛪 🙆 🧿	) 🏛 🥹 🗳	ፊ 🗂 🔺	CfgMgr Ste	pMgr	
▼ Buttons	Auto Mode		Max 0		
SBY Button (EIN) SBY Button CRU Button	Events	AND	OR NOT	Actions	+
TKO Button		Stick UP			AUTO
CMB Button					
✓ LND Button					
▼ Failsafe					
Auto when No Stick					
LinkOff to LND					
HLD when No GPS					
Low Battery					
▼ Stick				Delay 0.0	Periodical: Off
Auto Mode     Manual Mode (Arcad					
Transitions	Ó E	/ariable	▼ Stick	UP	<b>Time</b> 0.0
TKO to CMB	Variable		tick Input r8		
CMB to CRU		3			
✓ LND to Flare	Max				
✓ Arcade Trim	Min	0.75			
Vhen Event Mark	Invert range	2			
	invertrange				
$\langle $	Min				Max
		and an Island			
New Automation	Event trigge	ered on blue area			

Stick Auto

The action is:

• Mode: Auto

As it can be seen, the channel that controls the mode is the 8, so according to its value the mode is changed.

The process is the same when creating manual mode, but now the value of Stick Input r8 has to be lower than 0.25.

The Mentor UAV is a radio controlled, electric powered trainer aircraft. Made of special foam, is one of the largest RC aircrafts made of this material.



#### Mentor

It is a platform with the conventional controls of an airplane: elevator, ailerons, rudder and throttle, so it can be a good example of how to configure a typical airplane in Veronte Pipe.

# 12.2.1.2 Flying Wing-W210

# 12.2.1.2.1 Servo Configuration

W210 configuration process can be performed by using a VerontePipe software version connected with the hardware system and the Autopilot as explained in section *Aircraft Mounting* of the manual.

# 12.2.1.2.1.1 Servos Output

The first step of the process is the servos configuration.

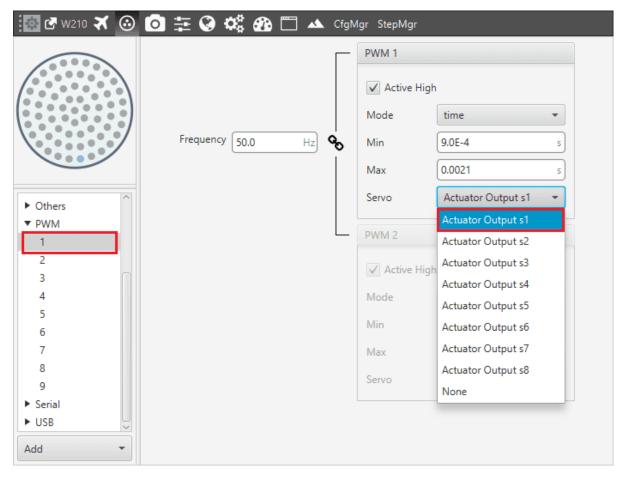
The controls of the airplane are the two control surfaces and throttle. Each one of these control corresponds to a pin of the connector and they must be positioned in the same order in an **S** vector who represents the **Actuator Output**. It is possible to connect any pin to any control surface or command but the easiest way to perform it and avoid confusion is by following the pins number.

💽 🛃 W210 🛪 📀	o 🏝 🚱 🗱 🙆 🗖 🔺 🖉	CfgM	gr StepMgr			
	]	- [	PWM 1			
			✓ Active High	1		
			Mode	time	*	
	Frequency 50.0 Hz	0	Min	9.0E-4	s	
			Max	0.0021	s	
► Others			Servo	Actuator Output s1	-	
▼ PWM		-	PWM 2			
2			✓ Active High	1		
4			Mode		-	
5			Min	9.0E-4	s	
7			Max	0.0021	s	
8			Servo	Actuator Output s8	*	
<ul> <li>Serial</li> </ul>						
► USB						
Add 👻						

Output-pin links

In this case, it is possible to use only 3 pins:

- Output 1 Actuator Output s1 (Aileron 1)
- Output 2 Actuator Output s2 (Aileron 2)
- Output 3 Actuator Output s3 (Throttle)



Output 1 – pin 1 configuration

# 12.2.1.2.1.2 SU Matrix

At this point, the **S** vector is defined and the **SU** matrix can be edited. By clicking on **Edit** it is possible to configure the relation between the controller outputs (U vector) and the servo movements (**S** vector).

💽 🕑 W210 🍣	( 😔 🖸 🗄 🔇	🗱 🚯 🗔	🔺 CfgMgr Ste	pMgr		
Vehicle name	W210	AES	0		Тур	e C 👻
US Set in	IV(SU) Edit					
SU Set in	v(US) Edit					
	Edit				×	
		-	-	-		
		Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling		
	- Actuator Output s1	1.0	0.0	-1.0	+	
	- Actuator Output s2	1.0	0.0	1.0		
	- Actuator Output s3	0.0	1.0	0.0		
			+			
				ſ	Apply	
					, the state of the	

#### SU matrix editing

The W210 is configured as follow:

- 1. **Pitch Control:** control surfaces must be moved in the same direction to modify the pitching angle. The contribution of the actuators has same magnitude and direction.
- 2. Thrust Control: the Actuator Output 1 is the only one that allows a thrusting change.
- 3. **Roll Control:** in this case, the contribution of the actuators must be set with the same magnitude and reverse direction in order to perform a rotation around the X axis.

**Warning:** This panel shows the reference system of the aircraft. It must be positioned in the same way of the Autopilot's one. If it results different, it can be edited by clicking on the corresponding axis in order to reverse its direction.

# 12.2.1.2.1.3 System Trim

As a final step, the system has to be trimmed. This can be performed by moving servos in three different positions: zero position, minimum and maximum deflection angle (angles are usually limited physically). These positions must be inserted and saved in the software by clicking on **Set** when the actuator is in the desired position. Otherwise, position can be introduced manually.

🔯 🗗 W210 🛪 🙆 🚺	\Xi 🚱 🗱 🚰 🛅 🔺 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
► Micro	
Sensors	
► Stick	A3 U3 -0.34 0.349
<ul> <li>Veronte</li> </ul>	A4 — — — — — — — — — — — — — — — — — — —
<ul> <li>Others</li> </ul>	A5 ~ ~
	Actuator Output s1         PWM 1         Set         -0.349         S         4.66         %           Disable servo         Set         0.0         S         46.73         %
	Start up 0.0 s
	Limit acceleration Set 0.349 S 76.89 %
	Limit deceleration
	B C C C C C C C C C C C C C
Add device 🔻	5

#### Actuator 1 Trimming

The picture shows the setting of the elevator number 1:

- Minimum: -0.34906 [rad] deflection; 4.6682%
- Zero position: 0.0[rad] deflection; 46.7317%
- Maximum: 0.34906 [rad] deflection; 76.8904%

**Warning:** The actuators can be moved directly from VerontePipe only when the system is in an Initial phase. During the actuator run, if the desired position is in the **Out of range** zone (red zone), it is possible to click on **Allow command out of limits** in order to move completely the actuator and find the correct position.

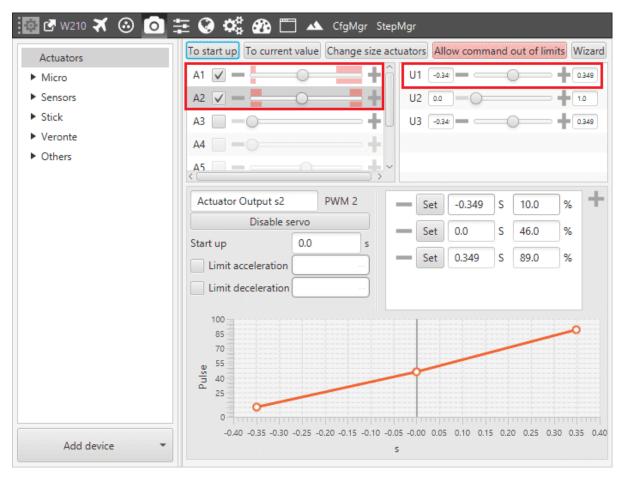
This procedure can be performed in the same way by using a **Wizard**. This tool allows moving actuators limits easily and finding the correct range.

Actuator Output s1											
		10	20	30	40	50	60	70	80	90	100
Actuator Output s2	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s3	0	10	20	30	40	50	60	70	80	90	100

#### Trim wizard tool

In order to perform a final checking, it is possible to select the desired channel and testing pitch, roll and thrust controls.

The image below shows a pitching output testing. By moving the U1 control, surfaces must change the position according to the reference system: positive corresponds to nose down and negative to nose up.



Pitching test

# 12.2.1.2.2 Mission Phases

In this section, it will be explained the W210 typical mission profile and the mission phases will be detailed.

# 12.2.1.2.2.1 Standby

Standby phase is a preliminary phase of the operation. During this phase is possible to check, for example, if the aircraft is correctly controlling the attitude by change it and seeing the control surfaces moving.

🔯 🗗 W210 🛪 📀 📀	🗄 😪 🗱 🖽 🗆	*				
▼ Phases	Guidance Loop Arc	ade TC Pannel	Automations	5		
Standby	Hold	<b>个</b>	Name	Standby		
Runway		+				
Envelope		×				
Smooth		*				
Modes		Pitch				
Arcade axis	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)     Constant value: 0.0 rad     O.O     Constant value: 0.0 rad					
	Roll					
	None     Time (Ramp time)	Slope (Ramp rate)	Ewma (TAU)			
	Constant value: 0.0 rad	0.0 c	onstant value: 0.0 rad			
Add 👻						

Standby phase panel

The guidance is a Hold of two angles:

• Pitch and Roll: kept at 0 [rad].

## 12.2.1.2.2.2 Hand-Launch

Hand-Launch phase is the first launch modality. In this case, the aircraft is launched "manually" by a person who has to increase is velocity trying to maintain the platform in a correct attitude. The image below shows the Hand-Launch phase configuration panel.

🔯 🛃 W210 🛪 🛞 🧿	🗄 🐼 🐝 🚳	🗂 🔺					
▼ Phases	Guidance Loop	Arcade	TC Pannel	Automations			
Standby	Hold		1	Name	Hand-Launch		
Hand-Launch			+				
Runway			×				
Envelope			4				
Smooth	Desired Pitch						
Modes	None Time (Ram	n time)	Slope (Ramp rate)	Ewma (TAU)			
Arcade axis	Constant value: 0.0 rad 0.0 Constant value: 0.1 rad 0.0 Constant value: 0.1700000017						
	Desired Roll —						
	None      Time (Ram	p time)	Slope (Ramp rate)	Ewma (TAU)			
	Constant value: 0.0 rad		0.0	onstant value: 0.0 rad			
Add 👻							

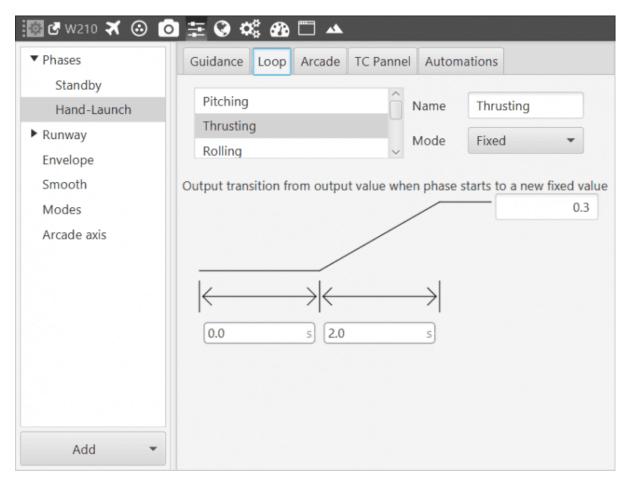
### Hand-Launch phase panel

In this phase, the Guidance is a Hold of two variables:

- **Desired pitch:** at 0.17 [rad].
- **Desired roll:** at 0.0 [rad].

It means the platform control system will keep to zero the roll angle and the pitch angle to 10° degrees.

Furthermore, during this phase the motor starts. The image below shows the thrust behavior: during the Hand-Launch phase, thrust starts from zero and reaches the fixed value of 0.3 in 2 seconds.



Hand-Launch phase thrust

### 12.2.1.2.2.3 Catapult

Catapult phase is the second launch modality. The takeoff is performed using a catapult which allows reaching the desired speed and maintaining the correct attitude during the launch. The image below shows the Catapult phase configuration panel.

🔯 🕑 W210 🛪 🛞 🧿	i ≣ © ¢	¢ 20		1			
Phases	Guidance	Loop	Arcade	TC Pannel	Automations	5	
Standby	Hold			1	Name	Catapult	
Hand-Launch				+			
Catapult				×			
Runway				$\checkmark$			
Envelope			Desired	Pitch		. +	
Smooth						_	
Modes	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)      Constant value: 0.0 rad						
Arcade axis		5142. U.U 194		0.0	P INGI		
	Desired Roll						
	None	) Time (Ram	p time)	Slope (Ramp rate)	Ewma (TAU)		
	Constant v	alue: 0.0 rad		0.0	onstant value: 0.0 rad		
Add 👻							

### Catapult phase panel

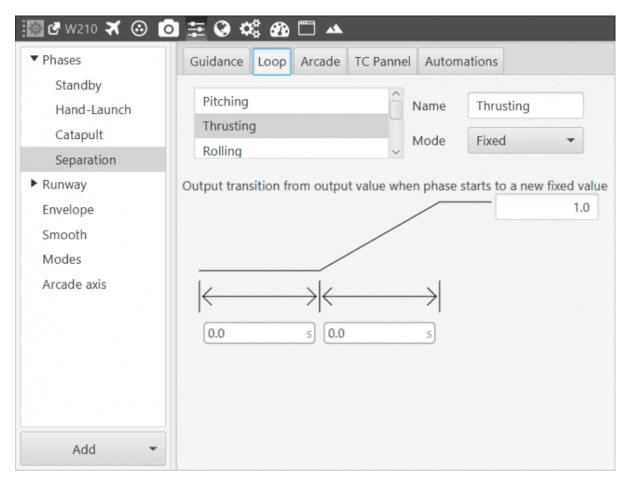
As happens in the Hand-Launch phase, the Guidance is a Hold of twop variables:

- **Desired Pitch angle:** at the current pitch angle.
- **Desired Roll angle:** at 0.0 [rad].

Thrusting, in this phase, is kept at zero.

## 12.2.1.2.2.4 Separation

Separation is the second phase of this takeoff modality. Guidance is the same **Hold** configuration of the Catapult phase but Thrusting changes. In fact, Thrusting is an instantaneous step from 0 to 1 in order to switch on the motor only when the fan can not be able to hit the catapult.



#### Separation thrusting

## 12.2.1.2.2.5 Climbing

Climbing phase is configured to make the airplane reach the mission altitude after the takeoff.

Phases	🗿 ፰ 🚱 🗱 🌆 🗂 🔺 Guidance Loop Arcade	r r	Automations	
Standby Hand-Launch Catapult Separation	Climbing	↑ + × +		Climbing
Climbing	Line attraction	40		
<ul> <li>Runway</li> <li>Envelope</li> </ul>	Patch	0		
Smooth	Acceleration proportion	0.0		
Modes	Set height mode	2.5D	-	
Arcade axis	Set limit acceleration			
	Acceleration	0.0	m/:	s <sup>2</sup>
	Deceleration	0.0	m/:	s²
	Set speed			
	Cruise	20.0	m,	/s
Add 👻	Waypoint reach	0.0	m/	/s

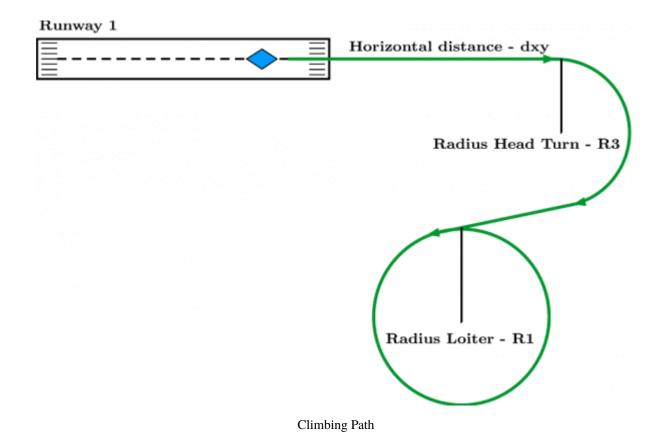
Climbing phase panel

This fase consists of a **Climbing** Guidance:

- Line attraction: value related to how strongly the aircraft tries to reach a path (climb path in this case). This value is commonly between 20 and 40 for airplanes. In this case, the value es set at 40.
- Set speed: speed that will have the airplane during the climb, in this case 20 [m/s] is a good value .

In this phase, the aircraft reaches the mission altitude by performing a spiral route. In order to determine the correct path, these parameters must be set:

- Runway: here is selected the runway which previously has been edited in its configuration menu.
- Flight Path Angle: angle at which the aircraft will climb, 0.1396 [rad].
- Horizontal Distance: is the distance from the point where the aircraft enters in the phase which contains the climbing guidance, to the start of the circular climbing path, 100 [m].
- Radius Head Turn R3: radius of the turn made to head the airplane towards the loiter direction, 100 [m].
- Radius loiter R1: radius of the loiter ascending made by the aircraft to reach an altitude suitable, 100 [m].



### 12.2.1.2.2.6 Cruise

In this phase, the Guidance is **Cruise**. The aircraft follows a route marked by a set of waypoints, which are defined by the user in the **Mission** menu.

🔯 🕑 W210 🛪 🛞 🧴	I 🗄 🥝 端 🙆 🗆	] 🔺			
▼ Phases	Guidance Loop A	rcade TC	Pannel A	Automations	
Standby Hand-Launch Catapult	Cruise	+ ×		Name	Cruise
Separation Climbing	Set limit acceleration	4		_	^
Cruise <ul> <li>Runway</li> <li>Envelope</li> </ul>	Acceleration Deceleration	0.0		√s² √s²	Π
Smooth	Set speed				
Modes Arcade axis	Cruise Waypoint rea	20.0		n/s n/s	
	Туре	Speed		-	
	Hover gain Horizontal	0.0			
Add 👻	Vertical	0.0			~

## Cruise phase panel

Parameters set here are the same as the ones from the climbing phase.

- Line attraction: 40.
- Set Speed: 20 [m/s].

In this guidance, there is an option related to the gains used to recover the hover point in an multicopter, **Hover Gain**. In this case, the platform configured is an airplane, so this option will not be used.

🔯 🛃 W210 🛪 🙆 🧿	📰 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Hand Lunch Climbing Cruise Separation Catapult	Hold Name Hold
Hold Landing Flare Standby	Desired Pitch       None     Time (Ramp time)       Slope (Ramp rate)     Ewma (TAU)       Constant value: 0.0 rad     0,0
<ul> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> </ul>	Desired Roll          • None       Time (Ramp time)       Slope (Ramp rate)       Ewma (TAU)       Constant value: 0.0 rad       0.0       Constant value: 0.0 rad
Arcade axis	Desired IAS (Indicated Airspeed)            • None         Time (Ramp time)         Slope (Ramp rate)         Ewma (TAU)         Constant value: 0.0 m/s         0.0         Constant value: 20.0 m/s
Add 👻	

## 12.2.1.2.2.7 Hold

#### Hold phase panel

In this phase, the Guidance is a **Hold** of three variables:

- Desired Pitch: at 0 [rad].
- Desired Roll: at 0 [rad].
- Desired I.A.S: (Indicated Air Speed) kept at a constant value of 20 [m/s]

It means the aircraft will maintain this attitude until the next phase change.

### 12.2.1.2.2.8 Landing

This phase is used to make the aircraft land at a certain airport. Also, when the flight altitude is too big, this phase contains the parameters which define the route performed by the platform to descent until an altitude where it can line up with the runway.

🔯 🗗 W210 🛪 🙆 🧿	🗄 😧 🗱 🌚 🖾 🔺	CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade TC P	annel		
Hand Lunch	Landing	1	Name La	inding
Climbing		+		
Cruise		×		
Separation		*		
Catapult		×		
Hold	Line attraction	20		ı î
Landing				101
Flare	Patch	0		
Standby	Acceleration proportional gain	0.0		
▼ Runway				
Runway 1	Set height mode	2.5D	•	
Envelope	Set limit acceleration			U
Smooth	Acceleration	0.0	m/s <sup>2</sup>	1
Modes	Acceleration		1117.5	
Arcade axis	Deceleration	0.0	m/s <sup>2</sup>	J
	Set speed			
	Cruise	18.0	m/s	)
Add -	Waypoint reach	0.0	m/s	)

### Landing phase panel

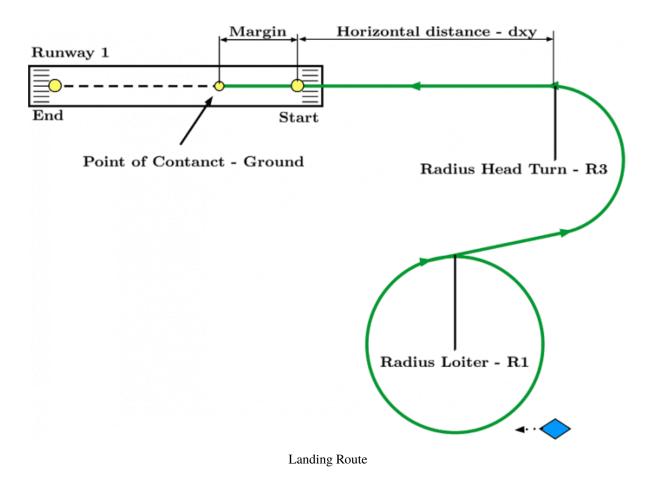
The guidance to be configured is Landing:

- Line Attraction: value related to how strongly the aircraft tries to reach a path, kept at 20.
- Set Speed–Cruise: 18 [m/s]

Finally, the following parameters define the path during this phase.

- Runway: here is selected the runway which previously has been edited in its configuration menu.
- Flight Path Angle: angle at which the aircraft will descend, -0.14 [rad].
- Horizontal Distance: is the distance from the point where the aircraft enters in the phase which contains the climbing guidance, to the start of the circular climbing path, 300 [m].
- Radius Head Turn R3: radius of the turn made to head the airplane towards the runway direction, 150 [m].
- **Radius loiter R1:** radius of the loiter descending made by the aircraft to reach an altitude suitable to perform the landing manoeuvre, 120 [m].

The route of this phase is shown in the following figure, where each one of the parameters that define it are defined.



### 12.2.1.2.2.9 Flare

Flare phase allows defining a point or a zone near the runway where the aircraft will perform a pitch angle change (nose-up) in order to modify its attitude before the touchdown and avoid a possible crash due to a nose-ground direct contact.

🔣 🕑 Mentor 🛪 🙆 🧿	🏣 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Take Off Climbing Waypoints	Hold Name Flare
Hold Landing	
Flare Standby Runway Envelope	Roll       None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)       Constant value: 0.0 rad     0.0     Constant value: 0.0 rad
Smooth Modes	Pitch
Arcade axis	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)     Constant value: 0.0 rad     0.0     Constant value: 0.0 rad
Add 👻	

## Flare phase panel

• Roll – Pitch Angle: kept at a constant value 0 [rad].

Regarding the thrust in this phase, the engines are shut off, so the mode of the controller is off.

### 12.2.1.2.3 L200 Catapult



### L200 Catapult

From the Embention website it is possible to download User Manual and the Datasheet of the L200 Catapult.

## 12.2.1.2.3.1 Configuration

In order to configure correctly the launch system, it is necessary to perform two different actions:

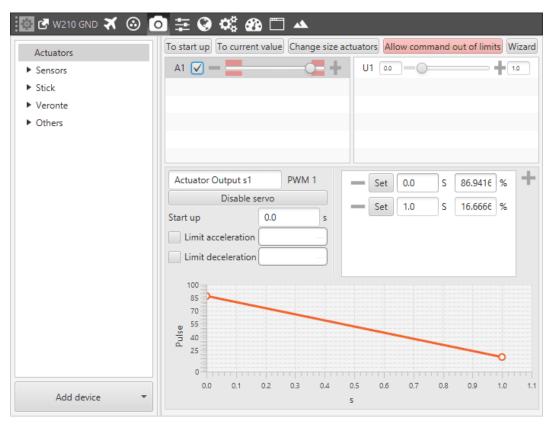
- Trimming of the launch actuator.
- Create the automation for the launch button.

To set them, it is necessary to connect the catapult to Veronte Ground using the catapult wire and completing the system with a PC connection with Veronte Pipe.

## 12.2.1.2.3.2 Actuator Trimming

To trim the actuator it is necessary to create the catapult actuator by following the path Devices>Control>Actuators.

1. Click on **Change size actuators** and select the actuator number (1) from the window.



Catapult actuator trimming

2. Once created an actuator, it is possible to trim it. Default values are shown in the previous figure, but user must be sure the servo can move covering all useful range, from bottom to top (0-1).

### 12.2.1.2.3.3 Launch Automation

The automation must be created in the Ground autopilot. The typical Event of the automation is a Button which will appear in the Ground Veronte Panel.

🔯 🛃 W210 GND 🛪 🙆	o 🗄 🛛 🐝 d	8 🗂 🔺		
✓ Launch System	Launch System			
	Events	AND OR NOT	Actions	+
	Launch	h Button		LAUNCH
			Delay 0.0	Periodical: Off
	Button	Laund     Time Contr	ch Button	Confimation
	icon 🕸			Commuton
	Visual range	Rvar Disabled		
				+
	<			>
New Automation	This button will be d	isplayed on Veronte Pane	ł	

#### Automation Event

The Action is the change from 0 to 1 of the actuator value. A second value of the actuator should be set in order to restore the initial null value (in this case, after 2 seconds).

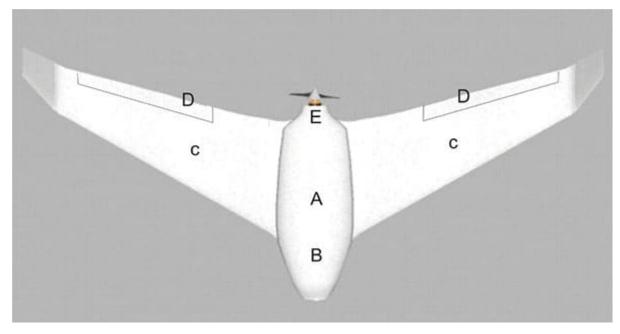
🔯 🛃 W210 GND 🛪 🙆	o 🇄 🛛 📽 🕰	) 🗂 🔺		
✓ Launch System	Launch System			
	Events	AND OR NOT	Actions	+
	Launch I	Button		LAUNCH
			Delay 0.0	Periodical: Off
	Output	- LAUN	ICH	
	Actuator Output s1	-		
		Time 0.2 Va	lue 1.0	+
	Interpolate		lue 0.0	-
New Automation				
New Automation				

Automation Action



W210

This airplane has a "flying wing" structure and can be piloted by using only two symmetrical control surfaces. They can be moved to control the aircraft attitude in a symmetrical way to perform a pitch variation and in an unsymmetrical way to control the roll.



W210 parts in XPlane model

• Power battery

- Control electronics
- Detachable wings
- Control surfaces (ailerons)
- Power motor and propeller

## 12.2.1.3 Quadcopter-M400

### 12.2.1.3.1 Servo Configuration

The M400 configuration process can be performed by using a VerontePipe software version connected with the hardware system and the Autopilot as explained in the section *Hardware Installation* of the manual.

## 12.2.1.3.1.1 Servos Output

The first step of the process is the servos configuration.

In this case, the controls of the airplane are the four electric motors. Motors can be controlled by changing their thrust, so each one of them corresponds to a pin of the connector and they must be positioned in the same order in an S vector who represents the **Actuator Output**. It is possible to connect any pin to any command but the easiest way to perform it and avoid confusion is by following the pins number.

🔯 🛃 м400 🛪 🙆	0 🗄 🛛 🗱 🚱 🗔 🔺	CfgM	lgr StepMgr			
			PWM 1			
			🗸 Active Hig	ıh		
(			Mode	time	*	
	Frequency 50.0 Hz	Ś	Min	9.0E-4	s	
			Max	0.0021	s	
► Arbiter			Servo	Motor 1	-	
► CAN			DUCAD			
► FTS		_	PWM 2			
► GPIO						
► 12C			🗸 Active Hig	In		
► Others			Mode		-	
▼ PWM			Min	9.0E-4	s	
2			Max	0.0021		
3			11100			
4			Servo		-	
Serial						
▶ USB						
Add 👻						

#### Output-pin connections

In this case, it is possible to use 4 pins:

- Output 1 Actuator Output s1 (Motor 1)
- Output 2 Actuator Output s2 (Motor 2)
- Output 3 Actuator Output s3 (Motor 3)
- Output 4 Actuator Output s4 (Motor 4)

🐼 🛃 м400 🛪 🙆	◙ ∄ 🖗 🗱 🖓 🗖 🔺	CfgM	gr StepMgr		
			PWM 1		
			✓ Active High	1	
			Mode	time 💌	
	Frequency 50.0 Hz	6	Min	9.0E-4 s	
			Max	0.0021 s	
► Arbiter			Servo	Motor 1 👻	
► CAN				Motor 1	
► FTS			PWM 2	Motor 2	
► GPIO			Antin 16-1	Motor 3	
► I2C			🗸 Active Higi	Motor 4	
<ul> <li>Others</li> </ul>			Mode	None	
▼ PWM			Min	9.0E-4 s	
1					
2			Max	0.0021 s	
3			Servo	Motor 2 👻	
4			50170		
<ul> <li>Serial</li> </ul>					
► USB					
Add 👻					

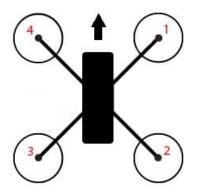
Output 1 – pin 1 configuration

## 12.2.1.3.1.2 SU Matrix

At this point, the **S** vector is defined and the **SU** matrix can be edited. By clicking on **Edit** it is possible to configure the relation between the controller outputs (**U** vector) and the servo movements (**S** vector).

le name	M400		AES		Тур	с
<b>US</b> Set i	inv(SU) Edit					
SU Set i	inv(US) Edit					
_						
Edit						×
		-	-	-	-	
		Control Output u1 -	Control Output u2 -	Control Output u3 -	Control Output u4 -	
		Pitching	Thrusting	Rolling	Yawing	
-	Motor 1			Rolling -0.35355338		
•	Motor 1 Motor 2	Pitching	Thrusting		Yawing	•
		Pitching -0.35355338	Thrusting 1.0	-0.35355338	Yawing 0.25	•
•	Motor 2	Pitching -0.35355338 0.35355338	Thrusting 1.0 1.0	-0.35355338 -0.35355338	Yawing 0.25 -0.25	•
•	Motor 2 Motor 3	Pitching -0.35355338 0.35355338 0.35355338	Thrusting 1.0 1.0 1.0 1.0	-0.35355338 -0.35355338 0.35355338	Yawing 0.25 -0.25 0.25	+

Output 1 – SU matrix edit



SU matrix and motors numbers

The M400 is configured as follow:

1. **Pitch Angle Control:** Control Output 1 is configured to perform a positive pitch angle change when motors 1-4 decrease their RPMs and motors 2-3 increase RPM value.

- 2. Thrust Control: the Control Output 2 is the one that allows a thrusting change (0-1).
- 3. **Roll Angle Control:** Control Output 3 is configured to perform a positive roll angle change when motors 1-2 decrease their RPMs and motors 3-4 increase RPM value.
- 4. Yaw Angle Control: Control Output 4 is configured to perform a positive yaw angle change when motors 2-4 decrease their RPMs and motors 1-3 increase RPM value, in this case with different proportions.

**Warning:** This panel shows the reference system of the aircraft too. It must be positioned in the same way of the Autopilot's one. If it results different, it can be edited by clicking on the corresponding axis in order to reverse its direction.

## 12.2.1.3.1.3 System Trim

As a final step, the system has to be trimmed. In this case, each motor will have a minimum and maximum value as shown in the picture.

🔣 🛃 M400 🛪 💿 🧧	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
► Micro	A1 🔽 - O
<ul> <li>Sensors</li> </ul>	A2 🗸 — 🔶 — 🕂 U2 00 — 🔶 — 🕂 1.0
Stick	A3 🗸 — 🕒 — 🕂 U3 -141- — — — 🕂 1.414
► Veronte	A4 V
<ul> <li>Others</li> </ul>	
	Motor 1 PWM 1 Set 0.0 S 0.0 % +
	Disable servo Set 1.0 S 100.0 %
	Start up 0.0 s
	Limit acceleration
	Limit deceleration
	100
	85 70
	9 55 40 25
	0.0.0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1
Add device 👻	S

M400 trim

- Minimum: 0.
- Maximum: 1.

## 12.2.1.3.2 Mission Phases

In this section, it will be explained the M400 typical mission profile and the mission phases will be detailed.

## 12.2.1.3.2.1 Standby

Standby phase is a preliminary phase of the operation. The guidance is simply a **Hold** with no change. Normally, the automation which allows the system to pass to Standby phase requires the GPS signal.

M400 🛪 🛞 🙆 🚍	🚱 🗱 🙆 🗂 🔺 (	⊘ Ⅲ		
▼ Phases	Guidance Arcade TC Panne	Automations		
0 Standby	Hold	<b>^</b>	Name	Standby
1 Hold		+		
2 VHold		×		
3 Hover		*		
4 Cruise				
5 Landing	+			
6 Takeoff				
Runway				
► Envelope				
Modes				
Arcade axis				
4x Config				
Add 👻				

Standby phase panel

## 12.2.1.3.2.2 Takeoff

Take-off phase is composed of two Guidances: VTol and Yaw. The first one is a vertical guidance and where following parameters are set:

- Arcade position/speed transition (horizontal and vertical): 1.0 [m/s]
- Set Speed: 1.0 [m/s].
  - Wypoint Reach: 0.1 [m/s]
  - Type: Ground Speed
  - Deceleration: 0.5 [m/s]

- Type: Straight
  - Extend: none
  - Safe Distance: -20.0 [m] and Relative (Positive down). With this value the platform will ascend.

м400 🛪 🙆 🙆 🗄	🚱 🗱 🙆 🗂 🔺 (	⊘ ▦	
▼ Phases	Guidance Arcade TC Panne	d Automations	
0 Standby	VTol	↑ Name Tak	keoff
1 Hold	Yaw	+	
2 VHold		×	
3 Hover		4	
4 Cruise			^
5 Landing			n
6 Takeoff	Section	0	
Runway			
Envelope	Set height mode	3D 👻	
Modes	Arcade position/speed trar	nsition	
Arcade axis	Horizontal		
4x Config			
	Vertical	1.0 m/s	
	Set speed		0
	Cruise	1.0 m/s	
	✓ Waypoint reach	0.1 m/s	
	Туре	Ground Speed 👻	
Add 👻	Deceleration	0.5 m/s <sup>2</sup>	~

VTol panel

Yaw guidance allows choosing the M400 orientation during takeoff:

- Mode: set to Current.
- Limit rate: limited rotation speed of 0.6 [rad/s].

M400 🛪 🛞 🧿 \Xi	🔮 🗱 🖽 🗀	▲ ⊘ 🏼		
▼ Phases	Guidance Arcade T	C Pannel Automati	ons	
0 Standby	VTol	1	Name	Takeoff
1 Hold	Yaw	+		
2 VHold		×		
3 Hover		*		
4 Cruise				<u>^</u>
5 Landing	Mode	current	*	
6 Takeoff	✓ Limit rate	0.6	rad/s	
Runway				
Envelope	Yaw	0.0	rad [-π,π]	
Modes				
Arcade axis	Relative App	roach Initial 💌	<b>e</b> [9]	
4x Config		mal Degrees 🔻	UAV POS MAP POS	
	Latitude 0.0			
	Longitude 0.0			
	WGS84 0.0		m	
	- MSL 0.0		m	
Add 👻	AGL 0.0		m	U ~

Yaw panel

## 12.2.1.3.2.3 Hover

Hover phase is configured to allow the multicopter maintain the position in the air. There are several ways to configure it: one of them is based on guidance specifications, while the other is related to automations.

The first way to configure the hover phase is by setting the guidances in order to maintain the position. The required guidances are **VTol** and **Yaw**.

🔯 M400 🛪 🛞 🙆 🚍	📀 🗘 🖓	) 🛅 🔺	⊘Ш				
▼ Phases	Guidance Arc	ade TC Panne	el Automati	ons			
0 Standby 1 Hold 2 VHold	VTol Yaw		<b>^</b>		Name	Hover	
3 Hover			×				
4 Cruise 5 Landing 6 Takeoff	Way Type	ypoint reach	5.0 Ground S	m/s 🕄			^
Runway <ul> <li>Envelope</li> <li>Modes</li> </ul>	Deceler		5.0	m/s	2		
Arcade axis 4x Config	Guidance o	Type	Schedu	ling variable		1	
	Horizontal Vertical	PID	•	Zero Zero			
	Туре		Straight		•		
	Extend		None 0.0	m	• •	Relative 🔻	
Add 👻	Touch					- %	~

Hover phase panel

The VTol is configured as the one in Take Off phase, but in this case Safe distance is set at 0 [m] and Relative.

The **Yaw** guidance is the same of the Take Off phase.

The second option has the same effect, but is configured differently. There are also 2 guidances, but instead of **VTol** it is possible to use **Cruise**. The cruise guidance parameters are not relevant, as the automation will be the responsible of performing the hover. The **Yaw** guidance can be the same as the Takeoff one. Once the phase is configured, it is necessary to add an automation. This automation will have a phase event that will be activated when the UAV is in hover phase. The action will be a Track type action, so that the UAV tracks the current position performing a hover over it.

🔯 M400 🛪 🛞 🧿 葦	😵 端 🍄 🗂	▲ ⊘ 🎟		
✓ 27 - REA Button	Hover HERE ( HVR ph	ase)		
✓ 20 - RTH Button	Events	AND OR NOT	Actions	+
▼ Stick				
11 - Auto Mode	41 - Ph	ase HVR	20 - Hove	r HERE
12 - Manual Mode				
18 - Ready Comma				
13 - Hold Phase (Ar				
15 - Arcade Trim				
▼ Transitions				
✓ 22 - RTH to Home				
🖌 2 - TKO to CRU				
✓ 23 - RTH to LAND			Delay 0.0 s	Periodical: Off
✓ 17 - SBY when land				
V 19 - REA to HLD (Al	🖉 📳 Track	<ul> <li>Hover HERE</li> </ul>		
✓ 25 - Hover HERE ( F				
▼ Failsafe	Position	•		
24 - SBY to AUTO				
10 - Auto when No	Location 🗸	Current	0.000000	Direct
8 - LinkOff to RTH		Lon:	0.000000	
16 - LinkOff to SBY	Coiter	Auto 👻		
14 - Low Battery				
9 - HLD when No G	Hover			
	Distance		01 - %	
New Automation 👻				

#### Hover automation

## 12.2.1.3.2.4 Cruise

In this phase, the Guidances are Cruise and Yaw.

The main parameters to set are the Cruise Speeds (Cruise and Waypoint reach) and Acceleration limits.

- Arcade position/speed transition (horizontal and vertical): 1.0 [m/s]
- Set Speed: 6.0 [m/s].
  - Wypoint Reach: 1.0 [m/s]
  - Type: Ground Speed
  - Deceleration: 0.5 [m/s]

🔯 M400 🛪 🛞 🙆 🗄	🚱 🗱 🕰 🗂 🔺	⊘ Ⅲ		
▼ Phases	Guidance Arcade TC Panne	el Automations		
0 Standby 1 Hold 2 VHold 3 Hover 4 Cruise	Cruise Yaw	↑ + ×	Name	Cruise
5 Landing 6 Takeoff Runway	Section	2	2	Â
► Envelope	Set height mode	3D 👻		
Modes	Arcade position/speed tran	sition		
Arcade axis 4x Config	Horizontal	1.0 m/s		
in coming	Vertical	1.0 m/s		
	Set speed			
	Cruise	6.0 m/s		U
	✓ Waypoint reach	1.0 m/s		
	Туре	Ground Speed 🔹	]	
Add 👻	Deceleration	0.5 m/s <sup>2</sup>	)	~

# Cruise panel

Yaw Guidance is set in order to make the multicopter controlling yaw angle following the heading angle.

M400 🛪 🛞 🙆 \Xi	😧 🗘 🔂	□ ▲ ⊘ 🏭
▼ Phases	Guidance Arcad	de TC Pannel Automations
0 Standby	Cruise	↑ Name Cruise
1 Hold	Yaw	+
2 VHold		×
3 Hover		*
4 Cruise		· · · · · · · · · · · · · · · · · · ·
5 Landing	Mode	heading -
6 Takeoff	✓ Limit rate	0.6 rad/s
Runway	Yaw	0.0 rad [-π,π]
Envelope	Taw	
Modes		
Arcade axis	Relative	Approach Initial
4x Config	Absolute	Decimal Degrees UAV POS MAP POS
	Latitude 0	0.0
	Longitude 0	0.0
	WGS84 0.	0.0 m
	- MSL 0.	0.0 m
Add 👻	AGL 0.	0.0 m

# Yaw Guidance panel

# 12.2.1.3.2.5 Landing

This phase has the same settings of the Take-off with some changes.

м400 🛪 🛞 💿 듣	🚱 📽 🕰 🗂 🔺 🤅	⊘ Ⅲ	
▼ Phases	Guidance Arcade TC Pannel	Automations	
0 Standby 1 Hold 2 VHold 3 Hover 4 Cruise	VTol Yaw	Nam	Landing
5 Landing 6 Takeoff Runway	Section	0	ŋ
<ul> <li>Envelope</li> <li>Modes</li> <li>Arcade axis</li> </ul>	Set height mode Arcade position/speed tran	3D	
4x Config	Horizontal Vertical	1.0         m/s           1.0         m/s	
	Set speed		
	Cruise	1.0 m/s	
	✓ Waypoint reach Type	0.2 m/s	
Add 👻	Deceleration	0.5 m/s <sup>2</sup>	~

## Landing phase panel

- Arcade position/speed transition (horizontal and vertical): 1.0 [m/s]
- Set Speed: 1.0 [m/s].
  - Wypoint Reach: 0.2 [m/s]
  - Type: Ground Speed
  - Deceleration: 0.5 [m/s]
- Type: Straight
  - Extend: none
  - Safe Distance: 100.0 [m] and Relative (Positive Down). In this case, we are supposing that at the instant when the Landing phase starts, the multicopter is flying at AGL<100m. It is possible select Extend Down and the aircraft will descend till user desire.

Yaw Guidance is configured in order to let the quadcopter with the Current yaw angle and limiting the yaw rate at 0.6 [rad/s].

м400 🛪 🛞 🧿 \Xi	😧 🗱 🕰 🗆	∃ ▲ ⊘ 🏭	
▼ Phases	Guidance Arcade	TC Pannel Automations	
0 Standby	VTol	A Name La	anding
1 Hold	Yaw	+	
2 VHold		×	
3 Hover		*	
4 Cruise		•	^
5 Landing	Mode	current 👻	
6 Takeoff	✓ Limit rate	0.6 rad/s	
Runway	Yaw		
Envelope	Yaw	0.0 rad [-π,π]	
Modes			
Arcade axis	Relative Ap	oproach Initial	
4x Config	Absolute	cimal Degrees • UAV POS MAP POS	
	Latitude 0.0		
	Longitude 0.0		
	WGS84 0.0	m	
	- MSL 0.0	m	
Add 👻	AGL 0.0	m	~

Yaw Guidance panel

## 12.2.1.3.2.6 VHOLD

VHold phase is used to perform a Stick controlled flight. The phase guidance is composed of Hold and Yaw guidances.

Hold guidance is used to keep the following values at a specific value:

- Desired Down GV: at 0.0 [m/s].
- Desired Lateral GV: at 0.0 [m/s].
- Desired Front GV: at 0.0 [m/s].

In this way, if the stick control is not active, the multicopter will keep its position in the air without the need of phase changing.

Yaw Guidance is set on Current. In this phase, the Arcade allows controlling the platform depending on the set gains.

🔯 🗗 м400 🛪 🙆 🧿	\Xi 🚱 🗱 🚰 📥 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Hold Name VHold
VHold	Yaw
Hover	×
Takeoff	J J
Landing	
Cruise	Desired Down GV (Ground Velocity)
Hold	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Runway	Constant value: 0.0 m/s 0.0 Constant value: 0.0 m/s
Envelope	
Smooth	Desired Lateral GV (Ground Velocity)
Modes Arcade axis	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Arcade axis	Constant value: 0.0 m/s 0.0 Constant value: 0.0 m/s
	Desired Front GV (Ground Velocity)
	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
	Constant value: 0.0 m/s 0.0 Constant value: 0.0 m/s
Add 👻	

Manual phase panel

## 12.2.1.3.2.7 Return to Home

This operation is used to make a multicopter return to a point, considering it as Home. In order to perform this, is necessary to create two automations and a new phase, all process is explained below.

1. First create an Automation to save the current position, this has to be the one where the aircraft take-off (Home). This action can be added when creating the Take Off Button. See section *Veronte Panel Buttons* for more information about creating a button.

🔯 🗗 M400 🛪 💿 💿	፰ 😡 📽 🚳 🗔 🔺			
▼ Buttons	TKO Button			
SBY Button VHLD Button	Events AND OR NOT Actio	-		1 Alton
HVR Button	TKO Button	тко	and and a start of the	A BAR
LND Button     CRU Button	TKO Phases	Save Home Point	and the second s	
✓ TKO Button				
✓ HLD Button ✓ RTH Button				
▼ Stick			and the latter water	
SBY to AUTO			and the second sec	Contraction of the second
✓ Auto Mode	Delay	0.0 Periodical: Off	and the second se	A STREET
Manual Mode (Arcad			Care of the second s	and the second second
✓ Hold Phase (Arcade) LinkOff to LND	Save Home Po	int	The second se	
HLD when No GPS	Value N: 0.000000 m, E: 0.000000	m. D: 0.000000 m	Absolute 💿 Relative UAV	-
✓ Auto when No Stick		East	0.0 m	.9. 191
Low Battery Arcade Trim	Save value in Inflight Reference P	Point 01 Nort	h 0.0 m	
Arcade Trim	Type Fixed +	WGS		m
< >	UNDEFINED		- MSL	
		L	AGL	
New Automation				

Automation – TKO Button

It is only necessary to add the action Feature and configure it as shown below:

- Value: select Relative and UAV. The parameters of position have to be set to 0, it means that the value to save is the UAV position.
- Save Value in: select Inflight Reference Point.
- Type: fixed.
- 2. The following step consists in creating a new phase. This phase can be named as **Return to Home** and it is necessary to include two guidances **VTol** and **Yaw**. VTol guidance has to be configured as follow:

🔯 🛃 м400 🛪 🙆 🧿	🗄 🛛 端 🕰 🗖 🔺	۵
▼ Phases	Guidance Loop Arcade 1	TC Pannel Automations
Standby	VTol	Name Return to Home
VHold	Yaw	+
Hover		×
Takeoff		•
Landing		
Cruise	Set speed	
Hold	Cruise	1.0 m/s
Return to Home	<b>— — — —</b>	
Runway	Waypoint reach	0.0 m/s
Envelope	Туре	Speed 👻
Smooth	Hover gain	
Modes	-	
Arcade axis	Horizontal	0.2
	Vertical	0.5
	Туре	Hangman 👻
	Extend	None
	Safe	30.0 m AGL -
Add 👻	Touch	✓ Ref Inflight Reference Point 01

Phase – Return to Home

See section *VTOL Guidance* for more information about configuring this guidance. It is worth noting the following parameters:

- Type: Hangman is selected.
- Extend: None
- **Safe:** 30 [m] and AGL, this means that the aircrat will perfom the Hangman path reaching an altitude of 30 [m] AGL.
- **Touch:** here is defined the point where the platform will touch ground. This has been defined in the first step (Inflight Reference Point) and now it is possible to select it.

Yaw guidance can be set to current and user may want to limit the rate.

3. The last step consits in the creation of a Button on the Veronte panel. Go to Automation Panel and create the following Events and Actions.

Two events have to created: Phase and Button.

🔯 🛃 M400 🛪 🙆 🧿	莘 🚱 📽 🕮 🖴			
Buttons     SBY Button (EIN)	RTH Button			
SBY Button	Events AND OR NOT Actions	+		
✓ HVR Button	RTH Phases RTH	RTH AUTO		
LND Button	AND AUTO			
CRU Button				
✓ HLD Button				
✓ RTH Button				
▼ Stick				
SBY to AUTO				
Manual Mode (Arc	Delay 0.0	Periodical: Off		
Hold Phase (Arcade)	Phase   RTH Phases	Time 0.0		
HLD when No GPS	- Hover			
Auto when No Stick	Cruise			
Arcade Trim	Hold			
	Takeoff			
	- Landing			
New Automation				

#### Automation

The actions configured are:

- **Phase:** here is selected the phase that the platform will enter in i.e, Return To Home.
- Mode: AUTO is selected.

Finally, user only have to click on the Button which appear on Veronte Panel to perform a Return Home.



### M400

This M400 multirotor has a quadcopter structure. Its control is performed by using a differential thrust for each motor depending on the desired attitude change:

- ALTITUDE
- PITCH ANGLE
- ROLL ANGLE
- YAW ANGLE

## 12.2.1.4 Helicopter T-Rex600

### 12.2.1.4.1 Servo Configuration

The T-Rex integration process can be performed by using Veronte Pipe connected with the hardware system and the Autopilot as explained in section *Aircraft Mounting* of the manual.

### 12.2.1.4.1.1 Servos Output

The first step of the process is the servos configuration. In this section will be explained how to set the servo-output matrix.

In this case, the controls of the helicopter are the cyclic, collective, RPM (main rotor) and blades pitch angle changing (tail rotor). To control the main rotor moving it is necessary to configure correctly the three servos that allow controlling the blades pitch angle and the one which changes the main rotor RPMs. In order to have the tail rotor control and to be able to change the blades pitch, another servo must be configured.

All the servos correspond to a pin of the connector and they must be positioned in the S vector who represents the **Actuator Outputs**. It is possible to connect any pin to any command but the easiest way to perform it and avoid confusion is by following the pins number.

💽 🗗 T-REX 🛪 🙆	🙆 葦 🚱 🗱 🚱 🖾 🔺 ः	fgN	lgr StepMgr		
	Г	-	PWM 1		
			✓ Active High		
			Mode	time 🔹	
	Frequency 50.0 Hz	<b>,</b>	Min	9.0E-4 s	
			Max	0.0021 s	
► ADC			Servo	NW 👻	
► Arbiter				NW	
► CAN		-	PWM 2	South	
► FTS			✓ Active High	NE	
GPIO     I2C				Rudder	
<ul> <li>Others</li> </ul>			Mode	Throttle	
▼ PWM			Min	None	
1			Max	0.0021 s	
2					
3			Servo	South 👻	
4					
Add 👻					

**T-Rex Outputs** 

In this case, it is necessary to use 5 pins:

- Output 1 NW main rotor cyclic/collective
- Output 2 South main rotor cyclic/collective
- **Output 3** NE main rotor cyclic/collective
- Output 4 Main rotor RPMs
- **Output 5** Tail rotor blades angle changing

## 12.2.1.4.1.2 SU Matrix

At this point, the **S** vector is defined and the **SU** matrix can be edited. By clicking on **Edit** it is possible to configure the relation between the controller outputs (**U** vector) and the servo movements (**S** vector).

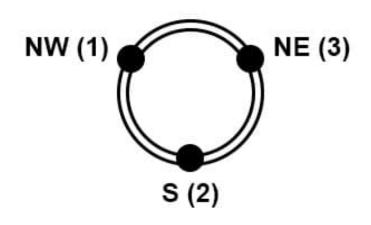
💽 🛃 T-REX 🛪	0 🖸 🛱 🔇	) 🗱 🚯 🗂 -	🔺 CfgMgr StepMgr	
Vehicle name	T-REX	AES	0	Type C 👻
US Set inv	/(SU) Edit			
SU Set inv	/(US) Edit			

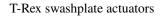
SU matrix edit

**Warning:** This panel shows the reference system of the aircraft too. It must be positioned in the same way of the Autopilot's one. If it results different, it can be edited by clicking on the corresponding axis in order to reverse its direction.

0.0	-0.28867513	0.0	-0.33333334	1
4 0.0	0.0	0.0	-0.33333334	
0.0	0.28867513	0.0	-0.33333334	]
0.0	0.0	1.0	0.0	)
1.0	0.0	0.0	0.0	1

SU matrix





The previous image shows the swashplate of the T-Rex with the 3 actuators able to modify its rotation plane (X axis is positive up). As showed in the SU matrix image, controls are performed as follow:

- 1. **Pitch Angle Control:** Control Output 1 is configured to perform a positive pitch angle change when servos 1-3 move following Z axis positive and servo 2 moves in the opposite direction with double magnitude.
- 2. **RPM Control (Main rotor):** the Control Output 2 (servo number 5) is the one that allows an RPM change with the throttle moving (0-1).
- 3. **Roll Angle Control:** Control Output 3 is configured to perform a positive roll angle change when servos 1-3 move with an opposite direction (servo 2 is in the longitudinal plane of the aircraft, so it has not any influence).
- 4. Yaw Angle Control: Control Output 4 is configured to perform a positive yaw angle change when tail rotor decreases the blades pitch angle.

5. **Collective Control:** The altitude control is performed using the Control Output 5. A positive change of the pitch angle blade is performed when servos 1-2-3 move contemporaneously in the same direction.

## 12.2.1.4.1.3 System Trim

As a final step, the system has to be trimmed. This can be performed by moving servos in three different positions: zero position, minimum and maximum (blade angles are usually limited physically). These positions must be inserted and saved in the software by clicking on Set when the actuator is in the desired position or introducing them manually.

🖸 🗗 T-REX 🛪 💿 🙆	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
Micro	
Sensors	
▶ Stick	A3 — — — + U3 -1.05 — + 1.299
▶ Veronte	A4 U4 -0.511 (0.519)
► Others	A5 U5 -1.75 0.610
	NW         PWM 1         Set         -0.349         S         97.0         %           Disable servo         Set         0.0         S         48.0         %
	Start up     0.0     s       Limit acceleration
Add device 👻	-0.40 -0.35 -0.30 -0.25 -0.20 -0.15 -0.10 -0.05 -0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.44 S

Actuator 1 trimming

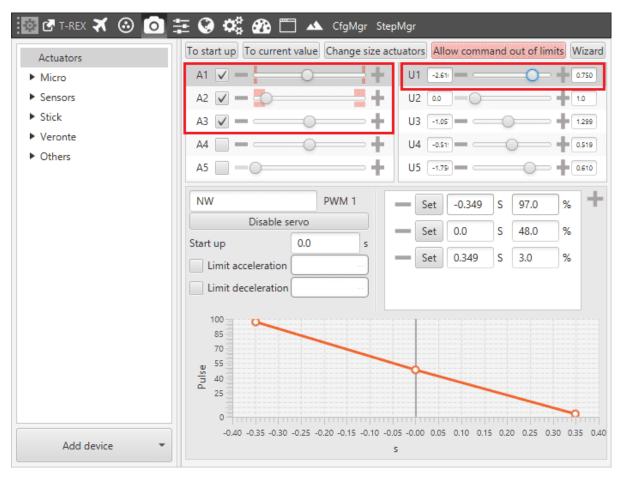
This procedure can be performed in the same way by using a **Wizard**. This tool allows moving actuators limits easily and finding the correct range.

Actuator Output s1	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s2	-0	-		122	40				0	90	
Actuator Output s3	0	10	20	30	40	50	60	70	80	90	© 100

## Trim wizard tool

In order to perform a final checking, it is possible to select the desired channel and testing pitching, rolling, yawing and thrusting controls.

The image below shows a pitching output testing. By moving the U1 control (Pitching – Cyclic), main rotor servos change the position according to the reference system: positive corresponds to nose down and negative to nose up.



Pitching test

## 12.2.1.4.2 Mission Phases

In this section, it will be explained the T-Rex typical mission profile and the mission phases will be detailed.

## 12.2.1.4.2.1 Stanby

Standby phase is a preliminary phase of the operation. During this phase is possible to check, for example, if the aircraft is correctly controlling the attitude by moving it and watching the servos positions changing.

📴 🗗 T-REX 🛪 🛞 🧿	\Xi 🚱 🗱 🚰 🗔 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Hold Name Standby
Warm up	+
Ready	×
Takeoff	<b>v</b>
Landing	
Hover	Desired Pitch
Cruise	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Hold	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
VHold	
No name	Desired Roll
Return to Home	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Engine OFF	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
Land at Base	
Autorotation	Desired Yaw
Collective UP	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Hover Yaw Heading	Constant value: 0.0 rad 0.0 Yaw
Liftoff	
Runway	Desired Down GV (Ground Velocity)
	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Add 👻	Constant value: 0.0 m/s 0.0 Constant value: 0.0 m/s

Standby phase panel

The guidance is a **Hold** of four variables:

- Pitch and Roll angles: at 0 [rad].
- Ground Speed: at 0 [m/s].
- Yaw angle: set at the current.

## 12.2.1.4.2.2 Engine Off

Engine OFF is the phase which allows the platform decreasing main rotor RPMs without attitude changes. In fact, the decreasing phase is not instantaneous and the autopilot needs to keep the control until the RPMs would not be able to make attitude changes. Following this fact, this phase has a **thrusting control** set at zero and VTol and **Yaw** Guidances.

🔯 🗗 T-REX 🛪 🙆 🧔	🕽 🚋 🔇 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	
Warm up	Pitching - Cyclic Name RPMs
Ready	RPMs
Takeoff	Rolling - Cyclic Mode Off 👻
Landing	Vania
Hover	Value 0.0
Cruise	
Hold	
VHold	
No name	
Return to Home	
Engine OFF	
Land at Base	
Autorotation	
Collective UP	
Hover Yaw Heading	
Liftoff	
Runway	
Add	

Thrusting fixed control

🔯 🛃 T-REX 🛪 🙆 🧿	i 🗄 🚱 📽 🙆 🗖 -	🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade	TC Pannel		
Standby	VTol	1	Name Engine OFF	
Warm up	Yaw	+		
Ready		×		
Takeoff		4		
Landing				
Hover	Set speed			^
Cruise	Cruise	0.0	m/s	
Hold				
VHold	Waypoint reach	0.0	m/s	
No name	Туре	Speed	-	
Return to Home				
Engine OFF	Hover gain			n
Land at Base	Horizontal	0.2		
Autorotation	Vertical	2.4		
Collective UP				
Hover Yaw Heading	Туре	Straight	•	
Liftoff	Extend	None	-	
Runway	Safe	0.0	m Relative -	
Add 👻	Touch	Ref Runway Touch Po		~

VTol Guidance settings

🔯 🕑 T-REX 🛪 🙆 🧿	🗄 🐼 🗱 🚯	🛅 🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Ar	cade TC Pannel	
Standby	VTol	1	Name Engine OFF
Warm up	Yaw	+	
Ready		×	
Takeoff		*	
Landing			
Hover	Mode	current 👻	
Cruise	✓ Limit rate	0.6 rad/s	
Hold			
VHold	Yaw	0.0 rad [-π,π]	
No name			
Return to Home	Absolute     Re	elative Approach Initial Point	*
Engine OFF			
Land at Base	Latitude 0.0	rad [-π,π]	521
Autorotation	Longitude 0.0	rad [-π,π]	
Collective UP	WGS84 0.0		m
Hover Yaw Heading			
Liftoff	- MSL 0.0		
Runway	AGL 0.0		m
Add 👻			

## Yaw Guidance settings

## 12.2.1.4.2.3 Ignite

The Guidance of this phase is a **Hold**, which allows to mantain:

• **Desired Roll and Pitch angles:** at 0 [rad].

During this phase RPM of the engine will increase until 35 % of thrust.

🔣 🗗 T-REX 🛪 🙆 🧿	) 🗮 🔇 🗱 🌇 🗂 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Hold Name Ignite
Warm up	+
Ready	×
Takeoff	
Landing	
Hover	Desired Pitch
Cruise	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Hold	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad
VHold	Constant value: 0.0 Tab
Ignite	Desired Roll
Return to Home	
Engine OFF	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Land at Base	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad
Autorotation	
Collective UP	
Hover Yaw Heading	
Liftoff	
Runway	
Add 👻	

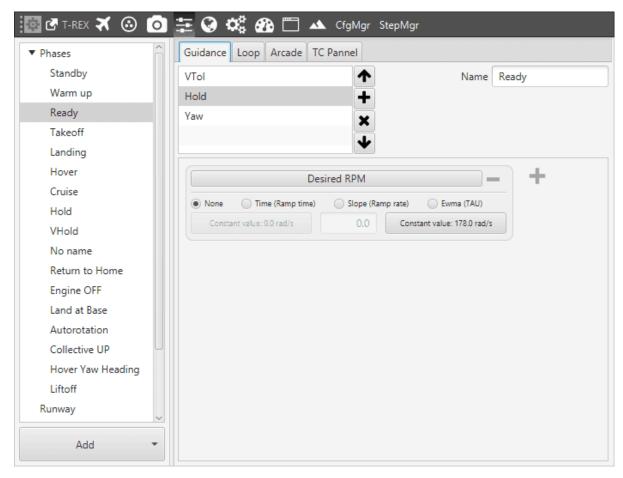
Hold Guidance configuration

🔯 🗗 T-REX 🛪 🙆 🧿	) ፰ 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby Warm up	Pitching - Cyclic Name RPMs
Ready Takeoff Landing	Rolling - Cyclic Mode Fixed -
Hover Cruise Hold	Output transition from output value when phase starts to a new fixed value 0.35
VHold Ignite Return to Home	
Engine OFF Land at Base	
Autorotation Collective UP Hover Yaw Heading	
Liftoff	
Add •	

Engine RPM increasing settings

## 12.2.1.4.2.4 Ready

This phase is the one that starts to control RPM value with PID controller to maintain it at the desired value (Desired RPM). The Guidance are a **Hold** of RPMs (this guidance will be present in all flight phases), and the same **VTol** and **Yaw** of the Standby phase.



Desired RPM value

🔝 🕑 T-REX 🛪 🙆 🖸	🕽 🚋 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	
Warm up	Pitching - Cyclic Name RPMs
Ready	RPMs
Takeoff	Rolling - Cyclic Mode On
Landing	V-min-
Hover	PID 1 -
Cruise	
Hold	
VHold	Desired RPM +
No name	
Return to Home	RPM 1
Engine OFF	
Land at Base	
Autorotation	
Collective UP	
Hover Yaw Heading	
Liftoff	
Runway	
Add 🗸	

## RPM control loop

## 12.2.1.4.2.5 Takeoff

Take-off phase is composed by 3 Guidances: **VTol**, **Hold** (RPM) and **Yaw** (Current). The first one is a vertical guidance and following parameters are set:

- Line attraction: 5.0 [m].
- Set Speed Cruise: 1.5 [m/s].
- Horizontal Hover Gain: 0.3.
- Vertical Hover Gain: 2.24.
- Safe Distance: -30 [m] and Relative (Positive down).

🔯 🗗 T-REX 🛪 🙆 🧿	🗄 🛛 端 🌮 🗖 🔺	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade T	TC Pannel	
Standby	VTol	Name Takeoff	
Warm up	Hold	+	
Ready	Yaw	×	
Takeoff		•	
Landing			
Hover	Set speed		^
Cruise	Cruise	1.5 m/s	
Hold			
VHold	✓ Waypoint reach	0.1 m/s	
Ignite	Туре	Speed 👻	
Return to Home	Hover gain		
Engine OFF	Hover gain		n
Land at Base	Horizontal	0.3	
Autorotation	Vertical	2.24	
Collective UP			
Hover Yaw Heading	Туре	Straight 👻	
Liftoff	Extend	None	
Runway	Safe	-30.0 m Relative -	
Add 👻	Touch	✓ Ref Runway Touch Point ▼	U V

VTol panel

## 12.2.1.4.2.6 Hover

Hover phase is configured to allow the helicopter maintain the position in the air. The only difference between this phase and the Take Off phase is the **Safe distance** value which is set at 0 [m] in this case.

🔯 🗗 T-REX 🛪 🛞 🧿	i 🗄 🚱 🗱 🖽 🗖 /	🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade	TC Pannel
Standby	Hold	Name Hover
Warm up	Yaw	+
Ready	VTol	×
Takeoff		•
Landing		•
Hover	Set speed	
Cruise	Cruise	1.5 m/s
Hold		
VHold	Waypoint reach	0.0 m/s
Ignite	Туре	Speed 👻
Return to Home	U	
Engine OFF	Hover gain	
Land at Base	Horizontal	0.3
Autorotation	Vertical	2.24
Collective UP		
Hover Yaw Heading	Туре	Straight 👻
Liftoff	Extend	None 👻
Runway	Safe	0.0 m Relative -
Add 👻	Touch	Ref Runway Touch Point

#### Hover phase panel

## 12.2.1.4.2.7 Cruise

In this phase, the Guidance is Cruise. The parameters to set are the Cruise Speeds (Cruise and Waypoint reach) and Acceleration limits.

- Acceleration limit: 0.1.
- Deceleration limit: 0.1.
- Set Speed Cruise: 2.0 [m/s].
- Waypoint reach: 0.5 [m/s].

🔯 🛃 T-REX 🛪 🙆 🧿	i 🇄 🚱 🗱 🖽 🗔	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade	TC Pannel	
Standby	Cruise	1	Name Cruise
Warm up	Hold	+	
Ready	Yaw	×	
Takeoff		4	
Landing	Set neight mode	ν 2.3U	<u>^</u>
Hover			
Cruise	Set limit acceleration		
Hold	✓ Acceleration	0.1 m/s <sup>2</sup>	
VHold	✓ Deceleration	0.1 m/s <sup>2</sup>	
Ignite	V Deceleration	0.1 11/5	
Return to Home	Set speed		
Engine OFF	oct speed		
Land at Base	Cruise	2.0 m/s	
Autorotation	✓ Waypoint reach	0.5 m/s	
Collective UP			
Hover Yaw Heading	Туре	Speed 👻	
Liftoff	Hover gain		
Runway	Horizontal	0.3	
Add 🗸	Vertical	2.24	~

## Cruise panel

Yaw Guidance is set in order to make the helicopter controlling yaw angle following the heading angle.

🔯 🕑 T-REX 🛪 🙆 🧿	🗄 😧 🔅	i 🚯 i	<u> </u>	🔺 CfgMgr S	itepMgr		
▼ Phases	Guidance Lo	oop Arc	ade T	C Pannel			
Standby	Cruise				Name	Cruise	
Warm up	Hold						
Ready	Yaw						
Takeoff							
Landing				$\checkmark$			
Hover	Mode		headi	ng	-		
Cruise	✓ Limit rate		0.6		rad/s		
Hold			_				
VHold	Yaw		0.0 rad [-π,π]				
Ignite							
Return to Home	Absolute	Re	lative			-	
Engine OFF			idirive.				
Land at Base	Latitude	0.0		rad [-π,π]	1	<b>[91</b> ]	
Autorotation	Longitude	0.0		rad [-π,π]			
Collective UP	WGS84	0.0				m	
Hover Yaw Heading							
Liftoff	- MSL	0.0					
Runway	L AGL	0.0				m	
Add 👻							

Yaw Guidance panel

# 12.2.1.4.2.8 Landing

This phase has the same settings of the Take-off with a positive value of Safe distance (positive down).

💽 🕑 T-REX 🛪 🛞 🧿	I 🏛 🚱 📽 🚳 🗔 /	🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade	TC Pannel
Standby	VTol	Name Landing
Warm up	Hold	+
Ready	Yaw	×
Takeoff		•
Landing		
Hover	Set speed	
Cruise	Cruise	0.6 m/s
Hold		
VHold	Waypoint reach	0.0 m/s
Ignite	Туре	Speed 👻
Return to Home	Hover gain	
Engine OFF	nover gain	
Land at Base	Horizontal	0.3
Autorotation	Vertical	2.24
Collective UP		
Hover Yaw Heading	Туре	Straight 👻
Liftoff	Extend	None 👻
Runway	Safe	-100.0 m Relative -
Add	Touch	✓ Ref Runway Touch Point -

## Landing phase panel

In this phase are set the same parameters of the Take Off phase. The only 2 changes are:

- Set Speed Cruise: 0.6 [m/s].
- **Safe Distance:** -100.0 [m] and Relative (Positive down). In this case, we are supposing that at the instant when the Landing phase starts, the helicopter is flying at AGL < 100 [m].

**Yaw** Guidance is configured in order to let the helicopter with the Current yaw angle and limiting the **yaw rate** at 0.6 [rad/s].

## 12.2.1.4.2.9 Hold

Hold phase is used to perform a Stick controlled flight. The phase guidance is composed of Hold and Yaw guidances. It is a Hold which allows maintaining:

- **Desired pitch:** at 0.0 [rad].
- **Desired roll:** at 0.0 [rad].
- Desired Down Ground Velocity: at 0.0 [m/s].
- Desired RPMs: at 178.0 [rad/s].

🔯 🗗 T-REX 🛪 🙆 🧿	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Hold Name Hold
Warm up	Yaw
Ready	×
Takeoff	
Landing	
Hover	Desired Pitch
Cruise	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Hold	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
VHold	
Ignite	Desired Roll
Return to Home	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Engine OFF	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
Land at Base	
Autorotation	Desired Down GV (Ground Velocity)
Collective UP	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Hover Yaw Heading	Constant value: 0.0 m/s 0.0 Constant value: 0.0 m/s
Liftoff	
Runway	Desired RPM
	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
Add 👻	Constant value: 0.0 rad/s 0.0 Constant value: 178.0 rad/s

## Hold phase panel

In this way, if the stick control is not active, the helicopter will keep its position in the air without the need of phase changing. The **Yaw** Guidance is set on **Current**. In this phase, the Arcade allows controlling the platform depending on the set gains.

🔯 🕑 T-REX 🛪 🙆 🧿	፰ 🚱 🗱 🖓 🗂 🔺 CfgM	/lgr StepMgr
▼ Phases	Guidance Loop Arcade TC Panne	1
Standby	Var	Gain DBand
Warm up	Desired Pitch	-3.0 0.0 Max 0 Integral +
Ready		
Takeoff	Desired Roll	3.0 0.0 Max 0 Integral
Landing	Desired GS (Ground Speed)	-10.C 0.0 Max 0 Integral
Hover	- Desired Yaw	2.0 0.02 Max 0 V Integral
Cruise	Desired Yaw	2.0 0.02 Max 0 V Integral
Hold		
VHold		
Ignite		
Return to Home		
Engine OFF		
Land at Base		
Autorotation		
Collective UP		
Hover Yaw Heading		
Liftoff		
Runway		
Add 👻		

## Arcade panel

The T-Rex has a helicopter structure. Its control is performed by using the pitch changing of the main rotor blades (cyclic and collective control) and the tail rotor blades depending on the desired attitude change:

- ALTITUDE Collective control
- PITCH ANGLE Cyclic control
- ROLL ANGLE Cyclic control
- YAW ANGLE Tail blades pitch angle control



T-Rex 600

## 12.2.1.5 Hybrid

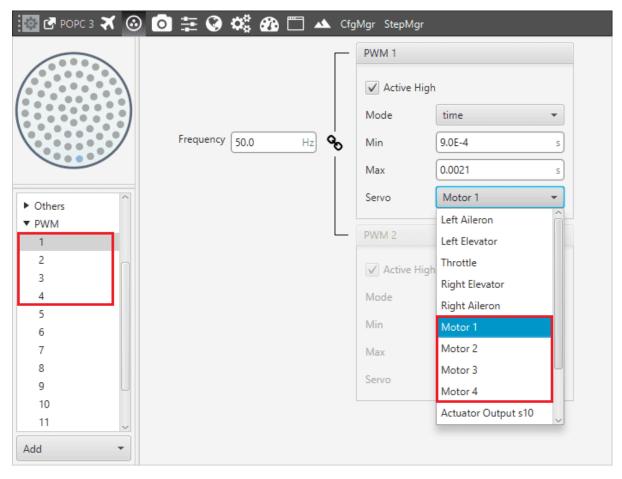
## 12.2.1.5.1 Servo Configuration

Once the Autopilot has been installed and connected according to the guidelines that appear in section 2.1 of this manual, the first step of the configuration process is the adjustment and trimming of the servos. This section contains the instructions to follow in order to trim the platform servos using Veronte Pipe.

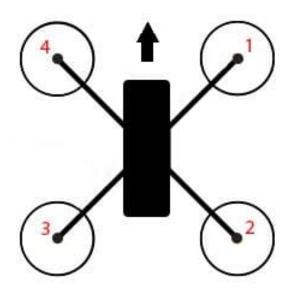
## 12.2.1.5.1.1 Quadcopter servos

## 12.2.1.5.1.2 Servos Output

In this case, the controls of the airplane are the four electric motors. Motors can be controlled by changing their thrust (from 0 to 1), so each one of them corresponds to a pin of the connector and they must be positioned in the same order in an S vector who represents the **Actuator Output**. It is possible to connect any pin to any command but the easiest way to perform it and avoid confusion is by following the pins number.



#### Quadcopter motors connections



Motors numbers

In this case, it is necessary to use 4 pins:

• Motor 1: Actuator Output s7.

- Motor 2: Actuator Output s8.
- Motor 3: Actuator Output s9.
- Motor 4: Actuator Output s10.

## 12.2.1.5.1.3 SU Matrix

At this point, the S vector is defined and the SU matrix can be edited. By clicking on **Edit** it is possible to configure the relation between the controller outputs (U vector) and the servo movements (S vector).

Vehicle name POPC 3	CfgMgr StepMgr	Type C 👻
US Set inv(SU) Edit SU Set inv(US) Edit		

SU matrix edit

**Warning:** This panel shows the reference system of the aircraft too. It must be positioned in the same way of the Autopilot's one. If it results different, it can be edited by clicking on the corresponding axis in order to reverse its direction.

	Control Output u1 - Pitching (Plane)	Control Output u2 - Rolling (Plane)	Control Output u3 - Yawing (Plane)	Control Output u4 - Pitching (Quad)	Control Output u5 - Throttle (Quad)	Control Output u6 - Rolling (Quad)	Control Output u7 - Yawing (Quad)	Control Output u8 - Throttle (Plane)
Right Aileron	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudder	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Throttle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Elevator	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Left Aileron	0.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0
Motor 1	0.0	0.0	0.0	-0.35355338	1.0	0.35355338	-0.25	0.0
Motor 2	0.0	0.0	0.0	-0.35355338	1.0	-0.35355338	0.25	0.0
Motor 3	0.0	0.0	0.0	0.35355338	1.0	0.35355338	0.25	0.0
Motor 4	0.0	0.0	0.0	0.35355338	1.0	-0.35355338	-0.25	0.0
				+				-

SU Matrix (blue - airplane, red - quadcopter)

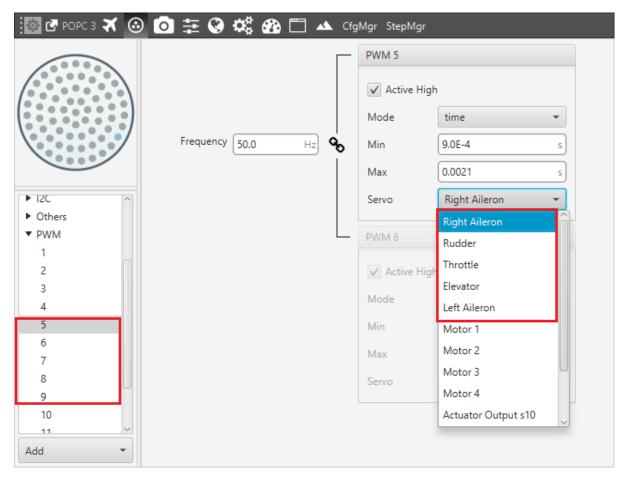
The Hybrid during quadcopter phases is configured as follow:

- 1. **Pitch Angle Control:** Control Output 5 is configured to perform a positive pitch angle change when motors 1-4 decrease their RPMs and motors 2-3 increase RPM value.
- 2. Thrust Control: the Control Output 6 is the one that allows a thrusting change (0-1).
- 3. **Roll Angle Control:** Control Output 7 is configured to perform a positive roll angle change when motors 1-2 decrease their RPMs and motors 3-4 increase RPM value.
- 4. Yaw Angle Control: Control Output 8 is configured to perform a positive yaw angle change when motors 2-4 decrease their RPMs and motors 1-3 increase RPM value, in this case with different proportions.

## 12.2.1.5.1.4 Plane Servos

## 12.2.1.5.1.5 Servos Output

In this case, it is necessary to configure a conventional aircraft configuration, so there are five controls: elevator, two ailerons, rudder and throttle. Each one of these controls is assigned to a value of the **Actuator Output** vector (s) according to the pin where it is connected and avoiding to use the quadcopter connection pins.



Plane servos connections

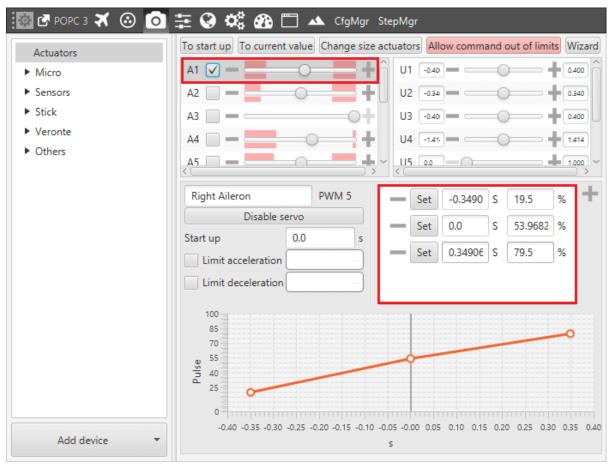
- 1. Right Aileron: Actuator Output s1
- 2. Elevator: Actuator Output s4
- 3. Throttle: Actuator Output s3
- 4. Rudder: Actuator Output s2
- 5. Left Aileron: Actuator Output s5

When the five controls are defined, the SU matrix plane part (blue part) can now be completed. In the case of this Hybrid, each control channel is related with only one servo: the pitching with the elevator, the rolling with the ailerons, the yawing with the rudder and the thrusting with the throttle:

- Pitching (u1): Actuator Output s4 (Elevator)
- Thrusting (u2): Actuator Output s3 (Throttle)
- Rolling (u3): Actuator Output s1 and s5 (Ailerons)
- Yawing (u4): Actuator Output s2 (Rudder)

## 12.2.1.5.1.6 System Trim

As a final step, the system has to be trimmed. This action can be performed by moving servos in three different positions: zero position, minimum and maximum deflection angle (angles are usually limited physically). These positions must be inserted and saved in the software by clicking on "Set" when the actuator is in the desired position.



#### Actuator 1 trimming

The picture shows the setting of the elevator number 1:

- Minimum: -0.34906 [rad] deflection ; 19.5%.
- Zero position: 0.0[rad] deflection ; 53.9682%.
- Maximum: 0.34906 [rad] deflection; 79.5%.

**Warning:** The actuators can be moved directly from Veronte Pipe only when the system is in an **Initial** phase. During the actuator run, if the desired position is in the "out of range" zone (red zone), it is possible to click on "Allow command out of limits" in order to move completely the actuator and find the correct position.

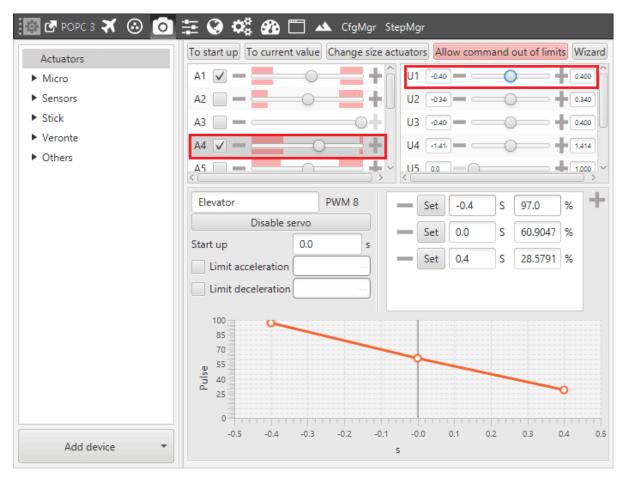
This procedure can be performed in the same way by using a "wizard". This tool allows moving actuators limits easily and finding the correct range.

	-		0						0		
Actuator Output s1	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s2	0	10	20	9 30	40	50	60	70	80	90	100
Actuator Output s3	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s4	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s5	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s6	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s7	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s8	0	10	20	30	40	50	60	70	80	90	0 100
Actuator Output s9	Q	10	20	30	40	50	60	70	80	90	100

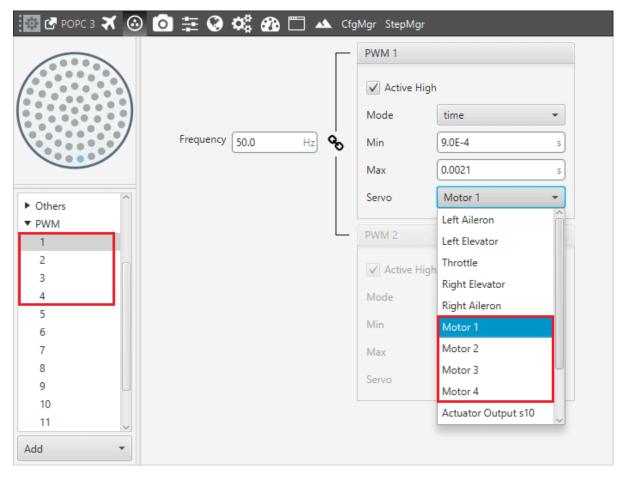
## Trim wizard tool

In order to perform a final checking, it is possible to select the desired channel and testing pitch, roll, yaw and thrust controls.

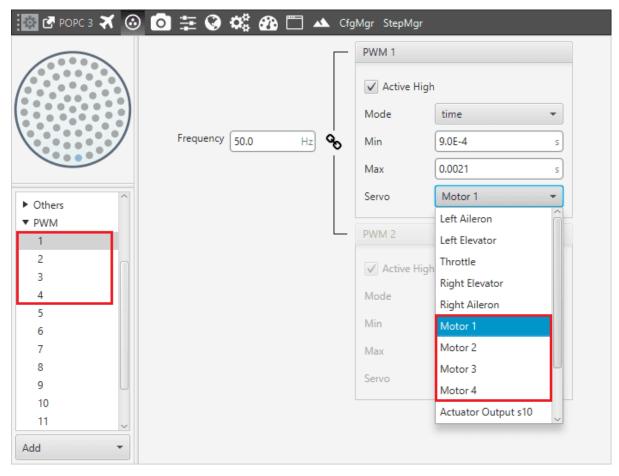
The image below shows a pitching output testing. By moving the U1 control, surfaces must change the position according to the reference system: positive corresponds to nose down and negative to nose up.



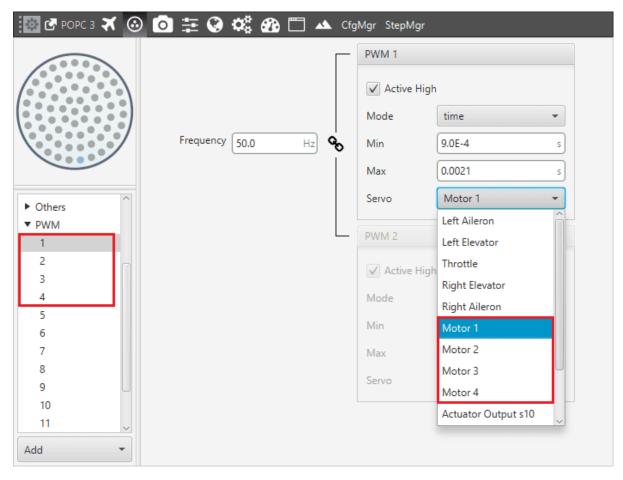
Pitching test



Quadcopter motors connections



Quadcopter motors connections



Quadcopter motors connections

## 12.2.1.5.2 Mission Phases

In this section, it will be explained the Hybrid typical mission profile and the mission phases will be detailed. The common phases of Quadcopter and Plane are:

- Standby
- Transition Quad to Plane
- Transition Plane to Quad

For all the other phases, the flight type will be specified.

## 12.2.1.5.2.1 Standby

Standby phase is a preliminary phase of the operation. Normally, the automation which allows the system to pass to Standby phase requires the GPS signal.

🔯 🗗 Hybrid 🛪 🙆 🧿	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Hold Name Standby
Takeoff - Quad	+
VHold - Quad	×
Landing - Quad	•
Loiter - Quad	
Hover - Quad	Desired Pitch
Hold Attitude - Quad	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Cruise - Plane	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
Climbing - Plane	
Approach - Plane Climb - Ouad	Desired Roll
Quad to Plane	None      Time (Ramp time)      Slope (Ramp rate)      Ewma (TAU)
Plane to Quad	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad
Hold - Plane	Desired Yaw
Armed - Quad	
Descend - Quad	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Hold Rates - Quad	Constant value: 0.0 rad 0.0 Yaw
Hold Rates - Plane	
Add 🗸	

Standby phase panel

The guidance is a **Hold** of three variables:

- Desired Pitch and Roll angles: at 0 [rad].
- Desired Yaw angle: set at the current.



#### Hybrid

This hybrid aircraft has an airplane – quadcopter integrated structure. Its control is performed by using typicals surfaces control for an airplane configuration during plane phases:

- PITCH
- ROLL
- YAW
- THRUST

And a differential thrust for each quadcopter motor depending on the desired attitude change during quadcopter phases.

The two transition phases are the most critical, in fact, it is important to keep the aircraft control during plane-quadcopter changing avoiding command overlaps.

This section contains the whole configuration process of four different platforms in Veronte Pipe. All the different menus that appear in the software will be covered so the final user of the system gains a fully understanding of how to totally configure its platform trough some real examples.

The platforms available are:

- Aircraft: Mentor.
- Flying Wing: W210.
- Multicopter: M400.
- Helicopter: T-Rex.

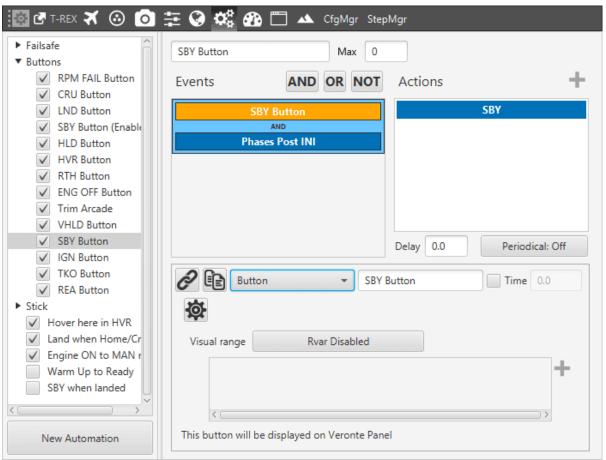
In this section we will explain the configuration of some devices and plataforms to improve the understandig of the user.

# **12.3 Automations**

# 12.3.1 Veronte Panel Buttons

## 12.3.1.1 Phase Change Buttons

The first automations to be created are the ones linked to the buttons of Veronte Panel. When clicking one of these buttons the phase is changed to the one shown on the button label. The image below shows the Standby Button automation.

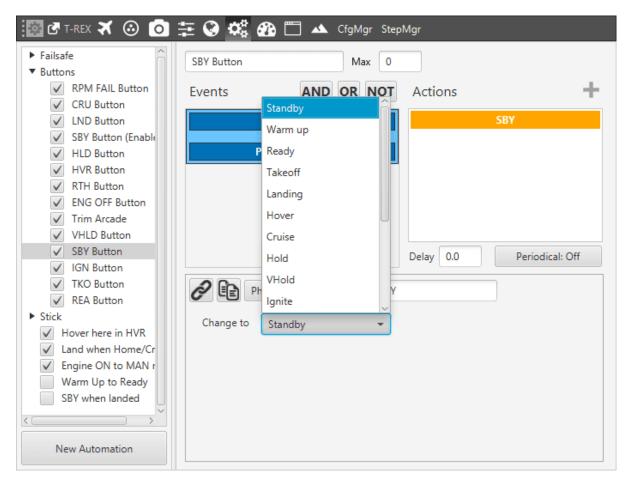


## Standby button automation

Normally, besides the button event, a safety condition is added to the automation, which consists on letting only the system to change to a phase when being in a certain set of phases. It is only necessary to create an **AND** condition with the phases to change from. For example, in this case, the set of phases is shown in the following image.

🔯 🛃 T-REX 🛪 🔕 🧿	፰ 🚱 🤹 🌇 🛅 🔺 CfgMgr StepMgr	
<ul> <li>▶ Failsafe</li> <li>▼ Buttons</li> </ul>	SBY Button Max 0	
RPM FAIL Button	Events AND OR NOT Actions	+
CRU Button	SBY Button	SBY
<ul> <li>✓ SBY Button (Enable</li> <li>✓ HLD Button</li> </ul>	AND Phases Post INI	
HVR Button     RTH Button		
ENG OFF Button     Trim Arcade		
VHLD Button		
✓ SBY Button ✓ IGN Button	Delay 0.0	Periodical: Off
TKO Button     REA Button	Phase   Phases Post INI	<b>Time</b> 0.0
<ul> <li>Stick</li> <li>Hover here in HVR</li> </ul>	Cruise	
✓ Land when Home/Cr	- Hold	
Engine ON to MAN r     Warm Up to Ready		
SBY when landed	Ignite 	
New Automation	Engine OFF	

Phases set



#### Standby action

In the previous figure, the automation is the change to StandBy when clicking on Veronte panel, being on any phase selected in the event. This process is normally repeated for the rest of phases.

## 12.3.1.2 Generic Button

There are other types of button which can be created on the Veronte Panel. In this case will be detailed the Hover Button which allows performing a hover (only for multicopters, for airplanes could be set a loiter point) on the point of the map exactly when the linked button is pushed. The images below show the automation set.

🔯 🕑 T-REX 🛪 📀 🧿	\Xi 🚱 🤹 🏤 🛅 🔺 CfgMgr StepMgr	
► Failsafe	HVR Button Max 0	
RPM FAIL Button     CRU Button	Events AND OR NOT Actions	+
<ul> <li>✓ Cho Button</li> <li>✓ LND Button</li> <li>✓ SBY Button (Enable</li> <li>✓ HLD Button</li> <li>✓ HVR Button</li> <li>✓ RTH Button</li> <li>✓ ENG OFF Button</li> <li>✓ Trim Arcade</li> <li>✓ VHLD Button</li> </ul>	HVR Button AND HVR Allowed	
SBY Button	Delay 0.0 Period	lical: Off
✓ TKO Button ✓ REA Button	Button - HVR Button Time	
<ul> <li>Stick</li> <li>Hover here in HVR</li> <li>Land when Home/Cr</li> <li>Engine ON to MAN r</li> <li>Warm Up to Ready</li> <li>SBY when landed</li> </ul>	Visual range Rvar Disabled	tion
New Automation	This button will be displayed on Veronte Panel	

Button Icon selection

🔯 🗗 T-REX 🛪 🙆 🧿	🗄 🐼 📽 🙆	👌 🛅 🔺 CfgMgr Step	Mgr	
► Failsafe	HVR Button	Max 0		
▼ Buttons				
RPM FAIL Button	Events	AND OR NOT	Actions	+
CRU Button				HVR
LND Button	н	VR Button		ник
SBY Button (Enable	LI N	AND VR Allowed		
✓ HLD Button		VK Allowed		
✓ HVR Button				
✓ RTH Button				
ENG OFF Button				
✓ Trim Arcade				
VHLD Button				
SBY Button			Delay 0.0	Periodical: Off
✓ IGN Button				
✓ TKO Button	Phase Phase	e 🔹 HVR	Allowed	Time 0.0
✓ REA Button				
▶ Stick	Cruise		+	
✓ Hover here in HVR				
✓ Land when Home/Cr				
<ul> <li>Engine ON to MAN r</li> </ul>				
Warm Up to Ready				
SBY when landed				
< · · · · · · · · · · · · · · · · · · ·				
New Automation				

Phases set

🔯 🕑 T-REX 🛪 🙆 🧿	\Xi 🚱 🧟 🛅 🔺 CfgMgr StepMgr	
CRU Button	HVR Button Max 0	
LND Button SBY Button (Enable	Events AND OR NOT Actions	
<ul> <li>✓ HLD Button</li> <li>✓ HVR Button</li> <li>✓ RTH Button</li> <li>✓ ENG OFF Button</li> <li>✓ Trim Arcade</li> <li>✓ VHLD Button</li> <li>✓ SBY Button</li> </ul>	HVR Button AND HVR Allowed	
<ul> <li>✓ IGN Button</li> <li>✓ TKO Button</li> <li>✓ REA Button</li> <li>✓ Stick</li> <li>✓ To Hold (manual)</li> </ul>	Delay 0.0 Periodical: Off	
✓ Manual ✓ Auto	Position	
<ul> <li>✓ Hover here in HVR</li> <li>✓ Land when Home/Cr</li> </ul>	Location Current Longitude: 0.0 Direct	
Engine ON to MAN r     Warm Up to Ready	O Loiter Auto -	
SBY when landed	Hover     Distance     100.0     m	
New Automation		

### Hover button defining

## 12.3.2 Phase Changing

## 12.3.2.1 Takeoff to Climb Change

The change from the take off to the climbing phase, in this case, occurs when the IAS of the airplane on the runway is greater than 8 m/s. The phase condition is set on Takeoff phase and the action is defined to pass in Climbing phase.

🔯 🛃 Mentor 🛪 🙆 🧿	i 🗄 🚱 📽 🙆 🗖 4	🔺 CfgMgr StepM	1gr	
▼ Buttons	TKO to CMB	Max 0		
SBY Button (EIN) SBY Button	Events AN	D OR NOT	Actions	+
TKO Button CMB Button LND Button	IAS>8 AND TKO Phase		CM	IB
<ul> <li>Failsafe</li> <li>Auto when No Stick</li> <li>LinkOff to LND</li> <li>HLD when No GPS</li> <li>Low Battery</li> <li>Stick</li> <li>Auto Mode</li> <li>Manual Mode (Arc</li> <li>Transitions</li> <li>TKO to CMB</li> </ul>	Variable	▼ IAS>8 Indicated Airspeed)	Delay 0.0	Periodical: Off
<ul> <li>CMB to CRU</li> <li>Arcade Trim</li> <li>When Event Mark</li> <li>LND to Flare</li> <li>No name</li> </ul>	Max Min 8 Invert range 🗸			
New Automation	Min Event triggered on blue are	ta		Max

Takeoff to climb automation

## 12.3.2.2 Climbing to Cruise Change

This kind of phase change is normally performed when a certain altitude is reached. In this case, the airplane changes to the "Cruise" phase where it starts to follow the path determined by the user. As a safety condition, the change will only happen when having a speed greater than 6 meters per second.

🔯 🗹 Mentor 🛪 🐼 🧿	🗄 🚱 🔅 (	🏠 🛅 🔺 CfgMgr Ste	pMgr	
▼ Buttons ✓ SBY Button (EIN)	CMB to CRU	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
TKO Button     CMB Button     LND Button		AGL>90 AND CMB Phase		CRU
<ul> <li>Failsafe</li> <li>Stick</li> </ul>		AND IAS > 6		
<ul> <li>▼ Transitions</li> <li>✓ TKO to CMB</li> <li>✓ CMB to CRU</li> </ul>				
<ul> <li>✓ Arcade Trim</li> <li>✓ When Event Mark</li> </ul>			Delay 0.0	Periodical: Off
✓ LND to Flare	🖉 🗈 Var	iable 👻 IAS >	6	<b>Time</b> 0.0
	Variable	IAS (Indicated Airspee	d)	
	Max	6		
	Invert range			
	Min			Max
New Automation	Event triggere	d on blue area		

Climbing to cruise change definition

The AGL to the change of phase is 90 meters. Both the velocity and altitude are specified through an event of type "Variable".

## 12.3.2.3 Landing to Flare Change

The change from the landing to flare phase is performed when the aircraft is above the runway and about to touch the ground. This idea is implemented with a set of three events:

- AGL: the aircraft is below a certain altitude, in this case, 8 meters.
- Inside Polygon: Mentor enters in a polygon defined in the map on the runway head.
- Landing Phase: the aircraft is landing phase.

🔯 🕑 Mentor 🛪 🙆 🧿	) 🏛 😧 🐝 6	🏠 🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	LND to Flare	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
<ul> <li>✓ TKO Button</li> <li>✓ TKO Button</li> <li>✓ CMB Button</li> <li>✓ LND Button</li> <li>✓ Failsafe</li> <li>Auto when No Stick</li> <li>LinkOff to LND</li> <li>HLD when No GPS</li> <li>Low Battery</li> </ul>		side Polygon AND AGL < 8 AND Phase LND		Flare
▼ Stick			Delay 0.0	Periodical: Off
<ul> <li>✓ Auto Mode</li> <li>✓ Manual Mode (Arcad</li> <li>✓ Transitions</li> <li>✓ TKO to CMB</li> <li>✓ CMB to CRU</li> <li>✓ LND to Flare</li> <li>✓ Arcade Trim</li> <li>✓ When Event Mark</li> </ul>	Variable Max Min Invert range	AGL (Above Ground Level)  8		Time 0.0
< >	Min			Max
New Automation	Event triggered	d on blue area		

### Landing to Flare

When these events are fulfilled, airplane enters in the Flare phase and lands.

## 12.3.3 Failsafe

Veronte allows users to create different types of Failsafe automations according to they need combining different Actions and Events. The more common automations are shown below.

## 12.3.3.1 Radio Error

When the radio connection from the ground station to Veronte Air is lost, the aircraft is forced to change to auto mode and landing phase.

🔯 🕑 Mentor 🛪 🙆 🧿	🏛 🚱 🤹 🚯	🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)     SBY Button	LinkOff to LND	Max 0	Actions	+
CRU Button TKO Button			Actions	LND
<ul> <li>✓ LND Button</li> <li>✓ Failsafe</li> <li>Auto when No Stick</li> </ul>		(Error		Αυτο
LinkOff to LND HLD when No GPS Low Battery	Fligh	t Phases		
<ul> <li>Stick</li> <li>Transitions</li> </ul>			Delay 0.0	Periodical: Off
Arcade Trim     When Event Mark     LND to Flare	Variable	e 🔹 TX Er		Time 1.0
	Max 0	.8		
	Min Invert range	]		
	Min			Max
New Automation	Event triggered or	n blue area		

Failsafe for radio link-off – Plane

When the value of the flag that evaluates the TX or RX error ("TX/RX Packet Error Rate (on board)") has a value of 1 (0.8 is established for safety), and the aircraft is in a certain phase (climb and cruise), it is forced to land.

Video Tutorial: https://www.youtube.com/watch?v=mmzRw9V9OCs

When using a multicopter the same proccess is done with some changes.

🔯 🛃 м400 🛪 🙆 🧿	🗄 🥝 🗘 🕯	B 🗂 🔺			
CRU 3 Button	LinkOff to LND				
CRU 4 Button	Events	AND OR	NOT	Actions	+
<ul> <li>✓ HLD Button</li> <li>▼ Transitions</li> <li>✓ Hover HERE when</li> </ul>		TX Error OR			AUTO Fly Home
REA to HLD (ARC)     TKO to HVR     RTH to SBY		RX Error AND Flight Phases			RTH
✓ LND to SBY ▼ Stick ✓ Auto Mode				Delay 0.0	Periodical: Off
Manual Mode (Arc     Arcade Trim     Ready Command     Hold Phase (Arcad	2 E		Insert na		
▼ Failsafe HLD when No GPS Low Battery to LNI LinkOff to LND					
Auto when No Stic					
New Automation					

Failsafe for radio link-off - Multicopter

The actions carried out now are:

- Mode: select a change to AUTO mode.
- **Phase:** change to the phase Return to Home, in this phase is defined the Home point. See the example of this phase for the quadcopter M400 in section *Mission Phases*.
- Go to: as safety condition, this action is added and the Home point is selected.

## 12.3.3.2 Low Bettery

When the battery is below a certain level (15.2 Volts in this case), and the aircraft is in climb or cruise, it is automatically commanded to land.

🔯 🗗 Mentor 🛪 🛞 🧕	፰ 🚱 🎎 🜇 🛅 🔺 CfgMgr StepMgr	
▼ Buttons	Low Battery Max 0	
SBY Button (EIN) SBY Button	Events AND OR NOT Actions	+
TKO Button	Power Input < 15.2V	LND
CMB Button LND Button	AND On Phase	AUTO
Failsafe	Un mase	
Auto when No Stick LinkOff to LND HLD when No GPS		
Low Battery  Stick		
Transitions	Delay 0.0	Periodical: Off
Arcade Trim     When Event Mark     LND to Flare	Variable	-1.0
	Max	
	Min 15.2	
	Invert range	
		Max
	Min	IVIdX
New Automation	Event triggered on blue area	

Failsafe for low battery

## 12.3.3.3 GPS Signal lost

When the UAV is not receiving the GPS signal, the system automatically adapts the navigation algorithm to avoid a possible accident by obtaining the aircraft attitude trough the AHRS reference system. Besides that, it is also needed that the aircraft changes to a flight phase where the control is made over the attitude angles instead of position variables (heading, flight path). This phase is commonly known as HOLD, which has a guidance to keep pitch, roll and IAS at a certain value, and with PIDs in pitch and roll having two blocks for that angles and its rates.

The event of this fail safe automation will be the loss of GPS signal (type alarm), while the action is type phase (Hold).

🔯 🕑 Mentor 🛪 🙆 🧿	) 🏛 🚱 🐝 6	🚹 🛄 🔺 Cfgl	Mgr Stepl	Mgr		
Buttons     SBY Button (EIN)	HLD when No GP	PS Ma	ах 0			
SBY Button	Events	AND OR	NOT	Actions		+
✓ TKO Button ✓ CMB Button		NO GPS AND			HLD	
<ul> <li>✓ LND Button</li> <li>▼ Failsafe</li> </ul>	FI	ight Phases				
Auto when No Stick LinkOff to LND						
HLD when No GPS Low Battery						
▼ Stick				Delay 0.0	Periodical: Of	f
Manual Mode (Arc	Alar	m 👻	NO GP	S	<b>Time</b> 0.0	
TKO to CMB	Type Fail o	ne 🔻	ХКВІТ	I_GPSNAV		
Arcade Trim     When Event Mark						
LND to Flare	Add					
Vo name		▼ +				
New Automation						

Failsafe for GPS signal lost

# 12.3.4 Photogrammetry

Veronte Pipe incorporates the Photogrammetry mission, see section *Photogrammetry*. It is possible to create it without using the tool incorporated within the mission toolbar.

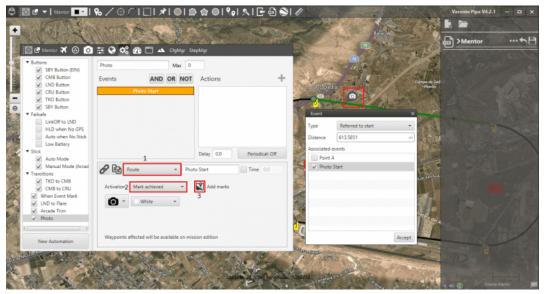
In the photogrammetry missions, the platform is wanted to take photos during the time that it is following a path previously defined. Commonly, the photo taking process begins at a certain location over the route and is repeated each certain distance. To create this automation the process detailed now has to be followed.

1. Create an Event Marker at the point where the photogrammetry mission has to start.



Photogrammetry Automation 1

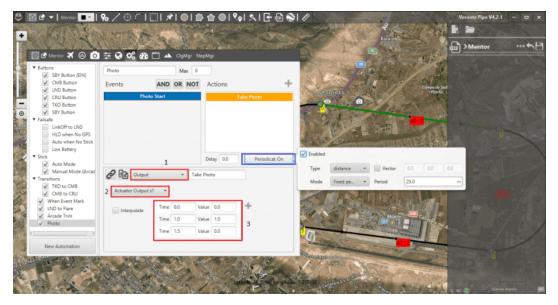
2. That **Event Marker** has then to be linked with an event that will trigger the process. Go to Automation in order to create it.



Photogrammetry Automation 2

The event is type **Route** (1) and will be triggered when the point is reached (2) (the other option is when flying towards the point). If the event is linked with a waypoint instead of an Event Marker, the point is selected in the map with button (3). Finally, with the event created in the automation menu, double-clicking on the event marker allows to link this automation to it.

3. The last step is to create the actions to be performed when the event is triggered.



Photogrammetry Automation 3

When the point is reached, a timer starts to measure the distance between the locations at which a photo will be taken. **Periodical** (blue box) has to be enabled, users have to indicate that the timer measures distance (the other option is time), and finally indicate that the distance measured is a fixed value (25 meters in this case).

The action type (1) is **Output**, which is used to send a signal trough one of the output pins of Veronte. In (2) is selected the actuator that is connected to the camera (or with the device that is controlled with this automation). Finally, in (3) are indicated the values of the PWM signal at each time instant.

## 12.3.5 Others

## 12.3.5.1 Stick Auto

This automation changes the control mode according to the command sent by the radio controller.

🔯 🕑 Mentor 🛪 🙆 🧿	🗄 🛛 🛱	🚯 🗂 4	🔺 CfgMgr Ste	pMgr	
▼ Buttons	Auto Mode		Max 0		
SBY Button (EIN) SBY Button CRU Button	Events	AN	D OR NOT	Actions	+
TKO Button		Stick UP			AUTO
CMB Button					
✓ LND Button					
▼ Failsafe					
Auto when No Stick					
LinkOff to LND					
HLD when No GPS					
Low Battery					
▼ Stick				Delay 0.0	Periodical: Off
Manual Mode (Arcad					
<ul> <li>Transitions</li> </ul>		Variable	▼ Stick	UP	Time 0.0
TKO to CMB	Variable		Stick Input r8		
CMB to CRU			Suckinputio		
✓ LND to Flare	Max				
✓ Arcade Trim	Min	0.75			
✓ When Event Mark	Invert range	e 🗸			
		- •			
$\langle $	Min				Max
New Automation		ered on blue ar	ea		
New Automation		eres on orde ur			

Stick Auto automation

In this case, the channel that controls the mode is the 8, so according to its value the mode is changed. With an event of type Variable the automation is defined. The process is the same for the manual mode, but when the r8 variable has a value lower than 0.25.

Video Tutorial: https://www.youtube.com/watch?v=C3A6P1jgFV4&feature=youtu.be

## 12.3.5.2 Automatic Landing (Multicopterss)

If the user wants the multicopter stops the motors when landed (pass to Standby automatically), it is possible to configure an automation which performs this action.

Normally, to control the automatic landing, the following variables are used:

- · Ground Speed Down
- AGL (Above ground level altitude)
- Thrust control
- Landing current phase

🔯 🛃 м400 🛪 🙆 🧿	\Xi 🔇 🤹 🌇 🛅 🔺 CfgMgr StepMgr	
Buttons     SBY Button (EIN)	SBY when LND Max 0	
SBY Button	Events AND OR NOT Actions	+
<ul> <li>✓ HVR Button</li> <li>✓ LND Button</li> <li>✓ CRU Button</li> <li>✓ TKO Button</li> <li>✓ HLD Button</li> <li>✓ Stick</li> <li>✓ SBY to AUTO</li> <li>✓ Auto Mode</li> </ul>	ON_VDOWN_LND     SBY       AND     ON_GAS_LND       AND     AND       AND     AND       Phase LND     AND	
<ul> <li>Manual Mode (Arcad</li> <li>Hold Phase (Arcade)</li> </ul>	Delay 0.0 Per	riodical: Off
LinkOff to LND HLD when No GPS Auto when No Stick Low Battery Arcade Trim SBY when LND	Variable     AGL < 20 cm     Tir       Variable     AGL (Above Ground Level) – Hei     Tir       Max     0.2       Min     Image: State	me 0.0
New Automation	Invert range V Min Event triggered on blue area	Max

#### Landing auto configuration

Variable values must be chosen depending on multicopter (rotor number, dimensions, altitude sensors, etc...) and an integral control increase can be taken into account in order to perform a faster RPM descending and a better landing.

The automations are the mechanisms used to perform an action when some event is verified (using the Boolean Logic AND, OR and NOT tools). These actions could be a change from one phase to another, taking a photo, dropping a payload and so on. In this section, the following automation types will be detailed:

- Veronte Panel buttons
- Phase changing
- Failsafe (link-off, power low, GoHome point)
- Photogrammetry
- Others

# 12.4 Veronte Tracker

# 12.4.1 Veronte Ground Configuration

The first step of the configuration is the creation of the SU matrix including 2 controls (PAN-TILT) and 2 servos, the ones installed on Veronte Tracker in order to move Pan and Tilt axes.

Edit		-	-	-
		Control Output u1 - Pan G1	Control Output u2 - Tilt G1	
•	Actuator Output s1	1.0	0.0	+
-	Actuator Output s2	0.0	1.0	
		+		

## SU Matrix

Once the SU matrix is complete, it is possible trimming both servos with the same procedure of aircraft servos in the **Devices > Actuators panel**. The user must set the center of the antenna and then maximum and minimum angles. The procedure has to been repeated for both servos.

🔯 🛃 W210 GND 🛪 📀	◎ # \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
Sensors	A1 + U1 -3.14 + 3.140
▶ Stick	A2
► Veronte	
► Others	
	Actuator Output s1       PWM 1         Disable servo         Start up       0.0         Limit acceleration         Limit deceleration         100         85
Add device	▼ 70 55 40 25 0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 S

## Servos Trimming

When servos are trimmed, the tracker has to be configured in the Devices >Payload panel as:

- Type: Pan Tilt.
- Logic: Conventional Gimbal, with Horizontal (Pan) and vertical (Tilt) axes.

<ul> <li>Actuators</li> </ul>	Туре	Pan Tilt	<ul> <li>Base to gimbal X</li> </ul>	0.0	
Communications	Logic	Conventional gimbal	<ul> <li>Base to gimbal Y</li> </ul>	1.0	
<ul> <li>Payload</li> </ul>		Arcade	Base to gimbal Z	0.0	
Gimbal/Tracker Transponder Sensors			ADD		
<ul> <li>Sensors</li> <li>Stick</li> </ul>					
Veronte					
<ul> <li>Others</li> </ul>					
Others					
<ul> <li>Others</li> </ul>					
<ul> <li>Others</li> </ul>					
<ul> <li>Others</li> </ul>					
• Others					
• Others					
• Others					
• Others					
• Others					

#### Tracker Payload configuration

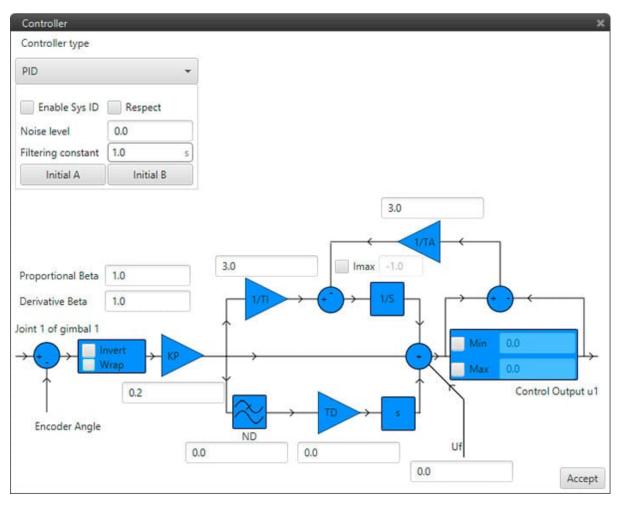
Next step is the configuration of the control loops for each axe: Pan and Tilt.

• Pan control loop is a closed loop with Joint 1 of gimbal 1 entry variable (the desired Pan angle) and the Encoder Angle variable in the feedback loop. The output is configured as the SU matrix: Control Output u1.

🔯 🛃 W210 GND 🛪 🙆	o 🗄 🚱 🗱 🚱 🗖 🔺		
▼ Phases	Guidance Loop Arcade TC Pannel A	utomations	
StandBy			
Runway	Pan G1	Name	Insert name
Envelope	Tilt G1		
Smooth		Mode	On 💌
Modes			
Arcade axis	PID 1 -		
	Joint 1 of Gimbal 1		
	Encoder Angle		
Add 🔻			

## Pan Loop Configuration

A typical setting for the loop is presented in the following figure. The proportional gain is set at 0.2 and the integral gain at 3.0.

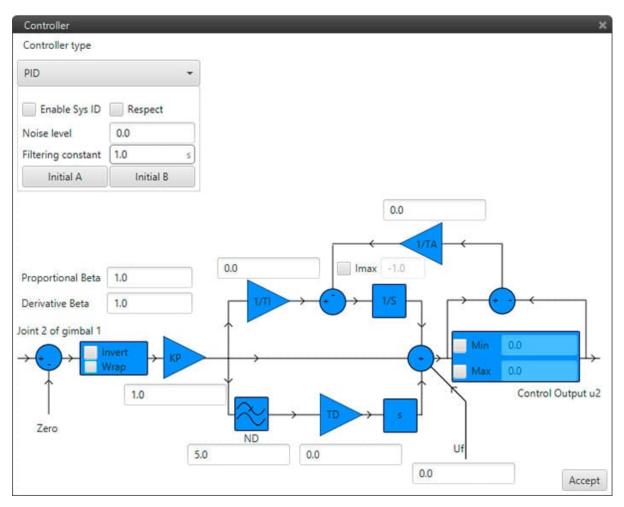


### Pan Control Loop

• For the Tilt control, an open control loop is sufficient. **Joint 2 of gimbal 1** is the entry variable (the desired Tilt angle) and the **Zero** variable is configured for the feedback loop. For those cases where an **encoder** is present it should replace **Zero** as feedback for Tilt angle. The output is configured as the SU matrix: **Control Output u2**.

🔯 🛃 W210 GND 🛪 🙆	े 🗄 🔇 🗱 🕰 🗂 🔺		
▼ Phases	Guidance Loop Arcade TC Pannel Autom	ations	
StandBy Runway Envelope Smooth Modes Arcade axis	Pan G1 Tilt G1 PID 1 • Joint 2 of Gi Zero	Name Mode	Insert name
Add 👻			

Tilt Loop Configuration



Tilt Control Loop

The last step of the Veronte Ground configuration is the Sniffer setting. Configuring a new Sniffer means allowing the Ground Station "knowing" the Veronte Air (UAV Address) position during flight and associating it with a Moving object. Veronte Air has to be configured to send its position to Veronte Ground. On **Address** it has to be selected the Veronte Air to be tracked.

📴 🛃 Verante Tracker 🛪 (			CONTRACT STREET, MANAGEMENT		1	IN .	Out	
<ul> <li>System Variables</li> </ul>	Search Cop	Y	Address Veronte 1070	- 0	4-	Link quality	Link quality of related pair	16
Telemetry     Data link to Pipe	Name	Enabled			Mapping variables	Position	Moving object icompress 2	
Data link to Veronte     Onboard Log	-+↑©: -+↑©:	ink quality			N.			
User Log		osition						
Fast Log								
▼ 📲 Sniffer								
Sniffer 1								
		DISABLE						
	- IAS (Indicated Airspi	eed)		6				
	- TAS (True Airspeed)							
	GS (Ground Speed)							
	+ Heading							
	🕂 Flight Path Angle							
	- Bank							

## Sniffer Ground Configuration

## 12.4.2 Veronte Air Configuration

Configuration of Veronte Air includes only one step which is the Data Link configuration. The new Data Link has to be defined as showed in the following image: the variable to send is the Position and **Address** has to be set according Veronte Ground (Unit that will receive this data) with a frequency of 10.0 Hz.

🔯 🛃 W210 🛪 🙆 🧿	i 🗄 🚱 📽 🔁 🖴	
System Variables	Search Copy Frequency (Hz) 10.0 Address	-
<ul> <li>Telemetry</li> <li>Data link to Pipe</li> </ul>	Enabled	
Data link to Veronte	Name	
Onboard Log	🗌 — 🐥 👚 📴 Link quality	
User Log	- I Position	
Fast Log		
Sniffer		
-		
	DISABLED	
		^
	IAS (Indicated Airspeed)	0
	TAS (True Airspeed)	
	GS (Ground Speed)	
	+ Heading	
	Flight Path Angle	
	Heank Bank	
		$\sim$

Data Link Veronte Air Configuration

# 12.4.3 Tracking Operation



Tracking Operation

In order to activate the tracking, the user must follow some steps.

1. First of all, it is necessary to configure the Tracker (Veronte Ground) position on the map. To do this it is sufficient to go in the **Veronte Ground Panel**, open the **Run Task** and then the **Command Position** window.



Absolute		Relative		
Latitude	0.6699061267967821	rad $[-\pi,\pi]$	-	591
Longitude	-0.012143301342789	$rad\left[ - \pi, \pi \right]$	2	N
WGS84	316.7396599671141			n
- MSL	266.2			m
LAGL	1.20			m

Tracker Position configuration

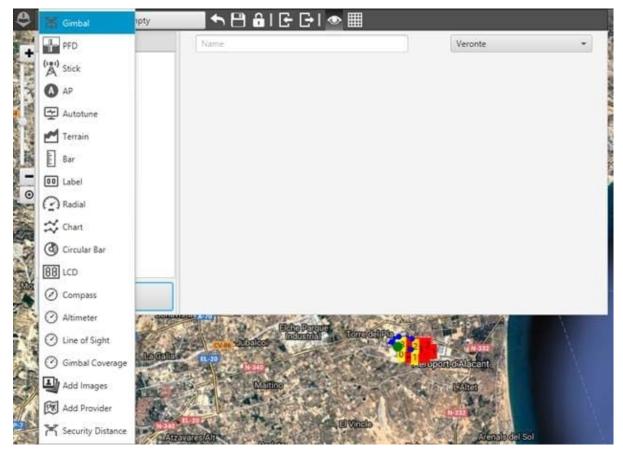
In this panel, it is necessary to insert the tracker position. The user can perform this action inserting Latitude and Longitude values manually or directly clicking on the Map location. The tracker altitude has to be defined too: normally, the tracker tripod is set at 1.20/1.40 [m] so this value has to be inserted in the AGL altitude.

2. Introduce Yaw initial orientation of the tracker. Go into Veronte Ground Panel, open the Run Task and then select Command Yaw.



Tracker Orientation configuration

When Veronte Tracker is completely positioned, it is possible to activate the tracking. To do this it is necessary to add a Gimbal widget on the Workspace.



Workspace: Gimbal

Select the Payload as the one in the Veronte Ground Devices configuration.

The addition of the second sec					SELECT	ED-VERONTE
近 Gimbal	Opacity Pos X	143.0	Pos y	472.0	0	
	Width Gimbal	800 Gimbal 1 - No gimbal Gimbal 1	Height Camera	600	*	Cut video

Workspace: Gimbal widget

After doing it click on ' ...' placed on the top right corner of the widget Gimbal.

Geotagging	Codeo	Record	
Vector Body	Absolute	Relative Approach Initial	Point 👻
Custom Axis     Location	Latitude	1.5784225029( rad [-π,π]	8 X
	Longitude	0.0 rad [-π,π]	
	WGS84	0.0	m
	- MSL	-17.161578498270735	m
	LAGL	0.0	m

Gimbal widget: Pointing

In this window it is possible to set where the tracker will point. It can be a absolute position, like the one from the image, or a **Relative position**. For example the **Moving object incompress 2** (Veronte Air in this case).

It is possible to test the correct tracking by moving the Veronte Air (or the platform if it is possible) and checking the tracker correspondent rotation in Pan and Tilt. To perform this test it is useful to maintain the UAV at > 20 [m] from the Ground Station because of the bad transmission link in case of small distances.



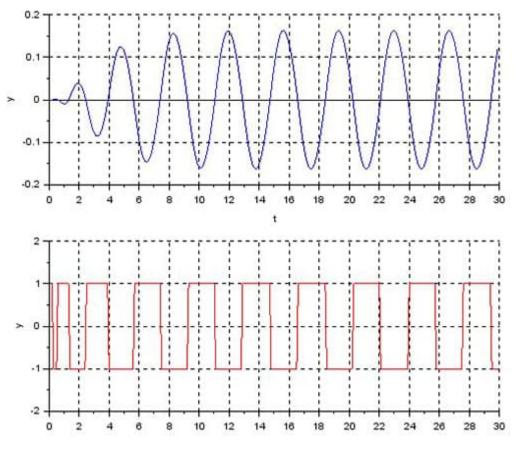
Veronte Tracker

Veronte Tracker is a high performance tracking antenna specifically designed for most demanding applications. The system can install any directional antenna for maximizing system operation capabilities. Embedded control actuators and installed encoders permit to automatically point the antenna with unique precision. Height (Tilt control) and orientation (Pan control) given to the antenna makes the device perfect for long range operations.

Video: Tracking Antenna - Veronte Tracker

# 12.5 Autotune

The Autotune allows finding the PID controller gains automatically. During the process, the PID controller is replaced with a relay function and the controller parameters are then determined from the period and the amplitude of the oscillation of the system by using FFTs.



Autotune output (blue) and input (red)

# 12.5.1 Modes Configuration

To be able to use the autotuning tool, the Autotune Mode has to be selected in the Modes menu for the control output which must be autotuned. In the following image, for example, for the rolling control is set the Autotune mode.

Phases		Pitching	Thrusting	Rolling	Yawing	Flaps	
Envelope	- Auto	A auto	auto	autotune	auto	auto	t
Smooth Modes	- Manual	M rc	rc	rc	rc	rc	T
Arcade axis			Ad	d			

Autotune mode

# 12.5.2 Workspace Configuration

In the Workspace panel, it is possible to select the Autotune Tool.

Cam Cam							
1 PFD							
(A) Stick	ap	<ul><li>► B</li></ul>	âi 🕒 🕞	👁 🏢			
🕼 AP		Norme,				SELECTED AR	
🕎 Autotune		Opacity					
Terrain		Pos X	100.0	Pos y	50.0		
Bar							
00 Label							
( Radial							
😂 Chart							
Circular Bar							
88 LCD							
Compass							
Ø Altimeter							
New	•						

#### Autotune tool in the Workspace

When the window is opened, it is possible to select the loop for the autotuning. If some control loop does not have a PID controller configured, it appears with transparency and it can not be autotuned (red).





When the loop is selected, the window changes and some parameters are showed and they can be edited:

- Time: It is the period of time in which the Autotune is performed [s].
- Stages: The number of stages of the Fast Fourier Transform (a value between 5 and 10 is allowed).
- **Relay:** This is the amplitude of the Relay function (R). The value has to be chosen in according with the proportional gain in the PID of the autotuned variable.
- **Respect:** A mean value of the variable has to be selected. If the respect is select, the autotune will start from the last value of the variable. If not, the value can be edited by the user and the Autotune Relay function will start from this value and it will go from -R to R.

When all parameters are set, it is possible to click on Start and the autotuning process will begin and the blue bar will move until the end of the process. The left bar of the window allows to check the flight Phase and the selected loop.



#### Autotune process

If the process is performed successfully, a new window will show up showing the PID gains found in the Autotune process and the output wave amplitude and period. From this window, it is possible to save the new values in the configuration or cancel them.

Success	×
Autotune completed	?
Loop id: 2 - ID: 0 Amplitude=0.29621893 Period=1.024 Kp=0.51579666 Ti_1=1.953125 Td=0.128	
You want to save these settings?	
OK	Cancel

Autotune completed

**Warning:** Always be sure the gain values are in the correct range. A bad value, if saved in the configuration, could cause a control loss of the platform.





When the Autotune is started, it is possible to see a message in the blue bar: "Waiting for autotune mode". In this

case, the autotune mode for the selected control is not correctly set. The user must change it in the control panel.

In this section, a series of different examples will be presented in order to improve the understanding that the final user will have of Veronte Pipe.

The different topics cover in this section are:

- **Configurations:** it will be explained how to configure some different platforms in Veronte Pipe, starting with the servo trimming process and the creation of the mission phases of a simple flight operation.
- Automations: this section will be focused on the creation of the common automations that are used for operating a UAV. Presenting this ones will make it easier for the user to develop its own automations for more specific operations.
- Autotune: the complete example of the autotune configuration and operation.
- 4G Communication: Steps to configure 4G communication with Veronte Autopilots.

# CHAPTER

# THIRTEEN

# TROUBLESHOOTING

In the following section there are examples of issues that can be found while integrating **Veronte Autopilot** and how to troubleshoot them





Troubleshooting Veronte

# 13.1 Maintenance mode



Maintenance mode tab

**Maintenance mode** is the main troubleshooting tool that **Veronte** puts at the user disposal. While in **Maintenance mode**, all communication channels are enabled by default, so it is possible to connect with **Veronte** through any of its configuration interfaces no matter its current configuration.

While in **Maintenance mode**, it is possible to perform actions such as force the load of a **new configuration** file or **format the SD card**.

The main use of maintanance mode is to solve issues related to the current configuration, mainly related with communication or memory writting issues.

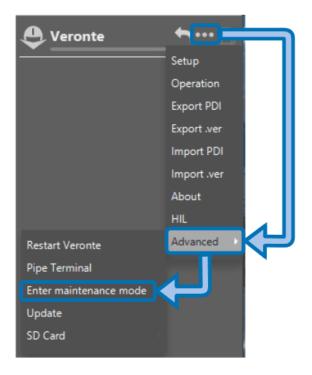
If at some point the communication with **Veronte** is lost, it is possible to use **Maintenance mode** to go back to a previous state of the configuration (as long as it was exported previously), **format the SD card** to start over or update the unit's **firmware**.

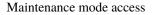
**Tip:** If you need to recover a **recent configuration**, but it has been some time since the configuration was **manually exported**, try using the *Post Flight* tool to recover your most recent configuration.

**Important:** It is heavily recommended to always use **Maintenance mode** to load a new configuration that is very different from the current one.

## 13.1.1 Entering maintenance mode

**Maintenance mode** can be entered by clicking the corresponding command, which can be found in Options -> Advaced -> Enter **Maintenance mode** 





## 13.1.2 Forcing maintenance mode

In the situation that communication is lost with the unit, it is also possible to activate **maintenance mode** using the power input.

In order to activate Maintenance mode, power cycle the unit repetively, with a period of 1 second.

Maintenance mode will be entered after 30 cycles are performed.

It is also possible that Veronte enters **Maintenance mode** if a problem with the power source (out of voltage/current range) is detected upon boot up.

**Tip:** Forcing a **Veronte PCS** unit into **maintenance mode** can be more difficult than average. For each power cycle, make sure that the Power LED is turned off before turning the unit on again.

## 13.1.3 Maintenance mode options

The following options are available while in Maintenance mode.

## 13.1.3.1 Exit maintenance mode

Exit Maintenance mode and restart the unit.

## 13.1.3.2 Remove Encryption

Remove encryption from the unit.

### 13.1.3.3 Change setup

Overwrite the **current configuration** with a new set of files. This option will force the load of the files, now matter if there are **PDI errors** on the new files.

## 13.1.3.4 Update

Update the unit's **firmware**.

### 13.1.3.5 Retry

Retry to boot Veronte system.

## 13.1.4 SD Loaded With errors

If upon booting, errors are found on **Veronte** configuration (be it an incorrect configuration or the absence of it), the boot will fail and **Veronte** will enter the **'SD loaded with errors'** mode.

Veronte will enter this mode if it detects an 'Ilegal' setting within the configuration, that could potentially affect the normal behaviour of Veronte. In order to escape SD loaded with errors mode, load an Older or Default configuration. If the configuration problem is known, it is also possible to use the Try load PDI feature to solve the issue directly.

This mode is very similar to Maintenance mode, but some of the troubleshooting actions are different

PDI Errors	ĸ
SD loaded with errors	
Veronte has some problem in his PDI.	
Select an option to exit compatibility mode	
Check PDI   Change setup Try load PDI Retry	

#### SD Loaded with errors tab

## 13.1.4.1 Check PDI

Re-attempt the PDI files check.

## 13.1.4.2 Try load PDI

**Pipe** will try to download the configuration from the unit. If the download succeeds, the configuration will be displayed. If the errors in the configuration are found and fixed, it is possible to save the changes and reboot the unit to exit **SD loaded with errors** mode.

## 13.1.5 Communications failure

This is not an actual **Maintenance mode**.

If this warning is displayed, it means that **Veronte Pipe** detected a **Veronte** unit, but was not able to stablish communication with it.

The only option available is attempting the connection again.

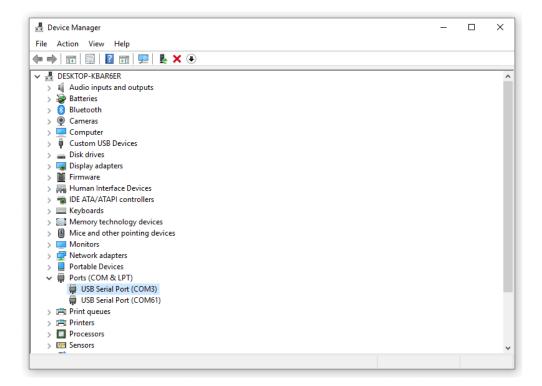
If unsuccessful, please review that all communication channels are correct and try again.

# 13.2 Veronte can't be detected through USB port

## 13.2.1 Check the COM port

If your **Veronte** unit cannot be detected through the USB port, please check if the PC is able to correctly detect the **COM port**.

On Windows OS systems this is done in the Device Manager:



#### Windows Device Manager

**Warning:** If the **COM port** is not detected, this will indicate a hardware issue. Please verify the integrity and continuity of all harnesses and wirings. If the problem persists please contact support@embention.com, one of our engineers will connect with you to diagnose the problem.

## 13.2.2 Check Pipe/Veronte Link

If the **COM Port** is correctly detected, the next step is to check that **Veronte Pipe/ Veronte Link** is correctly configured to read that **PORT**. Verify that either the individual **PORT** is configured or that the **Autodetect COMs** option is checked:

🔯 Preferences 🏟 😳 🛡 🖋 🛱				
TCP Server	Send telemetry			E Veronte Link (v.1.0.5)
Enable     Port 3000	Host 127.0.	0.1 Port 3000	Frequency 10.0 Hz	⇒ Devices
Autodiscover COMs				<b>?</b> 239.0.0.1
Ethernet	Port	COM3 -		€ COM61
Serial COM	Baudrate	115200 bps 🔹		COM3
	Parity	None 👻		
	Flow Control	None 🔻		
	Data Bits	8 bits 💌		
	Stop Bits	1 bit 👻		
Add 👻				

#### COM Port Configuration

### 13.2.3 Force Maintenance mode

If the **COM Port** is correctly configured but **Veronte** still cannot be detected, its is likely that the USB communication has been disabled in the configuration.

If thats the case, it is necessary to force *Maintenance mode* in order to recover the communication and load a new configuration.

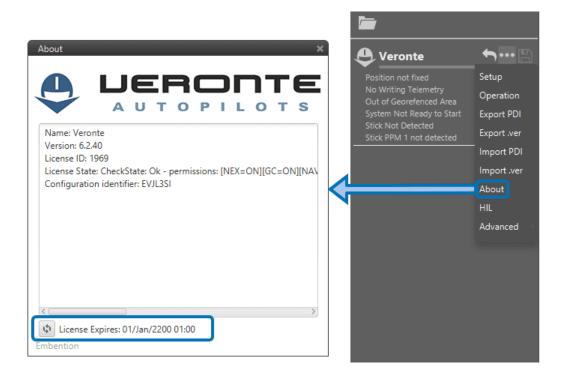
## **13.3 Licensed Expired**

Since 2019, it is not necessary to refresh the Veronte firmware license periodically anymore for lifetime licenses.

Still, if your Veronte unit has an Old License file, or its SD Card was formated recently, it is possible to get a License error when connecting the unit to Veronte Pipe software.

If that is the case, just connect **Veronte** to a PC with **Internet access**, open its **About** tab and then click on the **refresh** button.

ver



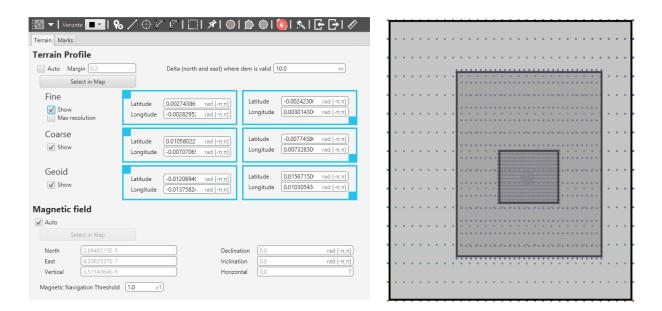


if this does not solve the issue, please contact support@embention.com.

# 13.4 Out of Georeferenced Area

This warning will appear whenever Veronte has no terrain information for its current position.

In order to solve it, go to the **Mission** menu and verify that your current position (as well as your whole **mission area**) is covered by at least one of the **Terrain Meshes**:



License check

### CHAPTER

# FOURTEEN

# **ACRONYMS & DEFINITIONS**

# 14.1 Acronyms

16 VAR	16 Bits variables (Integers)
32 VAR	32 Bits variables (Reals)
ADC	Analog to Digital Converter
AGL	Above Ground Level
AoA	Angle of Attack
ARC	Arcade Mode
AUTO	Automatic Mode
BIT	Bit Variables
CAN	Controller Area Network
CAP	Capture Module
СМВ	Climb Phase
CRU	Cruise Phase
DC	Direct Current
DGPS	Differential GPS
ECAP	Enhanced CAP
ECEF	Earth Centered – Earth Fixed
EGNOS	European Geostationary Navigation Overlay Service
EKF	Extended Kalman Filter
FCS	Flight Control System
FHSS	Frequency Hopping Spread Spectrum
FLR	Flare Phase
FTS	Flight Termination System
GIS	Geographical Information System
GND	Ground
GNSS	Global Navigation Satellite Systems
GPIO	General Purpose Input Output
GPS	Global Positioning System
GS	Ground Speed
GS	Ground Segment
HLD	Hold Phase
HUM	Hardware User Manual
I2C	Inter-Integrated Circuit
IAS	Indicated Air Speed
ID	Identification
ISM	Industrial Scientific and Medical

continues on next page

	Table 1 continued from previous page
LED	Light-Emitting Diode
LND	Landing Phase
MSL	Mean Sea Level
PFD	Primary Flight Display
PID	Proportional Integral Derivative
PWM	Pulse Width Modulation
QNH	Barometric atmospheric pressure adjusted to sea level
RC	Radio Control Mode
RF	Radio Frequency
RPAS	Remotely Piloted Aircraft System
RPM	Revolutions Per Minute
RS 232	Recommended Standard 232
RS 485	Recommended Standard 485
RX	Reception
SMA	SubMiniature Version A Connector
SSMA	Miniature-Sized Connector
STB	Standby Phase
SU	Servo-Output matrix
SUM	Software User Manual
TAS	True Air Speed
ТКО	TakeOff Phase
TX	Transmission
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
US	Output-Servo matrix
VTOL	Vertical TakeOff and Landing
WGS 84	World Geodetic System 84
WP	Waypoint
-	

Table 1 – continued from previous page

# **14.2 Definitions**

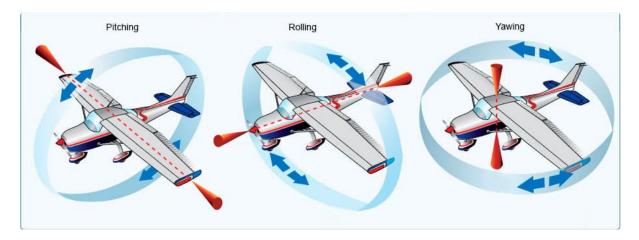
- **Control Phase:** The operation is divided into phases in which the UAV has a specific performance. Each of this phases is called a control phase.
- Control Channel: It is each of the signals used to control a behaviour or action.
- **Control Mode:** It is possible to make a manual control of the UAV by stick, assisted control and fully automatic control.
- Actuator: It is a mechanic device to provide force to move or "act" another mechanical device.

## CHAPTER

## **FIFTEEN**

# **AXES CONVENTION**

All signs in the system are managed according to the international aeronautical axes convention: It is considered positive any deflection that generates positive rotational forces or moments about the aerodynamic centre of the aircraft, except for "y" axis (elevator) where it is considered negative a positive moment.



#### Sign Convention

Example, an elevator down position will generate a positive pitch so the elevator is considered positive on down position. Main actuators rules:

Actuator	Positive	Negative
Elevator	Down	Up
Rudder	Right	Left
Right Aileron	Up	Down
Left Aileron	Down	Up
Tail Rotor	Right	Left

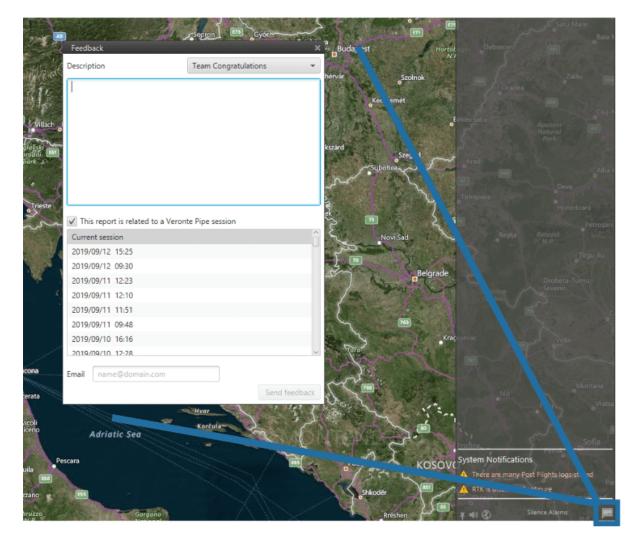
## CHAPTER

## SIXTEEN

# FEEDBACK

# 16.1 Feedback Panel

If you'd like to provide us with feedback on future releases, issue report or even team congratulations, please provide us with all possible details about your Veronte experience and we will be happy to listen and to help you.



Feedback Panel

We have created the tool shown in the previous figure in order to allow the user to directly give us feedback about:

- Team Congratulations: Give us your positive feedback about your Veronte experience.
- Suggestion for Next Releases: All your comments and suggestions would be greatly appreciated.
- **Configuration Support:** Your feedback will be sent directly to our configuration team. They will help you with all your configuration troubles.
- Failure Report: It would be extremely useful to help our developing team reaching all possible information about Veronte System bugs or failures.

Feedback	×
Description	Team Congratulations 🔹
1	
This report is related to a Veron	te Pipe session
Current session	Ô
2019/09/12 15:25	0
2019/09/12 09:30	
2019/09/11 12:23	
2019/09/11 12:10	
2019/09/11 11:51	
2019/09/11 09:48	
2019/09/10 16:16	
2019/09/10 12-28	~
Email name@domain.com	
	Send feedback
	Send reedback

#### Feedback Panel Options

Once the feedback type is selected, the user can add a **Description** to detail the content. Furthermore, the report can be sent adding the reference to the **Veronte Pipe session**, which could be the actual one or the one selected from the list. If the user is interested in having an answer directly to his e-mail address, an **Email** can be inserted in the corresponding field.

When the window is entirely completed and an internet connection is available, it is necessary to click on Send feedback and the report will be sent.

### CHAPTER

## SEVENTEEN

# **COMPATIBLE DEVICES**

## 17.1 Servos and ESC

The user can configure any actuator compatible with the communication interfaces

## 17.1.1 PWM Servos

1. Connect the servo following the manufacturer documentation and follow the *electrical chapter* connect it to Veronte.

Warning: 4x Redundant Veronte autopilot has different pinout specifications.

2. In the setup menu, go to **Connections/PWM** assign a given actuator to the PWM and set a frequency according to the manufacturer. In this example *Actuator Output 1* is assigned to PWM1

Veronte Air 🛪 🙆 🧿	I 🏗 🚱 端 🕰 🗀	▲ #	$\oslash$		
Pin: 1			PWM 1		
			✓ Active Hig	ıh	
			Mode	Time	•
	Frequency 50.0 H	z os	Min	9.0E-4	s
			Max	0.0021	s
			Servo	Actuator Output s1	•
ADC     Arbiter					
CAN			PWM 2		
► FTS			✓ Active Hig	h	
GPIO/EQEP     GPIO			Mode		-
► I2C			Min	9.0E-4	5
▶ Others			Max	0.0021	
▼ PWM					
1			Servo		*
3					
Add 👻					

PWM servo - connections



## 17.1.2 Serial servos

Serial servos are configured different compared to PWM servos since the protocol of a serial device must be defined in *custom messages chapter*. In this case an *Actuator Output* variable must be sent through a serial interface as the protocol for the devices specifies.

#### 17.1.2.1 Servo Volz DA26

1. In the setup menu go to **Devices/Other/I/O Manager**. In this example the routing is set to send *RS custom message 1* to use RS485 bus. As it can be seen for the RS485 consumer and producer configuration.

Actuators	Configu	ration				
Communications		- H 1	Producer	-	Consumer	
Payload	High	05	USB	$\leftrightarrow$	Commgr port 1	0
Sensors	- High	00	Veronte LOS	$\rightarrow$	Commgr port 2	
Stick	High	00	Veronte LTE	$\rightarrow$	None	0
Veronte Others	High	Q0	RS232	<b>→</b>	None	¢.
I/O Manager	High	Q0	RS485		RS custom message 1	0
CAN Config	High	00	Commgr port 1	$\leftrightarrow$	USB	¢.
Digital Input Manager	High	00	Commgr port 2	Ì↔Ì	Veronte LOS	
	High	<b>Q</b> _0	Commgr port 3	$\rightarrow$	None	¢
	High	$Q_0^0$	Commgr port 4	$\rightarrow$	None	0
	High	$Q_0^0$	Commgr port 5	$\rightarrow$	None	¢;
	High	$Q_0^0$	Commgr port 6	$\rightarrow$	None	Q.
	High	$Q_0^0$	RS custom message 1	┝┿	RS485	¢\$
	High	$Q_0^0$	RS custom message 2	$\rightarrow$	None	¢;
Add device	High	$Q_0^0$	RS custom message 3	$\rightarrow$	None	0
Add device		00	Tunnal 1		Nono	1

#### I/O manager configuration

- 2. Next step is to define the protocol specified by the manufacturer.
- In this case a silent mode command (0x77).

[Producer] RS custom message 1	24
	 Variable ASCII
- □ + Matcher x77	 
Value Bits Mask	
119 8 255 dec	
- 🗐 🕂 Matcher x1	
- 📑 🏠 Actuator Output s1	
- 🗊 🕂 CRC (Custom)	

0x77 Silent mode command

• Servo interface Id = 1.

Note: For Volz servos the Id will be different for each servo and/or interface.

[Producer] RS custom message 1	×
- Example Checksum Matcher Skip Varia	able ASCII
- □ + Matcher x77	
- 🕞 🗍 💠 Matcher x1	
Value         Bits         Mask           1         8         255         dec	
- 📑 🗇 💠 Actuator Output s1	
- 🕞 🗍 🕂 CRC (Custom)	
<	>

#### Servo Id

• *Actuator Output* is the variable that carries the information that has to be applied to the servo. Therefore it must be included in the message.

**Note:** For other actuators/devices the *Actuator Output* variable will be needed but it will be sent according to the specific protocol.

[Producer] RS custom message 1									×
- 📑 Message 0 Big endian Period	1.0	s Idle time 0.0	S	Checksum 1	Matcher 2	Skip O	Variable 1	ASCII 0	+
— 📑 🗇 💠 Matcher x77									-
— 📑 🗍 💠 Matcher x1									
- 📑 🗇 💠 Actuator Output s1									
Variable Compression	Decimals	s Encode/Decode	Enc	Max	Dec Min	Max			
Actuator O Compress - Bits Unigned	r 16	1	-0.436	0.436	1568	2527			
— 📑 🗍 💠 CRC (Custom)									
<							)	>	>

#### Actuator Output

• Finally a *Checksum* is needed to complete the communication protocol.

[Produ	cer] RS cust	tom message 1	1									×
	, O 🛛	lessage 0	Big endian	Period 1.0 s	ldle time 0.0	s	Checksum 1	Matcher 2	Skip O	Variable 1	ASCII 0	+
—	I, O	Hatche	er x77									
-	I, O	Hatche	er x1									
-	I, O	+ Actuato	or Output s1									
-	I, O		ustom)									
	Туре	Bits	Endianness			BackTo				R. In R. O	ut Sum8	
Pol	lynomial	• 16	Mixed	Custom	▼ 4	0	40961	65535	0			
<										)		>

Checksum

Note: For more information about checksum take a look here.

# **17.2 Altimeters**

The integration between Veronte and a lidar is performed using a variety of interfaces depending on the lidar device. The most common interfaces are I2C or analog although serial or CAN bus can also be used if the lidar is compatible.

## 17.2.1 Reading altimeter measurement

### 17.2.1.1 ADC lidar

An ADC lidar changes the voltage according to the distance measured and therefore the connection to Veronte is performed using the ADC pins(see section *Electrical*).

Warning: 4x Redundant Veronte autopilot has different ADC pins.

Once connected the value can be monitored in Veronte Pipe by using the variables ADC1 to ADC5. For pin *ANALOG\_1* the correspondent ADC variable in Veronte Pipe is *ADC1*.

- 1. Go to Programs.
- 2. Configure the following operation:

Veronte Air 🛪 🐵 🧿 葦 🕻	3 🗱 🙆 🗔 🔺 🎹 ⊘
0 - ADC LIDAR	ADC LIDAR
	ADC 1 Integer to Real Multiply 3.0 Numerator Denominator Lidar 1 Distance
Add	Memory in use

Lidar operation

After implementing the operation the variable Lidar 1 Distance will represent the distance measured by the lidar.

Note: 4x Redundat Veronte can read up to 36 V for each ADC thus 3 must be chanted to 36 if it is the case.

#### 17.2.1.2 I2C lidar

I2C lidars are configured slightly different. Connect the lidar following the pinout provided by the manufacturer and connect it to the I2C bus of Veronte by following the section *Electrical*. In this case it is not needed to transform the readings from the lidar, the readings will be directly reported in the selected lidar distance variable..

1. Go to Devices/Sensors/I2C devices.

Veronte Air 🛪 🛞 🙆	🗄 🛛 📽 🕰	🗂 🔺 🏭 (	0			
<ul> <li>Actuators</li> </ul>	Lidar I2C					
Communications	✓ Enable Lidar 1	Garmin Lida	▼ Add	dress 98	dec	Digital filter
Payload						Digital hite
▼ Sensors	Enable Lidar 2		- Ado	dress 0	dec	Digital filter
<ul> <li>Accelerometer</li> </ul>						
Altimeter	Enable Lidar 3		- Ado	dress 0	dec	Digital filter
GNSS						Di la Lett
<ul> <li>Gyroscope</li> </ul>	Enable Lidar 4		Add	dress 0	dec	Digital filter
I2C Devices	Enable Lidar 5		- Ado	dress 0	dec	Digital filter
Magnetometer						
<ul> <li>Obstacle detection</li> </ul>						
Pressure						
► RPM						
Speed down						
Ultrasound						
Stick						
▶ Veronte						
Others						
Add device 👻						

I2C Lidar

**Note:** I2C address will be different for different devices make sure to define it properly by checking the manufacturer documentation.

#### 17.2.1.3 CAN Radar

Radar altimeters are common devices for aircrafts. The following pictures correspond to the integration of the Smartmicro Radar. To get more information of the Smartmicro Radar - Altimeter datasheet you can go to:

- Micro Radar Altimeter Web
- Micro Radar Altimeter Data Sheet

This settings will allow Veronte to read from CAN A readings from the radar altimeter. In particular AGL and vertical speed. In the datasheet the user can access to the complete protocol of the device.

1. Go to Connections/CAN/A in the setup toolbar and configure the baudrate.

Veronte Air 🛪 🤅	◙ 至 ♀ ✿ ✿ ◻ ▲ ⅲ ⊘
Pin: 26 🗨	Baudrate 1000000.0 Bd
<ul> <li>ADC</li> <li>Arbiter</li> <li>CAN</li> <li>A</li> </ul>	
► B ► FTS	
► GPIO/EQEP	
► GPIO	
► I2C	
► Others	
► PWM	
<ul> <li>Serial</li> <li>LICP</li> </ul>	
Add 👻	

Baudrate configuration

2. Once the baudrate is set, go to Devices/Others/CAN Config/Configuration.

Set one input filter to read from CAN A in *custom message 1*, in this case Input Filter 3. On the next steps CAN custom message 1 will be configured.

Actuators     Communications			Producer		Consumer	
Payload	High	$\mathfrak{Q}^0_0$	Serial to CAN 1	$\rightarrow$	None	0
Sensors	High	$Q^0_0$	Serial to CAN 2	$\rightarrow$	None	Q
Stick	✓ High	00	CAN custom message 1	-	Output filter 3	0
<ul> <li>Veronte</li> <li>Others</li> </ul>	✓ High	00	CAN custom message 2	Ì→ [	Output filter 4	
I/O Manager	High	$Q_0^0$	Input filter 1	<b>→</b>	None	
CAN Config Digital Input Manager	High	$Q_0^\circ$	Input filter 2	<b>→</b>	None	
	High	$\Omega^{o}_{o}$	Input filter 3	→	Custom message 1	
	🗌 High	$Q^0_0$	Input filter 4	]→[	Custom message 2	¢.
	High	$Q^0_0$	CAN unwrapper 1	$\rightarrow$	None	¢.
	High	$Q^0_0$	CAN unwrapper 2	$\rightarrow$	None	Q.
	High	$Q^0_0$	CAN GPIO remote 1	$\rightarrow$	None	0
	High	$Q^0_0$	CAN GPIO remote 2	$\rightarrow$	None	Q.

CAN routing configuration

3. After specifying that *custom message 1* will receive the data from CAN A, go to **Devices/Others/CAN Config/ Mail Boxes**.

Set the mailboxes for the CAN message id: 1872

<ul> <li>Actuators</li> </ul>	Conf	igurat	tion Custom	message 1	Custom m	nessage 2 Mailboxes	
<ul> <li>Communications</li> </ul>	CAN	AC	AN B				
Payload							
<ul> <li>Sensors</li> </ul>	Unit	s ID	DEC 👻	Units	Mask BIN	-	
<ul> <li>Stick</li> </ul>	Mail	over	reserved RX5	Mailb	oxes availab	ale 27	
<ul> <li>Veronte</li> </ul>	#	JUNCS	Mailboxes		ID	Mask	1
Others	-			Extended			
I/O Manager	1		5		1872	1111111111	
CAN Config							
Digital Input Manager							
Add device 🔹	<						

Mail boxes setting

4. Move to the tab Custom message 1 and add new message under RX with the ID 1872.

🔯 Veronte Air 🛪 🛞 🙆	. ፰ 🛛 📽 🕰 🗖 ム ⅲ 🖉
<ul> <li>Actuators</li> </ul>	Configuration Custom message 1 Custom message 2 Mailboxes
Communications	► TX Ini
Payload	► TX
Sensors	▼ RX
Stick	
Veronte	EXT ID: 1872 Little endian
▼ Others	
I/O Manager	
CAN Config	
Digital Input Manager	
Add device 🔹	

Rx message definition: Id and endianess

5. Define the content of the incoming message:

CAN me	essage ID:	1872					×
Checksum	Matcher	Skip	Variable	ASCII	Position		
0	0	0	2	0	0		
1			dar AGL (Al		ound Level)	) – Height	+
- 🗔		🕂 Rac	dar Speed I	Down			

#### Rx message definition: message content

For more details about CAN messages configuration see Custom Messages.

**Note:** CAN ID messages and messages content will change for different Radar altimeters. Check the documentation of your device for further details.

## 17.2.2 Using altimeter readings

Once the information provided by a lidar sensor is saved in a system variable as Lidar Distance by means of an ADC reading, I2C, serial or CAN. The user has to set how this data will be considered. Common usages are: triggering an action based on a predefined event or considering the lidar data as external sensor which will be considered as an input to the EKF.

• Automation:

Veronte Air 🛪 🙆 🧿	☵ 🚱 📽 跑 🗀 🔺 ⅲ ⊘	
✓ 0 - LND to FLARE	LND to FLARE	
	Events AND OR NOT Actions	+
	0 - Phase LND AND	е
	1 - Lidar Distance < 5 m	
	2 - Runway polygon AND	
	3 - AGL < 10 m	
	Delay 0.0 s Per	riodical: Off
	Varia   Lidar Distance < 5 Compliance time 0.0	S
	Variable Lidar 1 Distance	
	🗸 Max 5.0 🌣	
	Min 0.0 🔅	
	Invert range	
	Min	Лах
New Automation 👻	Event triggered on blue area	

Lidar Automation example

This automation will be triggering a change of phase, flare phase, when the aircraft is landing and at 5 m AGL.

#### • External sensor:

Further information about this menu can be found in *altimeter section*.

Veronte Air 🛪 🙆 🧿	፰ 🚱 🗱 🖽 🗔 🔺 ⅲ ⊘
► Actuators	Senable Altimeter
Communications	Sensor Type Distance 💌
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Min time diff to allow preload 0.1 s
<ul> <li>Accelerometer</li> </ul>	X 0.0 m
Altimeter	Position of altimeter (Body frame) Y 0.0 m
► GNSS	Z 0.0 m
Gyroscope	
I2C Devices	Enable tilt limit
Magnetometer	Input Variable Lidar 1 Distance
Obstacle detection	Enable sensor limits (0.05 m), 40.0 m)
Pressure	Enable sensor limits (0.05 m, 40.0 m))
► RPM	Sensor variance (m²) 0.01
Speed down	
Ultrasound	Maximum variance 1.0
► Stick	Minimum variance 0.01
Veronte	Time to reset variance 1.0
Others	- //[hanned hank)
	τ (filter constant) 1.0
Add device 👻	

Altimeter configuration

# **17.3 External sensors**

Veronte is can be integrated with any external sensor that shares the communication interface. External sensors can be configured to be considered as part of the sensors fusion.

## 17.3.1 Magnetometer Honeywell HMR2300-232

Connect the serial interface according to the manufacturer specifications and following the *electrical chapter* of this document.

Warning: 4x Redundant Veronte autopilot has different pinout specifications.

1. Open the Setup Toolbar and go to Connections/Serial/232 and configure the serial communication settings.

Veronte Air 🛪 🙆	0 🗄 😵 📽	🛛 🚱 🗂 🔺		
Pin: 20	Functionality			
	Baudrate	9600	•	
	Length	8	-	
	Stop	1	-	
	Parity	Disabled	-	
► ADC ► Arbiter				
CAN				
► FTS				
► GPIO/EQEP				
► GPIO ► I2C				
► Others				
► PWM				
Serial     232				
► 485				
Add 👻				

Serial settings

2. Select Devices/Sensors/Magnetometer/Configuration and choose External HMR2300

Veronte Air 🛪 🙆 🧕	፰ 🚱 端 🙆 🗖 🔺 ⅲ ⊘
► Actuators	Use three axis
Communications	Navigation
▶ Payload	Custom setting 👻
▼ Sensors	
Accelerometer	Square error
Altimeter	Decimation 10
► GNSS	0 - Integer var sensor 1
<ul> <li>Gyroscope</li> </ul>	1 - Integer var sensor 2
I2C Devices	2 - Decimal var sensor 1
<ul> <li>Magnetometer</li> </ul>	
Configuration	3 - Decimal var sensor 2
Obstacle detection	4 - Internal
	5 - External HMR2300
Pressure	6 - External LIS3MDL
► RPM	7 - External HSCDTD008A
Speed down	8 - Internal MMC5883MA
Ultrasound	
► Stick	
► Veronte	
► Others 🗸	
Add device 👻	

#### Magnetometer selection

3. Set the rotation matrix according to the installation fo the sensor by clicking in *Edit Rotation Matrix*:

Edit		
1.0	0.0	0.0
0.0	1.0	0.0
0.0	0.0	1.0

Rotation matrix

4. In Devices/Other/ I/O Manager/ select the RS232 to receive External magnetometer information.

<ul> <li>Actuators</li> </ul>	Configu	ration				
Communications		- 8	Producer	_	Consumer	
<ul> <li>Payload</li> </ul>	High	05	USB	$\rightarrow$	Commgr port 1	-
Sensors	High	Q0	Veronte LOS		Commgr port 2	
Stick	High	00	Veronte LTE	$\rightarrow$	None	0
<ul> <li>Veronte</li> <li>Others</li> </ul>	High	Q0	RS232	]↔[	External magnetometer	
I/O Manager	High	00	RS485	$\rightarrow$	None	-03
CAN Config	High	00	Commgr port 1	→	USB	4
Digital Input Manager	High	00	Commgr port 2		Veronte LOS	
	High	Q0	Commgr port 3	$\rightarrow$	None	
	High	00	Commgr port 4	$\rightarrow$	None	
	High	00	Commgr port 5	$\rightarrow$	None	
	High	00	Commgr port 6	$\rightarrow$	None	
	High	$Q_0^0$	RS custom message 1	$\rightarrow$	None	Q
	High	00	RS custom message 2	$\rightarrow$	None	
Add device	High	00	RS custom message 3	$\rightarrow$	None	-
Add device		00	Tunnel 1		None	1

Producer

Actuators	Configu	ration			
Communications	High	3460	Producer Commgr port 3	Consumer None	24
Payload	High	Q0	Commgr port 4	None	4
Sensors Stick	High	00	Commgr port 5	None	
Veronte	High	Q0	Commgr port 6	None	
Others	High	00	RS custom message 1	None	0
I/O Manager CAN Config	High	00	RS custom message 2	None	
Digital Input Manager	High	<b>Q</b> _0	RS custom message 3	None	0
	High	$\dot{Q}^{0}_{0}$	Tunnel 1	None	4
	High	00	Tunnel 2	None	0
	High	<b>Q</b> _0	Tunnel 3	None	0
	High	00	GPS 1 RTCM	None	0
	High	Q0	GPS 2 RTCM	None	0
	High	$Q_0^0$	External magnetometer	• RS232	0
	High	Q <sub>0</sub> <sup>0</sup>	External ultrasound	None	¢

#### Consumer

To get more information about the Magnetometer Honeywell HMR2300-232 datasheet check out: Smart Digital Magnetometer HMR2300.

## 17.4 USB devices

## 17.4.1 Adding a USB joystick

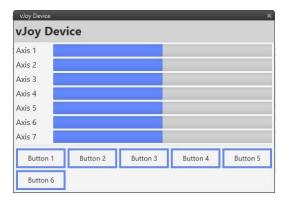
Veronte Pipe is able to detect USB devices such as joysticks. The buttons and axis of these devices can be read and configured to send stick information to Veronte Autopilot.

- 1. Connect your USB device to the computer and open Veronte Pipe.
- 2. Go to Preferences/General in Veronte Pipe. The USB device will be automatically detected and displayed.

Disable commit option at PDI saving				
oysticks	Sound			
🔹 vJoy Device	warning	Play	Change	Default
	U1	Play	Change	Default
	U2	Play	Change	Default
	U3	Play	Change	Default
	U4	Play	Change	Default
	U5	Play	Change	Default
	U6	Play	Change	Default
	U7	Play	Change	Default
	U8	Play	Change	Default
	U9	Play	Change	Default

Joystick device

Clicking the readings of the USB device channels will be visualized.



Usb device channels

## 17.4.2 Defining a virtual stick

Once the usb device is recognized:

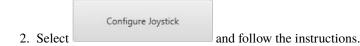
1. Add a virtual Stick: On the workspace window, select New , (\*) Telecommand and then stick.

Workspace								
Telemetry Map								
[Fixed widgets]	Name			Veronte	SELEC	TED-VERONTE -		
(IN) Stick				veronte	SELEC	TED-VERONTE *		
	Opacity				0			
	Pos X	190.0	Pos Y	86.0				
	Width	300	Height	300				
	V Horizon	Horizontal Axis		Vertical Axis		Frequency (Advanced)		
	Channel	11	▼ Channel	12	• M	in 10.0 H:		
	Axis Scale	100.0	Axis Scale	100.0	м	ax 10.0 H:		
	X initial:	Center	▼ Y initial:	Center	•	Start enabled		
	Endpoint	Endpoint Endpoint						
	Min	0.0	x1 Min	0.0	x1	Conformation to study		
	Max	1.0	x1 Max	1.0	x1	Configure Joystick		
New	✓ Return t	o initial point	Return f	to center				

Josytick workspace menu

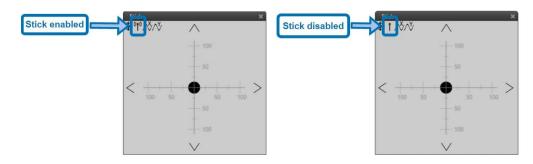
#### Josytick widget

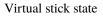
- 2. Assign a USB device channel to a stick input variable.
  - 1. For each axis specify which channel will be considered by choosing one of the channels listed.



- 3. Verify that the movement of the virtual stick is associated with the movement of the USB device.
- 4. Check that the stick input variables are changing with the movement of the virtual stick. i.e for channel 1, stick input r1.

**Note:** The virtual stick will be active by clicking on the antenna button.





Note: It is recommended disabling the axis that are not used.

**Warning:** A virtual stick can command on the same channels as a physical stick box. Make sure that the channels are not interfering to each other.

# 17.5 Silvus radio (StreamCaster 4200E model)

## 17.5.1 System Layout

The following image shows the standard connection between Silvus radios and 1xVeronte for operation:



#### Fig. 1: Silvus and Veronte connection

## 17.5.2 Hardware Installation

A wiring configuration of the PRI cable connected to the PRI port of the radio is required in order to connect to the power supply, ethernet and RS-232.

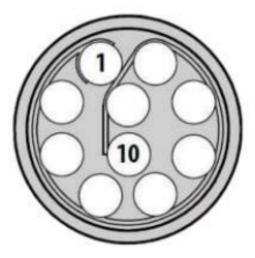


Fig. 2: PRI port connector (mounted in radio)

• Power supply



Fig. 3: Female DC Power Jack connector

PRI port connect	Power connector	
PIN № Signal		Signal
2	GND IN	Power -
3	VCC IN	Power +

• Ethernet

Fig. 4: RJ45 pinout T-568B

PRI port connecto	RJ45 Connector (T-568B)			
PIN Nº Signal		PIN №	Signal	Color
4	ETH0_MX2N (RX-)	6	RX-	Green
5	ETH0_MX2P (RX+)	3	RX+	Green-White
6	ETH0_MX1P (TX+)	1	TX+	Orange-White
10	ETH0_MX1N (TX-)	2	TX-	Orange

#### • RS-232

The RS-232 from the PRI cable should be connected to the RS-232 of Veronte harness.

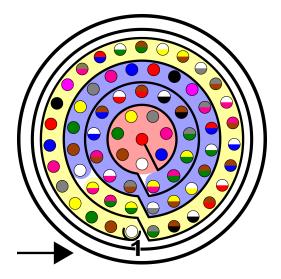


Fig. 5: CS harness plug

PRI port connecto	CS harness - Veronte			
PIN Nº	Signal	PIN №	Signal	Color
7	RS232_RXD	19	RS 232 TX	White-Pink
8	RS232_TXD	20	RS 232 RX	Pink-Brown
9	GND	21	GND	White-Blue

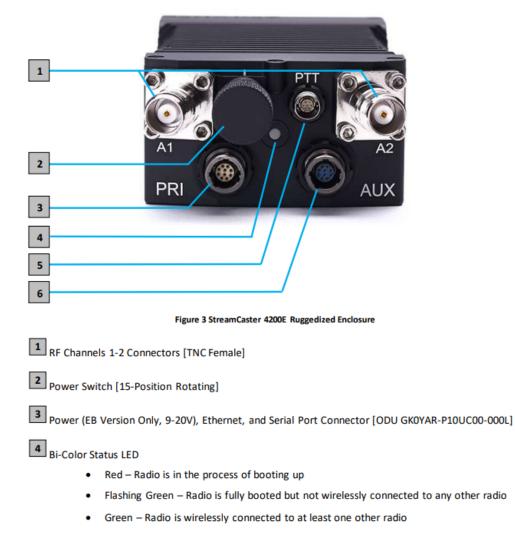
## 17.5.3 Silvus radio configuration

This section shows a basic configuration of the Silvus radio.

#### 17.5.3.1 First Steps

Follow the steps below to set up the radio

- 1. Connect antennas (or attenuators) with male TNC ends to 2 RF ports.
- 2. Connect power supply to power port on PRI cable.
- 3. Connect non-forked female side of PRI cable to radio's PRI port.



#### Fig. 6: Silvus connectors

- 4. When looking at the rotary multi position switch from the top, pull the knob towards you while rotating the knob towards the 1 position. This turns radio on. LED indicator will turn to fix red.
- 5. In order to access the StreamScape graphical user interface (GUI), connect Ethernet (RJ45) connector of PRI cable to Ethernet port of laptop/computer.
- 6. Make sure computer is set to static IP address on same subnet as radio.
  - a. Open network and sharing menu and click change adapter settings.

÷	Network and Sharing Centre					- 0	×
<	🗧 🔶 👻 🛧 🚆 > Control Pane	> Network and Internet > Network and Sharing Centr	e ~	Ö	Search Control Panel		Q,
	Control Panel Home	View your basic network information and s View your active networks	Access type: Internet				
	Change advanced sharing settings Media streaming options	Embention 2 Public network	Access type: Internet Connections: M Wi-Fi (Embention)				
		<b>Red no identificada</b> Public network	Access type: No Internet access Connections: I Ethernet				
		Change your networking settings					
		Set up a new connection or network Set up a broadband, dial-up or VPN connection, or set up a router or access point.					
		Diagnose and repair network problems or get troubleshooting information.					
	Constant						
	See also Internet Options						
	Windows Defender Firewall						

### Fig. 7: Ethernet connection 1

b. Select Local Area Connection, right click, and select properties.

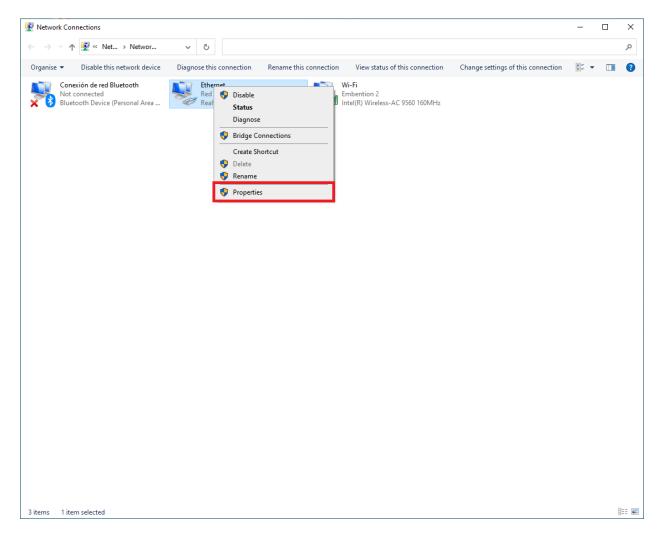


Fig. 8: Ethernet connection 2

c. Select IPv4 and click properties.

Ethernet Properties	$\times$
Networking Sharing	
Connect using:	
Realtek PCIe GbE Family Controller	
Configure	
This connection uses the following items:	
🗹 🌄 Cliente para redes Microsoft	~
🗹 🔄 Uso compartido de archivos e impresoras para redes M	
Programador de paquetes QoS	
Protocolo de Internet versión 4 (TCP/IPv4)	
Protocolo de multiplexor de adaptador de red de Micros	
Controlador de protocolo LLDP de Microsoft	
Protocolo de Internet versión 6 (TCP/IPv6)	<u>_</u>
< >	
Install Uninstall Properties	
Description	
Protocolo TCP/IP. El protocolo de red de área extensa	
predeterminado que permite la comunicación entre varias	
redes conectadas entre sí.	
OK Cance	el

Fig. 9: Ethernet connection 3

d. Set IP address to 172.20.XX.YY (e.g. if the IP of the radio is 172.20.178.203, set the IP 172.20.178.200) and subnet mask to 255.255.0.0. Click OK.

Protocolo de Internet versión 4 (TCP/IPv4) Properties				
General				
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.				
Obtain an IP address automatical	y			
Use the following IP address:				
IP address:	172 . 20 . 178 . 200			
Subnet mask:	255.255.0.0			
Default gateway:				
Obtain DNS server address auton	natically			
Use the following DNS server add	resses:			
Preferred DNS server:				
Alternative DNS server:				
Ualidate settings upon exit	Advanced			
	OK Cancel			

Fig. 10: Ethernet connection 4

- 7. Wait for LED indicator to turn to blinking green.
- 8. Access StreamScape GUI in web browser. To access, enter IP address of radio into web browser and press enter.

Note: Latest version of Firefox or Google Chrome preferred. IE or others not recommended.

(•) 172.20.178.203 - StreamCaster M × +					$\sim$	-	٥	$\times$
← → C 🔺 No es seguro   172.20.178.203		B 6	\$	0	* «	*		:
K Embention								
$\equiv \oplus$	SILVUS TECHNOLOGIES							
Local Radio Configuration <b>*</b> Basic Configuration			IP: 172.	20.178.	203			



9. User maual can be accessed by clicking the book icon in the GUI (Next to "Basic Configuration" in above screenshot.)

#### 17.5.3.2 Basic radio configuration

Once the website has been accessed, follow the steps below which show the parameters that need to be modified for correct operation and pairing of the radios.

**Note:** This is an example of the radio configuration linked to a Veronte air unit.

Note: After making changes to each window, it is important to click on "Save and apply".

#### 1. Basic Configuration

(••) 192.168.8.96 - StreamCaster MIM × (••)	192.168.895 - StreamCaster MIN 🗴   🕂	~ - O X
← → C ▲ No es seguro   192.16	\$8.8.96 B)	🖻 🕁 🗟 🤣 🗰 🔇 🛊 🔲 🛛 🗄
Embention		
	SILVUS technologies	=
Local Radio Configuration	Basic Configuration	IP: 172.20.179.131
RF	•	VIP: 192.168.8.96
	Frequency 2220 Bandwidth 20 MHz	Node Label: node45955_179.131
Basic		Temperature: 38°C
	Network ID EMB-SILV Link Distance 50000	Voltage: 11.69 V
Advanced	(meters)	GPS Mode: Unlocked
Networking	Total Transmit     Power     15 dBm / 0.032 W     Routing Mode Legacy	GPS Coordinates:
Bidirectional Amplifier	(requested)	34.057118.447_0
Bidirectional Ampliner	APPLY SAVE AND APPLY	Night Mode: 📃 🗆
Serial/USB Setup	AFEL SAVE AND AFEL	Scrollbars:
PTT/Audio		
Network Management	F	
Spectrum Dominance	•	
Security	×	© 2022 Silvus Technologies, Inc.   Legacy

Fig. 12: Basic configuration panel

• **Frequency** (**MHZ**): This defines the frequency of the signal. There is a drop-down menu for frequency selection. We recommend 2220 MHz.

**Warning:** Be careful when choosing the frequency. The user may see interference with the Wifi frequency band, consult the radio spectrum.

- **Bandwith**: This defines the RF bandwidth of the signal. Default value.
- Network ID: Network ID allows for clusters of radios to operate in the same channel, but remain independent. A radio with a given Network ID will only communicate with other radios with the same Network ID.
- Link Distance (meters): Set to an approximate maximum distance between any two nodes in meters. It is important to set the link distance to allow enough time for packets to propagate over the air. It is recommended to set the link distance 10-15% greater than the actual maximum distance.
- **Total Transmit Power (requested)**: This defines the total power of the signal (power is divided equally between the radio antenna ports). Set the appropriate power for each application. The power that has been set is small, as

it is sufficient for our tests.

• **Routing Mode**: As *Large Network* mode requires a license and is not available outside USA, we set *Legacy* mode.

(+•) 192.168.8.96 - StreamCaster MIM × (+•)	192.168.8.95 - StreamCaster MIM × +	~ - <b>D</b> ×
← → C ▲ No es seguro   192.1	3.8.96	🕸 🖻 🛧 🗟 🔣 🜟 🕻 🖈 🔲 🗄
Embention		
≡ ±		
Local Radio Configuration	Fragmentation Threshold Retransmissions	IP; 172.20.179.131
RF	▼ 1600 Bytes	VIP: 192.168.8.96
	-	Node Label: node45955_179.131
Basic	MCS Extended Auto	Temperature: 38°C
Advanced		Vollage: 11.69 V
Advanced		GPS Mode: Unlocked
Networking	>	GPS Coordinates:
Bidirectional Amplifier	GI Mode Variable - 16/32 Beam Forming	34.057118.447_0
Didirectional Ampliner		Night Mode:
Serial/USB Setup	Transmit Channels Receive Channels	Scrollbars:
PTT/Audio		2: 010 4: 010
Network Management	Radio Mode Network Mode(0)	
Spectrum Dominance	APPLY SAVE AND APPLY APPLY NETWORK SAVE AND APPLY NETWORK	
Security	>	© 2022 Silvus Technologies, Inc.   Legacy

2. Advanced configuration

Fig. 13: Advanced configuration panel

- **Transmit/Receive Channels**: Allows user to Enable or Disable each channel on the radio for TX/RX (each RF port is a channel). We have enabled both channels.
- 3. Networking. Multicast

(••) 192.168.8.96 - StreamCaster MIM × (••) 192.168.	895 - StreamCaster MIN 🗴   🕇	~ - <b>D</b> X
← → C ▲ No es seguro   192.168.8.96	2g	🖻 🖈 🗟 🤣 🕊 🔇 🗯 🔲 🛛 🗄
Embention		
		=
Networking <b>v</b>	Multicast 🗉	IP: 172.20.179.131
LAN Settings	Default Legacy	VIP: 192.168.8.96 Node Label: node45955 179.131
DLEP Settings	Multicast Algorithm Groups	Temperature: 38°C
WIFI Settings		Vollage: 11.71 V
DHCP Server	IGMP Snooping <sup>®</sup>	GPS Mode: Unlocked GPS Coordinates:
Multicast	Action for un- registered Block (Default) multicast Block (Default)	34.057118.447_0
QoS	traffic	Night Mode:
Infrastructure Networks	Custom Pruning/Augmenting	
Bidirectional Amplifier		
Serial/USB Setup	MANET Multicast/Broadcast	
PTT/Audio	APPLY SAVE AND APPLY APPLY NETWORK SAVE AND APPLY NETWORK	🛛 2022 Silvus Technologies, Inc.   Legacy

Fig. 14: Multicast panel

- Default Multicast Algorithm: Broadcast.
- Custom Pruning/Augmenting: Disable.
- 4. Serial/USB Setup

(••) 192.168.8.96 - StreamCaster MIN 🗙 (••)	192.168.8	95 - StreamCaster MIN 🗙 📔 🕂		~ - • ×
← → C ▲ No es seguro   192.16	68.8.96		₿ <sub>₽</sub>	🖻 🖈 🗟 🤣 🕊 🔇 🗯 🔲 🛛 🗄
Embention				
= +		Sil	LVUS Nologies	=
Local Radio Configuration	•	Serial Port Setup (Native) 🗉		IP: 172.20.179.131
RF	•			VIP: 192.168.8.96
		Serial Port Mode RS-232		Node Label: node45955_179.131
Basic		RS-232 Serial Port Settings		Temperature: 38°C
Advanced				Voltage: 11.71 V
Auvanocu		Baud Rate 115200	Data Bits 8	GPS Mode: Unlocked
Networking	•			GPS Coordinates:
		Parity None (N)	Stop Bits 1	34.057118.447_0
Bidirectional Amplifier				Night Mode:
Serial/USB Setup		Software Flow Control	Transport Protocol UDP	Scrollbars:
PTT/Audio		Peer IP 172.20.178.203	Peer Port 54321	
Network Management	•			
Spectrum Dominance	•	WIG-GPS Dongle Apply Save and Apply Apply Network	SAVE AND APPLY NETWORK	
Security	•	Enable		© 2022 Silvus Technologies, Inc.   Legacy

Fig. 15: RS-232 settings

• Serial Port Setup: RS-232.

- RS-232 Serial Port Settings
  - The value of the **Baudrate**, **Data Bits**, **Parity** and **Stop Bits** parameters must be the same as those configured in Veronte Pipe.
  - Software Flow Control: Disable.
  - **Transport Protocol**: We recommend **UDP**. If no data loss can be tolerated, change this setting to TCP on the radio corresponding to the Veronte **air** unit.
  - **Peer IP**: This should be the IP address of the radio on the other end of the RS-232. In this example, we must set the IP address of the radio linked to the GND unit.

**Note:** Both radios (the one connected to the GND unit and the one connected to the AIR unit) have the same configuration except for the **Peer IP**.

(••) 192.168.8.96 - StreamCaster MIM × (••) 19.	2.168.895 - StreamCaster MIN × +	~ - <b>D</b> ×
← → C ▲ No es seguro   192.168.8	8.95 8	🖻 🖈 🗟 🤣 🕊 🔇 🗯 🔲 🛛 🗄
Embention		
= +		=
Local Radio Configuration	Serial Port Setup (Native) 🗉	IP: 172.20.178.203
RF	Serial Port Mode RS-232	VIP: 192.168.8.95 Node Label: node45771 178.203
Basic	RS-232 Serial Port Settings	Temperature: 39℃
Advanced	Baud Rate 115200 Data Bits 8	Voltage: 11.82 V GPS Mode: Unlocked
Networking P		GPS Coordinates:
Bidirectional Amplifier	Parity None (N) Stop Bits 1	34.057118.447_0 Night Mode:
Serial/USB Setup	Software Flow Control Disable Transport Protocol UDP	Scrollbars:
PTT/Audio	Peer IP 172.20.179.131 Peer Port 54321	
Network Management		
Spectrum Dominance	APPLY SAVE AND APPLY APPLY NETWORK SAVE AND APPLY NETWORK	
Security	Enable	© 2022 Silvus Technologies, Inc.   Legacy

Fig. 16: Peer IP in radio linked to the GND unit

In addition to these settings, different configurations can be stored in the same radio, on the **Multi-Position Switch** panel. The user can select the one that will work, with the radio's switch position.

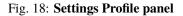
(••) 192.168.8.96 - StreamCaster MIM 🗙	(*) 192.168.8.95 - StreamCaster MII: × +	~ - 🗆 ×
← → C ▲ No es seguro   1	92.168.8.96 💩 🔤	요 ☆ 🗟 🔗 💥 🔇 🗯 🔲 🛛 🗄
Embention		
	SILVUS TECHNOLOGIES	
Local Radio Configuration	MPS Switch Position 1	IP: 172.20.179.131
Network Management		VIP: 192.168.8.96
		Node Label: node45955_179.131
Spectrum Dominance	Group Type Network	Temperature: 38°C
Convertitor	► Position 1 mirrors the Basic Tab.	Voltage: 11.71 V
Security		GPS Mode: Unlocked
Tools and Diagnostics		GPS Coordinates:
	Network ID EMB-SILV Frequency 2220	34.057118.447_0
Configuration Profiles		Night Mode:
Settings Profile	Bandwidth 20	Scrollbars:
Multi-Position Switch	Switch Configurations	
	Switch Configurations	
	1         2         3         4         5         6         7           Network ID         EMB-SILV         Image: Comparison of the second	
	APPLY SAVE AND APPLY APPLY NETWORK SAVE AND APPLY NETWORK	© 2022 Silvus Technologies, Inc.   Legacy

Fig. 17: Multi-Position Switch panel

In this example only one configuration has been created.

With the above settings the configuration is finished. Furthermore, this configuration can be saved and downloaded in the **Settings Profile** window of the Configuration Profiles section.

(••) 192.168.8.96 - StreamCaster MIN 🗙 (••) u	ser_manual.pdf x   (••) 192.168.8.95 - StreamCaster MIN x   +		~ - O ×
← → C ▲ No es seguro   192.168	.8.96	<b>闘 Q ビ</b>	☆ 🗟 🗳 🔆 🌲 🖬 🛛 🗄
Embention			
≡	STL	VUS Diodies	
Local Radio Configuration 🕨	Current Saved Profiles		IP: 172.20.179.131
Network Management			VIP: 192.168.8.96
	Saved Profiles		Node Label: node45955_179.131
Spectrum Dominance	APPLY SAVE AND APPLY DOWNLOAD DELETE SEM	ND PROFILE TO NETWORK	Temperature: 38°C
Security ►	APPLT SAVE AND APPLT DOWNLOAD DELETE SEP	ND PROFILE TO NETWORK	Voltage: 11.64 V
Security			GPS Mode: Unlocked
Tools and Diagnostics	Upload Profile		GPS Coordinates:
Configuration Profiles	Settings File		34.057118.447_0
Configuration Profiles	Seleccionar archivo Ninguno archivo selec.	Settings Name	Night Mode:
Settings Profile	Seleccional alchivo minguno alchivo selec.		Scrollbars:
Multi-Position Switch	UPLOAD		
	<b>↓</b>		
	Save Current Settings		
	Settings Name	Include Virtual IP Settings	
	SAVE		© 2022 Silvus Technologies, Inc.   Legacy



(••) 192.168.8.96 - StreamCaster MIM × (••)	user_manual.pdf x   🕪 192.168.8.95 - StreamCaster MIN: x   +	~ - <b>D</b> X
$\leftarrow$ $\rightarrow$ $C$ $\blacktriangle$ No es seguro   192.1	8.8.96	🖻 🛧 🗟 🤣 🗰 🔇 🗯 🔲 🛛 🗄
Embention		
= +	SILVUS	
Local Radio Configuration	APPLY SAVE AND APPLY DOWNLOAD DELETE SEND PROFILE TO NETWORK	IP: 172.20.179.131
Network Management	×	VIP: 192.168.8.96
5		Node Label: node45955_179.131
Spectrum Dominance	Upload Profile	Temperature: 38℃
0	► Settings File Settings	Voltage: 11.78 V
Security	Seleccionar archivo Ninguno hivo selec.	GPS Mode: Unlocked
Tools and Diagnostics		GPS Coordinates:
	UPLOAD	34.057118.447_0
Configuration Profiles		Night Mode:
Settings Profile		Scrollbars:
	Save Current Settings	
Multi-Position Switch	Settings Include	
	Settings Name Embsilvusair Include Virtual IP Settings	
	SAVE	
		© 2022 Silvus Technologies, Inc.   Legacy

Before downloading the configuration it is necessary to save it.

Fig. 19: Save settings

(•) 192.168.8.96 - StreamCaster MIM × (•)	user_manual.pdf x   🖗 192.168.895 - StreamCaster MIN x   +	~ - <b>D</b> ×
← → C ▲ No es seguro   192.16	58.8.96 B	🖻 🖈 🗟 Ø 🜟 🔇 🗯 🔲 🛛 🗄
Embention		
= +	SILVUS Iternologies	=
Local Radio Configuration	Settings Profile	IP: 172.20.179.131
Network Management	•	VIP: 192.168.8.96
		Node Label: node45955_179.131
Spectrum Dominance	Current Saved Profiles	Temperature: 38°C
Security	Saved Embsilvusair	Voltage: 11.66 V
Security	Profiles	GPS Mode: Unlocked
Tools and Diagnostics	APPLY SAVE AND APPLY DOWNLOAD DELETE SEND PROFILE TO NETWORK	GPS Coordinates:
		34.057118.447_0
Configuration Profiles		Night Mode:
Settings Profile	Upload Profile	Scrollbars:
Multi-Position Switch	Settings File Settings	
	Seleccionar archivo Ninguno hivo selec.	
	UPLOAD	
	SAVE	
		© 2022 Silvus Technologies, Inc.   Legacy

Fig. 20: Download settings

After configuring both radios with these settings they should be paired. Therefore, if we connect them to the power supply, when we switch them on, the LED will turn from fix red to fix green, this indicates that it is connected to at

least one radio. Also, if we connect only one of them to the computer, we can access the StreamScape GUI of both of them.

And, in the Network Topology window of the Network Management section, we can see the link between them.

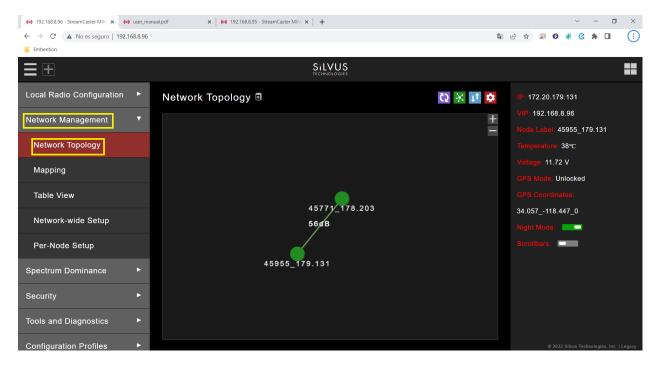


Fig. 21: Connection between radios

## 17.5.4 Silvus radio configuration in Veronte Pipe

The only configurations to be made in Veronte Pipe are the following:

1. Go to Connections -> Serial -> 232

Check that they are the same as the parameter values previously set in the Silvus radio.

	0 🗄 🛛 🗳	\$ 🚯 🗂 🔺 (	⊘ ☷
Pin: 19 🗨	Functionality		
	Baudrate	115200	•
(•	Length	8	•
	Stop	1	•
	Parity	Disabled	•
CAN			
► FTS			
<ul> <li>▶ GPIO/EQEP</li> <li>▶ GPIO</li> </ul>			
► 12C			
▶ Others			
▼ Serial ▼ 232			
RX			
тх			
▶ 485			
► USB			
Add 👻			

Fig. 22: RS-232 connection configuration

2. Go to Devices -> Others -> I/O Manager

RS-232 has to be configured as a bidirectional commgr port.

<ul> <li>Communications</li> </ul>	Configuration				
<ul> <li>Micro</li> </ul>	Priority	Producer		Consumer	
Payload	High 🗘	USB	$\rightarrow$	Commgr port 1	0
Sensors	High 😡	Veronte LOS	↔	Commgr port 2	
<ul> <li>Stick</li> </ul>	High 🕸	Veronte LTE	$\leftrightarrow$	Commgr port 3	0
<ul> <li>Veronte</li> <li>Others</li> </ul>	High 🕸	RS232	$\leftrightarrow$	Commgr port 4	0
I/O Manager	High 🔯	RS485	$\rightarrow$	Commgr port 6	0
CAN Config	High 🔯	Commgr port 1	<b>→</b>	Y1 splitter	Q.
Digital Input Manager	High 🕸	Commgr port 2	→	Veronte LOS	Q.
	High 🔯	Commgr port 3	→	Veronte LTE	Q;
	High 🔯	Commgr port 4	$\leftrightarrow$	RS232	Q.
	High 🔯	Commgr port 5	→	Serial to CAN 1	
	High 🔯	Commgr port 6	$\rightarrow$	None	Q;
	High 🙀	RS custom message 1	$\rightarrow$	None	Q;
	High 🙀	RS custom message 2	$\rightarrow$	None	Q.
	High 🕵	RS custom message 3	$\rightarrow$	None	0

Fig. 23: **RS-232 connection configuration** 

Note: These settings have to be made in both Veronte units (GND and AIR).













AVIONICS

# SONY OCTOPUS ISR SYSTEMS SightLine











## CHAPTER

## EIGHTEEN

# **4X REDUNDANT AUTOPILOT - ARBITER**



#### 4x Redundant Autopilot

**Note:** This section makes reference to the **Arbiter** device in **4x Veronte**. For information about **4x Veronte** and its hardware please check *this section*.

**4xVeronte Autopilot** is a triple redundant version of the Veronte Autopilot. It includes three complete Veronte Autopilot modules together with a dissimilar arbiter for detecting system failures and selecting the module in charge of the control.

All three modules are managed by a dissimilar microprocessor, the **Arbiter**. The **Arbiter** works in paralel to the Veronte units, monitors their status, and decides which one has access to the 4x connector based on a scoring algorithm.

The 4x Arbiter also includes a range of extra interfaces including **RS232**, **RS485**, **GPIO**, **ADC** and **CAN**, as well as the possibility of connecting a fourth autopilot to the arbitrating system.

# **18.1 Arbitration**

The arbitration algorithm in **Veronte 4x** is based on a **scoring system**.

Each autopilot must send continuously a set of **Arbitration Variables** that will be used by the arbiter in order to calculate the score for each unit.

Then, based on the scores and the current **Arbitration mode**, the arbiter will choose to keep the current **Selected autopilot**, or switching to one of the other units.

Arbitration

## 18.1.1 Scoring System

A Score is a 32 bit, single precission, floating-point value with a range between 0 and 0xFFFFFFFF, where 0 is a Perfect score. That is, the lower the value, the better the score.

Scores are calculated using the **Arbitration variables** received from each autopilot at their dedicated addresses. After receiving the value, each variable is multiplied by their respective **Arbitration weight**, and then it is used to compute the score for their respective unit.

**Tip:** The Arbitration weights should be used to increase or decrease the relevance that a certain arbitration variable has over the calculation of the score.

Any Variable in Veronte can be used as an arbitration variable. Depending on the platform, operation, application etc. the more relevant variables can be selected for its use as arbitration references.

Currently, the maximum amount of arbitration variables supported is 6.

#### **18.1.1.1 Absolute Arbitration Variables**

Absolute arbitration variables are indicators that are inherently **good** or **bad**, and so they are added directly to the score.

Examples of absolute arbitration variables are Link Quality, GNSS accuracy or warnings such as Sensors error or Position not fixed.

#### 18.1.1.2 Relative Arbitration Variables

Relative arbitration variables are not inherently good or bad, and hence need to be compared against the other autopilots in order to calculate its score contribution.

The contribution to the score from a relative arbitration variable will be its **Deviation** from the **Average** of the same variable from each autopilot.

Examples of relative arbitration variables are Attitude, Position, measurements from sensors, etc.

Autopilot	Var.	Veronte	Туре	Value	Mean	Deviation	Weight	Score	Total
-	N⁰	Variable					-		Score
1	1	Roll	Relative	0.12	0.096	0.024	1	0.024	0.058
	2	Pitch	Relative	0.30	0.283	0.017	1	0.017	
	3	GNSS 1	Absolute	1.7			0.01	0.017	
		Accuracy							
2	1	Roll	Relative	0.10	0.096	0.004	1	0.004	0.026
	2	Pitch	Relative	0.28	0.283	0.003	1	0.003	
	3	GNSS 1	Absolute	1.9			0.01	0.019	
		Accuracy							
3	1	Roll	Relative	0.07	0.096	0.026	1	0.026	0.054
	2	Pitch	Relative	0.27	0.283	0.013	1	0.013	
	3	GNSS 1	Absolute	1.5			0.01	0.015	
		Accuracy							

Lets see a practical example:

Arbitration Example

In the above example, AP2 is considered to be the **best**, since it has the **lowest score**. Vven though its **GNSS accuracy** is the worst of all 3, its values for pitch and roll are the ones with the lower deviation from the mean.

## 18.1.2 Arbitration modes & parameters

The following parameters will determine the selected autopilot at each moment depending on the scores

#### 18.1.2.1 Arbitration modes

The main arbitration modes are the following:

- Always best: The selected autopilot is always the one with the best score.
- **Change if worst:** The arbiter will only switch if the currently selected autopilot has the worst score. In that case, it will switch to the one with the best score.
- **Fixed while ok:** This mode does not take into account scores. In this mode, the **Preferred** autopilot will be selected by default. A switch will only happen if the current autopilot is considered **Dead** (See **Alive Status** in *Arbiter Operation*).

Additionally, the following modes are also available:

- **Round Robin Control:** The arbiter will periodically switch between autopilots. This mode is meant for testing purposes only.
- **Fixed:** Arbitration is disabled and one autopilot is selected arbitrarily. In this mode 4x Veronte will behave as a 1x Veronte.

#### 18.1.2.2 Arbitration parameters

- **Preferred autopilot:** The preferred autopilot will be chosen in case of a draw. **Fixed while ok** mode will always select this autopilot first.
- Holding CAP time: Amount of time needed from last switch in order to allow a new switch.
- Hysteresis: When comparing scores, the difference between them needs to be bigger than this value in order to consider a score better or worse than other. The difference is proportional to the score of the selected **autopilot**.

**i.e.** If current selected autopilot is AP1, arbitration mode is **Always best**, hysteresis is **0.5** and score for AP1 is **0.3**, AP2 will need a score lower than **0.15** in order to be selected.

## **18.2 Operation**

## 18.2.1 Arbiter Boot

When the arbiter is booted, it enters an **Iddle** state, trying to verify the status of the system.

While Iddle, the Status Message is not sent.

If all checks success, the arbiter will enter Normal mode.

If, after 30 seconds, system errors are still present, arbiter will enter Maintenance mode.

#### 18.2.2 Status message

Once in Normal mode, the Arbiter will start sending the Status and Scores telemetry messages.

The frequency of these messages is configurable. They can also be disabled.

The status message contains information such as:

- Arbitration ON/OFF
- · Selected autopilot
- System BITs
- etc.

While in **Maintenance Mode**, the Arbiter will send the **Status** message, even if it is disabled, but will not send the **Scores** messages.

## 18.2.3 Ready Status

After the Arbiter enters **Normal mode**, it will wait until a **Ready Message** from each autopilot is received. Only then the Arbitration will start.

#### Normal Arbitration start

If the Arbiter is in maintenance mode, the Arbitration **will not start**. Even if the **Ready messages** are recived.

#### Failed Arbitration start

## 18.2.4 Alive Status

Once arbitration starts, all autopilots are declared as alive by default, but it is possible that they are declared as **Dead** if a critical error is found.

#### APs being declared Dead

Tha arbiter will declare an autopilot dead if one of the following incidences is found:

- One of the arbitration messages (including the Ready message) is not received for 0.1 seconds.
- A Not Ready message is received.
- A System Not OK error is raised on any of the autopilots, activating the FTS signal.
- The watchdog signal for any autopilot is not ok.

**Attention:** Make sure to configure the sending of arbitration messages as **High priority**. Otherwise, the sending of the messages could be shortly interrupted by a higher priority task and the autopilot will be declared **Dead**.

APs being declared Dead when arbitration starts due to missed messages

A **Dead** autopilot can never be selected again as long as arbitration persists.

The **Dead** status is not reversible, it is necessary to reboot the whole system in order to recover a **Dead** autopilot.

If the number of **Alive** autopilots is **2 or less**, relative arbitration variables are disabled (since at least 3 autopilots are needed).

If only one autopilot is Alive, it will be selected no matter the score.

If all autopilots are **Dead**, the **Preferred** autopilot will be selected.

## 18.2.5 Maintenance Mode

Maintenance mode is used for changing the Arbiter configuration.

Arbitration is disabled while in maintenance mode.

Arbiter will also enter maintenance Mode after a failed boot.

The reason of the failed boot can be checked in the Status message.

# 18.3 Software



Veronte Link is the equivalent to the **Preferences/Connections** tab in **Veronte Pipe**.

It is used to open the **COM Ports** so that the 4x Arbiter can be detected by **4xVeronte PDI Builder**.

Attention: If Veronte Pipe has a certain COM Port open, Veronte Link will not be able to use it. If this happens, close Veronte Pipe and then restart Veronte Link

🔣 Veronte Link	-	×	🔣 Veronte Link — 🗆 🗙
⇒ Devices			456Connections
ଟ ଦ 2			+ 🛍 🌣 🚓 Auto discover 7
arbiter 51118			• 🕁 COM61
3			중 239.0.0.1
•			Planet ACID: 123
			8

### Veronte Link

1.	Refresh devices
2.	Add device
3.	Connected devices
4.	Add new connection
5.	Remove selected connection
6.	Edit selected Connections
7.	Auto-Discover connections
8.	Currently open connections list



4xVeronte PDI Builder is the configuration interface for 4xVeronte Arbiter.

It can be used to perform firmware updates, load new configurations, or modify current configurations, both Offline and Online.

🕮 4xVeron	te PDI Builder	-	o x
1	Load PDI offline to configure	Update 4xVeronte Update the 4xVeronte's version	2
3	Upload PDI Upload PDI to the 4xVeronte, this option can't be undone	Load 4xVeronte	4
4x Veronte		V	l lersion 6.2.31

4x Veronte PDI Builder

1.	Open Arbiter PDI files Offline
2.	Update selected Arbiter
3.	Upload PDI Files to selected Arbiter
4.	Open selected Arbiter PDI files
5.	Connect to 4x Arbiter
6.	Selected Arbiter mode. Toggle between Sorral and Maintenance modes
7.	Selected Arbiter Firmware version
8.	4xVeronte PDI Builder Software version

Board		×
	Configuration	
Arbitration		2 3
I/O Manager		
CAN I/O Manager		
SCI		
CAN		
Ports		
GPIO		
1		

#### 4x Veronte PDI Builder - Configuration

1.	Configuration Tabs
2.	Save PDI files to 4x Arbiter
3.	Save PDI files to PC

# 18.4 Update

In order to update 4x Arbiter:

#### 1. Open Veronte Link

Make sure to close first any Veronte Pipe instances.

#### 2. Connect 4x Arbiter to the PC

Connect it using the provided **4x Arbiter Harness** (Yellow connector) plus the 232 to USB converter. Make sure that 4x Veronte is correctly powered and that the COM Port is detected.

#### 3. Identify the COM Port and add it to Veronte Link

🔚 Veronte Link	_	$\times$
🛁 🕂 🖄 🔅 🕂 Auto d	liscover	
• COM61		

Veronte Link - Add COM

4. Open 4xVeronte PDI Builder and connect to the Arbiter

AUTO	SFILUT 4X
Select PDI	C Update 4xVeronte
Load PDI offline to configure	Update the 4xVeronte's version
Upload PDI	▲ Load 4xVeronte
Upload PDI to the 4xVeronte, this	Load PDI online and work with it
option can't be undone	

4xVeronte PDI Builder - Vinculate 4x

The ID for 4x Arbiter is its corresponding 4xVeronte S/N + 50000



4xVeronte PDI Builder - Connect to Veronte 4x1118

5. Select Update 4xVeronte and load the new firmware version

🐲 4xVeronte PDI Builder	- 🗆 X
Select PDI	C Update 4xVeronte
Load PDI offline to configure	Update the 4xVeronte's version
Upload PDI	▲ Load 4xVeronte
Upload PDI to the 4xVeronte, this option can't be undone	Load PDI online and work with it
4x Veronte 51118 😌 V4x Version 6.2.39	Version 6.2.31
Upgrading UAV	×
System Image 🔅 smart.bin [v6.2.39]	- 6
Configuration No change	- D Update

Update 4x Veronte Arbiter

## 18.4.1 Updating 4xArbiter from Firmware version older than 6.0.0

After an update from a version older than **6.0.0**, the **Arbiter PDI files** will be empty. Once the update is finished, it is necessary to, at least, load a set of **Default PDI Files**.

# **18.5 Configuration**

In order to configure the **4x Arbiter**, connect it to **4xVeronte PDI Builder** and select **Load 4xVeronte**. Alternatively, it is possible to modify PDI files Offline, and then upload them using **Upload PDI**.

Attention: If Veronte is in Normal Mode, it is possible that the Load 4xVeronte process takes longer than usual if arbitration is active.

4xVeronte PDI Builder	- 🗆 X
Load PDI offline to configure	Update 4xVeronte Update the 4xVeronte's version
Upload PDI to the 4xVeronte, this option can't be undone	Load 4xVeronte  Load PDI online and work with it
4x Veronte 51118	Version 6.2.31

Update 4x Veronte Arbiter

## 18.5.1 Arbitration

Configuration of the arbitration algorithm

## 18.5.1.1 Config

Board	Configuration	• <b>•</b>
Arbitration	Config CAN Config	
I/O Manager	Arbiter	
CAN I/O Manager	Preferred Autopilot 0 -	
SCI	Method Always best	
CAN	Number of variables     4     3       Holding CAP time     0.2     4       Hysteresis (0.001 - 1)     0.1     5	
Ports	Holding CAP time 0.2	
GPIO	Hysteresis (0.001 - 1) 0.1 5	
	Use external autopilot 6	
	Autopilots	
	Autopilot 0 Number of absolute variables 2 Autopilot 1	7
	Autopilot 2	
	1.0 1.0 <b>(8)</b>	
	1.0	
	10000.0	

## Update 4x Veronte Arbiter

1.	Preferred autopilot. Selected autopilot in case of a score draw
2.	Arbitration method
3.	Number of arbitration variables
4.	Time delay before a new switch is possible after an AP switch
5.	Score differential needed for a switch. This value represents a proportion of selected autopilot's
	score
6.	Enable arbitration of external autopilot
7.	Number of absolute variables. The asignation starts from the
	bottom. i.e. If there are 4 arbitration variables and 2
	absolute variables, variables 0-1 will be relative and
	variables 2-3 will be absolute
8.	Arbitration weights for each variable

## 18.5.1.2 CAN Config

Board		×
	Configuration	8
Arbitration	Config CAN Config	
I/O Manager	Send status Period 0.2	
CAN I/O Manager	Send score Period 1.0	
SCI	Status message ID 255 3	
CAN	Autopilot 0	
Ports	Extended 4	
GPIO	ID 8 Autopilot 1 ID 9 Autopilot 2 ID 10 6	

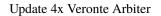
Update 4x Veronte Arbiter

1.	Enable and frequency of Status Message
2.	Enable and frequency of Score messages
3.	CAN ID at which Status and Score messages are sent
4.	CAN ID at which Arbitration messages for AP1 must be sent
5.	CAN ID at which Arbitration messages for AP2 must be sent
6.	CAN ID at which Arbitration messages for AP3 must be sent

## 18.5.2 I/O Manager

Configuration for serial interfaces

		Configuration			
Arbitration	Configur	ation			
I/O Manager		Producer		Consumer	
	00 C	RS232 1	$\leftrightarrow$	Commgr port 0	06
CAN I/O Manager	Q0	RS232 2	$\leftrightarrow$	Commgr port 1	00
SCI	Q0	RS485	$\rightarrow$	Serial to CAN 7	00
CAN	00	Commgr port 0	$\leftrightarrow$	RS232 1	00
Ports	OC	Commgr port 1	$\leftrightarrow$	RS232 2	Q0
GPIO	OC	Commgr port 2	$\rightarrow$	Serial to CAN 0	Q0
	OC .	Commgr port 3	$\rightarrow$	None	Q0
	Q0	Commgr port 4	$\rightarrow$	None	Q0
	Q0	Commgr port 5	$\rightarrow$	None	08
	00	CAN to serial 0	$\rightarrow$	Commgr port 2	Q0
	Q0	CAN to serial 1	$\rightarrow$	None	Q0
	Q0	CAN to serial 2	$\rightarrow$	None	Q8
	Q0	CAN to serial 3	$\rightarrow$	None	00
	00	CAN to serial 4	$\rightarrow$	None	Q0
	OC	CAN to serial 5	$\rightarrow$	None	00



#### 18.5.2.1 Producers

RS 232 1-2 Serial RS232 Rx physical interfaces		
RS 485	Serial RS485 Rx physical interfaces	
Commgr Port 1-5	ngr Port 1-5 Configuration ports	
CAN to Serial 0-7	RS message over CAN output (Connected to CAN I/O Consumer)	
CAN Wrapper 0-1	CAN message over RS output (Connected to CAN I/O Consumer)	

### 18.5.2.2 Consumers

RS 232 1-2	Serial RS232 Tx physical interfaces	
RS 485	Serial RS485 Tx physical interfaces	
Commgr Port 1-5	Configuration ports	
Serial to CAN 0-7	RS messages over CAN input (Connected to CAN I/O Producer)	
CAN unWrapper 0-1	CAN messages over RS input (Connected to CAN I/O Producer)	

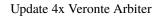
**Warning:** By default, **RS232 1-2** are set up for Arbiter configuration. If these connections are removed, it will not be possible to communicate with the arbiter in **Normal mode**. In this situation, force the Arbiter into **Maintenance mode** in order to recover the comunication.

## 18.5.3 CAN I/O Manager

Configuration for CAN interfaces.

**Mailbox** and **Custom message** configuration are identical to Veronte Autopilot. For more information please check the related sections.

itration	Configuration	Custom Message 1 Mailboxes		
Manager	Priority	Producer	Consumer	
Manager	🗌 High 🤷	Serial to CAN 0	Output filter 1	00
N I/O Manager	High 🛱	Serial to CAN 1	None	Q0
	High 🛱	Serial to CAN 2	None	Q0
	High 🛱	Serial to CAN 3	None	Q0
ts	High 🕸	Serial to CAN 4	None	Q0
)	High 🛱	Serial to CAN 5	None	Q0
	High 🛱	Serial to CAN 6	None	Q0
	High 🕸	Serial to CAN 7	Output filter 7	00
	High 🕸	Arbiter	Output filter 0	00
	High 🛱	Input filter 0	Arbiter	Q0
	High 🛱	Input filter 1	CAN to serial 0	00
	High 🗱	Input filter 2	None	00
	High 🗱	Input filter 3	None	00
	High 🗱	Input filter 4	None	Q <sub>0</sub> <sup>0</sup>
	High 🛱	Input filter 5	None	00



#### 18.5.3.1 CAN - Producers

Arbiter	Status and Score messages Output	
Input Filter	CAN Input Filters	
Serial to CAN 0-7	RS messages over CAN output (Connected to I/O Manager Consumer)	
CAN unWrapper 0-1	CAN messages over RS output (Connected to I/O Manager Consumer)	
Custom Message	CAN Custom Message 1 Tx	

#### 18.5.3.2 CAN - Consumers

Arbiter	Input for Arbitration messages	
Output Filter	CAN Output Filters	
CAN to Serial 0-7	RS messages over CAN output (Connected to I/O Manager Producer)	
CAN Wrapper 0-1	CAN messages over RS output (Connected to I/O Manager Producer)	
Custom Message	CAN Custom Message 1 Rx	
GPIO Consumer	Consumer for GPIO control Messages	

Attention: The Input Filter connected to the Arbiter consumer must have a mask that allows all Arbitration CAN IDs

## 18.5.4 SCI

Configuration of RS interfaces

## 18.5.5 CAN

Configuration of CAN Bus baudrates

## 18.5.6 PORTS

Commgr Port routing configuration

#### 18.5.7 GPIO

GPIO pin configuration

## 18.6 CAN Protocol

CAN Payload protocol for arbitration messages.Endianness is Little Endian for all messages.CAN IDs are configurable for all messages.

# 18.6.1 From Arbiter

## 18.6.1.1 Status Message

Byte	Position	Value	Description
0	0 - 7	0x00	Header
1	0 - 7	0xFF	Status message Header
2	0 - 6	0 - 3	Selected AP ( $0 = AP1$ , $1 = AP2$ , $2 = AP3$ , $3 = External AP$ )
	7	0 - 1	Arbitration OFF/ON
3	0	0 - 1	AP1 Alive
	1	0 - 1	AP2 Alive
	2	0 - 1	AP3 Alive
	3	0 - 1	External AP Alive
	4	0 - 1	AP1 Ready
	5	0 - 1	AP2 Ready
	6	0 - 1	AP3 Ready
	7	0 - 1	External AP Ready
4	0	0 - 1	CBIT. System error. Will fail if any of the below items fail.
	1	0 - 1	PBIT. System Boot Ok.
	2	0 - 1	PDI Ok. Will fail if there is an error in configuration files.
	3	0 - 1	Memory Allocation OK
	4	0 - 1	CAN A Ok
	5	0 - 1	CAN B Ok
	6	0 - 1	CIO Low Task Ok
	7	0 - 1	CIO High Task Ok
5	0	0 - 1	Power OK. All power indicators are OK.
	1	0 - 1	A Bus Voltage Ok
	2	0 - 1	B Bus Voltage Ok
	3	0 - 1	Arbiter Voltage Ok
	4	0 - 1	AP1 Voltage Ok
	5	0 - 1	AP2 Voltage Ok
	6	0 - 1	AP3 Voltage Ok
	7	0 - 1	Arbiter Mode. 1 = Normal, 0 = Maintenance

## 18.6.1.2 Score Message

Byte	Position	Value	Description
0	0 - 7	0x00	Header
1	0 - 7	0 - 3	Autopilot ID ( $0 = AP1$ , $1 = AP2$ , $2 = AP3$ , $3 = External AP$ )
2 - 5	0 - 31	0 -	Autopilot Arbitration Score
		0xFFFF	
		FFFF	

## 18.6.2 From Veronte

Send to its corresponding CAN ID address.

Recomended addresses 8,9,10 & 11 (AP1,AP2,AP3, External AP).

#### 18.6.2.1 Ready Message

Byte	Position	Value	Description
0	0 - 7	0x00	Header
1	0 - 7	0xFF	Ready Message Header
2	0 (1 bit)	0 - 1	Ready/Not Ready

#### 18.6.2.2 Arbitration Messages

Byte	Position	Value	Description
0	0 - 7	0x00	Header
1	0 - 7	0 - 5	Arbitration Variable Number
2 - 5	0 - 31	0 -	Arbitration Variable Value
		0xFFFF	
		FFFF	

CHAPTER

## NINETEEN

# **4X REDUNDANT AUTOPILOT**



4x Redundant Autopilot

# **19.1 Introducction**

**4xVeronte Autopilot** is a triple redundant version of the Veronte Autopilot. It includes three complete Veronte Autopilot modules together with a dissimilar arbiter for detecting system failures and selecting the module in charge of the control. The autopilot selected as the master will be the one controlling the actuators and communicating with the payloads.

Each Veronte autopilot contains all the electronics and sensors in order to properly execute all the functions needed to control the UAV. Veronte executes in real time all the guidance, navigation and control algorithms for the carrying airframe, acting on the control surfaces and propulsion system and processing the signals from different sensors: accelerometers, gyroscopes, magnetometer, static pressure, dynamic pressure, GNSS and external sensors.

All three modules are managed by a dissimilar microprocessor. This arbiter includes voting algorithms for managing the module in charge of vehicle control. This microprocessor compares data from all modules in real time and processes

it for discarding any autopilot module showing an undesired performance.

# 19.2 Setup

## 19.2.1 CAN bus

**4xVeronte Autopilot** includes three complete Veronte Autopilot modules that have to be configured independily in order to work porperly. 4xVeronte Autopilot is compatible with all configuration files from **Veronte Autopilot**. The communication channel between Veronte Autopilots modules and arbitrer is done by using CAN bus so in order to start arbitring, Veronte Autopilots modules have to send the following information.

Configuration	Value
Baudrate	1 Mbps
Endianess	Little endian

Each Veronte shall send using its CAN-TX ID and in little endian format.

#### 19.2.1.1 Variable value message:

Byte0	0	Telemetry message
Byte1	variable id	Variable id sent (0 to 127)
Byte2-5	variable value	Variable value as Float (32 bits)

#### 19.2.1.2 Status message:

Byte0	0	Telemetry message
Byte1	0xFF	Status flag
Byte3	bit0	1:Ready, 0:Not ready
	bit7-1	Reserved

By default the arbiter will send the following CAN messages.

#### 19.2.1.3 Variable value message:

Byte0	0	Telemetry message
Byte1	N, Autopilot id	Autopilot [0, 3]
Byte2-5	value	Autopilot score as Float(32 bits)

#### 19.2.1.4 Status message:

Byte0	0	Telemetry message
Byte1	0xFF	Status flag
Byte3	bit6-0	Selected autopilot
	bit7	Arbitrating 0:false, 1:true
Byte4	bit0	AP0 Alive
	bit1	AP1 Alive
	bit2	AP2 Alive
	bit3	AP3 Alive (external)
	bit4	AP0 Ready
	bit5	AP1 Ready
	bit6	AP2 Ready
	bit7	AP3 Ready (external)
Byte5	bit0	system ok
	bit1	start
	bit2	pdi
	bit3	memory alloc
	bit4	cana bus on
	bit5	canb bus on
	bit6	Reserved
	bit7	Reserved
Byte6	bit0	system ok
	bit1	Vcc A
	bit2	Vcc B
	bit3	Vcc arb
	bit4	Vcc1
	bit5	Vcc2
	bit6	Vcc3
	bit7	Reserved

## 19.2.2 Control

One modification has to be implemented in order to have smooth transition between Veronte Autopilots modules. This modification involves sending the control outputs of Veronte Autopilots modules to the rest of autopilots so it is considered in the transition. The user can refer to the configuration examples for this implementation.



#### Veronte autopilot

**Veronte Autopilot** is a miniaturized high reliability avionics system for advanced control of **unmanned systems.** This control system embeds a state-of-the-art suite of sensors and processors together with LOS and BLOS M2M datalink radio, all with reduced size and weight.

**4x Veronte Autopilot** is a **triple redundant** version of **Veronte Autopilot**. It includes three complete Veronte Autopilot modules fully integrated with a dissimilar arbiter for detecting system failures and selecting the module in charge of the control.

**Veronte Pipe** is the software designed for operating any Veronte powered platform. Users achieve a combination of easy-to-use application, real-time response and, firstly, safe operations.

The sections that follow this introduction explain in detail all the features of Veronte Pipe, the software used to control, configure and operate the platform fitted with the autopilot. Besides, the reader will find in *Hardware Installation* information about how to install both Veronte Autopilots in the aircraft (or the selected type of vehicle).