

# Ardupilot VSM User Guide

UgCS 3.2.113



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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:

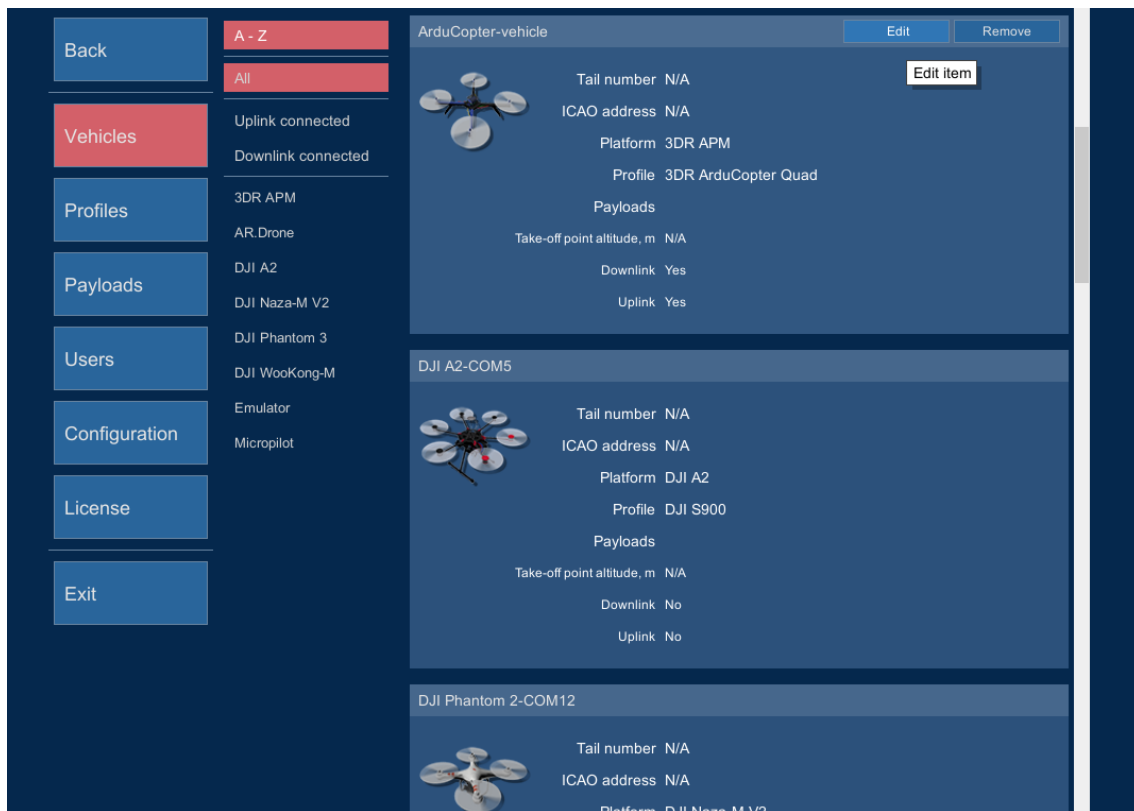


Figure 1: New Ardupilot vehicle

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.

- Repeat steps above for each your Ardupilot vehicle.

Supported vehicle types:

- Copters
- Planes
- VTOL

Supported Ardupilot firmware versions:

- Any version starting from 3.0.0 and up to 3.6.0

**Note**

When working with VTOL vehicles make sure the Q\_MAV\_TYPE correctly.

## 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. See <a href="#">Camera trigger command</a>  |
| Set camera by time           | Partial | "First shot delay" parameter is not supported. See note below.  |
| Set camera by distance       | Partial | Only "Distance" parameter is supported. See note below.   |
| Set camera attitude          | No      |   |
| Set POI                      | Yes     |   |
| Change yaw                   | Yes     |   |

**Note**

### Camera series by time and by distance

When mission includes a camera series (by time or by distance) action and mission flight is interrupted by issuing any command that interferes with mission (eg. Hold, Click&Go, RTH) during active camera series then triggering will stop until vehicle reaches the next waypoint with camera trigger action.

### Camera series by distance on ArduCopter prior version 3.6

When mission includes a camera series by distance action and mission flight is interrupted by issuing any command that interferes with mission (eg. Hold, Click&Go, RTH) during active camera series then triggering will go on until "Continue" command is issued and vehicle reaches the next waypoint without camera trigger action. This is because of Ardupilot limitation which does not allow to stop camera triggering via standalone command.

## 1.3 Current waypiont

UgCS can report current waypoint vehicle is navigating to. There are two options available for the feature to work: [Saving route hash on vehicle](#) and [Route download](#). Both options are disabled by default due to their limitations.

### 1.3.1 Saving route hash on vehicle

When [Route hash parameter name](#) is defined, VSM saves the hash of uploaded route to the vehicle as value of the given parameter.

Possible values: Any valid ardupilot parameter name which does not have enforced limits and is of type float.

Unfortunately, Ardupilot does not provide "user defined" parameters, therefore it is very important to select parameter which is not used in normal ardupilot operation. If that is not possible then [Route download](#) should be considered.

Recommended parameter is RALLY\_LIMIT\_KM which can be used for this purpose unless "rally points" Ardupilot feature is required. See [Route hash parameter name](#).

### 1.3.2 Route download

When enabled, VSM downloads route from the vehicle on each vehicle connect and after each route upload to the vehicle. This can take significant time when the route is large. This setting allows to see current waypoint at the expense of doubling route upload time. It should be enabled only if [Saving route hash on vehicle](#) is not available. See [Enable route download](#).

## 1.4 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:

*Vehicle altitude AGL = Reported vehicle altitude AMSL - Terrain elevation AMSL at vehicle location*

## 1.5 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.

**1.5.1 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.

The `RTL_ALT_FINAL` can be overridden in config file. See [RTL\\_ALT\\_FINAL parameter](#).

**Note**

`RTL_ALT_FINAL` parameter can be set using MissionPlanner software.

**1.6 Command execution specifics**

| Command        | Support | Notes  |
|----------------|---------|--|
| ARM            | Yes     | Arms vehicle.  |
| DISARM         | Yes     | Disarms vehicle. For copter this works only when vehicle is on the ground.   |
| 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. If mission is already completed then vehicle will restart the mission. |
| RETURN HOME    | Yes     | Vehicle will return to home location. See also <a href="#">Home Location</a> .   |
| TAKEOFF        | No      |  |
| LAND           | Yes     |  |
| EMERGENCYLAND  | No      |  |
| CAMERA_TRIGGER | Yes     | See <a href="#">Camera trigger command</a> for details   |

|               |     |                                    |
|---------------|-----|------------------------------------|
| MISSION_CLEAR | Yes | Deletes current route from vehicle |
|---------------|-----|------------------------------------|

## 1.7 Camera trigger command

There are two (mutually exclusive) ways to trigger camera on Ardupilot.

1) By default camera triggering done via DO\_DIGICAM\_CONTROL command.

This allows trigger by distance (typically used in aerial photo missions) and single shot. Trigger by time WP action is not possible with this command.

Camera interface must be configured via MissionPlanner or via "vehicle.ardupilot.parameter" settings before this command can be used.

Make sure that SERVO\*\_FUNCTION is set to 10 (camera trigger). Please refer to Ardupilot manual for details at <http://ardupilot.org/copter/docs/common-camera-shutter-with-servo.-html#shutter-configuration-with-pixhawk>.

2) If camera trigger by time in mission is required then it should be specially configured via vehicle.ardupilot.camera\_servo\_idx parameter in vsm-ardupilot.conf.

For configuration parameters see [Camera control parameters](#).

In this case camera is triggered via DO\_REPEAT\_SERVO command. This allows trigger by time and single shot. Trigger by distance WP action is not possible with this command.

When camera trigger command is issued then the specified servo is moved to the value specified by camera\_servo\_pwm and held there for the half of the specified interval. The servo then moves back to the value specified by the corresponding RC<camera\_servo\_idx>\_TRIM parameter. Make sure that SERVO<camera\_servo\_idx>\_FUNCTION is set to 0 (servo controlled by mission). Both parameters RC\_TRIM and SERVO\_FUNCTION should be configured via MissionPlanner or via "vehicle.ardupilot.parameter" settings.

3) Usage of both camera trigger actions "by time" and "by distance" in the same mission is not supported.

## 1.8 Autopilot parameters

There is a number of MAVlink parameters which are changed on the autopilot during operation. Some parameters are set on first vehicle connect, some are set during route upload and command execution. Any mavlink parameter supported by the autopilot can be set on vehicle connect using conf file setting "vehicle.ardupilot.parameter"

### 1.8.1 Parameters common for fixed wing and copters

| Parameter      | Description  |
|----------------|--|
| GND_ALT_OFFSET | Modified if set_ground_alt_offset is set to yes. See also <a href="#">Set ground altitude offset</a> |
| MIS_RESTART    | Modified during commands AUTO and CONTINUE   |
| RALLY_LIMIT_KM | Used to keep the hash of uploaded route. See also <a href="#">Saving route hash on vehicle</a>       |

### 1.8.2 Copter parameters

| Parameter       | Description   |
|-----------------|---|
| BATT_FS_LOW_ACT | Modified if route parameters sets failsafe action on low battery.     |
| FS_EKF_ACTION   | Modified if route parameters sets failsafe action on GPS signal loss. |



|                 |   |
|-----------------|---|
| FS_THR_ENABLE   | Modified if route parameters sets failsafe action on RC signal loss.                    |
| RTL_ALT         | Modified if route parameters sets Emergency return altitude.                            |
| WP_YAW_BEHAVIOR | Set to 0 if autoheading is set to yes. See also <a href="#">Vehicle heading control</a> |

### 1.8.3 Plane and VTOL parameters

| Parameter        | Description   |
|------------------|---|
| ALT_HOLD_RTL     | Set if route parameters sets Emergency return altitude.                                   |
| TRIM_ARSPD_CM    | Modified when Click&Go command issued on the vehicle.                                     |
| LAND_FLARE_ALT   | Set if vehicle profile has "Landing flare altitude" specified.                            |
| LAND_FLARE_SEC   | Set if vehicle profile has "Landing flare time" specified.                                |
| LAND_PITCH_CD    | Set if vehicle profile has "Minimum landing pitch" specified.                             |
| TECS_LAND_DAMP   | Set if vehicle profile has "Controller sink rate to pitch gain during flare" specified.   |
| TECS_LAND_ARSPD  | Set if vehicle profile has "Airspeed during landing approach" specified.                  |
| TECS_LAND_SPDWGT | Set if vehicle profile has "Weighting applied to speed control during landing" specified. |
| TECS_PITCH_MAX   | Set if vehicle profile has "Maximum pitch in auto flight" specified.                      |
| LIM_PITCH_MAX    | Set if vehicle profile has "Maximum pitch" specified.                                     |
| THR_MIN          | Set if vehicle profile has "Minimum throttle" specified.                                  |
| TECS_LAND_SINK   | Set if vehicle profile has "Landing sink rate" specified.                                 |
| RNGFND_LANDING   | Set if vehicle profile has "Enable rangefinder for landing" specified.                    |
| RNGFND_MIN_CM    | Set if vehicle profile has "Minimum rangefinder distance" specified.                      |

## 1.9 ADSB receiver support

Ardupilot supports connection with [PingRX ADS-B receiver](#) from uAvionix. Please refer to [Ardupilot docs](#) for details on hardware setup. UgCS will receive the ADSB messages from autopilot and show detected vehicles in client GUI.

## 1.10 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

One specific Ardupilot firmware version 3.4.3 does not support Joystick mode. Joystick control mode is disabled by default for fixed wing frames. To enable Joystick mode for planes please refer to section [Joystick control parameters](#).

## 1.11 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 |

## 1.12 Telemetry information specifics

### 1.12.1 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.

### 1.12.2 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.

## 1.13 Fail-safe actions

Route-specific fail safe settings can be set for ArduCopter.

### 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   |

**Warning**

UgCS does not support failsafe settings for ArduPlane. Please use Mission Planner of QGC to modify ArduPlane failsafe settings.

**Datalink loss:**

Failsafe actions on datalink loss not supported.

**1.14 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.

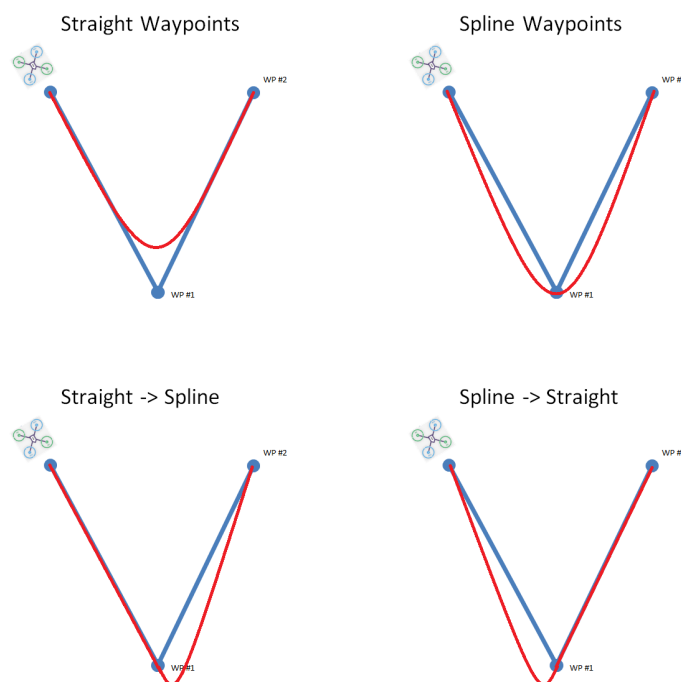


Figure 2: Turn type

| 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)

**1.15 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](#).

**1.16 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
```

**1.16.1 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
```

### 1.16.2 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 devices](#) for details

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

### 1.16.3 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
```

### 1.16.4 Camera control parameters

Camera trigger parameters. See also [Camera trigger command](#).

- **Name:** `vehicle.ardupilot.camera_servo_idx`
- **Default:** None. camera trigger is controlled via DO\_DIGICAM\_CONTROL command.
- **Description:** Index of the servo to use for camera triggering.
- **Example** (Use 8th servo output as camera trigger):

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

- **Name:** `vehicle.ardupilot.camera_servo_pwm`
- **Default:** Value from CAM\_SERVO\_ON parameter.
- **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`
- **Default:** Value from CAM\_DURATION parameter.
- **Description:** Time to hold camera servo at the specified PWM when triggering single photo in seconds. After that time servo will return to the RC<camera\_servo\_idx>\_TRIM value. This value is used only in single shot command. WP action camera\_trigger\_by\_time provides its own interval.
- **Example:**

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

### 1.16.5 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
```

### 1.16.6 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
```

### 1.16.7 Set ground altitude offset

Optional. By default Ardupilot VSM will set altitude offset so that uploaded Home Location altitude corresponds to reported raw altitude 0 m.

- **Name:** `vehicle.ardupilot.set_ground_alt_offset`
- **Description:** Enable/Disable Setting altitude offset on route upload.
- **Default:** yes
- **Example:**

```
vehicle.ardupilot.set_ground_alt_offset = no
```

### 1.16.8 Vehicle heading control

Optional. Forces heading to next waypoint.

yes - Change heading towards next waypoint. When set, each mission upload sets `WP_YAW_BEHAVIOR` to zero (yaw controlled by mission) and generates additional mission item `MAV_CMD_CONDITION_YAW` before each WP so that vehicle will point always to the next WP.

no - Do not force change heading between waypoints. This disables override of parameter `WP_YAW_BEHAVIOR` on mission upload. So the vehicle heading control is defined by current setting of `WP_YAW_BEHAVIOR`.

- **Name:** `vehicle.ardupilot.autoheading`
- **Description:** Enable/Disable generation of automatic heading change to next WP during route upload.
- **Default:** yes
- **Example:**

```
vehicle.ardupilot.autoheading = no
```

### 1.16.9 Telemetry rate configuration

ArduPilot VSM supports setting custom telemetry rate to manage datalink channel bandwidth. Rate of 1 produces ~350 bytes/sec of telemetry traffic. 56K radiolink in ideal conditions can sustain the `telemetry_rate = 5`. Higher telemetry rates are not recommended and should be tried only with fast datalinks.

- **Required:** No.
- **Supported values:** 1 - 50
- **Default:** 2
- **Description:** Set update frequency for vehicle state information (attitude, position, battery, etc...)
- **Example:**

```
vehicle.ardupilot.telemetry_rate = 1
```

### 1.16.10 Ignore route speed settings

Use this to disable all speed changes defined in route. Vehicle will fly with default speed the whole route.

- **Required:** No.
- **Supported values:** yes, no
- **Default:** no
- **Example:**

```
vehicle.ardupilot.ignore_speed_in_route = yes
```

### 1.16.11 Mavlink message injection

ArduPilot VSM can receive mavlink packets and forward them to the vehicle if vehicle with specified `target_id` is connected. It can be used to send GPS RTK corrections to vehicles. If message has no `target_id` or `target_id` is 0 then it is sent to all connected vehicles. Supported messages are: `COMMAND_LONG`, `COMMAND_INT`, `GPS_INJECT_DATA` and `GPS_RTCM_DATA`. The prefix `mavlink_injection` supports all the same syntax as "connection" prefix.

- **Required:** No.
- **Supported values:** Same as those for connection prefix.
- **Default:** Not set.
- **Example:**

```
mavlink.injection.udp_any.1.local_port = 44444
```

### 1.16.12 Mavlink System ID

MAVlink System ID used for outgoing MAVlink messages.

- **Required:** No.
- **Supported values:** 1 - 254
- **Default:** 1.
- **Example:**

```
mavlink.vsm_system_id = 100
```

### 1.16.13 Enable route download

Enable route download from the vehicle. See [Route download](#) for details.

- **Required:** No.
- **Supported values:** yes/no
- **Default:** no
- **Example:**

```
vehicle.ardupilot.enable_route_download = yes
```

### 1.16.14 Route hash parameter name

Enable saving of route hash on the vehicle. See [Saving route hash on vehicle](#) for details.

- **Required:** No.
- **Supported values:** yes/no
- **Default:** Not set.
- **Example:**

```
vehicle.ardupilot.route_hash_parameter = RALLY_LIMIT_KM
```

### 1.16.15 DISARM\_DELAY parameter

- **Required:** No.
- **Supported values:** 0 - 127
- **Default:** Do not set
- **Description:** Configure the delay after which vehicle automatically disarms if on the ground. 0 - disable the disarm timer.
- **Example:**

```
vehicle.ardupilot.parameter.DISARM_DELAY = 5
```

### 1.16.16 RTL\_ALT\_FINAL parameter

- **Required:** No.
- **Supported values:** Any positive integer
- **Default:** Do not set
- **Unit:** centimeter
- **Description:** Set the final altitude in cm the vehicle will hover at after "Return To Home". Vehicle will land if set to 0.
- **Example:** Hover at 5m altitude after RTH.

```
vehicle.ardupilot.parameter.RTL_ALT_FINAL = 500
```



## 1.17 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.

### 1.17.1 UgCS server configuration

VSM can connect to UgCS in two different ways:

- Listen for connection from the UgCS server. See [Listening address](#) and [Listening port](#).  
When VSM is configured in listening mode automatic VSM discovery can be set up, too. See [Automatic service discovery](#)
- Initiate connection to UgCS server. See [UgCS server address](#) and [UgCS server port](#).

At least one of the above must be configured for VSM to work.

#### 1.17.1.1 Listening address

Optional.

- **Name:** ucs.local\_listening\_address = [IP address]
- **Description:** Local address to listen for incoming connections from UgCS server.
- **Default:** 0.0.0.0 (listen on all local addresses)
- **Example:** ucs.local\_listening\_address = 10.0.0.2

#### 1.17.1.2 Listening port

Optional.

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

#### 1.17.1.3 UgCS server address

Optional.

- **Name:** ucs.address = [IP address]
- **Description:** UgCS server address to connect to.
- **Example:** ucs.address = 1.2.3.4

#### 1.17.1.4 UgCS server port

Optional.

- **Name:** ucs.port = [port number]
- **Description:** UgCS server port.
- **Example:** ucs.port = 3335

#### 1.17.1.5 Retry timeout

Optional.

- **Name:** ucs.retry\_timeout = [seconds]
- **Description:** Retry timeout for outgoing server connections in seconds.
- **Default:** 10
- **Example:** retry\_timeout = 11

#### 1.17.2 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

#### 1.17.3 Logging configuration

##### 1.17.3.1 Level

Optional.

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

##### 1.17.3.2 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

### 1.17.3.3 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`

### 1.17.3.4 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`
- 

### 1.17.4 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`

### 1.17.5 Command execution control

When vehicle is connected via unreliable link VSM will retry each command several times before failing. This section describes the parameters which control the command execution.

#### 1.17.5.1 Command try count

- **Name:** `vehicle.command_try_count = <number of="" times>="">`
- **Description:** Number of times the command will be issued before declaring it as failed. Must be greater than zero.
- **Default:** 3
- **Example:** `vehicle.command_try_count = 5`

## 1.17.5.2 Command timeout

- **Name:** vehicle.command\_timeout = <timeout in="" seconds>="">
- **Description:** Time to wait for response on issued command before retrying.
- **Unit:** second
- **Default:** 1

## 1.17.5.3 Vehicle serial prefix

Optional.

- **Name:** vehicle.serial\_prefix = string
- **Description:** String value used as prefix for all vehicle serial numbers connected to this VSM. Can be used to connect vehicles with equal serial numbers to the same server via different VSMS
- **Default:** not defined
- **Example:** vehicle.serial\_prefix = group1:

## 1.18 Communication with devices

VSM can communicate with Vehicle over different communication channels

Currently supported channels:

- Serial port, see [Serial port configuration](#) for details.
- Outgoing TCP, see [Outgoing TCP connection configuration](#) for details.
- Incoming TCP, see [Incoming TCP connection configuration](#) for details.
- Outgoing UDP, see [Outgoing UDP connection configuration](#) for details.
- Incoming UDP, see [Incoming UDP connection configuration](#) for details.
- Incoming UDP (any peer), see [Incoming UDP connection configuration \(any peer\)](#) for details.
- Named pipe , see [Named pipes](#) for details.
- vsm-proxy (XBee), see [Proxy configuration](#) for details.

## 1.18.1 Serial port configuration

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.

## 1.18.1.1 Port name

Required.

- **Name:** connection.serial.[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. [index] is a arbitrary port indexing name.
- **Example:** connection.serial.1.name = /dev/ttyUSB[0-9]+|com[0-9]+
- **Example:** connection.serial.2.name = com42

### 1.18.1.2 Port baud rate

Required.

- **Name:** connection.serial.[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. [index] is an arbitrary port indexing name.
- **Example:** connection.serial.1.baud.1 = 9600
- **Example:** connection.serial.1.baud.2 = 57600
- **Example:** connection.serial.2.baud = 38400

### 1.18.1.3 Excluded port name

Optional.

- **Name:** connection.serial.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:** connection.serial.exclude.1 = /dev/ttyS.\*
- **Example:** connection.serial.exclude = com1

### 1.18.1.4 Serial port arbiter

Optional.

- **Name:** connection.serial.use\_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:** connection.serial.use\_arbiter = no

## 1.18.2 Outgoing TCP connection configuration

VSM can be configured to connect to the vehicle via TCP. VSM will try to establish connection to the specified address:port.

Used to connect to vehicle simulator or when vehicle is equipped with WiFi adapter.

### 1.18.2.1 Remote TCP port

Required.

- **Name:** connection.tcp\_out.[index].port = [port number]
- **Description:** Remote port to connect to.
- **Example:** connection.tcp\_out.1.port = 5762

### 1.18.2.2 IP-address for outgoing TCP connection

Required.

- **Name:** connection.tcp\_out.[index].address = [IP-address]
- **Description:** IP-address of vehicle to connect to.
- **Example:** connection.tcp\_out.1.address = 10.0.0.111

### 1.18.3 Incoming TCP connection configuration

VSM can be configured to listen for incoming TCP connections from the vehicle. Multiple vehicles are supported on the same port.

Used to connect to vehicle equipped with WiFi adapter.

#### 1.18.3.1 Local listening TCP port

Required.

- **Name:** connection.tcp\_in.[index].local\_port = [port number]
- **Description:** Remote port to connect to.
- **Example:** connection.tcp\_in.1.local\_port = 5762

#### 1.18.3.2 Local IP address

Optional.

- **Name:** connection.tcp\_in.[index].local\_address = [IP-address]
- **Description:** Local ip address to bind to.
- **Default:** 0.0.0.0 (all interfaces)
- **Example:** connection.tcp\_in.1.local\_address = 127.0.0.1

### 1.18.4 Outgoing UDP connection configuration

VSM can be configured to connect to the vehicle via UDP. VSM will try to establish UDP connection to the specified address:port.

#### 1.18.4.1 Remote IP-address for UDP

Required.

- **Name:** connection.udp\_out.[index].address = [IP-address]
- **Description:** Remote IP-address to send outgoing UDP packets to.
- **Example:** connection.udp\_out.1.address = 192.168.1.1

#### 1.18.4.2 Remote UDP port

Required.

- **Name:** connection.udp\_out.[index].port = [port number]
- **Description:** Remote UDP port to send outgoing packets to.
- **Example:** connection.udp\_out.1.port = 14551

#### 1.18.4.3 Local IP-address for UDP

Optional.

- **Name:** connection.udp\_out.[index].local\_address = [IP-address]
- **Description:** Local ip address to bind to.
- **Default:** 0.0.0.0 (bind to all interfaces)
- **Example:** connection.udp\_out.1.local\_address = 0.0.0.0

#### 1.18.4.4 Local UDP port

Optional.

- **Name:** connection.udp\_out.[index].local\_port = [port number]
- **Description:** Local UDP port to listen for incoming packets on.
- **Default:** 0 (bind to random port)
- **Example:** connection.udp\_out.1.local\_port = 14550

#### 1.18.5 Incoming UDP connection configuration

VSM can be configured to listen for UDP connections from the vehicle. Vehicle must be actively sending heart-beat/telemetry on specified UDP port before it can be detected by VSM. VSM will automatically detect multiple vehicles on the same port. This is very useful for "drone swarm" setups as there is no need to specify connector for each vehicle and no need to know the IP address of each vehicle in advance.

##### 1.18.5.1 Local UDP port

Required.

- **Name:** connection.udp\_in.[index].local\_port = [port number]
- **Description:** Local UDP port to listen for incoming packets on.
- **Example:** connection.udp\_in.1.local\_port = 14550

##### 1.18.5.2 Local IP-address for UDP

Optional.

- **Name:** connection.udp\_in.[index].local\_address = [IP-address]
- **Description:** Local ip address to bind to.
- **Default:** 0.0.0.0 (bind to all interfaces)
- **Example:** connection.udp\_in.1.local\_address = 0.0.0.0

#### 1.18.6 Incoming UDP connection configuration (any peer)

This connection type is similar to "udp\_in" with the exception that all incoming traffic will be received as one stream. It is used for special purpose connections and cannot be used to connect vehicles.

### 1.18.6.1 Local UDP port

Required.

- **Name:** connection.udp\_any.[index].local\_port = [port number]
- **Description:** Local UDP port to listen for incoming packets on.
- **Example:** connection.udp\_any.1.local\_port = 14550

### 1.18.6.2 Local IP-address for UDP

Optional.

- **Name:** connection.udp\_any.[index].local\_address = [IP-address]
- **Description:** Local ip address to bind to.
- **Default:** 0.0.0.0 (bind to all interfaces)
- **Example:** connection.udp\_any.1.local\_address = 0.0.0.0

### 1.18.7 Named pipes

VSM is able to communicate with vehicle over named pipe. The pipe must already exist.

- **Name:** connection.pipe.[index].port = pipe\_name
- **Description:** Pipe name
- **Example:** connection.pipe.1.name = \\pipe\my\_named\_pipe

### 1.18.8 Proxy configuration

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.

#### 1.18.8.1 IP-address for proxy

Required.

- **Name:** connection.proxy.[index].address = [IP-address]
- **Description:** IP-address to connect proxy to. Specify local or remote address.
- **Example:** connection.proxy.1.address = 127.0.0.1

#### 1.18.8.2 TCP port for proxy

Required.

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



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