

# Ardupilot VSM User Guide

UgCS 2.9.1230



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## 1 Connecting Ardupilot autopilot to UgCS



### 1.1 First time vehicle connection

See [Disclaimer](#).

Please follow these steps to connect an Ardupilot vehicle to the UgCS:

1. Ardupilot vehicle must be properly configured, calibrated and tested using tools and instruction from the official [Ardupilot web site](#) prior to using it with UgCS. UgCS does not support initial configuration, setup and calibration of Ardupilot driven vehicles.
2. If more than one Ardupilot vehicle is planned to be used with UgCS, it must be ensured that each vehicle has a unique system id as defined by the parameter `SYSID_THISMAV`, otherwise UgCS will not be able to distinguish between different vehicles and it will not be possible to operate vehicles normally. To change the parameter, please use the official Ardupilot configuration software like Mission Planner.
3. Turn on the vehicle and plug in the radio modem paired with the vehicle or direct USB cable from the Ardupilot board to the computer where VSM is running. UgCS uses serial ports for communication with Ardupilot vehicles. Standard communication devices like 3DR radio modems (and their analogs) and direct USB connections are supported, as long as OS driver for virtual serial port is installed and serial port is successfully created. Please refer to your communication equipment manufacturer documentation about driver installation instructions.
4. As soon as uplink and downlink connection is established, the vehicle should appear in the active vehicles list in main (map) view. Open *Vehicles* window from main menu and choose the corresponding vehicle for editing by clicking on the menu item and selecting *Edit* button. Now you can select the vehicle profile and change the default vehicle name to be convenient for you:

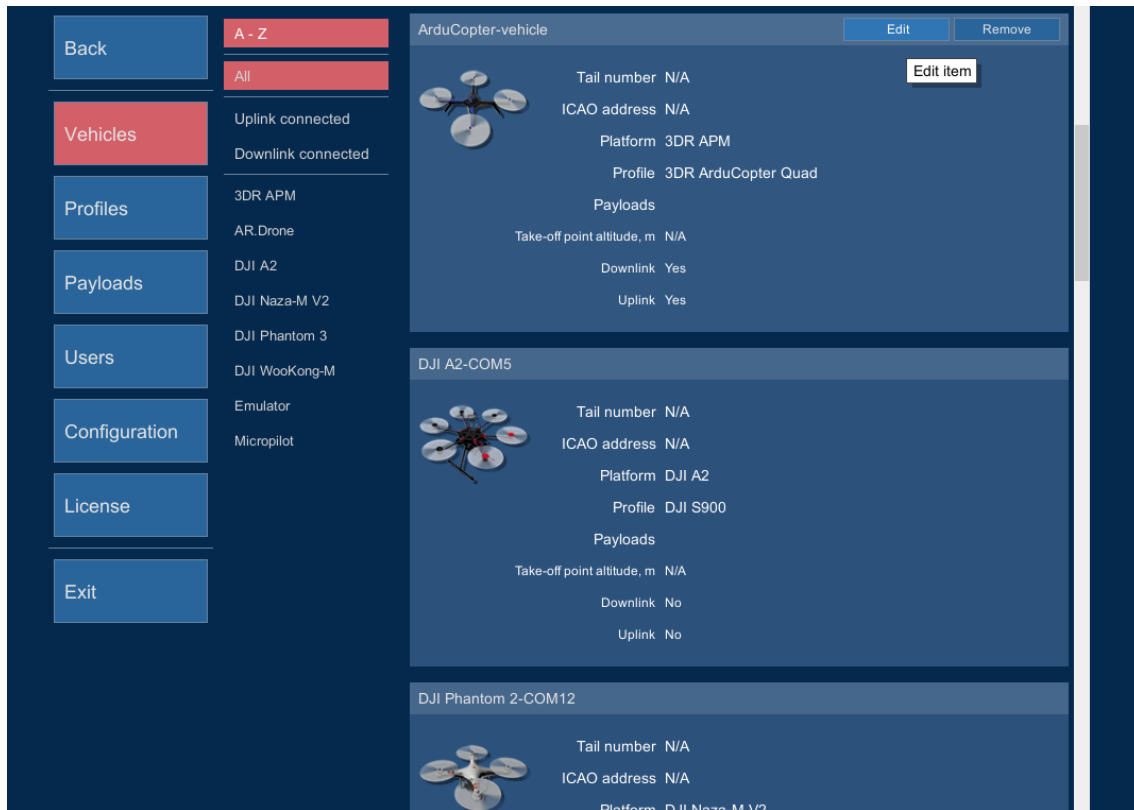


Figure 1: New Ardupilot vehicle

Vehicle profile needs to be assigned to allow mission planning with this vehicle. Vehicle avatar should be assigned in vehicle profile to properly see the vehicle location on map.

5. Repeat steps above for each your Ardupilot vehicle.

Supported vehicle types:

- Copters
- Planes

Supported Ardupilot firmware versions:

- 3.0
- 3.1.x
- 3.2.x
- 3.3.x

Supported hardware platforms:

- APM
- Pixhawk

*Note: Pixhawk with PX4 autopilot is not supported.*

## 1.2 Mission execution specifics

### Note

If one wants to use automatic take-off, it is strongly recommended to place the first waypoint above the actual location of the vehicle. Otherwise the vehicle will reach for the first waypoint in a straight line thus possibly causing danger.

### Mission action support:

Flight plan element / action	Support	Notes
Change speed	Partial	Changing of flight speed during the mission may work only on latest 3.3.x firmware.
Panorama	Partial	Only clock-wise movement is supported due to Ardupilot firmware bug. UgCS provides correct angle values according to Mavlink specification.
Set camera mode	Partial	Only photo mode is supported.
Set camera by time	Partial	"First shot delay" parameter is not supported.
Set camera by distance	Partial	Only "Distance" parameter is supported.
Set camera attitude	No	
Set POI	Yes	
Change yaw	Yes	

### Camera control

For using camera you should set up necessary parameters in ArduPilot native software according to your hardware configuration. See also [Camera control parameters](#)

- VSM configuration should match your copter configuration. See ArduCopter manual for details.

For example, in MissionPlanner the camera set up can be done in "Initial setup" page "Optional hardware/Camera gimbal/Shutter" section. Select the channel your shutter is connected to and set other parameters depending on your shutter control hardware.

## 1.3 Altitude

Ardupilot reports two altitude types - AMSL (Above Mean Sea Level) and AHL (Above Home Location). UgCS is using only the reported AMSL altitude. In previous versions altitude AHL from Ardupilot was reported as RAW altitude. It was decided not to show altitude AHL as RAW because it would be inconsistent with other supported autopilots. Altitude AHL will be added in future versions of UgCS.

Current altitude AGL (Above Ground Level) is calculated as:

$$\text{Vehicle altitude AGL} = \text{Reported vehicle altitude AMSL} - \text{Terrain elevation AMSL at vehicle location}$$

## 1.4 Home Location

Home location support differs depending on ArduPilot firmware.

### ArduCopter firmware version up to 3.2.1

### Warning

Home location set via mission is ignored by Ardupilot firmware version 3.2.1.

Ardupilot will always override home location with current position at the time of arming.

When "RETURN\_HOME" command is issued from UgCS Client or RC transmitter, vehicle will return to the location it was armed at regardless of home location set in mission.

### ArduCopter firmware version 3.3.1 and up

Mission upload automatically sets Home location. There are several restrictions on Home location:

- Home location can be set only while enough GPS satellites are visible.
- Home location should be close to current location (within 50km)

Mission will fail to upload if any of the above conditions do not hold.

### Note

Home location altitude is always 0m AGL (Above Ground Level). I.e. Vehicle must be launched from the ground level. This is a limitation of UgCS software and will be removed in future versions.

#### 1.4.1 Landing at Home Location

Vehicle behavior after returning at Home Location depends on on the configuration parameter RTL\_ALT\_FINAL:

- RTL\_ALT\_FINAL == 0: Vehicle will land automatically
- RTL\_ALT\_FINAL > 0: Vehicle will descend to given altitude (in centimeters) and hover there waiting for user control.

### Note

RTL\_ALT\_FINAL parameter can be set using MissionPlanner software.

## 1.5 Command execution specifics

Command	Support	Notes
ARM	Yes	Arms vehicle.
DISARM	Yes	Disarms vehicle.
AUTOMODE	Yes	Start mission from first waypoint. Sets vehicle into <i>Auto</i> flight mode.
MANUALMODE	Yes	Sets <i>Manual</i> mode. It's <b>LOITER</b> for multicopter frames and <b>STABILIZE</b> for fixed wing.
CLICK & GO	Yes	Sets <i>Click &amp; Go</i> (single waypoint) mode.
JOYSTICK	Yes	Sets <i>Joystick mode</i> . See also <a href="#">Joystick support</a> below.
HOLD	Yes	Pause mission execution. The drone will loiter at its current position.

CONTINUE	Yes	Continue with mission execution from next waypoint. Works from <i>Manual</i> , <i>Joystick_</i> and <i>Click&amp;Go</i> modes.
RETURN HOME	Yes	Vehicle will return to home location. See also <a href="#">Home Location</a> .
TAKEOFF	No	
LAND	Yes	
EMERGENCYLAND	No	
CAMERA_TRIGGER	No	

## 1.6 Joystick support

Ardupilot can be put into Joystick mode which allows user to manually control the vehicle in similar way to RC transmitter. Please note that Joystick mode is inherently more fragile than direct manual control via RC transmitter because it involves many different data links and components:

Joystick device -> UgCS client -> server -> VSM -> Ground Radio -> Air Radio -> Autopilot

If any of the above links fail, the joystick control is broken and vehicle automatically goes into manual mode. (Loiter for copters and Stabilize for planes) This is why user should be very careful when working with Joystick control mode. It is recommended to have RC transmitter as backup controller.

### Note

Joystick control mode is disabled by default for fixed wing frames. To enable Joystick mode for planes please refer to section [Joystick control parameters](#).

## 1.7 Command shading

UGCS Client can show command buttons in different shades. You can always press all buttons disregarding of shade. Highlighted buttons suggest recommended commands, depending on vehicle current status.

### Command shading

State	Button highlighted	Button shaded
Armed	DISARM, AUTOMODE, MANUALMODE, LAND, RETURNHOME, CLICK-GO, JOYSTICK, HOLD, CONTINUE	ARM
Disarmed	ARM	DISARM, AUTOMODE, MANUALMODE, LAND, RETURNHOME, CLICK-GO, JOYSTICK, HOLD, CONTINUE

## 1.8 Telemetry information specifics

### 1.8.1 Air speed

If there is no air speed sensor onboard, air speed will be shown as "Not available". If there is an air speed sensor onboard, the air speed value will be shown.

### 1.8.2 RC link quality

Ardupilot reports RC link loss correctly only when throttle failsafe is activated.

- Throttle failsafe must be configured. (Set parameter FS\_THR\_ENABLE to nonzero and configure throttle channel to go below FS\_THR\_VALUE on RC link loss)

- Ardupilot reports RC link correctly only while armed. If RC signal is lost while vehicle is disarmed it will still appear as 100%. (This is Ardupilot firmware limitation)
- RC link quality is available only for multicopter and heli firmware (ArduCopter). Fixed wing (ArduPlane) and rover (ArduRover) does not report RC link status.

## 1.9 Fail-safe actions

### GPS Lost:

Action	Result
Wait	Aircraft tries to maintain altitude
Land	Aircraft lands even if in loiter mode

### RC Lost:

Action	Result
Wait	Aircraft changes altitude to failsafe alt. (set via MissionPlanner) and returns home
Land	Aircraft lands even if in loiter mode
Return Home	Aircraft changes altitude to failsafe alt. (set via MissionPlanner) and returns home
Continue	Aircraft continues mission

### Battery Low:

Action	Result
Wait	Aircraft changes altitude to failsafe alt. (set via MissionPlanner) and returns home
Land	Aircraft changes altitude to failsafe alt. (set via MissionPlanner) and returns home
Return Home	Aircraft changes altitude to failsafe alt. (set via MissionPlanner) and returns home
Continue	Aircraft continues mission

### Datalink loss:

Failsafe actions on datalink loss not supported.

## 1.10 Waypoint turn types

UgCS supports two turn types for VTOL vehicles (Multicopter and Heli): Straight waypoint and Spline waypoint. You can choose turn type for each Waypoint, Circle, Perimeter. The default turn mode in the system is Straight type.



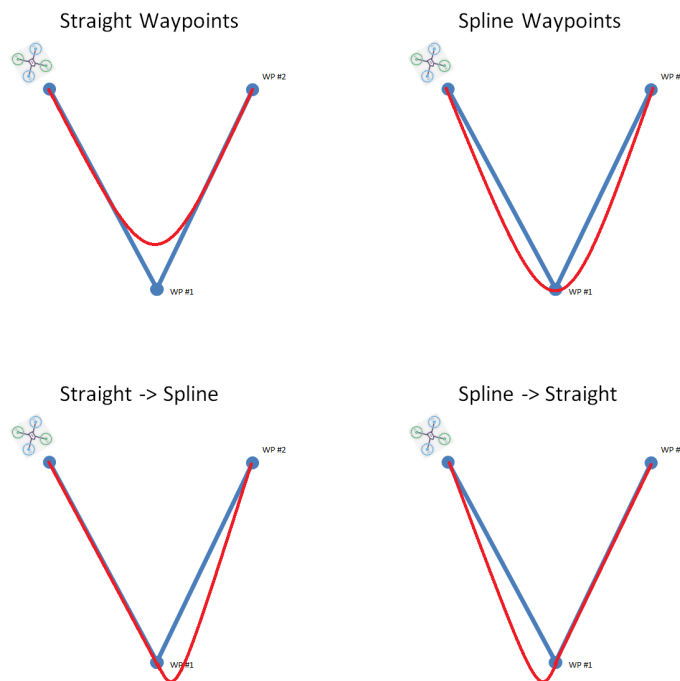


Figure 2: Turn type

Turn type	Support	Notes
Straight	Yes	The vehicle will fly a straight line to the location specified as a lat, lon and altitude.
Spline	Yes	The vehicle will fly to the location specified as a lat, lon and altitude, but when executed the vehicle will fly smooth paths (both vertically and horizontally) instead of straight lines.

**Note**

- When using Spline turn type make sure the line segment after the waypoint is long enough otherwise autopilot can fly unexpectedly missing some waypoints. What is "long enough"? The desired segment length varies with speed. Our tests show that with ground speed 5m/s route segment must be at least 20m long. If speed is set to 10m/s then route segment after the waypoint should be at least 50 meters.
- Different turn types for fixed wing vehicles are not supported.

You can find more information about turning mode and supporting autopilots on the sites:

- [https://github.com/diydrones/apm\\_planner/issues/274](https://github.com/diydrones/apm_planner/issues/274)
- [http://copter.ardupilot.com/wiki/mission-command-list/#spline\\_waypoint](http://copter.ardupilot.com/wiki/mission-command-list/#spline_waypoint)

**1.11 Connection using ZigBee interface**

There is a possibility to connect UgCS to Ardupilot vehicle using ZigBee interface. Connection is performed with two or more Digi XBee ZigBee modules (one on ground side, others on vehicles side) and dedicated UgCS software component called XBee Connector. Please refer to XBee Connector user guide for details.

In order to use such kind of connection you are to disable [Serial port configuration](#) and enable [Proxy configuration](#).

## 1.12 Configuration file

Default configuration file of the Ardupilot VSM suits most needs and it is generally not necessary to modify it.

Configuration file location:

- **On Microsoft Windows:**

```
C:\Program Files (x86)\UgCS\bin\vsm-ardupilot.conf
```

- **On GNU/Linux:**

```
/etc/opt/ugcs/vsm-ardupilot.conf
```

- **On Apple OS X:**

```
/Users/[user name]/Library/Application Support/UGCS/configuration/vsm-ardupilot.conf
```

### 1.12.1 Common parameters

All VSMs share a common set of configuration file parameters described in [Common configuration file parameters](#). Ardupilot VSM configuration file prefix is:

```
vehicle.ardupilot
```

### 1.12.2 Communication channel configuration

There must be at least one communication channel defined, otherwise VSM will not try to connect to the vehicle. See [Communication with vehicle](#) for details

Default installation is configured to detect autopilot automatically on any available serial port at 57600 or 115Kbps.

### 1.12.3 Model name and serial number override

Optional.

- **Name:** vehicle.ardupilot.custom.[name].system\_id = [system id]
- **Name:** vehicle.ardupilot.custom.[name].model\_name = [model name]
- **Name:** vehicle.ardupilot.custom.[name].serial\_number = [serial number]
- **Description:** In UgCS each vehicle is identified by a unique combination of model name and serial number represented as text strings. By default, Ardupilot vehicles are identified with a model name *Ardupilot* and serial number equal with the Mavlink system id read from the vehicle. It can be overridden by these parameters, where [name] is an arbitrary vehicle name, [system id] is the original Mavlink system id which should be overridden, [model name] is a new model name to be visible to the UgCS, [serial number] is a new serial number to be visible to the UgCS.
- **Example:**

```
vehicle.ardupilot.custom.my_drone.system_id = 2
vehicle.ardupilot.custom.my_drone.model_name = ArducopterQuad
vehicle.ardupilot.custom.my_drone.serial_number = 123456
```

#### 1.12.4 Camera control parameters

Mandatory. Read Ardupilot manual about camera triggering configuration to understand these parameters. It is assumed that the vehicle is configured in "servo" mode (not "relay") for camera triggering.

- **Name:** vehicle.ardupilot.camera\_servo\_idx
- **Description:** Index of the servo to use for camera triggering.
- **Example:**

```
vehicle.ardupilot.camera_servo_idx = 8
```

- **Name:** vehicle.ardupilot.camera\_servo\_pwm
- **Description:** PWM value to set for camera triggering servo when taking photo.
- **Example:**

```
vehicle.ardupilot.camera_servo_pwm = 1900
```

- **Name:** vehicle.ardupilot.camera\_servo\_time
- **Description:** Time to hold camera servo at the specified PWM when triggering single photo in seconds.
- **Example:**

```
vehicle.ardupilot.camera_servo_time = 1.0
```

#### 1.12.5 Joystick control parameters

Optional. By default joystick control mode is disabled for fixed wing frames due to safety reasons. Add vehicle.ardupilot.enable\_joystick\_control\_for\_fixed\_wing to enable joystick control for fixed wing vehicles, too.

- **Name:** vehicle.ardupilot.enable\_joystick\_control\_for\_fixed\_wing
- **Description:** Enable joystick control for fixed wing vehicles.
- **Default:** no
- **Example:**

```
vehicle.ardupilot.enable_joystick_control_for_fixed_wing = yes
```

#### 1.12.6 Report relative altitude

Optional. By default Ardupilot VSM will report relative altitude as RAW altitude because it is more precise than GPS altitude. For some installations GPS altitude from vehicle is more appropriate, e.g. when RTK GPS is used.

- **Name:** vehicle.ardupilot.report\_relative\_altitude
- **Description:** Enable/Disable reporting of relative altitude in telemetry.
- **Default:** yes
- **Example:**

```
vehicle.ardupilot.report_relative_altitude = no
```

### 1.13 Common configuration file parameters

VSM configuration file is a text file specified via command line argument - *-config* of the VSM application. Example:

```
--config /etc/opt/ugcs/vsm-ardupilot.conf
```

Each configuration parameter is defined as a line in the configuration file with the following structure:

```
name1.name2...nameX = value
```

where name1, name2 ... nameX are arbitrary names separated by dots to divide a variable into logical blocks and a value which can be a number value or a text string depending on the context. See below the description about common VSM configuration parameters.

#### 1.13.1 UgCS server configuration

##### 1.13.1.1 Listening address

Mandatory.

- **Name:** ucs.local\_listening\_address = [IP address]
- **Description:** Local TCP address to listen for incoming connections from UgCS server. Specify *0.0.0.0* to listen from all local addresses.
- **Example:** ucs.local\_listening\_address = 0.0.0.0

##### 1.13.1.2 Listening port

Mandatory.

- **Name:** ucs.local\_listening\_port = [port number]
- **Description:** Local TCP port to listen for incoming connections from UgCS server. Default is 5556.
- **Example:** ucs.local\_listening\_port = 5556

#### 1.13.2 Logging configuration

##### 1.13.2.1 Level

Optional.

- **Name:** log.level = [error|warning|info|debug]
- **Description:** Logging level.
- **Default:** info
- **Example:** log.level = debug

##### 1.13.2.2 File path

Optional.

- **Name:** log.file\_path = [path to a file]
- **Description:** Absolute or relative (to the current directory) path to a logging file. Logging is disabled if logging file is not defined. File should be writable. Backslash should be escaped with a backslash.
- **Example:** log.file = /var/opt/ugcs/log/vsm-ardupilot/vsm-ardupilot.log
- **Example:** log.file = C:\\Users\\John\\AppData\\Local\\UGCS\\logs\\vsm-ardupilot\\vsm-ardupilot.log

### 1.13.2.3 Maximum single file size

Optional.

- **Name:** `log.single_max_size = [size]`
- **Description:** Maximum size of a single log file. When maximum size is exceeded, existing file is renamed by adding a time stamp and logging is continued into the empty file. `[size]` should be defined as a number postfixed by a case insensitive multiplier:
  - Gb, G, Gbyte, Gbytes: for Giga-bytes
  - Mb, M, Mbyte, Mbytes: for Mega-bytes
  - Kb, K, Kbyte, Kbytes: for Kilo-bytes
  - no postfix: for bytes
- **Default:** 100 Mb
- **Example:** `log.single_max_size = 500 Mb`

### 1.13.2.4 Maximum number of old log files

Optional.

- **Name:** `log.max_file_count = [number]`
- **Description:** Log rotation feature. Maximum number of old log files to keep. After reaching `single_max_size` of current log file VSM will rename it with current time in extension and start new one. VSM will delete older logs so the number of old logs does not exceed the `max_file_count`.
- **Default:** 1
- **Example:** `log.max_file_count = 5`

### 1.13.3 Mission dump path

Optional.

- **Name:** `[prefix].mission_dump_path = [path to a file]`
- **Description:** File to dump all generated missions to. Timestamp is appended to the name. Delete the entry to disable mission dumping. All directories in the path to a file should be already created.
- **Example:** `vehicle.ardupilot.mission_dump_path = C:\\tmp\\ardupilot_dump`

### 1.13.4 Automatic service discovery

VSM can respond to automatic service discovery requests from UgCS server.

When this parameter is not configured, service discovery is disabled.

Optional.

- **Name:** `service_discovery.vsm_name = [Service name]`
- **Description:** Human readable service name.
- **Example:** `service_discovery.vsm_name = Ardupilot VSM`

## 1.14 Communication with vehicle

VSM can communicate with Vehicle over different communication channels

Currently supported channels:

- Serial port, see [Serial port configuration](#) for details.
- TCP link, see [TCP connection configuration](#) for details.
- UDP link, see [UDP connection configuration](#) for details.
- vsm-proxy (XBee), see [Proxy configuration](#) for details.

### 1.14.1 Serial port configuration

Optional. VSM which communicates with vehicles via serial ports should define at least one serial port, otherwise VSM will not try to connect to the vehicles. Port name and baud rate should be both defined. [prefix] is unique for each VSM.

#### 1.14.1.1 Port name

Optional.

- **Name:** [prefix].[port index].name = [regular expression]
- **Description:** Ports which should be used to connect to the vehicles by given VSM. Port names are defined by a [regular expression] which can be used to define just a single port or create a port filtering regular expression. Expression is case insensitive on Windows. [port index] is a arbitrary port indexing name.
- **Example:** vehicle.ardupilot.serial\_port.1.name = /dev/ttyUSB[0-9]+|com[0-9]+
- **Example:** vehicle.ardupilot.serial\_port.2.name = com42

#### 1.14.1.2 Port baud rate

Optional.

- **Name:** [prefix].[port index].baud.[baud index] = [baud]
- **Description:** Baud rate for port opening. [baud index] is an optional arbitrary name used when it is necessary to open the same serial port using multiple baud rates. [port index] is an arbitrary port indexing name.
- **Example:** vehicle.ardupilot.serial\_port.1.baud.1 = 9600
- **Example:** vehicle.ardupilot.serial\_port.1.baud.2 = 57600
- **Example:** vehicle.ardupilot.serial\_port.2.baud = 38400

#### 1.14.1.3 Excluded port name

Optional.

- **Name:** [prefix].exclude.[exclude index] = [regular expression]
- **Description:** Ports which should not be used for vehicle access by this VSM. Port names are defined by a [regular expression] which can be used to define just a single port or create a port filtering regular expression. Filter is case insensitive on Windows. [exclude index] is a arbitrary indexing name used when more than one exclude names are defined.
- **Example:** vehicle.ardupilot.serial\_port.exclude.1 = /dev/ttyS.\*
- **Example:** vehicle.ardupilot.serial\_port.exclude = com1

#### 1.14.1.4 Serial port arbiter

Optional.

- **Name:** [prefix].use\_serial\_arbiter = [yes|no]
- **Description:** Enable (yes) or disable (no) serial port access arbitration between VSMs running on the same machine. It is recommended to have it enabled to avoid situation when multiple VSMs try to open the same port simultaneously.
- **Default:** yes
- **Example:** vehicle.ardupilot.serial\_port.use\_serial\_arbiter = no

#### 1.14.2 TCP connection configuration

Optional. VSM which communicates with vehicles over TCP should define at least one network connection, otherwise VSM will not try to connect to vehicles. [prefix] is unique for each VSM.

##### 1.14.2.1 IP-address for outgoing TCP connection

Optional.

- **Name:** [prefix].detector.[con index].address = [IP-address]
- **Description:** IP-address of vehicle to connect to. Typically used for vehicle simulators.
- **Example:** vehicle.ardupilot.detector.1.address = 10.0.0.111

##### 1.14.2.2 remote TCP port

Optional.

- **Name:** [prefix].detector.[con index].tcp\_port = [port number]
- **Description:** Remote port to connect to.
- **Example:** vehicle.ardupilot.detector.1.tcp\_port = 5762

#### 1.14.3 UDP connection configuration

Optional. VSM which communicates with vehicles via network should define at least one network connection, otherwise VSM will not try to connect to vehicles. [prefix] is unique for each VSM.

##### 1.14.3.1 Local IP-address for UDP

Optional.

- **Name:** [prefix].detector.[con index].udp\_local\_address = [IP-address]
- **Description:** Local IP-address to listen for incoming UDP packets on. Specify 0.0.0.0 if you want to listen on all local addresses.
- **Example:** vehicle.ardrone.detector.1.udp\_local\_address = 0.0.0.0

##### 1.14.3.2 Local UDP port

Optional.

- **Name:** [prefix].detector.[con index].udp\_local\_port = [port number]
- **Description:** Local UDP port to listen for incoming packets on.
- **Example:** vehicle.ardrone.detector.1.udp\_local\_port = 14550

### 1.14.3.3 Remote IP-address for UDP

Optional.

- **Name:** [prefix].detector.[con index].udp\_address = [IP-address]
- **Description:** Remote IP-address to send outgoing UDP packets to.
- **Example:** vehicle.ardrone.detector.1.udp\_address = 192.168.1.1

### 1.14.3.4 Remote UDP port

Optional.

- **Name:** [prefix].detector.[con index].udp\_port = [port number]
- **Description:** Remote UDP port to send outgoing packets to.
- **Example:** vehicle.ardrone.detector.1.udp\_port = 14551

## 1.14.4 Proxy configuration

Optional. VSM is able to communicate with vehicle via proxy service which redirects dataflow received from vehicle through TCP connection to VSM and vice versa using specific protocol. In other words proxy service appears as a router between vehicle and VSM. At the moment there is one implementation of proxy in UgCS called XBee Connector which retranslates data from ZigBee network to respective VSM.

### 1.14.4.1 IP-address for proxy

Optional.

- **Name:** [prefix].tcp.[con index].proxy = [IP-address]
- **Description:** IP-address to connect proxy to. Specify local or remote address.
- **Example:** vehicle.ardupilot.tcp.1.proxy = 127.0.0.1

### 1.14.4.2 TCP port for proxy

Optional.

- **Name:** [prefix].tcp.[con index].port = [port number]
- **Description:** TCP port to be connected with proxy through. Should be the same as in configuration on proxy side.
- **Example:** vehicle.ardupilot.tcp.1.port = 5566

## 2 Disclaimer

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