# Veronte Autopilot (Up to HW 4.5 / SW 6.4) Release 5.42.28

Embention

2023-07-26

## CONTENTS

1	Quic	k Start		1
	1.1	First Steps		1
		1.1.1 Kit Ele	ments	2
		1.1.2 Veronte	e Pipe	2
	1.2	Model Simulati	on	5
				5
				7
		1.2.2.1		7
		1.2.2.2		7
		1.2.3 Execut		8
	1.3		Pairing	5
	1.4	*	vos	6
		-	Output	
			trix	
			1 Trim	
	1.5	•	nitter Configuration	
			2:	5
				6
	1.6	*	clist	7
		0	Checklist	
			ítems	
2	Hard	lware Installatio		
	2.1	Veronte Autopil	lot	5
			τ Mounting	5
		2.1.1.1	Enclosure	5
		2.1.1.2	OEM	6
		2.1.1.3	Mechanical Mounting	
		2.1.1.4	Vibration Isolation    3'	7
		2.1.1.5	Location	8
		2.1.1.6	Orientation	8
		2.1.1.7	Connector Layout	8
		2.1.1.8	Mating Connector	9
		2.1.1.9	Antenna Integration	9
		2.1.1.10	Pressure lines	0
		2.1.2 Electric	cal	0
		2.1.2.1	Power	0
		2.1.2.2	Veronte I/O Signals	1
		2.1.2.3	Flight Termination System (FTS)	3
		2.1.2.4	Joystick	3

		2.1.3	Performances	45
		2.1.4	Annex 1: Connector colour code	46
		2.1.5	Annex 2: Connection examples	48
			2.1.5.1 Ground Station	48
			2.1.5.2 Multicopter	49
				50
			6	51
		2.1.6	1	52
		2.1.7	L	53
		2.1.8		53
	2.2			55
	2.2	2.2.1	1	54
		2.2.1	6	
				54
				54
				55
				55
				56
			e e e e e e e e e e e e e e e e e e e	57
			2.2.1.7 Antenna Integration	58
			2.2.1.8 Pressure lines	58
		2.2.2	Electrical	59
			2.2.2.1 Power	59
			2.2.2.2 Redundant Connector Pinout	59
				65
		2.2.3		72
		2.2.4		73
		2.2.	1	73
		2.2.5	Annex 2: Connector colour code	73
		2.2.5	Annex 2: Connector colour code	73
3	Pipe			73 <b>79</b>
3	<b>Pipe</b> 3.1	Config	uration	
3	_	Config	<b>uration</b> lation	79
3	_	Config Install	uration lation	<b>79</b> 79
3	_	Config Install 3.1.1	guration lation	<b>79</b> 79 79 79
3	_	<b>Config</b> Install 3.1.1 3.1.2 3.1.3	uration lation	<b>79</b> 79 79 79 83
3	3.1	Config Install 3.1.1 3.1.2 3.1.3 3.1.4	guration         lation         System Requeriments         Windows         MAC         Linux	<b>79</b> 79 79 79 83 84
3	3.1 3.2	<b>Config</b> Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat	guration         lation         System Requeriments         Windows         MAC         Linux         te	<b>79</b> 79 79 83 84 88
3	3.1	<b>Config</b> Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer	Puration Ilation System Requeriments Mindows MAC Linux te	<b>79</b> 79 79 83 84 88 91
3	3.1 3.2	<b>Config</b> Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1	auration lation . System Requeriments . Windows . MAC . Linux . rences . General .	<b>79</b> 79 79 83 84 88 91 91
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2	guration         lation         System Requeriments         Windows         MAC         Linux         te         General         Gonnections	<b>79</b> 79 79 83 84 88 91 91 95
3	3.1 3.2	<b>Config</b> Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1	guration         lation         System Requeriments         Windows         MAC         Linux         te         rences         General         Connections         Encryption	<b>79</b> 79 79 83 84 88 91 91 95 00
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3	Juration lation	<b>79</b> 79 79 83 84 88 91 91 95 00
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2	guration         lation         System Requeriments         Windows         MAC         Linux         te         rences         General         Connections         Encryption         3.3.1         Remove Encryption         System Units	79 79 79 83 84 88 91 91 95 00 03 03
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3	puration         lation         System Requeriments         Windows         MAC         Linux         te         cences         General         Connections         Encryption         1         3.3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units	79 79 79 83 84 88 91 95 00 03 03 03
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4	puration         lation         System Requeriments         Windows         MAC         Linux         te         cences         General         Connections         Encryption         1         3.3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         1         3.3.4.2	79 79 79 83 84 88 91 91 95 00 03 03 03 04
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3	guration         lation         System Requeriments         Windows         MAC         Linux         te         rences         General         Connections         Encryption         1         3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         1         3.3.4.2         Units         1         Map	79 79 79 83 84 91 95 00 03 03 04 05 06
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4	guration         lation         System Requeriments         Windows         MAC         Linux         Linux         te         rences         General         Connections         Encryption         1         3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         3.3.4.2         Units         1         3.3.5.1         Terrain Height	79 79 79 83 84 88 91 95 00 03 03 04 05 06 07
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4	Paration lation	79 79 79 83 84 88 91 95 00 03 03 04 05 06 07
3	3.1 3.2	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4	Paration lation	79 79 79 83 84 88 91 95 00 03 03 04 05 06 07
	3.1 3.2 3.3	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4 3.3.5	paration         lation         System Requeriments         Windows         MAC         Linux         te         rences         General         Connections         Encryption         1         3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         1         3.3.5.1         Terrain Height         3.3.5.2         Download ALtitude Information         3.3.5.3         Custom Terrain File	<b>79</b> 79 79 83 84 91 95 00 03 03 04 05 06 07 07 07
	3.1 3.2 3.3 Worl	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4 3.3.5	paration         lation         System Requeriments         Windows         MAC         Linux         te         rences         General         Connections         Encryption         1         3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         3.3.4.2         Units         1         3.3.5.1         Terrain Height         3.3.5.2         Download ALtitude Information         1         3.3.5.3         Custom Terrain File	<b>79</b> 79 79 83 84 88 91 95 00 03 03 03 04 05 06 07 07 08 <b>11</b>
	3.1 3.2 3.3	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4 3.3.4 3.3.5	paration         lation         System Requeriments         Windows         MAC         Linux         ite         ences         General         Connections         Encryption         1         3.3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         1         3.3.4.2         Units         1         3.3.5.1         Terrain Height         3.3.5.2         Download ALtitude Information         1         3.3.5.3         Custom Terrain File	<b>79</b> 79 79 83 84 88 91 95 00 03 03 04 05 06 07 07 08 <b>11</b>
	3.1 3.2 3.3 Worl	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4 3.3.5 3.3.5 xspace Works 4.1.1	uration         lation         System Requeriments         Windows         MAC         Linux         Linux         te         ences         General         Connections         Encryption         1         3.3.1         Remove Encryption         1         3.3.4.1         Creating Custom Units         3.3.4.2         Units         1         3.3.5.1         Terrain Height         3.3.5.2         Download ALtitude Information         3.3.5.3         Custom Terrain File         1         space Toolbar         Open Details	<b>79</b> 79 79 79 83 84 88 91 95 00 03 03 04 05 06 07 07 08 <b>11</b> 11
3	3.1 3.2 3.3 Worl	Config Install 3.1.1 3.1.2 3.1.3 3.1.4 Updat Prefer 3.3.1 3.3.2 3.3.3 3.3.4 3.3.4 3.3.5	uration         lation         System Requeriments         Windows         MAC         Linux         te         ences         General         Connections         Encryption         3.3.1         Remove Encryption         System Units         3.3.4.1         Creating Custom Units         3.3.5.1         Terrain Height         3.3.5.2         Download ALtitude Information         3.3.5.3         Custom Terrain File         space Toolbar         I         Open Details         Load	<b>79</b> 79 79 83 84 88 91 95 00 03 03 04 05 06 07 07 08 <b>11</b>

	4.2	Map Display
		4.2.1 Map provider
		4.2.2 Custom image
	4.3	Widgets
		4.3.1 Gimbal
		4.3.2 Gauge Display
		4.3.2.1 Gauge Selection
		4.3.2.2 Gauge Configuration
		4.3.2.3 Alarm Creation
		4.3.3 Advanced Primary Flight Display (PFD)
		4.3.4 Stick
		4.3.5 Terrain
		4.3.6 Autotune Tool
		4.3.7 Line of Sight
		4.3.8 ADS-B decoder
		4.3.9 GNSS status
	4.4	Main Interface
5	Vana	nte Panel 135
3	5.1	Sensors Calibration
	5.1 5.2	Veronte Icon
	5.2 5.3	Veronte Panel
	5.5	veronie Panel
6	Vero	nte Configuration 141
Č	6.1	File Management
	0.11	6.1.1 Import Configurations
		6.1.1.1 CHECK PDI
		6.1.2 Export Configurations
		6.1.3 Offline Configurations
		6.1.4 Version Control
		6.1.5 Update Onboard Software
		6.1.6 Safe Mode
		6.1.7 CONFIGURATION FILES (.VER)
		6.1.8 PDI FILES
	6.2	Setup Toolbar
		6.2.1 Veronte
		6.2.2 Connections
		6.2.2.1 ADC
		6.2.2.1.1 Application example
		6.2.2.2 Arbiter - SuC
		6.2.2.3 CAN
		6.2.2.3.1 CAN Configuration
		6.2.2.3.2 CAN Telemetry
		6.2.2.3.2.1 TX Messages
		6.2.2.3.2.2 RX Messages
		6.2.2.3.3 CAN Messages
		6.2.2.3.3.1 Variable
		6.2.2.3.3.2 Checksum
		6.2.2.3.3.3 Matcher
		6.2.2.3.3.4 Skip
		6.2.2.3.3.5 Parse ASCII
		6.2.2.3.3.6 Position
		6.2.2.3.4 Arbiter CAN protocol
		6.2.2.3.4.1 CAN parameters

	6.2.2.3.4.2	CAN message structure	
	6.2.2.3.4.3	Single message structure	
	6.2.2.3.4.4	External autopilot simulation	
	6.2.2.3.4.5	Can protocol for 4-autopilot configuration	172
	6.2.2.4 GPIO/PWM .		175
	6.2.2.4.1 GPIO		175
	6.2.2.4.2 PWM		176
	6.2.2.4.3 Add		177
	6.2.2.5 Serial		179
6.2.3	Devices		182
	6.2.3.1 Actuators		182
	6.2.3.1.1 Physic	cal	182
	6.2.3.1.1.1	Calibration Interface	182
	6.2.3.1.1.2	Configuration Wizard	183
	6.2.3.1.2 Logic	al	187
	6.2.3.1.2.1	SU & US Matrices	187
	6.2.3.1.2.2	SU of a Flying Wing	190
	6.2.3.1.2.3	SU of a V-Tail Aircraft	190
	6.2.3.1.2.4	SU of a Quadcopter	191
	6.2.3.1.2.5	SU of a VTOL Aircraft	192
	6.2.3.1.3 Satura	ution	192
	6.2.3.1.3.1	Standard Saturation	193
	6.2.3.2 Communication	18	198
			199
	6.2.3.2.1.1	ESIM	199
	6.2.3.2.1.2	SIM	199
	6.2.3.2.2 Coms	tats	200
	6.2.3.2.3 Iridiu	m	201
	6.2.3.3 Payload		202
	6.2.3.3.1 Came	ra	202
	6.2.3.3.1.1	Veronte Gimbal Wizard	204
	6.2.3.3.2 Gimba	al/Tracker	207
	6.2.3.3.3 Transj	ponder	208
	6.2.3.3.4 ADS-	Β	211
	6.2.3.4 Sensors		216
	6.2.3.4.1 Accel	erometer	216
	6.2.3.4.1.1	Integer var sensor	217
	6.2.3.4.1.2	Decimal var sensor	218
	6.2.3.4.1.3	Internal	219
	6.2.3.4.2 Altim	eter	221
	6.2.3.4.3 GNSS		222
	6.2.3.4.3.1	GNSS 1 & 2 Configuration	222
	6.2.3.4.3.2	Configuration	222
	6.2.3.4.3.3	SBAS	224
	6.2.3.4.3.4	Message Rate	225
	6.2.3.4.3.5	Estimation Error	226
	6.2.3.4.3.6	Advanced	227
	6.2.3.4.3.7	GNSS Compass	228
	6.2.3.4.3.8	GNSS External	231
	6.2.3.4.3.9	Configuration	232
	6.2.3.4.3.10	Estimation Error	233
	6.2.3.4.3.11	NTRIP	233
	6.2.3.4.3.12	Registration	233
	6.2.3.4.3.13	Configuration	233

	6.2.3.4.4	Gyros	cope	236
	6.2.3.		Integer var sensor	
	6.2.3.	4.4.2	Decimal var sensor	
	6.2.3.	4.4.3	Internal	
	6.2.3.4.5	I2C D	evices	
	6.2.3.4.6		etometer	
	6.2.3.	-	Calibration	
	6.2.3.		Configuration	
	6.2.3.		Integer var sensor	
	6.2.3.		Decimal var sensor	
	6.2.3.		Internal	
	6.2.3.		External	
	6.2.3.4.7			
	6.2.3.		External	
	6.2.3.		Obsens	
	6.2.3.		Range sensors	
	6.2.3.4.8		ıre	
	6.2.3.4.9			
		-	Down	
			ounds	
	6.2.3.	4.11.1	Sensor	
	6.2.3.	4.11.2	Base	
	6.2.3.	4.11.3	Transmitter	257
	6.2.3.	4.11.4	Navigation	257
	6.2.3.5 Stick Co	onfigurat	tion	259
	6.2.3.5.1	Arcad	e trim	259
	6.2.3.5.2	Local	Sources	260
	6.2.3.	5.2.1	Transmitter	260
	6.2.3.	5.2.2	PPM	260
	6.2.3.	5.2.3	Exponential	262
	6.2.3.		Trim	
	6.2.3.		Output	
	6.2.3.		Virtual Stick	
	6.2.3.5.3		tick	
	6.2.3.5.4			
	6.2.3.		Wizard Stick	
	6.2.3.		Mask Servos	
		5.4.3		274
	6.2.3.6.1			
	6.2.3.	•	Payload Operation	
	6.2.3.6.2			
	6.2.3.6.3		Jint8	
	6.2.3.		Tunnel	-
6.0.1			CAP	
6.2.4				
	6.2.4.1.1	Guida		
	6.2.4.		Guidance Variables	
	6.2.4.	1.1.2	Taxi	286
	6.2.4.		VTOL	
	6.2.4.	1.1.4	Climb	
	6.2.4.	1.1.5	Cruise	294
	6.2.4.	1.1.6	Hold	297

	6.2.4.1	.1.7 Landing
	6.2.4.1	.1.8 Yaw
	6.2.4.1	.1.9 Rendezvous
	6.2.4.1.2	Loop
	6.2.4.1	.2.1 PID Controller
	6.2.4.1	.2.2 Adaptative-Predictive Control
	6.2.4.1	*
	6.2.4.1	· · · · · · · · · · · · · · · · · · ·
	6.2.4.1	
	6.2.4.1	
	6.2.4.1.3	Arcade
	6.2.4.1	
	6.2.4.1.4	TC Panel
	6.2.4.1	
	6.2.4.1	
	•	
	6.2.4.2.1	Runway
	6.2.4.2.2	Spot
	1	326
	6.2.4.6 Arcade A	.xis
6.2.5	Navigation	
	6.2.5.1 Wind Est	imation
6.2.6	Automations	
	6.2.6.1 Events .	
	6.2.6.1.1	Phase
	6.2.6.1.2	Variable
	6.2.6.1.3	Alarm
	6.2.6.1.4	Mode
	6.2.6.1.5	Button
	6.2.6.1.6	Route
	6.2.6.1.7	Timer
	6.2.6.1.8	Polygon
		345
	6.2.6.2.1	Change Active Sensor
	6.2.6.2.1	Custom TX
	6.2.6.2.3	
	012101210	
	6.2.6.2.4	Go To
	6.2.6.2.5	Track
	6.2.6.2	
	6.2.6.2	
	6.2.6.2	
	6.2.6.2.6	Terrain Obstacle
	6.2.6.2.7	Arcade Trim
	6.2.6.2.8	Navigation
	6.2.6.2.9	Mode
	6.2.6.2.10	Output
	6.2.6.2.11	Phases
	6.2.6.2.12	Select Arcade Axis
	6.2.6.2.13	Periodical
	6.2.6.2.14	Run Operation
	6.2.6.2.15	User Log
	6.2.6.2.16	Variable

		6.2.6.3 Other Options	366
		6.2.7 Variables	
		6.2.7.1 System Variables	
			371
			371
		6.2.7.2.2 Onboard Log	374
		6.2.7.2.3 User Log	374
		6.2.7.2.4 Fast Log	375
		6	376
			378
			378 378
			385
			386
		6.2.8 Panel	388
		6.2.8.1 Short Phases	388
		6.2.8.2 Checklists	389
		6.2.8.3 Confirmation	391
			393
			395
			396
		1 0	390 397
		1	399
			400
			404
	6.3	Installation	407
		6.3.1 System Position	407
	6.4	License & Safe Mode	408
		6.4.1 License	408
			410
	6.5		411
	6.6	Side Panel Options	
	0.0		+11
7	Missi	ion configuration	413
'	7.1		413
	/.1	1	
		7.1.1 Introducction	
		7.1.2 Terrain profile and Magfield	
		7.1.3 Marks	117
	7.2	Mission Tools	418
	7.3	Mission toolbar	419
8	Oper	ration	421
	8.1	LOG Record	421
		8.1.1 Create PDF	422
	8.2		423
	8.3		+23 424
	8.4	8 - 1	+24 424
	8.5	In-flight mission edition	425
0	<b>D</b> - 43		12-
9			427
	9.1		427
	9.2	$\mathbf{I}$	429
			429
		9.2.2 LOG	431

10	Simu	lation 435
	10.1	Professional HIL
		10.1.1 Mounting
		10.1.1.1 Cable Connection
		10.1.1.2 Veronte Pipe Configuration
		10.1.1.2.1         Autopilot Configuration         436           10.1.1.2.2         Magnetic Diagonalisation         428
		10.1.1.2.2 Veronte Pipe Communications
		10.1.2       X-Plane 10 Settings       438         10.1.2.1       X-Plane 10 Configuration       438
		10.1.2.1.1 Aircraft Model Installation
		10.1.2.1.2 X-Plane 10 Setup
		10.1.2.2 Low Performance Computer Configuration
		10.1.3 X-Plane 11 Settings
		10.1.3.1 X-Plane 11 Configuration
		10.1.3.1.1 Aircraft Model Installation
		10.1.3.1.2 X-Plane 11 Setup
		10.1.4 Operation
	10.2	SIL Simulink
		10.2.1 Autopilot Simulation
		10.2.2 Sensors Simulation & Input Examples
		10.2.3 Monitoring Telemetry with Simulink
		10.2.4 Complete Simulation
		10.2.5       Connecting Simulink & Veronte Pipe       464         10.2.6       Dealing with PDI files       467
	10.3	10.2.6       Dealing with PDI files       467         3D Simulation       468
	10.5	10.3.1         Veronte Pipe Configuration         469
11	Exan	
	11.1	4G Communication
	11.0	11.1.1 4G Communication with Veronte Autopilot
	11.2	Configurations
		11.2.1         Device Configurations         479           11.2.1.1         Magnetometer Honeywell HMR2300-232         479
		11.2.1.1         Wagnetonicet Honey wen HWR2500-252         479           11.2.1.2         Radar Altimeter Smartmicro         481
		11.2.1.3 Volz Servo
		11.2.2 Plataform Configurations
		11.2.2.1 Fixed Wing-Mentor
		11.2.2.1.1 Servo Configuration
		11.2.2.1.2 Mission Phases
		11.2.2.1.2.1 Takeoff 495
		11.2.2.1.2.2 Climbing 496
		11.2.2.1.2.3 Cruise
		11.2.2.1.2.4 Hold
		11.2.2.1.2.5 Landing
		11.2.2.1.2.6 Flare
		11.2.2.1.3 Automations
		11.2.2.1.3.1       Takeoff to Climb       504         11.2.2.1.3.2       Climbing to Cruise       505
		11.2.2.1.3.2       Climbing to Cruise       505         11.2.2.1.3.3       Radio Error       506
		11,2,2,1,3,3 Radio E1101
		11.2.2.1.3.4 Low Battery 507
		11.2.2.1.3.4       Low Battery       507         11.2.2.1.3.5       Landing to Flare       508
		11.2.2.1.3.5 Landing to Flare

11.2.2.2.1.1	Servos Output	511
11.2.2.2.1.2	SU Matrix	513
11.2.2.2.1.3	System Trim	515
11.2.2.2.2 Missio	on Phases	
11.2.2.2.2.1	Standby	
11.2.2.2.2.2	Hand-Launch	
11.2.2.2.2.3	Catapult	
11.2.2.2.2.4	Separation	
11.2.2.2.2.5	Climbing	
11.2.2.2.2.6	Cruise	
11.2.2.2.2.7	Hold	
11.2.2.2.2.8	Landing	
11.2.2.2.2.9	Flare	
11.2.2.2.3 L200		
	Configuration	
11.2.2.2.3.2	Actuator Trimming	
11.2.2.3.3	Launch Automation	
	00	
	Configuration	
11.2.2.3.1.1	Servos Output	
11.2.2.3.1.2	SU Matrix	
11.2.2.3.1.3	System Trim	538
11.2.2.3.2 Missic	on Phases	539
11.2.2.3.2.1	Standby	539
11.2.2.3.2.2	Takeoff	539
11.2.2.3.2.3	Hover	541
11.2.2.3.2.4	Cruise	
11.2.2.3.2.5	Landing	
11.2.2.3.2.6	VHOLD	
11.2.2.3.2.7	Return to Home	
	x600	
-	Configuration	
11.2.2.4.1.1	Servos Output	
11.2.2.4.1.2	SU Matrix	
11.2.2.4.1.2	System Trim	
	on Phases	
11.2.2.4.2 Wilssic		
	Stanby	
	Engine Off	
11.2.2.4.2.3	Ignite	561
11.2.2.4.2.4	Ready	563
11.2.2.4.2.5	Takeoff	565
11.2.2.4.2.6	Hover	566
11.2.2.4.2.7	Cruise	567
11.2.2.4.2.8	Landing	569
11.2.2.4.2.9	Hold	570
11.2.2.5 Hybrid		573
11.2.2.5.1 Servo	Configuration	573
11.2.2.5.1.1	Quadcopter servos	573
11.2.2.5.1.2	Servos Output	573
11.2.2.5.1.3	SU Matrix	575
11.2.2.5.1.4	Plane Servos	576
11.2.2.5.1.5	Servos Output	576
11.2.2.5.1.6	System Trim	578
	on Phases	
		- 55

		11.2.2.5.2.1 Standby	583
	11.3	Automations	586
		11.3.1 Veronte Panel Buttons	586
		11.3.1.1 Phase Change Buttons	
			588
			591
			591
		0 0	592
			593
			594
			595
		11.3.3.2 Low Bettery	597
		11.3.3.3 GPS Signal lost	597
		11.3.4 Photogrammetry	598
			600
			600
			601
	11 /		603
	11.4		
			603
		8	603
			604
	11.5	Veronte Tracker	605
		11.5.1 Veronte Ground Configuration	605
		11.5.2 Veronte Air Configuration	612
		· · · · · · · · · · · · · · · · · · ·	613
	11.6	0 1	617
	11.0		618
		e e	
	11.7	11.6.2 Workspace Configuration	
	11.7	USB joystick integration	
		11.7.1 Adding a joystick	
		11.7.2 Defining a virtual stick	623
12		8	625
		Veronte not detected	
	12.2	PFD Attitude	626
	12.3	Altitude Error	627
		12.3.1 Atmosphere Calibration	627
		12.3.2 Terrain Altitude Meshes	
	12.4	HIL Simulation Fails	
	12.5	Telemetry Overflow Error	
	12.5	•	630
		1 0	
	12.7		631
	12.8	License Expired	632
10			()=
13			635
		,	635
	13.2	Definitions	636
			< <b>-</b>
14	Axes	Convention	637
15	Es - P	hash	(20
12	Feedl		<b>639</b>
	15.1	Feedback Panel	639
17	4 D	adundant Autonilat	641
10			641
	16.1	Introducction	641

16.2	Setup	
	16.2.1 Radio	
	16.2.2 CAN	us
	16.2.2.	Variable value message:
	16.2.2.2	Status message:
	16.2.2.	Variable value message:
	16.2.2.4	Status message:
	16.2.3 Contr	644

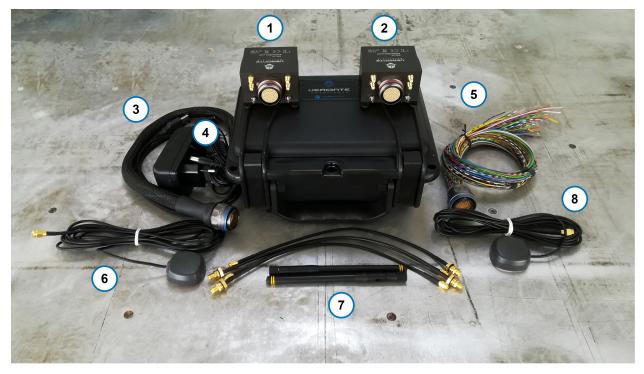
## CHAPTER

## ONE

## **QUICK START**

## 1.1 First Steps

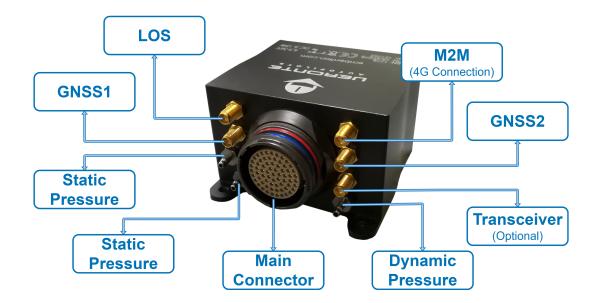
This section provides basic information of the connections of the autopilot and how to have it ready-to-use connected to the provided software **Veronte Pipe**.

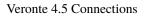


Autopilot Kit

### 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.

	http://suppor Your connecti Username Password						
			FTP Acces	Sign in	Cancel		
	Products Services	Projects Company	HIL Broadcast News	Contact			
FILES Update 5 38.8 update Veronte Pipe VerontePipe_x64-v5 38.36.exe							
	Autopilots - Veronte - NM8 Privacy - Work with Email	us Alici	s Atalayas, C/ Chelin, 16, 03114 ante (Spain)   +34 965 115 421 nbention@embention.com		NMS AIRCRAFT	*	

#### 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.

imgs/quick\_start\_guide/pipe\_version.png

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.

R	Contraction of the second seco									
	Cloud	Preferences 🌣 📀 🛡 🖋	ព							
	Mission	TCP Server		Send telemet	try					
	Log Post Flight	Enable		Enable						
5	✓ Preferences	Port 3		Host	127.0.0.1	Port	3000	Frequency	10.0	Hz
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		Add	•							
		Ethernet	1							
		Serial COM COM3	J							

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 **use** and then click on Import.

Veronte File				×
<b>Co fy T</b>	Hide	unsupported version		
Name	Veronte	Library	Version	+
	No content	in table		
Build from template 💌	VER File	PDI		Library

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



## 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



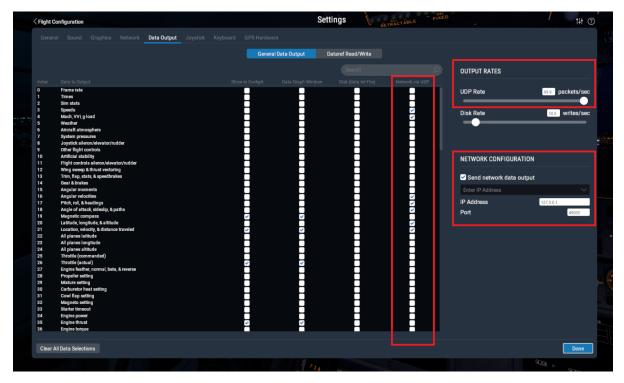
Veronte Pipe - HIL Configuration

#### 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:



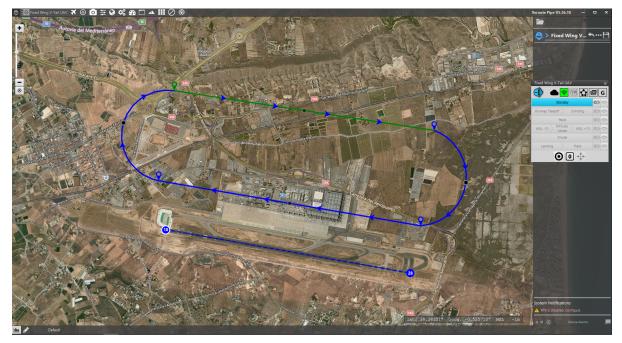
Fixed wing V-Tail template

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	:
Result of Setup migration	
Read the details of this panel for information on possible cha	nges 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>	
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<ul> <li>Migrating to version 5.29</li> </ul>	
<ul> <li>Migrating to version 5.30</li> </ul>	
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<ul> <li>Migrating to version 5.32</li> </ul>	
<ul> <li>Migrating to version 5.33</li> </ul>	
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<ul> <li>Migrating to version 5.36</li> </ul>	l
<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 all show extra all skow extra	rcraft from old versions	AIRPORT NAME Alexis creek Alfenas Alford A. Bratcher Alfredton	ID FEATURES AL5 Grass Strip SNFE 50K8 Grass Strip NZAN Grass Strip
		Alfredion Alfarver Alge Alger Houari Bournediene Algodoeira Alicante	NZAN Grass Strip BIAL 3D 50H0 Grass Strip DAAG SWF Gravel Strip LEAL 3D
		Start at Runway 10	
Military         F4 Phantom II         ☆         Penguin         ☆         Penguin cata	pult 🕁 🤇	WEATHER	Customize
Customize	?	Clea	
Seaplane		TIME OF DAY	Customize
Cessna Skyhawk (Floats)		12:13 lc 11:13 ut	
		5.03 m	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 Fid South Wood Co Alexander Ranch Alexandra Alexandria Alexandria Alexandria Homestead Alexandroupolis Dimokritos Alexis greek Alfenas Alford A. Bratcher Alford A. Bratcher Alfratarver Alger Houari Boumediene Alger Houari Boumediene Algedoeira Alicante STARTS RMMP RUMAY	ID       ID       FFEATURES       KISW     3D       513     Grass Strip       N2X     3D       N85     -       199     -       VALX     Dirt Strip       LGAL     3D       AL5     Grass Strip       SWFE     -       SOKE     Grass Strip       BIAL     3D       SOH0     Grass Strip       BIAL     3D       SOH0     Grass Strip       LEAL     3D       On runway     V	
RUMWAY         RUNWAY           Runway 10         3132×45 m           Runway 28         3132×45 m           Helipad H2N         25×25 m           Helipad H2S         25×25 m           Helipad H1N         25×25 m           Helipad H1N         25×25 m	On runway Asphalt Asphalt Concrete 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. 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 Configuration.



#### 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 its 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 phases definition :ref: Phases <phases>PNG All the stepsPNGtailed 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 Autopilot Radio Pairing

This section includes the information of how to pair the GND and AIR autopilots. Also, the configuration of the parameters of the radio module inside each unit will be covered. The steps described in here must be first performed on the GND unit, and then on the AIR one.

First display the Setup Toolbar: click on **under and then click on Setup**. This toolbar allows the user to modify the main features of the autopilot.

Veronte 1025 🛪	🐵 🧿 🗄	🚱 🗘 🚯	🗖 🔺 🕅
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	\$	Veronte 1025	×	$\odot$	0	#	Ø	$\mathbf{Q}_{0}^{0}$				9	Ì
--	----	--------------	---	---------	---	---	---	----------------------	--	--	--	---	---

Setup Toolbar

Now click on

Radio. The following menu pops up:

Radio model P400 (900MHz)   Out power  Connection  Address  Master   Network address  1  AT&F6  AT\$128=1  AT\$108=30  AT\$104=1  AT\$102=1  AT&W  ATA	Radio		
Connection PP  Address Master  Network address 1  AT&F6  AT\$128=1  AT\$108=30  AT\$104=1  AT\$105=1  AT\$105=1  AT\$102=1  AT\$W	Radio model	P400 (900MHz)	-
Address Master  Network address  AT&F6  AT\$128=1  AT\$108=30  AT\$104=1  AT\$105=1  AT\$102=1  AT\$W	Out power	30 dBm	-
AT&F6         1           AT\$128=1         AT\$108=30           AT\$104=1         AT\$105=1           AT\$102=1         AT\$6W	Connection	РР	•
AT&F6 ATS128=1 ATS108=30 ATS104=1 ATS105=1 ATS102=1 AT&W	Address	Master	•
	Network address	1	

#### Radio Configuration Menu

All these parameters have to be set accordingly to the radio module installed in the Veronte autopilot. Contact Embention if you need the details of your specific radio module.

- **Radio Module:** each autopilot has only one of the following radio modules P400/900, P900 and P2400. Select here the radio module installed.
- **Output power:** set the desired power output.
- **Connection:** Point to Point or Point Multi Point. That will depend on your mission and on the number of autopilots required in the same LOS network.
- Address: Master or Slave. Select the role for each autopilot 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 autopilots using the same network. First the master's address should be filled in so when the slave's is set to the same value, the GND autopilot will find the AIR autopilot and bind a connection with it.

By pressing Send the user sets all parameters .

## 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**.

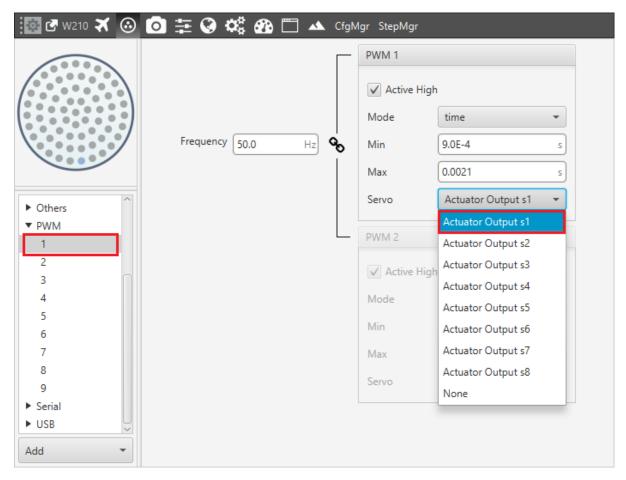
To assign the actuator outputs go the side panel , click on Setup, then go to Connections and open the PWM tab.

🔯 🛃 W210 🛪 🙆	◙ ∄ 🐼 🗱 🖾 🔺	CfgM	lgr StepMgr			
			PWM 1			
			Active High	ı		
			Mode	time	-	
	Frequency 50.0 Hz	Ś	Min	9.0E-4	s	
			Max	0.0021	s	
► Others			Servo	Actuator Output s1	•	
▼ PWM			PWM 2			
2 3			🗸 Active High	1		
4			Mode		-	
5			Min	9.0E-4	s	
7			Max	0.0021	s	
8			Servo	Actuator Output s8	Ŧ	
► 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).

🔯 🚰 W2	10 🛪	:	0 🗄 🔇	🗘 🖓 💭	🔺 CfgMgr St	æpMgr		
Vehicle name	e	W21	D	AES	0		Ту	ре С т
US	Set inv	(SU)	Edit					
SU	Set inv	(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		
					+			
						-		
							Apply	

#### SU matrix editing

A flying wing is configured as follow:

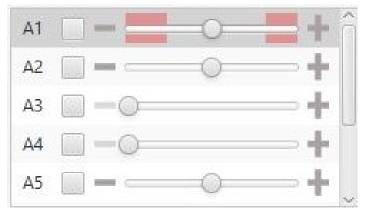
- 1. **Pitch Control:** control surfaces must be moved in the same direction to modify the pitching angle. The contribution of the actuators has same magnitude and direction.
- 2. Thrust Control: the Actuator Output 3 is the only one that allows a thrusting change.
- 3. **Roll Control:** in this case, the contribution of the actuators must be set with the same magnit:ref: Logical <logical>`ude 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.

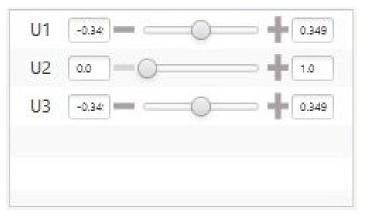
## 1.4.3 System Trim

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	A1 🗸
Sensors	
► Stick	A3 U U3 -0.34 0.249
► Veronte	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 Set 0.349 S 76.89 %
	Limit acceleration
	Limit deceleration
	100 85 70 55 40 25 0
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 0.40 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						0
Actuator Output s1	0 10	20 30		50 60	70 80	90 100
Actuator Output s2	-0				-	90 100
Actuator Output s3	0	20 30				
Stop PWM			Cancel	Finish	Previo	us 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.

🔯 🗷 W210 🛪 🛞 🙆 🗄	🗄 🔇 🗱 🚰 📥 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
► Micro	A1 🔽 - + 0349
Sensors	A2 🗸 — 💶 🕂 U2 🚥 — 🕂 1.0
► Stick	A3 U3 -0.34 0.349
Veronte	A4 — O — +
Others	A5 — — — — — — — — — — — — — — — — — — —
	Actuator Output s2 PWM 2 -0.349 S 10.0 %
	Disable servo Set 0.0 S 46.0 %
	Start up 0.0 s Set 0.349 S 89.0 %
	Limit acceleration
	Limit deceleration
	100
	85
	70
	9 55 1 40
	25
	0
Add device 👻	-0.40 -0.55 -0.55 -0.25 -0.25 -0.15 -0.10 -0.05 -0.05 -0.15 -0.15 -0.20 -0.25 -0.55 -0.40

#### 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.

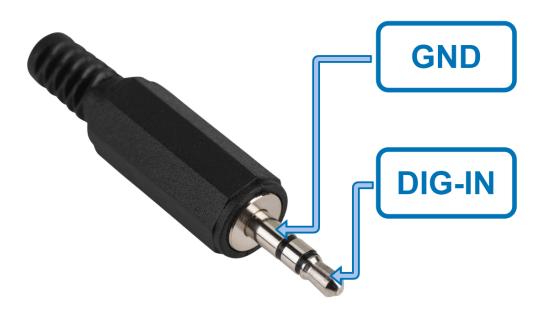
Veronte is compatible with standard Pulse Positon Modulation (PPM) signals between 8 and 16 channels.



#### 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

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Actuators	PPM Exponential	I 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	ss 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
- outers				
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:

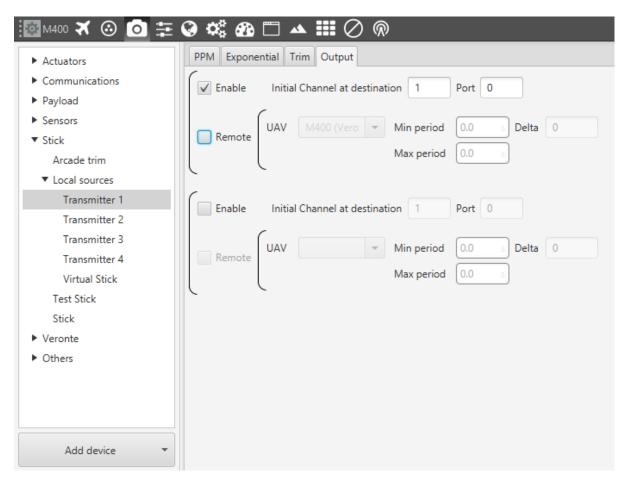
- Brand, Model & Channels:
  - Futaba.
    - \* Model 8J/10J/12K/14SG with 8 channels.
    - \* Model 12K/14SG with 12 channels.
    - \* Model T18SZ with 8 channels.
  - Jeti.
    - $\ast\,$  DC 16 / DC 24 with 16 channels.

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

If the User's transmitter is not present in the previou 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.



#### 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.

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Sort Phases	Precalibrate 👻	Norma
Checklist	Precalibrate	Name
Confirmation Notifications	Standby	
Notifications	Hold	-
	VHold	Required for phase change
	Hover	Show only once
	Cruise	
	Landing	
	Takeoff	
	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.

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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).

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Sort Phase	Precal	ibrate	•	News
Checklist	InRangeCheck		×	
Confirma Notificati	✓ Automatic Check			Link quality
Noulicau	Variable	Min	Мах	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
	4 (			
	Add variable	Cancel	Accept	
		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.

Sort Phase Checklist Confirmat Notificati	25	Precalibrate	₩ ⊘ ® -	Name GPS Signal OK In Range Check
	Variable Position not fixed	1.0	Max 1.0	Required for phase change     Show only once
	<			
	Add variable	Cancel	Accept	

### **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 Phases Checklist Confirmation Notification InRangeCheck Valuemat	Pre Link	calibrate	••••••••••••••••••••••••••••••••••••••	Name Battery voltage In Range Check 🔹 🖉
Va Power Input	riable	Min 21.0	Max           25.2	Required for phase change
< CAdd varia	able	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.

Sort Phases Checklist Confirmation Notificat	Precalibrate Link quality	▲ Ⅲ ⊘ @ - ×	Name Sensors OK In Range Check -
Varial Sensors Error	ble         Min           1.0	Max 1.0	Required for phase change Show only once
<add td="" variable<=""><td>Cancel</td><td>Accept</td><td></td></add>	Cancel	Accept	

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.

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Sort Phases	Precali	brate	-	Name
Checklist		12		Name
Confirmation	Link qu	uality		Stick OK
Notificat InRangeCheck	Check		×	In Range Check 🔹 🥒
Varia	able	Min	Max	Required for phase change
Stick Not Detec	ted	1.0	1.0	Show only once
< [				
Add variabl	le	Cancel	Accept	

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

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 sevos 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

# HARDWARE INSTALLATION

# 2.1 Veronte Autopilot

# 2.1.1 Aircraft Mounting

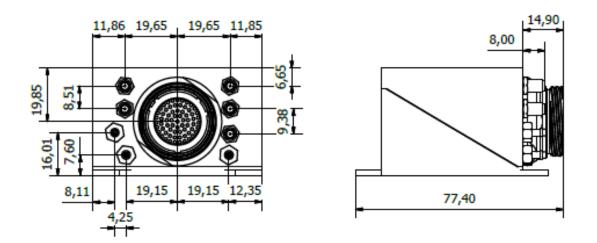
There are two versions of Veronte autopilot: with or without enclosure.

### 2.1.1.1 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.



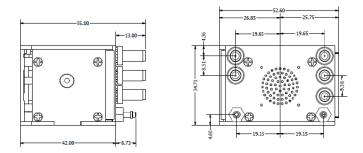
Veronte with aluminium enclosure



Veronte dimensions

### 2.1.1.2 OEM

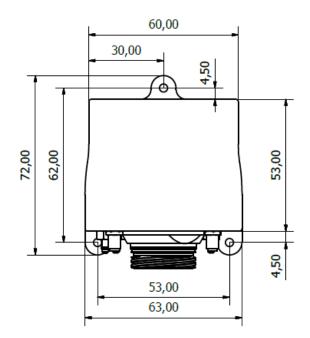
Veronte can be provided in OEM version too. The total approximate weight is 90g.



OEM dimensions

#### 2.1.1.3 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

#### 2.1.1.4 Vibration Isolation

Although Veronte ultimately rejects noise and high-frequency modes of vibration with electronic filters and internal mechanical filters, there might be situation 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.

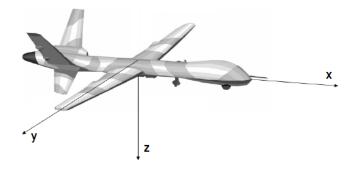
#### 2.1.1.5 Location

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.

#### 2.1.1.6 Orientation

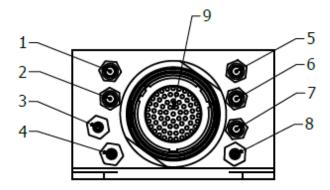
The orientation of Veronte has no restrictions either. You only need to configure Veronte axes with respect to the aircraft body axes by means of a rotation matrix or a set of correspondences between axes. The configuration of the orientation of Veronte can be easily configured using Veronte Pipe Software.

Veronte axes are printed on the box and aircraft coordinates are defined by the standard aeronautical conventions.



Aircraft Mounting

#### 2.1.1.7 Connector Layout



Veronte Connectors

Index	Connector
1	LOS SSMA connector
2	GNSS1 SSMA connector
3	Static pressure port (Fitting 5/64in)
4	Static pressure port (Fitting 5/64in)
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.

### 2.1.1.8 Mating Connector

Index	x 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

#### 2.1.1.9 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.

#### 2.1.1.10 Pressure lines

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

Absolute pressure connection on the aircraft is mandatory while pitot port can be obviated in some aircraft, 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

Pitot tube must be installed facing the airflow in the direction of the "x" axis of the aircraft. 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.

## 2.1.2 Electrical

#### 2.1.2.1 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.

#### 2.1.2.2 Veronte I/O Signals



68 pin connector for Veronte Autopilot (frontal view)

Pin	Signal	Туре	Comments		
1	I/O1	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
2	I/O2	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
3	I/O3	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
4	I/O4	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
5	I/O5	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
6	I/O6	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
7	I/O7	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
8	I/O8	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
9	GND	GROUND	Ground signal for actuators 1-8		
10	I/O9	I/O	WM/DIGITAL output /DIGITAL input signal (0-3.3V)		
11	I/O10	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
12	I/O11	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
13	I/O12	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
14	I/O13	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
15	I/O14	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
16	I/O15	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
17	I/O16	I/O	PWM/DIGITAL output /DIGITAL input signal (0-3.3V)		
18	GND	GROUND	Ground signal for actuators 9-16		
19	RS 232 TX	Output	RS 232 Output		
20	RS 232 RX	Input	RS 232 Input		

Pin	Signal	Туре	Comments
21	GND	GROUND	Ground signal for buses
22	Analog 4	Input Analog	Input 0-3V
23	Analog 5	Input Analog	Input 0-3V
24	GND	GROUND	Ground signal for buses
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
28	CANB_P	I/O	CANbus interface. It supports data rates up to 1 Mbps
29	CANB_N	I/O	Twisted pair with a 120 Zo recommended
30	GND	GROUND	Ground signal for buses
31	I2C_CLK	Output	Clk line for I2C bus
32	I2C_DATA	I/O	Data line for I2C bus
33	GND	GROUND	Ground for 3.3 V power supply
34	3.3V	POWER	3.3 V-100 mA power supply
35	GND	GROUND	Ground for 5 V power supply
36	5V	POWER	5 V – 100 mA power supply
37	GND	GROUND	Ground for analog signals
38	ANALOG_1	Input	Analog input 0-3 V
39	ANALOG_2	Input	Analog input 0-3 V
40	ANALOG_3	Input	Analog input 0-3 V
41	GND	GROUND	Ground for FTS signals
42	FTS_OUT	Output	Deadman (i.e. Heart-Beat, Alive) signal from comicro, monitors main MPU encoding
43	FTS2_OUT	Output	Output is a !SystemOK (0 when Ok, VCC when in Error) Bit Low (0 volts) if no failure d
44	GND	GROUND	Ground signal for safety buses
45	V_ARB_TX	Output	Veronte comicro UART output to activate safety mechanism
46	V_ARB_RX	Input	Veronte comicro UART output to activate safety mechanism
47	GND	GROUND	Ground signal comicro power supply
48	V_ARB_VCC	POWER	Veronte comicro power (6.5 to 36 V)
49	FTS3_OUT_MPU	Output	MPU alive voting signal, to use with 4xVeronte. It is a Square Wave at [100,125] Hz
50	OUT_RS485_P	Output	Non-inverted output from RS485 bus
51	OUT_RS485_N	Output	Inverted output from RS485 bus
52	IN_RS845_N	Input	Inverted input from RS485 bus
53	IN_RS845_P	Input	Non-inverted output from RS485 bus
54	RS-485_GND	GND	Ground for RS-485 bus
55	EQEP_A	Input	Encoder quadrature input A (0-3.3 V)
56	EQEP_B	Input	Encoder quadrature input B (0-3.3 V)
57	EQEP_S	Input	Encoder strobe input (0-3.3 V)
58	EQEP_I	Input	Encoder index input A (0-3.3 V)
59	GND	GROUND	Ground for encoders
60	V_USB_DP	I/O	Veronte USB data line
61	V_USB_DN	I/O	Veronte USB data line
62	V_USB_ID	I/O	Veronte USB ID line
63	FTS_OUT_MPU	Output	Abort mission voting signal from MPU, to use with 4xVeronte. Bit Low (0 volts) if missi
64	FTS2_OUT_MPU	Output	Abort mission voting signal 2 from MPU, to use with 4xVeronte. Bit Low (0 volts) if mis
65	GND	GROUND	Veronte ground input
66	ND	GROUND	Veronte ground input
67	VCC	POWER	Veronte power supply (6.5 to 36 V)
68	VCC	POWER	Veronte power supply (6.5 to 36 V)

#### 2.1.2.3 Flight Termination System (FTS)

In order to use the FTS of Veronte the user has to analyze Pins 42 and 43 (FTS ones). With pin 43 it can be studied with a !SystemOK bit if the system is working properly or not. Check below the information provided by each pin:

**Pin 42:** Deadman signal (i.e. Heart-Beat, Alive...) encoding its product-level bit. Deadman signal is a Square Wave at [100,125] Hz. It can be higher at rebooting (about 300-400Hz) but should never be less than 100 Hz.

**Pin 43:** Outputs a !SystemOK (0 when Ok, VCC when in Error) Bit. Low (0 volts) if no failure detected. High (3.3 volts) on error detected. This pin goes high if the deadman signal sent by the MPU (main processor unit) is lower than 63Hz. That means there is a critical error.

#### 2.1.2.4 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.

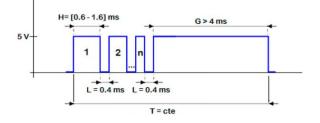
Veronte is compatible with standard Pulse Positon Modulation (PPM) signals, Futaba radios between 8 and 12 channels are recommended.



Futaba T10 Joystick

Pin	Designation	Connector
Shield	Ground	
1	VENCODER	
2	PPMout	
3		
4	V <sub>ENC2</sub>	
5	VBATTERY	
6	Unknown	
Pin	Designation	Connector
1	NC	
2	GROUND	
3	PPMout	(30 20 10
4	VBATTERY	60 50 40
5	Vencoder	
6		

#### Futaba T10 pinout

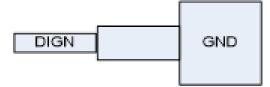


PPM signal

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

# 2.1.3 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

# 2.1.4 Annex 1: Connector colour code



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

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
23	White – Red	57	Gray – Green
24	Brown – Red	58	Yellow – Green
25	White – Black	59	Pink – Green
	· · · · · · · · · · · · · · · · · · ·	ontinu	les on next nage

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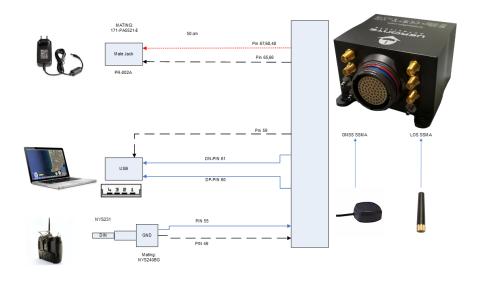
PIN	Color code	PIN	Color code
26	Brown – Black	60	Yellow – Pink
27	Grey – Green	61	White
28	Yellow – Green	62	Brown
29	Pink – Green	63	Green
30	Yellow – Pink	64	Yellow
31	White	65	Grey
32	Brown	66	Pink
33	Green	67	Blue
34	Yellow	68	Red

Table 2 – continued from previous page

**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.

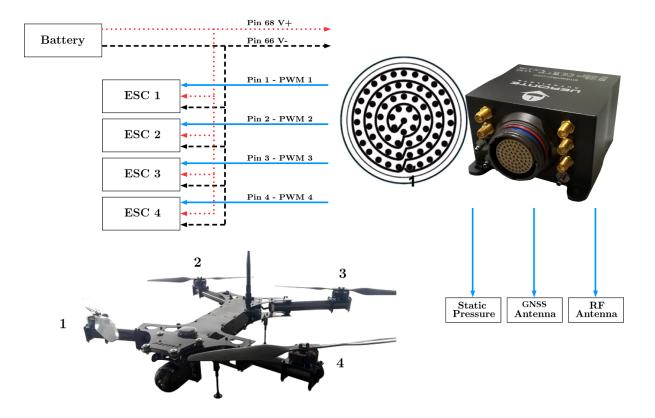
# 2.1.5 Annex 2: Connection examples

## 2.1.5.1 Ground Station



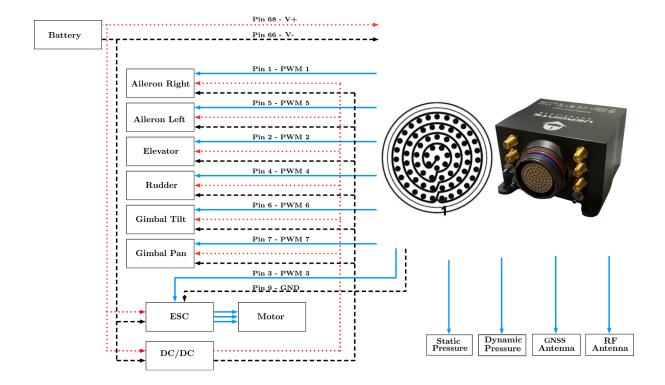
Ground Station

# 2.1.5.2 Multicopter



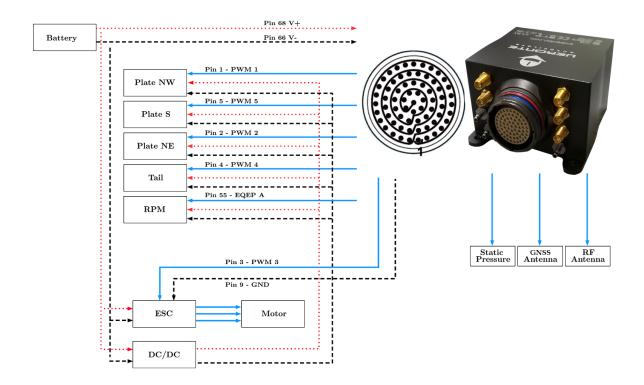
Multicopter

### 2.1.5.3 Fixed Wing



Fixed Wing

### 2.1.5.4 Helicopter



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.

# 2.1.6 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...

## 2.1.7 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.

## 2.1.8 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.

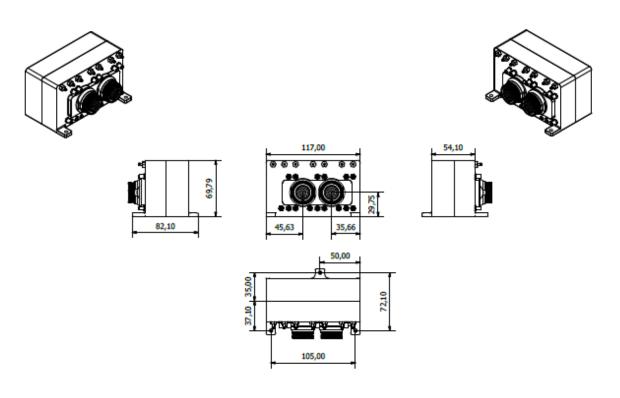
In case any malfunction occurs in the microprocessor, the comicro can activate different safety mechanism by means of 2 digital outputs and 1 serial port.

# 2.2 4x Veronte Autopilot

# 2.2.1 Aircraft Mounting

### 2.2.1.1 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)

### 2.2.1.2 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.

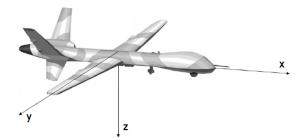
### 2.2.1.3 Location

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.

#### 2.2.1.4 Orientation

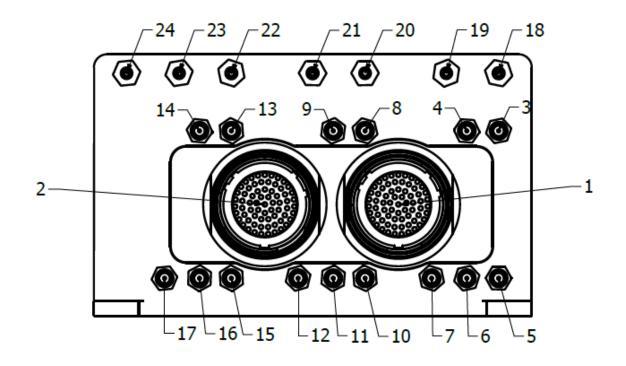
The orientation of 4xVeronte has no restrictions either. You only need to configure Veronte axes with respect to the aircraft body axes by means of a rotation matrix or a set of correspondences between axes. The configuration of the location of Veronte can be easily configured using Veronte Pipe Software.

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



Aircraft Mounting

# 2.2.1.5 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.

## 2.2.1.6 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\$65	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: FGW.LM.368.XLCT/Mating harness is available on		
	Connector/Connector	demand.		
	HEW.LM.368.XLNP			
7,12,17	TPDR antenna	SSMA male Plug, low-loss cable is recommended.		
	(SSMA Jack Female)			

#### 2.2.1.7 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.

#### 2.2.1.8 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.

### 2.2.2 Electrical

#### 2.2.2.1 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.

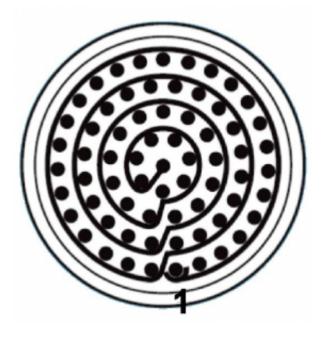
Veronte and servos can be powered by the same or different batteries. In case there are more than one battery on the system, a single point ground union it is needed to ensure a good performance. The ground signal should be isolated from other system ground references (e.g. engines).

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.

#### 2.2.2.2 Redundant Connector Pinout



68-pin redundant connector for 4xVeronte Autopilot

PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
			POWER DOMAIN	
1	I/O1	I/O	А	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
	1/0.4			(0-3.3V)
4	I/O4	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
5	I/O5	I/O		(0-3.3V) MUXED
5	1/05	1/0	Α	PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
6	I/O6	I/O	B	MUXED
0	1/00	1/0	Б	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	А	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)

PIN	SIGNAL		INTERNAL	COMMENTS
			POWER DOMAIN	
11	I/O10	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(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
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
14	I/O13	I/O	A	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
17	1/014	1/0	D	(0-3.3V)
15	I/O14	I/O	В	MUXED
				PWM/DIGITAL
				OUTPUT/DIGITAL INPUT SIGNAL
				INPUT SIGNAL (0-3.3V)
16	I/O15	I/O	A	MUXED
10	1/015	1/0	A	PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
17	I/O16	I/O	B	MUXED
	1,010	10		PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V)
18	GND	GROUND		GROUND SIGNAL
			•	FOR ACTUATORS
				9-16
19	RS_232_TX	OUTPUT	А	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
				tinues on next nage

Table 3 – continued from previous page

PIN	SIGNAL	3 – continued from p	INTERNAL	COMMENTS
FIN	SIGNAL		POWER DOMAIN	COMMENTS
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
28	CANB_P	I/O		CANbus interface.
			•	It supports data
				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	А	MUXED DATA
				LINE FOR I2C
				BUS
33	GND	GROUND		GROUND FOR
			•	3.3V POWER
				SUPPLY
34	3.3V	POWER	В	3.3V-100mA
25	GND			POWER SUPPLY
35	GND	GROUND	•	GROUND FOR 5V POWER SUPPLY
				rowek sorrei
36	5V	POWER	В	5V-100mA POWER
				SUPPLY
37	GND	GROUND		GROUND
			•	FOR ANALOG
				SIGNALS
38	ANALOG_1	INPUT	A	REDUNDANT
				ANALOG INPUT
20				0-36V
39	ANALOG_2	INPUT	A	REDUNDANT
				ANALOG INPUT
				0-36V

Table 3 – continued from previous page

PIN	SIGNAL	TYPE		COMMENTS
40		DIDUT	POWER DOMAIN	
40	ANALOG_3	INPUT	A	REDUNDANT ANALOG INPUT
				0-36V
41	GND	GROUND		GROUND SIGNAL
71	OND	GROOND	•	FOR BUSES
42	V3_USB_DP	I/O		VERONTE 3 USB
			•	DATA LINE
43	V3_USB_DN	I/O		VERONTE 3 USB
			•	DATA LINE
4.4	GND	CDOUND		
44	GND	GROUND		GROUND SIGNAL FOR BUSES
			•	FUR DUSES
45	UART TX	OUTPUT	В	MUXED UART
10	orner_m			OUTPUT
46	UART_RX	INPUT	В	REDUNDANT
				UART INPUT
47	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
40		CDOUND		
48	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
49	V3_USB_ID	I/O		VERONTE 3 USB
12	V3_05D_ID	1,0	•	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
	1.1.2.1.00.10_1		•	FOR MUXED RS-
				485 BUS
53	IN_RS485_P	INPUT		NON-INVERTED
			•	INPUT FOR
				MUXED RS-485
<u> </u>		CDOUBID		BUS
54	RS-485_GND	GROUND		GROUND FOR RS-
			•	485 BUS
55	EQEP_A	INPUT	A FOR VERONTE	ENCODER
			1&2 B FOR	QUADRATURE
			VERONTE 3	REDUNDANT
				INPUT A (0-5V)
	I	·		ntinues on next page

Table 3 – continued from previous page

PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
			POWER DOMAIN	
56	EQEP_B	INPUT		ENCODER
				QUADRATURE
				REDUNDANT
57				INPUT B (0-5V)
57	EQEP_S	INPUT		ENCODER STROBE
				REDUNDANT
				INPUT (0-5V)
58	EQEP_I	INPUT		ENCODER INDEX
38	EQEP_I	INPUI		REDUNDANT
				INPUT (0-5V)
59	GND3	GROUND		VERONTE 3
39	GNDS	GROUND		GROUND INPUT
			•	GROUND INPUT
60	V1 USB DP	I/O		VERONTE 1 USB
00	VI_CSD_DI	1/0	•	DATA LINE
61	V1_USB_DN	I/O		VERONTE 1 USB
01		10	•	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
				(6.5 to 36V)
65	GND2	GROUND		VERONTE 2
			•	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 – continued from previous page

### 2.2.2.3 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	COMMENTS
		10	POWER DOMAIN	
1	EXTERNAL FCU	I/O	A	EXTERNAL FCU
	I/O1			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
2		1/0	D	limited to 25mA.
2	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O2			PWM/DIGITAL 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	A	PWM/DIGITAL
	1/05			OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
4	EXTERNAL FCU	I/O	В	EXTERNAL FCU
	I/O4	10		PWM/DIGITAL
	101			OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
5	EXTERNAL FCU	I/O	A	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.

PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
		1/0	POWER DOMAIN	
7	EXTERNAL FCU	I/O	A	EXTERNAL FCU
	I/O7			PWM/DIGITAL OUTPUT/DIGITAL
				INPUT SIGNAL (0-3.3V). Input
				(0-3.3V). Input current must be
				limited to 25mA.
8	EXTERNAL FCU	I/O	В	EXTERNAL FCU
0	I/O8	1/0	D	PWM/DIGITAL
	100			OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
				limited to 25mA.
9	EXTERNAL FCU	I/O	A	EXTERNAL FCU
-	I/O9	10		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	A	EXTERNAL FCU
	I/O11			PWM/DIGITAL
				OUTPUT/DIGITAL
				INPUT SIGNAL
				(0-3.3V). Input
				current must be
10				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
				current must be limited to 25mA.
13	VCC2	POWER		
15	VCC2	PUWEK	•	VERONTE2POWERSUPPLY
			•	(6.5 to 36V)
				tinues on next page

Table 4 – continued from previous page	Table	4 – continued	from	previous	page
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PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
			POWER DOMAIN	
14	EXTERNAL FCU ANALOG INPUT 1	OUTPUT	A	EXTERNAL FCU ANALOG INPUT (0-36V). This is the analog signal corresponding
15	EXTERNAL FCU	OUTPUT	A	to Analog signal 1 on Redundant connector.
15	ANALOG INPUT 2			ANALOG INPUT (0-36V). This is the analog signal corresponding to Analog signal 2 on Redundant connector.
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	В	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	В	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

Table	4 - continued	from	previous	page
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PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
	OIGINAL		POWER DOMAIN	OOMMENTO
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
21	PAYLOAD TO EXTERNAL FCU RS-485_P	OUTPUT	•	RS-485_P OUTPUT SIGNAL FROM PAYLOAD (REDUNDANT CONNECTOR PIN 53)TO FCU RS-485_P INPUT
22	PAYLOAD TO EXTERNAL FCU RS-485_N	OUTPUT	•	RS-485_N OUTPUT SIGNAL FROM PAYLOAD (REDUNDANT CONNECTOR PIN 52)TO FCU RS-485_N INPUT
23	EXTERNAL FCU TO PAYLOAD RS-485_P	INPUT	В	RS-485_P OUTPUT SIGNAL FROM EXTERNAL FCU (REDUNDANT CONNECTOR PIN 50)TO PAYLOAD RS-485_P INPUT
24	EXTERNAL FCU TO PAYLOAD RS-485_N		В	RS-485_N OUTPUT 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.
			COL	ntinues on next page

Table 4 – continued from	previous page
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PIN	SIGNAL	TYPE		COMMENTS
27	VCC1	POWER	POWER DOMAIN	VERONTE 1
27	VCCI	POWER		POWER SUPPLY
				(6.5 to 36V)
28	CANB_P	I/O		CANbus interface.
20	CAND_F	1/0		It supports data
				rates up to 1 Mbps.
29	CANB_N	I/O		Recommended
		10	•	cable is a twisted
				pair with a 120 Zo.
30	ARBITER RS485	OUOUPTPUT	ARBITER	NON-INVERTED
				OUTPUT FOR
				ARBITER'S RS-
				485 BUS
31	ARBITER_RS485_	OUO <u>UN</u> PUT	ARBITER	INVERTED
				OUTPUT FOR
				ARBITER'S RS-
				485 BUS
32	ARBITER_RS485_	IN_INPUT	ARBITER	INVERTED INPUT
				FOR ARBITER'S
22				RS-485 BUS
33	ARBITER_RS485_		ARBITER	NON-INVERTED
				INPUT FOR ARBITER'S RS-
				485 BUS
34	ARBITER ARINC	TYNITPIT	ARBITER	ARBITER'S
54	ARDITER_ARTIC		ARDITER	ARINC POSITIVE
				OUTPUT
35	ARBITER_ARINC	TXDUTPUT	ARBITER	ARBITER'S
				ARINC
				NEGATIVE
				OUTPUT
36	ARBITER_ARINC	_RXIMPUT	ARBITER	ARBITER'S
				ARINC POSITIVE
				INPUT
37	ARBITER_ARINC	_RXBPUT	ARBITER	ARBITER'S
				ARINC
• •				NEGATIVE INPUT
38	GND	GROUND		GROUND SIGNAL
			•	FOR BUSES
39	ARBITER_I2C_SC	L OUTPUT	ARBITER	CLK LINE FOR
				ARBITER'S I2C
				BUS
40	ARBITER	I/O	ARBITER	DATA LINE FOR
	I2C_DATA			ARBITER'S I2C
				BUS
41	ARBITER_RS232E	B_RINPUT	ARBITER	ARBITER RS-232
				INPUT B
				tinues on next nage

Table	4 - continued	from	previous	page
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		continued from		
PIN	SIGNAL	TYPE	INTERNAL POWER DOMAIN	COMMENTS
42	ARBITER_RS232B_	ΓΙΟΟΤΡΟΤ	ARBITER	ARBITER RS-232 OUTPUT B
43	ARBITER_RS232A_	RINPUT	ARBITER	ARBITER RS-232 INPUT A
44	ARBITER_RS232A_	ΓØUTPUT	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)
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)

Table	4 - continued	from	previous	page
rabio	1 001101000		proviouo	pugo

PIN	SIGNAL	TYPE		COMMENTS
PIN	SIGNAL		POWER DOMAIN	COMMENTS
57	EXT_DETECT	I	ARBITER	CONNECT TO GND IF
				EXTERNAL FCU IS CONNECTED.
				OTHERWISE, LEAVE OPEN
58	GND	GROUND	•	GROUND SIGNAL FOR GPIO
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)

Table 4 – continued from previous page
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PIN	SIGNAL	TYPE	INTERNAL	COMMENTS
			POWER DOMAIN	
67	GND_ARBITER	GROUND		ARBITER
			•	GROUND INPUT
68	VCC_ARBITER	POWER		ARBITER POWER
			•	SUPPLY (6.5 to
				36V)

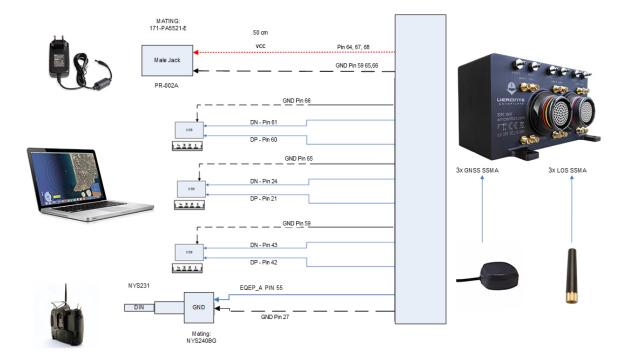
Table 4 – continued from previous page

## 2.2.3 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	$\pm 2\text{g}$ to $\pm 24\text{g}$ (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	

## 2.2.4 Annex 1: Connection Examples

### 2.2.4.1 Ground Station



Connection Example

### 2.2.5 Annex 2: Connector colour code

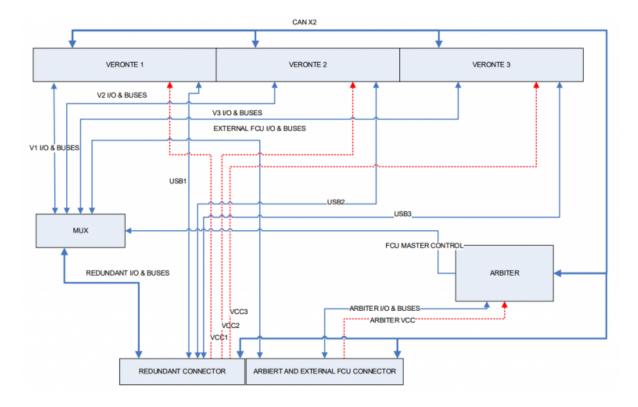


PIN	Color code	PIN	Color code
1	White	35	Gray
2	Brown	36	Pink
3	Green	37	Blue
4	Yellow	38	Red
5	Gray	39	Black
6	Pink	40	Violet
7	Blue	41	Gray – Pink
8	Red	42	Red – Blue
9	Black	43	White – Green
10	Violet	44	Brown – Green
11	Gray – Pink	45	White – Yellow
12	Red – Blue	46	Yellow – Brown
13	White – Green	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	Gray – Brown	52	Brown – Blue
19	White – Pink	53	White – Red
20	Pink – Brown	54	Brown – Red
21	White – Blue	55	White – Black
22		56	Brown – Black
23	Brown – Blue 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.

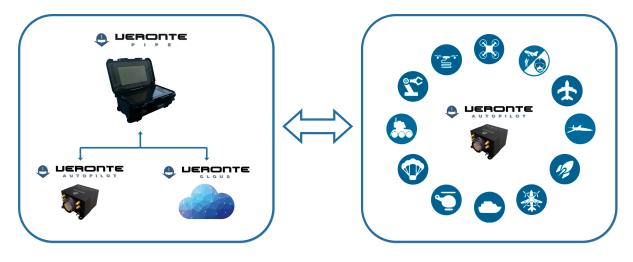
This redundant device allows platforms to perform **sensitive flight mission** and transport **valuable payload** with advanced safety conditions and high reliability. By installing a triple redundant core it is possible to extend the MTBF (Mean Time Between Failures) in the system. This control module 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

# THREE

# **PIPE CONFIGURATION**

# 3.1 Installation

### 3.1.1 System Requeriments

Minimum Hardware Specification for installation:

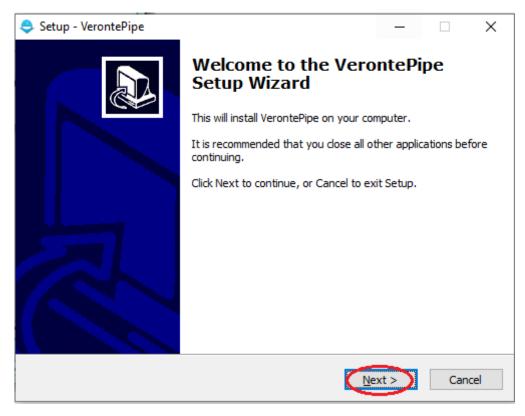
- Intel Core i5 Processor.
- 8 GB RAM
- USB port
- 500 MB free hard drive

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.

## 3.1.2 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.

🗢 Setup - VerontePipe	_		×
Select Destination Location Where should VerontePipe be installed?			21
Setup will install VerontePipe into the following folder.			
To continue, click Next. If you would like to select a different folder,	click Bro	wse.	
C:\Program Files\Embention\VerontePipe5.22.13	Bro	owse	>
At least 339.9 MB of free disk space is required.		Γ	
< <u>B</u> ack <u>N</u> ext		Can	icel

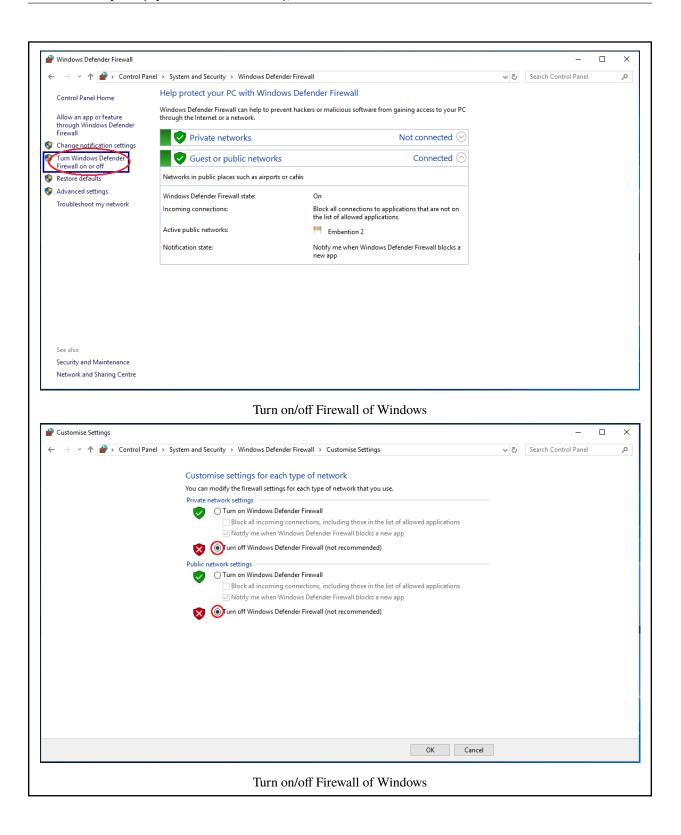
#### Windows Installation Step 02

#### 3. Finally, click on Install

🗢 Setup - VerontePipe	_		$\times$
Ready to Install Setup is now ready to begin installing VerontePipe on your computer.			21
Click Install to continue with the installation, or click Back if you want t change any settings.	o reviev	N OF	
Destination location: C:\Program Files\Embention\VerontePipe5.22.13		^	
<		>	
< <u>B</u> ack Insta		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.



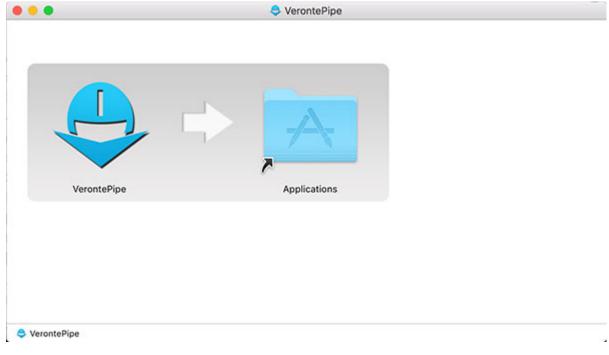
## 3.1.3 MAC

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.

• • •		VerontePipe_2.7	.2		
$\langle \rangle$	📰 🗸 🖬 💷 💷	· A O		Q Search	
		VerontePipe_2.7.2			+
Favorites	Name	^	Date Modified	Size	Kind
Applications	VerontePipe_2.7.2.dmg		10 May 2016 10:47	309,1 MB	Disk Im
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.



Mac Installation Step 02

the applicati		f VerontePipe, please check the firewall configuration of o "Security and Privacy" panel and be sure the program
Deactivating	g the antivirus can be useful too. Disabling the	antivirus depends on your antivirus software.
	Block all incoming connections Blocks all incoming connections except those r DHCP, Bonjour, and IPSec.	equired for basic Internet services, such as
3	RosettaStoneLtdServices	Block incoming connections
	S Skype	Allow incoming connections
	Spotify	Allow incoming connections
	Steam	Allow incoming connections
	OuTorrent	Allow incoming connections
	🗢 VerontePipe	Allow incoming connections
	X-Plane	Allow incoming connections \$
	<ul> <li>+ -</li> <li>Automatically allow signed software to re Allows software signed by a valid certificate au network.</li> <li>Enable stealth mode</li> </ul>	
	Don't respond to or acknowledge attempts to a applications using ICMP, such as Ping.	Cancel
	Turn on/off Fir	ewall on Mac

## 3.1.4 Linux

1. 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 -	verontepipe	– + ×
	erontepip	ies			Install Package
Version:	1.0	wn <unknown> al vn</unknown>	Lintian output		

#### Linux install step 1

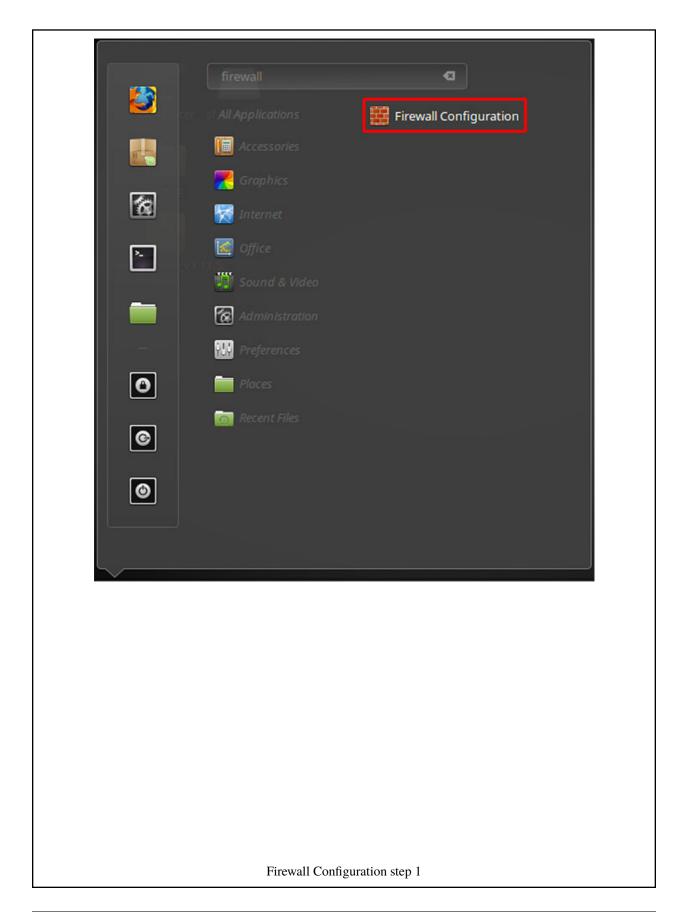
2. Then click on Install Package and wait the end of the installation process.

	P	ackage Installer - verontepipe	- + ×
File Edit	Help		
Package:	verontepipe		Install Package
Status:	All dependencies		
	P	ackage Installer - verontepipe	×
Descrip Veron	Installation finis	hed	
	▶ Terminal	e_v1.11.5.deb' was installed	rest lly applied
		ose after the changes have been suc	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.



	F	irewall	- +	×
Fil	e Edit Help	D	onate?	×
	Firewall			
	Profile: Home 🔻			
	Status: OFF			
	Incoming: Allow 💌			
	Outgoing: Allow 💌	•		
	Rules	Report	Log	
	N° Rule Name			
	+ - 🌣			
	Firewall disabled			
	Firewall Co	nfiguration step 2	2	

# 3.2 Update

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

#### Warning:

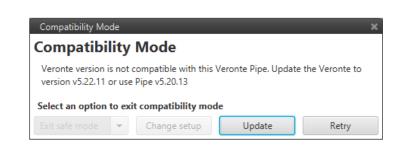
- Although newer versions are usually compatible with older ones, when upgrading the system, updates must be done in the correct order. It is mandatory to update **Veronte Pipe** first, then **Veronte Onboard** and finally **Veronte on the Control Station**. Otherwise, part of the system could become 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	.ver last saving	Compatibility
5.28.x	5.28.x	OK
5.28.x	5.22.x	OK
5.22.x	5.28.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 Veron	nte			
System Image	φ	5.22.11.update [v5.22.11]	D	
Configuration		Migrate 👻		
			Update	e

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 v2.12.7). 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.

Veronte File				×
<b>Co fy T</b>	Hide un	supported version		
Name	Veronte	Library	Version	+
Conf.ver	ZINGERCOPTER	Configurations	v5.20.13	
M600 Std.ver	M600	Configurations	v5.20.13	
Penguin_Default.ver	Fixed Wing V-T	Configurations	v5.20.21	
Veronte Ground-Tethered.ver	Veronte Groun	Configurations	v5.22.3	
Build from template 👻 🔹 VE	R File		DI	Library

#### Veronte File Selection

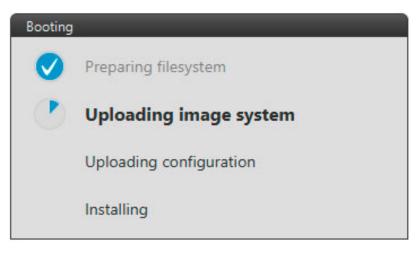
The previous window shows info about Pipe version used to save the configuration. Cell colour indicates the .ver compatibility:

- Green: Full compatibility.
- Yellow: Compatibility, but it needs migration.
- Red: No compatibility (.ver version is older than Pipe).

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.

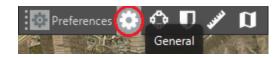


**Booting Process** 

# 3.3 Preferences

## 3.3.1 General

If you click in:



General Tool

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

JI Scale 100 125 150 175 200	Language Englis	h	Ŧ		
Notify update warnings					
oysticks	Sound				
	ALERT_AUDIOCLIP	Play	Change	Default	
	UO	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	

Software Setup

Where we will found:

• **UI Scale:** UI Scale permits to set the interface scale for adapting the application screen to the screen size on the system.

🖸 Preferences 🔅 🗘 🛡 🖋 ม	
Ul Scale - 0	Language English 🔹
Notify update warnings	

/sticks	Sound			
	ALERT_AUDIOCLIP	Play	Change	Default
	UO	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

#### UI Scale

• Language: you can choose the language that you want.

Notify update warnings sticks S	Sound ALERT_AUDIOCLIP U0	Play		
sticks S	ALERT_AUDIOCLIP	Play		
	_	Play		
	110		Change	Default
	00	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

#### Language

• **Update notification:** the Notify update warnings checkbox allows the user to receive an alert when a new update has been released for Veronte.

JI Scale 100 125 150 175 200	Language Engli	sh	*	
Notify update warnings				
pysticks	Sound			
	ALERT_AUDIOCLIP	Play	Change	Default
	UO	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

Update Notification

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

100 125 150 175 2	Language Englis			
Notify update warnings				
ysticks	Sound			
	ALERT_AUDIOCLIP	Play	Change	Default
	UO	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

- 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.

Scale 100 125 150 175 200	Language English	-
Notify update warnings		
ysticks	Sound	
	ALERT_AUDIOCLIP	Play Change Default
	UO	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

### Alert Audioclips

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

## 3.3.2 Connections

If you click in:



**Connections Tool** 

You can open the connections menu:

Preferences	* 🛡 🔄	n							
TCP Server			Send teleme	try					
Enable			Enable						
Port	3000		Host	127.0.0.1	Port	3000	Frequency	10.0	Hz
	Add	•							

## Connections Menu

Where you can configure:

• New veronte Units: When using Veronte Pipe for the first time, it is necessary to configure the connection with Veronte Units. Once it has been done, Veronte Units will be automatically detected by Veronte Pipe.

Preferences 🔅	🚱 🛡 🖋 邱	
TCP Server		Send telemetry
Enable		Enable
Port	.000	Host         127.0.0.1         Port         3000         Frequency         10.0         Hz
1		
	•	
Add	$\supset$ -	
Ethernet	Of Althering	
Serial COM COM	13 March 19 X	
COM	The second se	and the second second
L. CON	19	the second secon

New Veronte

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

Preferences 🔅 😳 🛡 🖋 🕅				
TCP Server	Send telemetry			
Enable	Enable			
Port 3000	Host 127.0	.0.1 Port	3000 Fre	equency 10.0 Hz
Serial COM	Port	COM9	•	
	Port	COMIS		
	Baudrate	115200 bps	-	
X	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.
- 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	🌣 🗘 🗸 🕻	1			
TCP Server		Send telemetry			
Enable Port	3000	Enable Host 127.0.	0.1 Port	3000 Freq	uency 10.0 Hz
Serial COM	dd -	Port Baudrate Parity Flow Control Data Bits Stop Bits	COM9 115200 bps None 8 bits 1 bit		

TCP Server

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

	🕸 🗘 🗘 🗸 🕻					
TCP Server Enable Port	3000	Send telemetry Enable Host 127.0.	0.1 Port	3000	Frequency 10.0	Hz
Serial COM	Add T	Port Baudrate Parity Flow Control Data Bits Stop Bits	COM9 115200 bps None 8 bits 1 bit			

Send Telemetry

# 3.3.3 Encryption

If you click in:

Preferences 🔅	¢	Encryption	

**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.

Pr	eferenc	es 🔅 🗘	U 🛩	Ø						
Cha	nge e	encryptior	n require	es reboo	t					
	State		Veron	te		Encryption	n			
$\bigcirc$	8	M600				Туре		None		-
$\sim$	1					Key		Nem		
						Confirm		AES 256		
							C	AES 192	)	
							Chan	AES 128	2	_
							-	-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 requires reboot	
	State	Veronte	Encryption
$\checkmark$	8	Octocopter	Type 😲 AES 256 👻
			Key
			Confirm
			Change the default encryption of: -Veronte Pipe -Octocopter
		Confirmation	×
		Pending changes require a restart Ver	ronte 1499 for take place
		What would you like to do?	
		Continue and restart ver	Abort without 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.

<ul> <li>Veronte 255</li> <li>Veronte 1</li> </ul>	
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.

## 3.3.3.1 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		
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.

## 3.3.4 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** (Veronte Pipe) – **Units**.

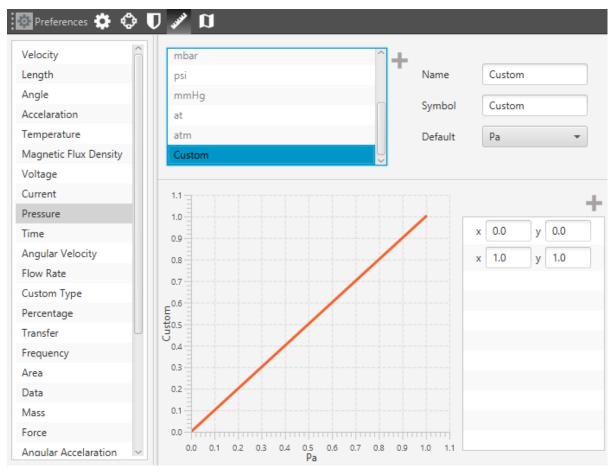
🔯 Preferences 🔅 🤇	° U	🥓 🚺 🔄			
Velocity	â	Pa	î +		
Length		kPa	T	Name	
Angle		bar			
Accelaration		mbar		Symbol	
Temperature		psi		Default	Pa
Magnetic Flux Density		mmHg			
Voltage					
Current					
Pressure					
Time					
Angular Velocity					
Flow Rate					
Custom Type					
Percentage					
Transfer	U				
Frequency					
Area					
Data					
Mass					
Force					
Angular Accelaration	$\sim$				

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.

## 3.3.4.1 Creating Custom Units

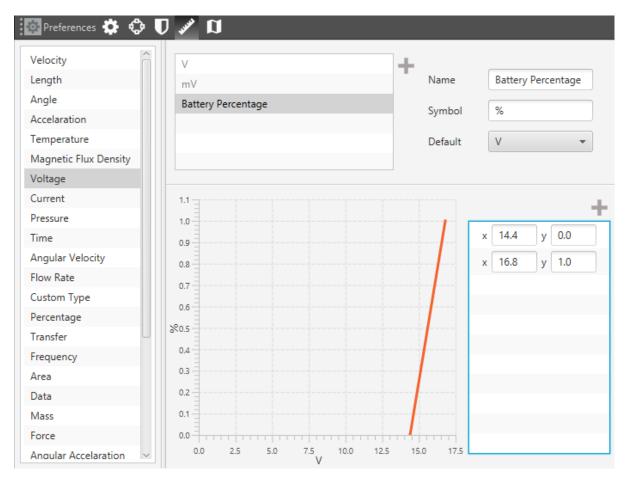
- 1. Click on "+" button, and a new variable will appear in the menu.
- 2. Introduce the conversion from the default unit to the new one. The conversion formula is created by introducing as many points as desired in the graph shown in the next figure.



#### 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.

## 3.3.4.2 Units

The table below shows all the available units in VerontePipe.

Variable Type	Units
Velocity	[m/s] [kt] [km/h] [mph] [ft/s] [ft/min]
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]
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]
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]
Mass	[kg] [g] [tonnes] [lbs] [oz]
Force	[N] [kN] [lbf] [pdl]
Angular Acceleration	$[rad/s^2] [rad/m^2] [rad/h^2]$
Baudrate	[Bd] [kBd] [MBd]
Pressure Variance	[Pa <sup>2</sup> ]
Magfield Variance	[T <sup>2</sup> ]
Velocity Variance	$[(m/s)^2] [(cm/s)^2] [(mm/s)^2]$
Numeral System	[bin] [octal] [dec] [hex]
Pressure Square Error Rate	[Pa <sup>2</sup> /s]

# 3.3.5 Map

If you click in:



Map Tool

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

## 3.3.5.1 Terrain Height

₽	Preferences 🔅 🛟	U 🖋 🛛		
	Coordinate preference	Decimal Degrees	• a)	
	Provid	ders terrain height		

Map Menu

You can select the units of the coordinates clicking on **a**)

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.

#### 3.3.5.2 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**.

Preferences 🏟 🗘 🍠	ũ
Coordinate preference Decimal	Degrees 👻
Providers terrain	height
SRTM USGS-SRTM3 Embention Embendion	tantic cean but the state of th
Add	Remove all cache files Load default

## 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.

### 3.3.5.3 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	
	Sav	/e

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.

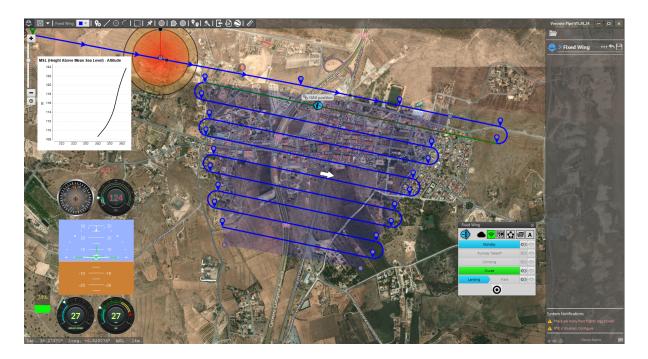
Click on (Main Menu), and then select Preferences in the pull-down menu, a new toolbar with different options will appear.



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
JUNE DE LE	Units	Open system units configuration
a	Мар	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

# FOUR

# WORKSPACE

# 4.1 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.



-	Open Details	Displays a panel where Widgets and Map are configured.
面	Remove	Remove selected workspace configuration.
ø	Rename	Change the name of the Workspace.
	Load	Select the workspace to be displayed or create a new one.
ł	Discard Changes	Discard all changes.
B	Save Workspace	Save workspace configuration.
ôb	Lock display position	Lock/Unlock display position.
Ŀ	Open	Open a workspace configuration.
<b>G</b>	Save as	Save workspace configuration as.
$\odot$	Show/Hide	Display or hide workspace elements.
▦	Regroup	Displays all widgets on the main screen.

Workspace Toolbar

# 4.1.1 Open Details

Open Detail prueba	▲ 🕒 🔓 🕒 🖝 🏢	
Widgets Main <sup>2</sup>	Name	SELECTED-VERONTE -
② Line of Sight		
▼ 🖏 1105	Location Ta	ke from Fixed Wing V-Tail UAV
Area		
Obstacles	Relative Approach Initial 🔹 🕒	
Route	Absolute Decimal Degrees      UAV POS	MAP POS
Bing Satellite		
Ly bing batenite	Latitude 0.0	
	Longitude 0.0	
	WGS84 0.0	m
	- MSL 0.0	m
	AGL 0.0	m
	Range 1000.0	
	Grid Resolu	
3 <sub>New</sub> -	Opacity	0

'Open Details' Menu

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

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

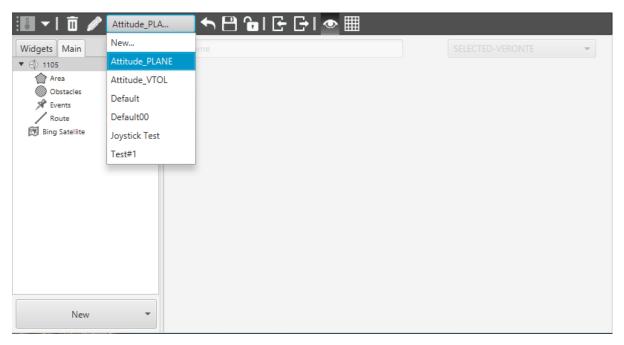
🔢 🕑 🕶 l 🗖	Default	► [	🖰 🔒 l 🔂 🗗	I 👁 🏢			
Widgets Main		Name				SELECTED-VER	ONTE 👻
Roll ▼ Attitude ☆ Solution ☆ Roll ♥ Pitch ☆ Solution Yaw	Hide Copy Change Group Remove	Variable Min Gauge	0.0 rad [-π,π]	Roll Max	1.0 rad [-π,π Ranges	Unit	rad [-π,π]
	Keniove	Enable	Variable	Time Since Har	dware Start-Up	Unit	s •
		Min	0.0 s	Max	1.0	s 🗸 Auto	
					Ranges		
		Opacity			(	$\supset$	
		Pos X	100.0	Pos y	50.0		
		Width	400	Height	300		
		Background		Front	•	Front 2	•
New	•	Time	60.0 s				

- Hide: Occults the selected element.
- Copy: Stores in the clipboard the selected element.

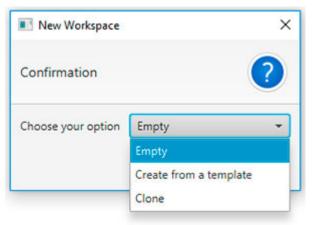
- Change Group: Opens a window to type the group to place the element in. If there is no group created or the name typed does not belong to any group, this option will create one and store the element in it.
- **Remove:** Deletes the selected element.

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.

## 4.1.2 Load



By clicking on 'Load' icon a dropdown list appears with the current workspaces. Workspaces can be created by clicking on **New...** 



New Workspace

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

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

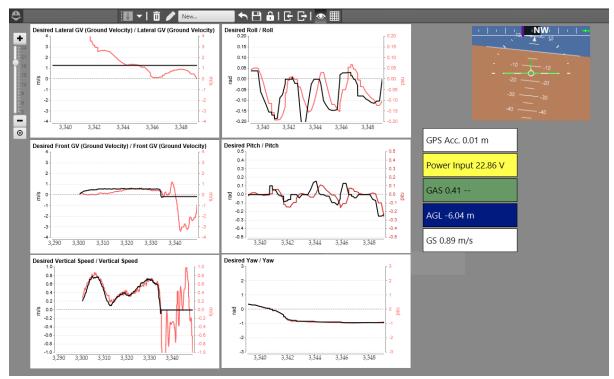
be saved by clicking on present in the toolbar.

**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:



## 4.1.3 Import/Export Workspaces

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



and are the buttons used to import and export a workspace respectively.

# 4.2 Map Display

## 4.2.1 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.

Widgets Main	Name		Bring to Front	SELECTED-VERONTE -
Penguin Embention     Area	Provider	Google Satellite	•	
Obstacles		Google Satellite	Â	
Route		Google Terrain		
🕅 Google Satellite		Google Street		
		Bing Satellite		
		Bing Street		
		Open Street Map Cycle		
		Open Street Map		
		Ovi Satellite		
		Ovi Street		
		Open Sea Map	~	
New				

Custom Map Example

# 4.2.2 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.

🔝 🔻 🛛 🗊 🧪 Default	▲ 🖰 🔓   단 단   👁 🏢	
Widgets Main Add Image Bing Satellite Bing Satellite	Name       Opacity	SELECTED-VERONTE -
Lto bing satellite	Relative Approach Initial   Absolute Decimal Degrees   Latitude   0.0   Longitude   0.0     Longitude     0.0     Example of the initial	Load image Resizable image (in map) Preserve ratio
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.

# 4.3 Widgets

## 4.3.1 Gimbal

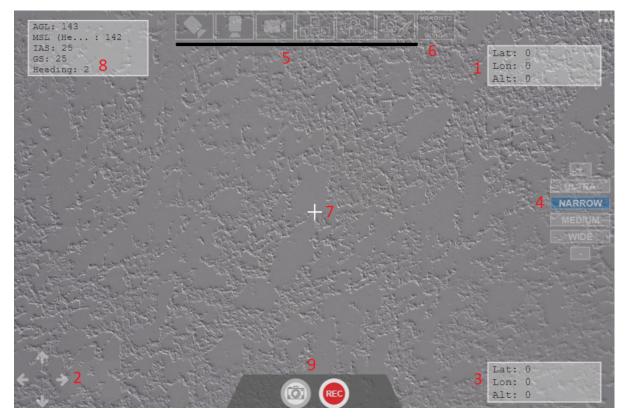
This widget allows the user to display a camera on screen and command a Gimbal if there is any device connected. The options configurable on this widget are the following ones:

- 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. Veronte Vision. Enables Veronte Vision software for detection and tracking.
- 7. Crosshair. Show/hide, resize and colour modification.
- 8. Telemetry Overlay. Enables a screen with telemetry information into Gimbal Widget.
- 9. Record control. Photography and video recording, choosing in which folder to be stored.
- 10. Gimbal. Choose controlled Gimbal.
- 11. Camera. Choose controlled Camera.

🔝 🔻 🛙 🗊 🥒 gimbal	►	<u>8 6   G G</u>		
Widgets Main	Name			SELECTED-VERONTE 👻
🛣 Gimbal				
	Opacity		GENERAL OVERLAY	TELEMETRY OVERLAY
	Pos X	50.0	Geotagging 1	Uav telemetry 8
	Pos Y	50.0	Pointing 2	Variables Telemetry
	Width	800	Crosshair telemetry 3	Decimals 0
	Height	600	Zoom control 4	RECORD
	Gimbal 10	No gimbal 🔹	Camera control 5	Record control 9
	Camera 11	0 -	Veronte Vision 6	Save Folder Change
			CROSSHAIR	
			Show crosshair 7	
			Size 🔍	>
			Color 📃 💌	
New 👻				

Gimbal Widget Configuration Menu



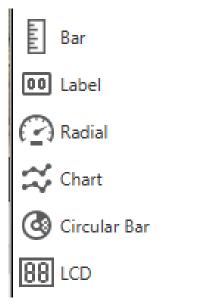
Gimbal Widget Display

# 4.3.2 Gauge Display

## 4.3.2.1 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**.



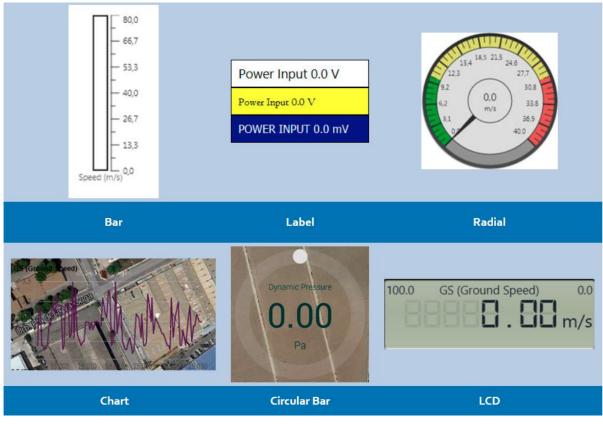
Gauge Selection Menu

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		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		
U ADC channel 16		~
	Cancel	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

# 4.3.2.2 Gauge Configuration

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

👃 🛃 🔻 📔 🗍 Default	<b>→</b> [	3 🔒 🕞 🕞	I 👁 🏢			
Widgets Main  Go AGL (Above Ground Level) – Height	Name		V	Bring to Front	SELECTED	-VERONTE 👻
	Variable	AGL (Abov	ve Ground Leve	el) – Height	Unit	m 🔹
	Gauge	00 Label 🔻		Ranges	Decimals	2
	Opacity			C		
	Pos X	100.0	Pos y	50.0		
	Width	400	Height	40		
	Background		Front	•		
	Font	System Regular		*		
	Font size	12 👻	Border			
<>						
New -						

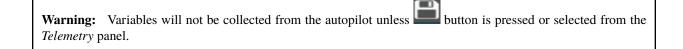
Gauge configuration

- 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.



### 4.3.2.3 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.

								0	Rai	iges	
₩idgets Main	Name	₿₿₿₽₽₽			SELECTED-VER	DNTE 👻		30.0 Caution	m/s]-> 40.0	m/s 🔳 👻	<b></b> +
Ground Velocity Down											
	Variable	Gr	ound Velocity l	Down	Unit	m/s 👻					
	Min	0.0 m/s	Max	1.0	m/s		-				
	Gauge	E Bar 💌		Ranges	Decimals	2					
	Opacity				Skin	Old 👻					
	Pos X	100.0	Pos y	50.0							
	Scale	Medium 👻									
										♦	
									Alarm	>	¢.
								N	Actived		
									Alarm	U0 -	
New 👻									Repeat	0.0 s	
									✓ Silenceable		
										Accept	



**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).

🔒 🕑 👻 📋 Default	● •	🖰 🔒 I 🕒 🕒 I	•			
Widgets Main	Name				SELECTED-VER	ONTE 👻
✓ Roll ✓ Attitude ✓ Attitude ✓ Pitch ✓ Yaw ✓ Change Group Remove	Variable Min Gauge Enable Min	0.0         rad [-π,π]           Chart            Variable         1           0.0         s	Roll Max Time Since Harr Max	1.0     rad [-π,π       Ranges       dware Start-Up       1.0       Ranges	Unit Unit Unit S Auto	rad [-π,π]
New 👻	Pos X Width Background Time	100.0 400 ••• 60.0 s	Pos y Height Front	50.0	Front 2	

### 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.

# 4.3.3 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.

🔠 🕑 🔽 📋 🔟 Default	S 🖻 🏦	E E   👁 🏢		<u>  ·   ·   ·   30 · + ·NE</u>   30 ·   ·   ·   ·
Widgets Main	Name	Bring to Front	SELECTED-VERONTE -	
	WIDGET	PFD	Surfaces	20 20 20
	Opacity	Indicators -	✓ Ailerons Control 3 -	
	Pos X 891.0	Compass 📃 👻	✓ Elevator Control 1 -	. 10 <u> </u>
	Pos y 181.0	Guidance 🔳 👻	✓ Rudder Control 4 -	· · ·
	Width 435	Compass Desired	<u>3D</u>	
	Height 435	V Pitch Desired	Enable 3D	$\sim$
		Roll Desired	Waypoints 📃 💌	
	Sky 🔳 💌	-	Camera	-10 -10
	Ground 📕 👻	Desired Heading		
	Advanced 🖌	Flight Path Angle	3D Model	-20 -20
			Manage models	
New 👻				-3030

#### 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.

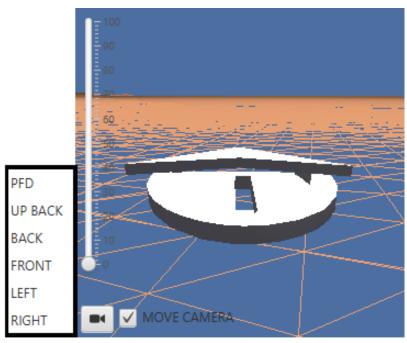
Widget	
Opacity	Change widget opacity.
Pos X/Y	Define widget's position in the screen's X/Y axis.
Width/Height	Define widget's width/height.
Sky/Ground	Select sky's/ground's color.
Advanced	When marked, displays all the configuration options available.

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.

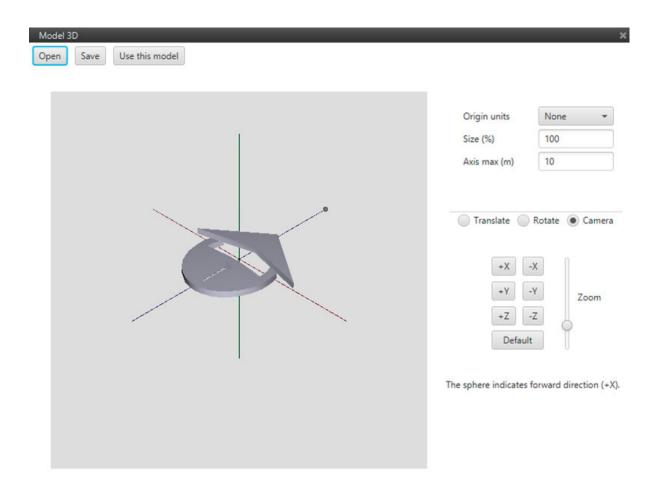
3D	
Enable 3D	When marked, it enables the 3D feature
Waypoints	Displays mission waypoints in the PFD.
Camera	Displays camera view if 'Enable 3D' feature is marked.

- 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

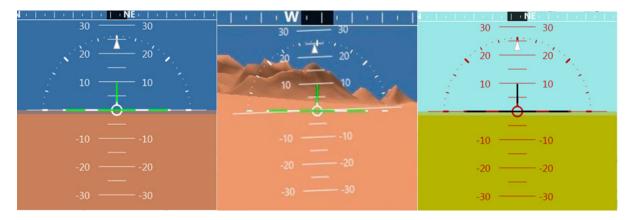
3D Model	
Manage models	Changes the 3D model display.



#### 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:



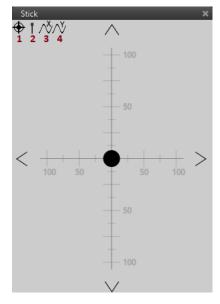
PFD Example

# 4.3.4 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.

🔝 🔻   🗓 🥢 gimbal		8 🔒 🕞 🕞	I 👁 🏢				
Widgets Main	Name				SELECTED-VER	ONTE	•
A Stick							
	Opacity			C			
	Pos X	1412.0	Pos y	313.0			
	Width	300	Height	300			
	✓ Horizonta	al Axis	✓ Vertical A	Axis	Frequency (Advanced)		
	Channel	2 -	Channel	3 -	Min	10.0	Hz
	Axis Scale	100.0	Axis Scale	100.0	Max	10.0	Hz
					Start ena	bled	
	Endpoint		Endpoint				
	Min	0.0 x1	Min	0.0 ×1			
	Max	1.0 x1	Max	1.0 x1	Cont	igure Joystick	
New 👻	Return to	center	Return to	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.

# 4.3.5 Terrain

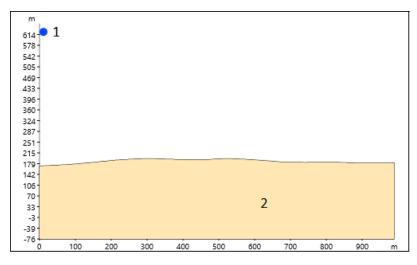
Vidgets Main	Name	Name					SELECTED-VERONTE		
🛃 Terrain									
	Opacity	0	Ground	<u> </u>					
	Pos X	375.0	Uav	• 1					
	Pos y	457.0	Distance	1000.0		]			
	Width	500	Orientation	Left	*				
	Height	300	Туре	AUTO	*	Min	0.0		
						Max	1.0		
New	-								

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

## 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
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 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

# 4.3.6 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							
PFD							
(A) Stick	ap	<b>↑</b> □	âl Œ ⊡	•			
AP		Name				SELECTED-AIR	*
Autotune		Opacity					
Terrain		Pos X	100.0	Pos y	50.0		
Bar							
00 Label							
Radial							
😂 Chart							
G Circular Bar	9						
88 LCD							
O Compass							
Altimeter							
New	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.

# 4.3.7 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.

🔝 🔻   🗓 🧪 gimbal		) 🔒   🕒 🕞   👁 🏢	
Widgets Main	Name		SELECTED-VERONTE 👻
Une of Sight			
▼ ⊕ 1408	Location	Take from Orbiter	1
Area			
Obstacles	Relative	Approach Initial	
Route	Absolute	Decimal Degrees • UAV POS MAP POS	
🕅 Bing Satellite	Latitude	38.28525931347715	
	Longitude	-0.563433937300282	
	WGS84	0.0	
	- MSL	-50.378392921733564 m	
	LA AGL	-77.37839292173356 m	
	Range Grid Resolu ⊂	2	⊃ 3
New 👻	Opacity <	0	⇒ 4

Line of Sight Configuration Menu

Line of Sight Simulation

## 4.3.8 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.

🔃 🕶   🛅 🥒 NEW	▲ 🖰 🔒   단 단   👁 🏢	
Widgets Main	Name SELECTED-VERONTE	-
ADS-B Decorder		
	Opacity O	
	Pos X 76.0 Pos y 697.0	
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

## 4.3.9 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:

🔝 👻   🗊 🥒 NEW	♠ 🖰 🔒   단 단   👁 🏢	
Widgets Main	Name SELEC	TED-VERONTE -
👫 GNSS Status		
	Opacity O	
	Pos X 1146.0 Pos y 471.0	
	GNSS 1	
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		SUI	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
STATUS					
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		Dette	
				DGNS	is

#### **GNSS** Status Display

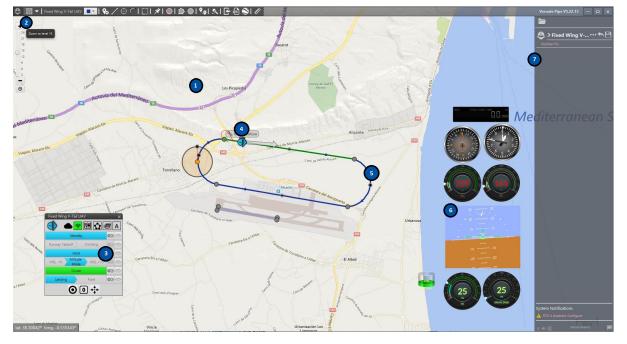
The information shown in the widget is as follows:

- 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.

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' under the **mathematical set on the set of t** 

# 4.4 Main Interface



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

Workspace Main Interface

Each section has the following functions:

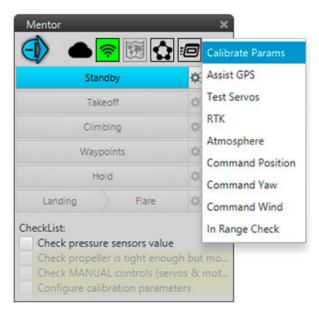
- 1. **Main Display:** Displays a selectable background map or a plain colour together with the most important mission data. To change it visit *Map Display*
- 2. Main Menu:
  - User: Manage user preferences.
  - Cloud: Provides access to the Cloud options.
  - Workspace: Select the way flight information 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

# **VERONTE PANEL**

# 5.1 Sensors Calibration

The internal sensors fitted in Veronte Autopilot can be calibrated through the menu that can be displayed from the Veronte Panel.



Veronte Panel - Parameters Calibration

The Calibrate Params option will open the calibration menu shown in the following figure.

Save	n time	3.0		s	
V C	alibrate Imu				
	Yaw *	0.0		rad [-m,m]	D
	Pitch *	0.0		rad (-n,n)	D
	Roll *	0.0		rad (-mm)	D
C	alibrate static	presure			
Pab	s *	0.0		Pa	
	s * alibrate dynan			Pa	
	alibrate dynan			Pa	
V C	alibrate dynan		x 0.0	Pa	
V Ca	alibrate dynan meter	nic presure		Pa	5
√ Ci Aagnetor bias_x	alibrate dynan meter 0.0	nic presure	у 0.0	Pa	

#### Sensors Calibration Menu

This menu allows calibrating the IMU, the Dynamic pressure sensor and the Static pressure sensor. When sensors are marked, the Save option is selected and the button "Accept" is clicked, the calibration is done, so the user should proceed with caution and mark only the sensors that he wants to calibrate in the red section.

• The IMU is calibrated according to the aircraft current position, so the UAV has to be located in a leveled position when performing the calibration. The three axes of the platform can be calibrated separately and at the desired angle. For example, the following figure represents the typical IMU calibration of Mentor which has 11° [deg] of pitch angle when positioned horizontally on the ground.

	on time	3.0	s	
✓ Save				
VC	alibrate Imu			
	Yaw *	0.0	rad [-m,m	
$\checkmark$	Pitch *	11.0	° [-180,180	0])
$\checkmark$	Roll *	0.0	° [-180,180	0])
0	alibrate static pr	esure		
Pab		0.0	p	
Pab		0.0	Þ	
Pab	s * alibrate dynamic	0.0	Þ	3
Pab	s * alibrate dynamic	0.0		3
Pab Ca Magnetor	s * alibrate dynamic meter	0.0 c presure	¢ 0.0	
Pab Ca Magnetor bias_x	s * alibrate dynamic meter 0.0	0.0 c presure	¢ 0.0 y 0.0	

#### IMU Calibration of Mentor

- The **Static pressure** sensor is used to obtain the altitude. If the pressure at the flight area is known, introducing this value and calibrating the sensor will improve the height estimation.
- The **Dynamic pressure** sensor (Pitot tube), used to estimate the velocity with respect to the air, has to be calibrated when the orifice of the tube is covered, so the calibration is done from a 0 m/s lecture.

The blue section of the panel allows the user to access to the Magnetometer calibration panel. For more info about the magnetometer, see section *Magnetometer*.

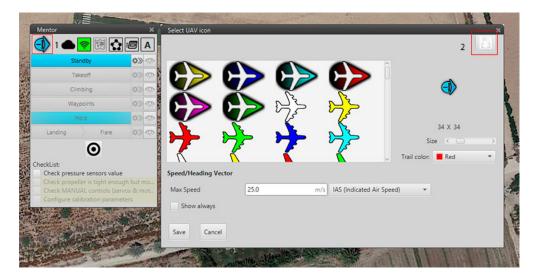
Veronte Panel is the display that shows the different phases of the flight operation and permits the user to change from one to another. Besides, it can be configured to allow the user to change different parameters of a phase during a real flight (gains, speed, altitude and so on). The panel also shows the checklist that contains a set of actions that must be done before entering into a new phase. In order to configure



### Veronte Panel

# 5.2 Veronte Icon

The system also makes it possible to change the icon that indicates the position of the autopilot over the map.



#### Veronte icon selection

In the Veronte Panel, pressing 1 will display a window where the user can change the icon that marks the current position of the autopilot (once it has GNSS coverage). There exist in the system a list of icons, but it is also possible to introduce new designs stored in the computer using option 2.

The trail that indicates the path that the autopilot has covered is also customizable by the user (color).

# 5.3 Veronte Panel

Double click on any Veronte to display its Veronte Panel. This item is the main interface to control the flight operations.



#### Veronte Panel checklist

The current phase is marked in green, select one of the available blue phases to change manually. When entering a new phase, all required **Checklist elements** (red) must be completed.

There are two options when entering a new phase:

- Clicking on the phase name (blue box) will make the aircraft enter the phase with the preconfigured parameters.
- If the **Options button** (black) is selected, the system will enter the phase but a window will appear allowing the user to change the parameters of that phase. Phase parameters can also be configured on the control tab on the setup menu.

The **Mode button** (blue) indicates the actual flight mode (A-Auto, M-Manual...) and allows to change it. Finally, the View button (purple) displays the phase route on the screen.

Dependencies between phases and automatic phase transitions are configured on the automations panel.

## CHAPTER

SIX

# **VERONTE CONFIGURATION**

# 6.1 File Management

## 6.1.1 Import Configurations

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



Import Configuration

Power and connect the autopilot to Veronte Pipe, in the side panel, click on and then select Import. The **Import Configuration** option displays a window used to select the file to be uploaded.

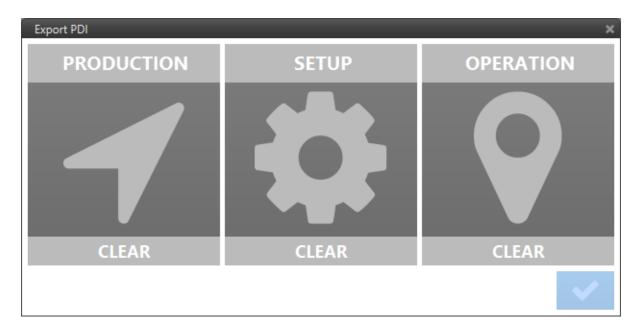
	Hide ur	nsupported versior	1	×
Name	Veronte	Library	Version	+
2020-04-06_17-02-43 Fixed Wing V-Tail UAV .ver	Fixed Wing V-T	Configurations	v5.38.21	
Build from template 💌	VER File	۲ ا	DI	Library

- **Build from template:** By selencting 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, fix wings, Ground station among others.
- **VER File:** Veronte Pipe will request the location of the .ver file to be loaded.

**Warning:** Overwriting Calibration when loading a .ver file will overwrite the factory calibration of the sensors.

• PDI: By selecting PDI The user will be able to select the locations of each folder and load them.

Warning: Loading Production files will overwrite the factory calibration of the sensors.



Import a Configuration File

Load D:\Users\ \Desktop\Configurations\Fixed \	Ving		×
D:\Users\ \Desktop\Configurations\Fixed Wing     .git	☆ Setup		
Operation Production	Log Description Base configuration	Author	Date 06/04/2020 05:32
Setup			
▼ ★ Favorites			Select

## Import a Configuration File

• Library: Loads a configuration from the library.

In order to include a folder as a part of the library select *Manage Libraries*. By incluing a folder to the library any .ver files in that folder will be displayed.

Veronte File					×
<b>6</b> 47		Hide	unsupported version		
	Name	Veronte	Library	Version	+
	Libraries			*	
				Save	
Build from tem	plate 🔻	VER File	D PI	וס	🛃 Library

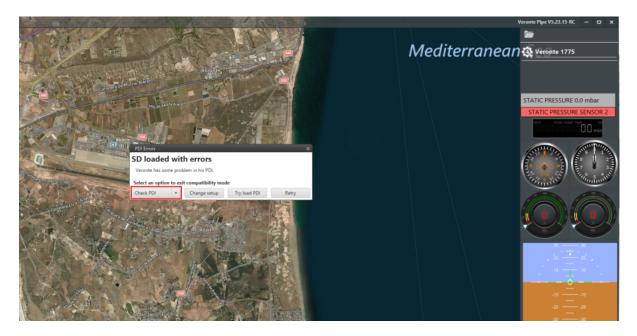
Library Menu

**Warning:** For each one of the configurations of the library appears its Version. About the 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. The colours are a way to show the compatibility: **Green** means fully compatible, **Yellow** means migration/PN adaptation and **Red** means not compatible.

**Warning:** Press *Save*, , to load the configuration on the autopilot. Otherwise, it will be only loaded on the system.

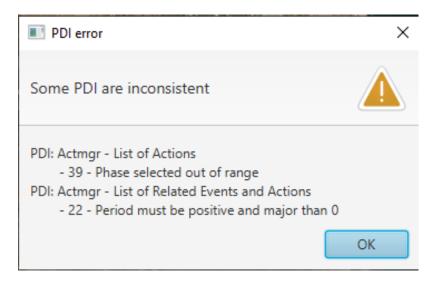
## 6.1.1.1 CHECK PDI

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 *Safe Mode*. When clicking on the unit affected it can be seen the following window appearing.



PDI Error Window

The option provided to the user are Check PDI (which generates an error display window), Change Setup (explained below), Try load PDI with which a new configuration can be loaded and Retry. When Checking PDI the window that appears is as follows:



#### PDI Error Display

Now the user must find and correct the errors shown in the list displayed. For that, access Setup through "Change Setup" in PDI Error window.



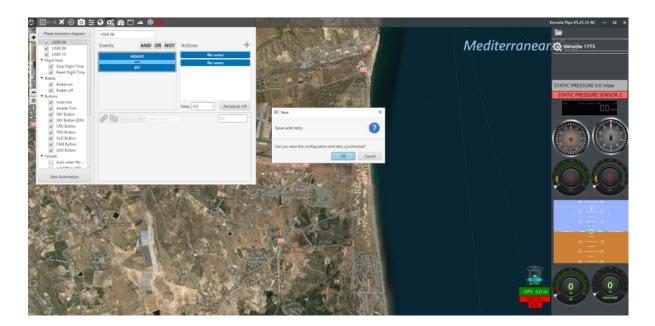
#### Check PDI setup

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

ТС-76 🛪 📀 🧰	😧 🗘 🚯	🗂 🔺 🖗 🖺		
Phase transition diagram	USER 08			
✓ USER 08	Events	AND OR NOT	Actions	+
VUSER 10		HEIGHT		No name
▼ Flight time		AND		No name
✓ Stop Flight Time		BIT		No hame
✓ Reset Flight Time				
▼ Brakes				
✓ Brakes on				
✓ Brakes off				
▼ Buttons				
✓ Hold trim			Delay 0.0	s Periodical: Off
✓ Arcade Trim			Delay 0.0	s Periodical: Off
SBY Button	2 E	<ul> <li>Insert name</li> </ul>		0.0 s
SBY Button (EIN)	C LE	* Insert name		0.0
✓ CRU Button				
✓ TKO Button				
✓ HLD Button				
CMB Button				
LND Button				
▼ Failsafe				
Auto when No				
New Automation				

#### 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 Setup after PDI Check

## 6.1.2 Export Configurations

When exporting a configuration, the file saved is a compression of a set of files with extension .bin, containing each one of them a part of the setup (mission, terrain information, servos, platform, communications and so on). This tool allows users to save configuration files from the autopilot or offline configuration.

In the side panel, click on **see and** then choose the kind of export to be done:

- Export PDI. Same as we have seen in VERONTE CONFIGURATION *File Management*, a 3-screen window will appear to let you choose where to save all XML files.
- **Export .ver.** A new window will be displayed to select the file destination and set the name. By default, the name of the file will be the autopilot name plus the current date, but it is fully customizable by the user.

🗢 Export configuratio	n			×
← → ~ ↑ 💻	> Este equipo	~ ē	Buscar en Este equipo	م
Organizar 👻				- ?
> 🍊 OneDrive	↑ ∨ Carpetas (6)			^
<ul> <li>Este equipo</li> <li>Descargas</li> <li>Documentos</li> </ul>	Descargas			
> 🔜 Escritorio	Documentos			- 1
> 📰 Imágenes > 🍌 Música > 📕 Vídeos	Escritorio			
> 🏪 Windows8_OS > 🛖 Disco Local (D	Imagenes			Ŷ
Nombre:	2017-11-03_10-26-34 Octocopter.ver			~
Tipo:	Veronte configuration (*.ver)			~
<ul> <li>Ocultar carpetas</li> </ul>			Guardar	Cancelar:

Exporting a configuration file

## 6.1.3 Offline Configurations

It is possible to load and modify a configuration when the autopilots are not connected. That configuration file can be changed and exported, and it is also possible to overwrite that one importing a new PDI file/.ver configuration.



#### Offline Configuration

The other features available working with a configuration file are **Mission** and **Setup** configuration. This configuration file can be uploaded to the Autopilot following the steps described in the section *Import Configurations*.

## 6.1.4 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.

## 6.1.5 Update Onboard Software

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



Advanced - Update Menu

Upgrading		×
UAV Veronte		
System Image 🛛 💠	5.22.11.update [v5.22.11]	
Configuration	Migrate - 🗗	
		Update

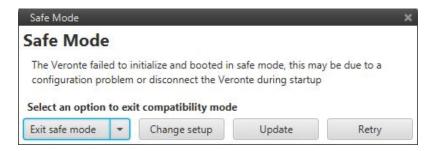
Update Veronte Autopilot

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 5.22* the onboard version will be *5.22.X* (with 'X' being the last option available). If the .update file is stored in the computer it can be uploaded 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: migrate will keep the current configuration for the new version and the folder icon will display the *Import Configurations*.

## 6.1.6 Safe Mode

Whenever there is an issue with connection, powering or configuration, the unit enters in Safe Mode and the following window is displayed.



Safe Mode

The options available are:

- Exit Safe Mode. The Veronte tries to initialise again in order to exit Safe Mode.
- **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 - 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.

- 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 from the Side Panel



#### Side Panel Options

The setup toolbar of Veronte Pipe is the section that contains the parameters to configure the system, which is formed by the autopilots (Air and Ground) and the software (Veronte Pipe).

## 6.1.7 CONFIGURATION FILES (.VER)

The .ver file contains the entire Veronte configuration and it means:

- Aircraft configuration (Sensors, Servos, Automations, Control, etc.)
- Mission (Terrain info, Waypoints, etc.)

The best way to manage .ver files is to keep a default version with the correct aircraft configuration which must contain no mission. In this way, it is possible to load the default config. when the user wants to create a new mission and, when it is complete, to save it with a different file name (normally the mission name or the mission site).

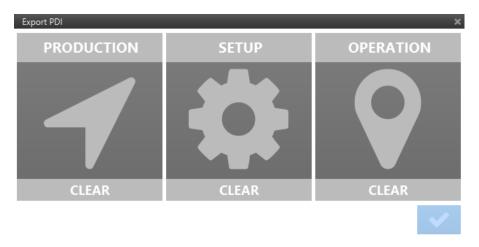
When the user wants to do the 'X' mission is sufficient to load the 'X' mission.ver file in the autopilot and the aircraft will be ready to perform the desired route.

## 6.1.8 PDI FILES

PDI files is a way of managing the configuration from Veronte, allowing the user for a modular control with improved version management. PDI files are split in:

- Production. Contains the configuration of the sensors, the calibration parameters, the active devices...
- Setup. Contains the configuration of the flight phases, guidance commands, control loops...
- Operation. Contains the operation values that are set before the operation starts (Cruise Speed, Altitudes...)

The optimal way is to work with a repository for version control, so each time the user exports the configuration there is a track of the changes done and the saving goes together with a commit message for later revision.



PDI Files management menu

# 6.2 Setup Toolbar

## 6.2.1 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.



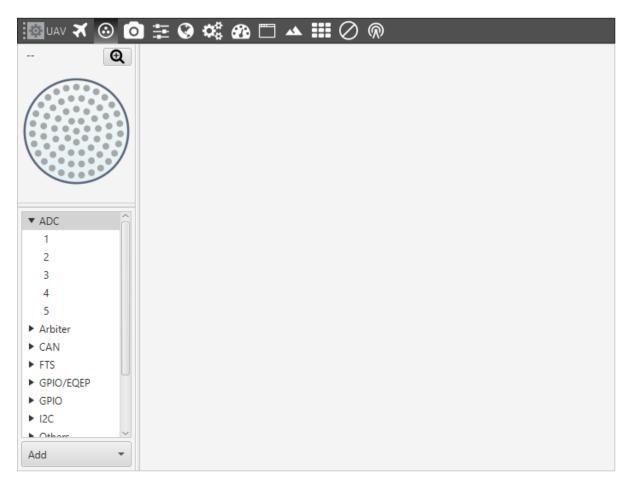
Autopilot Identification Data

## 6.2.2 Connections

## 6.2.2.1 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.



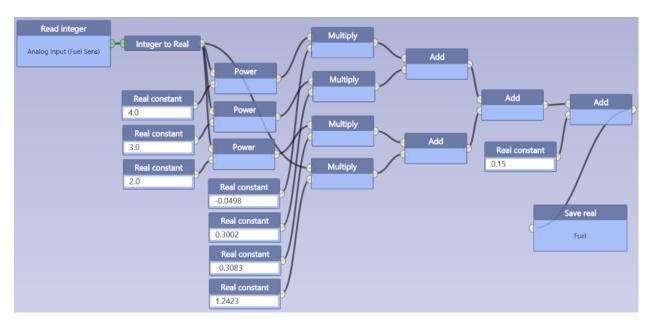
#### ADC Menu

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

### 6.2.2.1.1 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 operation 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

## 6.2.2.2 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	av 🛪 💿 💿 葦 🚱 🗱 🚳 🗔 🔺 🏭 ⊘
Pin: 46 🔍	
0.00	
\ • /	
0000	
► ADC	
▼ Arbiter	
RX	
ТХ	
VCC	
► CAN	
► FTS	
► GPIO/EQEP	
▶ GPIO	
▶ 12C	
► Others	
▶ PWM	
Sorial V	
Add 💌	

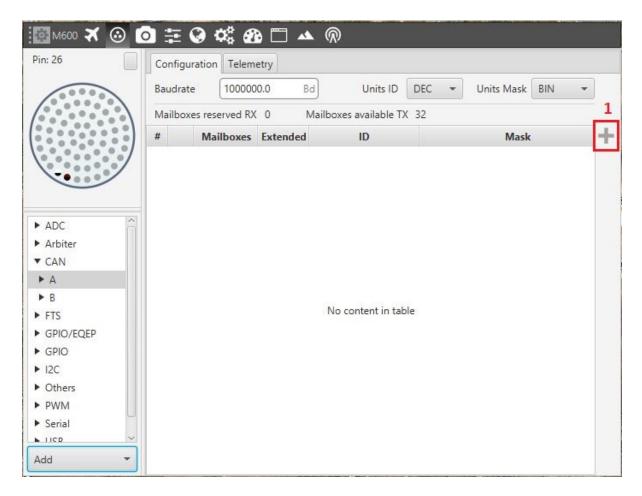
Connections – Safety microcontroller (SuC)

### 6.2.2.3 CAN

### 6.2.2.3.1 CAN Configuration

In this menu, it is possible to modify the Baudrate and the Mailboxes from the CAN bus.

When the user has to configure Veronte to receive data from the CAN Bus, it is mandatory configuring a Mailbox. In order to add a mailbox select (1).



#### CAN - Mailboxes

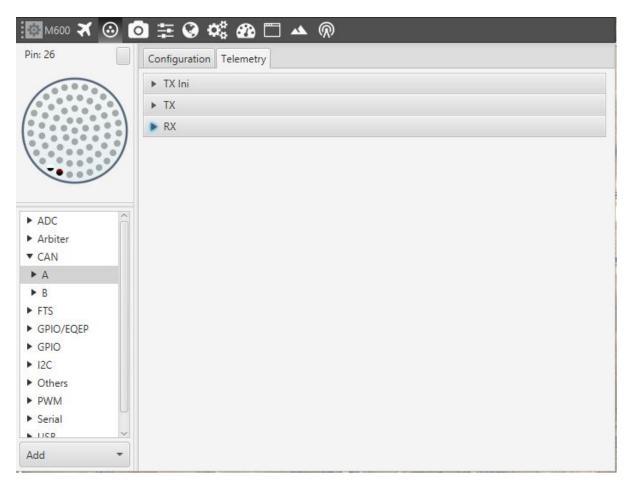
Mailboxes are used to save the data received, being possible to configure more than one. Veronte allows up to 32 mailboxes. The options available when adding a new mailbox are:

- Mailboxes: allows the user to identify a Mailbox with a determined configuration.
- Extended: frame format with 29 identifier bits.
- ID: identifier 11 or 29-bits (Extended), used to identify RX messages. The value set has to be decimal.
- **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).

#### 6.2.2.3.2 CAN Telemetry

Interactions between system variables and CAN variables are managed from the telemetry configuration. In this section the following elements can be configured:

- TX Ini: used to configure transmitted messages that are only sent once at the beginning of the operation
- TX: used to configure transmitted messages through CAN bus.
- **RX:** used to configure the interaction between the variables read from the CAN bus and the variables of the system i.e, how they are stored.



CAN - Telemetry

### 6.2.2.3.2.1 TX Messages

M600 🛪 🙆 🕻	• ∓ • • • ∞   • •	
Pin: 26	Configuration Telemetry	
	► TX Ini	
	▼ TX	
		1
	EXT V ID: 198 Little endian Period 2.0	+
	2 1	
► ADC		
<ul> <li>Arbiter</li> </ul>		
▼ CAN		
► A		
► B		
► FTS		
► GPIO/EQEP		
► GPIO	▶ RX	
► I2C		
<ul> <li>Others</li> </ul>		
▶ PWM		
▶ Serial		
▶ LICD ♥		
Add 👻		

#### CAN - Telemetry - TX

In order to add a message to be sent press "+" and a new element will be added into the panel.

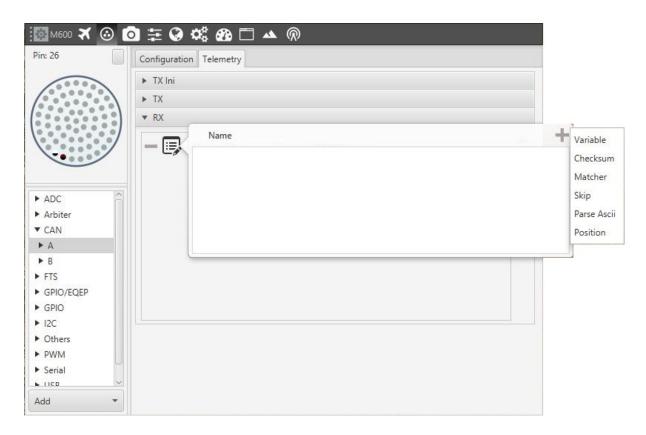
- **EXT:** enables the frame format with 29 identifier bits.
- **ID:** identifier 11 or 29-bits (Extended), used to identify TX messages. The value set has to be decimal as it was written on Configuration.
- Period: time in seconds between TX messages delivery.
- **Button 1:** open a new window to configure the endianness of the message, which indicates how the bytes that it contains are written:
  - **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.

Pin: 26	Configuration Telemetry	
	► TX Ini	
/	► TX	
	▼ RX	
	EXT ID: 23 Little endian Big end	ndian
	Custor	n
► ADC	Endian	ness Little endian
<ul> <li>Arbiter</li> <li>CAN</li> </ul>	Bit ord	er Low to high
► A		
► B		
► FTS		
► GPIO/EQEP		
► GPIO		
► 12C		
▶ Others		
► PWM		
Serial		
LICD	×	

CAN - Telemetry - RX Endianess

• Button 2: displays the menu to configure how the bits of the message are divided and sent.

There are six different elements that can be added when setting up a CAN message: Variable, Checksum, Matcher, Skip, Parce Ascii and Position.



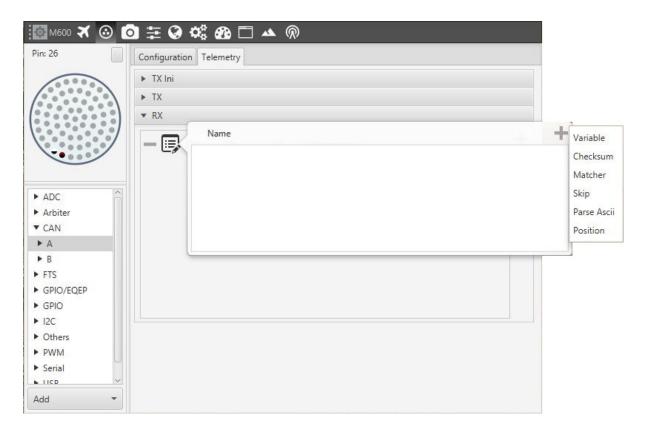
CAN - Telemetry - RX Message Confguration

### 6.2.2.3.2.2 RX Messages

Once a message is "captured" by Pipe (tab Configuration) and stored in the mailbox, its information can be read and saved in the software. To perform that, press "+" to create a new message and follow the steps explained for TX Messages, except by Period which is exclusive for TX.

### 6.2.2.3.3 CAN Messages

When using and configuring CAN messages either TX (transmitted) or RX (received), the following types of message are available.



#### Telemetry Panel

### 6.2.2.3.3.1 Variable

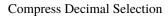
Used to store certain bits in a system variable (RX) or to send a certain variable through the CAN bus (TX).

Type	Variable	*
	AGL (Above Ground Leve	el) – Height
U	ncompressed	
() C	ompress	
O C	ompress (Decimals)	]
0 C	ompress (Bits signed)	0
) C	ompress (Bits unsigned)	
Enco	de	
Mi	n	0.0
Ma	ix	0.0
Deco	ode	
Mi	n	0
Ma	x	0
Enco	de / Decode	1.0



- 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. If it is a 32bits variable, it will take all 32bits from the CAN message directly.
  - **Compress.** The three subcategories of compressed Variable allow the user to input a digit, which is explained in the following lines:
    - \* **Compress (Decimals).** Sets the number of decimals to use i.e, if the AGL has a value of 500.43453, it will be compressed to 500.43.
    - \* **Compress (Bits signed).** Sets the number of bits, and these can be signed i.e, negative values are admitted. It is necessary that the user configures Encode/Decode options.
    - \* **Compress (Bits unsigned).** Sets the number of bits which will not accept negative values. It is necessary that the user configures Encode/Decode options.

AGL (Above Ground Lev	el) – Height
Uncompressed	
Compress	
Compress (Decimals)	]
Compress (Bits signed)	2
Compress (Bits unsigned)	
Encode	
Encode	
Min	0.0
	0.0 0.0
Min Max	
Min Max	
Min Max Decode	0.0



• **Encode/Decode.** These values are used to apply a scaling factor after the transformation from binary to decimal value.

When reading data from a CAN bus it is common to have information about the message layout. In that case, let's consider that the first 3 bits correspond to a certain variable. If that variable is always positive, unsigned has to be selected, if it could be positive or negative select signed. The fields Encode/Decode are used to make the transformation from binary to decimal, corresponding Encode to the decimal value and Decode to the binary one. Considering the example shown in the following figure, the binary number is divided by 10 to make the transformation to decimal (and decimal multiplied by 10 to go to binary), so the variable represented here will go from 0 to 0.7 (as 3 unsigned bits can represent numbers from 0 to 7).

User Variable 08 (Re	al - 32 bits)
Uncompressed	
Compress	
Compress (Decimals)	7
Compress (Bits signed)	3
Compress (Bits unsigned	i)
Encode	
Min	0.0
Min Max	0.0 0.1
Max	
Max	
Max Decode	0.1



## 6.2.2.3.3.2 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.

Back From	2	
Back To	0	
Endianness	Mixed endian -	
CRC	Polynomial	•
Туре	crc16veronte	*
nº Bits	16	
Polynomial	40961	
Start value	23073	
Final Xor	0	
🗸 Reflect In		
Reflect Out	E.	
Sum8		

#### 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 2's complement of the sum of all bytes. The checksum value, when added to the sum of all bytes, produces a zero.

## 6.2.2.3.3.3 Matcher

This option is used to send a constant value through the CAN bus in TX or wait for a particular value in RX.

Type N	latcher	•
nº Bits	۵	
Value	9	
Mask	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.

#### 6.2.2.3.3.4 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.

### 6.2.2.3.3.5 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.

IAS (Indicated A	Airspeed)
Number of characters in integer part	1
Number of characters in decimal part	0
Division character to separate integer and decimal part	

Parse ASCII Menu

### 6.2.2.3.3.6 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.

	Moving Object 01	l	
Units	of latitude and longitude	deg	*

#### Position Menu

#### 6.2.2.3.4 Arbiter CAN protocol

This section describes the CAN Bus protocol actually in use for the communication between the **Arbiter** and the Autopilots in **Redundant Veronte Autopilot**. Veronte is able to use both Standard CAN and Extended CAN messages. In this first integration step, the messages are configured following the Standard CAN communication protocol.

#### 6.2.2.3.4.1 CAN parameters

The following Standard CAN parameters are described according to the Veronte Pipe configuration:

- Baudrate: 1 [Mbps].
- TX Ini: in this section is set the Start Message. Period has a value of 1 [s].
- TX: this section has to be configured as it is shown below. Period has to be set to 0.1 [s]
- RX: None.

### 6.2.2.3.4.2 CAN message structure

The message that each Autopilot (Veronte or External) connected to the Arbiter must send through CAN Bus has to be as follows:

Name	Variable 1	Variable 2	Variable 3	Start Message (TX Ini)
Endianness	Little Endian	Little Endian	Little Endian	Little Endian
ID	Autopilot ID	Autopilot ID	Autopilot ID	Autopilot ID

- Table 1: Can Message Structure
- Variable X: variable sent to the Arbiter. In this first integration phase, they are Roll, Pitch and Yaw angles.

💽 🕑 AP1 🛪 🙆 I	ً ⊉ 🖓 🗱 🖽 🗖 🔺	
	Configuration Telemetry	
	► TX Ini	
	▼ TX	
	EXT ID: 0 Little endian Period 0.1	ŧ.
	EXT ID: 0 Little endian Period 0.1	
	EXT ID: 0 Little endian Period 0.1	
► ADC	Variable 1 Autopilot ID	
<ul> <li>Arbiter</li> <li>CAN</li> </ul>	Variable 2	
► A	Variable 3	
►B		
► FTS		
► GPIO		
▶ I2C		
Others	► RX	
► PWM		
Serial		
► USB		
Add		

#### Variable X – Veronte AP 1

• **Start Message:** the arbiter will start to arbitrate only when it reaches the start message from all Autopilots. The start message must be like the following:

Table 2. Start Message Structure				
Name:	Matcher 1	Matcher 2	Matcher 3	
Bits Number	16 bits	16 bits	1 bit	
Value	Autopilot ID	65535	1	

Where:

		· · ·		
Name:	Veronte AP 1	Veronte AP 2	Veronte AP 3	External AP
Autopilot ID	0	1	2	3

Table 3: Autopilot ID Number

The following image shows this configuration using Veronte Pipe and Veronte AP 1.

🔯 🕑 AP1 🛪 📀	ً ፤ 🖓 📽 🕮 🗂 ム	
	Configuration Telemetry	
	▼ TX Ini Autopilot ID	
	EXT D: 0 Little endian Period 1.0	+
	Name Start Message	+
	- 🗣 👚 📪 Matcher x0 Matcher 1	
► ADC	- 🗣 🛧 🕞 Matcher xFFFF Matcher 2	
<ul> <li>Arbiter</li> <li>CAN</li> </ul>	- + A B Matcher x1 Matcher 3	П
► A		1
► B		
► FTS		
► GPIO		
► I2C	▶ TX	
Others	► RX	
► PWM		
Serial		
► USB		
Add 👻		

Start Message - Veronte AP 1

- Endianness: In this case, all the messages are configured with a Little Endian structure.
- **ID:** The ID of the Autopilot that is sending the message (value from 0 to 3).

#### 6.2.2.3.4.3 Single message structure

The structure of the messages including the single variables sent from the Autopilots must be configured like the following:

Table 4: Variable Message Structure				
Matcher 1 Matcher 2 Variable				
16 bits	16 Bits	32 bits		

Where:

• Matcher 1: Autopilot Identifier. In this case, the value must be from 0 to 3.

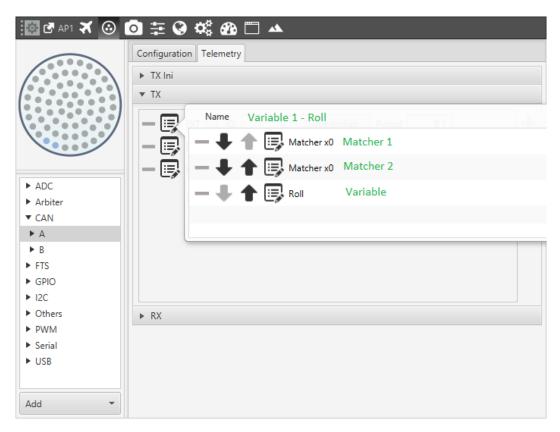
Veronte Autopilot 1	Veronte Autopilot 2	Veronte Autopilot 3	External Autopilot	
0	1	2	3	

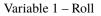
- Table 5: Autopilot ID Number
- Matcher 2: Value ranging from 0 to 2 meaning the variable ID.
- Variable: the variable that the Arbiter will receive and monitor. In this first integration step the variables are:

Variabl	e Description	Range [rad]	Variable ID	Bits	Туре
Roll	Roll Angle measured from Veronte Autopilot in real time in Body Axes.	(-, )	0	32	Float
Pitch	Pitch Angle measured from Veronte Autopilot in real time in Body Axes.	(-, )	1	32	Float
Yaw	Yaw Angle measured from Veronte Autopilot in real time in Body Axes.	(0, 2)	2	32	Float

Table	6٠	Variable	ID
Table	υ.	variable	$\mathbf{n}$

The following figure shows the configuration for Variable 1 – Roll, using Veronte AP 1.





The variables can be modified in the Autopilot CAN configuration using Veronte Pipe. To do this it is sufficient to change the variables in the single message in both the Autopilot configurations.

### 6.2.2.3.4.4 External autopilot simulation

When the External Autopilot is not connected to the Redundant network, it is possible to simulate its presence allowing the Arbiter to start the arbitration. To do this, it is sufficient to add a message sent from one of the active autopilots through the CAN Bus that contains the Start message of the External Autopilot (ID: 3). The following example represents this kind of message sent from Veronte Autopilot 1 (ID: 0):

Message	Autopilot	ID	Variable ID	Туре	Value	Description	
1	0	0	Variable	Roll Angle	Roll Angle	variable of Veronte Autopilot 1	
2	0	1	Variable	Pitch Angle	Pitch Angle	variable of Veronte Autopilot 1	
3	0	2	Variable	Yaw Angle	Yaw Angle	variable of Veronte Autopilot 1	
4	– TX Ini	0	65535	Start Message	1	Start message of Veronte Autopilot 1	
5	– TX Ini	3	65535	Start Message	1	Start message of External Autopilot	

#### External Autopilot Structure

Once the Arbiter starts to arbitrate, the External Autopilot will be automatically discarded and the process will be carried out using the Veronte Autopilots only.

### 6.2.2.3.4.5 Can protocol for 4-autopilot configuration

When the system in configured integrating four Autopilots (including then: three Veronte Autopilots, one Arbiter and one External Autopilot) the CAN Protocol structure does not change. In this case, the arbiter will expect to receive the Start Message from 4 Autopilots with different ID value that will go from 0 to 3.

The user must take into account that:

- the ID order is not important (Veronte 1 can be configured using ID:2 and vice-versa).
- the Arbiter does not need any information about the Autopilot type (External or Veronte).
- when the number of the Autopilots changes, the Arbiter software has to be modified.
- when the number of the monitored variables changes, the Arbiter software has to be modified

The following tables represent a possible configuration of the messages sent from four Autopilots using three monitored variables.

• Veronte Autopilot 1:

Message	Autopilo	t ID	Variable ID	Туре	Value	Description
1	0	0	Variable	Roll Angle	Roll	variable of Veronte Autopilot
					Angle	1
2	0	1	Variable	Pitch	Pitch	variable of Veronte Autopilot
				Angle	Angle	1
3	0	2	Variable	Yaw Angle	Yaw	variable of Veronte Autopilot
					Angle	1
4	– TX	0	65535	Start	1	Start message of Veronte
	Ini			Message		Autopilot 1

Message Structure AP1

• Veronte Autopilot 2:

Message	Autopilo	t ID	Variable ID	Туре	Value	Description
1	1	0	Variable	Roll Angle	Roll	variable of Veronte Autopilot
					Angle	2
2	1	1	Variable	Pitch	Pitch	variable of Veronte Autopilot
				Angle	Angle	2
3	1	2	Variable	Yaw Angle	Yaw	variable of Veronte Autopilot
					Angle	2
4	– TX	1	65535	Start	1	Start message of Veronte
	Ini			Message		Autopilot 2

Message Structure AP2

• Veronte Autopilot 3:

Message	e Aut	opilo	t ID	Variable ID	Туре	Value	Description
1	2		0	Variable	Roll Angle	Roll	variable of Veronte Autopilot
						Angle	3
2	2		1	Variable	Pitch	Pitch	variable of Veronte Autopilot
					Angle	Angle	3
3	2		2	Variable	Yaw Angle	Yaw	variable of Veronte Autopilot
						Angle	3
4	_	ΤX	2	65535	Start	1	Start message of Veronte
	Ini				Message		Autopilot 3

Message Structure AP3

• External Autopilot:

Message	Autopilo	: ID	Variable ID	Туре	Value	Description
1	3	0	Variable	Roll Angle	Roll Angle	variable of External Autopilot
2	3	1	Variable	Pitch Angle	Pitch Angle	variable of External Autopilot
3	3	2	Variable	Yaw Angle	Yaw Angle	variable of External Autopilot
4	– TX Ini	3	65535	Start Message	1	Start message of External Autopilot

Message Structure External

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

№         №	(	uration Telem		«Va				
0000	Baudra	te 100000	0.0 Bd	Units ID	DEC 👻	Units Mask	BIN -	
	Mailbo:	xes reserved RX	0 Mail	boxes available T	X 32			
	#	Mailboxes	Extended	ID		Mask		+
ADC Arbiter CAN A B FTS GPIO/EQEP GPIO I2C Others PWM Serial IICP				No content in tak	ble			

### 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.

## 6.2.2.4 GPIO/PWM

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

Fixed Wing V-Tail U	av 🛪 💿 💿 葦 🚱 🗱 🚳 🗂 🔺 🏢 ⊘
Pin: 14 <b>Q</b>	Direction GPIO as output 👻
ADC     Arbiter     CAN	
<ul> <li>FTS</li> <li>GPIO/EQEP</li> <li>▼ GPIO</li> </ul>	
11 12 13	
14 15 16	
Add -	

GPIO Menu

#### 6.2.2.4.1 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*.

Fixed Wing V-Tail UAV	X 💿 🖸 🏛 🚱 📽 🖉		) 🔺 🏢	$\oslash$	
Pin: 1		Г	PWM 1		
			Active I	High	
			Mode	Time	-
	Frequency 50.0 Hz	å	Min	9.0E-4	s
			Max	0.0021	s
			Servo	Right Aileron	-
ADC     Arbiter		L	PWM 2		
► CAN					
► FTS			Active I	High	
GPIO/EQEP     GPIO			Mode		*
► 12C			Min	9.0E-4	
▶ Others			Max	0.0021	
▼ PWM			Servo	Throttle	
2			Servo		
3					
Add 👻					
Adu					

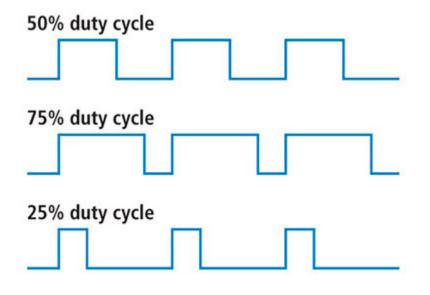
### PWM Menu

#### 6.2.2.4.2 PWM

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*.

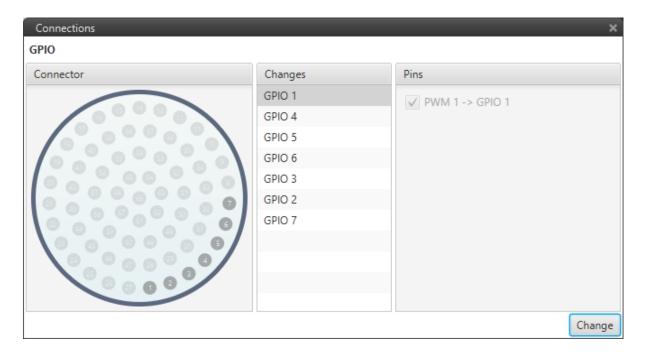
The option **Frequency** determines the period of the pulses sent by the autopilot. The PWM is built in pairs inside the autopilot, and that is why the frequency is indicated in pairs, i.e when the frequency of PWM 1 is changed, the one of PWM 2 also changes. The following table shows the PMW pairs as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

PWM Pai	PWM Pairs						
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).

### 6.2.2.4.3 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.



## **GPIO** Selection

Connections		×
PWM		
Connector	Changes	Pins
	PWM 10	✓ GPIO 10 -> PWM 10
	PWM 8	
	PWM 14	
	PWM 12	
	PWM 16	
	PWM 11	
	PWM 9	
	PWM 13	
0 0 0 0 0 0	PWM 15	
		Change

### **PWM Selection**

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

## 6.2.2.5 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 UAV	/ 🛪 💿 💿 葦	I I I I I I I I I I I I I I I I I I I	) 🖽 🔺 🎞 🤅	0	
Pin: 19	Functionality				
	Baudrate	115200	•		
	Length	8	•		
	Stop	1	-		
	Parity	Disabled	•		
Arbiter					
► CAN					
► FTS					
GPIO/EQEP     GPIO					
► I2C					
▶ Others					
► 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

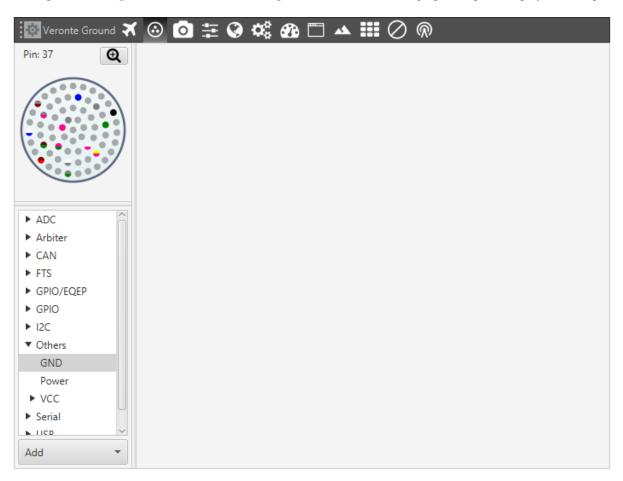
**Note:** All these settings are already specified for a given device, therefore, Veronte should match with them in order to be able to communicate.

Compatibility table:

Port name	RS-232	RS-422   RS-485	
Transfer Type	Full duplex	Full duplex   Half/Full dup	olex
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

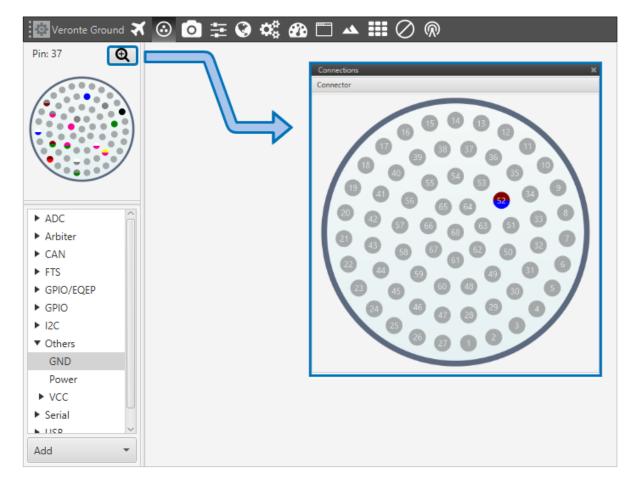
Refer to *examples* for a complete implementation of a serial device communication.

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.

#### 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*.

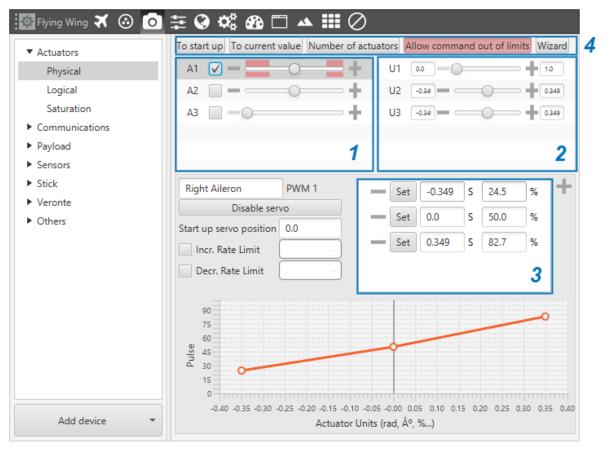
# 6.2.3 Devices

## 6.2.3.1 Actuators

## 6.2.3.1.1 Physical

## 6.2.3.1.1.1 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.

### 6.2.3.1.1.2 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											0
Actuator Output s1	0	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
top PWM				ſ	Cance	el	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.

ervos	U	
Actuator Output s1	Pitching	0.0
24 50 75 81.5	Thrusting	0.0
Actuator Output s2	Rolling	0.0
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.

Pitching	Actuator Output s1 - PWM 0		
itening	Actuator Output s2 - PWM 1		
hrusting	Actuator Output s3 - PWM 2		
Rolling	Actuator Output s1 - PWM 0		
uning	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.

Thrustin	g		Set i	n neutra	I				
Actuator	Output s3								
0		25		50		75			100
Stop PWM					Cancel	ish	2	vious	Next

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.

### 6.2.3.1.2 Logical

### 6.2.3.1.2.1 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.

Fixed Wing 🛪 💿 🖸	] ≑ 🚱 🗱 @ 🗆 ム ⅲ ⊘		Edit						
Actuators	US Set inv(SU) Edit			•	-	-		-	-
Physical				Control Output u1	. Control Output u2	Control Output u3	Control Output u4	Control Output u5	Control Output u6
Logical Saturation	SU Set inv(US) Edit		- S Right Aileron	0.0	0.0	1.0	0.0	0.0	0.0
mmunications			- Left Aileron	0.0	0.0	-1.0	0.0	0.0	0.0
load		$\Rightarrow$	- Left Flap	0.0	0.0	0.0	0.0	1.0	0.0
rs		-	- Right Flap	0.0	0.0	0.0	0.0	1.0	0.0
ite			- 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
						+			
Add device									

### 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.

ົ	Control Output u1	Control Output u2	- Control Output u3	Control Output u4	Control Output u5	- Control Output u6
C						
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
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.

V         Control Outp           S         Right Alleron         0.0           Left Alleron         0.0	tu1         Control Output u2           0.0         0.0           0.0         0.0           0.0         0.0	Control Output u3	Control Output u4 0.0 0.0 0.0	Control Output u5	Control Output u6 0.0 0.0		I Matrix
Left Flap 0.0 Right Flap 0.0	0.0	-1.0	0.0	0.0			Matrix
Left Flap 0.0 Right Flap 0.0	0.0				0.0		
Right Flap		0.0	0.0				
	0.0			1.0	0.0		The size or value of the matrix SU has changed.
		0.0	0.0	1.0	0.0	) *	
H. Stabilizer 1.0	0.0	0.0	0.0	0.0	0.0		The inverse matrix US has to be updated
V. Stabilizer 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		
Throttle 0.0	1.0	0.0	0.0	0.0	0.0		ון א
		+					

## $\boldsymbol{SU}$ to $\boldsymbol{US}$

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

1		เร	Right Aileron	Left Aileron	Left Flap	Right Flap	H. Stabilizer	V. Stabilizer	Wheel	Throttle	ה
	Control Output u1 - Pitching	2	-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	
						+					

#### US Matrix for a Fixed-Wing aircraft

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.

## 6.2.3.1.2.2 *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.

U S Right Aileron	Control Output u1 - Thrusting	Control Output u2 - Pitching	Control Output u3 - Rolling	ו
- S Right Aileron			Noning	J
	0.0	1.0	1.0	] -
- Left Aileron	0.0	1.0	-1.0	J
- Throttle	1.0	0.0	0.0	
		+		

SU Matrix of a Flying Wing

### 6.2.3.1.2.3 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.

	Ū	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	Control Output u5 - Flaps	Control Output u6 - Wheel
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

### 6.2.3.1.2.4 *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.

dit		Ū	- 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
IL	Motor 4		-0.8	1.0	1.0	-1.0
				+		

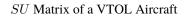
SU Matrix of a Quadcopter (non-symmetrical geometry)

## 6.2.3.1.2.5 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.

U	Control Output u1 - Pitching (P)	Control Output u2 - Rolling (P)	Control Output u3 - Yawing (P)	Control Output u4 - Pitching (Q)	Control Output u5 - Throttle (Q)	Control Output u6 - Rolling (Q)	Control Output u7 - Yawing (Q)	Control Output u8 Throttle (P)
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

The SU matrix of the VTOL aircraft looks like:



## 6.2.3.1.3 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.

Fixed Wing V-Tail UAV 🛪	🛛 🖸 🗄	😧 🗘 🖓 🖸	∃ 🔺 🖗	
<ul> <li>Actuators <ul> <li>Physical</li> <li>Logical</li> </ul> </li> <li>Saturation</li> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Stick</li> <li>Veronte</li> <li>Others</li> </ul>		Inactive - Inactive Linear Standard		
Add device 💌				

### Saturation Option for Actuators

#### 6.2.3.1.3.1 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).

Fixed Wing V-Tail UAV 🛪	💿 🧿 🏗 🚱 🗱 🌇 🔺 🖗
▼ Actuators Physical Logical	Protection Standard  Advanced Decrease Control Output u1 - Pitching
Saturation Communications Payload Sensors Stick Veronte Others	Control Output u2 - Thrusting Control Output u3 - Rolling Control Output u4 - Yawing Control Output u5 - Flaps Control Output u6 - Wheel
Add device 👻	

### Standard Saturation Menu

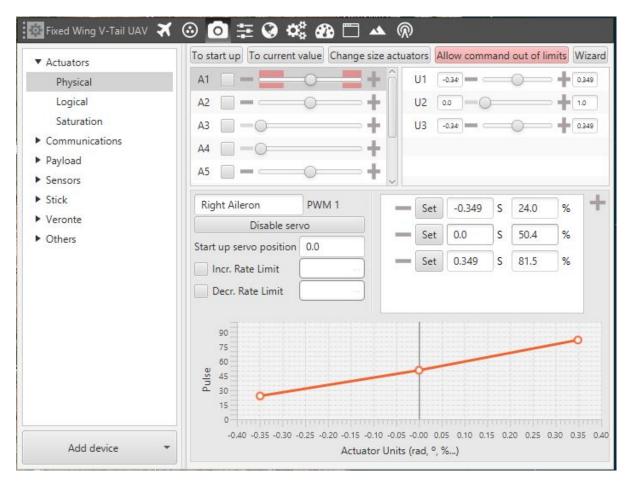
If clicking in the advance checkbox, a vector including all control outputs is generated, allowing for proportional control over the system when saturation happens. This tool is set for the user to have wider control over this feature if needed.

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
		means that the control output U2 and control . [ 0 1 0 2 ] , represents that control output U4 will .t 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.



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.

<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	
<ul> <li>Others</li> </ul>	

### 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.

imgs/veronte\_configuration/Actuators-Saturation.png

Saturation Actuators Configuration

# 6.2.3.2 Communications

Communications menu covers the configuration for the **4G** service, **Comstats** and **Iridium**, in three different menus which are showed and explained below:

## 6.2.3.2.1 4G

### 6.2.3.2.1.1 ESIM

If the user has decided to use the card from Embention (directly added to Veronte autopilot), this option brings already configured the data needed to connect to the cloud. **Host** and **Port** are to be configured as in the following picture.

Fixed Wing UAV 🛪 🙆	◙ ≑ 📀	🗱 🔁 🗖 🔺		
<ul> <li>Actuators</li> <li>Physical</li> <li>Logical</li> <li>Saturation</li> </ul>	C Enable	ESIM		
<ul> <li>Communications</li> <li>4G</li> <li>Comstats</li> <li>Iridium</li> <li>Payload</li> <li>Sensors</li> <li>Stick</li> <li>Veronte</li> <li>Others</li> </ul>	Host	cloud.embention.com	Port	3114
Add device 👻				

## ESIM Configuration for 4G

### 6.2.3.2.1.2 SIM

If the SIM embedded in Veronte is the customer's card (contact Embention for using your own SIM Card), the menu differs from the ESIM one, asking for the **PIN** of the card (4 digits code) and its **APN** (Access Point Name), data provided by the company issuing the card. Host and Port can also be changed if the cloud system differs from Embention Cloud, but the communication protocol does not change.

Fixed Wing UAV 🛪 🤅	9 🧿 🛱 🔇	¢° 🚯 🗂 🔺		
▼ Actuators	V Enable			
Physical	SIM Type	SIM	▼ APN er	n
Logical Saturation			PIN 0	0 0 0
▼ Communications	Host	cloud.embention.com	Port 31	14
4G				
Comstats				
Iridium				
Payload				
Sensors				
Stick				
<ul> <li>Veronte</li> <li>Others</li> </ul>				
P Others				
Add device	•			

SIM Configuration for 4G

# 6.2.3.2.2 Comstats

In the Comstats menu, the user can configure this type of communications. There are two clickable buttons with which:

- **RX Auto.** Enabling this option will use the first remote AP found and shall be only one remote. If it is not select the user can choose between Broadcast and Pipe selected.
- **TX.** When enabling it, the user needs to define which platform is going to be monitored by the system, establishing its address and the period of transmission.

м400 🛪 🛞 🧰 葦	😧 📽 🕰 🗆	] <b>A</b>	
▼ Actuators	🖌 RX Auto		*
Physical	V TX		
Logical Saturation	Address	Broadcast	•
▼ Communications	Period	0.2	s
4G			
Comstats			
Iridium			
<ul> <li>Payload</li> <li>Sensors</li> </ul>			
<ul> <li>Stick</li> </ul>			
▶ Veronte			
▶ Others			
Add device 🔻			

### Comstats Configuration Menu

## 6.2.3.2.3 Iridium

If your system is ready for an Iridium communication, it can be activated from this menu. The user only needs to define the **Synchronization time** for the system and the **Destination address** for the unit to be connected with this service.

м400 🛪 💿 🧰 葦	😧 🛱 🚳 🗂 🔺					
▼ Actuators	Enabled					
Physical	Synchronization time 120.0 s					
Logical	Destination address					
Saturation						
<ul> <li>Communications</li> </ul>						
4G						
Comstats						
Iridium						
Payload						
Sensors						
► Stick						
► Veronte						
► Others						
Add device 👻						

#### Iridium Configuration Menu

# 6.2.3.3 Payload

#### 6.2.3.3.1 Camera

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

м400 🛪 🛞 🧰 \Xi	🛛 🗱 🌇 🗂 🔺 🕅	
► Actuators	Default camera	Q
▶ Communications	36 mm	
▼ Payload	24 mm	
▼ Cameras		
🛑 Default camera	5784	
Gimbal/Tracker	3856	
Transponder/ADS-B	<b>9 √</b> 35 mm	
▼ Sensors		
Accelerometer	Streaming Cam assoc	iated with gimbal
Altimeter	URL	
► GNSS	O Device	
► Gyroscope		
I2C Devices	Photogrammetry	
<ul> <li>Magnetometer</li> </ul>		
Obstacle detection		
Pressure		
► RPM		
Speed down		
Ultrasound 🗸		
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.
- **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.

# 6.2.3.3.1.1 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).

🖾 M400 🛪 💿 🙍 葦	🛛 📽 🙆 🗀	<b>▲</b>	
<ul> <li>Actuators</li> </ul>			
Communications			
▼ Payload			
▼ Cameras			
- Default camera			
Gimbal/Tracker			
Transponder/ADS-B			
Sensors			
Stick			
▶ Veronte			
► Others			
Add device 🔻			
Camera			
😚 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	<u>Automations</u> Group name	Veronte Gimbal	
			App	oly

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	😧 📽 🕰 🛙	ר בא ו				
<ul> <li>Actuators</li> </ul>	EO Camera					Q
Communications	9,070	) mm		Reserved Cam	era Variables	
▼ Payload	1 9,070	) mm		Command	1 gimbal	
▼ Cameras		,		Command	2 gimbal	ň.
EO Camera	1080				-	5
Gimbal/Tracker				Command	-	
Transponder/ADS-B	₽ � 4,300	) mm		Command	4 gimbal	
Sensors	✓ Streaming	$\checkmark$ (	Cam a	associated with gimbal	1 -	
► Stick	• URL	udp://@:15004				
▶ Veronte	Device			-		
<ul> <li>Others</li> </ul>	Photogramm	etrv				
Add device 👻	Add Acti	ion				

#### 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

## 6.2.3.3.2 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).

м400 🛪 💿 🙆 🗄	00	\$ 🕰 🗂 🔺 🕅	)			
Actuators	Туре	Pan Tilt	*	Base to gimbal X	0.0	_
Communications	Logic	Conventional gimbal	-	Base to gimbal Y	0.0	
▼ Payload		Arcade		Base to gimbal Z	0.0	
<ul> <li>Cameras</li> </ul>						
- Default camera				ADD		
Gimbal/Tracker						
Transponder/ADS-B						
Sensors						
► Stick						
► Veronte						
► Others						
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.
  - Max. Defines a maximum value for the control output. Useful if it has been defined a big Gain.

Var	Gain	DBand X	DBand Y	Max	
Joint 1 of Gimbal 1	1.0	0.02	0.0	0	+
Joint 2 of Gimbal 1	2.0	0.0015	0.0	0	

Gimbal/Tracker Arcade - Configuration Parameters

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

### 6.2.3.3.3 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.

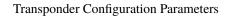
- 1. The first step to configure it is to go to **Device Payload Transponder/ADS-B** and check the enable button. Once there, select the **Custom message** to be used for the information exchange, since it will automatically be filled with the information that the Transponder needs.
- 2. Choose the model 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 🛪 🙆 🙆	🗄 🚱 🗱 🖽 🗖 🗚	<b>▶</b> @
<ul> <li>Actuators</li> </ul>		
Communications	Custom message	Custom message 1 👻
▼ Payload	Туре	uAvionix ping 20S 👻
Gimbal/Tracker		
Transponder/ADS-B	Mode	Off 👻
▼ Sensors	Call sign	
Accelerometer	Icao	0 hex
Altimeter	Council Conto	
► GNSS	Squawk Code	0
Gyroscope	Enable ident mo	ode
I2C Devices		
Magnetometer		
Obstacle detection		
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.

-	111		Producer		Consumer	
Actuators	High	$Q_0^0$	USB	$\leftrightarrow$	Commgr port 1	00
<ul> <li>Communications</li> <li>Payload</li> </ul>	High	$Q_0^0$	Veronte LOS	<b>i</b> ↔	Commgr port 2	00
· Sensors	High	Q <sup>0</sup>	Veronte LTE	i↔i	Commgr port 3	¢
Stick	High	08	RS232	$\leftrightarrow$	Custom message 1	Q0
Veronte		00	RS485	$\rightarrow$	None	00
' Others	High	- 46Å	K3480		Ivone	
I/O Manager	High	$Q_0^{\circ}$	Commgr port 1	$\leftrightarrow$	USB	
Digital Input Manager	High	00	Commgr port 2	→	Veronte LOS	Q0
	High	$Q^0_0$	Commgr port 3	↔	Veronte LTE	Q
	High	$Q^0_0$	Commgr port 4	$\rightarrow$	None	Q <sub>0</sub>
	High	00	Commgr port 5	$\rightarrow$	None	Q <sub>0</sub>
	High	$\varphi^{o}_{o}$	Commgr port 6	$\rightarrow$	None	Q <sub>0</sub>
	High	$\mathbf{Q}_0^0$	Custom message 1	→	RS232	Q
	High	$\mathbf{Q}_{0}^{0}$	Custom message 2	→	None	Q
	High	$\mathbf{Q}_0^0$	Custom message 3	$\rightarrow$	None	Q
	High	08	Tunnel 1	$\rightarrow$	None	¢,

## 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 🛪	⊙ ፬ ⊉ ତ ¢	* 🙆 🗂	▲ @
FII: 13	Functionality		
•	Baudrate	57600	-
$\langle \cdot \cdot \cdot \rangle$	Length	8	•
	Stop	1	•
	Parity	Disabled	-
► ADC			
<ul> <li>Arbiter</li> <li>CAN</li> </ul>			
► FTS			
► GPIO/EQEP			
► GPIO			
► 12C			
<ul> <li>Others</li> <li>Serial</li> </ul>			
<ul> <li>Senal</li> <li>232</li> </ul>			
▶ 485			
► USB			
Add 👻			

#### RS232 Configuration Menu

### 6.2.3.3.4 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.

100 🛪 🛞 🧰 🛱	E 🚱 📽 🙆 🗂 🔺 🤇	R	
Actuators	✓ 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			
► GNSS	Squawk Code	0	
Gyroscope	Enable ident mode		
I2C Devices	Enable reception		
Magnetometer		e refresh time in the obstacle	
Obstacle detection	detection tab	e renesir unie in the obstacle	
Pressure			
► RPM			
Speed down			
Ultrasound			
► Stick			
► Veronte ~			
Add device 👻			



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

! 🖾 M400 🛪 🐼 🙍 🏗	🚱 🗱 🖽 🗔 🔺 🖗
Actuators	🖌 Enable
► Communications	Refresh time 2.0 s
Payload	
▼ Sensors	
Accelerometer	
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.

	111		Producer		Consumer	
Actuators	High	$Q_0^0$	USB	$\leftrightarrow$	Commgr port 1	00
Communications	High	Q <sup>0</sup>	Veronte LOS	Ĩ⇔Ĩ	Commgr port 2	¢
Payload						5
Sensors	High	$Q_0^{\circ}$	Veronte LTE	$\rightarrow$	Commgr port 3	Q
Stick	High	$Q_0^0$	RS232	÷	Custom message 1	Q <sup>0</sup>
' Veronte ' Others	High	$Q^0_0$	RS485	$\rightarrow$	None	00
I/O Manager	High	$Q_0^0$	Commgr port 1	↔	USB	Q
Digital Input Manager	High	00	Commgr port 2	→	Veronte LOS	Q <sup>0</sup>
	High	$Q_0^0$	Commgr port 3	→	Veronte LTE	
	High	$ \Phi_0^0 $	Commgr port 4	$\rightarrow$	None	Q0
	High	$Q_0^0$	Commgr port 5	<b>→</b>	None	Q0
	High	$\varphi^{o}_{o}$	Commgr port 6	$\rightarrow$	None	Q <sup>0</sup>
	High	$\mathbf{Q}_{0}^{0}$	Custom message 1	Ì	RS232	Q
	High	$\mathbf{Q}_{0}^{0}$	Custom message 2	→	None	Q
	High	$Q_0^0$	Custom message 3	$\rightarrow$	None	Q
	High	05	Tunnel 1	$\rightarrow$	None	03

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 🛪	⊙ 🖸 🗄 🐼 🔇	📽 🚯 🗂	▲ @		
Pin: 19	Functionality				
(•	Baudrate	<b>57600</b>	-		
	Length	8	•		
	Stop	1	-		
	Parity	Disabled	-		
► ADC					
Arbiter					
► CAN					
► FTS					
► GPIO/EQEP					
► GPIO					
▶ I2C					
▶ Others					
▼ Serial					
▶ 232					
▶ 485					
► USB					
Add 👻					

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.

🔯 м400 🛪 🛞 🙆 🛱	🎯 🗱 🍘 🗂 🔺
<ul> <li>Actuators</li> </ul>	]
Communications	
▼ Payload	
Gimbal/Tracker	
Transponder/ADS-B	
Sensors	
Stick	
Veronte	
<ul> <li>Others</li> </ul>	
Add device 👻	

Payload Menu

## 6.2.3.4 Sensors

## 6.2.3.4.1 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. Veronte uses the internal sensor.

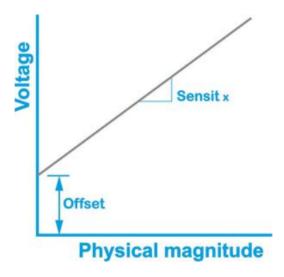
## 6.2.3.4.1.1 Integer var sensor

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

🔣 M400 🛪 🛞 🙆 🗄	: 🚱 🗱 🙆 🗂 🔺 🕅	)
► Actuators	0 - Integer var sensor 1     1 - Integer var sensor 2	Edit Rotation Matrix
Communications     Payload	2 - Decimal var sensor 1	X Axis
▼ Sensors	3 - Decimal var sensor 2	Zero Signed
▼ Accelerometer	4 - Internal 1	$V_0 + V_1 \cdot X^1$ -
Configuration	5 - Internal 2	V <sub>0</sub> V <sub>1</sub>
Altimeter		0.0 0.0
► GNSS		Y Axis
Gyroscope		Zero
I2C Devices		
Magnetometer		$V_0 + V_1 \cdot X^1 + V_2 \cdot X^2$ $\bullet$
Obstacle detection		V <sub>0</sub> V <sub>1</sub> V <sub>2</sub>
Pressure		0.0 0.0 0.0
► RPM		Z Axis
Speed down		User Variable 01 (Unsigned Integer - 16 Signed
Ultrasound		
▶ Stick		0 -
► Veronte		
► Others ~		
Add device 👻	)	< ()>

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.

## 6.2.3.4.1.2 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.

м400 🛪 🛞 🙆 葦	🚱 🗱 🕰 🖾 🔺 🕅	
Actuators     Communications	0 - Integer var sensor 1 1 - Integer var sensor 2	Edit Rotation Matrix
▶ Payload	<ul> <li>2 - Decimal var sensor 1</li> <li>3 - Decimal var sensor 2</li> </ul>	X User Variable 01 (Real - 32 bits)
▼ Sensors ▼ Accelerometer	4 - Internal 1 5 - Internal 2	Y User Variable 02 (Real - 32 bits) Z User Variable 03 (Real - 32 bits)
Configuration Altimeter		
GNSS     Gyroscope		
I2C Devices  Magnetometer		
<ul> <li>Obstacle detection</li> <li>Pressure</li> </ul>		
<ul> <li>RPM</li> <li>Speed down</li> </ul>		
Ultrasound ► Stick		
► Veronte ► Others		
Add device 🔹	<>	

Decimal var Accelerometer Menu - Configuration Parameters

# 6.2.3.4.1.3 Internal

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

🔝 м400 🛪 💿 🙍 葦 (	🛛 🗱 🗛 🗔 🔺 🛞		
<ul> <li>Actuators</li> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> </ul>	0 - Integer var sensor 1 1 - Integer var sensor 2 2 - Decimal var sensor 1 3 - Decimal var sensor 2 4 - Internal 1	Edit Rotation M Accelerometer Range	4g •
Configuration Altimeter GNSS Gyroscope I2C Devices Magnetometer Obstacle detection Pressure RPM Speed down Ultrasound Stick Veronte Others Add device	5 - Internal 2	Antialiasing filter bandwith    Enable digital filter sensor  Cutoff frequency  Digital Filter	50 Hz •

#### 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.

## 6.2.3.4.2 Altimeter

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

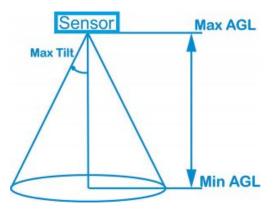
Fixed Wing 🛪 🙆 🙆	🗄 🚱 📽 🖓 🗂 🔺 🖗	
► Actuators	M Enable Altimeter	
Communications		
Payload	Sensor Type	AGL 👻
▼ Sensors	Min time diff to allow preload	0.1 s
Accelerometer		
Altimeter		X 0.5 m
► GNSS	Position of altimeter (Body frame)	Y (0.0 m)
Gyroscope	indine,	Z 0.0 m
I2C Devices		
Magnetometer	✓ Enable tilt limit	0.34 rad [-π,π]
Obstacle detection	Sensor variance (m <sup>2</sup> )	10.0
Pressure	Input Variable	Lidar 1 Distance
► RPM		
Speed down	<ul> <li>Enable sensor limits</li> </ul>	( 2.0 m), 120.0 m)
Ultrasound		
► Stick		
► Veronte		
► Others		
Add device 🔹		

Altimeter Menu - Configuration Parameters

- Sensor Type. The system configured in this menu could be used to measure the altitude of the aircraft or to detect the distance from the vehicle to a certain object. This option allows the change between these 2 operation modes
  - AGL for altitude measurement
  - Distance for measurement to object detection.
- 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. For example, if the altimeter installed is a LIDAR, whose precision is quite high, the value of sensor variance has to be low. Actually, the value of the sensor variance is fixed and depends on each sensor, commonly a LIDAR has an error of 0.5 meters more or less, so the variance will be 0.25. Now it depends on the application if the user wants to put this value or a higher one, that will imply that the altitude information depends not almost only on the LIDAR reading.
- **Input Variable**. User chooses the variable in which the sensor data is stored to be processed by Veronte Pipe. There are 5 Lider variables in case it is configured.
- **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

For configuring a Lidar, go to Examples - Lidar Integration.

## 6.2.3.4.3 GNSS

### 6.2.3.4.3.1 GNSS 1 & 2 Configuration

### 6.2.3.4.3.2 Configuration

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

Fixed Wing 🛪 🙆 🙆	🗄 🚱 🗱 🕰 🖾 🔺 🖗	
Actuators	Configuration SBAS Message rate Estimation	ation error
Communications	GNSS	Survey In
<ul> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> </ul>	Meas Rate 0.25 s	Enabled Minimum duration 0.0 s
Altimeter GNSS		Position accuracy limit 0.0 m
GNSS 1 Configuration	Protocols	
GNSS 2 Configuration GNSS Compass	Mask in	Mask out
GPS External NTRIP	✓ ublox nmea	✓ ublox nmea
<ul> <li>Gyroscope</li> <li>I2C Devices</li> </ul>	rtcm rtcm3	rtcm3
Magnetometer     Obstacle detection		
Pressure     RPM	Distance to mass center	
► KPM < > `	Х Ү	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 .

## 6.2.3.4.3.3 SBAS

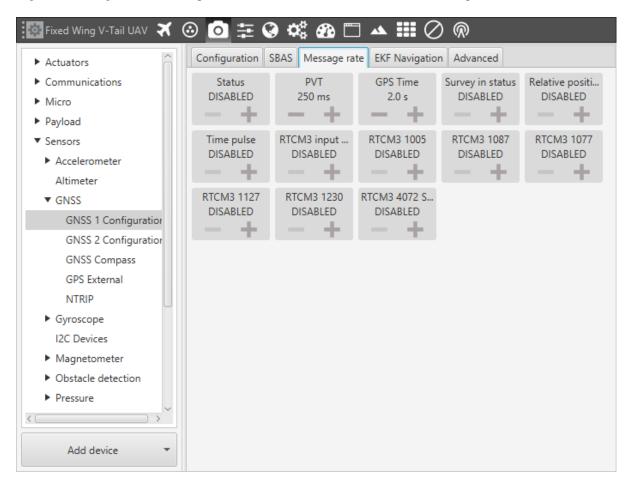
**SBAS** stands for Satellite Based Augmentation System. It is a set of geostationary satellites that are used to check the status of the signals sent by the GPS Satellites, and to improve the tracking via the correction of atmospheric disturbations, orbit deviations, clock errors and so on. In Veronte 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.

Actuators	Co	onfigur	ation	SBAS	Mess	age rat	e Est	timatio	n error					
<ul> <li>Communications</li> </ul>	N	/ Auto	omatic											
Payload		120	121	122	123	124	125	126	127	128	129	130	131	132
<ul> <li>Sensors</li> </ul>		133	134	135	136	137	138	139	140	141	142	143	144	145
Accelerometer		146	147	148	149	150	151	152	153	154	155	156	157	158
Altimeter														
▼ GNSS														
GNSS 1 Configuration														
GNSS 1 Configuration GNSS 2 Configuration														
GNSS 2 Configuration														
GNSS 2 Configuration GNSS Compass														
GNSS 2 Configuration GNSS Compass GPS External														
GNSS 2 Configuration GNSS Compass GPS External NTRIP														
GNSS 2 Configuration GNSS Compass GPS External NTRIP • Gyroscope														
GNSS 2 Configuration GNSS Compass GPS External NTRIP Gyroscope I2C Devices														
GNSS 2 Configuration GNSS Compass GPS External NTRIP • Gyroscope I2C Devices • Magnetometer														
GNSS 2 Configuration GNSS Compass GPS External NTRIP Gyroscope I2C Devices Magnetometer Obstacle detection														

GNSS - SBAS Menu

## 6.2.3.4.3.4 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 .

# 6.2.3.4.3.5 Estimation Error

Fixed Wing V-Tail UAV 🛪	i 🙆 🔁 🕄 📽 🙆 🖸	🗂 🔺 🏭 (	$\oslash $	
Actuators	Configuration SBAS Message	rate EKF Navigat	ion Adva	nced
► Communications	Enable GNSS in EKF Navigation	n		
Payload	Square error on strong acceler	ation for position		20.0 m <sup>2</sup>
▼ Sensors	Square error on strong acceler	ation for speed		20.0 (m/s) <sup>2</sup>
Accelerometer	Acceleration			30.0 m/s <sup>2</sup>
Altimeter	Duration of effect (disappears	linearly with time)		2.5 s
<ul> <li>GNSS</li> <li>GNSS 1 Configuration</li> <li>GNSS 2 Configuration</li> </ul>	Use position measures in t		tion	
GNSS 2 compass	· · · · · · · · · · · · · · · · · · ·			
GPS External		Square e	rror	Use receptor value if is present
NTRIP	GPS Position Error North	10.0	m²	$\checkmark$
Gyroscope	GPS Position Error East	10.0	m²	$\checkmark$
I2C Devices	GPS Position Error Down	10.0	m²	$\checkmark$
Magnetometer     Obstacle detection	GPS Velocity Error North	0.1	(m/s) <sup>2</sup>	$\checkmark$
Pressure	GPS Velocity Error East	0.1	(m/s) <sup>2</sup>	$\checkmark$
► RPM	GPS Velocity Error Down	0.1	$(m/s)^2$	$\checkmark$
$\langle \hfill \hfil$				
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 .

### 6.2.3.4.3.6 Advanced

Fixed Wing V-Tail UAV 🔾	◎ 🖸 莘 🚱 端 🕰 🗂 🔺 🎟 🖉 🖗
Actuators	Configuration SBAS Message rate EKF Navigation Advanced
► Communications	
► Micro	Minimum satellites to calculate position 4
Payload	Maximum satellites to calculate position 20
▼ Sensors	Minimum elevation of used satellites 5.0
Accelerometer	
Altimeter	PDOP Mask 25.0
▼ GNSS	TDOP Mask 100.0
GNSS 1 Configuration	P Acc Mask
GNSS 2 Configuration	T Acc Mask
GNSS Compass	T Acc Mask
GPS External	
NTRIP	Dynamic model Airbone 4G 🔹
Gyroscope	
I2C Devices	
Magnetometer	
Obstacle detection	
Pressure	
<→*	
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	

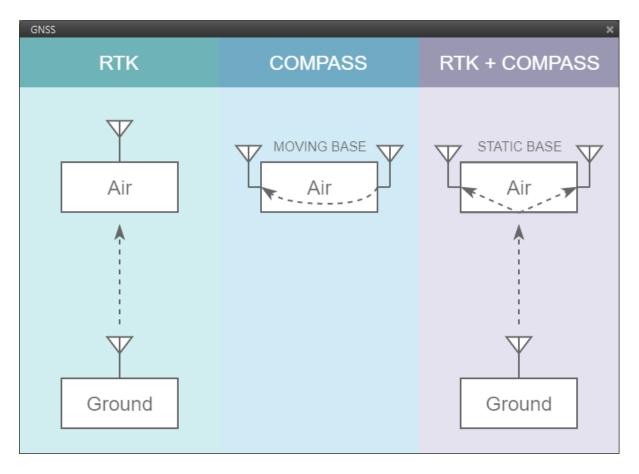
## 6.2.3.4.3.7 GNSS Compass

GNSS Compass is a menu where the user has 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.

GNSS compass configura Rover with moving base GPS 2	tion
Rover with moving base	* *
	•
	•
	Ţ
	*

# 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.

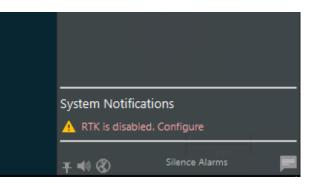
I GNSS	×
Select the function of each GPS	?
GNSS1 Base, GNSS GNSS1 Rover, GNS (	Cancel

GNSS Compass - Compass Base/Rover

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)". Consider the parameter established will be the one coming from the Wizard configuration.
- **Base source**. Where option are GPS 1 or 2.

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.

### 6.2.3.4.3.8 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:

# 6.2.3.4.3.9 Configuration

м400 🛪 💿 🧰 (	3 📽 🔁 🗂 🔺 🕅			
► Actuators	Configuration Estimation error			
Communications	✓ Enable			
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Period	0.25 s		
Accelerometer	Fix bit	BIT Dummy Error		
Altimeter ▼ GNSS	Time of week	Rvar Disabled		
GNSS 1 Configuration	GPS week	Rvar Disabled		
GNSS 2 Configuration GNSS Compass	GPS position	Value used when invalid ID is tried		
GPS External	Horizontal position error	2.0 m		
NTRIP	Vertical position error	5.0 m 🌣		
Gyroscope     I2C Devices	Velocity north	Rvar Disabled		
Magnetometer     Obstacle detection	Velocity east	Rvar Disabled Rvar Disabled		
Pressure	Velocity down			
► RPM	Horizontal velocity error	1.0 m/s		
< <u> </u>	Vertical velocity error	1.0 m/s		
Add device 👻				

### GNSS External - Configuration Menu

Check GNSS External device communication protocol before filling this menu.

- 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 defininf 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.

## 6.2.3.4.3.10 Estimation Error

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

### 6.2.3.4.3.11 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.

### 6.2.3.4.3.12 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

## 6.2.3.4.3.13 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 🗘 🖉	a 🗂 🔺 🖗		
► Actuators	V Enable			
► Communications	URL	193.145.206.163	Port	2101
Payload	User	USER	Ĩ	
▼ Sensors	Pass		1	
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
	Navigation system	
✓ Torrevieja RTCM 2.3	Network	erva ESP
Torrevieja RTCM 3.0	Country	0.00
Denia RTCM 2.3	Longitude	0.00
ALAC RTCM 2.3	NMEA	1
ALAC RTCM 3.0	Solution	1
✓ Ayora RTCM 2.3	Generator	Trimble GPSNet
Ayora RTCM 3.0	Encryption	none
✓ Valencia-IGN RTCM 2.3	Authentication	В
Valencia-IGN RTCM 3.0	Fee	N
RED RTCM 3.1 NETWORK-MAC	Bit rate	0
PEÑISCOLA RTCM 2.3		
RED_CMR1	,	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 🛪 🙆 🙆	≣ <b>© ¢</b> \$	🕉 🗂 🔺	R	
► Actuators				
Communications				
▶ Payload				
▼ Sensors				
Accelerometer				
Altimeter				
▼ GNSS				
GNSS 1 Configuration				
GNSS 2 Configuration				
GNSS Compass				
GPS External				
NTRIP				
Gyroscope				
I2C Devices				
<ul> <li>Magnetometer</li> </ul>				
<ul> <li>Obstacle detection</li> </ul>				
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.

### 6.2.3.4.4 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. Veronte uses the internal sensor.

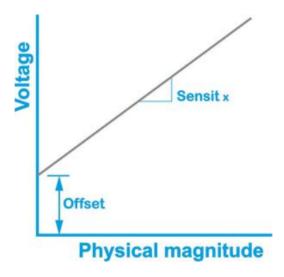
## 6.2.3.4.4.1 Integer var sensor

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

🔯 M400 🛪 💿 🖻	፰ 🚱 🗱 283
<ul> <li>Actuators</li> </ul>	0 - Integer var sensor 1     Edit Rotation Matrix
<ul> <li>Communications</li> <li>Payload</li> <li>Sensors</li> </ul>	2 - Decimal var sensor 1     X Axis       3 - Decimal var sensor 2     Zero
<ul> <li>Accelerometer</li> <li>Configuration</li> <li>Altimeter</li> </ul>	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$
<ul> <li>GNSS</li> <li>Gyroscope</li> <li>Configuration</li> </ul>	Y Axis Zero Signed
I2C Devices  Magnetometer  Obstacle detection	$V_0 + V_1 \cdot X^1 + V_2 \cdot X^2 \\ V_0 V_1 V_2 \\ 0.0 - 0.$
Pressure     RPM	Z Axis User Variable 01 (Unsigned Integer - 16 Signed
Speed down Ultrasound	
<ul> <li>Stick</li> <li>Veronte</li> </ul>	×
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.

## 6.2.3.4.4.2 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.

<ul> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> <li>Configuration</li> <li>Altimeter</li> <li>GNSS</li> <li>Gyroscope</li> <li>Configuration</li> <li>I2C Devices</li> <li>Magnetometer</li> </ul>	
<ul> <li>Accelerometer</li> <li>Configuration</li> <li>Altimeter</li> <li>GNSS</li> <li>Gyroscope</li> <li>Configuration</li> <li>I2C Devices</li> <li>Magnetometer</li> </ul>	on Matrix 07 (Real - 32 bits) 05 (Real - 32 bits)
<ul> <li>Obstacle detection</li> <li>Pressure</li> <li>RPM</li> <li>Speed down</li> <li>Ultrasound</li> <li>Stick</li> <li>Veronte</li> </ul>	06 (Real - 32 bits)

Decimal var Gyroscope Menu - Configuration Parameters

# 6.2.3.4.4.3 Internal

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

🔟 M400 🛪 💿 🧰 🗄	🛇 🗱 🖓 🗂 🔺 🕅	
<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> <li>Gyroscope</li> <li>Configuration</li> </ul>	<ul> <li>O - Integer var sensor 1</li> <li>O - Integer var sensor 2</li> <li>2 - Decimal var sensor 2</li> <li>3 - Decimal var sensor 2</li> <li>4 - Internal 1</li> <li>5 - Internal 2</li> </ul>	Edit Rotation Matrix Gyroscope Range 2000 °/s • Digital Filter
I2C Devices Magnetometer Obstacle detection Pressure RPM Speed down Ultrasound Stick Veronte		

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**.

# 6.2.3.4.5 I2C Devices

The I2C bus allows the connection of several devices with different addresses to the same line. In our case, Veronte allows up to 5 Lidar devices to be connected to the system.

The configuration menu can be seen below:

м400 🛪 🛞 🙆 葦	😧 🗱 🍄 🖸	<b>▲</b> @				
<ul> <li>Actuators</li> </ul>	Lidar I2C					
Communications	✓ Enable Lidar 1	Garmin Lida 👻	Address	0	dec	Digital filter
<ul> <li>Payload</li> <li>Sensors</li> </ul>	Enable Lidar 2	Garmin Lidar Lite v3	dress	0	dec	Digital filter
<ul> <li>Accelerometer</li> </ul>		SF11 Lidar	uress		Cec	Digital inter
Altimeter	Enable Lidar 3	Garmin Lida 👻	Address	0	dec	Digital filter
► GNSS	Enable Lidar 4	Garmin Lida 🔻	Address	0	dec	Digital filter
<ul> <li>Gyroscope</li> <li>I2C Devices</li> </ul>			, 1001 025	_		
Magnetometer	Enable Lidar 5	Garmin Lida 🔻	Address	0	dec	Digital filter
<ul> <li>Obstacle detection</li> </ul>						
Pressure						
► RPM						
Speed down Ultrasound						
<ul> <li>Stick</li> </ul>						
▶ Veronte						
Others						
Add device 👻						

### 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**. nables 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*.

## 6.2.3.4.6 Magnetometer

## 6.2.3.4.6.1 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.

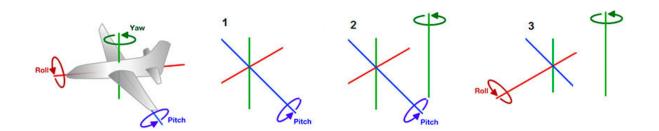
м400 🛪 🛞 🙆 葦 (	ə 🗱 🕰 🗖 4	<u>∧</u> @		
► Actuators		Hard Iro	n Calibration	
► Communications	Charles of Florentines	bias_x 2.4103548E	-4 k_x	0.020631598
▶ Payload ▼ Sensors	Start calibration	bias_y 1.73196E-4	k_y	-0.06729847
Sensors     Accelerometer	Compute	bias_z -1.2533966	E-5 k_z	-0.051240724
Altimeter				
► GNSS				
Gyroscope				
I2C Devices				
▼ Magnetometer Calibration				
Configuration				
Obstacle detection				
► Pressure				
► RPM Speed down				
Ultrasound				
► Stick	Precalibrate:	x	Υ	z
► Veronte 🗸	Actual calibrate:	x	γ	z
Add device 👻	New calibrate:	x	γ	z

#### 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. Hold the platform with your hands on the Y axis and rotate it parallel to the ground.
- 2. While the platform is rotating, rotate also yourself so the platform turns in two axes simultaneously.
- 3. Turn the platform 90 degrees within your hands and repeat the operation.



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:	X	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	

Magnetometer - Calibration Values

### 6.2.3.4.6.2 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. 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.

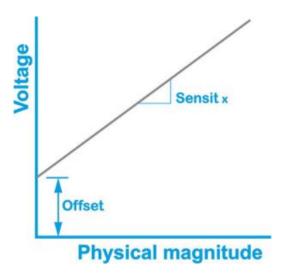
### 6.2.3.4.6.3 Integer var sensor

0 M400 🟹  $( \mathbf{ } )$ 🔺 🕅 0 **6** D Use three axis Actuators Navigation Communications Payload Custom setting Sensors 1.0E-10 T<sup>2</sup> Square error Accelerometer 10 Altimeter Decimation GNSS 0 - Integer var sensor 1 Edit Rotation Matrix Gyroscope 1 - Integer var sensor 2 I2C Devices X Axis 2 - Decimal var sensor 1 Magnetometer 3 - Decimal var sensor 2 Zero Signed Calibration 4 - Internal 0 Configuration 5 - External HMR2300 Obstacle detection 6 - External LIS3MDL Pressure RPM **Y** Axis Speed down Zero Signed Ultrasound 0 Stick Veronte Add device Z Axis

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

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.

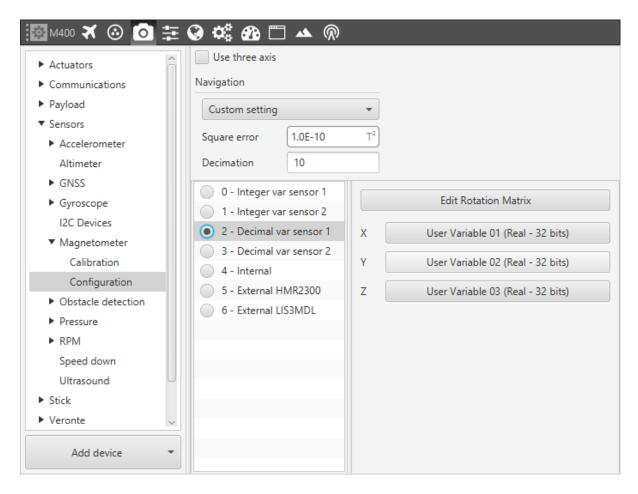


Linear relation of 2 Variables

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.

# 6.2.3.4.6.4 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.



Decimal var Magnetometer Menu - Configuration Parameters

# 6.2.3.4.6.5 Internal

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

M400 🛪 🙆 🙆 🗄	E 🚱 🗱 🖽 🗂 🔺 🖗
► Actuators	Use three axis
Communications	Navigation
<ul> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> </ul>	Custom setting       Square error       1.0E-10
Altimeter GNSS Gyroscope I2C Devices Magnetometer Calibration Configuration Obstacle detection Pressure RPM	Decimation       10         0 - Integer var sensor 1       1 - Integer var sensor 2         2 - Decimal var sensor 1       3 - Decimal var sensor 2         3 - Decimal var sensor 2       Digital Filter         5 - External HMR2300       6 - External LIS3MDL
Speed down Ultrasound > Stick > Veronte	

#### 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**.

### 6.2.3.4.6.6 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	$Q_0^0$	USB	$\rightarrow$	Commgr port 1	Q6
Altimeter	High	$Q^0_0$	Veronte LOS		Commgr port 2	Q
► GNSS	High	08	Veronte LTE	l ↔ l	Commgr port 3	0
Gyroscope	_	08	RS232	$\leftrightarrow$	2.	Q.
I2C Devices	High	2465	R5232		External magnetometer	- 2443
<ul> <li>Magnetometer</li> </ul>	High	00	RS485	$\rightarrow$	None	0
Calibration	High	$Q_0^0$	Commgr port 1		USB	Q.
Configuration  Obstacle detection	High	05	Commgr port 2	<b>→</b>	Veronte LOS	0
Pressure	High	00	Commgr port 3	i⇔i	Veronte LTE	
► RPM	High	¢\$	Commgr port 4	<b>→</b>	None	
Speed down		¢\$		l → l	None	
Ultrasound	High	- 444 (S	Commgr port 5		None	
Stick	High	00	Commgr port 6	$\rightarrow$	None	0
Veronte	High	$\mathbf{Q}_{0}^{0}$	Custom message 1	$\rightarrow$	None	Q.
Others		442				) Card
I/O Manager	High	<b>Q</b> _0	Custom message 2	$\rightarrow$	None	0
Digital Input Manager 🜷	High	$\mathbf{Q}_{0}^{0}$	Custom message 3	$\rightarrow$	None	<b>\$</b>
	High	08	Tunnel 1	$\rightarrow$	None	00

External Magnetometer - Channel Configuration

# 6.2.3.4.7 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.

# 6.2.3.4.7.1 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.

🔤 M400 🛪 🛞 🙆 葦	🚱 🕰 🕰 🗂 🔺 🖗
Accelerometer	✓ Enable
Altimeter	
► GNSS	Refresh time 2.0 s
Gyroscope	
I2C Devices	
Magnetometer	
<ul> <li>Obstacle detection</li> </ul>	
External	
Obsens	
Range sensors	
Pressure	
► RPM	
Speed down	
Ultrasound	
▶ Stick	
▶ Veronte	
▼ Others	
I/O Manager	
Digital Input Manager 💛	
Add device 🔻	

### Obstacle Detection - External

# 6.2.3.4.7.2 Obsens

This panel contains the configuration menu to set the obstacles creation.

м400 🛪 💿 🧰 葦	🚱 🗱 🌇 🖾 🔺 🖗	
Accelerometer     Altimeter	Mode	Cir2d 🗸
GNSS	Number of obstacles	64
<ul> <li>Gyroscope</li> </ul>	Type of obstacles generated	2D 👻
I2C Devices	Distance parameter for obstacles generated	0.0 m
Magnetometer	Time constant for field filter	0.2 s
<ul> <li>Obstacle detection</li> </ul>	Time constant for field litter	0.2 5
External	Wrapper to ignore measures bassed on elevation:	:
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.

## 6.2.3.4.7.3 Range sensors

The following figure shows the menu to configure the sensors which are used during the obstacle detection.

M400 🛪 🛞 🙆 \Xi	😧 📽 🚳 🛙	□ <u> </u>			
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	
Magnetometer					
<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	Valid	Constant value: 0.0	v1	Constant value: 0.0	
► RPM	Valio	Constant value: 0.0		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 🗸					
Add device 👻					

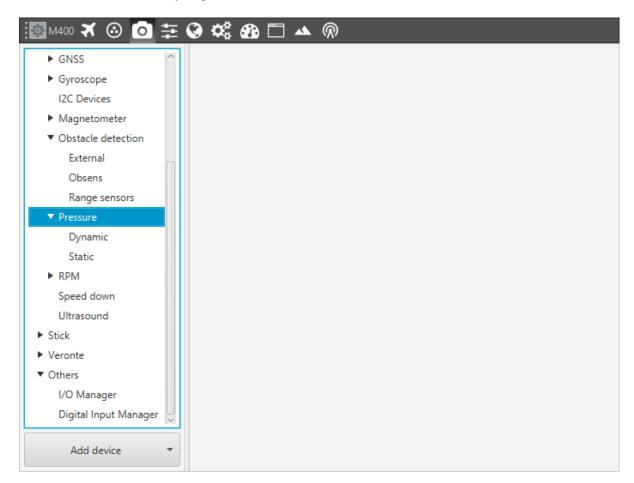
### **Obstacle Detection - Range Sensors**

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.

## 6.2.3.4.8 Pressure

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



### Pressure - Options available

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

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.

# 6.2.3.4.9 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.

м400 🛪 💿 🙍 葦	🛇 📽 🚳 🗂 🔺		
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.

## 6.2.3.4.10 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.

м400 🛪 💿 🔁 🏗	🚱 🗱 🕰 🗂 🔺		
► Actuators	C Enable Speed down		
<ul> <li>Communications</li> <li>Payload</li> </ul>	Sensor variance ((m/s)²)	0.0	
<ul> <li>Sensors</li> </ul>	Input Variable	Rvar Disabled	
Accelerometer	Enable tilt limit		
Altimeter • GNSS	Max tilt	0.0 rad [-π,π]	
Gyroscope	Enable speed limits		
I2C Devices	Min speed down	0.0 m/s	
Magnetometer     Obstacle detection	Max speed down	0.0 m/s	
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.

### 6.2.3.4.11 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.

# 6.2.3.4.11.1 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.

🖾 M400 🛪 🛞 🙆 葦	Q 🗱 🗛 🗔 🔺
► 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	
Gyroscope	
I2C Devices	
Magnetometer	
Obstacle detection	
Pressure	
► RPM	
Speed down	
Ultrasound	
▶ Stick	
▶ Veronte	
▼ Others	
I/O Manager 🔍 🗸	
Add device 🔹	

Ultrasound - Sensor Menu

# 6.2.3.4.11.2 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.

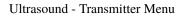
м400 🛪 💿 🧰 🏥	) 🗱 🚯 🗂 🔺 🛛	
► Actuators	Sensor Base Transmitter	Navigation
Communications	Rotation	
Payload		
▼ Sensors	Base yaw	Sniffer Yaw
Accelerometer	Base pitch	Sniffer Pitch
Altimeter	Base roll	Sniffer Roll
► GNSS	base foli	Shirler Koli
Gyroscope	Position	
I2C Devices	Position	
Magnetometer	Relative Moving Obj	iect 01 🔹 🕒 🛐
Obstacle detection	Absolute Decimal Dec	grees VAV POS MAP POS
Pressure	North 10746.974609	9375 m
► RPM	10140.514005	
Speed down	East -8720.189453	3125 m
Ultrasound	Down -182.6650085	j4492188 m
Stick	0.0	m
▶ Veronte	0.0	
► Others	0.0	m
Add device 👻		

Ultrasound - Base Menu

# 6.2.3.4.11.3 Transmitter

Defines the distance between the Internest system and the mass center from the platform.

🔝 м400 🛪 💿 🧕 🗄	😧 🗱 🆽 🗔 🔺	
Actuators	Sensor Base Transmitter Navigation	
<ul> <li>Communications</li> <li>Payload</li> </ul>	Distance to mass center	
<ul> <li>Sensors</li> </ul>	X Y Z	
<ul> <li>Accelerometer</li> <li>Altimeter</li> </ul>	Vector 0.0 0.0 0.0	
► GNSS		
<ul> <li>Gyroscope</li> <li>I2C Devices</li> </ul>		
<ul> <li>Magnetometer</li> <li>Obstacle detection</li> </ul>		
Pressure		
► RPM Speed down		
Ultrasound		
Stick     Veronte		
▼ Others I/O Manager ~		
Add device -		



# 6.2.3.4.11.4 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.

M400 🛪 🛞 🙆 葦	🚱 🗱 🍘 🗂 🔺
► Actuators	Sensor Base Transmitter Navigation
Communications	Enable
Payload	Ulso error computed by concer
▼ Sensors	✓ Use error computed by sensor
<ul> <li>Accelerometer</li> </ul>	
Altimeter	
► GNSS	
Gyroscope	
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

## 6.2.3.5 Stick Configuration

### 6.2.3.5.1 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.

м400 🛪 🛞 🙆 \Xi	😧 🗘 🖓	) 🗂 🔺	
▼ Gyroscope ^	Stick projected	d to control channels, used f	or neutral arcade command
Configuration	Channel 1	0.525519	
I2C Devices	Channel 2	0.49890113	
Magnetometer	Channel 3	0.5206349	
<ul> <li>Obstacle detection</li> <li>Pressure</li> </ul>	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.

# 6.2.3.5.2 Local Sources

## 6.2.3.5.2.1 Transmitter

The wired connected transmitters are configured through the following menus.

## 6.2.3.5.2.2 PPM

This tab provides the options to configure a Pulse Postion Modulation (PPM) radio controller to control the platform fitted with the autopilot.

🔯 M400 🛪 🛞 🙆 🗐	🛛 🗱 🏖 🗆	🔺 🏭 ⊘ 🖗		
► Actuators	PPM Exponential	Trim Output		
Communications	Brand Futaba	✓ Model 8J/10J/1	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	Position		max paise	5.02 4
▼ Local sources	Min accepted	8.0E-4 s	Max accepted	0.0022 s
Transmitter 1 Transmitter 2	Min value encoded	9.0E-4 s	Max value encoded	0.0021 s
Transmitter 3	Min channels	7	Max channels	8
Transmitter 4 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	ss 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
P Others				
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.

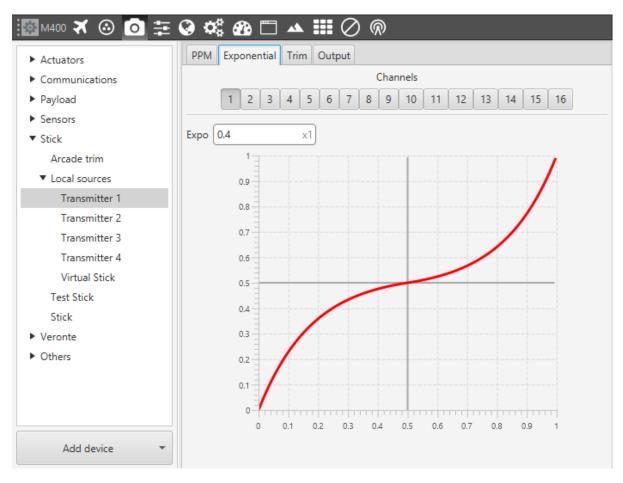
🖾 м400 🛪 💿 🧰 葦	I I I I I I I I I I I I I I I I I I I	d 🗂 🔺	▶ Ⅲ 🤅	$\mathbb{R}$				
Actuators	PPM Expo	onential Tr	im Output					
Communications				Wiza	rd trim			
Payload								
Sensors	✓ Advance	ea						Reset
▼ Stick		Trim	Range	Neutral		Trim	Range	Neutral
Arcade trim	Channel 1	0.0	0.7	Zero	Channel 9	0.0	0.7	Zero
▼ Local sources	Channel 2	0.0	0.7	Zero	Channel 10	0.0	0.7	Zero
Transmitter 1 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	Channel 5	0.0	0.7	Zero	Channel 13	0.0	0.7	Zero
Virtual Stick	Channel 6	0.0	0.7	Zero	Channel 14	0.0	0.7	Zero
Test Stick								
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
<ul> <li>Others</li> </ul>								
Add device 🔻								

Transmitter - PPM Signal

# 6.2.3.5.2.3 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

# 6.2.3.5.2.4 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.

🔤 м400 🛪 💿 🧰 🔁	I 🗘 🖉	لم 🗂 🖌	▶ Ⅲ 🤇	$\mathbb{P}$				
<ul> <li>Actuators</li> </ul>	PPM Expo	onential Tri	m Output					
Communications				Wiza	rd trim			
<ul> <li>Payload</li> <li>Sensors</li> </ul>	✓ 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
<ul> <li>Veronte</li> <li>Others</li> </ul>	Channel 8	0.0	0.7	Zero	Channel 16	0.0	0.7	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.

### 6.2.3.5.2.5 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.

м400 🛪 💿 🔁 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> <li>Arcade trim</li> </ul>	Remote UAV M400 (Vero  Min period 0.0 s Delta 0 Max period 0.0 s	
<ul> <li>Local sources</li> <li>Transmitter 1</li> </ul>		
Transmitter 2 Transmitter 3	Enable Initial Channel at destination 1 Port 0	
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 🔻		

#### 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**).

### 6.2.3.5.2.6 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 🛪 🛞 🙆 🛱	E 🚱 🗱 🏧 🗂 🔺 🏭 ⊘ 🙊
<ul> <li>Actuators</li> </ul>	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> <li>Transmitter 2</li> </ul> </li> </ul>	Input Variable Update Period User Variable 02 (Real - 3 User Variable 03 (Real - 3 User Variable 03 (Real - 3)
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.

# 6.2.3.5.3 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 🛪 🞯 🙍 \Xi	😧 🗱 🖽 🗀 🔺 🏭 📿 🖗	
<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> </ul> </li> </ul>	Channels Channel 1 Channel 2 Channel 3 Channel 4 Channel 5 Channel 6 Channel 7 Channel 8 Channel 8	%
Transmitter 2 Transmitter 3 Transmitter 4 Virtual Stick Test Stick Stick Veronte Others	Channel 9 Show on the checklist.	
Add device 🔻		

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.

### 6.2.3.5.4 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 V On Overwrite X		
<ul> <li>Others</li> </ul>	↑ 1 UAV Pipe fixed ▼ Port 0 Time 0.2 V On Overwrite X		
	Add		
Add device 👻			

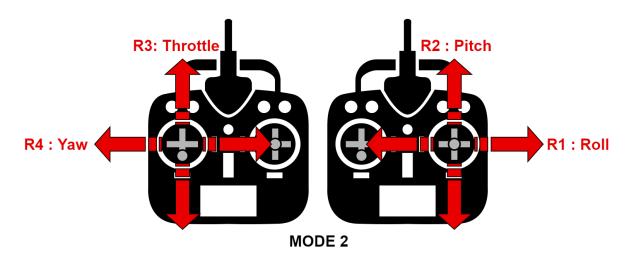
#### Stick - Configuration Parameters

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
			+		

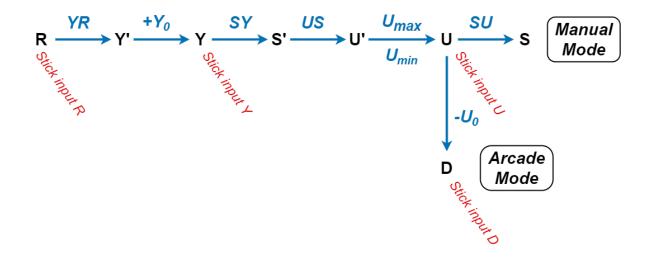
Stick - YR Matrix for a Quadcopter

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

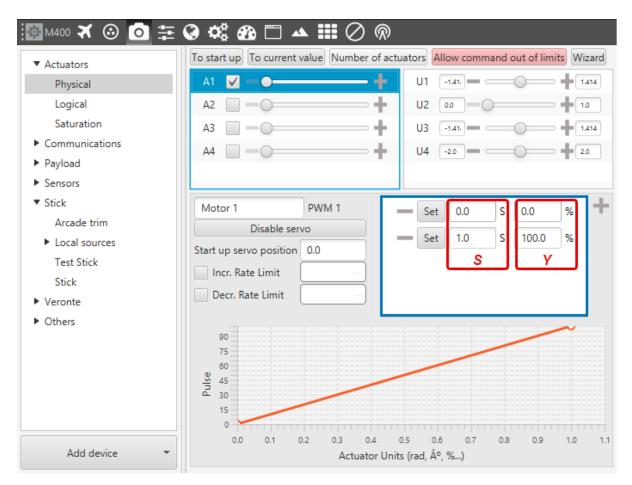
The offset  $Y_0$  is calculated by setting R and Y with a specific value. Take the neutral position of a quadcopter: the sticks are  $R_{neut} = [0.5; 0.5; 0; 0.5]$  (the third value is 0 as it corresponds to the neutral position of channel 3, i.e. the throttle) and the actuators PWM signals  $Y_{neut} = [0; 0; 0; 0]$ . 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

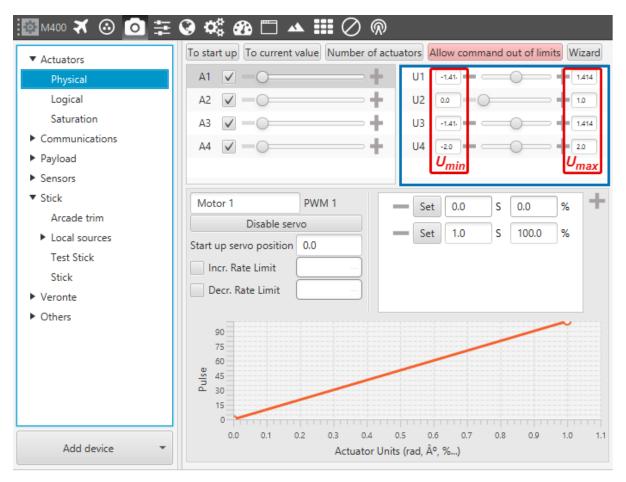
The above diagram depicts the whole transformation process of the incoming raw input R vector. It also shows in red the naming of some important variables in Veronte Pipe. Step by step, the process is:

- 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  $\boldsymbol{SY}$  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.

# 6.2.3.5.4.1 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 in	iputs	s Actuator outputs	
Use	Invert	Control Output u1 - Pitching Control Output u2 - Thrusting Control Output u3 - Rolling Control Output u4 - Yawing	Stick Channel	r2 0 Value 0.0 r3 0		Servo 1 Value 0.0 Servo 2 0	1 1
Confi	igure Neut	rais	Accept	Value 0.0 r1 Get of Telemetry	. ~	Value 0.0 Servo 3 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.

### 6.2.3.5.4.2 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.

1 🖾 🐼 🛪 🕺	🚱 🗱 🖽 🗂 🔺 🏭 ⊘ 🖗			
Actuators	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	◆ 0 ↓ UAV Local ▼ Port 0 Time 0.2 ✔ On Overwrite ▼			
► Others	1 UAV Pipe fixed - Port 0 Time 0.2 V On Overwrite X			
	Add			
Add device 👻				

Stick - Mask Servos

# 6.2.3.5.4.3 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  Veronte	◆ 0 ● UAV Local    Port 0 Time 0.2    On Overwrite		
Others			
P Others			
	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  $\mathbf{R}$  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  $\mathbf{Y}$ , 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*.

### 6.2.3.6 Others

#### 6.2.3.6.1 Payload

This panel allows users to configure the gimbal settings, including the number of gimbal axis, servos used for gimbal connection and distance from the autopilot to the Gimbal.

🔯 🕑 M400 🛪 🛞 🙆 🗄	<b>E 🔇</b>	🗱 🏤 🗂 🔺			
Actuators	Туре	Pan Tilt 👻	Base to gimbal X	0.0	_
Sensors	Logic	Conventional gimbal 🔹 👻	Base to gimbal Y	0.0	
► Stick		Arcade	Base to gimbal Z	0.0	
► Veronte			-		
▼ Others	Туре	Pan Roll Tilt 👻	Base to gimbal X	0.0	—
Payload	Logic	Self-stabilized gimbal 🔹 💌	Base to gimbal Y	0.0	
SARA		Arcade	Base to gimbal Z	0.0	
XPC Uint8			-		
XPC CAP			ADD		
Add device 👻					

#### Payload Configuration Menu

- **Type:** user can install a Pan -Tilt, Roll-Tilt or Pan-Roll-Tilt Gimbal, depending on the degrees of freedom of the Gimbal Device.
- Logic: Conventional gimbal or Self-stabilized gimbal.
- Base to gimbal X, Y, Z: relative position between the Gimbal and Veronte.

It is possible to configure two gimbals at the same time, press **ADD** to incorporate one into the Panel.

# 6.2.3.6.1.1 Payload Operation

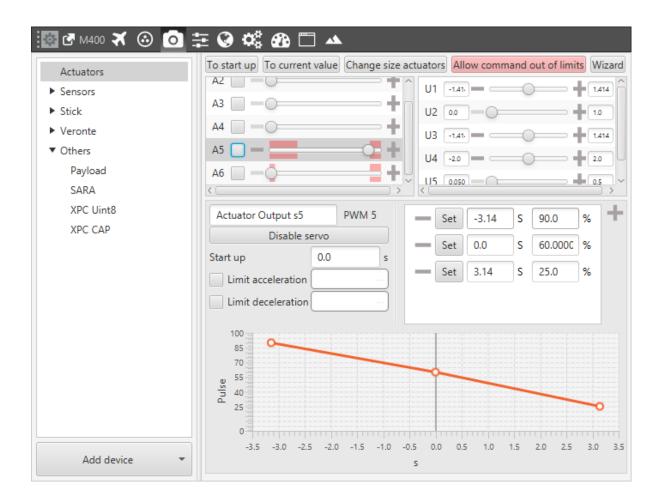
In order to configure a complete Payload Operation, the following steps have to be done. All steps are based on a Conventional Gimbal with two axes of rotation (Pan and Tilt).

1. Configure the US matrix selecting the control outputs (U) and actuator outputs (S). This has to be done according to the Gimbal used.

	Control Output u1 - Pitching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	Control Output u5 - Pan G1	Control Output u6 - Tilt G1
Motor 1	-0.35355338	1.0	-0.35355338	0.25	0.0	0.0
Motor 2	0.35355338	1.0	-0.35355338	-0.25	0.0	0.0
Motor 3	0.35355338	1.0	0.35355338	0.25	0.0	0.0
Motor 4	-0.35355338	1.0	0.35355338	-0.25	0.0	0.0
Actuator Output s5	0.0	0.0	0.0	0.0	1.0	0.0
Actuator Output s6	0.0	0.0	0.0	0.0	0.0	1.0
			+			

### SU Matrix

2. Configure the relationship between PWM signals and actuator outputs (S), it depends on the device used, prior to configure this check performances. It may requiere to add PWM Outputs, in its correspondent panel, Connections.



SU Matrix

3. Configure the Payload Device.

🔯 🕑 Penguin Embention 💥	★ ⊙	) 🖸 🗄 🔇 📽	🕜 (			
► Veronte	Туре	Pan Tilt	-	Base to gimbal X	0.0	_
► Control	Logic	Conventional gimbal	-	Base to gimbal Y	0.0	
Sensors		Arcade		Base to gimbal Z	0.0	
Stick						
▼ Others				ADD		
Payload						
SARA						
XPC Uint8						
XPC CAP						
Add device 🔻						

#### Payload Configuration

- 4. Next step is the configuration of the control loops for each axe: Pan and Tilt. Control loops can be either close loop or open loop. It depends on if there is any variable available for feedback.
  - Pan control: select **Joint 1 of gimbal 1** as entry variable (desired Pan angle) and if exists a feedback variable select it, otherwise select the variable **Zero**, this sets a open loop.
  - Tilt control: select **Joint 2 of gimbal 1** as entry variable (desired Tilt angle) and if exists a feedback variable select it, otherwise select the variable **Zero**, this sets a open loop.

🔯 🛃 м400 🛪 🙆 🧿	🗄 🚱 📽 🙆 🗂 🔺
<ul> <li>▼ Phases</li> <li>Standby</li> <li>VHold</li> <li>Hover</li> <li>Takeoff</li> <li>Landing</li> <li>Cruise</li> <li>Hold</li> <li>Runway</li> </ul>	Guidance       Loop       Arcade       TC Pannel       Automations         Yawing       Name       Pan G1         Pan G1       Mode       On         Tilt G1       Image: Compare the second s
	Joint 1 of Gi Zero
Add 👻	

#### Control Loop

- A typical setting for the control loop incorpores: a proportional and integral gain.
- 5. The last step consists in configuring the widget that displays all the information related to the gimbal. Generally, this devices incorpores a Camera being possible to stream the signal in this widget. To configure this widget go to the Workspace Panel and add the widget of Gimbal. In this panel is possible to select a **Gimbal** and **Camera** if there is any device available.

								•0.051 rad [-m,m]	
🐻 🕑 🔻 🔒 📋 Default	5	8 ô   6 6							
Widgets Main	Gimbal				SELECTED-VERONTE	•			
🐮 Gimbal	Opacity				=0				
	Pos X	1146.0	Pos y	333.0					
	Width	800	Height	600	Cut video	•			
	Gimbal	No gimbal 👻	Camera		*	$\rightarrow$			
							← 0 rad [-π,π]		0 rad [-π,π] →
New									
							[π,π] bar 0 C	-0.051 rad [-π,π]	0 rad [-π,π] C

#### Widget Configuration

When configuring this widget the window above will be shown, this allows the user to control the gimbal. The movements are controlled with the arrows shown on the window, the user can press on them to move the gimbal or introduce a value.

### 6.2.3.6.2 SARA

In this panel it is possible to enable the 4G connection. This consisists in a step of configuration when using Cloud capabilities, this feature allows user to command Veronte Autopilots beyond the light of sight.

🔯 🕑 Penguin Embention 💥	* 💿 🖸	i 🇄 🚱 🗱 🕰 🗠 🔺		
► Veronte	Enable			
Control	SIM Type	ESIM -		
Sensors				
Stick	Host	cloud.embention.com	Port	3114
▼ Others				
Payload				
SARA				
XPC Uint8				
XPC CAP				
Add device 👻				

SARA Configuration Menu

- SIM Type: It is possible select either a ESIM or a SIM card.
- Host: Host Address.

Once configured, the user can access the cloud services. See section Users and Access Levels for more information.

# 6.2.3.6.3 XPC Uint8

# 6.2.3.6.3.1 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.

★ ⊙ o ≡ 📀 🗱 🔯 🕝 Penguin Embe CfgMgr 676 ~ StepMgr  $M^{*}$ Producer Consumer Actuator  $\rightarrow$ None Micro SCIB -USB Ports Sensors SCIA - Sara  $\rightarrow$ GPS 1 RTCM Stick Veronte ID 2  $\dot{Q}^0_0$ SCID - Connector 232  $\rightarrow$ Tunnel 1 Veronte Port Port 1 08 SCIC - Connector 485 Tunnel 2 Others 0.01 Time betwe... Payload None Arbiter Bytes to send 22 Commgr port 2 SCIB SARA Drop System  $\rightarrow$ None XPC Uint8 None XPC CAP Commgr port 5 None  $\rightarrow$ None

 $\rightarrow$ 

Let's consider the following image.

#### XPC Uint8 Configuration Menu

None

None

None Non

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 where the device is connected.

The option available when configuring Tunnel as Consumer are:

• Veronte ID: identifies the Autopilot which will receive the information.

Custom message 3

- Port: number of port is used to avoid mistakes and identify a Tunnel when using more than one.
- Time between messages.

Add device

• Bytes to send: sets the message size to send.

¢°

¢\$

00

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.

byte

	1	Producer		Consumer	
Veronte	06	USB	$\leftrightarrow$	Commgr port 1	08
Control Sensors	08	SCIB		Commgr port 2	Q0
Stick		SCIA - Sara	→	Commgr port 3	¢\$
Others		SCID - Connector 232	_ ←	Custom message 1	¢,
Payload SARA		SCIC - Connector 485		Commgr port 4	
XPC Uint8	08	Commgr port 1	$\leftrightarrow$	USB	00
XPC CAP		Commgr port 2	Ì↔Ì	SCIB	Q0
		Commgr port 3		SCIA - Sara	Q0
	Q <sub>0</sub> <sup>0</sup>	Commgr port 4		SCIC - Connector 485	Q0
	Q <sub>0</sub>	Commgr port 5	$\rightarrow$	None	Q0
	Q <sub>0</sub> <sup>0</sup>	Commgr port 6	$\rightarrow$	None	Q <sub>0</sub>
	Q0	Custom message 1	$\leftrightarrow$	SCID - Connector 232	Q <sub>0</sub>
	Q <sup>o</sup>	Custom message 2	<b>→</b>	None	Q0
	$\mathbf{Q}_{0}^{0}$	Custom message 3	$\rightarrow$	None	Q0
Add device 👻		Tunnel 1	$\rightarrow$	None	08

### 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:

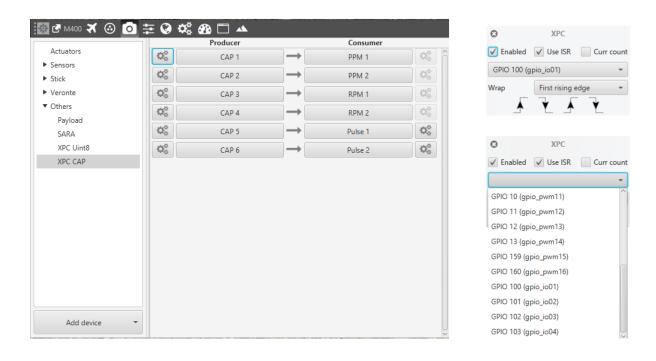
Field	Description
Tunnel	Creates a bidirectional brigde between two devices, see section <i>Tunnel</i>
Custom Message	This allows user to send/receiver a custom message.see section Custom Messages
GPS RTCM	Differential GPS.
Magneto	External magnetometer sensor, see section Magnetometer
Ultrasound	External ultrasound sensor, see section Ultrasounds
Splitter	Used to split a signal into 2.

More information about each element can be found in the links provided before.

# 6.2.3.6.4 XPC CAP

PWM outputs can work as Digital Input or Output, these pins are used to configure some custom sensors such as a Stick PPM, RPM Sensor or a Pulse Sensor. In addition to these pins, Enhanced Quadrature Encoder Pulse Inputs (EQEP) are also used, see section 2.1.2 for more information about Veronte 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 window will be displayed, see image above.
- In the new window is possible to select the pin where the device is connected. Pins available are PWM outputs, they are named as **gpio\_pwmX**, and EQEP pins (GPIO 100, 101, 102, 103) these corresponds with pins 55, 56,

57 and 58, see section 2.1.2. When using the connector provided by Embention the Radio Digital In is connected to the pin 55 (GPIO 100) with pin 49 as Ground (see Ground Station)

• Wrap options allows to configure how the information is treated, for example if it will read the first rising edge or the falling. Clicking on the arrows it can be configured as desired.

Some sensors have their own configuration menu, visit them for more information: Stick and RPM.

This section of the manual contains the information about external sensors configuration. The following devices are available:

Field	Description
Payload	Gimbal configuration
SARA	4G Connection configuration
XPC-	In this panel users can configure how elements communicate each other, enabling to configure external
Uint8	sensors or messages.
XPC-	This panel enables users to configure a joystick, pulse or rpm sensor.
CAP	

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

# 6.2.4 Control

# 6.2.4.1 Phases

#### 6.2.4.1.1 Guidance

#### 6.2.4.1.1.1 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.

Selec	t variable			×
Sele	ct var	Desired		
R	Desired Forward Load Fac Unit:	tor - X Bod	ly Axis	^
R	Desired Front GV (Ground Unit: m/s	Velocity)		
R	<b>Desired</b> GS (Ground Speed Unit: m/s	d)		
R	<b>Desired</b> Heading Unit: rad [-π,π]			
R	Desired IAS (Indicated Airs Unit: m/s	speed)		
R	<b>Desired</b> 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.

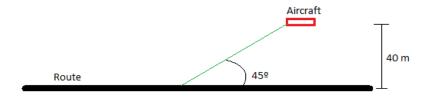
# 6.2.4.1.1.2 Taxi

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.

📴 🕑 Penguin Embention 🔧	🕻 🛪 💿 🖸 🗄 🚱 🌣	\$ 🚯 🗂 🔺	
▼ Phases	Guidance Loop Arcade TC F	Pannel	
Standby Climbing Hold	VTol Taxi	↑ +	Name Taxi
No name		*	
Cruise Landing Runway Takeoff	Deceleration	0.0	m/s <sup>2</sup>
<ul> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> </ul>	Set speed Cruise	5.0	m/s
Modes Arcade axis	Waypoint reach	0.0 Speed	m/s
	Type Hover gain	эреео	
	Horizontal Vertical	0.0	
		Advanced	
Add 👻	End point  V Direction	Ref         Runway End Position           Ref         Runway Direction	*

#### TAXI Guidance

• Line attraction: is a parameter that determines how the platform is attracted to the line that determines the path that has to follow. The value is the distance perpendicular to the path at which the vehicle will try to go back to the line with a heading of 45 degrees with respect to it. When it is closer than this distance the heading angle is lower, and bigger when the distance is higher. So a small value will make the aircraft go to the line at high angles during more time (because the distance of 45 degrees is now small), and a big value implies less attraction because the platform will go to the line at smaller angles than 45 degrees from a bigger distance.



### Angle and distance

In this phase the path is not directly indicated by the user as in the Cruise (which is defined in the Mission menu) but there is still a trajectory whose parameters are detailed later in this section, so this value is as important as it is for the Waypoint following route. The common values of the line attraction are between 20 and 40 for airplanes, and 15 for multicopters. This parameter only has to be changed by advanced users.

- Acceleration proportional gain: this parameters is releated with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 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 goes from the altitude at which it enters in the mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
  - **3D mode:** is used in multicopters only, in this case the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
- Set limit acceleration: establish a limit for acceleration and deceleration.
- 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.
- **Runway:** here it is seleceted a runway previously configured, see section *Runway*. Besides, it is possible to use the advanced mode and select a different end point or direction.

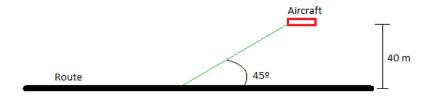
# 6.2.4.1.1.3 VTOL

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.

🔯 🕑 Penguin Embention 놧	🕻 🛪 💿 🖸 🗄 🚱	🗱 🚯 🗂 🔺	
▼ Phases	Guidance Loop Arcade T	IC Pannel	
Standby Climbing Hold	VTol	Name VTol	
No name		<b>↓</b>	
Cruise Landing	Set speed		^
Runway Takeoff Runway	Cruise	5.0 m/s	
Envelope Smooth	Waypoint reach	0.0 m/s Speed -	
Modes Arcade axis	Hover gain		Π
	Horizontal	0.0	
	Туре	Straight •	
	Extend	None	
	Safe	0.0 m Relative -	
Add 👻	Touch	Ref Lat: 0.0000 Lon: 0.0000	Ŷ

VTOL Guidance

• Line Attraction: is a parameter that determines how the platform is attracted to the line that determines the path that has to follow. The value is the distance perpendicular to the path at which the vehicle will try to go back to the line with a heading of 45 degrees with respect to it. When it is closer than this distance the heading angle is lower, and bigger when the distance is higher. So a small value will make the aircraft go to the line at high angles during more time (because the distance of 45 degrees is now small), and a big value implies less attraction because the platform will go to the line at smaller angles than 45 degrees from a bigger distance.



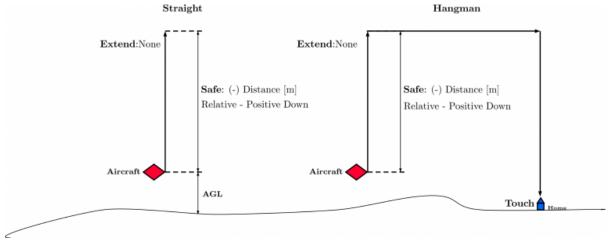
### Angle and distance

In this phase the path is not directly indicated by the user as in the cruise (which is defined in the Mission menu) but there is still a trajectory whose parameters are detailed later in this section, so this value is as important as it is for the Waypoint following route. The common values of the line attraction are between 20 and 40 for airplanes, and 15 for multicopters. This parameter only has to be changed by advanced users.

- Acceleration proportional gain: this parameters is releated with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 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 goes from the altitude at which it enters in this mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
  - **3D mode:** is used in multicopters only, in this case the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
- Set limit acceleration: limit the values of the acceleration and deceleration during this guidance.
- Set Speed: this option sets the speed that the vehicle will have during this guidance. 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 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.
- Hover Gain: those gains are used by a multicopter when it is hovering over a certain location. When the vehicle is moved from that hover point because of a wind gust, it will try to go back to that location using the gains specified here.
- **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 performing this movement the platform can avoid them and landing safety.

**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

### 6.2.4.1.1.4 Climb

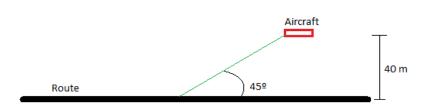
Climb guidance is used to make the aircraft climb from the start of the phase to another altitude. Commonly, this guidance is used after the take off to climb from the ground to the cruise altitude, but can be used for the proposit desired by the user.

🔯 🕑 Penguin Embention 🔆	( 🛪 💿 🖸 🗄 🚱 📽	: 🚜 🗂 🔺	
▼ Phases	Guidance Loop Arcade TC Pa	annel	
Standby	Climbing	<b>^</b>	Name Climbing
Climbing		+	
No name		×	
Cruise		4	
Landing			A
Runway Takeoff	Line attraction	20.0	
Runway			101
Envelope	Patch	0	
Smooth	Acceleration proportional gain	0.0	
Modes			
Arcade axis	Set height mode	2.5D	•
	Set limit acceleration		
	Acceleration	0.0	m/s <sup>2</sup>
	Deceleration	0.0	m/s <sup>2</sup>
	Set speed		
	Cruise	20.0	m/s
Add 👻	Waypoint reach	0.0	m/s

Climbing Guidance

All the parameters that appear in the previous figure (and can be modified) are the ones that rule the climb of the aircraft. They are detailed as follows:

• Line attraction: is a parameter that determines how the platform is attracted to the line that determines the path that has to follow. The value is the distance perpendicular to the path at which the vehicle will try to go back to the line with a heading of 45 degrees with respect to it. When it is closer than this distance the heading angle is lower, and bigger when the distance is higher. So a small value will make the aircraft go to the line at high angles during more time (because the distance of 45 degrees is now small), and a big value implies less attraction because the platform will go to the line at smaller angles than 45 degrees from a bigger distance.



#### Angle and distance

In this phase the path is not directly indicated by the user as in the cruise (which is defined in the Mission menu) but there is still a trajectory whose parameters are detailed later in this section, so this value is as important as it is for the Waypoint following route. The common values of the line attraction are between 20 and 40 for airplanes, and 15 for multicopters. This parameter only has to be changed by advanced users.

- Acceleration proportional gain: this parameters is releated with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 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 goes from the altitude at which it enters in this mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
  - **3D mode:** is used in multicopters only, in this case the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
- Set limit acceleration: here are set the limits for deceleration and acceleration of the platform when it is climbing. Normally the limits set here are due to structural stability and to avoid extreme movements of the vehicle.
- Set Speed: this option sets the speed that the vehicle will have during the climb. 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 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.
- Hover Gain: those gains are used by the multicopters when it is hovering over a certain location. When the vehicle is moved from that hover point because of a wind gust, it will try to go back to that location using the

gains specified here.

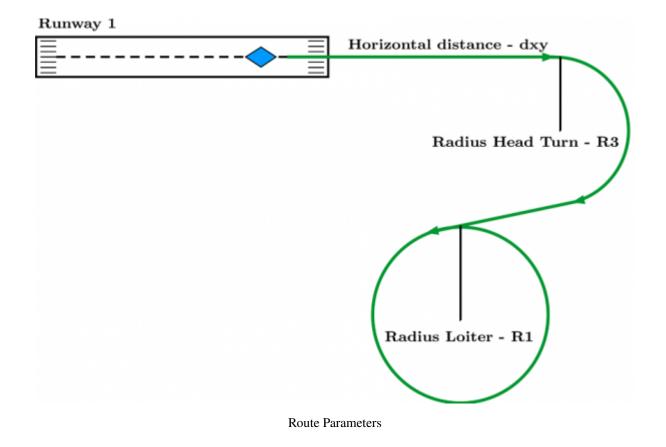
- **Route:** here are set the parameters that define the route followed by the aircraft when is climbing until a certain altitude. The climb is done in two segments. First a straight flight and then a circular route that allows the climb to be done in a reduced area.
  - **Runway:** here is selected the runway which previously has been edited, see section *Runway* It is possible to use the advanced mode and select a different loiter point (defines the altitude) or direction.
  - Flight Path Angle: angle at which the aircraft will climb.
  - 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.
  - Radius Head Turn R3: radius of the turn made to head the airplane towards the loiter direction.
  - Radius loiter R1: radius of the loiter ascending (helix) made by the aircraft to reach an altitude suitable.
- **Height:** this is determined by the **Loiter point**, by default, this value is definied with the runway (Runway Loiter). It can be changed when defining the runway or using **Advanced** options, see image below.

hases	Guidance Loop Arcade To	C Pannel Automatic	ns	Server and			SA CONSTRACT
Standby	Climbing	<b>^</b>	Name Climbing	There are an	the second second	ALCONTROL .	1.1
Climbing Flare		+		See Strand	1.50		a second
Cruise		ж		「日本語」の注意	NAL TO BE	- Later and	A STOR
Landing		*		Service and the service of the servi	AND IN THE	Cles P	343 1 1 1
Runway Takeoff	Hover gain			A THE REAL PROPERTY AND	TATO DEAL		Home
lunway	Horizontal	0.0		100		100	
invelope				ALC: CONSIGN	Z. Com		an Andrew
imooth Aodes	Vertical	0.0		Ride Farmer	1 1000	SARE STILL	
vioues Arcade axis	Runway Runway 1 💌 🗸	/ Advanced	Absok	te Relative Accrosch Initial Point	CRIPTION CONTRACTOR	A CONTRACTOR	10-10-07/11
	Loiter point	Ref Lat: 38.	3301 Lon: -0.5578			Con R Gum	
	Direction	Ref (A) 0	rad [-m.m]	0.66806864475 rad [-n,n]		Alaberti	
			Longitude	-organize iso [-i(ii)]	-	AT HERE	12 A 1 1 1 1 1 1 1
	Flight-path angle	Ref 0.1392	rad [-n,n] WGS84	118.72079467773438		a la constante and	APPLICATION IN COMPANY
	Horizontal distance (dxy)	Ref 200.0	m – MSL	68.34602314740548	- m 5/4	3 COM	and the second
	Radius head turn (R3)	Ref 250.0	m AGL	29.346023147405475	m 24	A AN	A CONTRACTOR
	Radius loiter (R1)	Ref 250.0	m		and the second		Company (Second
Add	·				the set	State State	An Williams
No. Constant of the Instant	NO AND DESCRIPTION OF THE OWNER.	N-340	ALA SALATER AND	The Party of the P	CONTRACTOR OF THE OWNER	A Charles of A Charles	The Martin Contraction of the

Climbing Guidance

As it can be seen, it possible to change the Loiter Point and Direction (Heading). If **Ref** is marked, it is possible to select any reference point/direction integrated into Veronte, by default these values are set to Runway Loiter and Runway Direction.

The following figure details schematically some parameters detailed previously.



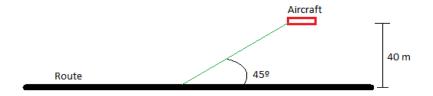
# 6.2.4.1.1.5 Cruise

This phase is used to make the aircraft follow a determined route created by the user in the Mission menu. This is the principal use of this guidance mode, but it can also be used to make the aircraft go to a certain location (waypoint) without indicating the full route, so in general is a guidance used to command a movement to be done by the platform. Some examples will be detailed later, by firstly all the parameters that define the cruise guidance are detailed.

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▼ Phases	Guidance Loop Arcade	TC Pannel	
Standby Climbing Hold	Cruise	* + ×	Name Cruise
No name		•	
Cruise			^
Landing	Line attraction	20.0	
Runway Takeoff • Runway	Patch	0	
Envelope	Acceleration proportional	0.0	
Smooth Modes	Set height mode	3D •	
Arcade axis	Set limit acceleration		
	Acceleration	0.0 m/s <sup>2</sup>	)
	Deceleration	0.5 m/s <sup>2</sup>	)
	Set speed		
	Cruise	22.0 m/s	J
Add 🔹	Waypoint reach	0.0 m/s	)

#### Cruise Guidance

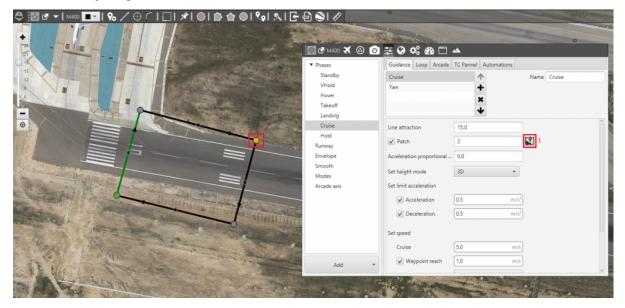
• Line attraction: is a parameter that determines how the platform is attracted to the line that determines the path that has to follow. The value is the distance perpendicular to the path at which the vehicle will try to go back to the line with a heading of 45 degrees with respect to it. When it is closer than this distance the heading angle is lower, and bigger when the distance is higher. So a small value will make the aircraft go to the line at high angles during more time (because the distance of 45 degrees is now small), and a big value implies less attraction because the platform will go to the line at smaller angles than 45 degrees from a bigger distance.



#### Angle and distance

In the this phase the path is not directly indicated by the user as in the cruise (which is defined in the Mission menu) but there is still a trajectory whose parameters are detailed later in this section, so this value is as important as it is for the Waypoint following route. The common values of the line attraction are between 20 and 40 for airplanes, and 15 for multicopters. This parameter only has to be changed by advanced users.

• **Patch:** in Pipe, a path is defined as the line between two waypoints. This option is used to force the aircraft to go to a certain patch when entering in the cruise phase. For example, it the Mission created by the used has 4 lines (a square), this option could be used to force the aircraft to take one of the lines (path) as the first line to cover during its operation.



#### Patch

In the previous figure, if the line that starts at the yellow waypoint wants to be taken as the first one of the route, clicking on 1 will allow the user to select that patch (a patch is selected by choosing its first waypoint, taking into account the direction). The numeration of the patchs is related with the order in which they were created. If the waypoint selected in the "Patch" option is alone (is not in a line), the aircraft will go to this point continuosly, so it will loiter around it. To sum up, if the path selected is part of a route with more than one line, the platform will first go to this line and the it will continue with the route. On the other hand, if the path selected is a single point, the vehicle will loiter around it (or hover in the case of a multicopter).

- Acceleration proportional gain: this parameters is releated with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 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 goes from the altitude at which it enters in this mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
  - **3D mode:** is used in multicopters only, in this case the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
- Set limit acceleration: the acceleration and deceleration can be limited to increase the safety of the operation.
- Set speed: this option sets the speed that the vehicle will have during the climb. 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 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.

• Hover Gain: those gains are used by the multicopters when it is hovering over a certain location. When the vehicle is moved from that hover point because of a wind gust, it will try to go back to that location using the gains specified here.

### 6.2.4.1.1.6 Hold

Hold guidance is used to introduce in the control system a desired variable with a certain value especified by the user. It is different than the other guidances, where for example the user determines a path to follow and the desired heading that makes the aircraft follow that path is not determined by the user, is determined by the path.

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▼ Phases	Guidance Loop Arcade TC Pannel
Standby Climbing	Modified PN Name Hold
No name	Hold +
Cruise Landing	•
Runway Takeoff  Runway	Desired Pitch
Envelope Smooth	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)     Constant value: 0.0 rad     O.0     Constant value: 0.0 rad
Modes Arcade axis	Desired GS (Ground Speed)
	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)     Constant value: 0.0 m/s     0.0     Constant value: 0.0 m/s
Add 👻	

#### Hold Guidance

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. For example, to make the aircraft keep the heading that it has when changing to a phase, select Desired Heading as the hold variable, and choosing heading.
- **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 reached the value (or variable) indicated.

- **Slope** (**Ramp Rate**): the same case as before, but know instead of the time between the two values of the ramp, the slope of that ramp can be indicated.
- Ewma (TAU): the variation between the start and final points is exponential.

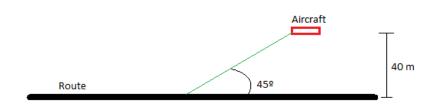
# 6.2.4.1.1.7 Landing

Landing guidance is used to create the route that the airplane will follow to land in a certain runway (defined by the user).

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▼ Phases	Guidance Loop Arcade TC Pa	annel
Standby	Landing	Name Landing
Climbing		+
Hold		×
No name		
Cruise		
Landing	Line attraction	20.0
Runway Takeoff		
Runway	Patch	0
Envelope	Acceleration proportional gain	0.0
Smooth		
Modes	Set height mode	2.5D -
Arcade axis	Set limit acceleration	U
	Acceleration	0.0 m/s <sup>2</sup>
	Deceleration	0.0 m/s <sup>2</sup>
	Set speed	
	Cruise	19.0 m/s
Add 👻	Waypoint reach	0.0 m/s

#### Landing Guidance

• Line attraction: as in the case of the climbing, is a parameter that determines how the aircraft is attracted to the line that it has to follow. The value is the distance perpendicular to the path at which the vehicle will try to go back to the line with a heading of 45 degrees with respect to it. When it is closer than this distance the heading angle is lower, and bigger when the distance is higher. So a small value will make the aircraft go to the line at high angles during more time (because the distance of 45 degrees is now small), and a big value implies less attraction because the platform will go to the line at smaller angles than 45 degrees from a bigger distance.



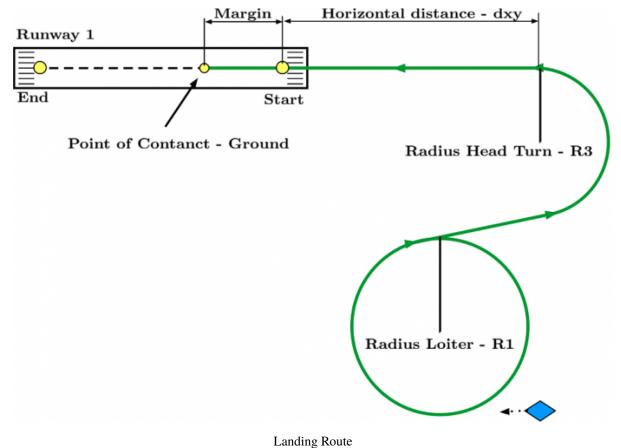
#### Angle and distance

In the this phase the path is not directly indicated by the user as in the cruise (which is defined in the Mission menu) but there is still a trajectory whose parameters are detailed later in this section, so this value is as important as it is for the Waypoint following route. The common values of the line attraction are between 20 and 40 for airplanes, and 15 for multicopters. This parameter only has to be changed by advanced users.

- Acceleration proportional gain: this parameters is releated with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 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:** is used in multicopters only, in this case the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
  - 3D mode: the vehicle goes from the altitude at which it enters in cruise mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
- Set speed: this option sets the speed that the vehicle will have during the climb. 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.
- **Route:** the route section of the landing guidance defines the route that the aircraft takes to go from the point when this phase is commanded, to the point where it touches the ground. The landing route has two parts: the first one consists on a descending loiter used to descend from the cruise altitude to an altitude where the manoeuvre of heading the airplane towards the runway direction and make it touch ground can be performed, the second part is the path that takes the aircraft to ground (to the runway). If the airplane starts the landing phase at an altitude at which it can perform the landing manoeuvre without the descending loiter, this one will not be performed, so the descending circular route will automatically be done when the aircraft is at a great height. The parameters that define the landing route are presented as follows:
  - Loi Force: force aircraft to perform loiter manoeuvre.
  - **Runway:** select a runway o spot previously defined, see section ref 6.7.2. Besides, it is possible to use the advanced mode and select a different loiter/touch point and direction.
  - Loiter Pos: center point of the loiter descending route.

- Flight Path Angle: angle at which the aircraft will descend.
- Horizontal Distance: is the distance from the point where the aircraft is alligend with the runway to the start of the it.
- Radius Head Turn R3: radius of the turn made to head the airplane towards the runway direction.
- **Radius loiter R1:** radius of the loiter descending made by the aircraft to reach an altitude suitable to perform the landing manoeuvre.

The following figure details schematically all the parameters detailed previously.



# 6.2.4.1.1.8 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.

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▼ Phases	Guidance Loo	oop Arcade TC Pannel
Standby	Yaw	Name No name
Climbing		+
Hold		×
No name		•
Cruise		
Landing	Mode	current 👻
Runway Takeoff	Limit rate	0.0 rad/s
Runway	Yaw	
Envelope	Yaw	0.0 rad [-π,π]
Smooth		
Modes	Absolute	Relative Approach I 🔻
Arcade axis	Latitude 0	0.0 rad [-π,π]
	Longitude 0	0.0 rad [-π,π]
	WGS84 0	0.0 m
	- MSL 0	0.0 m
	L AGL O	0.0 m
Add 👻		

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).

### 6.2.4.1.1.9 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.

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▼ Phases	Guidance Loop Arcade TC I	Pannel Automations		
Standby	Rendezvous	1	Name	No name
VHold		+		
Hover		×		
Takeoff		*		
Landing		· ·		^
Cruise	Section	0	591	1
Hold	Jecuon	0	(bi)	
No name	Acceleration proportional	0.0		
Runway	Set height mode	2.5D	-	
Envelope	Serneigheiniode	2.50		
Modes	Set speed			
Arcade axis		6.0		
	Cruise	5.0	m/s	
	Waypoint reach	Operation Gui	- %	
	Туре	Speed	*	
	Deceleration	5.0	m/s <sup>2</sup>	
	Axe	es controller		
Add	•			~

Rendezvous Guidance – Menu 1

- Acceleration proportional gain: this parameter is related with a new control system that Embention is developing in which elevator and thurst work side by side in both the pitching and thrusting.
- Set height mode: the height mode indicates how the aircraft will perform the route.
  - 2D mode: if this mode it is selected, the platform will follow the predefined route without taking into account the altitude of the waypoints, it will keep the altitude that it has at the moment it enters in this guidance.
  - **2.5D mode:** is used in multicopters only, in this case, the vehicle will climb vertically to the altitude of the first point of the route and then it will begin it.
  - **3D mode:** the vehicle goes from the altitude at which it enters in this mode, to the beginning of the route in a diagonal trajectory (it follows a 3D trajectory that connects the two points).
- 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 Loop Arcad	de TC Pannel A	utomations	
Standby VHold Hover Takeoff Landing	Rendezvous	↑ + ×	Name	No name
Cruise Hold No name	Horizon	ntal	Vertical	
Runway Envelope Modes Arcade axis	Rendezvous relative pos Docking relative positio Base rotation matrix		Y m 0.0 m m 0.0 m	
	Base yaw Base pitch	Constant Constant		
	Base roll	Constant	value: 0.0	
Add	Docking base	Moving Object	01	~ °o

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

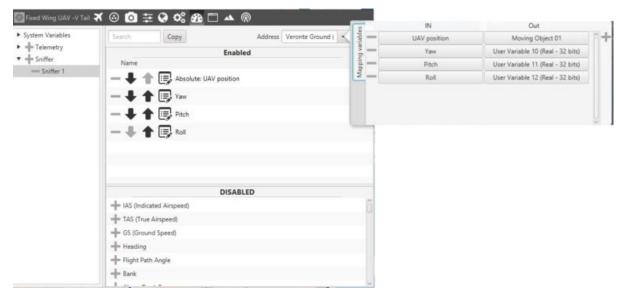
- Axes Controller (Horizontal and Vertical): configuration of the PIDs from the system for both axes.
- Docking base: defines the position of the GNSS antenna connected to Veronte Ground.
- **Base yaw, pitch & roll:** defines the attitude from the base body. These values affect the navigation by orienting 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 · 🔻
Telemetry	
- Data link to Pipe	Enabled
- Data link to Veronte	Name
Onboard Log	- 📕 🛖 📑 Absolute: UAV position
User Log	— 🗣 🏚 📪 Yaw
Fast Log	
Sniffer	- I I I Pitch
Sniffer 1	
	DISABLED
	DISABLED IAS (Indicated Airspeed)
	Has (Indicated Airspeed)
	TAS (Indicated Airspeed)
	<ul> <li>IAS (Indicated Airspeed)</li> <li>TAS (True Airspeed)</li> <li>GS (Ground Speed)</li> <li>Heading</li> </ul>
	<ul> <li>IAS (Indicated Airspeed)</li> <li>TAS (True Airspeed)</li> <li>GS (Ground Speed)</li> </ul>

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).





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.	

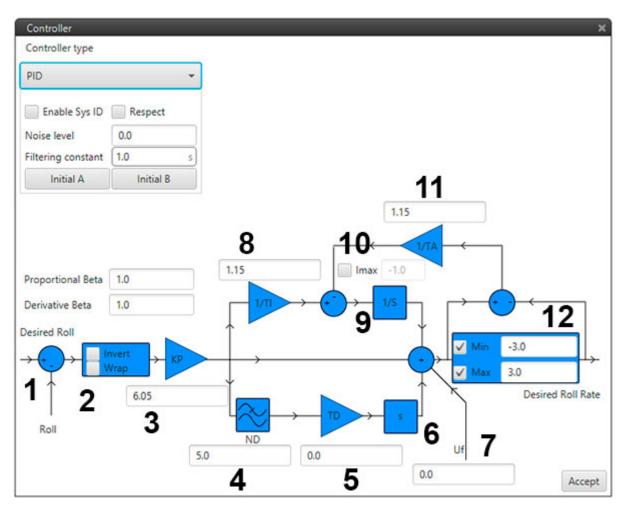
**Note:** in section *Configurations* there are some examples of how to combine these guidances to create phases for common platforms (Plane, Quadcopter, etc.).

# 6.2.4.1.2 Loop

#### 6.2.4.1.2.1 PID Controller

Classical PID controller. The values for each one of the elements (proportional, integral, derivative and so on) can be changed directly on the screen.

Focusing on the PID structure the next figure and table describe all its elements and what means each one of them.



PID Architecture

Value	e Description
1	Measure
2	Invert: Change error sign/Wrap: Wrap to pi [-, ]/It is used in some angular variables (radians) for avoiding
	numerical errors on the – to change and keep continuity of the error signal
3	Proportional gain
4	Discrete filter parameter
5	Derivative time parameter
6	Derivative gain
7	Constant value added to output (Feedforward Control)
8	Integral gain
9	Inverse integral time parameter
10	The maximum value of integral admitted
11	Anti-windup parameter
12	Output bounds

Output values for PID controller refer to virtual control channels, units must coincide with servo trim configuration settings.

PID diagram represents the following PID model:

$$C = K_p \left( 1 + \frac{1}{T_i} IF(z) + \frac{T_d}{\frac{T_d}{N} + DF(z)} \right)$$

#### PID Mathematical Model

- Kp=proportional gain
- Ti=Integrator time
- Td=Derivative time
- N=Derivative filter constant

For the derivation and integration models, Backward Euler and Trapezoidal (respectively) models have been integrated:

• Backward Euler:

$$DF(z)=T_srac{z}{z-1}$$

• Trapezoidal

$$IF(z)=rac{T_s}{2}rac{z+1}{z-1}$$

#### PID Mathematical Model - Trapezoidal

= Td/N where is the time constant on a first order low pass filter (LPF). In Laplace notation:

$$LPF(s) = rac{1}{ au s + 1}$$

PID Mathematical Model - Laplace

# 6.2.4.1.2.2 Adaptative-Predictive Control

This controller incorpores an algorithm for self-tuning i.e, the controller settings are ajusted automatically.

Controller				×
Controller type				
AP 👻				
Enable S Respect Noise level 0.0 Filtering con 1.0 s Initial A Initial B				
	Prediction			
	Lambda	6		
	Optimal			
	f	0.0		
Desired Flight Path Angle	rO	0.0	✓ Min	-0.52
$\rightarrow$ $+$ $ +$ $ +$ $ +$ $ +$ $ +$ $ +$ $ +$ $ +$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$	Driver		✓ Max	0.52
	Enabled			Desired Pitch
Flight Path Angle	TAU	0.0		
				Accept

PID Mathematical Model - Adaptative Predictive controller configuration

The next table describes all the parameters available and what means each one of them.

Field	Description		
Enable	Activates the option of system identification. The plant is modified continuously by predicting a new		
Sys ID	one according to a set of parameters. This option must be activated when working in Adaptative -		
	Predictive control.		
Noise	Supposed noise level during System Identification		
Level			
Filtering	Constant value for the filter		
Constant			
Initial A	Used to establish the initial plants constants for the system identification process		
& Initial			
В			
Lambda	Parameter that defines the control aggressiveness. High value means less aggressive control, low		
	lambda means more aggressive control		
Optimal	Select this option to use the Optimal AP algorithm		
f	Sampling input period		
ro	Control output period		
Enable/Disa	bMark this option to use the Driver Block		
Driver			
TAU	Time constant for the desired default trajectory		

In addiction, it is possible to display an AP panel in the workspace that allows the user to perform the following actions:

- Initial to Current: to set the initial platform model to the current one.
- Current to Initial: to save the actual model to the initial one

Initial to current	Current to initial
Initial	
Current	
Initial	
Current	

PID Mathematical Model - AP Tool in Workspace

#### 6.2.4.1.2.3 Gain Scheduling

This aproach uses a group of linear controllers for different operation points. Each controller adjusts its gains automatically according to scheduling variables.

Veronte incorporates 4 approaches for this type of control:

• **Table Scheduler:** gain scheduling controller with variation of the parameters according to a table interpolation. In this option, the values of the PID controller vary according to a variable that is selected when this option is marked. For example, if the IAS is selected as the scheduling parameter, depending on the velocity of the aircraft the parameters of the PID will change.

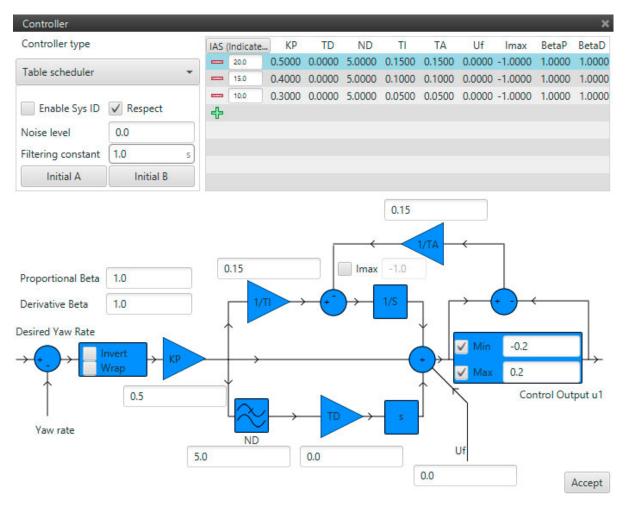


Table Scheduler controller

- **Inverse Scheduler:** gain scheduling controller with variation of the parameters according to the selected variable using inverse proportionality.
- **Proportional Scheduler:** gain scheduling controller with variation of the parameters according to the selected variable using direct proportionality.
- **Quadratic Scheduler:** gain scheduling controller with variation of the parameters according to the selected variable using quadratic proportionality.

For the last three approaches, the only gain that changes according to a certain variable is the proportional one. Now there is not a table interpolation but a mathematical expression, that can be inverse (KP1/V1=cte), proportional (KP1 \* V1=cte) and quadratic (KP1 \*V1^2=cte). The nominal point given by the expressions will remain fixed. Therefore, the proportional gain will change when V1 varies in order to mantain the same value.

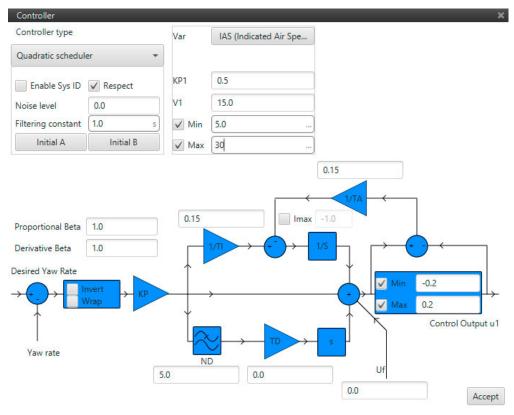
	С	Кр	Result ( $Kp$ )
Inverse	$\frac{Kp}{V_i}$	C * V	$Kp_i \frac{V}{V_i}$
Proportional	$Kp_i * V_i$	$\frac{c}{v} (V > 0)$	$Kp_i \frac{V_i}{V}$
Quadratic	$Kp_i * V_i * V_i$	$\frac{c}{V*V}(V^2>0)$	$Kp_i \frac{{V_i}^2}{V^2}$

#### Scheduler table

In the previous expressions, shall be clear that limits are applied to the variable (V) and not to the gain (Kp).

The following figure shows the quadratic case, where the proportional gain changes according to the IAS, having as nominal point (KP1 and V1) 0.5 and 15 m/s respectively.

The values Min and Max are used to establish a limit of the scheduler. Below and above those limits, the system works as a conventional PID with the gain indicated in KP1.



Quadratic Scheduler controller

# 6.2.4.1.2.4 Fixed Control

📴 🚰 Penguin Embention 🛪	🕻 💿 🧰 🚱 🗱 🌇 🗂 🔺 CfgMgr StepMgr
▼ Phases Standby Climbing Hold Cruise Landing	Guidance     Loop     Arcade     TC Pannel       Pitching     Image: Arcade     Name     Thrusting       Thrusting     Mode     Fixed     Image: Arcade
Runway Takeoff Runway Envelope Smooth Modes Arcade axis	Output transition from output value when phase starts to a new fixed value 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9 0.9
Add 👻	

When **Fixed** mode is selected, the Open Loop Control parameters are set to a fixed value.

Fixed Value Settings

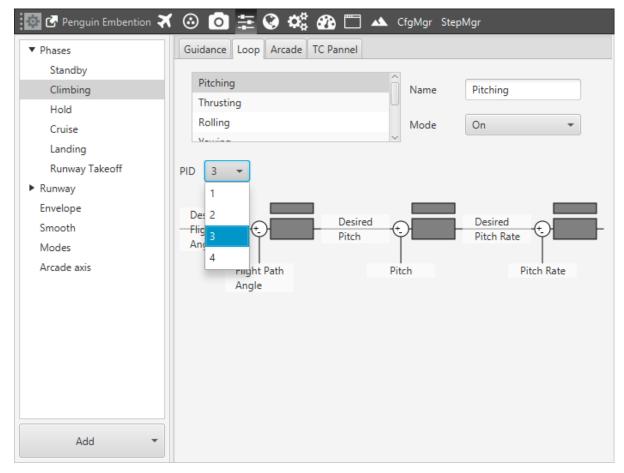
Three values must be entered:

- Remaining time in the starting conditions.
- Transition time
- Variable final value.

In each one of the mission phases, it is possible to configure a controller for each control channel defined on Veronte Configuration. There are three different options for the control status.

Value	Description
Off	Disables the controller.
On	Enables the Closed Loop Control.
Fixed	Sets the Open Loop Control parameters to a fixed value.

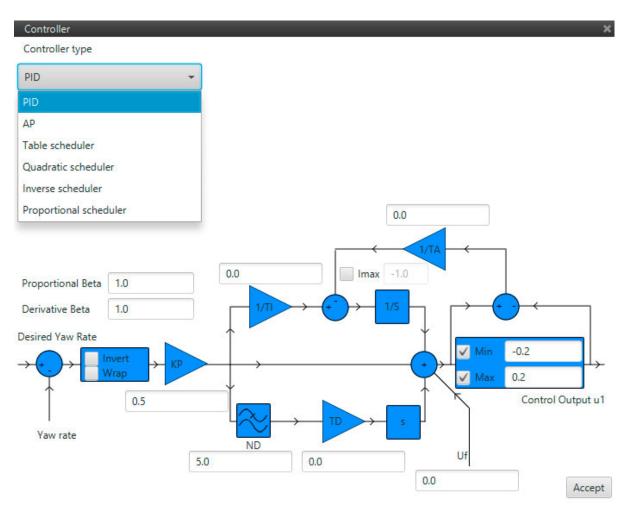
# 6.2.4.1.2.5 PID Settings



When creating the controller for a channel, it is possible to select up to four different loops connected in series.

## Loops Diagram

For each block, it is possible to configure the controller type and its parameters by selecting it on the pull-down menu shown in the following figure.



#### Loop Configuration

There are six different options that can be implemented for a controller on Veronte Pipe:

PID	Classical PID controller.
AP	Adaptative-Predictive control.
Gain scheduling	Gain scheduling controller with variation of the parameters: Table Scheduler, Inverse Scheduler,
controller	Proportional Scheduler, Quadratic Scheduler

In addition to the controller type, there are another set of parameters that can be changed in the window of each block.

- Enable Sys ID: activates the option of system identification. The plant is modified continuously by predicting a new one according to a set of parameters. This option must be activated when working in Adaptative-.Predictive control.
- **Respect:** this option is used for transition between phases. When activated the output of the controller is respected (is kept) when going from one phase to another. Normally, this is used in the internal control loops (rates) only to avoid great steps in the control parameters during transitions. If Respect is active in the external loops, the control will maintain attitude angles and heading/fly path angles during phase changing (for example), and this kind of control could be too much aggressive for the platform (depending on phases configuration). The Respect option **can be activated in PID controllers only.**
- Noise Level & Filtering constant: parameters used for the AP controller.
- Initial A & B: these buttons are used to establish the initial plants for the system identification process.

# 6.2.4.1.2.6 Exporting PIDs To Other Phases

Once it is considered that the PID is tuned, the user can easily export that PID in order to use it in other phases. To do so, just select **Copy** by right-clicking on the desired PID and click on the **Block** cell of the desired phase. That would copy only the gains of the PID (P, D and I), if the user also wants to copy the **Limits**, that column has to be checked.

🔯 🖸 Penguin Embention 🔾	K 💿 🖸 🏛 🚱 🗱 🖽 🗔	🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel	
Standby	Pitching	
Climbing	Thrusting	Name Pitching
Hold	Rolling	Mode On 👻
Cruise Landing	Vauina	~
Runway Takeoff	PID 3 -	
► Runway		
Envelope	Desired	
Smooth	Flight Path + Desired	Desired Pitch Rate
Modes	Angle Copy	Fillin Rate
Arcade axis	Flight Path	Pitch Pitch Rate
	Angle	v)
	Copy to	
	Cruise (Pitching)	E LIMIT 🗸 ID E BLOCK
	Landing (Pitching)	🖹 ІІМІТ 🗸 ІД 🖺 ВІОСК
Add 👻		

PID Exporting

# 6.2.4.1.3 Arcade

# 6.2.4.1.3.1 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 🛪	i 💿 🖸 🗄 🚱 🗱 🕰 🖾	] 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel	
Standby	Var	Gain DBand
Climbing	- Desired Pitch	-1.0 0.0 Max 0 Integral +
Hold		
Cruise	Desired Roll	1.0 0.0 Max 0 Integral
Landing	- Desired Yaw	2.0 0.02 Max 0 V Integral
Runway Takeoff		
Runway		
Envelope		
Smooth		
Modes		
Arcade axis		
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*.

## 6.2.4.1.4 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.

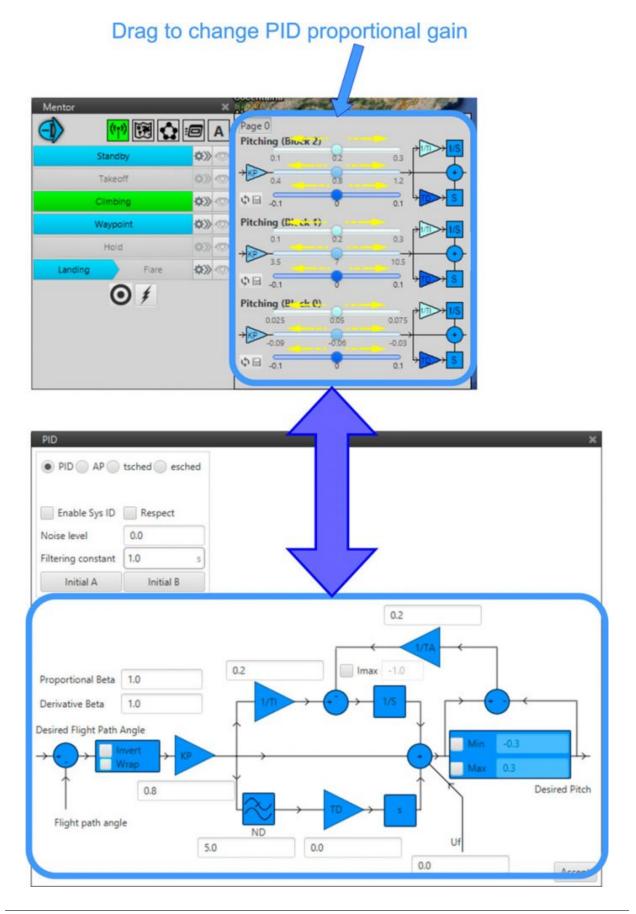
Penguin Embention 🗙	<ul> <li>O ➡ O ➡ O ➡ O ➡ O CfgMgr StepMgr</li> <li>Guidance Loop Arcade TC Pannel</li> </ul>
<ul> <li>Phases</li> <li>Standby</li> <li>Climbing</li> <li>Hold</li> <li>Cruise</li> <li>Landing</li> <li>Runway Takeoff</li> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> <li>Arcade axis</li> </ul>	Cuidance       Loop       Arcade       IC Panel <ul> <li>Fly route</li> <li>Speed</li> <li>Speed IAS</li> <li>Fly and loiter</li> <li>Fly and hover</li> <li>Height WGS84</li> <li>Height MSL</li> <li>Height MSL</li> <li>Height AGL</li> <li>Pitching (Block 2)</li> <li>Pitching (Block 2)</li> <li>Thrusting (Block 1)</li> <li>Pitching (Block 2)</li> <li>Thrusting (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 0)</li> <li>Rolling (Block 0)</li></ul>
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.

# 6.2.4.1.4.1 PID Gains

The parameters that are used the most for the TC Panel are the gains of the PID controller, because that provides the operator with an easy way to adjust the gains on a real flight. Each control configured in the Loop Panel will be shown on the TC Panel.



## Set PID Parameters

# 6.2.4.1.4.2 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.
- Route: Fly route, Fly and loiter, Fly and hover and Follow Leader.

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).

🔯 🕑 Penguin Embention 🛪	🕻 💿 🧰 🚱 🗱 🏤 🛅 🔺 CfgMgr StepMgr
▼ Phases Standby Climbing Hold	Guidance Loop Arcade TC Pannel
Cruise Landing Runway Takeoff • Runway Envelope Smooth Modes Arcade axis	<ul> <li>Speed IAS</li> <li>Fly and loiter</li> <li>Fly and loiter</li> <li>Fly and hover</li> <li>Height WGS84</li> <li>Height MSL</li> <li>Height AGL</li> <li>Pitching (Block 2)</li> <li>Pitching (Block 1)</li> <li>Pitching (Block 2)</li> <li>Thrusting (Block 0)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 1)</li> <li>Rolling (Block 0)</li> <li>Rolling (Block 0)</li> </ul>
Add 👻	

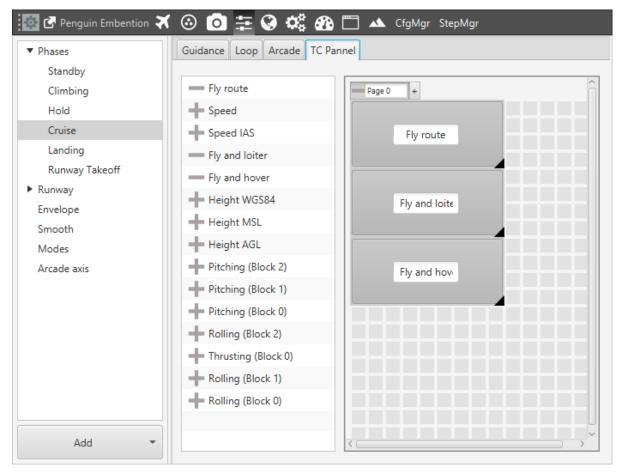
TC Panel variables change set

W210 [10 Hz]		×				
) 🕘 🖉	:0	A	Page 0			
Standby	<b>\$</b> >>	0				
Takeoff	\$X	0	Speed	18	20	22
Climbing	<b>\$</b>	0		10		
Waypoints	<b>\$</b>	0				
Hold	<b>\$</b> >>	0				
Landing Flare	\$	0	IAS		0	
			IAS	20	22.5	25
			Height AGL	_	0	
				100	125	150

TC Panel during Waypoint phase (Variables)

The route tools can be used when the user wants to change the actual route:

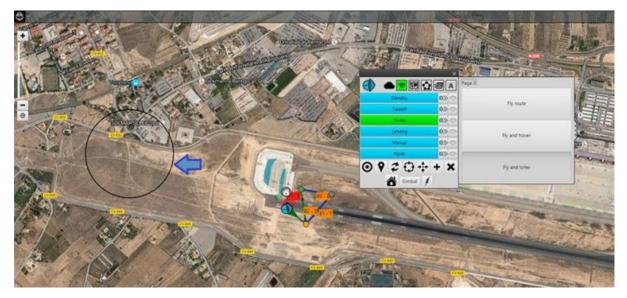
- Fly route: the platform will create a new route to reach the selected waypoint.
- Fly and loiter: the platform (Plane) will create a new route to reach the selected point and start loitering. In order to set the loiter radius it is necessary to click and maintain to enlarge or reduce the circle.
- Fly and hover: the platform (Multicopter) will create a new route to reach the selected point and start hovering.
- Follow liader: the platform (Multicopter) will follow an moving object.



TC Panel routes change set

W210 [11 Hz]	×	
(1)	:0 A	Page 0
Standby	<b>\$</b>	
Takeoff	۵» 🗇	Fly route
Climbing	<b>\$</b>	
Waypoints	<b>\$</b>	
Hold	<b>\$</b> }©	Fly and hover
Landing Flare	<b>\$</b>	ny ano nover
		Fly and loiter

TC Panel during Waypoint phase (Routes)



Fly and loiter example

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.

🔯 🖸 Penguin Embention 💥	( 🛪 🐵 🖸 🚋 🚱 🗱 🖽 🗂 🔺
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	Name No name
Climbing	+ 2
No name	×
Cruise	3
Landing	
Runway Takeoff	■ Guidance ×
Runway	
Envelope	Confirmation (2)
Smooth	
Modes	
Arcade axis	Add Cruise 👻
	OK Cancel
1	
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 New 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 :ref: Guidance <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.

The second tab of the Control menu contains the **Control – Loop** system for each phase. The control system refers to the type of controller used for each one of the control channels of the platform (Pitching, Yawing, Rolling and Thrusting). More information about this section is found in *Loop*.

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*.

Finally, 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.

## 6.2.4.2 Runway

## 6.2.4.2.1 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
Phases	Select airport
▼ Runway	
Runway 1	
Spot 1	
Envelope	
Smooth	Lat: 38.2798 Lon: -0.5413 Lat: 38.2845 Lon: -0.5750
Modes	Margin 0.3 x1 Margin 0.3 x1
Arcade axis	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	
☆ <i>⊘</i> ×	ETEU	08	26	[Duplicate] Giebelstadt Army Air Field	DE	DE-BY	9.95201	49.6461	9.98092	49.6501	
☆ Ø×	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	
☆ Ø×	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	
☆ Ø ×	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	
☆ Ø×	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	
☆ Ø×	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	
☆ Ø×	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	
☆ Ø ×	LFOI	02	20	Abbeville-Buigny-Saint-Maclou Airport	FR	FR-S	1.82865	50.1383	1.83513	50.1487	
1	KODO		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.

# 6.2.4.2.2 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 🛪	( 💿 💿 🗄	E 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr	
▶ Phases	Select airport		
▼ Runway		Azimuth	
Runway 1		4.8884273	rad [-π,π]
Spot 1			
Envelope		Delta	
Smooth	Lat: 38	3.2798 Lon: -0.5413 0.0	rad [-π,π]
Modes			
Arcade axis			
	Loiter position	Lat: 38.2798 Lon: -0.5413	
	Alarms		
			+
Add 👻			
Ada			

#### Spot Configuration Menu

## 6.2.4.3 Envelope

Menu to configure the flight envelope of the aircraft. Here are set the limits that will not be exceeded during the operation.

🔯 🕑 Penguin Embention 놧	🕻 🛪 💿 🖸 🗄 🔇	🗱 🚯 🗂 🔺	<b>`</b>	
Phases	Envelope 1	✓ Stall speed	11.0	m/s
<ul> <li>Runway</li> <li>Envelope</li> </ul>		Speed	0.0	m/s
Smooth		VTOL		
Modes		Vertical speed		
Arcade axis				
		Max up	2.0	m/s
		Max down	2.0	m/s
		FPA		
		V Min	-0.34 r	rad [-π,π]
		✓ Max	0.34 r	rad [-π,π]
Add 👻	Add Envelope			

#### Envelope

- **Stall speed:** lower limit for the aircraft velocity. Below this level, the aircraft is not able to create enough lift to keep the flight and starts to fall. 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.
- **Speed:** minimum 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.
- VTOL: this option is used to limit the maximum upwards and downwards velocities in the case of multicopters.
- FPA: maximum and minimum values for the flight path angle (angle of climb or descent).

With the last VerontePipe update (from v2.11.1) is possible to insert multiple envelopes (useful for hybrid configurations for example). The change between envelopes can be performed using *Automations*.

📴 🗗 Penguin Embention 💥	ं 🛪 💿 🙆 🗄 🔇	📽 🙆 🗂 🗚	<b>`</b>
▶ Phases	Envelope 1	Stall speed	0.0 m/s
<ul> <li>Runway</li> <li>Envelope</li> </ul>	Envelope 2	Speed	0.0 m/s
Smooth		VTOL	
Modes Arcade axis		Vertical speed	
Arcade axis		Max up	0.0 m/s
		Max down	0.0 m/s
		FPA	
		Min	0.0 rad [-π,π]
		Max	0.0 rad [-π,π]
Add 👻	Add Envelope		

Multiple envelope configuration

# 6.2.4.4 Smooth

The Smooth menu establish the parameters for the smoothing of the aircraft trajectory when changing from a phase to another, i.e to go from the final point of a phase to the start of the new one.

There are two different ways to smooth the path:

- Line creates a linear track between the two points of the smoothed trajectory being possible only to set the position of the start and final points.
- **OGH** creates a cubic curve where is possible to set the position and velocity that the aircraft will have at those points.

🔯 🕑 Penguin Embention 🤌	🕻 🛪 💿 🖸 葦 🚱 📽 🖽 🗖 🔺	
<ul><li>Phases</li><li>Runway</li></ul>	Smooth type	Line 👻
Envelope Smooth	Minimum speed that will considered when using nav as starting point	2.0 m/s
Modes Arcade axis	Minimum distance between start and end points to use smooth	0.0 m
	Minimum time at current speed between start and end points to use smooth.	[1.0 s]
Add 👻		

#### Smooth Configuration Menu

The other options that appear in this menu are parameters to limit when the smooth will be used or not.

- The first one establish the minimum velocity at which the smooth will start working,
- The second one is the minimum distance between the start and final points of the trajectory to begin with the smoothing.
- The last option is the minimum time between points to use smooth, considering that the aircraft flies at the current speed.

All these options are safety features to avoid a malfunction of the system when the final and start points of the phases are close to each other.

## 6.2.4.5 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 M	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
			Ac	bb				

#### 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 🗙	🕻 🛪 💿 🖸 🗄	<b>E</b> (	) 🗘 🖉	ð 🗂 🔺				
► Phases			Pitching	Thrusting	Rolling	Yawing	Flaps	V
► Runway	- Auto	Α	auto	auto	auto	auto	auto	
Envelope Smooth	- G-Arcade	G	arc	_ arc	arc	arc		
Modes		X	mix	Assist	De	sired Pitch		
Arcade axis	- Manual	Μ	rc	Gain 1	.0			
				Ad	d			
Add 👻	<							>

#### 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.

## 6.2.4.6 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 🗙	🛪 💿 🖸 🗄	E 🚱 🗱 🍄 🖸	<b>A</b>
Phases	Reference	Offset	
Runway	Body	- 0.0	rad [-π,π] Edit point
Envelope			
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 6 section, each one showing a different menu of configuration.

🔯 🕑 Penguin Embention 🗲	<  ◎ 🖸 🚋 🚱 🗱 🕸 🗂 ム
▶ Phases	
Runway	
Envelope	
Smooth	
Modes	
Arcade axis	
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.
- **Smooth:** in this section is defined the trajectory of the aircraft when going from the final point of a phase to the beginning of the new one.
- **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.

# 6.2.5 Navigation

## 6.2.5.1 Wind Estimation

From the Navigation window can be configured the parameters that affects the wind estimation algorithm.

✓ Acceleration	Intensity
Es	timation
Un	certainty

#### 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.

Edit	_	_	3
0.0	0.0	0.0	
	0.0	0.0	

## Estimation Vector

1.0	0.0	0.0
0.0	1.0	0.0
0.0	0.0	1.0

#### Intensity matrix

4.0	0.0	0.0
0.0	4.0	0.0
0.0	0.0	4.0

Uncertainty 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 5.0	re restricte	d mask	Accelero	meter			
0		de ccelerometer yroscope	Qnfb Qdfb Gyroscop Qnwb	12.0 4.0E-5 0.12	12.0 4.0E-5 0.12	12.0 4.0E-5	
Wind			Qdwb	4.0E-6	4.0E-6	4.0E-6	
✓ Acceleration	In	tensity	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>z</sup> Initial	0.0 rad/s <sup>2</sup>					
Advanced	Steps	50					
	-			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.

# 6.2.6 Automations

# 6.2.6.1 Events

# 6.2.6.1.1 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.

🔯 🕑 Penguin Embention 🛪	🕻 💿 🧰 😵 🕰 🌇 🛅 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	Insert name automation 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>Auto when No Stick</li> <li>LinkOff to LND</li> </ul>	No Name No Name	
<ul> <li>HLD when No GPS</li> <li>Low Battery</li> <li>▼ Stick</li> <li>✓ Auto Mode</li> </ul>	Delay 0.0 Periodical: O	ff
<ul> <li>✓ Manual Mode (Arc</li> <li>▼ Transitions</li> </ul>	Phase   No Name  Time 0.0	
<ul> <li>TKO to CMB</li> <li>CMB to CRU</li> <li>Arcade Trim</li> <li>When Event Mark</li> </ul>	Cruise	
New Automation		

Event - Phase

# 6.2.6.1.2 Variable

This event is triggered when a variable selected is between a range established.

🔯 🕑 Penguin Embention 🛪	🛛 💿 🏗 🚱 📽 🌇 🗂 🔺 CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
✓ TKO Button	No Name No Name	
CMB Button		
LND Button		
▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
Low Battery		
▼ Stick	Delay 0.0 Period	dical: Off
✓ Auto Mode		
✓ Manual Mode (Arc ▼ Transitions	Variable - No Name Time	0.0
TKO to CMB	Variable IAS (Indicated Airspeed)	
CMB to CRU	Variable IAS (Indicated Airspeed)	
✓ Arcade Trim	Max 5	
V When Event Mark	Min 20	
$\checkmark$		
	Invert range 🗸	
	Min	/lax
		1972
New Automation	Event triggered on blue area	

Event - Variable

- The variable to be evaluated is selected on **Variable**.
- Max-Min: maximum and minimum values of the threshold are established here.
- 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.

# 6.2.6.1.3 Alarm

When one of the elements selected in the Add menu fails or when all of them are working correctly, the event is triggered.

🔯 🕑 Penguin Embention 🔾	🐵 💿 葦 🔇 🕰 🌇 🗂 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
✓ TKO Button	No Name No Nam	e
✓ CMB Button		
✓ LND Button		
▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
Low Battery		
▼ Stick	Delay 0.0 P	eriodical: Off
✓ Auto Mode		
Manual Mode (Arc	🖉 🗈 Alarm 🛛 🗸 No Name 🗌 1	Time 0.0
▼ Transitions		
✓ TKO to CMB	Type Fail one  X KBIT_GPS0DNAV	
CMB to CRU	All ok	
Arcade Trim     When Event Mark	Fail one	
	Add	
V	Add	
	DGPS1 Navigati 👻 +	
New Automation		

Event – Alarm

- The type options are Fail one and All ok.
- In the Add pull\_down menu there are a series of parameters to include in the event.

A common alarm event is the GPS Navigation Down, that is triggered when there is not GPS signal in the autopilot.

# 6.2.6.1.4 Mode

The event is triggered when the aircraft is in one of the modes selected.

🔯 🕑 Penguin Embention 🛪	💿 🖸 🗄 🔇	🧿 🗱 🚱 🗂 🔺 🖉	CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name autor	mation Max 0		
SBY Button	Events	AND OR NOT	Actions	+
<ul> <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> </ul>		No Name		No Name
HLD when No GPS Low Battery ▼ Stick ✓ Auto Mode ✓ Manual Mode (Arc ▼ Transitions	Ø 🖹 Mod	le 👻 No N	Delay 0.0	Periodical: Off
TKO to CMB     CMB to CRU     Arcade Trim     When Event Mark	Auto		G-Arcade Manual	
New Automation				

Event - Mode

These modes have been created previously. See section *Modes*, for more information about creating modes.

# 6.2.6.1.5 Button

This option creates a button that will trigger the event when it is clicked.

🔯 🕑 Penguin Embention 🛪	🐵 💿 葦 😵 🗱 🏤 🛅 🔺 CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
✓ CRU Button ✓ TKO Button	No Name No Name	
CMB Button		
✓ LND Button ▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS Low Battery		
▼ Stick	Delay 0.0 Pe	riodical: Off
Auto Mode		
✓ Manual Mode (Arc ▼ Transitions		me0.0
✓ TKO to CMB	Icon O Time Control 0 Confi	mation
CMB to CRU  Arcade Trim		
When Event Mark	Visual range Rvar Disabled	_
$\checkmark$		+
	< (	>
New Automation	This button will be displayed on Veronte Panel	

Event - Button

• **Visual range** option is 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.

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. The Confirmation option will display a pop-up window that asks for confirmation after pushing the button, so it is a safety measure. The **time** control option is used to trigger the action when the button is being pushed during the time specified in this option.

## 6.2.6.1.6 Route

This event is related with the waypoints defined by the user in the Mission menu.

			Veronte Pipe V2.11.1 - D
	1		Ground (GND) Task 3 read time enty Task 2 read time enty
1 1 2 0	2 ·   2 Max	× ← 816 6 + 1 →	
	Veronte Connections Device	Control Navigation Automation Variables	Panel HL
	Fail Safe Bateria	No name	
	Open Servo Camera Wi	Events AND OR NOT	Actions +
	Close Servo Camera La:	No name	
	No Stick to Auto		
	Car To Climbing		
	BTN Take Picture     BTN Open Camera Doo		
	✓ BTN Close Camera Doo		
	WP Start, Map		
	🗹 Start Flighttime		Delay 0.0 Periodical: Off
	V Tomar Fotos Periodicas	(marked)	
	BTN to Hold     BTN Trim Arcade Joysti	le Route • No 1	ame Time 0.0
	WP to Landing	Activation Mark achieved *	Add marks
	N N N N N N N N N N N N N N N N N N N	Plying to waypoint	1
	Stop FlightTime	V Icon Merk achieved	
	😥 Stick to Arcade		
	V No name		
	New Automation	Waypoints affected will be available on mis	sion edition
	group aparter for the	1	

Event - Route

There are two modes in the event type.

- Mark achieved: triggers the action when the vehicle has reached the selected waypoint.
- Flying to waypoint: triggers the action when the platform is flying towards that waypoint (is the next waypoint of the route).

Clicking on **1** allows the selection of the waypoint among the ones created by the user (in this case **2** has been selected). 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.

# 6.2.6.1.7 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*).

🔯 🕑 Penguin Embention 🛪	🐵 💿 葦 🔇 🕰 🚜 🗂 🔺 CfgMgr StepMgr	
▼ Buttons	Insert name automation Max 0	
SBY Button (EIN) SBY Button CRU Button	Events AND OR NOT Actions	+
TKO Button	No Name No Nam	e
CMB Button		
LND Button		
▼ Failsafe Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
Low Battery		
▼ Stick	Delay 0.0 Pr	eriodical: Off
Auto Mode     Manual Mode (Arc		
▼ Transitions	No Name	ïme 0.0
✓ TKO to CMB	Timer 1 👻	
CMB to CRU	limer 1 🗸	
Arcade Trim		
When Event Mark		
	Function and particular the based on selected Times Continues of the	
New Automation	Event triggered periodically based on selected Timer. See timer action fo	r 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.

# 6.2.6.1.8 Polygon

The event is triggered when the aircraft is inside or outside a polygon defined in the Mission menu.

😂 🔝 🕑 🔻   Penguin Embention 🔳 📲   🗞 🖊 🕀 🦳   🛄	*	ol 🔊 🕒 🗗	> ا ا	- HE		v	ronte Pipe V4.2.1	
+	The start of the start of the	Children of		XA	P		-	
	The states		MIL	X		÷	> Penguin Er	nb 🛧 💾
	File 🖉 Penguin Embention 🛪	⊚ ⊇ ≑ ⊙	¢; 🕫 🗆 🔺	CfgMgr StepM				12-100
Poura a Ba	Buttons     S8Y Button (EIN)	Insert name automa	tion Max 0					
	SBY Button	Events	AND OR NOT	Actions		+		
-	TKO Button CMB Button	No	Name		No Name			
	LND Button Failsafe							
Contraction of the second	Auto when No Stick LinkOff to LND							
	HLD when No GPS Low Battery							
C Events > No N	Anto Mode			Delay 0.0	Periodical	Off		
Relative  Remove	Manual Mode (Arc      Transitions	🔗 💼 Polygo	n * No N	lame	Time 0.0			
	CMB to CRU	Type Inside	*					
	Arcade Trim     When Event Mark							
	New Automation							
	A REAL PROPERTY OF		ad the set	Planne	1			
cientales	Los Linon Launde 28.2	0100	and the Grand	2 Hans	VALNALS			

Event - Polygon

- When the event has been labeled ("Event Name (No Name)" 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.

An example about using this automation can be found in Circular Area.

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.

😨 🕑 Penguin Embention 🛪	🐵 💿 葦 🔇 📽 😰 🖿 🔺 CfgMgr StepMgr
▼ Buttons SBY Button (EIN)	No name Max 0
SBY Button CRU Button	Events 1 AND OR NOT Actions
✓ TKO Button	No name
CMB Button	AND No name
✓ LND Button ▼ Failsafe	Remove
Auto when No Stick	Add 🕨
LinkOff to LND	
HLD when No GPS Low Battery	
▼ Stick	
✓ Auto Mode	Not ay 0.0 Periodical: Off
Manual Mode (Arcad      Transitions	Button Vo name Dime 0.0
<ul> <li>TKO to CMB</li> </ul>	<b>\\$</b>
CMB to CRU	
Arcade Trim	Visual range Rvar Disabled
When Event Mark  LND to Flare	+
✓ No name	
< >	< >
New Automation	This button will be displayed on Veronte Panel

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.

Event1	
AND	
Event2	
OR	
NOT	
Event3	

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.

# 6.2.6.2 Actions

## 6.2.6.2.1 Change Active Sensor

This option allows the change of the sensor used as accelerometer, gyroscope and magnetometer, between the internal and external ones. In addition, it is also possible to disable the selected sensor.

🔯 🖨 Fixed Wing UAV -V	. 🛪 📀 🕻	🗅 🏛 🔇 🖾 🕰 🗈 🗆	] 🔺		
TKO Button	Test				
✓ SBY Button ▼ Failsafe	Events	AND OR NOT	Actions	+	
LinkOff to LND HLD when No GP Auto when No Sti Low Battery Stick Auto Mode Manual Mode (Ar Transitions	N	o name test		Test	
TKO to CMB			Delay 0.0	Periodical: Off	
<ul> <li>✓ CMB to CRU</li> <li>✓ When Event Mark</li> <li>✓ Arcade Trim</li> <li>✓ LND to FLARE</li> <li>✓ Obs</li> <li>✓ Avoid</li> <li>✓ Test</li> <li>✓ &gt;</li> </ul>	Change act  Test  Accelerom Gyroscope Magnetomet GPS  2nd Acceleromet 2nd Gyrosc  Type 65535				
New Automation					

Action - Change Active Sensor

# 6.2.6.2.2 Custom TX

When this action is triggered, a previously configured message is sent trough the serial port of the autopilot. The message has to be configured in Custom messagess section.

🔯 🗹 Penguin Embention 🔾	⊚ 💿 🗄 🤇	) 🗱 🚯 🗂 🔺 🛛	CfgMgr StepMgr	
▼ Buttons	Insert name auton	nation Max 0		
SBY Button	Events	AND OR NOT	Actions	+
TKO Button	N	lo Name	No	o Name
CMB Button				
▼ Failsafe				
Auto when No Stick				
HLD when No GPS				
Low Battery ▼ Stick				
Auto Mode			Delay 0.0	Periodical: Off
✓ Manual Mode (Arc ▼ Transitions	Custo	om TX 👻 No N	lame	] [
TKO to CMB	Producer	Producer Custom messag	ge 1 🔻	
✓ Arcade Trim	Custom messages	Message 1	-	
When Event Mark				
New Automation				

Action - Custom TX

The two parameters to configure in this action are:

- Producer: which is linked to a type of serial port SCIC, SCID (XPC Unit8 panel).
- Custom message: that will be sent ( configured in the XPC Uint8 panel and Custom messages option).

# 6.2.6.2.3 Envelope

This action is used to change the envelope during the flight mission. Envelopes are created in the Control Panel, see section *Envelope*.

🔯 🕑 Penguin Embention 🔾	🕻 💿 🧰 🚱 🕰 🌇 🗂 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	Insert name automation Max 0	
<ul><li>✓ SBY Button</li><li>✓ CRU Button</li></ul>	Events AND OR NOT Actions +	
✓ TKO Button	No Name No Name	
✓ CMB Button		
✓ LND Button ▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
■ Low Battery ▼ Stick		5
Auto Mode	Delay 0.0 Periodical: Off	
Manual Mode (Arc		
▼ Transitions	Prvelope   No Name	
✓ TKO to CMB	Select Envelope 1 👻	
CMB to CRU		
<ul> <li>Arcade Trim</li> </ul>		
✓ When Event Mark		
$\checkmark$		
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.

### 6.2.6.2.4 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*.

6 6 21 20		Veronte Pipe V2.11.1 - C ×
	× → 816 6 +1 ™	Ground (GND)
Veronte Connections Devices Stock to Manuel Fail Safe Bateria Copen Servo Camera W. Cose Servo Camera La No Stock to Auto	Control Navigation Automation Variables Insert name administration Events AND OR NOT No name	-
Car To Climbing     BTN Take Picture     BTN Open Camera Doo     BTN Open Camera Doo     WP Start, Map     Sast Flighttime     Tomar Fotos Periodicas		Delay 0.0 Periodical Off
W         BTN to Hold           W         BTN Trim Arcade Joysti-           W         No transferration           W         Stop FlightTime           V         Stok to Arcade           V         No name	Co to 1 • No / Co to rest	White +
New Automation		

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.

#### 6.2.6.2.5 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 fly the aircraft by the movement of a camera installed on it (fly **By cam**) and an option to follow a moving object.

😨 🖸 Penguin Embention 🔾	🛛 💿 葦 🔇 🕰 🌇 🗂 🔺 CfgMgr StepMgr	
<ul> <li>Buttons</li> <li>SBY Button (EIN)</li> </ul>	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
✓ TKO Button	No Name No Name	
✓ CMB Button		
✓ LND Button		
▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
Low Battery		
▼ Stick	Delay 0.0 Periodical: 0	Off
Manual Mode (Arc		
▼ Transitions	🔗 🗈 Track 👻 No Name	
TKO to CMB	Position	
CMB to CRU		
✓ Arcade Trim	Location Current Longitude: 0.0 Direct	
✓ When Event Mark		
$\checkmark$	Loiter Auto	
	Hover	
	Distance 100.0 m	
New Automation		

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.

#### 6.2.6.2.5.1 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.

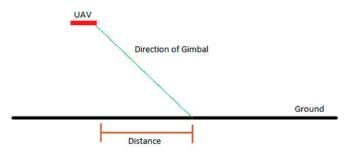
#### 6.2.6.2.5.2 By cam

-	No name	
▼ Cam	1	•
Auto	•	
100.0	m	
	Auto	Cam 1

The direction of flight is controlled by the movement of a camera.



Let's consider that there is a virtual stick on the workspace that controls the movement of a gimbal that contains the camera. The horizontal movement of the stick that controls the yaw axis of the gimbal will act directly on the yaw axis of the aircraft. Considering that the longitudinal axis of camera and vehicle are lined up, the aircraft will point all the time to the same direction as the camera. On the other hand, the vertical movement of the stick will control the vertical axis of the gimbal. When the direction of the gimbal intersects with the ground, the vehicle will stop (or loiter) when being at a certain distance away from that intersection point (that distance is indicated by the user in **Distance**). If the vehicle is hovering because the distance is reached, once the gimbal vertical axis is risen again the vehicle will move again in the direction indicated by the gimbal. The following figure explains what has been said in this paragraph.



By CAM Distance

# 6.2.6.2.5.3 Follow Leader

🔯 🕑 Veronte Air 🛪 🙆	💿 🏗 🚱 🤹 🌇 🛅 🔺 CfgMgr StepMgr	
CDI 2 OFF	Follow Lider Max 0	
▼ PC		
PC Motor Disablec	Events AND OR NOT Actions	+ .
PC Motor Active	FLW Button Follow	
✓ PC Rotor Disabled		_
✓ PC Safety		
V PC in Flight		
V PC No Flight		
✓ PC Rotor Engaged		
✓ Disable PC		
✓ Enable PC Release		
✓ Enable PC safety		
SBY when landed	Delay 0.0 Periodical: O	ff
Land when Home/Cr		
Engine ON to MAN r	Follow	
Warm Up to Ready		
✓ Hover here in HVR	Follow Lider   Lider Moving Object 01	
✓ Trim Arcade	Distance to lider	
BINGO	Distance to lider 15.0 m	
✓ Start Engine Button	Offset 💿 Body 💿 NED	
Throttle Hold	x 0.0 m	
Follow Lider	X 0.0 m	
	Y 0.0 m	
New Automation	Z 0.0 m	

The platform (Multicopter) will follow an moving object.

#### Follow Leader

- Leader: here is selected the moving object i.e, the object to follow.
- **Distance:** distance to lider over trajectory.
- 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.

### 6.2.6.2.6 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.

🔯 🕑 Penguin Embention 🛪	🐵 🧿 🗄	😧 🗘 🕯	🏠 🛅 🔺 🤇	CfgMgr StepMg	r
▼ Buttons	Insert name au	tomation	Max 0		
SBY Button (EIN) SBY Button CRU Button	Events	ANI	OR NOT	Actions	+
✓ TKO Button		No Name			No Name
<ul><li>✓ CMB Button</li><li>✓ LND Button</li></ul>					
▼ Failsafe					
Auto when No Stick					
HLD when No GPS					
Low Battery					
▼ Stick				Delay 0.0	Periodical: Off
Manual Mode (Arc	2 🗈 T	errain obstacle	▼ No N	ame	
▼ Transitions				unic	
TKO to CMB CMB to CRU	Enable	-			
✓ Arcade Trim	Distance	0.0		m	
When Event Mark					
$\checkmark$					
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.

### 6.2.6.2.7 Arcade Trim

This action trims the radio controller, i.e sets as zero the current sticks positions. As seen in te picture below, it consists on simply creating a *Button* on the **Events** side and adding an **Action** which is called *Arcade trim*. The latter action is already configured to copy the current stick position into the the trim vector.

🔯 🕑 Penguin Embention 🛪	💿 💿 🛱 🔇	🗘 🕰 🖾 🔺	CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Arcade Trim	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
✓ TKO Button	Trin	n Button	Trim	Arcade
CMB Button				
LND Button				
▼ Failsafe				
Auto when No Stick				
LinkOff to LND				
HLD when No GPS				
■ Low Battery ▼ Stick				
Auto Mode			Delay 0.0	Periodical: Off
Manual Mode (Arc				
▼ Transitions	Arcade	trim 🔻 Trim	Arcade	
TKO to CMB	✓ Update			
CMB to CRU	V Opdate			
✓ Arcade Trim	✓ Save			
✓ When Event Mark				
✓ LND to Flare				
New Automation				

Action – Arcade Trim

### 6.2.6.2.8 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.

🔯 🖸 Penguin Embention 🛪	💿 💿 🏗 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
✓ TKO Button	No Name No Nam	e
CMB Button		
✓ LND Button		
▼ Failsafe		
Auto when No Stick		
LinkOff to LND		
HLD when No GPS		
■ Low Battery ▼ Stick		
Auto Mode	Delay 0.0 P	eriodical: Off
Manual Mode (Arc		
▼ Transitions	Navigation Vo Name	
✓ TKO to CMB	Type Internal 💌	
CMB to CRU	Internal	
Arcade Trim	Simulation	
✓ When Event Mark		
$\checkmark$	External	
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: uses external data for navigation. Data (position, attitude, etc.) is provided by an external device.

## 6.2.6.2.9 Mode

The flight mode is changed to the one specified in this option.

🔯 🕑 Penguin Embention 🛪	🐵 💿 葦 🔇 🗱 🌇 🛅 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	Insert name automation Max 0	
SBY Button	Events AND OR NOT Actions	+
TKO Button	No name No Name	
CMB Button  LND Button		
▼ Failsafe		
Auto when No Stick		
HLD when No GPS		
Low Battery ▼ Stick		
Auto Mode	Delay 0.0 Per	iodical: Off
✓ Manual Mode (Arcad ▼ Transitions	No Name	
<ul> <li>TKO to CMB</li> </ul>	Change to	
CMB to CRU	Auto	
Arcade Trim     When Event Mark	G-Arcade	
	Manual	
New Automation		

#### Action - Mode

These modes have been created previously. See *Modes section* for more information about creating modes.

### 6.2.6.2.10 Output

This action is used to set an actuator at a certain position.

🔯 🕑 Penguin Embention 🔾	🐵 🖻 葦 🔇	🗱 🚯 🗔 🔺	CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name automatic	on Max 0		
SBY Button	Events	AND OR NOT	Actions	+
✓ CKO Button	No N	lame		No Name
CMB Button				
✓ LND Button				
▼ Failsafe				
Auto when No Stick				
LinkOff to LND				
HLD when No GPS				
■ Low Battery ▼ Stick				
<ul> <li>✓ Auto Mode</li> </ul>			Delay 0.0	Periodical: Off
Manual Mode (Arc				
▼ Transitions	Output	▼ No	Name	
✓ TKO to CMB				
CMB to CRU	Wheel	•		
Arcade Trim		Time 0.0	Value 0.0	+
✓ When Event Mark	Interpolate	Time 0.0	Value 0.0	
$\checkmark$		Time 1.0	Value 1.0	
		Time 1.5	Value 0.0	
		Time 1.5	Value 0.0	
New Automation				

Action - Mode

The **desired output** is selected in the menu, and then a set of points with the time and value of the actuator can be indicated with the button "+".

Taking the previous figure as an example, when the action is triggered a series of commands are sent to the output **Wheel**. In this case, this pin is connected to a camera, which takes a photo when the trigger is active during 0.5 seconds.

If the output pin has been configured as GPIO (visit section *GPIO*), the possible output signals to be commanded are a **continuous on** or **off pulse**, and a **limited** on and **off pulse**, whose **time** is set by the user.

🔣 🗗 Penguin Embention 🛪 💿 🧿 葦 🚱 🧱 🕐 🛅 🔺 CfgMgr StepMgr	
▼ Buttons SBY Button (EIN) Insert name automation Max 0	
SBY Button     Events     AND     OR     NOT       CRU Button	+
TKO Button No Name No Name	
✓ CMB Button	
✓ LND Button	
▼ Failsafe	
Auto when No Stick	
LinkOff to LND	
HLD when No GPS	
▼ Stick	
V Auto Mode Delay 0.0 Periodi	cal: Off
Manual Mode (Arr	
▼ Transitions Output ▼ No Name	
TKO to CMB	
✓ CMB to CRU GPIO 1 ✓	
Arcade Trim	
✓ When Event Mark	
✓ Time 0.0 s	
New Automation	

Action - Mode

### 6.2.6.2.11 Phases

The flight phase is changed to the one selected in this action.

😨 🕑 Penguin Embention 🛪	😔 💿 🛱	Q 📽 🚯 🗔 🔺	CfgMgr StepMgr	
Buttons     SBY Button (EIN)	Insert name au	tomation Max 0		
SBY Button	Events	AND OR NOT	Actions	+
✓ TKO Button		No Name	No I	Name
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 (Arc				
Transitions	Ø 🗈 P	hase 🔻 No N	Name	
TKO to CMB				
CMB to CRU	Change to	-		
Arcade Trim		Standby		
V When Event Mark		Climbing		
$\checkmark$		Cruise		
		Landing		
		Runway Takeoff		
New Automation				

Action - Phases

# 6.2.6.2.12 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* 

📴 🕑 Penguin Embention 🛪	💿 💿 🗄 🚱 📽	🚯 🛅 🔺 Cfg	gMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	Insert name automation	Max 0		
SBY Button	Events A	ND OR NOT	Actions	+
✓ TKO Button	No Name	e	No Narr	ie
CMB Button				
LND Button				
▼ Failsafe				
Auto when No Stick				
LinkOff to LND				
HLD when No GPS				
Low Battery				
▼ Stick		C	Delay 0.0 F	Periodical: Off
Auto Mode				
Manual Mode (Arc	Select Arcade	axis 👻 No Nam	ne	
▼ Transitions				
✓ TKO to CMB	Arcade axis selection			
CMB to CRU	Body - Offset: 0.0			
✓ Arcade Trim				
✓ When Event Mark				
$\checkmark$				
New Automation				

Action - Select Arcade Axis

### 6.2.6.2.13 Periodical

This action is used to set a timer during a flight operation.

🔯 🕑 Penguin Embention 🛪	🛛 💿 🏗 🔇 🗱 🏤 🗂 🔺 CfgMgr StepMgr	
▼ Buttons	Insert name automation Max 0	
SBY Button (EIN) SBY Button	Events AND OR NOT Actions	+
<ul> <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> </ul>	No Name No Name	
HLD when No GPS     Low Battery      Stick     Auto Mode	Delay 0.0 Period	dical: Off
✓ Manual Mode (Arc ▼ Transitions	Periodical - No Name	
✓ TKO to CMB ✓ CMB to CRU ✓ Arcade Trim ✓ When Event Mark	Timer 1 - Run Run Stop Reset	
	✓ Type     Distance     ✓     Vector     0     0       ✓ Mode     Fixed peri     ▼     Period     0.0	m
New Automation		

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.

# 6.2.6.2.14 Run Operation

An operation previously defined in Variables/System Variables is carried out, see section System Variables.

Buttons SBY Button (EIN)	🕑 🙆 葦	omation Max 0	CfgMgr StepMgr	
<ul> <li>✓ SBY Button</li> <li>✓ CRU Button</li> <li>✓ TKO Button</li> </ul>	Events	AND OR NOT No Name	Actions	+ No Name
CMB Button LND Button				
Auto when No Stick LinkOff to LND HLD when No GPS Low Battery				
▼ Stick ✓ Auto Mode ✓ Manual Mode (Arc		n operation 👻 No N	Delay 0.0	Periodical: Off
<ul> <li>▼ Transitions</li> <li>♥ TKO to CMB</li> <li>♥ CMB to CRU</li> <li>♥ Arcade Trim</li> </ul>	Execute	Tether Multiplier Tether Multiplier	•	
When Event Mark		Voltage Conversion Lidar		
New Automation				

Action - Run Operation

# 6.2.6.2.15 User Log

An entry is added to the log on board.

😨 🖸 Penguin Embention 🛪	🕹 🧿 🗄	🎯 📽 🖽 🗖 🔺	🔺 CfgMgr StepM	gr
▼ Buttons ✓ SBY Button (EIN)	Insert name aut	omation Max	0	
SBY Button CRU Button	Events	AND OR N	<b>OT</b> Actions	+
✓ TKO Button		No name		No Name
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	Ø 🗈 Us	er Log 🔹 👻	No Name	
TKO to CMB	Add entry to th	e log on board		
CMB to CRU		-		
✓ Arcade Trim				
When Event Mark				
New Automation				

Action – User Log

# 6.2.6.2.16 Variable

Allows user to select a variable and save it in a user variable.

🔯 🕑 Penguin Embention 🔾	🐵 🧿 🗄	🛛 📽 📽 🗖	] 🔺 c	fgMgr StepM	gr	
▼ Buttons ✓ SBY Button (EIN)	Insert name auto	omation M	ax 0			
SBY Button CRU Button	Events	AND OR	NOT	Actions		+
✓ TKO Button		No Name			No Name	
CMB Button						
✓ LND Button						
▼ Failsafe						
Auto when No Stick						
LinkOff to LND						
HLD when No GPS						
Low Battery						
▼ Stick				Delay 0.0	Periodica	l: Off
✓ Auto Mode				-		
Manual Mode (Arc	🖉 🗈 Var	iable 👻	No Na	ame		
▼ Transitions						_
TKO to CMB	Value		Const	ant value: 0.0		
CMB to CRU	Save value in		Const	ant value: 0.0		<b>-</b>
✓ Arcade Trim	Save value in		Const	ant value: 0.0		
When Event Mark						
$\checkmark$						
New Automation						

### Action - Variable

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.

😨 🕑 Penguin Embention 🛪	🐵 💿 🛱 🔇	🧿 📽 🛍 🛅 🔺 🖉	CfgMgr StepMgr	
▼ Buttons	No name	Max 0		
SBY Button CRU Button	Events	AND OR NOT	Actions	+
TKO Button     CMB Button		No name AND		
<ul> <li>✓ LND Button</li> <li>▼ Failsafe</li> </ul>		No name		
Auto when No Stick LinkOff to LND				
HLD when No GPS Low Battery				
▼ Stick ✓ Auto Mode			Delay 0.0	Periodical: Off
Manual Mode (Arcad	8 Butto	on 👻 No na	ame	<b>Time</b> 0.0
✓ TKO to CMB ✓ CMB to CRU	墩			
Arcade Trim     When Event Mark	Visual range	Rvar Disabled		
✓ LND to Flare ✓ No name				+
	<			>
New Automation	This button will b	e displayed on Veronte Pane	9	

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.

🔯 🖸 Penguin Embention	📢 💿 🧰 😵 🤹 🏤 🛅 🔺 CfgMgr StepMgr	
▼ Buttons	TKO to CMB Max 0	
✓ SBY Button (EIN) ✓ SBY Button	Events AND OR NOT Actions	+
CRU Button TKO Button	IAS>17 CMB	
CMB Button	AND TKO Phase	
▼ Failsafe		
Auto when No Stick		
HLD when No GPS		
■ Low Battery ▼ Stick		
Auto Mode	Delay 0.0 Periodic	cal: Off
✓ Manual Mode (Arc ▼ Transitions	Variable   IAS>17  Time	0.0
✓ TKO to CMB	Variable GS (Ground Speed)	
CMB to CRU	Max	
When Event Mark	Min 17.0	
	Invert range 🗸	
	Min Ma	x
New Automation	Event triggered on blue area	

#### Automation Display

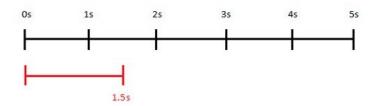
Automations (red) are a combination of events (blue) and actions (green). All actions will be performed on event or an event combination triggering. There a are some parameters that can be configured in the events and actions menu and which are applicable independently of the type of event/action configured (black).

- Delay: time between the triggering of the event and the beginning of the action.
- **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.ç

✓ Enabled						
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

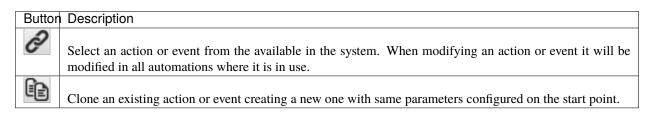
Let's consider that the system evaluates the automations each second (black line), and the automation that contains the periodical option is wanted to execute each 1.5 seconds (red line). In that case, the first action will be triggered at the second 1.5 but will be evaluated at second 2. The second 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.

### 6.2.6.3 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**.

Common configuration options are:



# 6.2.7 Variables

#### 6.2.7.1 System Variables

#### 6.2.7.1.1 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.

🥻 🚰 Penguin Embention	≫ ⊼ ⊗	◙ ≌ ♀ ₡			
' System Variables	Search	Сору			
Names	🗡 Use	Default name	Custom name	Default unit	Init value
Operations		Actuator Output s1	Right Aileron	Custom Typ	
Telemetry		Actuator Output s2	Left Aileron	Custom Typ	
Sniffer		Actuator Output s3	Left Flap	Custom Typ	
		Actuator Output s4	Right Flap	Custom Typ	
		Actuator Output s5	Right Stabilizer	Custom Typ	
		Actuator Output s6	Left Stabilizer	Custom Typ	
		Actuator Output s7	Wheel	Custom Typ	
		Actuator Output s8	Throttle	Custom Typ	
		Actuator Output s9	Landing Gear	Custom Typ	
		User Variable 77	Desired RPM	Angular Vel	
		Acceleration Down		Accelaration	
		Acceleration East		Accelaration	
		Acceleration North		Accelaration	
		Accelerometer - X Bo		Accelaration	
	$\checkmark$	Accelerometer - Y Bo		Accelaration	
		Accelerometer - Z Bo		Accelaration	
	$\checkmark$	Accelerometer 2 Bias		Accelaration	
		Accelerometer 2 Bias		Accelaration	

#### Variable Name Customization

Name	Туре	Size
U	Unsigned int	16
R	Float	32
В	Bit	1

#### Operations

It is possible to configure custom operations to be performed in Veronte by selecting the input and output variables and operation parameters. For instance, in this menu it is possible to configure a Lidar sensor, converting the variable measured (voltage) into a physical variable.

The menu shown in the following figure allows the user to create operations with the system variables.

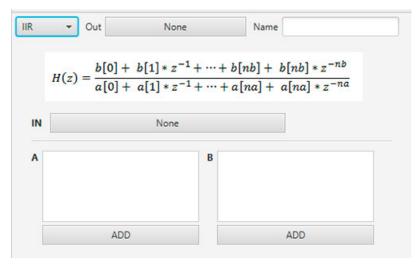
🔯 🕑 Penguin Embention 놧	🕻 🛪 💿 🧰 🚱 🗱 🚱 🖾 🔺	
<ul> <li>System Variables Names</li> <li>Operations</li> <li>Telemetry</li> <li>Sniffer</li> </ul>	Search Copy     Idle     User operation 3     None   Other     None   Out   Rvar Disabled   Name     IIR   FXY   Linear expression   Multiply   Divide   Max	
	Max Min Wrap Angle unwrap	

#### Operations Menu

Super high, High, Low and Idle are the different processing velocities for the tasks performen in Veronte Autopilot (the workin frequencies for each one of them are indicated in **Devices/Veronte/Frequencies**). By default, the new operation appears in **Idle**, but it can be moved to another option just dragging it to the desired place.

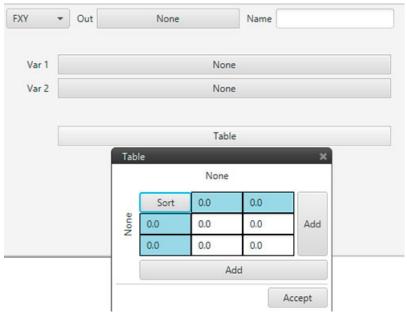
When creating a new operation, the following types are available in Pipe.

• IIR: IIR digital filter, enter the parameters for filtering the variable value.



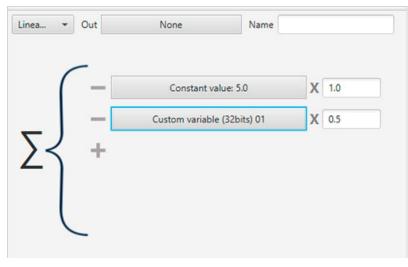
IIR

• FXY: FXY matrix, complete the table for setting an output value according to two input ones.



FXY

• Linear Expression: Output variable acquires the value of the sum of input variables multiplied for a constant value.



Linear

• Multiply/Divide: Output variable acquires the vulue of the multiplication/divition of input variables.

Multi 👻 Out	Rvar Disabled Name	
х	Constant value: 0.0	
~	Constant value: 0.0	_
Mult		+

### Multiply/Divide

• Wrap: Output variable is wrapped to keep value between upper and down limits. For example, if the desired IAS is wrapped between 0 and 12 m/s, the output variable will have a value of 12 when the desired IAS is greater than this value, and a value of 0 when it is negative.

Wrap	*	Out	Custom variable (32bits) 01	Name
			Constant value: 1	2.0
L			Desired IAS (Indicated A	ir Speed)
-	_		Constant value: (	.0



• **Angle Unwrap:** When an angle is wrapped in the PIDs, its value is delimited between pi and -pi radians. The operation presented here undoes that calculation by representing the angle in a range starting at 0 radians.

Angl 👻	Out	Custom varia	able (32bits) 0	2	Name	
An	ngle Unwr	ap	н	eading	9	
			unwrap			

### 6.2.7.2 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
ĺ	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.

### 6.2.7.2.1 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.

🔯 🕑 Penguin Embention 🥍	<  ⊗ 🖸 ፰ 🚱 🗱 🕰 🗂 斗	
System Variables	Search Copy Frequency (Hz) 10.0 Address Pipe fixed	-
<ul> <li>Telemetry</li> </ul>	Enabled	
- Data link to Pipe	Name	
Data link to Veronte	- 🖶 🛖 🕞 Heading	ŕ
Onboard Log User Log	Yaw	L
Fast Log		
<ul> <li>Sniffer</li> </ul>	- 🗣 🛧 🕞 Longitude	
	- I I I I I I I I I I I I I I I I I I I	
	- Image: WGS84 Elevation (Height Over the Ellipsoid)	
	- 🖡 🕇 🗒 Actuator Mode	
		~
	DISABLED	
	TAS (True Airspeed)	C
	GS (Ground Speed)	
	Bank	
	Along-Track Error	
	Cross-Track Error	
	Vertical-Track Error	
· · · · · · · · · · · · · · · · · · ·	The second second second	~

# <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 🗙	<  ⊙ o ≑ © ≉ 22 t
<ul> <li>System Variables</li> </ul>	Search Copy Frequency (Hz) 10.0 Address Veronte 1085 💌
Telemetry	Enabled
Data link to Pipe	Name
Data link to Veronte Onboard Log	- 🗣 👚 📑 Latitude
User Log	- 🖶 🛧 拱 Longitude
Fast Log Sniffer Sniffer 1	- 🕂 🛧 🕞 AGL (Above Ground Level) – Height
	DISABLED
	IAS (Indicated Airspeed)
	TAS (True Airspeed)
	GS (Ground Speed)
	Heading
	Flight Path Angle
<>	Bank

#### Data Link (Ground/Air)

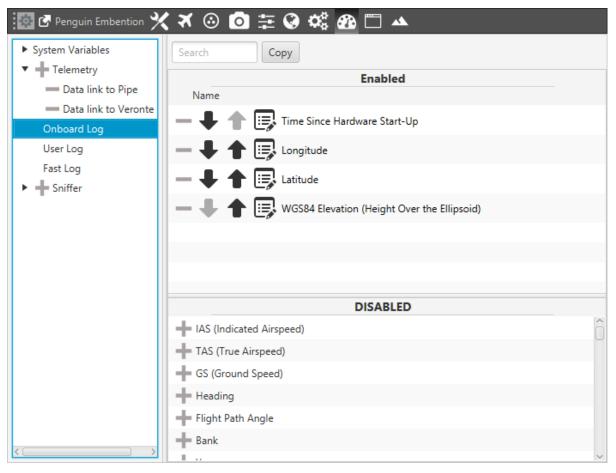
The autopilot **Penguin Embention** will send the Latitude, Longitude and AGL to the autopilot with address **Veronte 1085**. The sending rate is set to 10 Hz.

The unit that receives the telemetry has to configure its sniffer in order to store the data.

**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.

### 6.2.7.2.2 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. The SD management task is **Low**, which is an execution level running at 30 Hz.



Onboard Log

### 6.2.7.2.3 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.

🔯 🕑 Penguin Embention 놧	<  ⊙ 🙆 ☵ 🚱 🤹 💑 🗂
<ul> <li>System Variables</li> </ul>	Search Copy
<ul> <li>Telemetry</li> <li>Data link to Pipe</li> </ul>	Enabled Name
Data link to Veronte Onboard Log	- 🗣 🛧 🕞 Latitude
User Log	- 🖶 🛧 🕞 Longitude
Fast Log	- 🕂 🛧 🕞 AGL (Above Ground Level) – Height
	- IAS (Indicated Airspeed)
	- 🗣 🕇 📑 Heading
	DISABLED
	TAS (True Airspeed)
	GS (Ground Speed)
	Flight Path Angle
	Bank
	Yaw
	Pitch
	V

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 ref section 6.9 of the manual (Actions).

# 6.2.7.2.4 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]		×
۲ 🌔	🕅 🏠	:0 A
Standt	у	<b>\$</b>
Takeo	ff	\$ \$ \$
Climbir	ng	*
Waypoi	nts	\$>> (C)
Hold		*
Landing	Flare	\$>> (C)
CheckList: Check pressure = Check propeller Check MANUAL Configure calibr	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.

# 6.2.7.3 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.

📴 🕑 Penguin Embention 🗙	🛪 💿 🖸	🗄 🚱 🔅 (	🌮 🗔 🔺			
System Variables	Search	Сору	Address	Veronte 1085	•	Configure
Telemetry			Enabled			
<ul> <li>Sniffer</li> </ul>	Name					
- Sniffer 1	-++	Link quality				
	-++	Position				
			DISABLED			
	HIAS (Indicate	ed Airspeed)				ô
	🕂 TAS (True Ai	irspeed)				
	GS (Ground	Speed)				
	Heading					
	Flight Path A	Angle				
	Bank					

Sniffer Configuration Menu

The source UAV, in this case, is the ground station (1085), which communicates to the Air UAV its position and the quality of the radio link between them. 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 the air autopilot has information about the state of the communications so it can perform an action when the link is lost, and also to make the aerial platform know about the ground station position so it can perform a mission in relation to that point.

	IN	Out	001		
-	Link quality	Link quality of related pair	None	*	] <b>^+</b>
-	Position	Moving object icompress 1	None	*	
					Ų
		Link quality	Link quality Link quality of related pair	Link quality Link quality of related pair None	Link quality Link quality of related pair None -

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.

# 6.2.7.4 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.

# 6.2.7.4.1 32 VAR

ID	Name	Units/Values	Description
0	IAS (Indicated Air Speed)	m/s	Pitot-static measurement speed
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	radian	Direction in which the vehicle velocity vector is pointing
4	Flight Path Angle	radian	Angle between velocity vector and local horizontal line
5	Bank	radian	Velocity vector lateral component
6	Yaw	radian	Angle around the Vertical axis of the vehicle
7	Pitch	radian	Angle around the Transverse axis of the vehicle
8	Roll	radian	Angle around the Longitudinal axis of the vehicle
9	Along-Track Error	m	Fix error along the flight track
10	Cross-Track Error	m	Fix error across the flight track
11	Vertical-Track Error	m	Fix error in the vertical flight track
12	Roll Rate	rad/s (RDS)	Rate of change of the Roll angle
13	Pitch Rate	rad/s (RDS)	Rate of change of the Pitch angle
14	Yaw Rate	rad/s (RDS)	Rate of change of the Yaw angle
15	Forward Acceleration – X Body Axis	m/s <sup>2</sup>	Acceleration in the X-axis
16	Right Acceleration – Y 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 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 Y component
21	Velocity	m/s	Velocity vector module
22	Forward Load Factor – X Body Axis	customType	G-force in X body axis
23	Right Load Factor – Y Body Axis	customType	G-force in Y body axis
24	Bottom Load Factor – Z Body Axis	customType	G-force in Z body axis
25	Tangential Acceleration	m/s <sup>2</sup>	Absolute acceleration for tangential direction
26	Energy Rate	customType	Variation from system total energy (kinetic & potential)
27	Energy Distribution	customType	Division of energy used between kinetic and potential
28	co-yaw	radian	Acrobatic Yaw with Body Z' axis pointing to X
29	co-pitch	radian	Acrobatic Pitch with Body X' axis pointing to -Z
30	co-roll	radian	Acrobatic Roll with Y' keeping same as Y
31	Roll acceleration	radian/s <sup>2</sup>	Acceleration around the longitudinal axis
32	Pitch acceleration	radian/s <sup>2</sup>	Acceleration around the transverse axis
33	Yaw Acceleration	radian/s <sup>2</sup>	Acceleration around the vertical axis
40	RSSI	decimal	Received Signal Strength Indicator
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	radian	Commanded Heading from guidance
104	Desired Flight Path Angle	radian	Commanded Flight Path Angle from guidance

			Table 7 – continued from previous page
ID	Name	Units/Values	Description
105	Desired Bank	radian	Commanded Bank from guidance
106	Desired Yaw	radian	Commanded Yaw from guidance
107	Desired Pitch	radian	Commanded Pitch from guidance
108	Desired Roll	radian	Commanded Roll from guidance
109	Desired Along-Track Error	m	Commanded Along-Track error from guidance
110	Desired Cross-Track Error	m	Commanded Cross-Track error from guidance
111	Desired Vertical-Track Error	m	Commanded Vertical-Track error from guidance
112	Desired Roll Rate	rad/s (RDS)	Commanded Roll rate from guidance
113	Desired Pitch Rate	rad/s (RDS)	Commanded Pitch rate from guidance
114	Desired Yaw Rate	rad/s (RDS)	Commanded Yaw rate from guidance
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 (RDS)	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	Desired Energy Rate	customType	Commanded Energy Rate from guidance
127	Desired Energy Distribution	customType	Commanded Energy Distribution from guidance
128	Desired co-yaw	radian	Commanded co-yaw from guidance
129	Desired co-pitch	radian	Commanded co-pitch from guidance
130	Desired co-roll	radian	Commanded co-roll from guidance

Desired North GV (Ground Velocity) Desired East GV (Ground Velocity)	m/s	Commanded North (NED Coordinates system) G
Desired East GV (Ground Velocity)		
Desired East GV (Ground Verberty)	m/s	Commanded East (NED Coordinates system) GV
Desired Down GV (Ground Velocity)	m/s	Commanded Down (NED Coordinates system) G
Desired 2D MSL (Heigh Above Mean Sea Level)	m	Commanded MSL from guidance in 2D height mo
Desired 2D AGL (Above Ground Level) – Height	m	Commanded AGL from guidance in 2D height mo
Desired 2D WGS84 Elevation (Height Over The Ellipsoid)	m	Commanded WGS84 Elevation from guidance in
Desired Longitude	radian	Commanded Longitude from guidance
Desired Latitude	radian	Commanded Latitude from guidance
Desired WGS84 Elevation (Height Over The Ellipsoid)	m	Commanded WGS84 Elevation from guidance
Desired MSL (Height Above Mean Sea Level) – Altitude	m	Commanded MSL Altitude from guidance
Desired AGL (Above Ground Level) – Height	m	Commanded AGL Altitude from guidance
Guidance north position error	m	Difference from Desired and actual north position
Guidance east position error	m	Difference from Desired and actual east position
Guidance down position error	m	Difference from Desired and actual down position
Guidance PID north desired velocity	m/s	Difference from Desired and actual PID north velo
Guidance PID east desired velocity	m/	Difference from Desired and actual PID east veloc
Guidance PID down desired velocity	m/s	Difference from Desired and actual PID down velo
Desired velocity X body axis	m/s	Commanded velocity in X-axis from guidance
Desired velocity Y body axis	m/s	Commanded velocity in Y-axis from guidance
Desired velocity Z body axis	m/s	Commanded velocity in Z-axis from guidance
External yaw	radian	Yaw from external navigation source
	Desired Down GV (Ground Velocity)Desired 2D MSL (Heigh Above Mean Sea Level)Desired 2D AGL (Above Ground Level) – HeightDesired 2D WGS84 Elevation (Height Over The Ellipsoid)Desired LongitudeDesired LatitudeDesired MSL (Height Above Mean Sea Level) – AltitudeDesired AGL (Above Ground Level) – HeightGuidance north position errorGuidance down position errorGuidance PID north desired velocityGuidance PID down desired velocityDesired velocity X body axisDesired velocity Z body axis	Desired Down GV (Ground Velocity)m/sDesired 2D MSL (Heigh Above Mean Sea Level)mDesired 2D AGL (Above Ground Level) – HeightmDesired 2D WGS84 Elevation (Height Over The Ellipsoid)mDesired LongituderadianDesired LatituderadianDesired WGS84 Elevation (Height Over The Ellipsoid)mDesired MSL (Height Above Mean Sea Level) – AltitudemDesired MSL (Height Above Mean Sea Level) – AltitudemDesired AGL (Above Ground Level) – HeightmGuidance north position errormGuidance east position errormGuidance PID north desired velocitym/sGuidance PID down desired velocitym/sDesired velocity X body axism/sDesired velocity Y body axism/s

			nom previous page	
260	External pitch	radian	Pitch from external navigation source	
261	External roll	radian	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	
269	External acceleration y body axis	m/s <sup>2</sup>	Acceleration y body axis from external navigation	
270	External acceleration z body axis	m/s <sup>2</sup>	Acceleration z body axis from external navigation	
271	External GPS Time of Week	S	GNSS Time of week from external navigation sou	
300	Time since Hardware Start-Up	sec	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	pascal	Physical measurement from Pitot	
304	Static Pressure	pascal	Physical measurement from Pitot	
305	Internal Temperature	kelvin (K)	Physical measurement from internal sensors	
306	External Temperature	kelvin (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 (RDS)	Gyroscope measurement for X axis	
311	Gyroscope – Y Body Axis	rad/s (RDS)	Gyroscope measurement for Y axis	
312	Gyroscope – Z Body Axis	rad/s (RDS)	Gyroscope measurement for Z axis	
313	Magnetometer – X Body Axis	tesla	Magnetometer measurement for X axis	
314	Magnetometer – Y Body Axis	tesla	Magnetometer measurement for Y axis	
315	Magnetometer – Z Body Axis	tesla	Magnetometer measurement for Z axis	
322	Internal magnetometer raw X in SI	tesla	Magnetometer raw measurement for X axis	
323	Internal magnetometer raw Y in SI	tesla	Magnetometer raw measurement for Y axis	
324	Internal magnetometer raw Z in SI	tesla	Magnetometer raw measurement for Z axis	
325	Internal magnetometer temperature	kelvin (K)	Magnetometer temperature	
326	External LIS3MDL magnetometer raw X in SI	tesla	LIS3MDL external Magnetometer raw measureme	
327	External LIS3MDL magnetometer raw Y in SI	tesla	LIS3MDL external Magnetometer raw measureme	
328	External LIS3MDL magnetometer raw Z in SI	tesla	LIS3MDL external Magnetometer raw measureme	
329	External LIS3MDL magnetometer temperature	kelvin (K)	LIS3MDL external Magnetometer temperature	
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 (RDS)	IMU 0 raw gyroscope x measurement	
334	IMU 0 raw gyroscope y measurement	rad/s (RDS)	IMU 0 raw gyroscope y measurement	
335	IMU 0 raw gyroscope z measurement	rad/s (RDS)	IMU 0 raw gyroscope z measurement	
336	IMU 0 temperature measurement	kelvin (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 (RDS)	IMU 1 raw gyroscope x measurement	
341	IMU 1 raw gyroscope y measurement	rad/s (RDS)	IMU 1 raw gyroscope y measurement	
342	IMU 1 raw gyroscope z measurement	rad/s (RDS)	IMU 1 raw gyroscope z measurement	
242		1 .1 . (IZ)		

kelvin (K)

### Table 8 – continued from previous page

IMU 1 temperature measurement

343

IMU 1 temperature measurement

344	Static pressure sensor (MS56) raw measurement	pascal	Static pressure sensor 1 raw measurement	
345	Static pressure sensor (MS56) temperature	kelvin (K)	Static pressure sensor 1 temperature	
346	Dynamic pressure sensor raw measurement	pascal	Dynamic pressure sensor raw measurement	
347	Dynamic pressure sensor temperature	kelvin (K)	Dynamic pressure sensor temperature	
348	Static pressure sensor (HSC) raw measurement	pascal	Static pressure sensor 0 raw measurement	
349	Static pressure sensor (HSC) temperature	kelvin (K)	Static pressure sensor 0 temperature	
350	Vectornav Message Frequency	Hz	Frequency at which external navigation source Ve	
351	Vectornav Raw Acc x measurement	m/s <sup>2</sup>	Raw accelerometer X measurement from external	
352	Vectornav Raw Acc y measurement	m/s <sup>2</sup>	Raw accelerometer Y measurement from external	
353	Vectornav Raw Acc z measurement	m/s <sup>2</sup>	Raw accelerometer Z measurement from external	
354	Vectornav Raw Gyr x measurement	m/s <sup>2</sup>	Raw gyroscope X measurement from external nav	
355	Vectornav Raw Gyr y measurement	m/s <sup>2</sup>	Raw gyroscope Y measurement from external nav	
356	Vectornav Raw Gyr z measurement	m/s <sup>2</sup>	Raw gyroscope Z measurement from external nav	
400	Power Input	volts	Power received by Veronte	
401	Power Comicro 3.3V	volts	Power received by Veronte through 3.3V port	
402	Power 5V	volts	Power received by Veronte through 5V port	
403	Power Comicro Regulator	volts	Power received by Veronte Comicro Regulator	
404	Power 3.6V	volts	Power received by Veronte through 3.6V port	
405	CPU Temperature	kelvin (K)	Internal computer temperature	

Table 8 – continued from previous page

500	Longitude	radian	East-West geographic coordinate	
501	Latitude	radian	North-South geographic coordinate	
502	WGS84 Elevation (Height Over the Ellipsoid)	m	Elevation over WGS84 reference frame	
503	MSL (Height Above Mean Sea Level) – Altitude	m	Altitude over the Mean Sea Level	
504	AGL (Above Ground Level) – Height	m	Height Above Ground Level - Dependent on external	
505	Ground Velocity North	m/s	Ground Velocity component in the North direction (I	
506	Ground Velocity East	m/s	Ground Velocity component in the East direction (N	
507	Ground Velocity Down	m/s	Ground Velocity component in the resultant axis from	
508	Sensor IAS (Indicated Air Speed)	m/s	Pitot-static measurement speed	
509	Angle of Attack – AoA	radian	Angle between reference body line and flow directio	
510	Sideslip	radian	Angle between the flow direction vector and the long	
600-603	Temperature 1-4	kelvin (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 gimba	
653	Gimbal stick pitch	customType	Pitch received from the joystick controlling the gimb	
654	Gimbal pitch correction 1	customType	Correction calculated by the gimbal for the pitch con	
655	Gimbal pitch correction 2	customType	Correction calculated by the gimbal for the pitch con	
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 radian/td>	customType	Auxiliar variable for Gimbal control configuration	
661	Gimbal yaw output	customType	Yaw value the gimbal is outputting	
662	Gimbal pitch output	customType	Pitch value the gimbal is outputting	
700-705	RPM 1-6	rad/s (RDS)	RPM associated to pulse captured 1-6	
750	Selected controller time step	sec	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	

	Table 9 – continued from previous page			
500	Longitude	radian	East-West geographic coordinate	
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	
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	Cross-track Distance	customType	Shortest distance to desired path (perpendicular dista	
1201	Radar AGL (Above Ground Level) – Height	m	User Variable	
1202	Radar Speed Down	m/s	User Variable	
1203	External Rotation for Follow Route	radian	Relative vector rotation when using Follow Route	
1204	Time to Impact with Obstacles	sec	Time calculated with Distance to Obstacle and travel	
1300-1309	Clock 1-10	sec	Configurable timers for automations – Clock 1 correct	

1400	Velocity – X Body Axis	m/s	Velocity vector X compo
1401	Velocity – Y Body Axis	m/s	Velocity vector Y composition
1402	Velocity – Z Body Axis	m/s	Velocity vector Z compor
1403	Estimated Dynamic Pressure	pascal	Dynamic pressure sensor
1404	Barometric Pressure at Sea Level (QNH)	pascal	Introduced value for QNI
1450-1453	Captured pulse 1-4	customType	Input values from pulses
1490	Internest raw x distance	m	Raw measurements for X
1491	Internest raw y distance	m	Raw measurements for Y
1492	Internest raw z distance	m	Raw measurements for Z
1493	Internest raw angle	radian	Raw measurements for in
1494	Internest raw xy standard deviation	m	Raw measurements for X
1495	Internest raw z standard deviation	m	Raw measurements for Z-
1496	Internest raw angle standard deviation	radian	Raw measurements for in
1497	Internest position update frequency	Hz	Frequency at which Intere-
1500	GNSS1 Time of Week	S	Data from GNSS1 modul
1501	GNSS1 ECEF Position X	m	Data from GNSS1 modul
1502	GNSS1 ECEF Position Y	m	Data from GNSS1 modul
1503	GNSS1 ECEF Position Z	m	Data from GNSS1 modul
1504	GNSS1 Longitude	radian	Data from GNSS1 modul
1505	GNSS1 Latitude	radian	Data from GNSS1 modul
1506	GNSS1 Height Above Ellipsoid (WGS84)	m	Data from GNSS1 modul
1507	GNSS1 Mean Sea Level (MSL)	m	Data from GNSS1 modul
1508	GNSS1 Above Ground Level (AGL)	m	Data from GNSS1 modul
1509	GNSS1 PDOP (Dilution of Precision of Position)	customType	Data from GNSS1 modul
1510	GNSS1 Accuracy	m	Data from GNSS1 modul
1511	GNSS1 Horizontal Accuracy Estimate	m	Data from GNSS1 modul
1512	GNSS1 Vertical Accuracy Estimate	m	Data from GNSS1 modul
1513	GNSS1 Velocity North	m/s	Data from GNSS1 modul
1514	GNSS1 Velocity East	m/s	Data from GNSS1 modul
1515	GNSS1 Velocity Down	m/s	Data from GNSS1 modul
1516	GNSS1 Speed Accuracy Estimate	m/s	Data from GNSS1 modul

Table 10 – continued from previous page

1517	GNSS1 Related Base Longitude	radian	Data from GNSS1 modu
1518	GNSS1 Related Base Latitude	radian	Data from GNSS1 modu
1519	GNSS1 Related Base WGS84 Altitude	m	Data from GNSS1 modu
1520	GNSS1 Related Base to Rover Azimuth	radian	Data from GNSS1 modu
1521	GNSS1 Related Base to Rover Elevation	radian	Data from GNSS1 modu
1522	GNSS1 Related Base to Rover Distance	m	Data from GNSS1 modu
1523	GNSS1 Related Base to Rover Accuracy	m	Data from GNSS1 modu
1524	GNSS1 Survey in Accuracy	m	Data from GNSS1 modu
1525	GNSS1 Related Base to Rover North	m	Data from GNSS1 modu
1526	GNSS1 Related Base to Rover East	m	Data from GNSS1 modu
1527	GNSS1 Related Base to Rover Down	m	Data from GNSS1 modu
1600	GNSS2 Time of Week	S	Data from GNSS2 modu
1601	GNSS2 ECEF Position X	m	Data from GNSS2 modu
1602	GNSS2 ECEF Position Y	m	Data from GNSS2 modu
1603	GNSS2 ECEF Position Z	m	Data from GNSS2 modu
1604	GNSS2 Longitude	radian	Data from GNSS2 modu
1605	GNSS2 Latitude	radian	Data from GNSS2 modu
1606	GNSS2 Height Above Ellipsoid (WGS84)	m	Data from GNSS2 modu
1607	GNSS2 Mean Sea Level (MSL)	m	Data from GNSS2 modu
1608	GNSS2 Above Ground Level (AGL)	m	Data from GNSS2 modu
1609	GNSS2 PDOP (Dilution of Precision of Position)	customType	Data from GNSS2 modu
1610	GNSS2 Accuracy	m	Data from GNSS2 modu
1611	GNSS2 Horizontal Accuracy Estimate	m	Data from GNSS2 modu
1612	GNSS2 Vertical Accuracy Estimate	m	Data from GNSS2 modu
1613	GNSS2 Velocity North	m/s	Data from GNSS2 modu
1614	GNSS2 Velocity East	m/s	Data from GNSS2 modu
1615	GNSS2 Velocity Down	m/s	Data from GNSS2 modu
1616	GNSS2 Speed Accuracy Estimate	m/s	Data from GNSS2 modu
1617	GNSS2 Related Base Longitude	radian	Data from GNSS2 modu
1618	GNSS2 Related Base Latitude	radian	Data from GNSS2 modu
1619	GNSS2 Related Base WGS84 Altitude	m	Data from GNSS2 modu
1620	GNSS2 Related Base to Rover Azimuth	radian	Data from GNSS2 modu
1621	GNSS2 Related Base to Rover Elevation	radian	Data from GNSS2 modu
1622	GNSS2 Related Base to Rover Distance	m	Data from GNSS2 modu
1623	GNSS2 Related Base to Rover Accuracy	m	Data from GNSS2 modu
1624	GNSS2 Survey in Accuracy	m	Data from GNSS2 modu
1625	GNSS2 Related Base to Rover North	m	Data from GNSS2 modu
1626	GNSS2 Related Base to Rover East	m	Data from GNSS2 modu
1627	GNSS2 Related Base to Rover Down	m	Data from GNSS2 modu
1700-1731	Actuator Output s1 – s32	customType	Configurable variable fro
1800-1895	Distance, azimuth and elevation to Object of Interest 1-32	m, radian and m (respectively)	Spherical coordinates to
L		- •	1

2000	RX Packet Error Rate (on board)	decimal	Value relating RX packets and expected RX
2001	TX Packet Error Rate (on board)	decimal	Value relating TX packets and expected TX
2002	Computed RX pkt/s used for RX PER	messages	Packages per second received to the UAV co
2003	Remote RX pkt/s used for TX PER	messages	Same as Computed RX pkt/s, received throu
2004	Computed TX pkt/s used for TX PER	messages	Packages per second transmitted to the UAV
2005	Remote TX pkt/s used for RX PER	messages	Same as Computed TX pkt/s, received throu
2019	Stick RX rate	Hz	Stick messages received per second

			continued from previous page
2020	Position fix Time	sec	Time spend with GNSS not losing fix
2040	Tunnel producer receive frequency 1	Hz	Frequency at which the Tunnel producer rec
2041	Tunnel producer receive frequency 2	Hz	Frequency at which the Tunnel producer rec
2042	Tunnel producer receive frequency 3	Hz	Frequency at which the Tunnel producer rec
2043	Tunnel consumer send frequency 1	Hz	Frequency at which the Tunnel consumer se
2044	Tunnel consumer send frequency 2	Hz	Frequency at which the Tunnel consumer se
2045	Tunnel consumer send frequency 3	Hz	Frequency at which the Tunnel consumer se
2046	Max duration of step in acquisition	sec	Longest time duration from a step in CIO
2047	Acquisition task timestep	sec	Average period for executing the acquisition
2048	Acquisition task maximum timestep	sec	Maximum period for executing the acquisiti
2049	Cross core message queue CPU ratio	percentage	% of time of CPU that CIO waits for inter-co
2050	Acquisition task average CPU ratio	percentage	Average % of time of CPU from the acquisit
2051	Acquisition task maximum CPU ratio	percentage	Maximum % of time of CPU from the acqui
2052	Acquisition task average time	sec	Average time acquisition task has used
2053	Acquisition task maximum time	sec	Maximum time acquisition task has used
2054	CIO Max time	sec	Maximum time in acquisition from Core Inp
2055	CIO average time	sec	Average time in acquisition from Core Input
2094	GNC task average CPU ratio	percentage	Average % of time of CPU from GNC task
2095	GNC task maximum CPU ratio	percentage	Maximum % of time of CPU from GNC tas
2096	GNC task average time	sec	Average time spent on GNC task
2097	GNC task maximum time	sec	Maximum time spent on GNC task
2098	GNC task maximum timestep	sec	Maximum execution period for GNC task
2099	Max duration of step in GNC	sec	Maximum duration of one step in GNC
2100	Gyroscope Based on Accelerometer – X Body Axis	rad/s (RDS)	Gyroscope measurements obtained from acc
2101	Gyroscope Based on Accelerometer – Y Body Axis	rad/s (RDS)	Gyroscope measurements obtained from acc
2102	Gyroscope Based on Accelerometer – Z Body Axis	rad/s (RDS)	Gyroscope measurements obtained from acc
2103	Acceleration North	m/s <sup>2</sup>	Acceleration in the North direction (NED C
2104	Acceleration East	m/s <sup>2</sup>	Acceleration in the East direction (NED Co
2105	Acceleration Down	m/s <sup>2</sup>	Acceleration in the Down direction (NED C
2112	Estimated Dem	m	Altitude given by the estimated Digital Elev
2200	Curve Length Covered	m	Total distance from current mission leg cove
2201	Curve Length	m	Total distance from current mission leg
2202	Curve Length Pending	m	Total distance from current mission leg to be
2203	Curve Parameter Covered	customType	Total amount from current mission leg cover
2204	Curve Parameter Range	customType	Total distance from current mission leg acco
2205	Curve Parameter Pending	customType	Total distance from current mission leg to be
2250-2259	Reserved 1-10	customType	System reserved variables
2300-2302	Joint 1-3 of Gimbal 1	radian	Variables for Gimbal 1 configuration – Angl
2303-2305	Joint 1-3 of Gimbal 2	radian	Variables for Gimbal 2 configuration – Angl
2400-2419	Control Output u1 – u20	customType	PID Output values that are transformed into
2500-2519	Stick Input u1-u20	customType	Intermediate values from stick used for arca
2600-2619	Stick Input d1-d20	customType	Intermediate values from stick used for arca
2700-2712	Operation Guidance 1-13	customType	Configurable values used in different guidan
2800	Wind Velocity North	m/s	Wind velocity vector pointing North direction
2801	Wind Velocity East	m/s	Wind velocity vector pointing East direction
2802	Wind Velocity Down	m/s	Wind velocity vector pointing Down direction
2803	Wind Velocity North Estimation Covariance	m/s	Wind velocity vector pointing North direction
2804	Cross North-East Wind Velocity Estimation Covariance	m/s	Wind velocity vector pointing cross North-E
2805	Wind Velocity Estimation Uncertainty (Element 2-0)	m/s	2-0 element from covariance matrix in wind
2806	Wind Velocity Estimation Uncertainty (Element 0-1)	m/s	0-1 element from covariance matrix in wind
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## Table 11 – continued from previous page

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2807	Wind Velocity Estimation Uncertainty (Element 1-1)	m/s	1-1 element from covariance matrix in wind
2808	Wind Velocity Estimation Uncertainty (Element 2-1)	m/s	2-1 element from covariance matrix in wind
2809	Wind Velocity Estimation Uncertainty (Element 0-2)	m/s	0-2 element from covariance matrix in wind
2810	Wind Velocity Estimation Uncertainty (Element 1-2)	m/s	1-2 element from covariance matrix in wind
2811	Wind Velocity Estimation Uncertainty (Element 2-2)	m/s	2-2 element from covariance matrix in wind
2900	MSL Right from Actual QNH and Pressure Measurement	m	Mean Sea Level obtained from Actual QNH
2901	MSL for ISA and Pressure Measurement	m	Mean Sea Level calculated for ISO Internati
2902	Time Since Entering Current Phase	sec	Time-lapse considered since entering the cu
2903	GNC Timestep	sec	Task execution period from GNC
2904	Total Flight Time	S	Time-lapse since the vehicle exited Standby
2905	Total Flight Distance	m	Distance covered by the vehicle in all missic
2906	Reception Frequency of Simulated Navigation Data	Hz	Frequency at which the system receives Sim
2907	Reception Frequency of External Navigation Data	Hz	Frequency at which the system receives Exte
2908-2927	Time Spent Within Phase 1-20	sec	Time-lapse spent by the vehicle in any phase
3000-3031	Simulation Variable 1-32	customType	Variables used for Simulation data
4100	Zero	customType	Constant value 0
4101	Rvar disabled	customType	Disabled variable

### 6.2.7.4.2 BIT

ID	Name	Units/Values	Descripti
0-2	Initialisation values	-	Bit for fai
3	System Readiness	-	System is
4	Writing telemetry	-	Telemetry
5	Readiness to flight	-	System is
6	File System state	-	System fil
7	System state	-	System is
8	Memory Allocation	-	Memory a
9	PDI State	-	PDI files a
10	4X Arbiter state	-	Arbiter is
50	Sensors error	-	Error/Run
51	Sensors-Main IMU	-	0 for not e
52	Sensors-Secondary IMU	-	0 for not e
53	Sensors-Magnetometer	-	Internal m
54	Sensors-External magnetometer (HMR2300)	-	HMR2300
55	Sensors-External Magnetometer (LIS3MDL)	-	LIS3MDI
56	Sensors-Static pressure (HSC)	-	HSC Stati
57	Sensors-Static pressure (MS56)	-	MS56 Sta
58	Sensors-Dynamic pressure (HSC)	-	HSC Dyn
59	Sensors-External I2C devices	-	0 for not e
60-64	Sensors-External I2C 0-4	-	External c
65-72	SCI A-D	-	Serial Co
73-76	CAN A-B	-	CAN Bus
77	Vectornav States for GPS Fix, IMU, Mag/Press, GPS Error, Navigation-Vectornav state	-	0 for error
100	Position not Fixed	-	GNSS dat
101	Georeferenced Area	-	0 for bein
102-103	CAN A-B	-	CAN A of
104-105	Stick PPM 1-2 detection	-	Stick PPM

106-108SCI A-C State-Defines ti109MCBSP-Defines ti110Stick state-CAN Ac111-112CAN A-B-CAN Ac113Iridium Readiness-Iridium r114-115EKF-Extended116Radar Altimeter CAN-RX-Radar Alt117-118Power A-B State-Power A-30EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External181Reserved State-System B190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-CDifferen300-306Ground effect compensation-System B401GNC progress-GNC Ste402Acquisition progress-GNC Ste500Ground effect compensation-GNC Ste700-731Serve I-32 state-Serves st800-815PWM GPIO State-PWM GPI815-819IO 1-4 State-Input/Ou802-822RSSI LED 1-3 State-Received1000-1009Simulation BTT 1-10 State-Variables1200-1299User BIT 1-100-Free bits		Tał	ole 12 – continued	I from prev
109MCBSP-Defines ti110Stick state-Show if t1110Stick state-Show if t111112CAN A-B-CAN A c113Iridium Readiness-Iridium r114-115EKF-Extended116Radar Altimeter CAN-RX-Radar Al117-118Power A-B State-Power A-130EFK Navigation State-Power A-130External VCP State-External160External VCP State-External160External Var Navigation Error-External180Attitude-Kind of a181Reserved State-0 for error191Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 (Differen300-306(D)GNSS1-(Differen300-306(D)GNSS2GNC Ste401GNC progress-Acquisition500Ground effect compensation-Ground effect state600-815PWM GPIO StatePWM GFI810-819IO 1-4 State-Nervors st820-822RSSI LED 1-3 State-Narustate1200-1299User BIT 1-100-Variables1200-1299User BIT 1-100-Free bits	ID	Name	Units/Values	Descriptio
110Stick state-Show if t111-112CAN A-B-CAN A or113Iridium Readiness-Iridium r114EKF-Extended116Radar Altimeter CAN-RX-Radar Alti117-118Power A-B State-Radar Alti117-118Power A-B State-Power A-I130EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External180Attitude-Kind of a181Reserved State-0 for error191Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error190OlySIS1-Olyfferen400, 403-405Reserved-System B401GNC progress-GNC Ste402Acquisition progress-Ground effect compensation500Ground effect compensation-Servos st500-815PWM GPIO State-Nervos st600-815PWM GPIO State-Input/Ou820-815PWM GPIO State-Input/Ou820-822RSSI LED 1-3 State-Nariables1000-1009Simulation BTI 1-10 State-Variables1000-1299User BIT 1-100-Free bits	106-108	SCI A-C State	-	Defines th
111-112CAN A-B-CAN A co113Iridium Readiness-Iridium r114-115EKF-Extended116Radar Altimeter CAN-RX-Radar Al117-118Power A-B State-Power A-I130EFK Navigation State-Extended150External VCP State-Extended160External VCP State-Extended180Attitude-Kind of a190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-0 for error200-306(D)GNSS2Offferen401GNC progress-GNC Ste402Acquisition progressAcquisitio500Ground effect compensation-GNC Ste700-731Servo 1-32 state-Servo st800-815PWM GPIO State-PWM GPI810-819IO 1-4 State-Neerved100-1009Simulation BTI 1-10 State-Variables1200-1299User BIT 1-100-Variables	109	MCBSP	-	Defines th
113Iridium Readiness-Iridium r114-115EKF-Extended116Radar Altimeter CAN-RX-Radar Al117-118Power A-B State-Radar Al130EFK Navigation State-Extended150External VCP State-Extended160External VCP State-External180Attitude-Kind of a181Reserved State-0 for error191Internest ultrasound position status-0 for error200-206(D)GNSS1-0 for error200-206(D)GNSS2-(D)ifferen400, 403-405Reserved-System B401GNC progress-GNC Ste500Ground effect compensation-Ground effect compensation500Ground effect compensation-Servos st700-731Servo 1-32 state-Servos st800-815PWM GPIO State-Input/Ou810-815PWM GPIO State-Reserved810-815PWM GPIO State-Reserved810-822RSSI LED 1-3 State-Reserved1000-1009Simulation BT 1-10 State-Variables1200-1299User BIT 1-100-Free bits	110	Stick state	-	Show if th
114-115EKF-Extended116Radar Altimeter CAN-RX-Radar Al117-118Power A-B State-Power A-130EFK Navigation State-Power A-130EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External180Attitude-Kind of a181Reserved State-0 for error190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-0 for error300-306(D)GNSS2-GNC Ste401GNC progress-System B401GNC progress-Acquisiti500Ground effect compensation-Ground effect stress st600-815PWM GPIO State-Servos st800-815PWM GPIO State-Nervos st800-815PWM GPIO State-Input/Ou820-822RSSI LED 1-3 State-Received1000-1009Simulation BIT 1-10 State-Variables1200-1299User BIT 1-100-Free bits		CAN A-B	-	CAN A or
116Radar Altimeter CAN-RX-Radar Alt117-118Power A-B State-Power A-B130EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External180Attitude-Kind of a181Reserved State-0 for error190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-0 for error300-306(D)GNSS2-(Differen401GNC progress-System B401GNC progress-GNC Ste402Acquisition progress-Ground effect compensation500Ground effect compensation-Serve st800-815PWM GPIO State-Input/Our816-819IO 1-4 State-Input/Our820-822RSSI LED 1-3 State-Netwidelege1200-1299User BIT 1-100-Free bits	113	Iridium Readiness		Iridium re
117-118Power A-B State-Power A-130EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External180Attitude-Kind of a181Reserved State-System B190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-(Differen300-306(D)GNSS2-(Differen401GNC progress-System B402Acquisition progress-Ground effect compensation500Ground effect compensation-Servos st700-731Servo 1-32 state-PWM GH816-819IO 1-4 State-Input/Ou820-822RSSI LED 1-3 State-Received1000-1009Simulation BIT 1-10 State-Variables1200-1299User BIT 1-100-Free bits	114-115	EKF		Extended
130EFK Navigation State-Extended150External VCP State-External160External var Navigation Error-External180Attitude-Kind of a181Reserved State-System B190Internest ultrasound position status-0 for error191Internest ultrasound angle status-0 for error200-206(D)GNSS1-0 for error300-306(D)GNSS2-(Differen401GNC progress-System B401GNC progress-GNC Ste402Acquisition progress-Ground effect compensation500Ground effect compensation-Ground effect served state700-731Servo 1-32 state-Servos st800-815PWM GPIO State-Input/Our820-822RSSI LED 1-3 State-Received1000-1009Simulation BIT 1-10 State-Variables1200-1299User BIT 1-100-Free bits	-	Radar Altimeter CAN-RX		Radar Alti
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700-731         Servo 1-32 state         -         Servos state           800-815         PWM GPIO State         -         PWM GPI           816-819         IO 1-4 State         -         Input/Out           820-822         RSSI LED 1-3 State         -         Received           1000-1009         Simulation BIT 1-10 State         -         Variables           1200-1299         User BIT 1-100         -         Free bits	-			Acquisitio
800-815         PWM GPIO State         -         PWM GPIO           816-819         IO 1-4 State         -         Input/Out           820-822         RSSI LED 1-3 State         -         Received           1000-1009         Simulation BIT 1-10 State         -         Variables           1200-1299         User BIT 1-100         -         Free bits	500			Ground ef
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1000-1009         Simulation BIT 1-10 State         -         Variables           1200-1299         User BIT 1-100         -         Free bits				Input/Out
1200-1299 User BIT 1-100 – Free bits				Received
	1000-1009			Variables
2200 BIT Dummy – Bit for co	1200-1299	User BIT 1-100	-	Free bits
	2200	BIT Dummy	-	Bit for co

### 6.2.7.4.3 16 VAR

ID	Name	Units/Values	Description
0	Control Mode	-	Index pointing to the Control mode in use
1	Mission Phase ID	-	Phase Identifier
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
80	Detour calculation identifier	-	Index for a route change
100-101	GNSS1-2 Satellites Number Information	-	Number of Satellites Used in Solution
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
310-311	Iridium	-	Sent & Received
398	VectorNav Mode	-	Index showing external source VectorNav mode

ID	Name	Units/Values	Description
399	Identifier of max duration step in acquisition	-	Index
400	Internest raw status	-	Index
401	Navigation source	-	Index pointing to the primary navigation source
402	Raw position source identifier	-	Index
403-410	Sensor selection	-	Static & Dynamic Pressure, Primary accelerometer &
425	Step in GNC max duration	-	Identifier for the step with maximum duration
450-453	CAN errors	-	Tx & Rx
490	Number of moving objects detected	-	Index
497-499	Configuration	-	Config manager status, global configuration state of file
500	Transponder sequence number	-	Value of the transponder sequence number
501	System Reserved	_	System variables not configurable
550-553	Command 1-4 gimbal	_	Index
900-909	Simulation variables	_	Variables used for Simulation data
1000-1099	User Variables	_	Free variables for the user to use
2000	Uvar State	-	Index
2001	Zero	-	Uvar with constant 0 value

Table 13 – continued from previous page

The following figure shows the menu to manage the variables in the system.

🔯 🕑 Penguin Embention 🗙	🗙 💿 🧧	≑ Ø 3	🎗 🔁 🗖 🔺		
<ul> <li>System Variables</li> </ul>		Сору	Frequency (Hz)	Address	-
Telemetry     Sniffer	Super high				â 🕂
	▶ High				
	Low				
	None				
	Other				
		Out		Name	

### Variables Configuration Menu

The three options available on the **Variables** menu are:

Value	Description	
System	In this menu,	User can find the name of all system
Variables		variables and carry out operations with
		them
Telemetry	In this menu user can set the priority of the system variables	
	to be saved. Also, the variables that will be sent between	
	Veronte	
Sniffer	Option used to configure what messages user wants to receive	

## 6.2.8 Panel

In this menu, the user can decide how the phases will look in Veronte Panel, create checklists for each phase, create manual confirmation for particular phase changes and configure some notification that will appear behind the Veronte Unit (Side Panel) upon activation.

### 6.2.8.1 Short 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 💥 🛪	🕻 💿 🧰 🚱 🗱 🕮 🛄 🔺
Sort Phases	
Checklist	Standby
Confirmation	Runway Takeoff
Notifications	Climbing
	Cruise
	Landing
	Flare
	V

Phases Disposition

### 6.2.8.2 Checklists

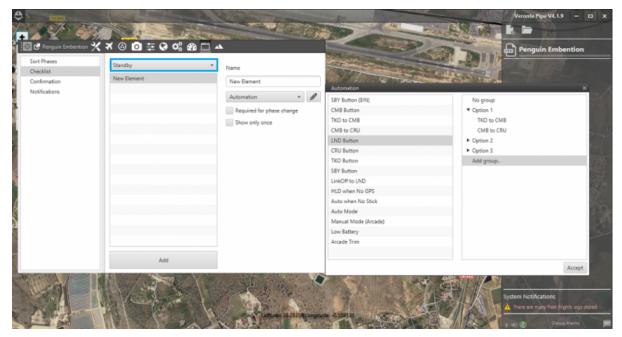
This feature is used to make sure that some requirements have been accomplished, for example, prior to a phase change or to avoid a possible malfunction.

In this menu, the checklist that will appear in the Panel is configured. The blue box displays all the phases configured for the operation. In each one of them, new elements for the checklist can be added with the button **Add**.

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.

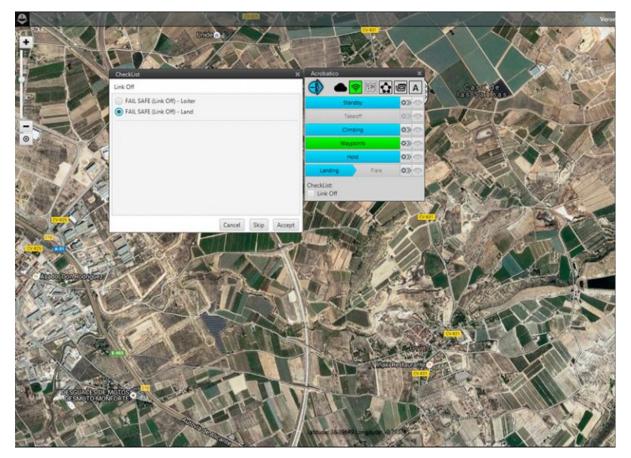
- None: any action is performed, been just a check for the user to do something external to Pipe
- **Command:** send to the UAV a position, a yaw angle or the wind velocity in the three axes.
- In Range Check: Allows checking if a variable is between the range selected.
- Atmosphere: set the atmosphere 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.



**Checklist Elements** 

Drag the automations into a group to create the selection, it is possible to have more than one.

As an example, the following figure shows 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.



## 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.

🔯 🗗 Penguin Embention 💥	🛪 💿 🖸 🗄 🚱 🗱 🖾 🗖	▲
Sort Phases	Standby 👻	Name
Checklist Confirmation Notifications	Mode AUTO and check control in SBY         Check mission (First and last waypoint)         Check Veronte battery V(>15V)         Arm catapult	Arm catapult         None         Required for phase change         Show only once

**Checklist Configuration** 

### 6.2.8.3 Confirmation

This menu is used to create confirmation messages that appear when a button is pressed. It is a safety system for not pressing any keys by mistake.

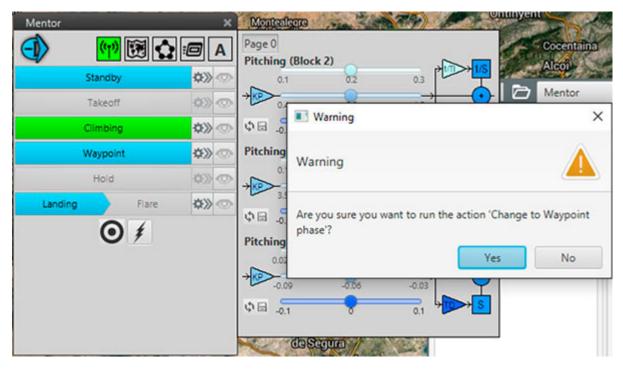
By default, this window displays only one button to ask confirmation from: the radio link.

🔯 🕑 Penguin Embention 💥	★ ③ 🖸 🗄 🚱 🗱 🚱 🗖 🔺
Sort Phases Checklist	Ask for confirmation before running
Confirmation	Disable/enable telecommand
Confirmation Notifications	

### Panel Confirmation

For the other custom buttons created by the user for Veronte panel, the confirmation option is included when creating the button. When configuring the Button event, the system provides a check to include a confirmation when selecting that option (visit *Automations*).

When the user is trying to do an action (previously selected), Veronte Pipe will show a warning message like the following, asking us confirmation.



Confirmation - Example

### 6.2.8.4 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:

- 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.

· · · · · · · · · · · · · · · · · · ·	Xativ	Gandia	Veronte Pipe V2.8.1 -
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A REAL	Divis	Ground (GND)
Cristo Almini Montofrere Cristofrere	Onthryant Co	Dénia 1-11 Xabia 2004 ELextendo	Mentor Stick error Servo 2 satured Servo 5 satured
ronte Connections Devices	Control Navigation Automation Va	Tunnel UDP	
Sort Phases	Servo 2 satured	Mouse confirmation	1/3
Checklist Confirmation	Task 3 real time error	Mouse confirmation 🔹	
Notifications	- File system error	Mouse confirmation 🔹	
	- Servo 1 satured	Mouse confirmation -	10-cale
	- Servo 8 satured	Mouse confirmation 👻	
	System not ready to start	Mouse confirmation	A Contraction
	- Task 2 real time error	Auto-Hide No show	
	Servo 4 satured	Mouse contirmation *	A State of the local state
	- Capture A error	Mouse confirmation 👻	Carl Carl
	- Task 1 real time error	Mouse confirmation *	A State of the second s
	- Servo 6 satured	Mouse confirmation *	10.20
	- Servo 3 satured	Mouse confirmation 👻	200
	- Stick error	Mouse confirmation 💌	
	- No writing telemetry	Mouse confirmation 👻	
	- Out of georefenced area	Mouse confirmation	

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 popup window that allows the selection of a new variable. It is also possible to delete the notifications shown by default, click on "-" to eliminate it from the error list.

In the following table, it will be described the error types of the notification panel.

Notification	Cause	Possible solution
GPS	The system is not connected to	Check the GPS signal in the area and the GPS antenna
navigation	GPS signal	connection
down		
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
e	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	The alimentation voltage is out of	Go to "Electrical" section of the manual to check admitted
error	the admitted 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	System is not able to complete all	Check system variables in Variables Panel and move the
real time	tasks: 1 means High level,5 means	operations to a lower level.
error	Low level	
Stick error	The stick is not connected to Air	Check radio signal and stick connection (in case of HIL
	autopilot	simulation it will be simulated)
Capture A	The Ground is not receiving the	Check the Ground-Stick connection
error	stick signal	
Inside	The aircraft is actually inside the	Exit the aircraft from the polygon
Polygon X	selected polygon (X is the polygon	
	number)	

**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).

## 6.2.9 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*.

### 6.2.9.1 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 💥 🤅	X 💿 🖸 葦 🚱 🗱 👧	) 🛅 🔺 CfgMgr Ste	pMgr
DISABLED		To XPlane	
Throttle 01	— Throttle 00	Control	Output u2
Throttle 02	- Elevator	Offset	0.0
Throttle 03	- Aileron	о	
Throttle 04	Rudder	Conversion Factor	1.0
Throttle 05			
Throttle 06	- Flap handle		
Throttle 07			
RPM 1			
RPM 2			
Aileron 1 Left 00			
Aileron 1 Right 00		To Veronte	
Aileron 1 Left 01		Sele	ct 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 0.01 11.04			

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 Accept

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.

### 6.2.9.2 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="1" message="11" nameUI="Aileron"/>
            <DATA name="rud" desc=" convertTo=" unit=" xplaneName=" readOnly="false" parameter="2" message="11" nameUI="Aileron"/>
            <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="1" message="70" nameUI="Aileron 1 Right 00"/>
            <DATA name="srvAil1L1" desc=" convertTo=" unit=" xplaneName=" readOnly="false" parameter="2" message="70" 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>
            <DATA name="srvAil1L
```

#### 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.

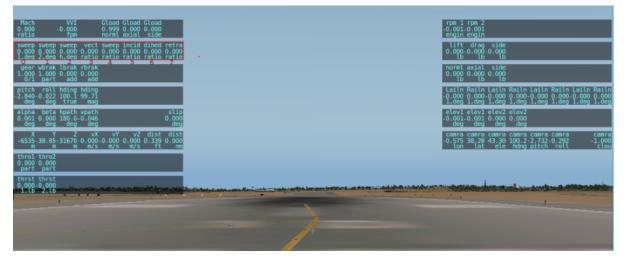
Consider the following example that explains how to add a new variable. Imagine you have a wing with variable incidence (configurable in Plane Maker) and this parameter doesn't appear in Veronte Pipe.

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         Image: Constraint of the second secon	33   Image: Starter timeout     34   Image: Starter timeout     35   Image: Starter timeout	70  Gefs: ailerons 1 71  Gefs: ailerons 2 72  Gefs: roll spoilers 1
3 🗭 🗎 🗭 📄 speeds 4 🗑 🗎 🗑 Mach, VVI, G-load	36   engine torque     37   S     38   prop RPM     39   prop pitch	73    defs: roll spoilers 2      74    defs: elevators      75    defs: rudders      76    defs: rudders      76    defs: yaw-brakes
5 atmosphere: weather 6 atmosphere: aircraft 7 a system pressures	40	77
8    9    9    9    0    other flight controls      10    9    9    9    1    0    0      11    9    9    1    1    1    1	44 E EPR 45 E FF 46 E E EGT	80       9       9       pitch cyclic disc tilts         81       9       7       roll cyclic disc tilts         82       9       9       pitch cyclic flapping         83       9       7       roll cyclic flapping
12    Image: Second strain stra	48 CHT 49 cil pressure 50 cil pressure 51 cil cil temp 51 cil cil pressure	84 📄 📄 📄 grnd effect lift, wings 85 📄 📄 📄 grnd effect drag, wings 86 📄 📄 📄 grnd effect wash, wings

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 convertto="" desc="" message="11" name="elv" nameui<="" parameter="0" readonly="false" td="" unit="" xplanename=""><td>"Elevator"/&gt;</td></data>	"Elevator"/>
<data convertto="" desc="" message="11" name="ail" nameui="&lt;/td" parameter="1" readonly="false" unit="" xplanename=""><td>"Aileron"/&gt;</td></data>	"Aileron"/>
_ <data convertto="" desc="" message="11" name="rud" nameui<="" p="" parameter="2" readonly="false" unit="" xplanename=""></data>	="Rudder"/>
<data <="" convertto="" desc="" message="12" name="incid" nameter="5" p="" parameter="5" readonly="false" unit="" xplanename=""></data>	I="Canard"/>

### 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.

### 6.2.9.3 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.

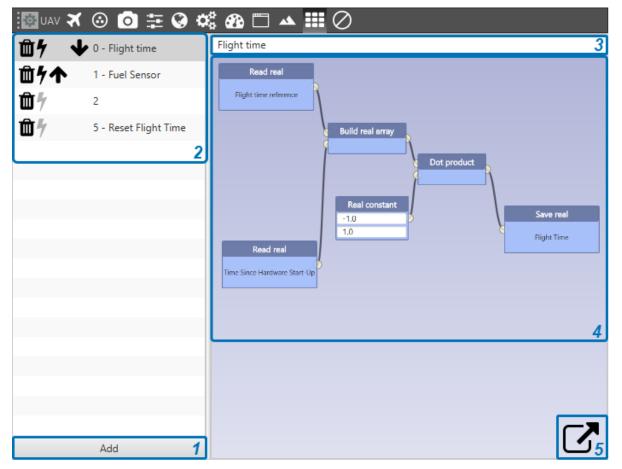
**Warning:** The simulation must be started when the aircraft is in the Initial phase (the one that gets in once is powered). In this phase the X-Plane will simulate the GPS signal to locate the autopilot in the place indicated by the airport on X-Plane.

## 6.2.10 Blocks

Veronte autopilot allows the user to perform custom operations, thus adapting to the user's data management requirements. Within this menu the user can select the desired input variables, a wide variety of operations to transform the latter, and the output variables where the final processed value will be stored. For instance, in this menu it is possible to configure a Lidar sensor, converting the measured variable by the sensor (voltage) into a physical variable (meters).

The menu to create custom operations is called **Blocks** – see the Figure below. Within the menu the user has:

- 1. Add button to add a new custom operation.
- 2. Custom operations display. Next to every operation entry the user will find the following buttons **trash bin** deletes the operation, the *lightning bolt* marks that operation so it is executed continuously, and the *arrows* allow the user to arrange the priority of the operations that have been marked. The non-marked operations are reserved to be executed on demand by creating an Automation.
- 3. Operation's name.
- 4. Operation definition: input variable(s), output variable(s) and transformations to be executed.
- 5. Clicking on the button will enlarge the working space



### Blocks Menu

As mentioned above, when the *lightning bolt* is marked the operation is then executed at the same frequency as the GNC algorithm (Guidance, Navigation and Control). Following, the blocks available to define an operation are presented.

UAV 🛪	💿 🧿 🗄 🔇 🔇	<b>\$ &amp;</b> 🗂	] 🔺 🏢	$\oslash$				
⑪ヶ ↓	• 0 - Flight time	Example						
前十个	1 - Fuel Sensor							
<b>ŵ%</b>	2 - Example							
<b>ش</b> ۲	5 - Reset Flight Time			Add 🔸	Angle unwrap			
					Build real array			
					Dot product			
					Functions	۲		
					Read value	۲	Boolean	
					Real constant		Integer	
					Save value	Þ	Real	
					Type casting	×	_	
					Wrap			
	Add							C)

To add a block, the user needs to right-click on the background of the menu – see Figure below.

### Adding Blocks

- The user will commonly want to start reading a variable coming from either the autopilot or a sensor/device. The option **Read value** must be selected, choosing among *boolean*, *integer* or *real* as the variable type.
- **Type casting**: this block is used to change from one data type to another. The options available are *Bool to real*, *Integer to real*, *Real to bool* and *Real to integer*.
- Wrap: the output variable is wrapped to keep a value between the upper and lower limits. For example, if the desired Inidicated Air Speed (IAS) is wrapped between 0 and 12 m/s, the output variable will have a value of 12 when the desired IAS is greater than this value, and a value of 0 when it is negative.





• Angle Unwrap: when an angle is wrapped in the PIDs, e.g. the heading angle, its value is delimited between  $\pi$  and  $-\pi$  radians. The operation presented here undoes that calculation by representing the angle in a range starting at 0 radians.

- **Build real array**: when choosing this block, the user needs to define the length of the array. The default value is 3. A block with as many entries as defined will appear. Only one exit dot will be available.
- Dot product: this block allows the user to multiply two real arrays of the same length.
- **Real constant**: when choosing this block, a single constant or an array of constants can be defined. The user needs to define the length of the array, which by default is 1 i.e. a single constant.
- **Save value**: the user must choose a variable or several variables to save the transformed information. The variable type can be *boolean*, *integer* or *real*.
- Functions: there are 3 kinds of functions depending on the number of input variables required. There are 1x1, 2x1 and N

### - 1x1 functions:

- \* Abs: returns the absolute value, i.e. the non-negative value, of a variable/operation.
- \* 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 a variable/operation.
- \* **Exp**: returns the exponential of a variable/operation.
- \* Log: returns the natural logarithm of a variable/operaton.
- \* Ceil: returns the least integer greater than or equal to the incoming variable/operation.
- \* Floor: returns the greatest integer less than or equal to the incoming variable/operation.
- \* Wrap[pi,-pi]: returns an angle (in *rad*) wrapped between  $\pi$  and  $-\pi$ .
- \* Wrap[0,2pi]: returns an angle (in *rad*) wrapped between 0 and  $2\pi$ .
- \* **IIR** digital filter: the output filtered variable depends on the present and past inputs (numerator) as well as the past outputs (denominator). The order n and m of both the numerator and denominator, respectively, is chosen by adding the desired amount of n and m terms see the Figure below.

IIR filter Edit	$H(z) = \frac{b[0] + b[1] * z^{-1} + \dots + b[nb] + b[nb] * z^{-nb}}{a[0] + a[1] * z^{-1} + \dots + a[na] + a[na] * z^{-na}}$
	A Custom B Custom

IIR Filter Block

### • 2x1 functions:

- Add: returns the sum of two variables.
- Substract: returns the substraction of two variables the upper dot minus the lower dot.
- Multiply: returns the multiplication of two variables.
- Divide: returns the division of two variables the upper dot divided by the lower dot.
- **Power**: returns *a* raised to the *b* power where *a* is the *upper dot* and *b* the *lower dot*.
- Max: returns the maximum value of two variables.
- Min: returns the minimum value of two variables.
- **Remainder**: returns the remainder after dividing one variable by another the remainder of the *upper dot* divided by the *lower dot*.
- Atan2: returns an angle in *rad* following the function atan2(y, x)- where y is the *upper dot* and x the *lower dot*.
- **RTable3D**: returns a variable according to the mapping of two variables a mapping matrix/table must be defined, where the output variable will be interpolated from.

Real table 3D	Tabl	e	)	K		×
Edit		Sort	0.0	2.0	4.0	
		-1.0	1.0	0.0	-3.0	
	≻	0.0	2.0	4.0	6.0	Add
		2.0	1.0	2.0	0.0	
		3.0	1.0	-4.0	3.0	
				Add		
					Ace	cept

### RTable3D Block

### • Nx1 functions:

- Array max: returns two variables, the maximum value of the array and an integer with the position (starting from 0) of the maximum value on the array. The block has one *input dot* (left side) for the array, and two *output dots* (right side): one for the outcoming maximum value and another for the position (in green that colour indicates that an integer variable must be used).
- Array min: same principle as the previous block but returning the minimum value.
- Array multiply: multiplies all the components of a real array.

## 6.2.11 Radio

From this window is possible to modify the configuration of the radio module inside Veronte. By default these are the parameters that are shown in Veronte Pipe.

Radio	
Radio model	P400 (900MHz) -
Out power	30 dBm 👻
Connection	pp 💌
Address	Master
Network address	1
	Sen

### Radio Panel

All these parameters have to be set accordingly to the radio module installed in Veronte. Contact Embention if you need the details of your specific radio module.

- **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.

By pressing Send the user sends all parameters .

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.



# 🔣 Veronte 1025 🛪 💿 🧰 😤 🚱 🗱 🕋 🛤 🖗

### 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.
o°	Automation	Configure automatic actions on event detection (go home, change phase).
<b>6</b> 22	Variables	Customize variable names and traffic: log, telemetry
	Panel	Configure Veronte Panel layout.
	HIL	Configure parameters for Xplane Simulator.
R	Radio	Configure radio settings.

Each option will be explained in detail in the next sections.

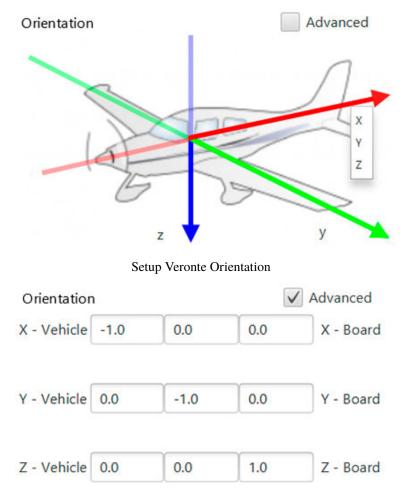
# 6.3 Installation

This menu allows the user to select the orientation of the autopilot installed.

## 6.3.1 System Position

Aircraft axes are defined according to international aviation convention; Veronte axes are drawn on Veronte box as defined in the *Hardware Installation*.

It is not compulsory to install the autopilot in the platform aligned with the aircraft axes. There could be a rotation, for example, the box can have its X axis directed to one of the wings, like in the case of the figure shown as follows.

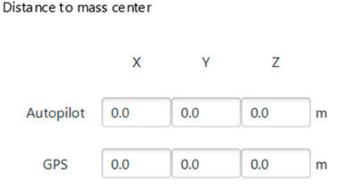


### Setup Veronte Orientation Advanced

In order to indicate the box disposition inside the platform, click on the axis in the aircraft diagram and select the corresponding axis according to the autopilot layout.

The case of a non-orthogonal installation is also covered in the software. The right menu of the figure shows the values of the rotation matrix, which are totally modifiable by the user.

Veronte and GPS antenna distance from centre of mass must also be entered. This distance is entered in meters and accordingly to aircraft axes.



Setup Veronte Position

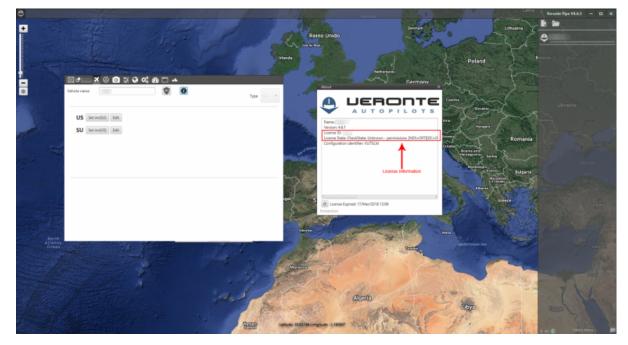
This information is used to take into account the moment produced by the weight of the autopilot and GPS antenna.

Note: Since the latest versions of Pipe, this configuration has to be done in Devices-Veronte-Attitud.

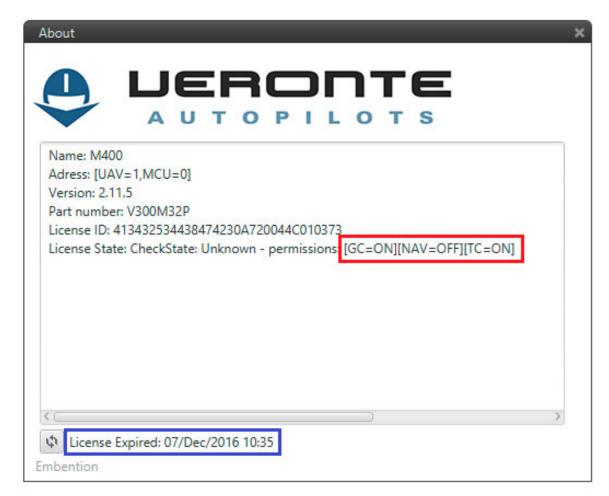
# 6.4 License & Safe Mode

## 6.4.1 License

To access the License you have to open setup, then select Veronte and click on **W**. 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:

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)

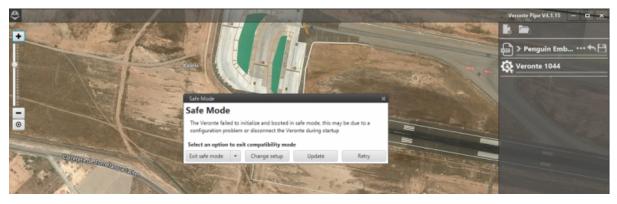
The license state shows the possible action for the selected autopilot (ON=Active, OFF=Not Active). The Ground Autopilot license state for a normal configuration is **ON: OFF: ON**. The Air state is **ON: ON: ON**.

## 6.4.2 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.

# 6.5 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.

# 6.6 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

The next table gives a brief overview of each option.

Item	Description
Discard	Discard all changes
Save	Save all modified data
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)
Remove	Remove the selected configuration (only available for offline configurations)
HIL	Hardware in the loop simulation
Advanced	Update Veronte Unit and Reboot it

## CHAPTER

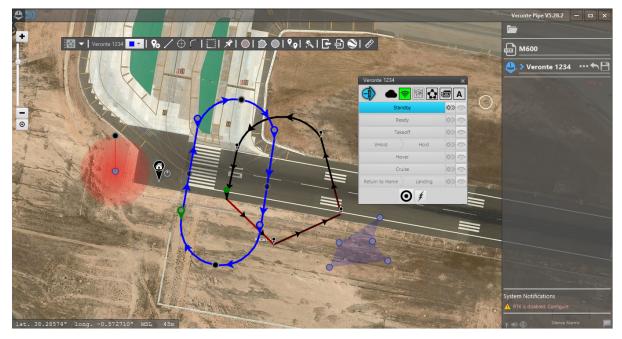
## SEVEN

# **MISSION CONFIGURATION**

# 7.1 Mission Setup

## 7.1.1 Introducction

A mission can be configured using the Mission Menu. Firstly, Veronte Air has to be selected (it usually appears with the name of the UAV) because **the Mission will be saved in the Air Autopilot**. Then, using the graphical tool of this menu, the trajectory of the aircraft can be drawn, along with other elements to take into account during the mission such as polygons, obstacles or event markers.



### Mission Setup

You can realice two or more missions simultaneously. The path created here 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 made in the mission menu.

## 7.1.2 Terrain profile and Magfield

you can access to this settings.

in

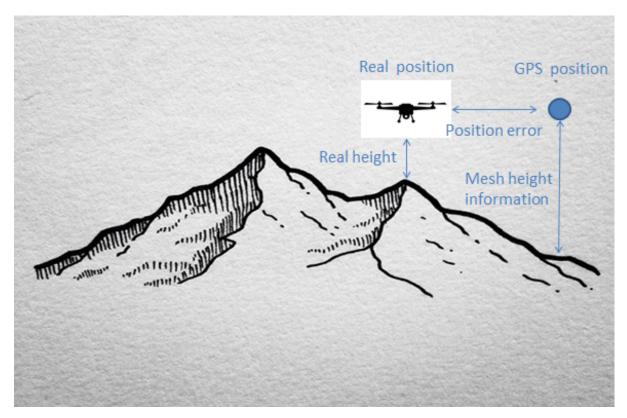
Before to start the configuration of your mission, you have to set the terrain profile and the magnetic field. If you click

Terr	rain Profile						
	Auto Margin 0.2	×1	Delta (north	and east) where	dem is valid	10.0	m
	Select in Map						
F	Show Max resolution	Latitude Longitude	0.6686564	rad [-π,π] rad [-π,π]	Latitude Longitude	0.668068	rad [-π,π]) rad [-π,π]
в 🚽 🗌	Show	Latitude Longitude	0.6742094	rad [-π,π] rad [-π,π]	Latitude Longitude	0.6604325	rad [-π,π] rad [-π,π]
	Geoid Show	Latitude Longitude	0.6758933	rad [-π,π] rad [-π,π]	Latitude Longitude	0.6601853 9.599E-4	rad [-π,π] rad [-π,π]
Mag	gnetic field						
VA	luto						
	Select in Map						
C N	lorth 2.6797716E-	5		Declina	tion 0.0		rad [-π,π]
	ast 2.0086921E-	7		Inclinat	tion (0.0		rad [-π,π]

Terrain profile and magnetic field settings

А	Delta parameter
В	Meshes of terrestrial mode
С	Magnetic vector

**Delta parameter**: when you are flying, your aircraft measures the distance to the floor (AGL) through two or more systems: LIDAR, or another similar, and with the data of the meshes. During the flight it is possible that the position error is so large that the measure of the meshes can be wrong. So we define delta parameter to describe the radio of the circunference where we will use both systems, if the position error is bigger than the delta parameter we will use LIDAR alone.



Delta Parameter

**Meshes of terrestrial mode**: we establish three different meshes (Fine, Coarse and Geoid), for each one we will introduce the coordenates of the upper left corner and the lower right corner or we can selec the zone in the map too.

- Fine: Smaller mesh than the coarse one, but with detailed information about the altitude at more points.
- Coarse: Big mesh with not much detail.
- Geoide: Big mesh which provides the geoid height



Fine and Coarse meshes

The meshes have fixed optimal start dimensions but they can be modified. Dimensions increasing means a lower zone definition so the tool must be changed if really necessary (the greater the resolution the smaller the mesh, because more resolution implies a heavier file to store that data).

If Auto is enabled the system will move automatically the meshes. In order to move them manually and save the updates is important to deselect the Auto tool. The system will display an error if there is not a configured mission on the map.

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 of the 60% of the area (Coarse or Fine) and the margin is set at 0.8 (the value can be set in percentage by changing the measurement unit) 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 value (or zero) of Margin means more precision of the terrain profile but the system will recalculate more times (or each time) when the mission is modified.

Show option displays the mesh on the screen, allowing the user to move them in order to locate them over the mission area.

**Magnetic vector**: you can introduce or select in the map the magnetic vector of the zone. As far as the Magfield is concerned, the Auto check has to be marked to take the magnetic declination information of the mission area.

**Warning:** Before the flight, check that the meshes are over the mission area, especially if carrying out an operation in mountainous terrain.

## 7.1.3 Marks

💽 🔻 🛛 Fixed Wing	g V-Tail UAV 💶 🖌 伦 🖊 💮 I	<b>○</b>   <b>○</b>   <b>★</b>   (	◎ 🖄 🌒	। 🍫 । 📩 । 🚰 🖨 (
Terrain Marks				0
Patches	Patch	Туре	Value	(+
	No conter	nt in table		

### Marks menu

If you click in Marks flange you will access to this menu, and with "+" you can add new patches.

Patches	Patch	Туре	Value	
Route 👻 Route	:1	Referred to start	0.0	
Approach Rout	1	Referred to start	0.0	
Climbing				
Route				
Taxi				
VTol				
Rendezvous				

### Guidance methods

Doing double click in **Route** you can select the guidance method that you want and with double click in **Route n** you will reference the patch to the **Route n** (for example), it is the same procedure for the other methods.

Patches	Patch	Туре	Value	
oute	Route 1	<ul> <li>Referred to start</li> </ul>	0.0	
oute	Route 1	Referred to start	0.0	
	Route 2	_		
	Route 3			
	Route 4			
	Route 5			
	Route 6			
	Route 7			
<u> </u>	Route 8			
	Route 9			
	Route 10			

### Guidance Method Number

Approach	L0/A1/L2/A3/L4/L5
Climbing	L4/A3/L2/A1
Route	800 waypoints
Taxi	Taxi1/Taxi2
VTol	VTol1/VTol2/VTol3
Rendezvous	Rendezvous1/Rendezvous2/Rendezvous3

This channels are available for each guidance method.

# 7.2 Mission Tools

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 has to be select in the right menu.





Once the autopilot is selected (1), the toolbar will be activated with its corresponding name (2).

# 7.3 Mission toolbar

The mission toolbar provides the graphical tools to create the path that the aircraft follows while it is in **cruise phase**. The created mission is stored in the *VER file* of the configuration.

Veronte Setup dialogue can be opened in the main menu clicking on (upper left corner of the screen) and selecting **Mission** in the pull-down menu.



Mission toolbar

The elements that appear on the toolbar are detailed in the following table.

_		
	Open Detail	Displays Terrain and Marks configuration
•	Colours	Line colour
୧୦	New Waypoint	Add new waypoint on click position
/	Segment	Add a straight line
$\odot$	New Orbit	Add a orbit
$\cap$	Fly By	Tool to adapt turns in multirotor aircrafts
Ĺ.!	Multiple Choice	It is a selection tool
Ŕ	Event Mark	Add a mark to trigger an event
	Obstacle	Add an obstacle where the plane will not cross
	New Polygon	Draw areas on the map for association with polygon events
	Circular Area	Draw circular areas on the map for association with polygon events
<b>₹</b> ₽	References	Create points of reference
*	Mapping	Draw a polygon for mapping applications.
Ŀ	Import Route	Import route configuration
Ð	KML	Download a .kml file with the route created.
	Google Hearth	Open Google Earth and show the route that user has drawn
et l'	Ruler	Measure on map

How each one of the tools shown in the previous table works will be detailed in the section *Mission Tools*.

## CHAPTER

# EIGHT

# **OPERATION**

# 8.1 LOG Record

Log toolbar shows recorded events and permits to introduce custom events to be saved. It can be opened in the main menu clicking on and selecting Log in the pull-down menu.

In order to create a new log event, introduce event information and press enter to record it on the log.

	œ ▼	New log ev	/ent		🗖   🔜
No	Time	Uav	Board	State	RE
296	12:56:35	Veronte	3:28:31.0	Hover	FSM transition
297	12:56:35	Veronte	3:28:31.1	Hover	FSM transition
298	12:56:35	Veronte	3:28:31.2	Hover	FSM transition
299	12:56:36	Veronte	3:28:31.3	Hover	FSM transition
300	12:56:36	Veronte	3:28:31.4	Hover	FSM transition
301	12:56:36	Veronte	3:28:31.5	Hover	FSM transition
302	12:56:36	Veronte	3:28:31.6	Hover	FSM transition
303	12:56:36	Veronte	3:28:31.7	Hover	FSM transition
304	12:56:36	Veronte	3:28:31.8	Hover	FSM transition
305	12:56:36	Veronte	3:28:31.9	Hover	FSM transition
306	12:56:36	Veronte	3:28:32.0	Hover	FSM transition
<					) >

Log Toolbar

• **Record/Stop button:** permits to start/stop capturing log information. By clicking on REC, a new log saving will start.

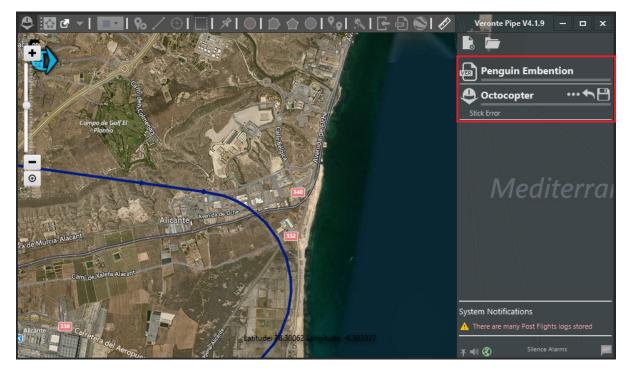
## 8.1.1 Create PDF

It is possible to generate PDF reports containing saved log information. Click on the Report icon and enter requested information to generate the report.

Create PDF	×
Pilot	
Reference	
Clouds - Rain - Wind	•
Description	
Comments	
Path C:\	
✓ Open PDF after creating Creat	e

#### **Report Information**

Once both Veronte units, the one on the Ground Station and the one OnBoard, are configured and the mission has been loaded to the aircraft, the system is ready to start the mission. A list with linked Veronte units and configurations are displayed on the side panel. This display shows information and warnings.



Connected Autopilots and Warnings

# 8.2 Veronte Panel

Double click on any Veronte to display its Veronte Panel. This item is the main interface to control the flight operations.



Veronte Panel

The current phase is marked in green, select one of the available blue phases to change manually. When entering a new phase, all required Checklist elements (red) must be completed.

There are two options when entering a new phase:

- Clicking on the phase name (blue box) will make the aircraft enter the phase with the preconfigured parameters.
- If the **Options button** (black) is selected, the system will enter the phase but a window will appear allowing the user to change the parameters of that phase. Phase parameters can also be configured on the control tab on the setup menu.

The **Mode button** (blue) indicates the actual flight mode (A-Auto, M-Manual...) and allows to change it. Finally, the View button (purple) displays the phase route on the screen.

Dependencies between phases and automatic phase transitions are configured on the automations panel.

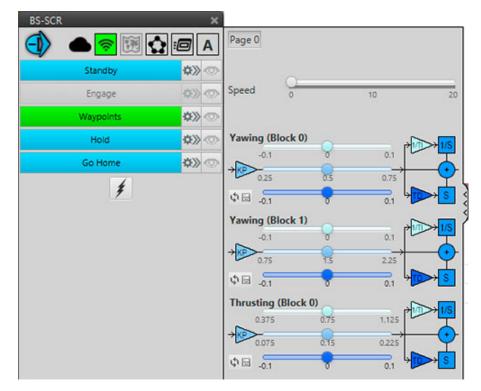
# 8.3 Flight Options

During a flight operation, the following actions can be performed:

- Flight monitoring: Flight data can be monitored in the control station using telemetry displays. Telemetry display configuration can be edited during the flight.
- Edit mission: Mission can be edited prior or during the flight. If the mission is modified during the flight, it will not be recalculated until the new mission will be saved. The aircraft behavior will not change and it will follow the last saved mission.
- **Change phase:** Phases permit to set the vehicle configuration to a specific performance. Click on a phase to initiate it.
- Activate Manual/Assisted/Automatic modes: As shown in the previous figure of Veronte Panel is used to change between the different flight modes (which were created in Modes, see section *Modes*). This change can also be made with an automation or directly from the joystick (an example of this automation is describen in Automation Examples section).
- Abort mission: "Go Home" button can be configured in the automations panel and shown in the lower part of Veronte Panel (see Automation Examples).

# 8.4 In-flight Settings

During the operation it is possible to adjust the controller parameters and some guidance commands (desired roll, pitch, IAS and so on) directly on Setup – Control, or using the TC Panel, which is a shortcut that shows all this values directly on the Veronte Panel. The configuration of this option is detailed in *TC Panel*.



Controller adjust tools



Guidance tools

# 8.5 In-flight mission edition

Once the aircraft is flying the mission created a priori, it is still possible to change the route. While the platform is in the air following the waypoints, entering in the mission menu will allow the user to modify those waypoints, routes, loiters and so on "in-flight". Those modifications won't produce any change until the mission is saved. So saving the variations over the mission will make the vehicle to follow now the new route created.

## CHAPTER

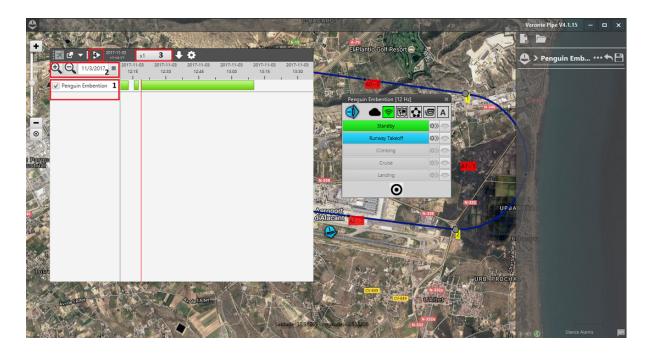
# NINE

# 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.

# 9.1 Tour Play



## Post Flight Panel

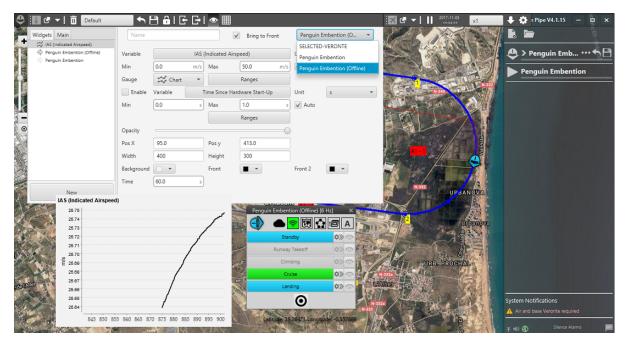
When opening the post flight menu, there are a series of options to configure in order to display the tour:

- 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.

# 9.2 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.

## 9.2.1 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:

 $C: UsersName\_of\_the\_userAppDataRoamingVerontePipe4. Xsession$ 

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.

· I ► 2017-11 17-35	1-03 -52 x1	•	<b>.</b>			
	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
	2017-11-03	12:30	12:45	13:00	13:15	

### 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

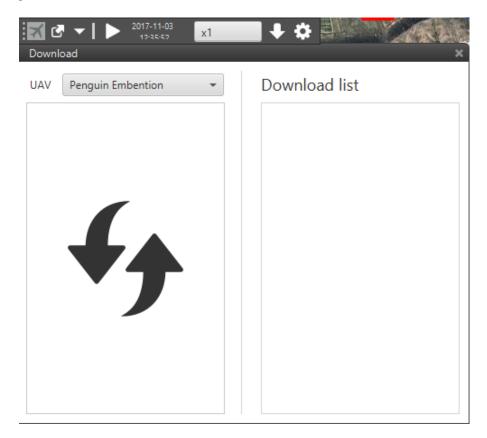
## Export CSV

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.

## 9.2.2 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).



JAV	Mentor		*	Dow	nload li	st
2017/	01/19 10:02:20	S	TR	×	Mentor	2016/12/16 10:1
2016/	12/19 13:42:18	5	TR	×		
2016/	12/16 10:17:33		TR VT			
2016/	12/20 12:35:12	S	TR			
2017/	01/09 12:52:13	S	TR			
2017/	01/09 12:40:16		TR VT			
2017/	01/09 12:20:00	S	TR			
2016/	12/20 14:21:02	S	TR			
2016/	12/02 16:58:02	S	TR			
2016/	12/05 15:36:52	Ş	TR			
2016/	12/20 11:33:29	S	TR			
2016/	12/20 14:12:55	S	TR			
2016/	12/20 13:23:16	S	TR			

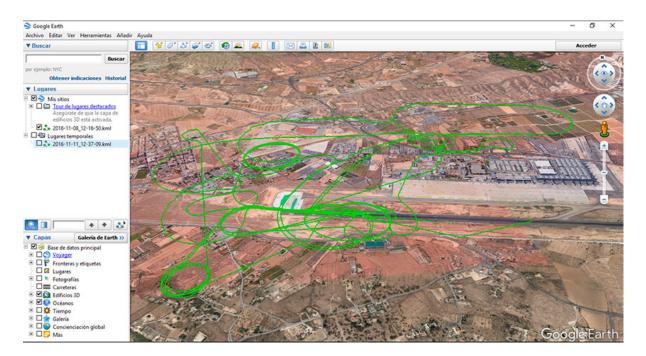


The bar STR corresponds with the information of the Onboard Log and EVT is for the User Log. Once the file has been downloaded, the bar will turn green and right-clicking over it (SRT or EVT) will allow the user to download a CSV file with that information.

The following two images show a .CSV and a .KML files opened respectively with Microsoft Excel and Google Earth.

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854	0.099976	-0.009955	0.669152	-0.101984	15.780.312	157.583.496	3.935.194.250	.000 2.911.20	9 2.911.209	-0.010472	C
855	0.099976	-0.009955	0.669152	-0.002543	15.735.466	157.538.986	3.935.194.250	.000 2.917.49	3 2.917.493	-0.010472	C
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858	0.000000	-0.009955	0.669152	-0.096459	15.765.465	157.569.153	3.935.194.250	.000 2.923.77	6 2.923.776	-0.013614	(
859	0.099976	-0.009955	0.669152	-0.090935	15.718.254	157.522.095	3.935.194.250	.000 2.920.63	4 2.920.634	-0.013614	C
2860	0.000000	-0.009955	0.669152	-0.107508	15.758.446	157.562.958	3.935.194.250	.000 2.923.77	6 2.923.776	-0.011519	C
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Post flight in Microsoft Excel (.csv)



Post flight in Google Earth (.kml)

## CHAPTER

## TEN

# SIMULATION

# **10.1 Professional HIL**

## 10.1.1 Mounting

## 10.1.1.1 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.



HIL Simulator Cable

#### 10.1.1.2 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.

#### 10.1.1.2.1 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.

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DISABLED		To XPlane
Throttle 01	🦳 💻 Throttle 00	Control Output u2
Throttle 02	- Elevator	Offset 0.0
Throttle 03	— Aileron	Comming Factor
Throttle 04	- Rudder	Conversion Factor 1.0
Throttle 05		
Throttle 06	- Flap 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 1.01	~	

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	Ĉ	]
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.

### 10.1.1.2.2 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.

## 10.1.2 X-Plane 10 Settings

## 10.1.2.1 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.

#### 10.1.2.1.1 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.

### 10.1.2.1.2 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

×	Entrada y s	salida de datos	
Configurar Ver datos Prueba de v	uelo	Habilitar: 👿 Internet 🛛 👿 Arch. disc	co 👿 Grafico 🛛 📄 Pantalla de la cabina clear a
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1 8 8 8 times	34 🗄 🖶 🖶 engine power	71 📄 📄 📄 defs: allerons 2	107 🗖 🗖 🗖 switches 2:EFIS
2 🗄 🖶 🖶 sim stats	35 📄 📄 🔂 engine thrust	72 🗖 🗖 🗖 defs: roll spollers 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 hield
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		79	115
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0 0 0 0 art stab ail/elv/rud		82 8 P P pitch cyclic flapping	117
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		83	118
	48 8 8 8 8 8 CHT		
2 2 8 8 8 9 wing sweep/thrust vect	49	84 🖪 🗖 🗖 grnd effect lift, wings	119
3		85 C C C grind effect drag, wings	
4	51	86 C C G grind effect wash, wings	
* C C C @ gear/orakes	52	87	122 1 1 1 radar status
5 BBBB angular moments	52 G G G Generator amperage	88	123
	53 54 54 54 54 54 54 54 54 54 54 54 54 54		
6 M A angular velocities	54 C Dattery voltage	89 grnd effect wash, stabs	
7 👿 📄 🛃 pitch, roll, headings		90 grnd effect lift, props	125
8 📄 🗖 👿 🖌 AoA, side-slip, paths	55 📄 📄 📄 elec fuel pump on/off	91 📄 📄 📄 grnd effect drag, props	126
9 🗖 🗖 🗖 lupa brújula	56 📄 📄 📄 idle speed lo/hi		127
	57 📄 📄 📄 battery on/off	92 9 92 9 92 9 92 92 92 92 92 92 92 92 9	128 📑 📑 📑 flite-plan legs
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1 👿 📄 👿 👿 loc, vel, dist traveled	59 📑 📑 📑 inverter on/off	94 🗖 🗖 🗖 stab lift	129
	60 🖪 🖪 🖪 FADEC on/off	95 📄 📄 📄 stab drag	130 📄 📄 🛃 camera location
2 📄 📄 📄 all planes: lat	61 📑 📑 📑 igniter on/off		131
3 📑 📑 📑 all planes: Ion		96 📄 📄 📄 COM 1/2 frequency	
4 🗄 🖶 🖶 all planes: alt	62 🗧 🗖 🗖 fuel weights	97 🗄 🖶 📄 NAV 1/2 frequency	132 📄 📄 📄 climb stats
	63 📑 📑 📑 payload weights and CG	98 🗖 🗖 🗖 🖪 NAV 1/2 OBS	133 📮 📮 📮 cruise stats
5 📄 📄 🛃 throttle command		99 🗖 🗖 🗖 NAV 1 deflections	Cabina durante el vuelo
6 📑 📑 📑 throttle actual	64 📑 📑 🛃 aero forces	100 📄 📄 📄 NAV 2 deflections	Visualización gráfica en Ver D Archivo en disco 'data.txt' Internet a traves de UDP
7 📑 📑 📑 pluma-norm-beta-revers	65 📄 📄 🛃 engine forces	101 🗖 🗖 🗖 ADF 1/2 status	Internet a traves de LIDP
8	66 📄 📄 📄 landing gear vert force	102 📄 📄 📄 DME status	Velocidad 000
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X-Plane 10 Input and Output Data

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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	

48 altMs1 Mean sea level 48 altAg1 Above ground level 21 loc, vec, dist traveled Vx X velocity – Body Axis Vy Y velocity – Body Axis 59 Vz Z velocity – Body Axis

10.1. 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/	//Pad Dates	
Franciagadaa Excess visadai inscractor informer		
Conecteue a Internet como dempino lo hace para novegar, ingrese la dirección in de LOS (DEMAS explose a continua SUS direccións in esta: Sending to data output at IP address 127.0.0.1 0.0 sec Not receiving any messages now.	, revisar el correo electronico, etc. Si lo deses puede ejecutar el navegador de Internet para probar la conexion. ación. cconds ago, and the send was successful.	
1	10 este estido de debre	
	IP para salida de datos	
Conecti vayan a	te este equipo a otro con un cable de ethernet. Si tiene datos seleccionados para que Internet en la pantalia COMFIGURAR SALIDA DE DATOS, se iran a esta direccion. iUse estos datos UDP para enviar lo que se le ocurra!	
127	.0.0.1 49005 V 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	
	port that 49.000 is the default	
	we send on 49.00 1 49001 is the default	
	port that we 49.002 is send to IPad on 49.002 is the default	
		Y

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				
Idio	ma				
<ul> <li>English</li> <li>Français</li> <li>Deutsch</li> </ul>	<ul> <li>Русский</li> <li>Português</li> <li>Italiano</li> <li>日本語</li> <li>Español</li> </ul>				
Modelo d	ie vuelo				
flight models 2 is OK for most situations, more may be needed for per frame 93 very fast, light, small aircraft or low framerate!					
Inicio <ul> <li>Iniciar vuelo con los motores funcionando</li> <li>Iniciar cada vuelo en rampa</li> <li>Guardar preferencias</li> </ul>	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

### 10.1.2.2 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.

				Opciones graficas		
				RESOLUCIONES		
compress textures to save VRAM	res de	olución alta e (los c textura efect	ambios tendrán o al reiniciar)		framerate- lock to monitor	do not lock (will steady the frame-rate)
run full-screen at this resolution	resolution Parian	netros por defecto del moni	(only app screen bu	olies if the full- atton is checked)	gan	nma 2.2 (takes effect on restart)
			0	OSAS PARA DIBUJAR		
draw view indicator		draw forest fires and balloons		sparse en number of trees		medium    world detail distance
dim under high load or hypoxia	G-	draw birds and deer in nice weather		too many  number of objects		extreme  airport detail
draw hi-res pla textures from o	PE GPT G	draw aircraft carriers and frigates		default   number  of roads	-	static shadow detail
runways follow terrain contour	s	Borealis	=	Siberia Winter   number of cars		medium  water reflection detail
		EFECTOS ESPECIAL	ES		1	DETALLE DE NUBE
3-D bump-maps		draw per pixel lighting	22	(nice) screen anti- aliasing		40%: some.
gritty detail textures		HDR rendering				number of cloud puffs
draw volumetric fog			2)	(nice)  inivel de filtro anisotrópico		
			OPCIONES E	SPECIALES DE VISUALIZACIÓN		
compensación lateral para paisaje en red	0 0 0.0 (grado	s) Campo lateral 0.6 0 de vista	0.00 (g)	display IOS and cockpit on two monitors	O cylinder projection	ir por defecto a la visualización del panel
enne en exclán vestical	0000			FOV (campo de vista) vertical no proporcional	O dome projection	O Vista no-HUD a pantalla completa por defecto
compensación vertical para paísaje en red	0 0 0.0 (grado	rs)				O bloquear a la visualización del panel
mpensación del alabeo	0 0 0.0 (grado		0.0 0 (screen ratio)		set a	II rendering options for maximum speed!

X-Plane 10 Graphics Option

## 10.1.3 X-Plane 11 Settings

### 10.1.3.1 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.

### 10.1.3.1.1 Aircraft Model Installation

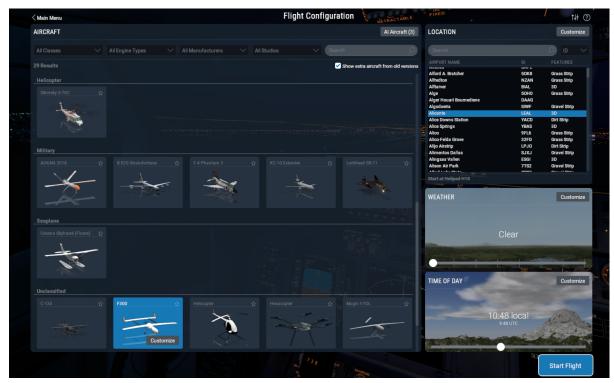
X-Plane 11 simulator is compatible with a wide variety of platforms: airplane, helicopter, multicopter, surface vehicle.... In order to create the platform model, **Plane Maker** tool provided by X-Plane 11 must be used.

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.

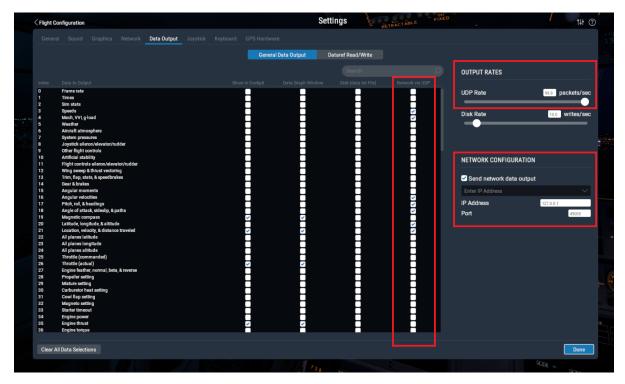
### 10.1.3.1.2 X-Plane 11 Setup

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

## 10.1.4 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.

9		X	8166 +1		2000
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10			XPlane	and a second second	×
12	0	A CONTRACTOR OF A CONTRACT OF	Type simulation		-
		80 - 0	VAV		
-		- 12.	Frequency	50	No.
0	B2 - 2	B1 - 1	IP IP	127.0.0.1	
Co La Coloria	The second second second	-	Recive Port	49005	1000
AN A	and the second	COL COL	Send Port	49000	
	Franking and			STOP	
and the second	the allow , Fo	an Transferran	Ser later and and	and the second	- ALCONTRACTOR
No.	· ····································	and the second second	El IST A TOTAL	The states	and the second s

#### Start GPS simulation

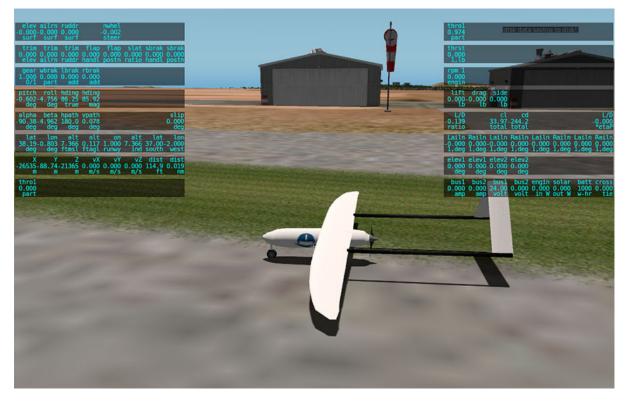
Moreover, it is possible to create a new airport. In order to do that, the user should follow the X-Plane tutorial presented in the next link . Once the aircraft has taken off from the airport on X-Plane the automatic control will start and the aircraft will fly to the defined mission on Veronte Pipe.

**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.

# 10.2 SIL Simulink

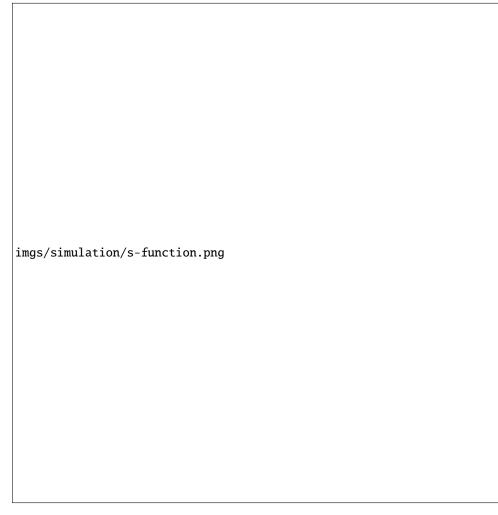
A software in the loop simulation consists of a Simulink model that simulates the behaviour of the system formed by the autopilot and a vehicle, without having the physical devices connected to the computer, in contrast to the HIL which has both the autopilot and (optionally) vehicle connected to the 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.

## 10.2.1 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.



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_measure	en2ant;sensor	Pa / K
			temperature]		
2	Input	Static Pressure 2	[pressure_measure	en2antt;sensor	Pa / K
			temperature]		

	Circuit Time e	Table 1 – continued		-	
PIN	Signal Type	Description	Form	Size	Units
3	Input	Static Pressure 3	[pressure_measure_measure]		Pa / K
4	Input	Dynamic Pressure	[pressure_measure_temperature]		Pa / K
5	Input	IMU 1	[acc_x;acc_y;acc_ temperature]	c_z <b>7gsylr</b> _x;gyr_y;gyr_	z,1512/1988@17/m/s/K
6	Input	IMU 2	· ·	c_z <b>7gylr</b> _x;gyr_y;gyr_	z,szenséðr/m/s/K
7	Input	IMU 3		c_z <b>7gylr</b> _x;gyr_y;gyr_	z,szénégí/m/s/K
8	Input	Magnetometer 1	[mag_x;mag_y;m temperature]	nag4x1sensor	Т
9	Input	Magnetometer 2	[mag_x;mag_y;m temperature]	hag4_x1sensor	Т
10	Input	Magnetometer 3	[mag_x;mag_y;m temperature]	nag4_zelsensor	Т
11	Input	Magnetometer 4	[mag_x;mag_y;m temperature]	nag4_x1,sensor	Т
12	Input	GNSS 1	· ·	<b>r_ådœul</b> ;vert_accu;v	/_ndet\$h;*1@A3t/vmdnown;v_accu] /mm/s
13	Input	GNSS 2	[1;3;lon;lat;alt;hc	r_ <b>ådœul</b> ;vert_accu;v_	/_ndetsh;∜1@ast/vmdown;v_accu] /mm/s
14	Input	Relative Position 1	[1;x_rel;y_rel;z_r	rel;t0xthnce_x;distar	nceny;/linstantel02;xl_accu;y_accu;z
15	Input	Relative Position 2	[1;x_rel;y_rel;z_r	rel;t0xthnce_x;distar	ncæ <u>n</u> y;/linstan*cel_02;xl_accu;y_accu;z
16	Input	GPS Time	[week_number;se	ecoînds_of_week]	• / s
17	Input	Lidar 1	[lidar_measureme	-	m
18	Input	Lidar 2	[lidar_measureme		m
19	Input	Lidar 3	[lidar_measureme		m
20	Input	Lidar 4	[lidar_measureme	-	m
21	Input	Lidar 5	[lidar_measureme	-	m
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	•
26	Input	SCIA Data	[serial_data]	1024x1	•
27	Input	SCIA Length	[serial_length]	1x1	•
28	Input	SCIB Data	[serial_data]	1024x1	•

Table 1 – continued from previous page

PIN	Signal Type	Description	Form	Size	Units
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;lateBad1_v;velocity(mo	dunh#\$]
6	Output	IAS TAS GS	[ias,tas,gs] 3x1	m/s
7	Output	MSL	[msl_from_qnh;msl2ft1om_ISA]	m
8	Output	Angle of Attack / Sideslip	[angle_of_attack;sideslip]	rad
9	Output	Q_Infinty	[dynamic_pressure]1x1	Pa
10	Output	IAS RAW	[ias_raw] 1x1	m/s
11	Output	Tangential Acceleration	[tangential_acceleration]	m/s^2
12	Input	Body Velocities	[lon_v;lat_v;verticaBx4]	m/s
13	Output	Angular Velocities	[roll_rate;pitch_rate3y.dw_rate]	rad/s
14	Output	Angular Acceleration	[acc_z_axis;acc_y_ <b>3xib</b> ;acc_x_axis]	rad/^2
15	Output	Acceleration NED	[acc_north;acc_east3adc_down]	m/s^2

PIN	Signal Type	Description	d from previous pa		Units
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	th <b>3,ba</b> nk_angle]	rad
20	Output	Acceleration Body	[acc_x,acc_y;acc_	zßx1	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	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	•
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	•

Table 2 – continued from previous page

PIN	Signal Type	Description	Form   Size		Units
34	Output	Real Variables	[selected variables(1- 50)]	50x1	•

Table	2 - continued	from	previous page
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## **10.2.2 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:

imgs/simulation/env.png

Environment Example Block

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):

imgs/simulation/static.png

#### 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:

imgs/simulation/dynamic.png

Dynamic Pressure Example Block

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.

imgs/simulation/imu.png

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):

imgs/simulation/magneto.png

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:

imgs/simulation/gps.png

GNSS Receiver Example Block

imgs/simulation/rned.png

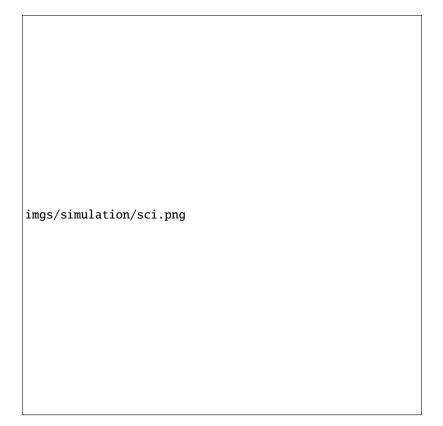
Relative Position (RTK) Example Block

The analogue inputs follow the same reasoning, the user must add the desired values to the mux:

imgs/simulation/adcs.png

ADCs Example Block

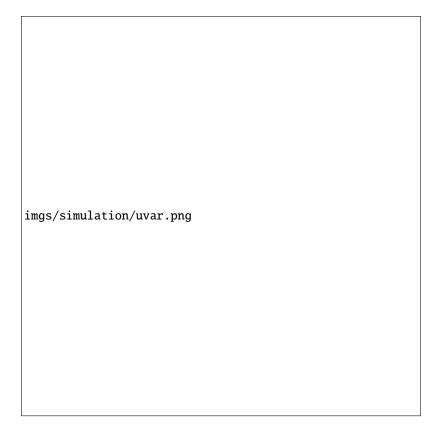
Veronte can manage input and output serial ports as explained here. An easy way to create serial frames (data en length wires) is by using the simulink UDP block. Therefore, the data coming in to veronte should be sent though UDP (if this approach is taken):



SCI Example Block

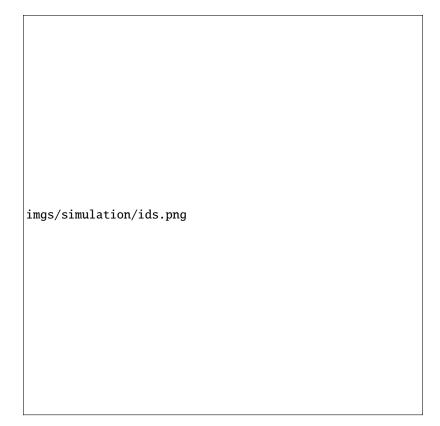
## 10.2.3 Monitoring Telemetry with Simulink

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:

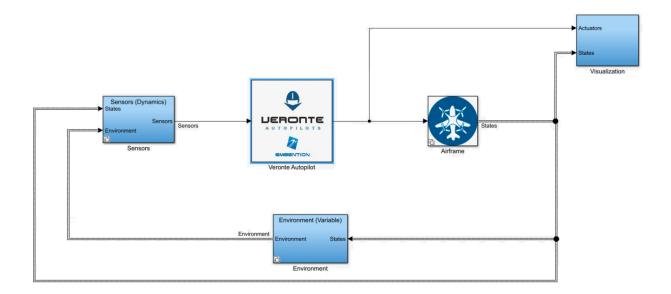


### ID indicator

Lastly, to see their values, just place a *scope* connected to the matching output (pins 32, 33 or 34).

## 10.2.4 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:

imgs/simulation/settings.png

Time step settings

## 10.2.5 Connecting Simulink & Veronte Pipe

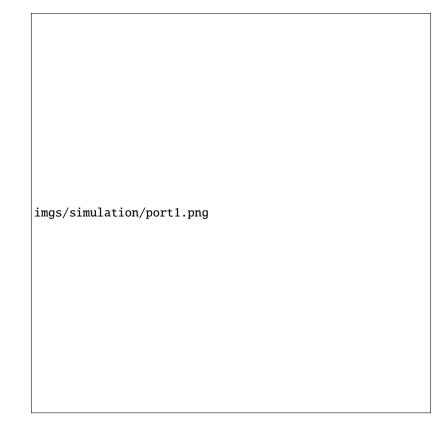
Our Software-in-the-loop simulator can be connected and used alonside Veronte Pipe software. To do it. Follow this steps:

- 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.

imgs/simulation/udp.png

UDP Blocks

3. Configure your destination port.



### Destination UDP Port

4. Set an ethernet network in Preferences as shown using the destination port selected before.

imgs/simulation/port2.png

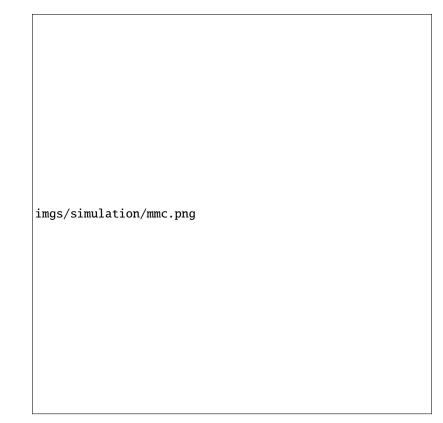
Destination UDP Port (Pipe)

## 10.2.6 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*:



Folder structure (matlab)

# 10.3 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.

## **10.3.1 Veronte Pipe Configuration**

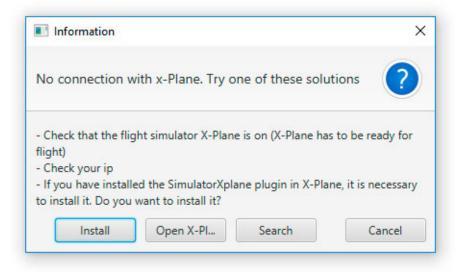
To configure the 3D Simulation in Veronte Pipe it is necessary to complete some steps. First of all, the user must connect Veronte Autopilots to the PC and run Veronte Pipe and XPlane simulator.

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.



Plugin installation request

← → ~ ↑ 📥 > Est	te equipo > DATA (D:) >	5 V	Buscar en DATA	(D:) ,0
Organizar 👻 Nueva ca	arpeta			)ii • 🕜
🔄 Img Manual 🔷	Nombre	Fe	cha de modifica	Tipo
Mentor	Program Files (x86)	04	/01/2017 14:38	Carpeta de archiv
ConeDrive	Users	18	/04/2016 12:00	Carpeta de archiv
Cheonive	VerontePipe2.6.2	09	/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
📰 Imágenes	VerontePipe2.11.1	05	/10/2016 12:35	Carpeta de archiv
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:) ~	<			>
Carpe	eta: XPlane			
		Sele	ccionar carpeta	Cancelar

#### X-Plane folder selection

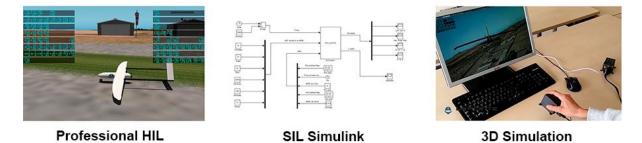
When the XPlane connection is correctly configured, it is possible to click on "Start" in the XPlane connection panel and the 3D Simulation will start. XPlane will take position on the map and attiude datas from Veronte Pipe and will reproduce the aircraft movement in the simulation environment following 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

## **ELEVEN**

## **EXAMPLES**

# 11.1 4G Communication

## 11.1.1 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			+
<b>1025</b> V4 1025	Version: Un Last conne	known ction: Unknown	
<b>1043</b> V4 1043	Version: Last conne	ction: 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



🕂 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	V 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

Cloud

All veronte autopilots registered in Veronte Clould will appear showing the **Name**, **Version** and **Last** connection information.

(Logout) 15/05/2018 13:28:58 Disconnect
Version: 5.1.0 Last connection: 10/05/2018 13:16:27 🐼 🎧 😱 🚺
Version: 4.12.3 Last connection: 11/05/2018 09:35:38 🐼 🏠 💭 🛈

Cloud

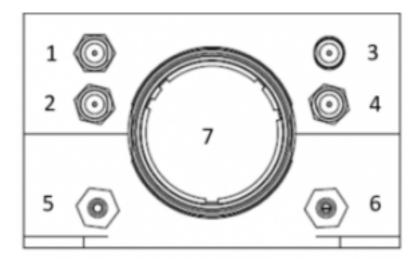
When a Veronte is **ONLINE** the user is able to download the information of the cloud by clicking  $\bigcirc$ 

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		USB		Commgr port 1	00
Payload	Ø6	SCIB	$\leftrightarrow$	Commgr port 2	Q
Sensors	Q0	SCIA - Sara	$\leftrightarrow$	Commgr port 3	00
Stick		SCID - Connector 232	$\rightarrow$	None	00
Veronte Others		SCIC - Connector 485	$\rightarrow$	None	00
XPC Uint8		Commgr port 1	$\leftrightarrow$	USB	00
XPC CAP		Commgr port 2		SCIB	00
		Commgr port 3		SCIA - Sara	00
		Commgr port 4	$\rightarrow$	None	03
		Commgr port 5	$\rightarrow$	None	00
		Commgr port 6	$\rightarrow$	None	08
	<b>Q</b> <sup>0</sup>	Custom message 1	$\rightarrow$	None	00
	Ø0	Custom message 2	$\rightarrow$	None	00
	Q <sub>0</sub>	Custom message 3	$\rightarrow$	None	0
Add device		Tunnel 1	$\rightarrow$	None	Q.
Addracylee	80	Tunnal 2		None	86

XPC Uint8

# **11.2 Configurations**

## **11.2.1 Device Configurations**

### 11.2.1.1 Magnetometer Honeywell HMR2300-232

We will configure this device in Pipe directly. If we click in:





Pipe will display you the Setup Toolbar (for more information see *Setup Toolbar*):

🖾 м600 🛪 💿 🧿 葦	🚱 🗱 🕮 🗂 🔺
► Actuators	Use three axis
► Communications	Navigation
▶ Payload	Custom setting 👻
Sensors 1 Accelerometer	Square error T <sup>2</sup>
Altimeter	Decimation 10
► GNSS	0 - Integer var sensor 1
Gyroscope	1 - Integer var sensor 2
I2C Devices	2 - Decimal var sensor 1
Magnetometer 2	3 - Decimal var sensor 2
Configuration 3	4 - Internal
<ul> <li>Obstacle detection</li> </ul>	5 - External HMR2300
Pressure	6 - External LIS3MDL
► RPM	
Speed down	
Ultrasound	
Stick	
► Veronte	
► Others ~	
Add device 🔹	

### Step 2

Following the steps you will arrive to the configuration panel and you have to choose **5** - **External HMR2300**. Furthermore, you can configure your own Rotation Matrix clicking in:

мбоо 🛪 🙆 🖸 🗄	E 🚱 🗱 🍘 🗂 🔺	5%**
► Actuators	Use three axis	
<ul> <li>Communications</li> <li>Payload</li> <li>Sensors</li> <li>Accelerometer</li> </ul>	Navigation       Custom setting       Square error     1.0E-10	
Altimeter GNSS Gyroscope I2C Devices Magnetometer	Decimation 10 2 0 - Integer var sensor 1 1 - Integer var sensor 2 2 - Decimal var sensor 1 3 - Decimal var sensor 2	
Configuration <ul> <li>Obstacle detection</li> <li>Pressure</li> <li>RPM</li> </ul>	4 - Internal         1           • 5 • External HMR2300         0.0           • 6 - External LIS3MDL         0.0	×
Speed down Ultrasound Stick Veronte	0.0 0.0 1.0 3 4	$\mathbf{y}$
► Others		二十二十二

Step 3

To finish the configuration of our magnetometer, you have to go to the **Connections** section in the **Setup Toolbar**.

м600 🛪 🙆 💿	🗄 👀 端 🙆	ð 🗂 🔺	
Pin: 19 1	Functionality		
			4
	Baudrate	9600 -	
	Length	8 👻	
	Stop	1 -	
	Parity	Disabled -	
► ADC			
Arbiter			-
► CAN			
► FTS			
► GPIO/EQEP			
► GPIO			
► 12C			
▶ Others			
▶ PWM 2			
Serial			
232 3			
▶ 485			
▶ HCD V			
Add 👻			

Step 4

If you follow the indications and introuce the values shown in the **Figure: Step 4** your magnetometer will be configured. To get more information of the Magnetometer Honeywell HMR2300-232 datasheet you can go to: Smart Digital Magnetometer HMR2300

### 11.2.1.2 Radar Altimeter Smartmicro

We will configure this device in Pipe direcly. If we click in:





Robbie 🛪 🧿	0		😧 🗘 🕯	🏠 🗂 🖌	<b>\$</b>		
Pin: 26 1	Co	onfigu	ation Telem	etry			
	Ba	udrate	250000	. <b>0</b> B	d Units ID	DEC 🝷 Units Mask	BIN 👻
	Ma	ailboxe	es reserved RX	8 1	Mailboxes available TX	( 24	
	#		Mailboxes	Extended	ID	Mask	+
	1	-	8		577	0	
► ADC							
► Arbiter							
CAN 2							
► ► FTS							
► GPIO/EQEP	_						
► GPIO							
► I2C							
▶ Others							
► PWM							
<ul> <li>Serial</li> <li>LICP</li> </ul>							
Add -							
	< 🗆						→

Pipe will display you the Setup Toolbar (for more information see *Setup Toolbar*):

Step 2

Following the steps you can access successfully in the CAN connections data sheet, here we will configure our altimeter. As you can see, you can work with two independent CAN data buses (A and B), each one have two cables (High and Low) one with positive polarity and another one negative, the figure of the upper left corner shows you what pins they are.

In this example we have configured the Smartmicro Radar-Altimeter in channel B, the recommended values to this configurtion are:

Robbie 🛪 🙆	◎ ‡ 🛛 <	🖏 🖾 🔺		
Pin: 28	Configuration	Telemetry		
	Baudrate	000000.0 Bd	Units ID DEC	Units Mask BIN 👻
	Mailboxes reserv	ved RX 5 Mailł	oxes available TX 27	2
	# Mailb	oxes Extended	ID	Mask
	1 - 5	187	2 0	1
		3		
► ADC				
Arbiter				
▼ CAN				
►A				
► B				
► FTS				
► GPIO/EQEP				
► GPIO				
▶ I2C				
▶ Others				
► PWM				
▶ Serial				
LICD V				
Add 👻	4			

Step 3

Robbie 🛪 🙆	ً 至 🗘 🗱 🕰 🗖 🔺	
Pin: 28	Configuration Telemetry	
	► TX Ini	
	▶ TX	
	<b>⊙</b> RX	
(		Э
	EXT ID: 1872 Little endian	J
ADC     Arbiter		
▼ CAN		
► A		
► B		
► FTS		
► GPIO/EQEP		
► GPIO		
► 12C		
Others     PWM		
<ul> <li>Serial</li> </ul>		
► LICD V		
Add 👻		



In **Telemetry** section you can add or delete messages clicking in "+" or "-"

Robbie 🛪 🙆 (	o 🔁 🚱 📽 🕰 🗔 🔺	
Pin: 28	Configuration Telemetry	
	▶ TX Ini	
	► TX	Second States
	▼ RX	A. Harrison
	Name	2 Variable 3
	🐨 🗕 🕂 🕞 Radar AGL (Above Ground Level) – Height	Checksum
	- + + Radar Speed Down 4	Matcher
► ADC	- V V Lavar speed bown	Skip
Arbiter		Parse Ascii
▼ CAN		Position
► A ► B		and the second sec
► FTS		and the second sec
► GPIO/EQEP		
► GPIO		and the second s
► 12C		9
Others     PWM		and the state of the second
<ul> <li>Serial</li> </ul>		and the second second
▶ 11CD ~		
Add 👻		

Step 5

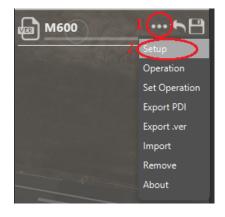
If you have followed the indications and introuced the values shown in previous figures, your radar-altimeter will be configured.

To get more information of the Smartmicro Radar - Altimeter datasheet you can go to:

- Micro Radar Altimeter User Manual
- Micro Radar Altimeter Data Sheet

#### 11.2.1.3 Volz Servo

We will configure this device in Pipe direcly. If we click in:





Pipe will display you the Setup Toolbar (for more information see *Setup Toolbar*):

. 1			Producer		Consumer	
Actuators 1	High	00	USB	$\leftrightarrow$	Commgr port 1	03
Communications Payload	High	$Q^0_0$	Veronte LOS	<b>→</b>	Commgr port 2	Q.
Sensors	High	$Q_0^0$	Veronte LTE	$\leftrightarrow$	Commgr port 3	Q.
Stick	High	$Q^0_0$	RS232		External magnetometer	Q
Others 2	High	$Q^0_0$	RS485	$\rightarrow$	None	Q;
1/0 Manager 3	High	$Q_0^0$	Commgr port 1	$\leftrightarrow$	USB	Q.
CAN Config	High	$Q^0_0$	Commgr port 2	$\leftrightarrow$	Veronte LOS	Q;
Digital Input Manager	High	$Q_0^0$	Commgr port 3	$\leftrightarrow$	Veronte LTE	Q;
	High	$Q^0_0$	Commgr port 4	$\rightarrow$	None	Q\$
	High	$Q^0_0$	Commgr port 5	$\rightarrow$	None	Q;
	High	$Q^0_0$	Commgr port 6	$\rightarrow$	None	Q;
	📃 High	$\dot{Q}^{0}_{0}$	Custom message 1		RS485	Q\$
	High	$\mathbf{Q}_0^0$	Custom message 2	$\rightarrow$	None	
	High	$Q^0_0$	Custom message 3	$\rightarrow$	None	Q;
	High	Q <sup>0</sup> <sub>0</sub>	Tunnel 1		Y1 splitter	-03

Step 2

Following the steps you can access successfully in the I/O Manager menu, here you will find three differents channels to use in your Volz Servo, you have to be sure that the consumer cell (right column) of your Custom message is configured with **RS485**.

• • •			Producer		Consumer	
Actuators	High	00	USB 🔶	→	Commgr port 1	
Communications Payload	High	00	Veronte LOS	→	Commgr port 2	¢;
Sensors	High	00	Veronte LTE	→	Commgr port 3	Q <sup>0</sup>
Stick	High	08	R\$232		ternal magnetometer	08
Veronte					-	
Others	High	00	RS485	→	None	00
I/O Manager	High	00	Commar port 1	→	USB	03
CAN Config	High	08	Big endian	Time o	out 0.02 s	Ða
Digital Input Manager						
	High	00	-			03
	High	00				00
	High	$Q_0^0$				00
	High	$Q^0_0$				03
	🗌 High					Q <sup>0</sup>
	High	$Q^0_0$				Q <sup>0</sup>
	High	$\mathbf{Q}_0^0$				Q <sup>0</sup>
	High	00	1			03

Step 3

You can add or delete messages clicking in "+" or "-".

Time Out: frequency of the messages.

Actuators		Producer	_	Consumer		A CONTRACTOR OF THE OWNER
Communications	High 👯	USB	$\rightarrow$	Commgr port 1	$Q_0^0$	
Payload	High 🕸	Veronte LOS	$\leftrightarrow$	Commgr port 2	$Q_0^0$	
Sensors	High	Veronte LTE	$\leftrightarrow$	Commgr port 3	00	the same
Stick	High 🕵	RS232	ī→	External magnetometer	Q <sup>0</sup>	
Veronte Others	High 👯	RS485	$\rightarrow$	None	Q0	
I/O Manager	High 🕵	Commgr port 1	$\leftrightarrow$	USB	Q <sub>0</sub> <sup>0</sup>	
CAN Config	High 🕵	Name				
Digital Input Manager	High 🕵			Matcher x77	1	
	High 🕵	- 4		Matcher x1		
	High 🔯	- 4		Actuator Output s1		
	High 🕸			CRC (Custom)		
	High 🕵			CRC (Custorii)		
	High 🕵				00	the set
	High				00	1
	High 🕰					

Step 4

We differentiate four items:

• Matcher x77: activate the silence mode, servo do not reply when it receive the messsage.

•			Producer		Consumer		Sor and
Actuators	High	Q0	USB	$\leftrightarrow$	Commgr port 1	<b>0</b> 8 ^	
Communications	High	08	Veronte LOS		Commgr port 2		and the
Payload							
Sensors	High	Ф <u>8</u>	Veronte LTE	$\rightarrow$	Commgr port 3	Ф <u>0</u>	
Stick	High	Q <sup>o</sup>	RS232	$\rightarrow$	External magnetometer	08	Superior and
Veronte Others	High	¢8	RS485	<b>→</b>	None	08	
I/O Manager	High	¢\$	Commgr port 1	T↔	LISR	ac l	
CAN Config			Name		Type Matcher		
Digital Input Manager							
			-+		nº Bits 8.0		
	High	<b>0</b> °		· 🛧 🗉	Value 119.0		
	High	00	_ 1		Mark 0		
	High	00					
	High High	¢°					
	High	Q <sup>o</sup>					
	High	Q <sup>o</sup> o					
Add device 👻	High	¢8					

🖸 Voltz-4s_s 🛪 🙆 🧕	<u>‡ 🛛 🌣</u>	ê 🗗					
Actuators			Producer		Consumer		AT REAL
Communications	High	Ф <u>С</u>	USB	$\rightarrow$	Commgr port 1	$ \Phi_0^0 $	<b>N</b> States
Payload	High	Q0	Veronte LOS	]↔[	Commgr port 2	00	atte
Sensors	High	Q <sup>0</sup>	Veronte LTE	$\leftrightarrow$	Commgr port 3	$\Phi_0^0$	- Hitson a
► Stick	High	<b>Q</b> \$	RS232	i→i	External magnetometer	Q0	C. Harris
<ul> <li>Veronte</li> <li>Others</li> </ul>		¢8	RS485	i→i	None	00	
I/O Manager		<b>Q</b> <sup>2</sup>	Commgr port 1	Ì↔Ì	LISR	62	
CAN Config		08	Name		Type Matcher		*
Digital Input Manager	High	08	- 🗊	1	nº Bits 8.0		)
	High	<b>Q</b> 0	-+		Value 1.0		)
	High		- 4				dec
	High	0°			-		
	🔲 High	<b>Q</b> o			- 64*		
	High -	<b>Q</b> <sup>o</sup>					
	High H	<b>Q</b> o					
Add device 👻	High	<b>Q</b> 0					

- Step 5
- Martcher x1: it represents the identification of the servo.

Step 6

• Actuator Output s1: it references the output variable of the servo.

		Producer	Consumer	All and a second
Actuators Communications	High 🕵	USB	Commgr port 1	
Payload	High 🕵	Veronte LOS	Commgr port 2	08
Sensors	High	Veronte LTE	Commgr port 3	03 - 4 k
Stick	High 🕸	R\$232	External magnetometer	
Veronte			External magnetometer	
Others	High 🕸	RS485	None	
I/O Manager	High 🕸	Commgr port 1		0°.
CAN Config Digital Input Manager	High 🕵	Name	Type Variable	
	High 🕵		Actual	tor Output s1
	High 🕵			
	High 🕸		Compress	
		- ↓ 1	🕨 📑 ' 🔵 Compress (Decir	mals)
			🕨 🔲 ( OCompress (Bits s	igned) 16.0
	High		Compress (Bits u	unsigned)
	High 🛱		Encode	and the second
	riigit 🔤			
	High High		Min	45.0
Add device 👻			Min	45.0
Add device 🔹	High 🙀			
Add device 🔹	High 🕵		Max	
Add device •	High 🕵		Max Decode	-45.0



Value "16" is very important to realice a correct configurtion.

• **CRC:** it is a parameter used by *Veronte* to check the consistency of the messages.

Actuators       High & USB ← Commgr port 1         Communications       High & Veronte LOS ← Commgr port 2         Payload       High & Veronte LOS ← Commgr port 2         Sensors       High & RS232 ← External magnetometer         Stick       High & RS232 ← External magnetometer         Veronte       High & Commgr port 1         Others       High & Commgr port 1         I/O Manager       High & Commgr port 1         CAN Config       High & Commgr port 1         Digital Input Manager       High & Commgr port 1         High & High & Commgr port 1       IICR         High & High & Commgr port 1       IICR         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1         High & Commgr port 1       High & Commgr port 1     <			Producer		Consumer	and the second second
Payload       High S       Veronte LOS       Commgr port 2       S         Sensors       High S       Veronte LTE       Commgr port 3       S         Stick       High S       RS232       External magnetometer       S         Veronte       High S       Commgr port 1       IISR       S         Others       High S       Commgr port 1       IISR       S         I/O Manager       High S       Commgr port 1       IISR       S         Others       High S       Commgr port 1       IISR       S         Digital Input Manager       High S       Name       Back From       4.0         High S       Image: S       Image: S       Image: S       Image: S       Image: S         High S       Image: S <th></th> <th>High</th> <th>USB</th> <th><math>\rightarrow</math></th> <th>Commgr port 1</th> <th>- Cal 1</th>		High	USB	$\rightarrow$	Commgr port 1	- Cal 1
Sensors       High S       Veronte LTE       Commgr port 3       S         Stick       High S       RS232       External magnetometer       S         Others       High S       Commgr port 1       ISR       None       S         I/O Manager       High S       Commgr port 1       ISR       C       S         CAN Config       High S       Commgr port 1       Type Checksum       Back From       4.0         Back To       0.0       Endianness       Big endia         High S       High S       C       Polynomia         High S       High S       Endianness       Big endia         High S       High S       Endiannes       Big endia         High S       High S       Endiannes       Big endia         High S       Endiannes<		High	Veronte LOS	$\rightarrow$	Commgr port 2	
Stick       Veronte       High ØS       RS232       External magnetometer       ØS         Others       High ØS       RS485       None       ØS         I/O Manager       High ØS       Commgr port 1       HISR       HISR         CAN Config       High ØS       Name       HISR       Mame         Digital Input Manager       High ØS       Name       Back From       4.0         High ØS       HIGH ØS       Item for the second s			Veronte I TF	ī ↔ ī	Commar port 3	
Veronte       High       RS485       None       RS485         I/O Manager       High       Commgr port 1       USR       Type       Checksum         CAN Config       High       Image: Commgr port 1       Image: Checksum       Type       Checksum         Digital Input Manager       High       Image: Commgr port 1       Image: Checksum       Back From       4.0         High       Image: Checksum       Image: Checksum       Back From       4.0         High       Image: Checksum       Back To       0.0         Endianness       Big endia       Image: Checksum       Image: Checksum         High       Image: Checksum       Image: Checksum       Image: Checksum         High       Image: Checksum       Image: Checksum       Image: Checksum         Optional       High       Image: Checksum       Image: Checksum         High       Image: Chec						100 4 40
I/O Manager         CAN Config         Digital Input Manager         High         High         High         High         High         High         High         High         Commgr port 1         High         High <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
CAN Config   Digital Input Manager     High &   High &<		High 👯	RS485	$\rightarrow$	None	
Digital Input Manager     High     High     High     High     Name     Back From     Back To     0.0     Endianness     Big endia     High     High     Name     Back From     Back To     0.0     Endianness     Big endia     Ocrean     High     High     Name     Back From   Back To   0.0   Endianness   Big endia   Ocrean   High   Image: Start value     Custom     Name     Back To   0.0   Endianness   Big endia   Or Polynomia   Type   Custom   nº Bits   16.0   Polynomial   40961.0   Start value	nager	High	Commgr port 1	$\leftrightarrow$	LISR	
Digital Input Manager     High &	2	High	Name		Type Checksum	1
High &   Start value	Input Manager				Rack From	40
High        Big endia         High        Big endia         High        CRC         High        Custom         High        Big endia         High        Delta						
High 📽       Image: Construction of the const			-+	TU	Natcher XI	
High 📽       Image: Custom       Type       Custom         High Image: Custom       N° Bits       16.0         High Image: Custom       Polynomial       40961.0         Add device       High Image: Custom       Start value			-+	1	Actuator Output s1	-
High     Custom       High     Image: Custom       High     Image: Custom       N° Bits     16.0       Polynomial     40961.0       Start value     65535.0		High	- 4		CRC	Polynomial
Add device     High 📽       High 📽       Bigh 📽       Bigh 📽       Bigh 📽       Bigh 📽       Polynomial       40961.0       Start value		High 🕵				Custom
Add device  High		High 🔯			nº Bits	16.0
Add device		High 🖧			Polynomial	40961.0
Add device	davias —	High			Start value	65535.0
	device				Final Xor	0.0
Reflect In	San Prairie				Reflect In	
Reflect Out	A LANGE	and the second			Reflect Out	
Sum8	aller.					



This structure is repeated depending of the servos number.

If you have followed the indications and introuced the values shown in previous figures, your Volz Servo will be configured.

This section contains the whole configuration process of four different devices 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 device trough some real examples.

The devices available are:

- Magnetometer P/N HMR2300-232 (Local P/N SESN007)
- Volz Servo Actuators
- Radar Altimeter P/N SESN001

# **11.2.2 Plataform Configurations**

# 11.2.2.1 Fixed Wing-Mentor

## 11.2.2.1.1 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 🛪	🐵 🖻 🗄 😵 🖲	🗱 🙆 🗀	🔺 CfgMgr	StepMgr	
			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		L	PWM 2	Actuator Output s2	
2			✓ Active High	Actuator Output s3	
3				Actuator Output s4	
4			Mode	Actuator Output s5	
6			Min	Actuator Output s6	
7			Max	Actuator Output s7	
8				Actuator Output s8	
9			Servo	None	
Serial		L			
► 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*.

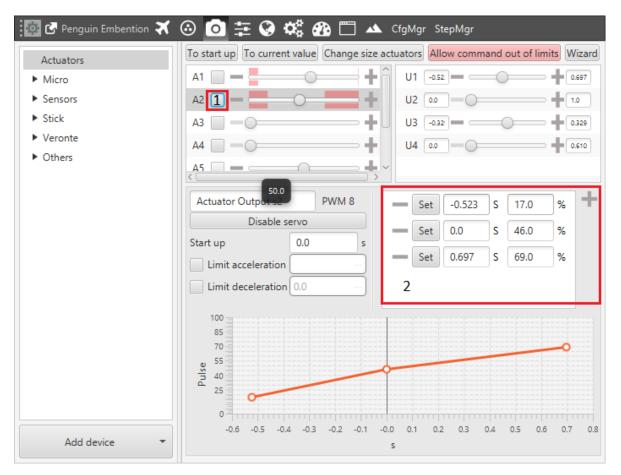
2. With the five controls now having a value of the S vector, the SU matrix can now be edited. Here the user configures the relation between the controller outputs ("u") and the servo movements ("s"). In the case of

**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.

e name Pe	nguin Embe	ention	AES (			Type C
US Set inv(SU)	Edit					
Set inv(US)	Edit					
Edit						×
	ſ	-	-	-	-	
		ontrol Output u1 - ching	Control Output u2 - Thrusting	Control Output u3 - Rolling	Control Output u4 - Yawing	
- Actuator C	)utput s1	0.0	0.0	1.0	0.0	
- Actuator C	)utput s2	1.0	0.0	0.0	0.0	+
- Actuator C	Output s3	0.0	1.0	0.0	0.0	
- Actuator C	Output s4	0.0	0.0	0.0	1.0	
- Actuator C	output s5	0.0	0.0	1.0	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 (s2,A2) 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).

#### 11.2.2.1.2 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.

#### 11.2.2.1.2.1 Takeoff

The takeoff phase will be the one where the aircraft goes from the initial to the lift off point.

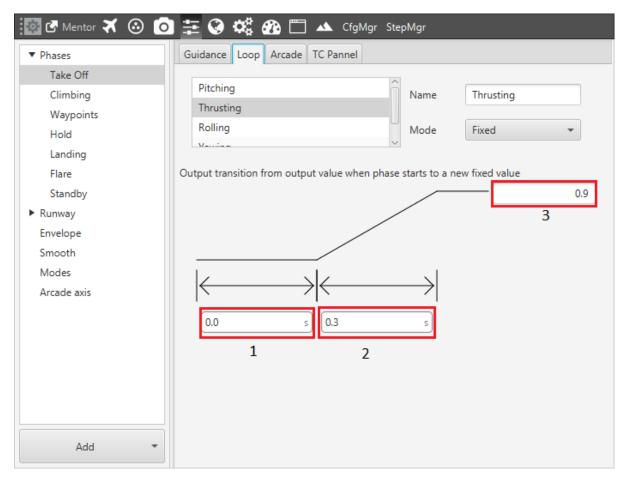
🔯 🗹 Mentor 🛪 🛞 🧿	\Xi 🚱 🗱 🚰 📥 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Take Off	Hold Name Take Off
Climbing	+
Waypoints	×
Hold	•
Landing	
Flare	Pitch -
Standby	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)
▶ Runway	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad
Envelope 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.

## 11.2.2.1.2.2 Climbing

The climbing phase is used to make the airplane reach the cruise altitude after the takeoff.

🔯 🕑 Mentor 🛪 🙆 🧿	I 🗄 🏵 端 🕰 🗖	] 🔺 CfgMgr StepMg	r	
▼ Phases	Guidance Loop Arcade	TC Pannel		
Take Off	Climbing	<b>^</b>	Name Climbing	٦
Climbing		+		
Waypoints		×		
Hold		*		
Landing				^
Flare	Hover gain			
Standby	Horizontal	0.0		
Runway				
Envelope Smooth	Vertical	0.0		
Modes	Runway Runway 1 👻	Advanced		
Arcade axis	Loiter point	✓ Ref Runway Loiter	· · · · ·	
	Direction	✓ Ref Runway Direct	tion 💌	
	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			Ļ

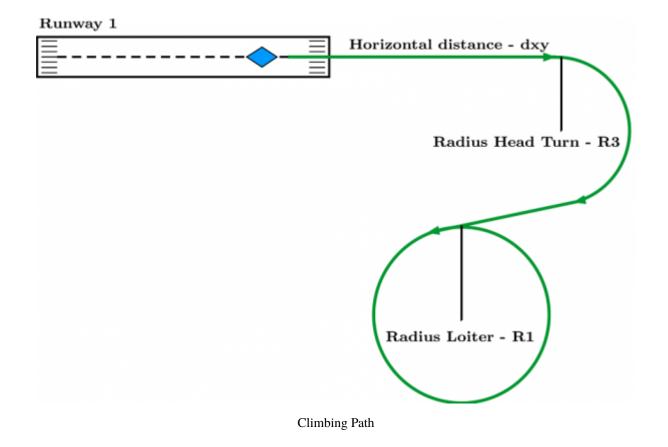
Climbing Phase – Guidance

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].



## 11.2.2.1.2.3 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 🛪 🙆 🧿	1 🗄 🚱 端 🚳 🗔	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade	TC Pannel	
Take Off	Cruise	<b>^</b>	Name Waypoints
Climbing		+	
Waypoints		×	
Hold		*	
Landing		<b>`</b>	~
Flare	Line attraction	40	]
Standby	Patch	0	[9]
Runway			
Envelope	Acceleration proportional	0.0	J
Smooth Modes	Set height mode	2.5D 👻	
Arcade axis	Set limit acceleration		
	Acceleration	0.0 m/s <sup>2</sup>	)
	Deceleration	0.0 m/s <sup>2</sup>	)
	Set speed		
	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.

# 11.2.2.1.2.4 Hold

This phase is used to keep the aircraft at a constant heading, for example, when the radio connection is lost.

▼ Phases	💿 🚋 🚱 🗱 🚱 🛅 🔺 CfgMgr StepMgr Guidance Loop Arcade TC Pannel
Take Off Climbing Waypoints Hold Landing	Hold Name Hold
Flare Standby • Runway Envelope	Pitch
Smooth Modes Arcade axis	Roll       None     Time (Ramp time)       Slope (Ramp rate)     Ewma (TAU)       Constant value: 0.0 rad     0.0
	IAS (Indicated Airspeed)
	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)     Constant value: 0.0 m/s     0.0 Constant value: 0.0 m/s
Add	

#### 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.

### 11.2.2.1.2.5 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	<b>^</b>	Name Landing
Climbing		+	
Waypoints		×	
Hold		4	
Landing	Horizontal	0.0	^
Flare			
Standby	Vertical	0.0	
Runway	LoiForce		
Envelope		Advanced	
Smooth	Runway Runway 1 👻		
Modes	Touch point	Ref Runway Touch Point	· ·
Arcade axis	Loiter point	✓ Ref Runway Loiter	*
	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

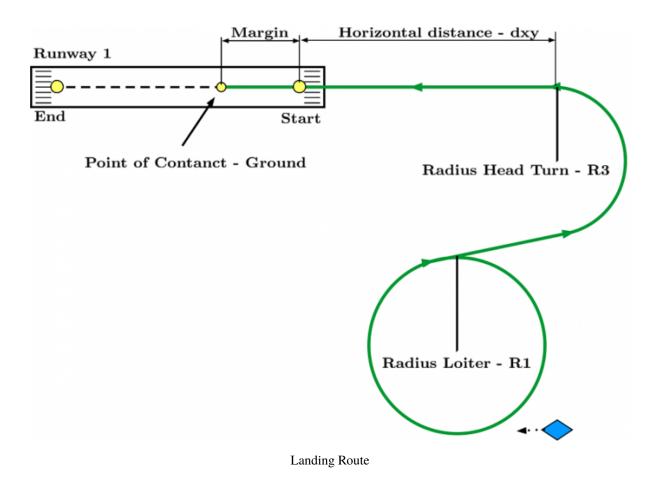
The guidance to be configured is Landing:

- 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.



#### 11.2.2.1.2.6 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 🛪 🙆 🧿	🕽 🇱 🚱 🗱 🚰 📥 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Take Off Climbing Waypoints Hold	Hold Name Flare
Landing Flare	Roll — +
Standby Runway Envelope	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU) 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 – 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.

#### 11.2.2.1.3 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 🛪 🙆 🧿	🛿 葦 🚱 🗱 🖽 🗂 🔺 CfgMgr StepMgr	
▼ Buttons SBY Button (EIN) SBY Button	TKO Button     Max     0       Events     AND     OR     NOT     Actions	+
<ul> <li>CRU Button</li> <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     Delay	
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.

## 11.2.2.1.3.1 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 🛪 🙆 🧿	l 🏛 🎯 📽 (	🌮 🗔 🔺	CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	TKO to CMB		Max 0		
SBY Button	Events	AND	OR NOT	Actions	+
TKO Button		IAS>8			СМВ
CMB Button  LND Button		AND TKO Phase			
▼ Failsafe					
Auto when No Stick					
LinkOff to LND					
HLD when No GPS					
Low Battery					
▼ Stick				Delay 0.0	Periodical: Off
🖌 Auto Mode					
Manual Mode (Arc	🖉 🖹 Var	iable	→ IAS>8	8	Time 0.0
<ul> <li>Transitions</li> </ul>				-	
✓ TKO to CMB	Variable	IAS (Indi	icated Airspee	d)	
CMB to CRU Arcade Trim	Max				
✓ When Event Mark	Min	8			
<ul><li>✓ LND to Flare</li><li>✓ No name</li></ul>	Invert range	$\checkmark$			
	Min				Max
New Automation	Event triggere	d on blue area			

Take off to Climb - Automation

The action will be a change of Phase:

• Phase: Climbing.

#### 11.2.2.1.3.2 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 🛪 🙆 🧿	I 🇄 🥝 🐝 6	🏠 🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	CMB to CRU	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
✓ TKO Button ✓ CMB Button		AGL>90 AND		CRU
✓ LND Button ► Failsafe		CMB Phase AND		
► Stick		IAS > 6		
<ul> <li>▼ Transitions</li> <li>✓ TKO to CMB</li> <li>✓ CMB to CRU</li> </ul>				
Arcade Trim  When Event Mark			Delay 0.0	Periodical: Off
LND to Flare	🔗 🖹 Vari	able 👻 🖬 IAS >	6	<b>Time</b> 0.0
	Variable	IAS (Indicated Airspee	d)	
	Max			
	Min	6		
	Invert range	$\checkmark$		
	Min			Max
New Automation	Event triggered	d on blue area		

to Cruise - Automation

Finally, the action will be a change of Phase:

• Phase: Cruise.

# 11.2.2.1.3.3 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 ✓ CRU Button	LinkOff to LND Events	Max 0	Actions	+
✓ TKO Button ✓ CMB Button		TX Error OR		LND AUTO
<ul> <li>✓ LND Button</li> <li>✓ Failsafe</li> <li>Auto when No Stick</li> <li>LinkOff to LND</li> </ul>	F	RX Error AND light Phases		
HLD when No GPS Low Battery				
► Transitions			Delay 0.0	Periodical: Off
Arcade Trim     When Event Mark     LND to Flare	Variable	iable  TX E		Time 1.0
	Max	0.8		
	Min Invert range			
	Min			Max
New Automation	Event triggere	d on blue area		

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.

#### 11.2.2.1.3.4 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 🛪 🙆 🧿	I 🇄 😧 🐝	🕐 🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	Low Battery	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
TKO Button	Pov	ver Input < 15.2V		LND
CMB Button LND Button		AND On Phase	AUTO	
▼ Failsafe				
Auto when No Stick				
HLD when No GPS				
Low Battery				
<ul> <li>Stick</li> <li>Transitions</li> </ul>			Delay 0.0	Periodical: Off
<ul> <li>Arcade Trim</li> <li>When Event Mark</li> </ul>	8 🗈 Va	ariable 👻 Powe	r Input < 15.2V	<b>Time</b> -1.0
✓ LND to Flare	Variable	Power Input		
	Max			
	Min	15.2		
	Invert range			
				Max
New Automation	Min Event trigger	ed on blue area		Wida

Low Battery – Automation

Two actions are configured:

- Phase: Landing.
- Mode: Auto.

#### 11.2.2.1.3.5 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 🛪 🙆 🧿	i 🌐 😧 🛱	🚯 🛅 🔺 CfgN	/lgr Ste	pMgr	
Buttons     SBY Button (EIN)	LND to Flare	Ma	ах 0		
SBY Button	Events	AND OR	NOT	Actions	+
<ul> <li>✓ TKO Button</li> <li>✓ CMB Button</li> <li>✓ LND Button</li> <li>✓ Failsafe</li> <li>✓ Auto when No Stick</li> </ul>		nside Polygon AND AGL < 8 AND Phase LND			Flare
LinkOff to LND HLD when No GPS Low Battery ▼ Stick				Delay 0.0	Periodical: Off
<ul> <li>✓ Auto Mode</li> <li>✓ Manual Mode (Arcad</li> <li>▼ Transitions</li> </ul>	Ø 🗈 Va	ariable 👻	AGL •	< 8	<b>Time</b> 0.0
TKO to CMB     CMB to CRU     LND to Flare     Arcade Trim	Variable Max Min	AGL (Above Groun	d Level) ·	– Hei	
When Event Mark	Invert range			_	Max
New Automation	Min Event trigger	ed on blue area			WIGA

#### Landing to Flare

When these events are fulfilled, Mentor enters in the Flare phase and lands.

#### 11.2.2.1.3.6 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 🛪 🙆 🧿	I ≢ Ø 🕸	🖁 🕸 🗂 🔺	CfgMgr Ste	pMgr	
▼ Buttons	Auto Mode		Max 0		
SBY Button (EIN) SBY 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	2 🗈	Variable	▼ Stick	UP	<b>Time</b> 0.0
▼ Transitions					
✓ TKO to CMB	Variable	St	ick Input r8		
✓ LND to Flare	Max				
Arcade Trim	Min	0.75	_		
When Event Mark	IVIII	0.75			
	Invert rang	je 🗸			
	Min	1			Max
New Automation	Event trigg	gered 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.

## 11.2.2.2 Flying Wing-W210

#### 11.2.2.2.1 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.

#### 11.2.2.2.1.1 Servos Output

The first step of the process is the servos configuration.

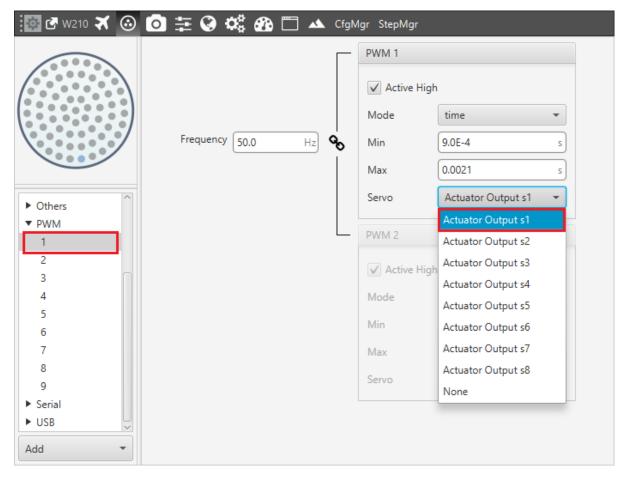
The controls of the airplane are the two control surfaces and throttle. Each one of these control corresponds to a pin of the connector and they must be positioned in the same order in an **S** vector who represents the **Actuator Output**. It is possible to connect any pin to any control surface or command but the easiest way to perform it and avoid confusion is by following the pins number.

🔯 🛃 W210 🛪 🙆	🙆 🗄 🚱 🗱 🚱 🖾 🗠 ः	fgM	lgr StepMgr			
	Г	-	PWM 1			
			Active High	1		
			Mode	time	-	
	Frequency 50.0 Hz	>	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	-	
Serial						
► 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

#### 11.2.2.2.1.2 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	★ ⊙	0 ≣ 0	<b>*: 2</b>	🔺 CfgMgr Ste	pMgr		
Vehicle name	W21	0	AES	0		Тур	e C 👻
US Se	et inv(SU)	Edit					
SU Se	et inv(US)	Edit					
	Edit	:				×	
			- Control Output u1 -	- Control Output u2 -	- Control Output u3 -		
	-	Actuator Output s1	Pitching	Thrusting 0.0	Rolling -1.0	+	
		Actuator Output s2	1.0	0.0	1.0		
	-	Actuator Output s3	0.0	1.0	0.0		
				+			
					[	Apply	

#### 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.

### 11.2.2.2.1.3 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	A1 🗸
Sensors	
▶ Stick	A3 U 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
	Start up 0.0 s
	Limit acceleration Set 0.349 S 76.89 %
	Limit deceleration
	100 85 70 55 40 25 0 -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 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.

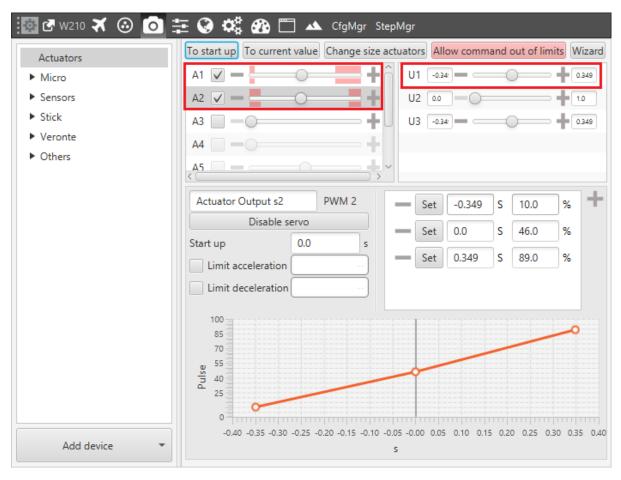
This procedure can be performed in the same way by using a **Wizard**. This tool allows moving actuators limits easily and finding the correct range.

Actuator Output s1	Q	anapana	annquua					0	nuquu	mapris	
Actuator Output st		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	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 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

## 11.2.2.2.2 Mission Phases

In this section, it will be explained the W210 typical mission profile and the mission phases will be detailed.

#### 11.2.2.2.2.1 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 🛪 🛞 🧿	🗄 🚱 🎝 🔂	<b>_</b>						
▼ Phases	Guidance Loop	Arcade TC Pann	el Automations					
Standby	Hold	<b>个</b>	Name	Standby				
Runway		+						
Envelope		×						
Smooth		4						
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 ra	ite) 💮 Ewma (TAU)					
	Constant value: 0.0 rad	0.0	Constant value: 0.0 rad					
Add								

Standby phase panel

The guidance is a Hold of two angles:

• Pitch and Roll: kept at 0 [rad].

# 11.2.2.2.2.2 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			$\mathbf{\Psi}$						
Smooth	Desired Pitch								
Modes	None     Time (Ran		Slope (Ramp rate)	Ewma (TAU)					
Arcade axis	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)     Constant value: 0.0 rad     O,O     Constant value: 0.1700000017								
		Desired	Dell						
					-				
	None     Time (Ran		Slope (Ramp rate)	Ewma (TAU)					
	Constant value: 0.0 rad		0.0	onstant value: 0.0 rad					
Add 👻									

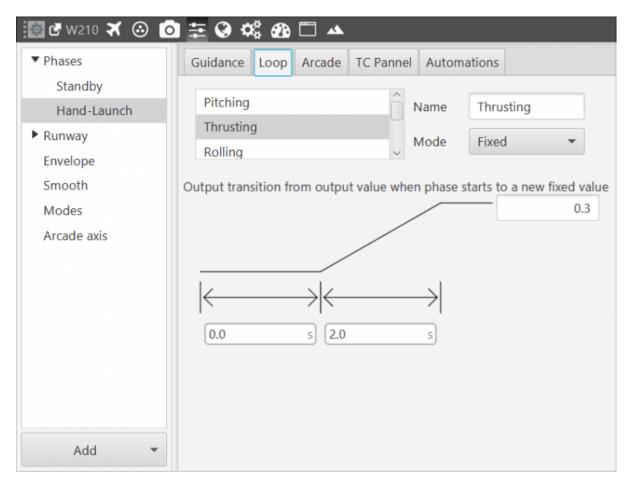
#### Hand-Launch phase panel

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

#### 11.2.2.2.3 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 🛪 🙆 🧿	🗄 🐼 🐝	🚯 🗂 🔺						
▼ Phases	Guidance L	oop Arcade	TC Pannel	Automations				
Standby Hand-Launch Catapult Runway	Hold		↑ + × +	Name	Catapult			
Envelope Smooth Modes Arcade axis	Desired Pitch     —     +       • None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)       Constant value: 0.0 rad     0.0     Pitch							
	None  Tir	ne (Ramp time) (	Slope (Ramp rate)	Ewma (TAU)				
	Constant value			onstant value: 0.0 rad				
Add 👻								

#### Catapult phase panel

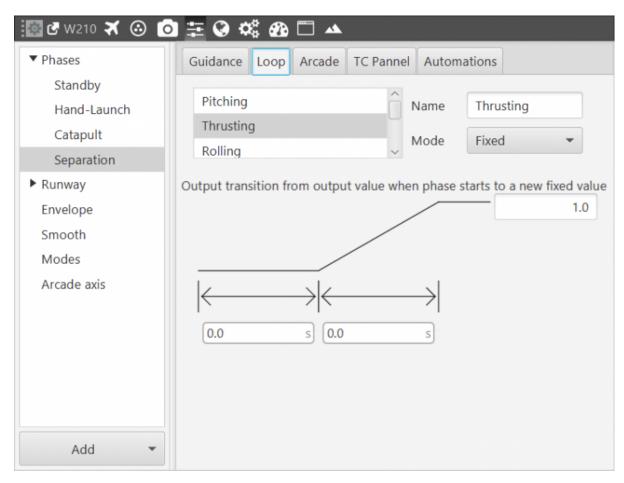
As happens in the Hand-Launch phase, the Guidance is a Hold of twop variables:

- Desired Pitch angle: at the current pitch angle.
- **Desired Roll angle:** at 0.0 [rad].

Thrusting, in this phase, is kept at zero.

#### 11.2.2.2.2.4 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

## 11.2.2.2.2.5 Climbing

Climbing phase is configured to make the airplane reach the mission altitude after the takeoff.

🔟 🗗 W210 🛪 🙆 🧿	🗄 🚱 🗱 🙆 🗔 🔺		
▼ Phases	Guidance Loop Arcade	TC Pannel Automations	
Standby Hand-Launch	Climbing		Climbing
Catapult		+ ×	
Separation		*	
Climbing	Line attraction	40	n î
▶ Runway	Patch	0	
Envelope Smooth	Acceleration proportion	0.0	
Modes	Set height mode	2.5D 👻	
Arcade axis	Set limit acceleration		U
	Acceleration	0.0 m/s	2
	Deceleration	0.0 m/s	2
	Set speed		
	Cruise	20.0 m/	s
Add 👻	Waypoint reach	0.0 m/	s -

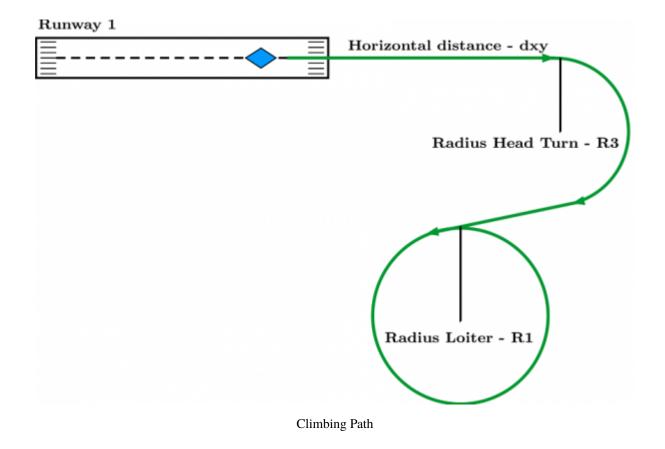
Climbing phase panel

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].



## 11.2.2.2.2.6 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 🛪 🛞 🧔	1 🗄 🚱 🗱 🙆	🗂 🔺			
▼ Phases	Guidance Loop	Arcade	TC Pannel	Automations	
Standby Hand-Launch Catapult	Cruise		↑ + ×	Name	Cruise
Separation	Set limit acceleratio	n	<b>*</b>		^
Cruise <ul> <li>Runway</li> <li>Envelope</li> </ul>	Acceleration	0.0		m/s²	Π
Smooth	Set speed				
Modes Arcade axis	Cruise Waypoint re		- 4	m/s	
	Type Hover gain Horizontal	Spee	ea	•	
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.

## 11.2.2.2.7 Hold

🔯 🛃 W210 🛪 🙆 🧿	፰ 🚱 🗱 🚰 🗂 🔺 CfgMgr StepMgr				
▼ Phases	Guidance Loop Arcade TC Pannel				
Hand Lunch	Hold Name Hold				
Climbing	+				
Cruise	×				
Separation	•				
Catapult					
Hold	Desired Pitch				
Landing	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)				
Flare	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad				
Standby					
Runway	Desired Roll —				
Envelope	None     Time (Ramp time)     Slope (Ramp rate)     Ewma (TAU)				
Smooth	Constant value: 0.0 rad 0.0 Constant value: 0.0 rad				
Modes Arcade axis					
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 👻					

#### 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.

### 11.2.2.2.2.8 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 Pa	annel	
Hand Lunch	Landing	1 Nan	ne Landing
Climbing		+	
Cruise		×	
Separation		*	
Catapult			<u>^</u>
Hold	Line attraction	20	
Landing			M01
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>
Modes	Acceleration	0.0	110/5
Arcade axis	Deceleration	0.0	m/s <sup>2</sup>
	Set speed		
	Cruise	18.0	m/s
Add 👻	Waypoint reach	0.0	m/s

Landing phase panel

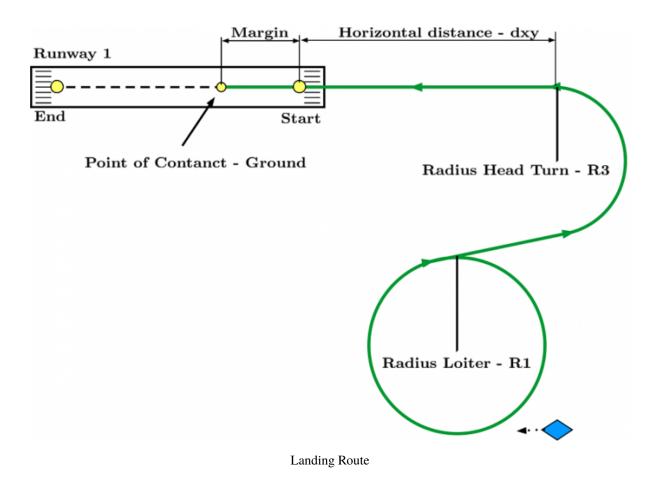
The guidance to be configured is Landing:

- 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.



### 11.2.2.2.2.9 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 Landing Flare Standby	Hold Name Flare Name Flare
<ul> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> </ul>	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad 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.

### 11.2.2.2.3 L200 Catapult



### L200 Catapult

From the Embention website it is possible to download User Manual and the Datasheet of the L200 Catapult.

## 11.2.2.2.3.1 Configuration

In order to configure correctly the launch system, it is necessary to perform two different actions:

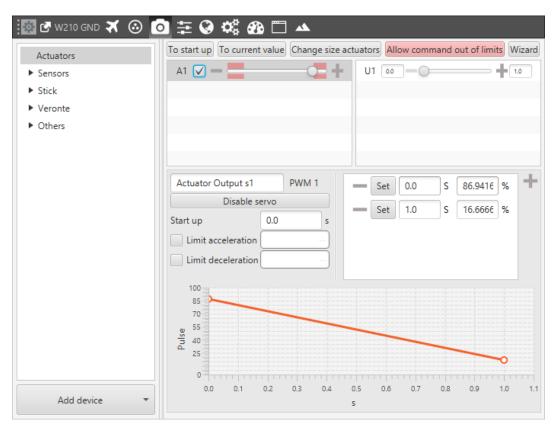
- Trimming of the launch actuator.
- Create the automation for the launch button.

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.

### 11.2.2.3.2 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).

### 11.2.2.3.3 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 🛪 🛞	े 🗄 🚱 📽 🕰 🗖 🔺	
✓ Launch System	Launch System	
	Events AND OR NOT Actions	+
	Launch Button	LAUNCH
	Delay 0.0	Periodical: Off
	Button - Launch Button	Time 0.0
	Icon 🔆 🛛 Time Control 0	Confimation
	Visual range Rvar Disabled	
		+
	< (	
New Automation	This button will be displayed on Veronte Panel	

#### 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).

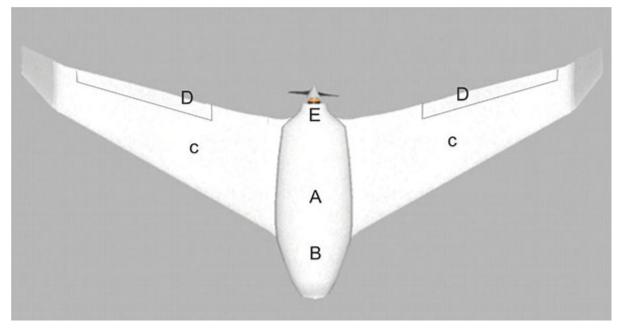
🔯 🛃 W210 GND 🛪 🙆	o 🗄 🛛 📽 🙆	) 🗂 🔺		
✓ Launch System	Launch System			
	Events	AND OR NOT	Actions	+
	Launch	Button		LAUNCH
			Delay 0.0	Periodical: Off
	Output	✓ LAUN	ICH	
	Actuator Output s1	-		
		Time 0.2 Va	lue 1.0	+
	Interpolate		lue 0.0	-
New Automation				
New Automation				

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

## 11.2.2.3 Quadcopter-M400

### 11.2.2.3.1 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.

## 11.2.2.3.1.1 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.

🔯 🛃 M400 🛪 📀	◙ ☵ 🐼 🗱 🖾 🗚	CfgM	lgr StepMgr			
			PWM 1			
			🗸 Active Hig	h		
			Mode	time	-	
	Frequency 50.0 Hz	å	Min	9.0E-4	s	
			Max	0.0021	s	
Arbiter			Servo	Motor 1	•	
► CAN			PWM 2			
► FTS						
► GPIO			✓ Active Hig	h		
► I2C						
► Others			Mode		*	
▼ PWM			Min	9.0E-4	s	
2			Max	0.0021	s	
3			Servo	Motor 2	-	
4			00110			
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	Ś	Min	9.0E-4 s	
			Max	0.0021 s	
► Arbiter			Servo	Motor 1 👻	
► CAN				Motor 1	
► FTS			PWM 2	Motor 2	
► GPIO			✓ Active High	Motor 3	
▶ 12C			V Active High	Motor 4	
▶ Others			Mode	None	
▼ PWM 1			Min	9.0E-4 s	
2			Max	0.0021 s	
3					
4			Servo	Motor 2 👻	
► Serial					
► USB					
Add 👻					

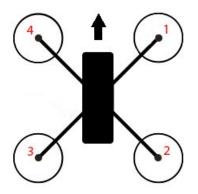
Output 1 – pin 1 configuration

# 11.2.2.3.1.2 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).

e name	M400	‡ @ ¢\$ Ø	AES D		Тур	ре С
	inv(SU) Edit inv(US) Edit					
Edit	i					×
		-	-	-	-	
		- Control Output u1 - Pitching	- Control Output u2 - Thrusting	- Control Output u3 - Rolling	- Control Output u4 - Yawing	
-	Motor 1					
-	Motor 1 Motor 2	Pitching	Thrusting	Rolling	Yawing	- - -
		Pitching -0.35355338	Thrusting	Rolling -0.35355338	Yawing 0.25	
•	Motor 2	Pitching -0.35355338 0.35355338	Thrusting 1.0 1.0	Rolling -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	Rolling -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.

## 11.2.2.3.1.3 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.

🔯 🗗 м400 🛪 💿 🗄	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
Actuators	To start up To current value Change size actuators Allow command out of limits Wizard
► Micro	A1 🔽 — O — + U1 -1.41. — — + 1.414
Sensors	A2 🗸 — 🔶 — 🕂 U2 00 — 🔶 — 🕂 1.0
► Stick	A3 🔽 — 🕒 — 🕂 U3 -1.41. — — — 🕂 1.414
Veronte	A4 V
► Others	
	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
Add device 🝷	5

M400 trim

- Minimum: 0.
- Maximum: 1.

### 11.2.2.3.2 Mission Phases

In this section, it will be explained the M400 typical mission profile and the mission phases will be detailed.

## 11.2.2.3.2.1 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 🛪 🛞 🧿	i 🗄 🚱 📽 🙆 🗔 4	🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade	TC Pannel		
Standby	Hold	<b>^</b>	Name	Standby
VHold		+		
Hover		×		
Takeoff		*		
Landing				
Cruise	H +			
Hold				
Runway				
Envelope				
Smooth				
Modes				
Arcade axis				
Add 👻				

Standby phase panel

## 11.2.2.3.2.2 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:

- Line attraction: 8.0 [m].
- Set Speed: 1.0 [m/s].
- Horizontal Hover Gain: 0.34.
- Vertical Hover Gain: 0.1.
- Safe Distance: -10 [m] and Relative (Positive down). With this value the platform will ascend.

🔯 🛃 M400 🛪 🙆 🧿	🗄 🚱 🗱 🕰 🖾 🔺	CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade TC P	annel		
Standby	VTol	<b>^</b>	Name Takeoff	
VHold	Yaw	+		
Hover		×		
Takeoff		↓		
Landing				^
Cruise	Line attraction	8.0		
Hold			P01	
Runway	Patch	0		
Envelope	Acceleration proportional gain	0.0		
Smooth	Cathaishtasada	3D	•	
Modes	Set height mode	50	•	
Arcade axis	Set limit acceleration			
	Acceleration	0.5	m/s²	
	Deceleration	0.5	m/s <sup>2</sup>	
	Set speed			
	Cruise	1.0	m/s	
Add 👻	Waypoint reach	0.0	m/s	~

# 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].

🔯 🕑 м400 🛪 💿 🧿	🗄 🚱 📽 🚱 🗄	🗂 🔺 CfgMgr StepM	gr
▼ Phases	Guidance Loop Ard	ade TC Pannel	
Standby	VTol	1	Name Takeoff
VHold	Yaw	+	
Hover		×	
Takeoff		*	
Landing			_
Cruise	Mode	current 👻	
Hold	✓ Limit rate	0.6 rad/s	s
Runway	Yaw	0.0 rad [-π,π]	
Envelope	Taw	0.0 rad [-π,π]	
Smooth			
Modes	💿 Absolute 🔵 Re	lative Approach Initial Po	pint 👻
Arcade axis	Latitude 0.0	rad [-π,π]	h MOI
	Longitude 0.0	rad [-π,π]	
	WGS84 0.0		m
	MSL 0.0		m
	AGL 0.0		m
Add 👻			

Yaw panel

# 11.2.2.3.2.3 Hover

Hover phase is configured to allow the multicopter maintain the position in the air.

🔯 🗗 м400 🛪 🐼 🧿	🗄 🛛 🗱 🍪 🗂 🗚	CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade T	'C Pannel	
Standby	VTol	A Name Hover	٦
VHold	Yaw	+	
Hover		x	
Takeoff		×	
Landing			~
Cruise	Set speed		
Hold	Cruise	1.0 m/s	
Runway	Waypoint reach	0.0 m/s	
Envelope	waypoint reach		
Smooth	Туре	Speed 👻	
Modes Arcade axis	Hover gain		
Arcade axis	Horizontal	0.34	
	Vertical	0.1	
	Туре	Straight 👻	
	Extend	None	
	Safe	0.0 m Relative -	
Add 👻	Touch	✓ Ref Runway Touch Point -	J

#### Hover phase panel

The Guidance is a **VTol** as the one in Take Off phase but, in this case:

- Safe distance: set at 0 [m] and Relative.
- Horizontal Hover Gain: 0.34.
- Vertical Hover Gain: 0.1.

The Yaw guidance is the same of the Take Off phase.

### 11.2.2.3.2.4 Cruise

In this phase, the Guidances are Cruise and Yaw.

The parameters to set are the Cruise Speeds (Cruise and Waypoint reach) and Acceleration limits.

- Acceleration limit: 0.5.
- Deceleration limit: 0.5.
- Cruise Speed: 3.0 [m/s].
- Waypoint reach: 0.5 [m/s].

🔯 🕑 M400 🛪 🙆 🧿	🗄 🔮 📽 🖽 🗔 4	🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade	TC Pannel	
Standby	Cruise	<b>^</b>	Name Cruise
VHold	Yaw	+	
Hover		×	
Takeoff		4	
Landing			
Cruise	Line attraction	15.0	
Hold	Patch	0	<b>L</b> 91
Runway			
Envelope	Acceleration proportional	0.0	
Smooth	Set height mode	3D 👻	
Modes	_		
Arcade axis	Set limit acceleration		
	✓ Acceleration	0.5 m/s <sup>2</sup>	)
	✓ Deceleration	0.5 m/s <sup>2</sup>	
			)
	Set speed		U
	Cruise	3.0 m/s	
	Cruise	5.0 m/s	
Add 👻	✓ Waypoint reach	0.5 m/s	J
			) v

# Cruise panel

Yaw Guidance is set in order to make the multicopter controlling yaw angle following the heading angle.

🔯 🛃 м400 🛪 🙆 🧿	葦 🚱 📽 🚯 🛙	🗂 🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arc	ade TC Pannel		
Standby	Cruise	<b>^</b>	Name	Cruise
VHold	Yaw	+		
Hover		×		
Takeoff		*		
Landing		•		
Cruise	Mode	heading 🔹		
Hold	✓ Limit rate	0.6 rad/s		
Runway				
Envelope	Yaw	0.0 rad [-π,π]		
Smooth				
Modes	💿 Absolute 🔵 Re	ative Approach Initial Point	~	
Arcade axis	Latitude 0.0			
		rad [-π,π]	~9]	
	Longitude 0.0	rad [-π,π]		
	WGS84 0.0		m	
	- MSL 0.0		m	
	AGL 0.0		m	
Add 👻				

# Yaw Guidance panel

# 11.2.2.3.2.5 Landing

This phase has the same settings of the Take-off with some changes.

🔯 🗗 м400 🛪 🙆 🧿	🗄 😧 🗱 🕰 🖬 🔺	CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade T	C Pannel
Standby	VTol	Name Landing
VHold	Yaw	+
Hover		×
Takeoff		×
Landing		
Cruise	Set speed	
Hold	Cruise	0.6 m/s
Runway	Waypoint reach	0.0 m/s
Envelope	waypoint reach	0.0 m/s
Smooth	Туре	Speed 👻
Modes Arcade axis	Hover gain	
Arcade axis	Horizontal	0.34
	Vertical	2.24
	Туре	Straight 👻
	Extend	None
	Safe	100.0 m Relative 💌
Add 👻	Touch	Ref Runway Touch Point

Landing phase panel

- Line Attraction: kept at 8.
- Set Speed-Cruise: 0.6 [m/s].
- Horizontal Hover Gain: 0.34.
- Vertical Hover Gain: 2.24.
- **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 😧 🗱 🛙	🗂 🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arc	ade TC Pannel		
Standby	VTol	<b>^</b>	Name	Landing
VHold	Yaw	+		
Hover		×		
Takeoff		*		
Landing				
Cruise	Mode	current 👻		
Hold	✓ Limit rate	0.6 rad/s		
Runway	Yaw	0.0 rad [-π,π]		
Envelope	TOW			
Smooth Modes				
Arcade axis	Absolute Re	lative Approach Initial Point	~	
Arcade axis	Latitude 0.0	rad [-π,π]	[2]	
	Longitude 0.0	rad [-π,π]		
	WGS84 0.0		m	
	- MSL 0.0		m	
	AGL 0.0		m	
Add 👻				

Yaw Guidance panel

# 11.2.2.3.2.6 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 D0wn 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	Ţ	
Landing		
Cruise	Desired Down GV (Ground Velocity)	- +
Hold	None     Time (Ramp time)     Slope (Ramp rate)	Ewma (TAU)
Runway Envelope	Constant value: 0.0 m/s 0.0 Cons	tant value: 0.0 m/s
Smooth		
Modes	Desired Lateral GV (Ground Velocity)	—
Arcade axis	None      Time (Ramp time)      Slope (Ramp rate)	Ewma (TAU)
	Constant value: 0.0 m/s 0,0 Cons	tant 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 Cons	tant value: 0.0 m/s
Add 👻		

Manual phase panel

# 11.2.2.3.2.7 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 🛪 💿 💿 🗄	≢ 🛛 📽 🕰 🕰 🗠					-
Buttons     SBY Button (EIN)	TKO Button		The second			
✓ SBY Button ✓ VHLD Button	Events AND OR NOT		+ 5			1 fer
✓ HVR Button	TKO Button	ТКО		and the second		and in
✓ LND Button	AND TKO Phases	Save Home Point	Dist:	the second	and the state	6 1
CRU Button TKO Button	TKO Phases		1000		- Jul -	
✓ HLD Button					a contract of	-
✓ RTH Button			Louis		and the owner of the	
▼ Stick				the case of the least open		-
SBY to AUTO			Salar .		See Long	
✓ Auto Mode		Delay 0.0 Periodical: O	ff	and the second second		and some
Manual Mode (Arcad			1000	A Real Property of		
Hold Phase (Arcade)	Save	e Home Point	10 100			The second
LinkOff to LND HLD when No GPS			Absolute	Relative UAV		*
✓ Auto when No Stick	Value N: 0.000000 m, E:	0.000000 m, D: 0.000000 m	East			
Low Battery	Save value in Inflight R	leference Point 01	East	0.0 m	A.	<b>C9</b> 1
✓ Arcade Trim			North	0.0 m		~
	Type Fixed 💌		WGS84	0.0		m
1	UNDEFIN		- MSL			
			L AGL			
New Automation			AGL		N/A	

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:

🔯 🕑 M400 🛪 🙆 🧿	🗄 🚱 📽 🚱 🗔 🔺	
▼ Phases	Guidance Loop Arcade 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		
Runway	Waypoint reach	0.0 m/s
Envelope	Туре	Speed -
Smooth	Hover gain	
Modes	nover gain	
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 🛪 🛞 🧿	1 🌐 🖓 📽 🖽 🗂 🔺	
Buttons     SBY Button (EIN)	RTH Button	
SBY Button	Events AND OR NOT Actions	+
VHLD Button	RTH Phases RTH	
LND Button	AND AUTO	
CRU Button	RTH Button	
✓ TKO Button ✓ HLD Button		
✓ RTH Button		
▼ Stick		
SBY to AUTO		
Manual Mode (Arc	Delay 0.0 Periodic	al: Off
Hold Phase (Arcade)	RTH Phase Time	0.0
HLD when No GPS	- Hover	
Auto when No Stick     Low Battery	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

### 11.2.2.4 Helicopter T-Rex600

### 11.2.2.4.1 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.

### 11.2.2.4.1.1 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 🚱 🗱 🙆 🗔 🔺 G	gМ	lgr StepMgr		
	Г	-	PWM 1		
			✓ Active High		
			Mode	time 🔹	
	Frequency 50.0 Hz		Min	9.0E-4 s	
			Max	0.0021 s	
► ADC			Servo	NW 👻	
► Arbiter				NW	
► CAN	L	-	PWM 2	South	
► FTS			✓ Active High	NE	
► GPIO			V Active High	Rudder	
► 12C			Mode	Throttle	
<ul> <li>Others</li> <li>PWM</li> </ul>			Min	None	
1			Max	0.0021 s	
2					
3			Servo	South 👻	
4					
5 ~					
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

# 11.2.2.4.1.2 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).

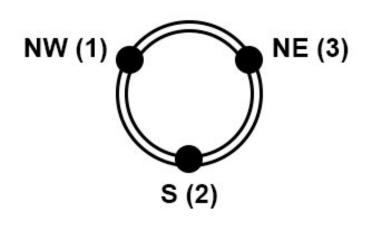
T-REX 🛪	( 💿 🖸 🗄 😵 🌣	🕻 孙 🛅 🔺 CfgMgr S	StepMgr
Vehicle name	T-REX	(ES)	Туре С 👻
US Set inv	v(SU) Edit		
SU Set inv	v(US) Edit		

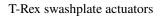
SU matrix edit

**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 - Cyclic	Control Output u2 - RPMs	Control Output u3 - Rolling - Cyclic	Control Output u4 - Yawing	Control Output u5 - Collective
NW	0.16666667	0.0	-0.28867513	0.0	-0.33333334
South	-0.33333334	0.0	0.0	0.0	-0.33333334
NE	0.16666667	0.0	0.28867513	0.0	-0.33333334
Rudder	0.0	0.0	0.0	1.0	0.0
Throttle	0.0	1.0	0.0	0.0	0.0

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.

### 11.2.2.4.1.3 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	A1 -2.611 - 0.750
Sensors	A2 + U2 00 + 10
▶ Stick	A3 — U3 -1.05 — 1299
Veronte	A4 — U4 -0.512 — 0.519
<ul> <li>Others</li> </ul>	A5 U5 -1.751 - 0.610
	NW PWM 1 Set0.349 S _97.0 % +
	Disable servo Set 0.0 S 48.0 %
	Start up 0.0 s Set 0.349 S 3.0 %
	Limit acceleration
	Limit deceleration
	100
	70
	8 55 금 40
	25
	0
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 0.40
Add device +	S

Actuator 1 trimming

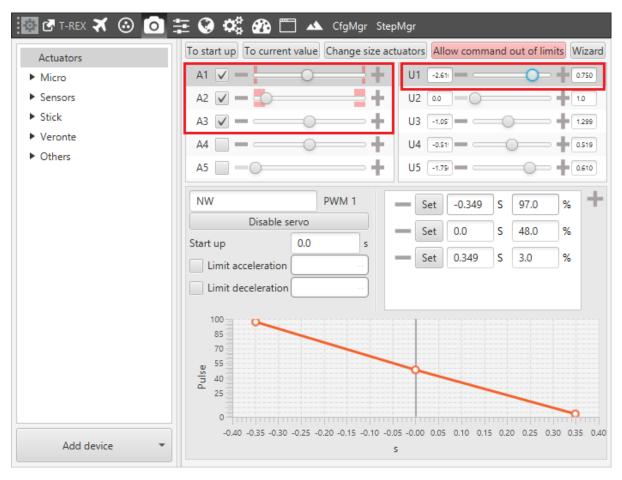
This procedure can be performed in the same way by using a **Wizard**. This tool allows moving actuators limits easily and finding the correct range.

Actuator Output s1	Q							,Q	mquu	mapan	
		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 -											
		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

## 11.2.2.4.2 Mission Phases

In this section, it will be explained the T-Rex typical mission profile and the mission phases will be detailed.

### 11.2.2.4.2.1 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 🛪 🛞 🧿	🗄 🚱 🗱 🌇 🗂 🔺 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.

## 11.2.2.4.2.2 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 Ready	Pitching - Cyclic     Name     RPMs       Rolling - Cyclic     Mode     Off	
Takeoff Landing 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	<b>^</b>	Name Engine OFF
Warm up	Yaw	+	
Ready		×	
Takeoff		*	
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	University		
Engine OFF	Hover gain		
Land at Base	Horizontal	0.2	
Autorotation	Vertical	2.4	
Collective UP			
Hover Yaw Heading	Туре	Straight •	·
Liftoff	Extend	None	·
Runway	Safe	0.0 r	n Relative 👻
Add 👻	Touch	Ref Runway Touch Point	*

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     R	elative Approach Initial Point	v
Engine OFF			
Land at Base	Latitude 0.0	rad [-π,π]	591
Autorotation	Longitude 0.0	rad [-π,π]	
Collective UP	WGS84 0.0		
Hover Yaw Heading			
Liftoff	MSL 0.0		
Runway	AGL 0.0		m
Add 👻			

#### Yaw Guidance settings

## 11.2.2.4.2.3 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 🛪 🙆 🚺	🖸 ፰ 🔇 🗱 🌇 🛅 🔺 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	
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	
Collective UP	
Hover Yaw Heading	
Liftoff	
Runway	×
Add	

Hold Guidance configuration

🔯 🛃 T-REX 🛪 🙆 🧔	🕽 🚋 🚱 🗱 🚰 📥 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby Warm up Ready Takeoff Landing Hover Cruise Hold	Pitching - Cyclic       Name       RPMs         Rolling - Cyclic       Mode       Fixed         Vention       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	
Autorotation Collective UP Hover Yaw Heading Liftoff Runway	
Add	

Engine RPM increasing settings

## 11.2.2.4.2.4 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.

🖥 🛃 T-REX 🛪 💿 🚺	\Xi 🚱 🗱 🌇 🛅 🔺 CfgMgr StepMgr
▼ Phases	Guidance Loop Arcade TC Pannel
Standby	VTol Name Ready
Warm up	Hold
Ready	Yaw
Takeoff	
Landing	
Hover	Desired RPM - +
Cruise	
Hold	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
VHold	Constant value: 0.0 rad/s 0.0 Constant value: 178.0 rad/s
No name	
Return to Home	
Engine OFF	
Land at Base	
Autorotation	
Collective UP	
Hover Yaw Heading	
Liftoff	
Runway	
Add 👻	

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	Maxima
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

## 11.2.2.4.2.5 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 🛪 🙆 🧿	i 🗄 🥝 📽 🙆 🗔 4	🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade	TC Pannel		
Standby	VTol	<b>个</b>	Name Takeoff	
Warm up	Hold	+		
Ready	Yaw	×		
Takeoff		4		
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 To	uch Point -	$\bigcup_{i=1}^{n}$

VTol panel

### 11.2.2.4.2.6 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 🛪 💿 🧿	🗄 😧 📽 🕰 🗔 4	🔺 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	Hover gain	
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

## 11.2.2.4.2.7 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 🛪 🙆 🧿	1 🗄 🚱 🗱 🚳 🗂	🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Arcade	TC Pannel		
Standby	Cruise	<b>^</b>	Name	Cruise
Warm up	Hold	+		
Ready	Yaw	×		
Takeoff		Ţ.		
Landing	Set neight mode	2.30		
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 m/s <sup>2</sup>		
Return to Home	Set speed			
Engine OFF	Set 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		Ų

## Cruise panel

Yaw Guidance is set in order to make the helicopter controlling yaw angle following the heading angle.

🔯 🗗 T-REX 🛪 🙆 🧿	🗄 🐼 🗱 🚯	🛅 🔺 CfgMgr StepMgr		
▼ Phases	Guidance Loop Ar	cade TC Pannel		
Standby	Cruise	1	Name Cruise	
Warm up	Hold	+		
Ready	Yaw	×		
Takeoff		*		
Landing				
Hover	Mode	heading 👻		
Cruise	✓ Limit rate	0.6 rad/s		
Hold	V Linit fate			
VHold	Yaw	0.0 rad [-π,π]		
Ignite				
Return to Home	Absolute     R	elative Approach Initial Point	T	
Engine OFF		Approach initial Point		
Land at Base	Latitude 0.0	rad [-π,π]	521	
Autorotation	Longitude 0.0	rad [-π,π]		
Collective UP	WGS84 0.0			
Hover Yaw Heading				
Liftoff	- MSL 0.0		m	
Runway	AGL 0.0		m	
Add 👻				

## Yaw Guidance panel

## 11.2.2.4.2.8 Landing

This phase has the same settings of the Take-off with a positive value of Safe distance (positive down).

💽 🕑 T-REX 🛪 🙆 🧔	) 🗄 🛛 🗱 🖓 🖾 /	🔺 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].

### 11.2.2.4.2.9 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	Desired Pitch
Hover	
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 🛪 🙆 🧿	🛛 🏗 🚱 🗱 🌇 🗂 🔺 CfgMgr StepMgr	
▼ Phases	Guidance Loop Arcade TC Pannel	
Standby	Var Gain DBand	
Warm up	Desired Pitch     -3.0     0.0     Max     Max     Integral	
Ready		
Takeoff	Desired Roll 3.0 0.0 Max 0 Integral	
Landing	-10.C 0.0 Max 0 Integral	
Hover	→ Desired Yaw 2.0 0.02 Max 0 ✓ Integral	
Cruise		
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

## 11.2.2.5 Hybrid

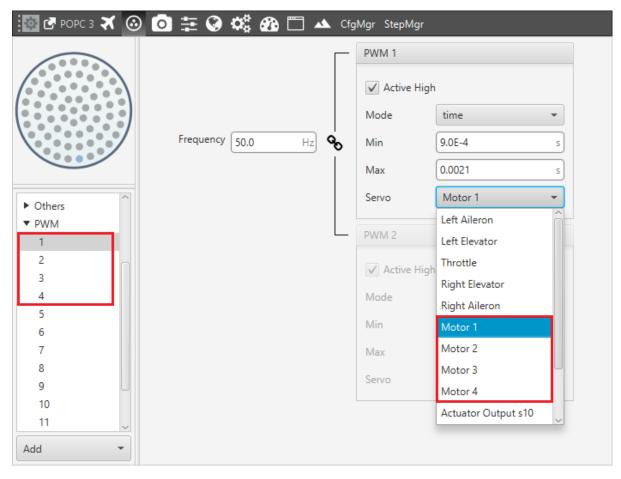
## 11.2.2.5.1 Servo Configuration

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.

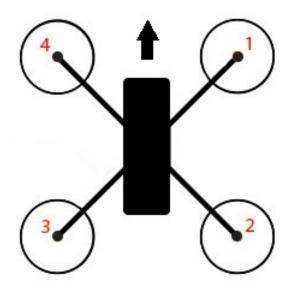
### 11.2.2.5.1.1 Quadcopter servos

### 11.2.2.5.1.2 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.

## 11.2.2.5.1.3 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	🖌 💿 🧰 🚱	AES	0	Type C 🔻
US Set inv				

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	1
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)

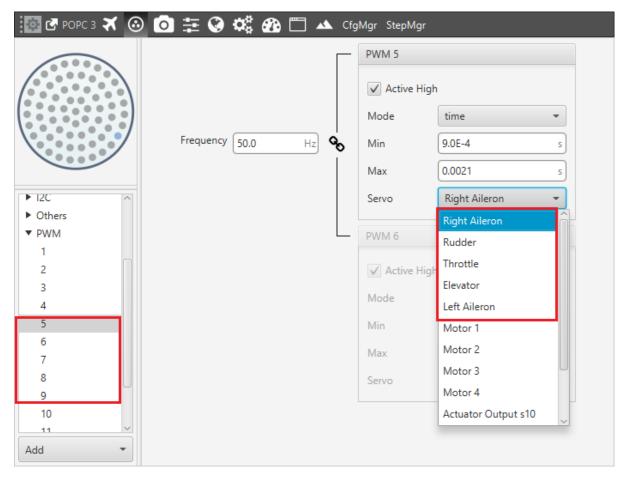
The Hybrid during quadcopter phases is configured as follow:

- 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.

## 11.2.2.5.1.4 Plane Servos

## 11.2.2.5.1.5 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

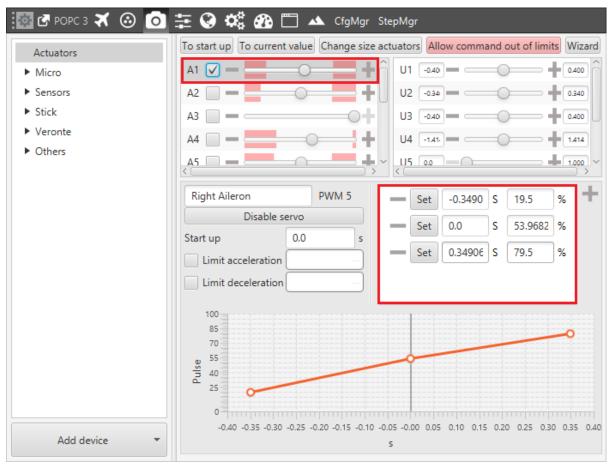
- 1. Right Aileron: Actuator Output s1
- 2. Elevator: Actuator Output s4
- 3. Throttle: Actuator Output s3
- 4. Rudder: Actuator Output s2
- 5. Left Aileron: Actuator Output s5

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)

## 11.2.2.5.1.6 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.

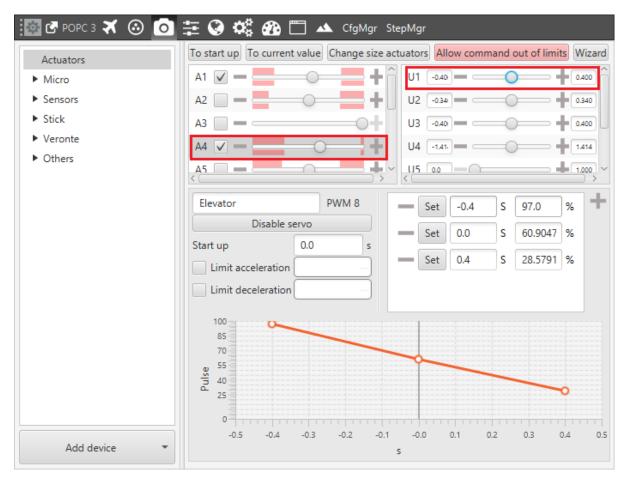
This procedure can be performed in the same way by using a "wizard". This tool allows moving actuators limits easily and finding the correct range.

-			-0						0		
Actuator Output s1	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s2	0	10	20	30	40	50	60	70	80	90	100
Actuator Output s3	Q 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	100
Actuator Output s9	Q	10	20	30	40	50	60	70	80	90	100

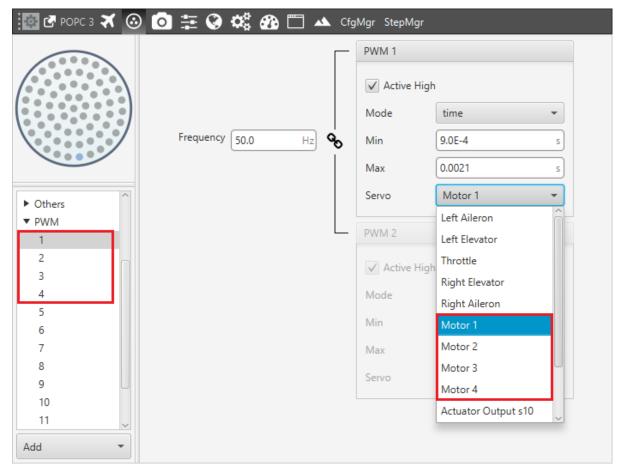
### Trim wizard tool

In order to perform a final checking, it is possible to select the desired channel and testing pitch, roll, yaw and thrust controls.

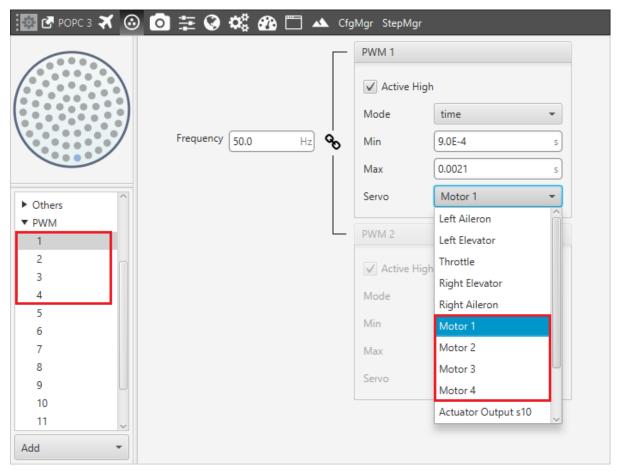
The image below shows a pitching output testing. By moving the U1 control, surfaces must change the position according to the reference system: positive corresponds to nose down and negative to nose up.



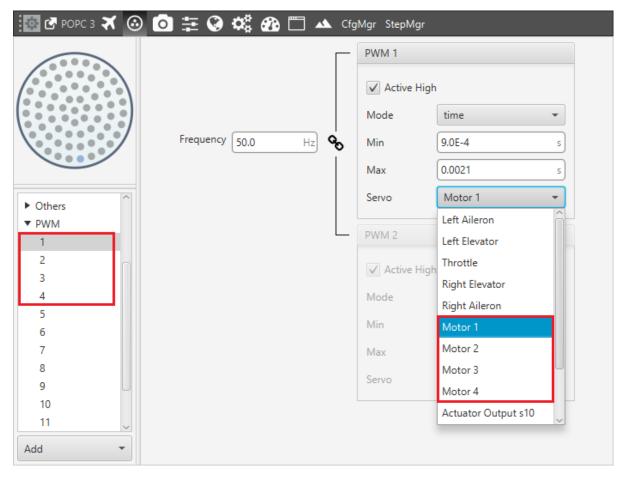
Pitching test



Quadcopter motors connections



Quadcopter motors connections



Quadcopter motors connections

## 11.2.2.5.2 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.

### 11.2.2.5.2.1 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 0.0 Constant value: 0.0 rad
Climbing - Plane	
Approach - Plane	Desired Roll
Climb - Quad	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Quad to Plane	Constant value: 0.0 rad 0,0 Constant value: 0.0 rad 0,0 Constant value: 0.0 rad
Plane to Quad	
Hold - Plane	Desired Yaw
Armed - Quad	None Time (Ramp time) Slope (Ramp rate) Ewma (TAU)
Descend - Quad	
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.

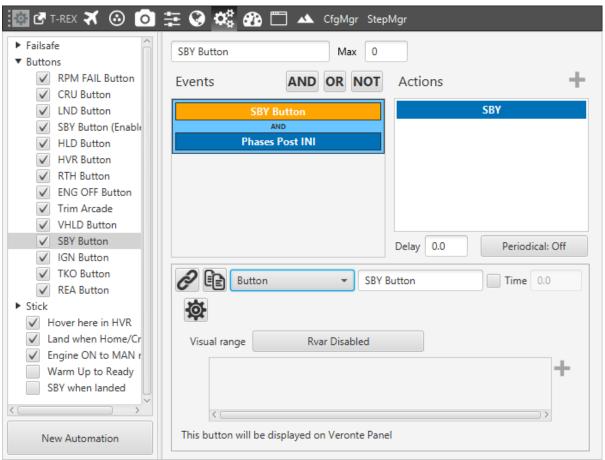
In this section we will explain the configuration of some devices and plataforms to improve the understandig of the user.

# **11.3 Automations**

## **11.3.1 Veronte Panel Buttons**

## 11.3.1.1 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.

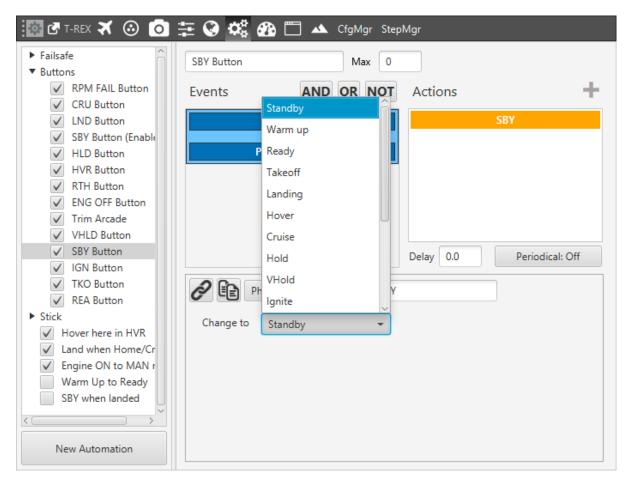


### Standby button automation

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 🛪 🙆 🧿	🔁 🚱 🥶 🗂 🔺 CfgMgr StepMgr	
<ul> <li>▶ Failsafe</li> <li>▼ Buttons</li> </ul>	SBY Button Max 0	
RPM FAIL Button     CRU Button	Events AND OR NOT Actions	+
<ul> <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>	SBY Button AND Phases Post INI	
<ul> <li>✓ SBY Button</li> <li>✓ IGN Button</li> <li>✓ TKO Button</li> <li>✓ REA Button</li> <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>	Delay 0.0 Periodic Phase Phase Post INI Time ( Cruise Hold VHold Ignite Return to Home	
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.

### 11.3.1.2 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	
<ul> <li>▶ Failsafe</li> <li>▼ Buttons</li> </ul>	HVR Button Max 0	
RPM FAIL Button     CRU Button	Events AND OR NOT Actions	+
LND Button  SBY Button (Enable  HLD Button  HVR Button  RTH Button	HVR Button AND HVR Allowed	
<ul> <li>✓ KITI Button</li> <li>✓ ENG OFF Button</li> <li>✓ Trim Arcade</li> <li>✓ VHLD Button</li> <li>✓ SBY Button</li> <li>✓ IGN Button</li> </ul>	Delay 0.0 Periodi	cal: Off
<ul> <li>✓ TKO Button</li> <li>✓ REA Button</li> <li>▶ Stick</li> <li>✓ Hover here in HVR</li> </ul>	Icon     Icon	
✓ Land when Home/Cr ✓ Engine ON to MAN r Warm Up to Ready SBY when landed	Visual range Rvar Disabled	+
New Automation	This button will be displayed on Veronte Panel	

Button Icon selection

🔯 🕑 T-REX 🛪 📀 🧿	🗄 🐼 📽 🚳	) 🛅 🔺 CfgMgr Step	Mgr	
<ul> <li>▶ Failsafe</li> <li>▼ Buttons</li> </ul>	HVR Button	Max 0		
RPM FAIL Button     CRU Button	Events	AND OR NOT	Actions	+
<ul> <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>		/R Button AND R Allowed		HVR
SBY Button			Delay 0.0	Periodical: Off
<ul><li>✓ TKO Button</li><li>✓ REA Button</li></ul>	Phase Phase	e 🔹 HVR	Allowed	<b>Time</b> 0.0
<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>	Cruise		+	
New Automation				

Phases set

🔯 🗗 T-REX 🛪 🛞 🧿 🗄	🗄 🚱 🕰 🌇 🛅 🔺 CfgMgr StepMgr
CRU Button CRU Button LND Button SBY Button (Enable	HVR Button     Max     0       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> <li>✓ IGN Button</li> </ul>	HVR Button AND HVR Allowed
✓ TKO Button ✓ REA Button	Delay 0.0 Periodical: Off
▼ Stick ▼ To Hold (manual) ▼ Manual ▼ Auto	Position
Hover here in HVR     Land when Home/Cr     Engine ON to MAN r	Location     Current     Longitude: 0.0 Latitude: 0.0     Direct       Loiter     Auto     Image: Current
Warm Up to Ready SBY when landed	Hover     Distance     100.0

### Hover button defining

## 11.3.2 Phase Changing

## 11.3.2.1 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 🛪 🙆 🧿	) 🏛 😧 📽 🕰	) 🛅 🔺 CfgMgr Ste	pMgr	
▼ Buttons	TKO to CMB	Max 0		
SBY Button (EIN) SBY Button	Events	AND OR NOT	Actions	+
TKO Button CMB Button LND Button		AS>8 AND O Phase		СМВ
Failsafe Auto when No Stick LinkOff to LND HLD when No GPS Low Battery				
▼ Stick			Delay 0.0	Periodical: Off
✓ Manual Mode (Arc ▼ Transitions	Variab	le 👻 IAS>	8	<b>Time</b> 0.0
TKO to CMB     CMB to CRU     Arcade Trim	Variable Max	IAS (Indicated Airspee	d)	
<ul> <li>✓ When Event Mark</li> <li>✓ LND to Flare</li> <li>✓ No name</li> </ul>	Min Invert range ↓	-		
	Min			Max
New Automation	Event triggered o	n blue area		

Takeoff to climb automation

## 11.3.2.2 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		AGL>90 AND MB Phase		CRU
<ul> <li>LND Button</li> <li>Failsafe</li> </ul>		AND		
<ul> <li>Stick</li> <li>Transitions</li> </ul>		IAS > 6		
✓ TKO to CMB ✓ CMB to CRU				
Arcade Trim     When Event Mark			Delay 0.0	Periodical: Off
✓ LND to Flare	🔗 🗈 Varia	ble 👻 🖬 IAS >	6	<b>Time</b> 0.0
	Variable	IAS (Indicated Airspee	d)	
	Max			
	Min	6		
	Invert range			
	Min			Max
New Automation	Event triggered	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".

## 11.3.2.3 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 🛪 🙆 🧿	) 🏛 😧 📽 d	🏠 🛅 🔺 CfgMgr Ste	pMgr	
Buttons     SBY Button (EIN)	LND to Flare	Max 0		
SBY Button	Events	AND OR NOT	Actions	+
<ul> <li>✓ CKU 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>		de Polygon AND AGL < 8 AND hase LND		Flare
Low Battery  Stick  Auto Mode  Manual Mode (Arcad  Transitions  TKO to CMB  CMB to CRU  LND to Flare  Arcade Trim When Event Mark	Variable Max Min	Ible  AGL (Above Ground Level) 8		Periodical: Off
<	Invert range Min Event triggered	on blue area		Max

### Landing to Flare

When these events are fulfilled, airplane enters in the Flare phase and lands.

## 11.3.3 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.

## 11.3.3.1 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 StepMgr	
▼ Buttons SBY Button (EIN)	LinkOff to LND Max 0	
✓ SBY Button ✓ CRU Button	Events AND OR NOT Actions	+
✓ TKO Button	TX Error LND	
CMB Button	OR AUT	o
✓ LND Button ▼ Failsafe	AND	
Auto when No Stick	Flight Phases	
LinkOff to LND		
HLD when No GPS Low Battery		
► Stick	Delay 0.0	Periodical: Off
Transitions		
<ul> <li>Arcade Trim</li> <li>When Event Mark</li> </ul>	Variable - TX Error	Time 1.0
✓ LND to Flare	Variable TX Packet Error Rate (on board)	
	Max 0.8	
	Min	
	Invert range	
	Min	Max
New Automation	Event triggered on 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 🛪 🙆 🧿	🗄 😧 😋 é	ß 🗂 🔺		
CRU 3 Button	LinkOff to LND			
CRU 4 Button RTH 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)		RX Error AND Flight Phases		RTH
RTH to SBY     LND to SBY     Stick	'	ingiter mases		
Auto Mode     Manual Mode (Arc			Delay 0.0	Periodical: Off
Arcade Trim     Ready Command     Hold Phase (Arcad	0	Ŧ	Insert name	
▼ Failsafe				
Low Battery to LNI LinkOff to LND				
Flight Time				
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.

## 11.3.3.2 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 🛪 🛞 🧕	🏗 🚱 🗱 🜇 🛅 🔺 CfgMgr StepMgr	
▼ Buttons	Low Battery Max 0	
SBY Button (EIN) SBY Button CRU Button	Events AND OR NOT Actions	+
✓ TKO Button	Power Input < 15.2V	LND
CMB Button	AND On Phase	AUTO
<ul> <li>✓ LND Button</li> <li>▼ Failsafe</li> </ul>		
Auto when No Stick		
HLD when No GPS		
Low Battery		
Stick	Delay 0.0	Periodical: Off
Transitions		
Arcade Trim     When Event Mark	Variable   Power 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 on blue area	

Failsafe for low battery

## 11.3.3.3 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 🛪 🙆 🧿	🏗 🚱 📽 🌇 🗂 🔺 CfgMgr StepMgr	
Buttons     SBY Button (EIN)	HLD when No GPS Max 0	
SBY Button	Events AND OR NOT Action	s 🕂
TKO Button	NO GPS	HLD
CMB Button LND Button	Flight Phases	
▼ Failsafe Auto when No Stick		
LinkOff to LND		
HLD when No GPS Low Battery		
▼ Stick	Delay 0	.0 Periodical: Off
<ul> <li>✓ Auto Mode</li> <li>✓ Manual Mode (Arc</li> </ul>	Alarm VO GPS	Time 0.0
▼ Transitions		
✓ TKO to CMB ✓ CMB to CRU	Type Fail one  X KBIT_GPSNA	V
Arcade Trim		
When Event Mark  LND to Flare	Add	
V No name	<b>• +</b>	
New Automation		

Failsafe for GPS signal lost

## 11.3.4 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.

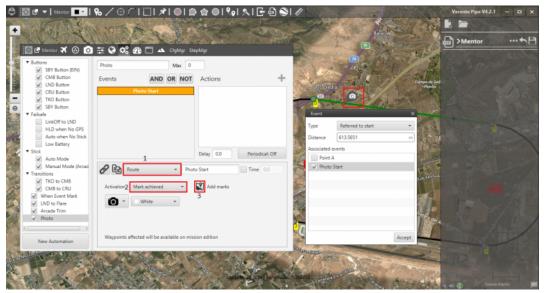
In the photogrammetry missions, the platform is wanted to take photos during the time that it is following a path previously defined. Commonly, the photo taking process begins at a certain location over the route and is repeated each certain distance. To create this automation the process detailed now has to be followed.

1. Create an Event Marker at the point where the photogrammetry mission has to start.



Photogrammetry Automation 1

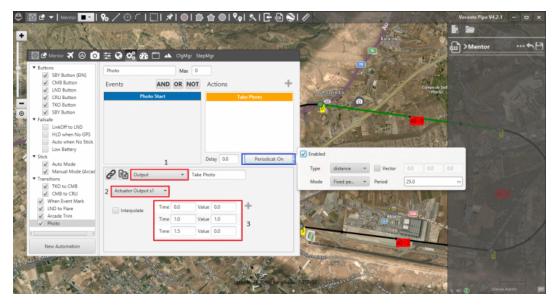
2. That **Event Marker** has then to be linked with an event that will trigger the process. Go to Automation in order to create it.



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.

### 11.3.5 Others

### 11.3.5.1 Stick Auto

This automation changes the control mode according to the command sent by the radio controller.

🔯 🗹 Mentor 🛪 🙆 🧿	🗄 🚱 😋	🕐 🛅 🔺 CfgMg	ır StepMgr	
▼ Buttons	Auto Mode	Max	0	
SBY Button (EIN) SBY Button CRU Button	Events		IOT 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				
✓ Auto Mode			Delay 0.0	Periodical: Off
Manual Mode (Arcad		••••	011110	
▼ Transitions	8 🖻 Va	riable 🔻	Stick UP	<b>Time</b> 0.0
✓ TKO to CMB	Variable	Stick Input	: r8	
CMB to CRU	Max			
✓ LND to Flare				
Arcade Trim     When Event Mark	Min	0.75		
Vinen Event Mark	Invert range	$\checkmark$		
	Min			Max
New Automation	Event trigger	ed on blue area		

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

### 11.3.5.2 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 🛪 🛞 🧿	፰ 🔇 📽 🕾 🛅 🔺 CfgMgr StepMgr	
▼ Buttons ✓ SBY Button (EIN)	SBY when LND Max 0	
✓ SBY Button ✓ VHLD 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> </ul>	ON_VDOWN_LND     SBY       AND     ON_GAS_LND       AND     AND       AGL < 20 cm	
Auto Mode     Manual Mode (Arcad     Hold Phase (Arcade)     LinkOff to LND		iodical: Off
HLD when No GPS	Variable   -   AGL < 20 cm	ne 0.0
Auto when No Stick	Variable AGL (Above Ground Level) – Hei	
Low Battery ✓ Arcade Trim	Max 0.2	
SBY when LND	Min	
	Invert range 🗸	_
< <u> </u>	Min	Max
New Automation	Event triggered on blue area	

#### 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

# **11.4 Lidar Integration**

## 11.4.1 Lidar Configuration

The integration between Veronte and Lidar is performed using the analog interface on the main connector which produces a voltage proportional to the measured altitude. In this example, a lightweight laser altimeter for above-ground level measurement (SF11) is configured.

You can get more information about our Lidar clicking here

### 11.4.2 Veronte configuration - ACD In

When Lidar connection to Veronte is performed, the autopilot configuration has to be completed (see section Connections). To do this, it is necessary to configure the operations to set the correct conversion from the voltage measurement to the physical variable.

- 1. Go to Variables/System Variables/Operations.
- 2. Configure the following operation, see section *System Variables* for more information on how to create a custom operation.

😨 🕑 Penguin Embention 🛪	🛛 💿 🔁 🔇	) <b>Q</b>	🌮 🗔 🔺	CfgMgr StepM	gr	
<ul> <li>System Variables</li> <li>Names</li> <li>Operations</li> </ul>	Search Super high	Сору				î +
<ul> <li>Telemetry</li> <li>Sniffer</li> </ul>	<ul> <li>▼ High</li> <li>── Voltage C</li> <li>── Tether Mu</li> <li>Low</li> </ul>		'n			~
	Multi • Out	t	Lidar 1 Distance	Name	Voltage	Conversion Lidar
		Х		C Channel 2 ant value: 3.3		
	Mult	Х	Constant	value: 2.4414E-4	ļ	]—
						+

### Lidar Configuration

3. Save the result of this linear operation in a variable (selected by the user), in this case Lidar 1 Distance [m].

Users have to select the ADC channel where the device is connected (ADC Channel 2-6), and set the previous operation that converts the voltage measured.

It is possible to create an alarm variable that will be triggered when the measured value is lower or greater than a fixed values, see section *Gauge Display*. For example, in this case, an alarm could be triggered when the measure is lower

than 0 [m] or greater than 120 [m] meters (Lidar limits). The alarm is stored in a variable selected by the user (in this case, the alarm Power B error is used).

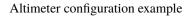
Lider 1 altitude	Lidar 1 altitude
125	125
100	100
75	75
30	50
25	25
0	0
2,060 2,090 2,100 2,110 2,120 2,130	2,090 2,100 2,110 2,130 2,130 2,140
Lidar 1 altitude 80.08 m	Lidar 1 altitude -14.9 m
Power B error	Power B error
	100 123 100 75 50 23 0 2,560 2,590 2,500 2,110 2,120 2,130 Lidar 1 altitude 80.08 m



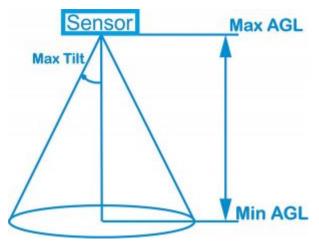
## 11.4.3 Veronte Configuration - altimeter

The Altimeter configuration has to be defined in the Devices panel of Veronte (Devices > Sensors > Altimeter). Configuration tools are explained in section *Altimeter* but a good configuration for the SF11 Lidar is the one showed in the following figure.

🔯 🕑 Penguin Embention 🛪	💿 🧰 😨 🗱 🙆 🖾	CfgMgr StepMgr
Actuators	V Enable Altimeter	
► Micro		
▼ Sensors	Sensor Type	AGL -
Altimeter	Min time diff to allow preload	0.1 s
► GPS		x 0.0 m
► IMU	Position of altimeter (Body	
Magnetometer	frame)	Y 0.0 m
Obstacle detection		Z 0.0 m
Pressure	Sensor variance (m²)	10
► RPM		
Speed down	Input Variable	Lidar 1 Distance
Terrain settings	✓ Enable tilt limits	
Ultrasound	Max tilt	0.34 rad [-π,π]
► Stick	With the	
▶ Veronte	Enable altitude limits	
<ul> <li>Others</li> </ul>	Min AGL	-3.0 m
	Max AGL	120.0 m
Add device 🔹		



The following figure shows a diagram with the values of maximum and minimum Above Ground Level altimeter, and the maximum tilt angle.



Payload limits

It is important to correctly define the distance of the altimeter from the gravity center and the AGL and Tilt angle limits in order to avoid a possible measurement errors.

It is possible to test the correct measurement of the Lidar by positioning it at different AGL altitudes and checking the associated variable in the workspace.

## **11.5 Veronte Tracker**

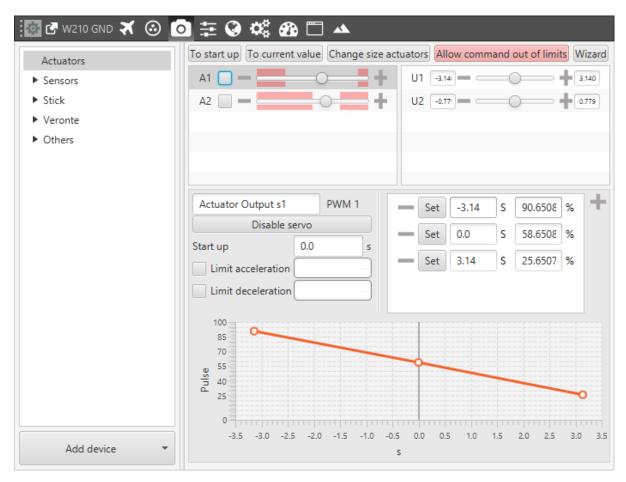
## **11.5.1 Veronte Ground Configuration**

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.

		-	-	
		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.



### 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	▼ Base to gimbal X	0.0	] –
Communications	Logic	Conventional gimbal	<ul> <li>Base to gimbal Y</li> </ul>	1.0	
▼ Payload		Arcade	Base to gimbal Z	0.0	
Gimbal/Tracker Transponder			ADD		
<ul> <li>Sensors</li> </ul>					
▶ Stick					
Veronte					
<ul> <li>Others</li> </ul>					
▶ Others					
▶ Others					
► Others					
▶ Others					
► Others					
▶ Others					
▶ Others					
► Others					
► Others					

#### Tracker Payload configuration

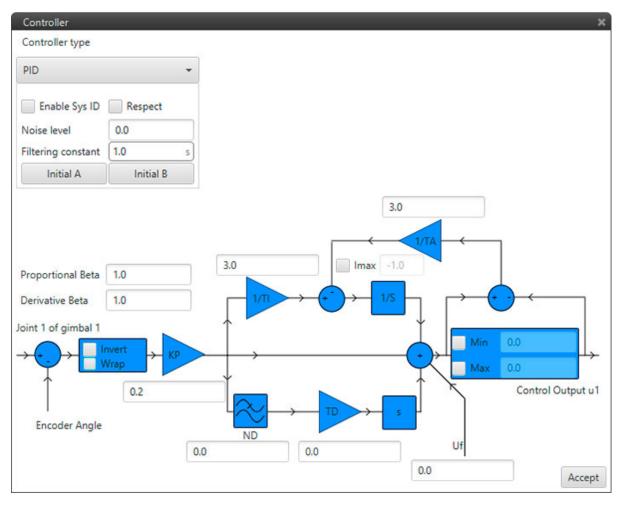
Next step is the configuration of the control loops for each axe: Pan and Tilt.

• 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 Autom	ations	
<ul> <li>▼ Phases</li> <li>StandBy</li> <li>Runway</li> <li>Envelope</li> <li>Smooth</li> <li>Modes</li> <li>Arcade axis</li> </ul>	Guidance Loop Arcade TC Pannel Autom Pan G1 Tilt G1 PID 1 Joint 1 of Gimbal 1 Encoder Angle	Ations Name Mode	Insert name
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.

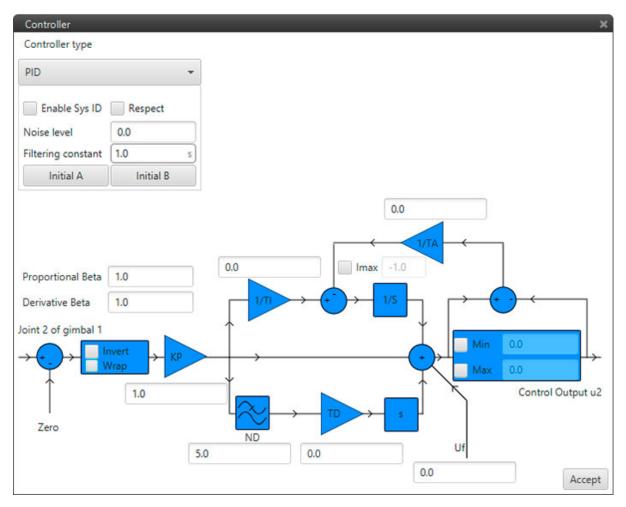


### Pan Control Loop

• 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 🛪 📀	0 🗄 🚱 🗱 🚳 🗔 🔺		
▼ Phases StandBy	Guidance Loop Arcade TC Pannel Autom	]	
Runway Envelope Smooth	Tilt G1	Name Mode	Insert name On
Modes Arcade axis	PID 1 -	-	
	Joint 2 of Gi Zero		
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.

		¢; 🙆 🗆 🔺			IN		Out	
<ul> <li>System Variables</li> </ul>	Search	Сору	Address Veronte 1070	- 0 4	Link qua	ity I	Link quality of related pair	18
Telemetry     Data link to Pipe     Data link to Veronte	Name		abled	Apping variables	Positio	n N	Aoving object icompress 2	
Onboard Log		Link quality		Z				
User Log	-++	Position						
Fast Log								
-Sniffer 1				-				~
		DIS	ABLED					
	+ IAS (Indicated		ABLED	ô				
	+ IAS (Indicated + TAS (True Airsp	Airspeed)	ABLED	Ô				
	and the second se	Airspeed) peed)	ABLED	6				
	= TAS (True Airs)	Airspeed) peed)	ABLED	Û				
	+ TAS (True Airsp GS (Ground Sp	Airspeed) peed) peed)	ABLED					

### Sniffer Ground Configuration

## 11.5.2 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 🛪 🙆 🧿	🗄 🚱 📽 🚾 🖴	
<ul> <li>System Variables</li> <li>Telemetry</li> </ul>	Search Copy Frequency (Hz) 10.0 Address	)
Data link to Pipe	Enabled	
Data link to Veronte	Name	
Onboard Log	🛛 — 🗣 👚 📴 Link quality	
User Log	- I Position	
Fast Log	- V Posición	
<ul> <li>Sniffer</li> </ul>		-
	DISABLED	
	IAS (Indicated Airspeed)	Ô
	TAS (True Airspeed)	
	GS (Ground Speed)	
	Heading	
	Flight Path Angle	
	Bank	
$\langle $		$\sim$

Data Link Veronte Air Configuration

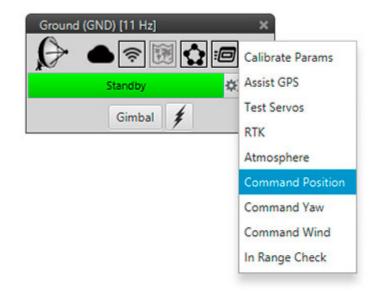
## **11.5.3 Tracking Operation**



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		Ť
Latitude	0.6699061267967821 rad [-π,π]		[9]
Longitude	-0.012143301342789 rad [-π,π]	1	
WGS84	316.7396599671141		m
- MSL	266.2		m
	1.20		m
	3		

Tracker Position configuration

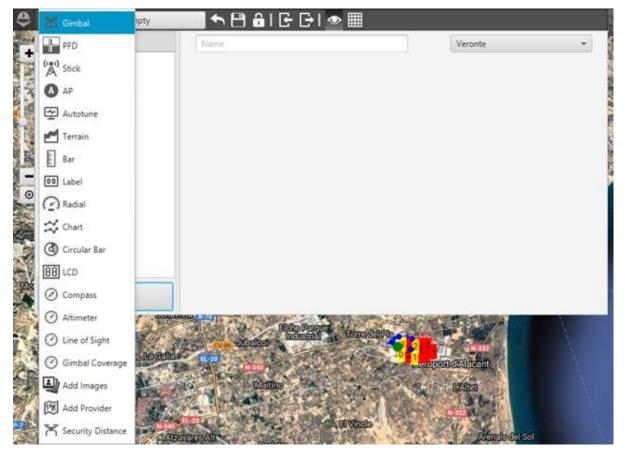
In this panel, it is necessary to insert the tracker position. The user can perform this action inserting Latitude and Longitude values manually or directly clicking on the Map location. The tracker altitude has to be defined too: normally, the tracker tripod is set at 1.20/1.40 [m] so this value has 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.

Widgets Main	Name				SELECTE	D-VERONTE
꿃 Gimbal	Opacity Pos X	143.0	Pos y	472.0	0	
	Width	800	Height	600		Cut video
	Gimbal	Gimbal 1 •	Camera		*	
		No gimbal				
		Gimbal 1				
New						

Workspace: Gimbal widget

After doing it click on ' ...' placed on the top right corner of the widget Gimbal.

amo 🥢	Geotagging Pointing	Codec	Record c to compress DIVX -	14
	<ul> <li>Vector Body</li> <li>Custom Axis</li> </ul>	Absolute	e Relative Approach Initial Point -	
	Location	Latitude	1.5784225029( rad [-π,π])	
		Longitude	0.0 rad [-π,π]	
		WGS84	0.0 m	
		— MSL	-17.161578498270735 m	
		L AGL	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.



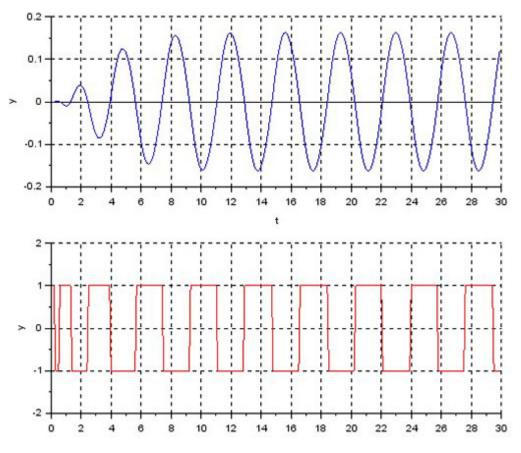
Veronte Tracker

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

# 11.6 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)

## **11.6.1 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.

Veronte Connections Dev	vices Control Naviga	tion Automation	Variables Pa	nel HIL Co	onfig Manage	er StepMg	5
Phases		Pitching	Thrusting	Rolling	Yawing	Flaps	
Envelope Smooth	- Auto	A auto	auto	autotune	auto	auto	
Modes	Manual	M rc	rc	rc	rc	rc	
Arcade axis			Ad	d			

Autotune mode

## **11.6.2 Workspace Configuration**

In the Workspace panel, it is possible to select the Autotune Tool.

Cam							
PFD							
( Stick	ap		6   G- G-	● Ⅲ			
() AP		Name				SELECTED-AIR	
Autotune		Opacity					
Terrain		Pos X	100.0	Pos y	50.0		
Bar							
00 Label							
Radial							
😂 Chart							
G 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?	
ОК	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.

## 11.7 USB joystick integration

## 11.7.1 Adding a 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	<b>Change</b>	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.

vJoy Device				×
vJoy Dev	ice			
Axis 1				
Axis 2				
Axis 3				
Axis 4				
Axis 5				
Axis 6				
Axis 7				
Button 1	Button 2	Button 3	Button 4	Button 5
Button 6				

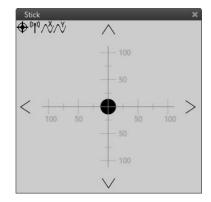
Usb device channels

## 11.7.2 Defining a virtual stick

Once the usb device is recognized:

Workspace							3
Telemetry Map							
[Fixed widgets]	Name			Veronte	SELECTED-VI	DONTE	•
(iiii) Stick				veronite	OCCUPED-VI	INOMIE	•
	Opacity						
	Pos X	190.0	Pos Y	86.0			
	Width	300	Height	300			
	V Horizon	tal Axis	Vertical	Axis	Frequenc	y (Advanced)	
	Horizon Channel	tal Axis	Vertical	Axis	Frequenc	y (Advanced)	Hz
					_		Hz Hz
	Channel	11	✓ Channel	12	• Min Max	10.0	$\equiv$
	Channel Axis Scale	11	Channel     Axis Scale	12	• Min Max	10.0	$\equiv$
	Channel Axis Scale X initial:	11	Channel Axis Scale Y initial:	12	Min     Max     Start	10.0	$\equiv$

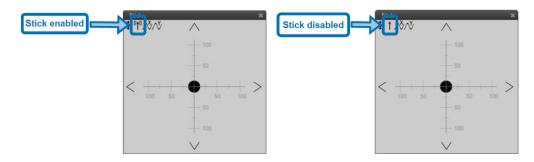
Josytick workspace menu

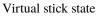


Josytick widget

- 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.
  - 2. Select "Configure joystick" and follow the instructions.
- 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.

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.
- Stick configuration: this section shows how to configure completely a new joystick.
- Lidar integration: in the lidar section is explained how to set the settings of the Altimeter using the analogic port.
- Autotune: the complete example of the autotune configuration and operation.
- 4G Communication: Steps to configure 4G communication with Veronte Autopilots.

### CHAPTER

## TWELVE

## TROUBLESHOOTING

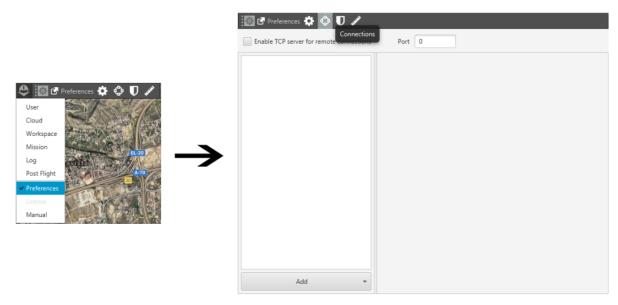
## 12.1 Veronte not detected

If a Veronte Unit is not detected by Veronte Pipe:

- Check if the unit it is correctly connected to the PC.
- Check if the connection is configured in **PreferencesConnections**.

If the connection it is not configured:

- 1. Go to **Preferences > Connections**
- 2. Select Add and then, if the device is conected using the USB port select Serial COM.
- 3. When the connection is completely configured, it is necessary to click on **Save Connection** in order to make it effective.



### Preferences Panel

If the problem persists, maybe there is a problem with the configuration file. Try accessing the safe mode and upload another configuration file into the Veronte Unit. For more information see section *License & Safe Mode*.

# 12.2 PFD Attitude

When the PFD not displays the correct attitude, there may be an error with the calibration of the inertial measurement unit (IMU). To solve this issue follow the next steps:

- 1. Go to Verote Panel.
- 2. Click on Calibrate Params.



### Calibrate Params

3. A new window will be displayed, here user has to procede to calibrate the IMU, see section *Sensors Calibration* for more information about this process.

	on time	3.0			5	
/ Save						
V C	alibrate Imu					
	Yaw *	0.0			rad [	$\pi,\pi$ ]
$\checkmark$	Pitch *	(11.0			° [-180	180])
	Roll *	0.0			° [-180	180])
C	alibrate static	presure				1000
Pab	s *	0.0				Pa
	s * alibrate dynan					Pa
C	alibrate dynan					Pa
Calagnetor	alibrate dynan meter					Pa
C	alibrate dynan		k_x	0.0		Pa
Calagnetor	alibrate dynan meter		k_x k_y	0.0		Pa
Cagnetor bias_x	alibrate dynar meter 0.0					Pa

IMU Calibration

# 12.3 Altitude Error

When the AGL lectures obtained from telemetry are showing strange results, like a very great value when the UAV is in the ground or even negative ones, the problem can come from different areas and the possible solution will be presented in this section.

### 12.3.1 Atmosphere Calibration

The atmosphere has to be calibrated according to the current temperature. The calibration options are open directly on Veronte Panel.



Calibration Menu - Atmosphere

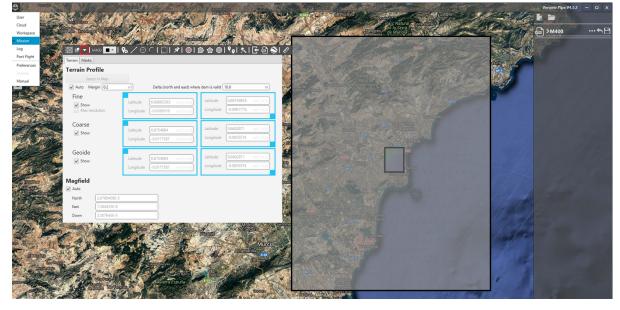
The pop-up window contains the atmosphere parameters, which should be varied to match the actual ones.

CheckList				×
Above ground Altitude	0.0	m	AGL	•
✓ Use current pressure				
Time to adquire mean	3.0	s		
Static pressure	0.0	Pa		
Temperature	288.0	к		
		Cancel	Skip	Accept

Atmosphere Calibration Window

## 12.3.2 Terrain Altitude Meshes

Another source of error could be the terrain model, which contains the information about the heights in the mission area. It could happen that the mesh with this data is not located over the mission trajectory, so when having an error in the height measures this option should be checked.



Meshes are displayed in Mission/Terrain Profile, clicking the option show.

Terrain Height Meshes

- **Show:** this option makes the mesh visible. They can be moved directly by dragging them, so they have to be located over the mission waypoints.
- Auto: to avoid a future error, select this option. When this is enabled, meshes are moved automatically to the mission area.

# **12.4 HIL Simulation Fails**

When HIL Simulation does not work properly, is possible that:

- Simulation frequency is not well configured. In this case, check the XPlane and VerontePipe frequency as described in section *Professional HIL* of the manual.
- The aircraft in XPlane is load in a different airport, so be sure of loading it in the correct one.
- Terrain profile is not correctly positioned: Coarse and Fine zones must be positioned on the mission to have the correct terrain information (see section Mission Setup).
- The radio connection is down. Check the radio link (Antenna, Cable).
- Reboot the whole system: Veronte Pipe, Veronte Autopilot and PC.

# **12.5 Telemetry Overflow Error**

The telemetry Data Link between Veronte Units (GND-AIR) has a limit on the number of variables that it can transmit. If this number is exceeded, the system will not transmit the last ones added and an error will appear on the sidebar (below the autopilot that has this error).

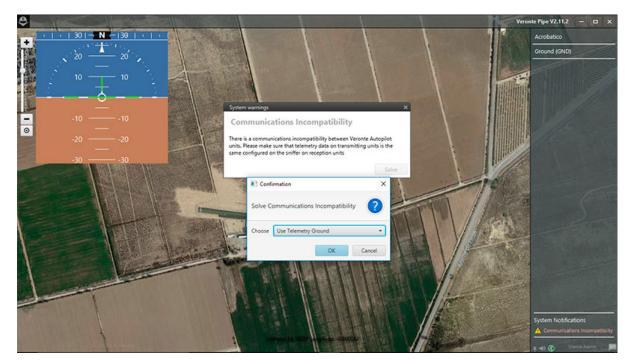


Telemetry Overflow error

To solve this problem, delete from the Data Link some variables until the error disappears (visit section *Telemetry* to check how to deal with the telemetry on Veronte Pipe). This problem is not critical to the flight. The operation can be carried out, with the only difference that the last variables added to the Link can not be displayed on the workspace.

# **12.6 Communications Incompatibility**

This error appears on the lower part of the sidebar. It means that the variables sent by an autopilot to the other one are not the same as the ones sniffed ("captures") by the one who is receiving the telemetry.



**Communications Incompatibility** 

The software provides a dialogue which solves this problem by selecting which one of the options (telemetry or sniffer) will "take control" over the other one making it having the same variables. Check the sniffer and telemetry link before the operation to make sure that the variables sent and listen are the correct ones (section *Variables*).

# 12.7 No enough information of terrain height

When the user tries to save a new mission or an edited one, it is possible that a Warning message appears: **"The mission does not have enough information of terrain height. Check the internet and retry"**.

	NOTAX	AN C	
/		M400 [10 Hz	No. of Concession, Name of
	WARNING X		Standby
	Warning		Takeoff 000 Cruise 000 000
	The mission does not have enough information of terrain	Philippine	Landing 🔅 🗇
	height. Check internet and retry.		Hover 🔅
		CheckList Check gra Check stic	sion

Warning terrain height

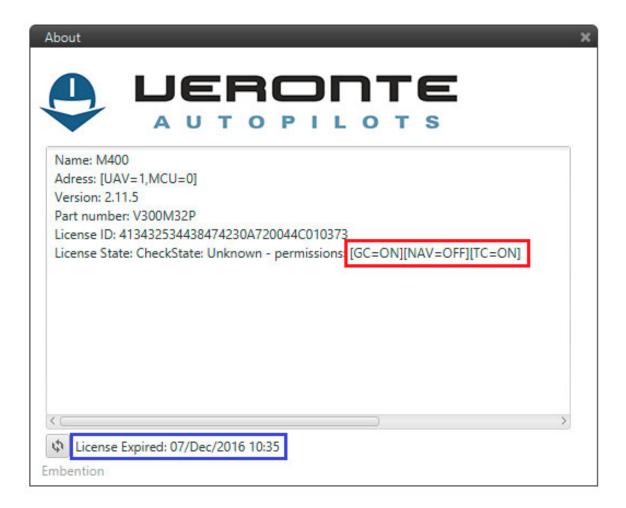
It can be solved in two different ways:

- The problem is the internet connection, check it and re-try.
- The mission has been saved with no waypoints or routes. In this case, the system does not have information about mission location and it is not able to update terrain information.

# 12.8 License Expired

When Veronte Autopilots start, the license state is always checked. As described in section *License & Safe Mode*, the Veronte license has to be renovated biweekly.

If the license warning is displayed in the right bar (below the autopilot name) as showed in the following figure, it is sufficient a left-click on it and the license panel will show up. The panel is useful to check the following information:



License panel

- 1. License State (red)
- 2. License Expiration Date and Time (blue)

In order to solve the problem, user must check:

- Internet connection: to renovate the license it is necessary an internet connection.
- **GPS connection:** if during the license checking the GPS connection is down, the second check (NAV) will be kept to OFF and the license warning will not disappear.
- **PC date and time:** check the date and time settings of the PC. If the date is not correct the system could not be able to check or renovate the license.

### CHAPTER

# THIRTEEN

# **ACRONYMS & DEFINITIONS**

# 13.1 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

LED	Light-Emitting Diode			
LLD	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

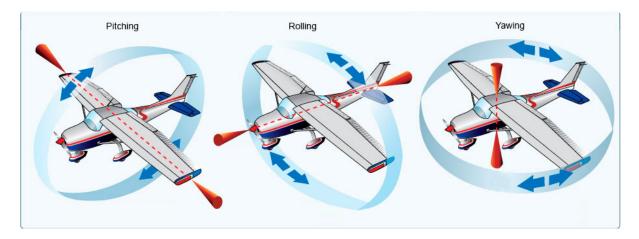
# **13.2 Definitions**

- **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 FOURTEEN

# **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	

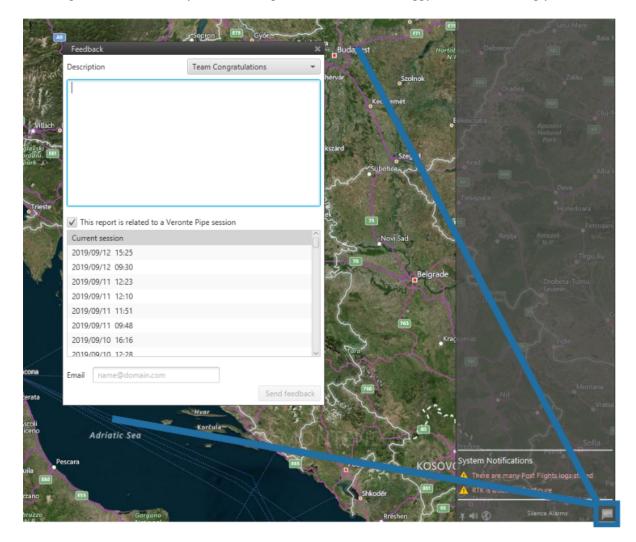
### CHAPTER

## **FIFTEEN**

# FEEDBACK

# **15.1 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 🔹
This report is related to a Veron	te Pipe session
Current session	0
2019/09/12 15:25	
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

#### 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

## SIXTEEN

## **4X REDUNDANT AUTOPILOT**



4x Redundant Autopilot

# **16.1 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.

# 16.2 Setup

## 16.2.1 Radio

Each one of the Vereonte Autopilots modules inside 4xVeronte Autopilot has it own radio module featuring frequency hopping the best possible communication. For each one of the module the user can set the configuration from veronte Pipe.

Radio model P90	00		Licensed Band Frequency		equency	430.0			
dio configuration			F	requency	y hopping	table			
Model Frequency		req. Ho 🔻		Min Frequency 430			.0		
Out power	30 dBm (1W)			Max Frequency 479.0		479.0			
Address	*2W only P Slave 2	400 C2S Model							
Connection	PP	•							
Network address	1								
Packet retransmission	cket retransmission 2 0-		254						
Advanced configura	ition	Commands (Deb	oug)						
		AT&F11 ATS108=30	Ô						
		ATS104=1 ATS105=2 ATS102=1							
		ATS113=2	PI	ease ma	ke sure t	hat:			

Radio menu in Veronte Pipe

**Note:** For each particular case the configuration of the radio may vary. Common radio configurations are PP for complet redundant communication or PMP for one 4xVeronte Autopilot and one Ground Autopilot

## 16.2.2 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.

### 16.2.2.1 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)

### 16.2.2.2 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.

### 16.2.2.3 Variable value message:

Byte0	0	Telemetry message
Byte1	N, Autopilot id	Autopilot [0, 3]
Byte2-5	value	Autopilot score as Float(32 bits)

### 16.2.2.4 Status message:

0	Telemetry message
0xFF	Status flag
bit6-0	Selected autopilot
bit7	Arbitrating 0:false, 1:true
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)
bit0	system ok
bit1	start
bit2	pdi
bit3	memory alloc
bit4	cana bus on
bit5	canb bus on
bit6	Reserved
bit7	Reserved
bit0	system ok
bit1	Vcc A
bit2	Vcc B
bit3	Vcc arb
bit4	Vcc1
bit5	Vcc2
bit6	Vcc3
bit7	Reserved
	0xFF           bit6-0           bit7           bit0           bit1           bit2           bit3           bit4           bit5           bit6           bit7           bit6           bit7           bit6           bit7           bit6           bit7           bit0           bit1           bit2           bit3           bit4           bit5           bit6           bit7           bit3           bit4           bit5           bit4           bit5           bit6

### 16.2.3 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).