Content Overview

Parachute Manual DRS-M300

Version 2.3-EN
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Drone Rescue Systems GmbH
Andritzer Reichsstraße 15
8045 Graz
AUSTRIA
www.droneresc ue.com

Contents

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Your safety is your own responsibility, including proper use of equipment and safety gear, and determining whether you have adequate skill and experience. Our products may be dangerous, unless used properly and with adequate precautions, including safety gear. Our products are not intended for use by hobbyists or non-professional users.

Warranty will be terminated if parachute is re-packed by yourself.

2 Introduction

The DRS-M300 is an autonomous parachute solution for the DJI M300 (UAV), providing the following advantages

- **UAV-independent sensors**
- **Very light-weighted**
- **Easy to reuse** within minutes
- **Visual and acoustical indication signals**
- **No use of pyrotechnics/explosive components** to deploy the parachute
- **No use of compressed gas cartridges** to deploy the parachute
- **Bayonet mechanism** to simply attach and detach the whole system

This document will guide you through the system components, installation, configuration, pre-flight checks, and storage and maintenance recommendations.

Beside the standard device the **RC variant** is available **to trigger the parachute via handheld remote control.**

3 Components

Table 1 lists all systems components. Within the document, parts are linked by their short ID e.g., container for the carbon container.

Short ID	Picture[1]	Quantity	Description
Container		1	Carbon container of the DRS system
Container lid		1	Lid of the container.
Parachute		1	Parachute (wrapped in a plastic cover secured by some rubber bands)
Parachute cord		2	Cords mounted to the UAV
Long hook and loop fastener		2	Used to fix the parachute cords
Short hook and loop fastener		1	Used to fix the container cord

[1] Depending on the actual DRS configuration, the component pictures in Table 1 may slightly differ from your system.

Short ID	Picture[1]	Quantity	Description
Container cord		1	Safety cord for the container
Hook		1	Brummel hook to link the parachute to the parachute cords
Hook protection sleeve		1	Protection sleeve for the brummel hook
Cord box		1	Self-adhesive cord box to stow the parachute cords away
Cord box lid		1	Lid of the cord box
Cable clip		1	Self-adhesive cable clip
Nut		4	M3 self-retaining nut
Clamp		2	Clamp pair
Spacer set		1	Spacers for top-mounted payload (1 short, 3 long)

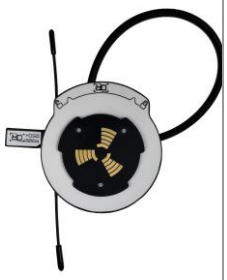
Short ID	Picture[1]	Quantity	Description
DRS M300 connector		1[2]	M300 standard connector with mounting plate for the DRS system
		1[3]	M300 RC connector, including antenna, with mounting plate for the DRS system *Optional component depending on device variant.*
Emergency Trigger		1[3]	Handheld radio controlled (RC) transmitter and antenna to deploy parachute in case of emergency. *Optional component depending on device variant.*

Table 1 System components

[2] For standard variant only
[3] For DRS-M300 RC variant only

4 Installation Tools

Table 2 lists all tools used for the system installation. These tools are not part of the system and have to be provided by the user. Within the document, tools are linked by their short ID.

Short ID	Picture	Description
Nut driver M3		Nut driver 5.5mm (M3)
Cutter knife		Cutter knife, also known as Utility/Stanley knife

Table 2 Installation Tools

5 Installation

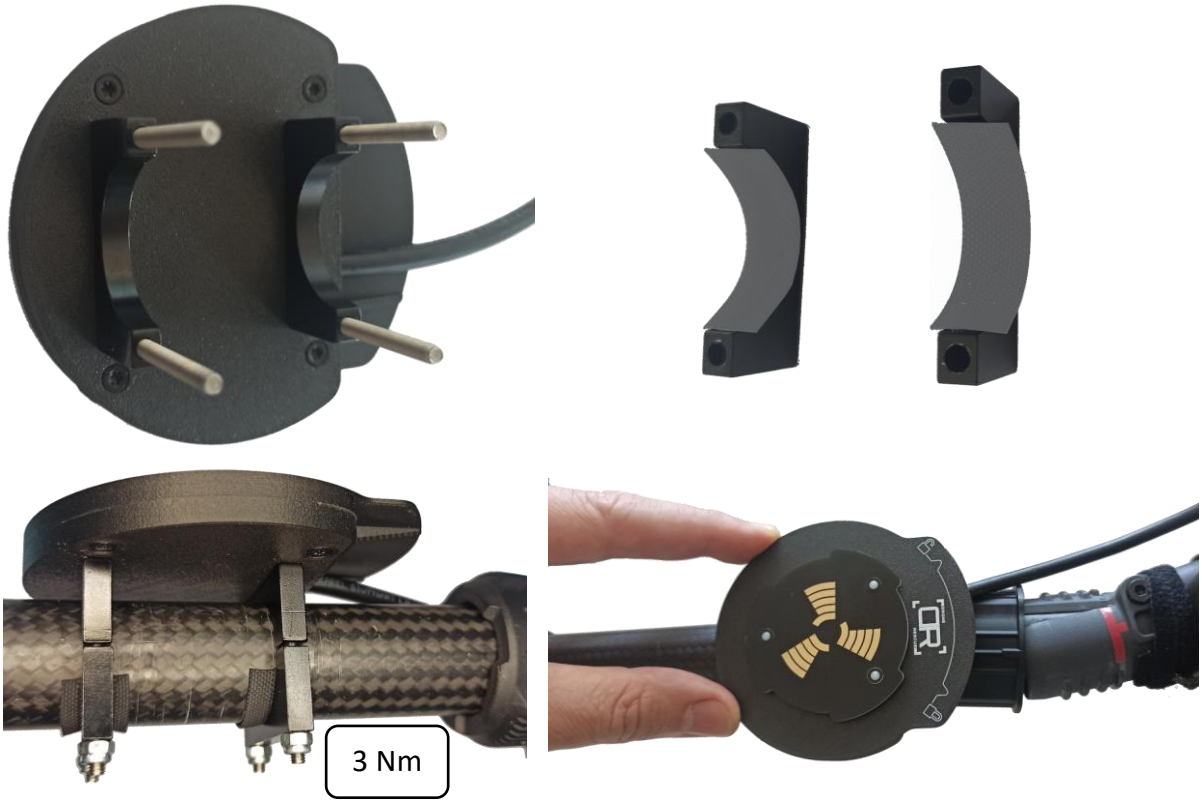
Unmount all propellors and detach all batteries and other power supplies before starting the installation!

Caution:
Mounted propellors may cause injuries or damages.

Caution:
It is mandatory to verify the correct operation with an assembly test right after the installation! See chapter "5.7 Assembly test" for details.

5.1 Install the M300 connector

Use the clamps, the rubber strips, and the nuts to fixate the mounting plate of the DRS M300 connector on the front right arm of the UAV with the cable pointing to the UAV center. Place it as close to the center as possible, so that you can still unlock and fold the arm. The mounting plate must be in a horizontal position when the arm is unfolded to the flying position or the banking angle measurement will be faulty during flight which could lead to an unwanted deployment. Make sure that the rubber strips are between the arm and the clamps, then tighten all nuts equally with 3 Nm using the nut driver M3.



Caution:
It is necessary to mount the plate as tight as possible to the mechanism, because otherwise it will scratch on the other arm, when folded (e.g., during transport).

Connect the plug of the DRS M300 connector to the OSDK interface on the top of the UAV and fix it with the short spacer of the spacer set. Screw the three long spacers into the drones thread holes for top-mounted payloads. You may mount other top-mounted payloads to these spacers.

Clean the front right side of the UAV shown in the picture below. Afterwards remove the backside foil of the cable clip, clip the cable and stick the clip centered on the cleaned side of the UAV.

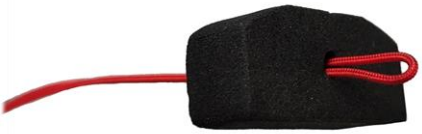
5.2 Mount the parachute cords

Mount one parachute cord to each front arm and pull it around close to the hinge. Thread one end of the cord through the other end's loop.

Put one hook and loop fastener over each parachute cord.

Tighten the parachute cords well and fasten the hook and loop fasteners.

When both sides are done, it should look like this.



Push the container cord ribbon through the tiny hole in the cord box lid.

Then feed it through both loops at the end of the parachute cords.

Wrap the ribbon over the cord box lid.

Slide the cord box lid down, till the parachute cords protrude on the other end of the lid.

Remove the container cord, it will be used later again.

Thread the open ends of both parachute cords through the hook's small hole without opening.

Push the parachute cords far enough through the hole to wrap the loops over the hook.

Tighten the parachute cords well and slide the cord box lid to the end.

Remove the protection film from the adhesive tape on the bottom side of the cord box.

Press the cord box on the center of the UAV front.

Tighten the parachute cords and put them into the cord box. Close the cord box with the cord box lid.

CORRECT

INCORRECT

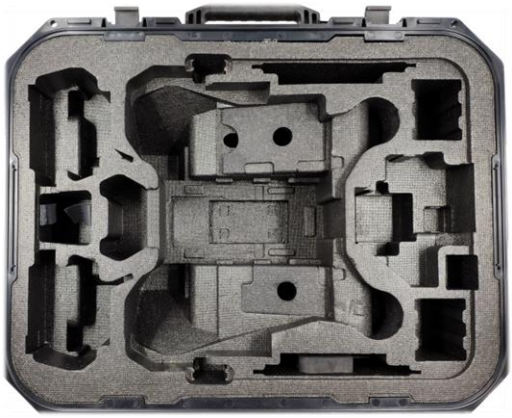
Caution:
If the parachute cords are not tightened well, the cords might get tangled up in the UAV propellors and cause a crash!

5.3 Mount the container cord

Wrap the container cord around the front right arm, next to the mounting plate of the DRS M300 connector.

Put the short hook and loop fastener over the container cord and fasten it.

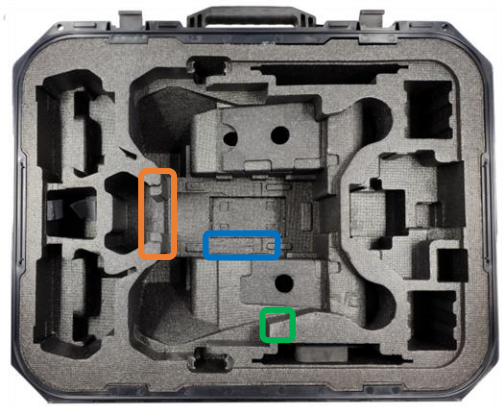
5.4 Modification of the UAV carrying case



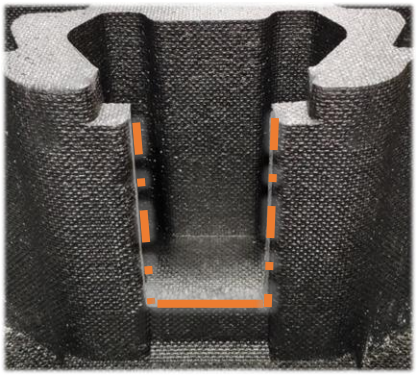
Inside original DJI M300 carrying case

Due to the installation of the DRS-M300 system the UAV will not fit in the original carrying case. A simple, but irreversible, modification will allow to fit the UAV including the DRS-M300 system (without container), in the carrying case. The steps below describe the modification.

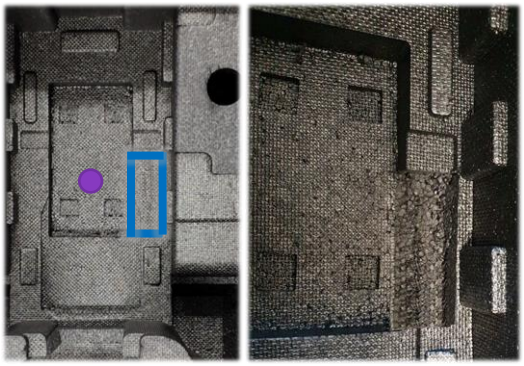
Caution:
Any modification of the case is done at your own risk!



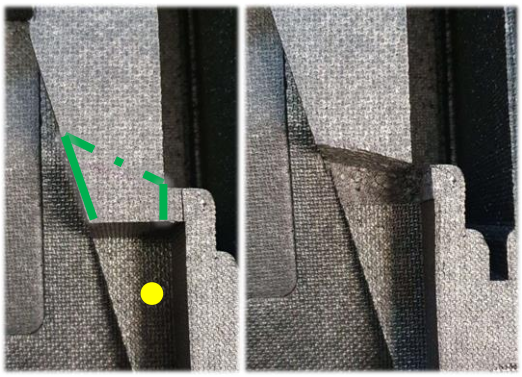
The colored areas in the picture on the left should be partly removed. The same color coding is used in the detailed description below.



Take a cutter knife and cut down along the two orange dashed lines (in line with the original recess). Afterwards cut horizontally between the orange lines about 1cm above ground and remove the plastic.



Take a cutter knife and cut down along the two blue lines. Afterwards cut horizontally at the same level as the purple marking and remove the plastic.



Take a cutter knife and cut down along the two green lines. The longer continuous line should be twice as long as the shorter one. Afterwards cut horizontally at the same level as the yellow marking and remove the plastic.

The UAV + DRS M300 connector and cord box should now fit in the case.

5.5 Configure the M300

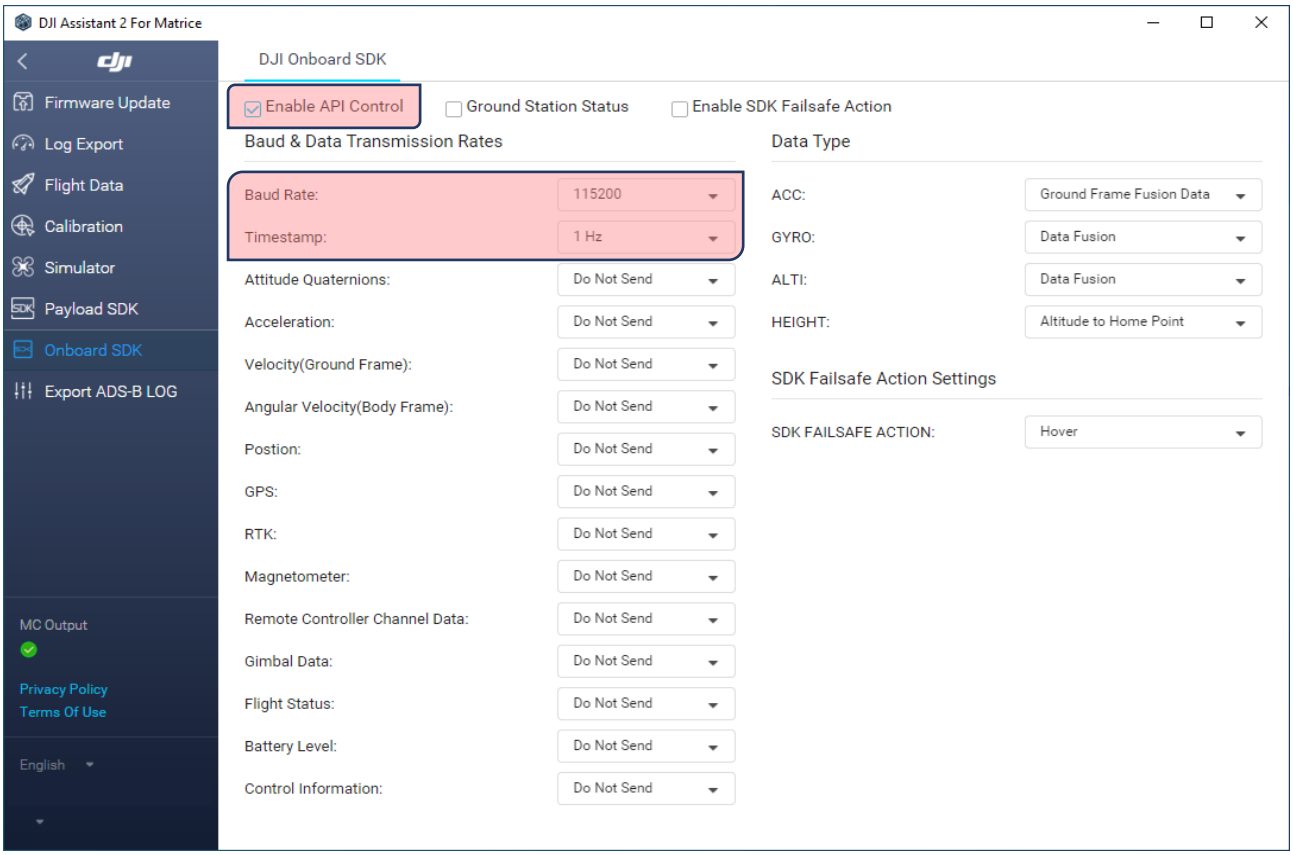
5.5.1 Configure Onboard SDK in DJI Assistant Application

Onboard SDK is used to switch off the UAV motors before the parachute is deployed.

- Remove the container from the UAV.
- Turn the UAV on.
- Connect the UAV to a PC using a USB-cable and start DJI Assistant 2 to configure the API (see DJI M300 user manual for details).
- Select "**Onboard SDK**" on the left.
- Tick the "**Enable API Control**" box on the top left.

- Set "**Baud rate**" to ***115200*** via dropdown list.
- Set "**Timestamp**" to ***1 Hz*** via dropdown list.

The correct DJI Onboard SDK settings are shown in the figure below.

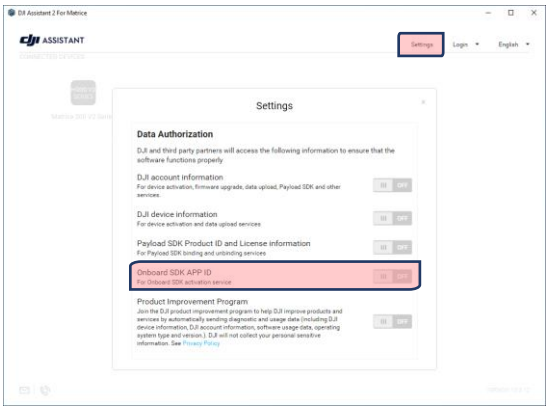


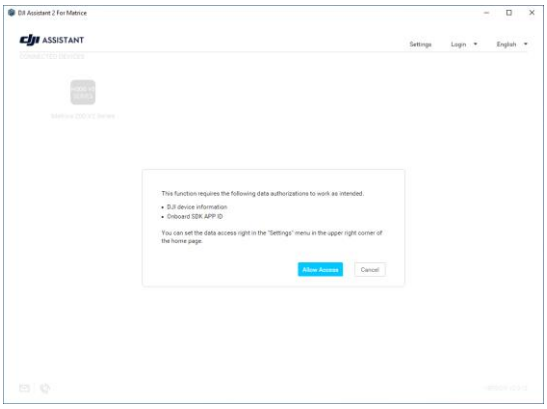
5.5.2 Onboard SDK activation

The UAV requires an activation of the parachute system before it can be used. This must be done only once when installing the DRS and also once after each firmware-update of the UAV or the remote controller. Perform these steps to do this:

- Mount the container on the UAV.
- Connect the UAV to a PC with internet access via USB cable (see DJI user manual for details).
- Start "DJI Assistant 2 for Matrice".
- Turn the UAV on.

- The DRS requests the activation automatically. If your "DJI Assistant 2 for Matrice"-setting **Onboard SDK APP ID** is set to OFF, then "DJI Assistant 2 for Matrice" prompts you to confirm the request. Otherwise you will not be asked for a confirmation.





- Wait as long as the LED indicates that the DRS is waiting for the interface (see Firmware Manual chapter "Device States and Signals"). The activation is done when the state has moved forward.
- Close "DJI Assistant 2 for Matrice" and disconnect the USB cable.

Once activated, the UAV does not need internet access at future flights for the DRS to work.

Caution:
If the activation is skipped or if it fails, then the DRS cannot turn off the motors and the parachute or the cords can get tangled up in the propellors when the parachute is deployed. It is therefore absolutely inevitable to verify that the motors stop at the assembly test (see "5.7 Assembly test").

5.6 DRS Configuration

The DRS parachute system's behavior can be configured with multiple parameters. It is pre-configured for a DJI M300 standard use case application. Fit the configuration to your specific usage. Configuration is described in the firmware manual in chapter "DRS Configuration".

Take care to set especially MANUAL_DEPLOY_INPUT according to your device variant (standard or RC).

5.7 Assembly test

Perform this assembly test right after the installation (before the first flight) and after every 50th flight to verify the proper operation of the parachute system. The intention is to test the engine shutdown and the deployment mechanism without a parachute actually being loaded in the container. It is necessary to switch on the motors but keep the UAV on the ground during this test.

Carefully read the checklist below to become familiar with the procedure, and execute the steps afterwards!

Follow this checklist:

- Unmount the propellors

Caution:
Mounted propellors may cause any injuries or damages

- Verify that all cables are connected tightly and fixated in the clips.
- Verify that all screws that fix the mounting plate of the DRS M300 connector are pulled tight.
- Verify that the spacers, especially the short one which fixes the plug of the DRS M300 connector is pulled hand-tight.
- Attach the container and put it under tension as described in chapter 6.2.1. The system should be strained but not loaded with the parachute after this step.
- Insert a dummy load into the container (e.g., an appropriate bottle filled with water).

Caution:
Triggering (deploying) an empty container will cause damage to the device!

- If you have the standard variant, prepare the DRS for timed deployment as described in the firmware manual in chapter "Timed Deployment via File". In case of the RC variant turn on the Emergency Trigger.
- Turn on the UAV and perform the usual takeoff procedure until the motors are spinning but without taking off.
- Verify the correct status of the DRS by observing the LED and the buzzer signals (see firmware manual). The DRS should be in the MANUAL state if you intend to trigger the test-deployment via a PWM signal (RC variant), or in the TIMED DEPLOYMENT state if you want to use the timed deployment feature for the test (standard variant).
- Prepare to catch (or at least dodge) the dummy.

Caution:
The dummy load will be shot out heavily. Take precautions to prevent it from causing any harm or damage!

- Wait until the deployment timer has elapsed (standard variant) or press both push buttons on the Emergency Trigger (RC variant).

Verify that

- **the motors have been switched off,**
- **the dummy load has been deployed,**
- **the DRS's buzzer and LED indicate the DEPLOYED state.**

All these conditions must be met for a positive test result.

Turn off the UAV afterwards.

6 Flight

6.1 Pre-Flight Inspection

To ensure a safe and reliable operation visually check the following components before each flight. Verify that

- there is no visual damage to the elastic rubber springs of the container or any other component
- all cables are connected tightly and fixated in the clips
- all screws that fix the mounting plate of the DRS M300 connector are pulled tight
- the spacers, especially the short one which fixes the plug of the DRS M300 connector is pulled hand tight
- the container is fully under tension and the deployment base is at the bottom
- the parachute is packed in the plastic cover and the rubber bands which secure it have been removed
- the parachute is fully loaded inside of the container and no parachute fabric is protruding
- the container is rotated to its locked position
- the parachute is properly linked to the UAV with the cords, the hook, and the hook protection sleeve
- the container lid is tightly clipped on the top of the container
- the container cord is linked to the UAV and is connected to the safety cord of the container
- the parachute cords are stashed inside the cord box and the cord box lid is clipped onto it

In case of RC variant, additionally verify that:

- the Emergency Trigger is prepared and the battery is fully charged

6.2 Loading and unloading the parachute

6.2.1 Put the container under tension

First open the release mechanism of the container, which is the small white shutter at the bottom. The easiest way to do so is to get underneath the shutter with your fingernail and lift it to the end stop.

Use a solid object which fits the inner diameter of the container and which is longer than the whole unit. A plastic pipe is very convenient, but a small bottle of water works as well. Use it to gently push down the catapult platform until it reaches the bottom position and exert counter-pressure with your hand when doing so to avoid damaging the UAV's arm or landing gear.

Release the shutter and gently push it back in place until it does not stick out of the container tube. Then gently decrease the pressure on the catapult platform.

Caution:
In case the shutter is not fully back in place or is manually pulled out, the parachute will get deployed and might cause injuries or damages!

6.2.2 Load the parachute

Remove the rubber band from the parachute but keep the plastic cover shut or the parachute will unfurl.

Completely insert the parachute into the container with the jagged edge first.

Check if the parachute fabric is fully covered by the plastic cover. Pay special attention to the bottom side.

Caution:
Protruding parachute fabric at any side might impede a proper parachute deployment!

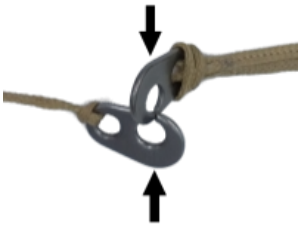
Clip on the container lid to protect the parachute from sunlight and other environmental influences. The cord of the parachute should lead out underneath the container lid at its designated position pointing to the center of the UAV.

Place the container onto the mounting plate of the DRS M300 connector with the small pike (arrow) at the bottom pointing towards the open padlock symbol.

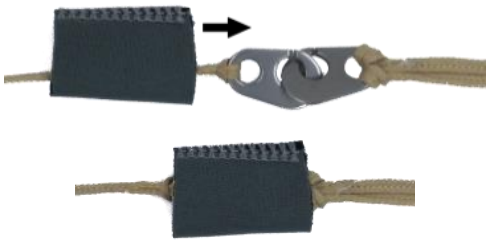
After pushing it down a bit, rotate it clockwise until the arrow points towards the closed padlock symbol.

Connect the safety cord of the container to the container cord mounted on the drone's arm.

Pull the hook protection sleeve over the hook of the parachute.



Fit the two hooks into each other (I. e. link the parachute to the UAV).



Afterward slide the hook protection sleeve over both hooks.

Caution:
The protection sleeve prevents an unintentional detachment of the hooks, thus always has to be in place!

6.2.3 Unload the parachute

Execute the instructions to load the parachute in reverse order. Be careful not to unfold the parachute when you remove it from the container. Use the rubber bands to fix it.

Use the pipe or bottle that you used for putting the container under tension. Hold it tight before you open the shutter. Let the catapult platform move slowly to the top. Do not let it snap up without any load or the mechanism will get damaged!

6.3 Takeoff

The system runs through the INITIALIZATION states where it initializes all necessary HW components for the operation and features as configured by the parameters (see firmware manual chapter "Configuration Parameters"). It also performs an offset calculation of the built in gyroscope.

Caution:
Do not move or apply vibration to the drone and PRS during the initialization phase. Otherwise the attitude calculation can be erroneous during flight which could lead to malfunction.

As soon as the MANUAL state is shown, the DRS is ready for takeoff. Do not take off if a warning or an error is shown.

Right after the takeoff you must observe the LED and buzzer to check if the DRS has correctly detected the takeoff. Hover the UAV above the configured TAKEOFF_HEIGHT over the ground for a few seconds and wait until the DRS switches its state to AUTOMATIC. The automatic failure detection is only active if the DRS is in this mode and shows no warning or error.

Caution:
If the DRS does not detect the takeoff, you must land the UAV because the automatic deployment function is inactive. Switch the power off, wait 10 seconds and repeat the start procedure.

6.4 After flight

After each flight it is recommended to do a short visual overall inspection to see if any part or component looks abnormal, worn out or broken. Replace damaged parts before using the DRS-M300 the next time.

If you don't use the parachute rescue system for a longer period of time, we recommend to take out the parachute and remove the tension from the container as described in chapter 7.

7 Storage

If you don't use the parachute rescue system for a longer period of time, we recommend to take out the parachute and remove the tension from the container (see chapter 6.2.3 "Unload the parachute").

Always store the system in a dry environment to prevent moisture accumulating inside of the parachute canopy, because it will increase the inflation time in case of a deployment.

8 Maintenance

The DRS-M300 parachute rescue system needs to be maintained once a year. The maintenance includes the following steps:

- Repacking of the parachute
- Replacement of the plastic cover
- Replacement of the elastic rubber springs
- Replacement of the parachute cords

The maintenance needs to be done by Drone Rescue Systems GmbH or a certified partner of Drone Rescue Systems GmbH.

9 Specifications

9.1 Operational and environmental conditions

Service life (before repack required)	1 year
Maximum altitude above sea level	3000 m (9842 ft)
Maximum UAV speed	23 $\frac{m}{s}$ (82.8$\frac{km}{h}$, 51.4 mph)
Maximum wind speed	15 $\frac{m}{s}$ (54 $\frac{km}{h}$, 33.6 mph)
Temperature range	-10 C° to +40 C°
Overall weight	520 g (1.15 lbs)
Maximum number of deployments*	10

*not including manual deployment within chapter 5.7 "Assembly test"

9.2 Approved payloads

The DRS-M300 is approved for the DJI M300 series with any additional payload as long as it is operated within the specifications provided by the manufacturer DJI.

Emergency Trigger Device Manual

Version 1.1-EN
2022-07-01

Drone Rescue Systems GmbH
Andritzer Reichsstraße 15
8045 Graz
AUSTRIA
www.droneresc ue.com

Contents

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Drone Rescue Systems GmbH, its subsidiaries, the directors, employees and agents cannot be held liable for the use of and reliance of the opinions, estimates, forecasts and findings in these documents.

We recommend that you do not fly prior to purchasing liability insurance. This helps cover costs in the event that persons are hurt or property is damaged as a result of your use of DRONE RESCUE technology. In general, RC aircraft are not covered by standard liability insurance.

Your safety is your own responsibility, including proper use of equipment and safety gear, and determining whether you have adequate skill and experience. Our products may be dangerous, unless used properly and with adequate precautions, including safety gear. Our products are not intended for use by hobbyists or non-professional users.

Warranty will be terminated if parachute is re-packed by yourself.

2 Introduction

The Emergency Trigger Device is an accessory for the DRS parachute system. It provides a comfortable way of manually triggering a parachute deployment. It is easy to install and simple to use. Because the sending frequency of the signal is subject to governmental constraints, the device is available as an EU-variant and a non-EU-variant.

This document will guide you through the components, installation, and operation of the device.

3 Components

Table 1 lists all system components. Within the document, parts are linked by their short ID, e.g. Emergency Trigger for the handheld RC transmitter.

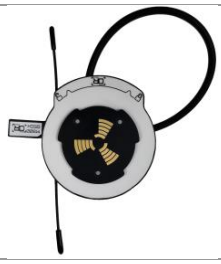
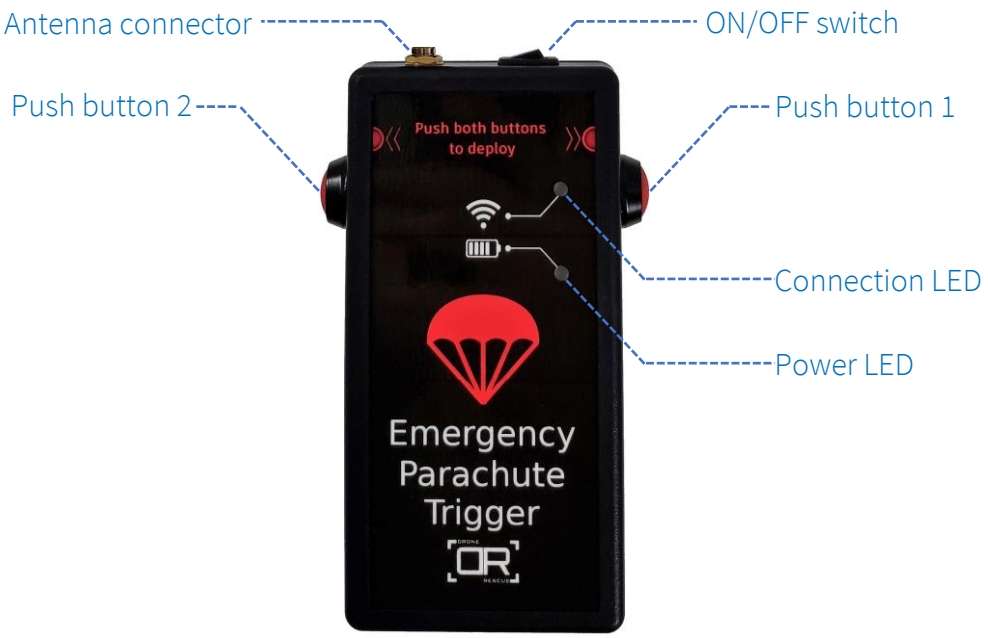
Short ID	Picture[4]	Quantity	Description
Emergency Trigger		1	Handheld radio controlled (RC) transmitter and antenna to deploy parachute in case of emergency.
Selective components			
RC Receiver (general)[5]		1[5]	Radio controlled (RC) receiver for the emergency trigger; general model, not developed for a special drone.
DRS M300 connector with RC Receiver (DJI-M300)[6]		1[6]	Radio controlled (RC) receiver for the emergency trigger, integrated in the DRS M300 connector.

Table 3 System components

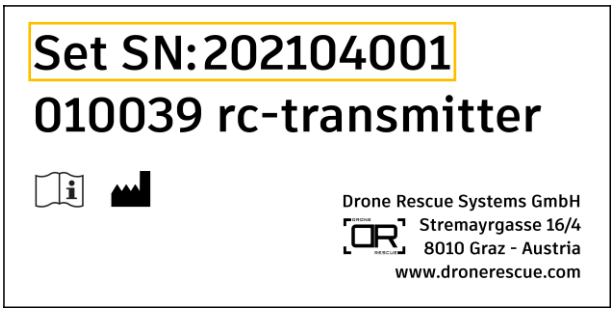
[4] Depending on the actual configuration, the component pictures in Table 1 may slightly differ from your system.
[5] For general variant only
[6] For DRS-M300 variant only

4 Emergency Trigger Device

The handheld radio controlled (RC) Emergency Trigger allows the user to deploy the parachute in case of an emergency by pressing both push buttons simultaneously.



Each Emergency Trigger device is paired with a single RC-receiver. The paired devices have the same set serial number (see pictures below).



4.1 RC-Receiver Installation

4.1.1 General variant

If you have the general variant, connect the cable of the RC receiver to the corresponding lines of the logic/PWM breakout cable or the MAVLink breakout cable and board – whichever interface you use in your application. See the “Parachute Manual DRS-General” chapter “Connect the DRS” for the pinout of the cables.

The RC-receiver has an adhesive tape on its rear which you can use to fix it to the UAV. Clean a proper area of the UAV with alcohol. Remove the protection film from the adhesive tape on the backside tape of the RC-receiver and press the device on the center of the cleaned area.

4.1.2 DRS-M300 variant

The DRS-M300 variant has the RC receiver already integrated in the DRS M300 connector. Simply mount it according to the instructions in the "Parachute Manual DRS-M300" in chapter "Install the M300 connector".

4.2 Usage

Screw the antenna on the connector on the top of the Emergency Trigger. Insert a 9V battery in the rear side battery box. Change the power switch position to "ON".

Caution:
Using the device without antenna may destroy the Emergency Trigger or cause permanent connectivity problems!

Check if the power LED indicates good battery state (Table 4) and the connection LED indicates good RC connection state (Table 5).

Press both push buttons simultaneously to deploy the parachute.

Caution:
Pressing both push buttons will immediately initiate a parachute deployment! Take precautions to prevent accidental usage.

4.3 LED states

4.3.1 Power LED

The power LED indicates the battery state according to Table 4. Recommended batteries are rechargeable Li-Ion, but standard 9V batteries will work as well.

Power LED color	State	Supply voltage (VCC) range
green	battery good	VCC > 7.0V
cyan	battery medium	6.5V < VCC ≤ 7.0V
orange	battery low	6.0V < VCC ≤ 6.5V
blinking red	battery empty	VCC ≤ 6.0V
blinking blue	DEPLOYMENT INITIATED	-

Table 4 Power LED states

4.3.2 Connection LED

Connection LED color	State	RSSI value
blinking purple	RC connection pending	-
green	RC connection good	RSSI > 50
orange	RC connection low	35 < RSSI ≤ 50
blinking red	RC connection bad	RSSI ≤ 35
blinking blue	DEPLOYMENT INITIATED	-

Table 5 Connection LED states

5 Specifications

	EU variant	NON-EU variant
Operating frequency	868 MHz	915 MHz
max. RF power	25 mW	100 mW
max. current consumption (@9V)	190 mA	150 mA
Tested range[7]	2000 m	2000 m
Power supply	9V battery (PP3 size)	
Dimensions	133x80x33 mm (without antenna)	

[7] The range was tested at free visual line of sight between Emergency Trigger Device and drone. Note, that objects in between - like buildings, trees, etc. - can reduce the range dramatically.

DRS Firmware Manual

Version 2.6-EN
2022-07-19

Applies to DRS-FW v2.4

Drone Rescue Systems GmbH
Andritzer Reichsstraße 15
8045 Graz
AUSTRIA

www.droneresc ue.com

Contents

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Warranty will be terminated if parachute is re-packed by yourself.

2 Introduction

The DRS-FW is designed to run on all DRS systems. It has the following main features:

- Easy to configure
- Adaptable to your specific needs
- Autonomous sensor data processing and parachute deployment (i.e. independent of the UAV)
- Visual and acoustical indication of the system status
- Provides system date and time
- Configurable logging to SD-card
- Supports MAVLink and MAVLink FTP
- Supports DJI-API (Onboard SDK)
- Supports customizable motor-off-signal
- Supports external system state control
- Supports test deployment via software

The DRS container is equipped with a micro SD memory card slot. The SD card is FAT32 formatted and is used to store logfiles, perform firmware updates, and load configuration parameters.

This document will guide you through the installation/update, configuration, and operation of the firmware. It also explains the supported interfaces.

3 Firmware Installation/Update

The newest firmware is already installed on the DRS when it is shipped to the customer. If you want to update it, you need the new FW which is a file with the extension ".bin" provided by Drone Rescue Systems GmbH. Simply store this file in the root directory of the micro SD card to perform a firmware update. When the DRS powers up, the file will be found and the update process starts automatically. The status LED indicates the UPDATE state during the update process which takes about 5 to 10 seconds. After a successful update the LED blinks green for a few seconds, the ".bin"-file is deleted, and the new firmware is started. In case of any error the LED blinks red for a few seconds and the old firmware is started. Observe the LED carefully to see if the update was successful. A file named "bootloader.txt" is written to the SD card in any case. It contains information about the update process, especially about the success. Also check this file to see if the update was successful. You can delete it afterwards.

4 DRS Configuration

4.1 Configuration Parameters

The DRS parachute system's behavior can be configured with multiple parameters. A configuration-file (ASCII text) named "config.txt" contains mandatory parameters, optional parameters, and comments. It is processed when the system is turned on and must be placed in the root directory of the micro SD card.

All mandatory parameters must be set exactly once in the configuration-file. Optional parameters may be omitted. If an optional parameter occurs repeatedly, its previous value is overwritten. A hash symbol (#) marks the rest of the line as a comment. To set a parameter to a specific value just write the parameter's name and the value separated with a space (see example file below).

If the configuration-file cannot be processed for any reason, the system enters the INITIALIZATION-error state which is indicated by the LED and buzzer, and it also writes an example file named "config_example_v2.4.txt" to the root of the SD card. You can use this file as a template for your own configuration.

```
# DRS CONFIGURATION FILE FOR FW v2.4

# A hash symbol marks the rest of the line as a comment.
# All mandatory parameters must appear exactly once. Optional
# parameters may be omitted.
# A complete list and a description of the parameters can be
# found in the parachute manual.


#----------------------#
# Sensor configuration #
#----------------------#

TAKEOFF_HEIGHT 3.0      # [m]
MAX_BANK_ANGLE 55       # [deg]
MAX_SINKRATE 15.00      # [m/s]
MAX_YAWRATE 350         # [deg/s]
MIN_ACCELERATION 3.00   # [m/s/s]
POWER_MONITOR 1


#-------------------------#
# Interface configuration #
#-------------------------#

MANUAL_DEPLOY_INPUT 2
INTERFACE 0
UART_BAUDRATE 57600


#-------------#
# Peripherals #
#-------------#

GNSS_MODE 0
GNSS_TIMEOUT_DEPLOY 0
```

```
#---------------#
# Miscellaneous #
#---------------#

DEPLOY_DELAY 0.000   # [s]
LOG_MODE 1
#DRONE_NAME John_Doe          # optional
```

Contents of "config_example_v2.4.txt"

Table 6 shows a list of all mandatory parameters.

TAKEOFF_HEIGHT Specifies the height in meters where the DRS switches to AUTOMATIC state. You can set it to zero if you want to "fake" a takeoff, i.e. to switch to automatic immediately at start, but take special care when doing so because the parachute can be deployed immediately when any other deployment criteria is met (e.g. bank angle).				
Recommended: 3	Range: 0 – 1000	Resolution: 0.1	Unit: m	
MAX_BANK_ANGLE Maximum allowed bank angle in degrees. Deploy when the system is in automatic state and the bank angle exceeds the set value. Set to zero to disable this feature. ATTENTION: This feature is disabled in FW v2.4.2				
Recommended:	55 (DJI M600) 55 (DJI M210) 63 (DJI M300)	Range: 0, 20 – 90	Resolution: 1	Unit: deg
MAX_SINKRATE Maximum allowed sink rate in m/s. Deploy when when the system is in automatic state and the vertical velocity exceeds the set value. Set to zero to disable this feature. Note, that the sink rate cannot be measured exactly due to wind/aerodynamic conditions. Better set this limit higher rather than lower to avoid unwanted deployments.				
Recommended: 15	Range: 0, 5 - 100	Resolution: 0.01	Unit: $\frac{m}{s}$	
MAX_YAWRATE Maximum allowed yaw rate in deg/s. Deploy when when the system is in automatic state and the yaw rate exceeds the set value. Set to zero to disable this feature.				
Recommended: 350	Range: 0, 100 - 500	Resolution: 1	Unit: $\frac{deg}{s}$	
MIN_ACCELERATION The parachute is deployed when the system is in automatic state and the norm of the acceleration vector drops below this value given in m/s/s. Set to zero to disable this feature.				
Recommended: 3	Range: 0, 0.05 - 5	Resolution: 0.01	Unit: $\frac{m}{s^2}$	

POWER_MONITOR

0: no deployment on power loss
1: deploy on power loss when when the system is in automatic state (Caution: opening the bayonet mount of the DRS container disconnects the power supply which is interpreted as a power loss, thus causes a deployment if the system is in automatic state!)

Recommended: 1 | Range: 0, 1 | Resolution: - | Unit: -

MANUAL_DEPLOY_INPUT

0: PWM signals are not used
1: PWM input 1 is used to trigger deployment
2: PWM input 2 is used to trigger deployment
3: a trigger signal must be sent on both PWM inputs to deploy the parachute
4: a trigger signal can be sent on either PWM input to deploy the parachute
5: an SBUS signal on PWM input 2 is used to deploy the parachute (used by the Emergency Trigger Device)

Recommended: - | Range: 0 - 5 | Resolution: - | Unit: -

INTERFACE

The interfaces are explained in chapter 6.
0: logic motor enable signal
1: PWM motor enable signal
2: *reserved for future use*
3: DJI-API (Onboard SDK)
4: MAVLink (UART)

Recommended: - | Range: 0 - 4 | Resolution: - | Unit: -

UART_BAUDRATE

This baudrate is used for the UART connection of the specified INTERFACE. It applies to DJI-API and MAVLink. The DJI-API usually uses 115200, MAVLink usually uses 57600 baud. The baudrate must match the setting of the flight controller (see the parachute manual for setup instructions).

Recommended: - | Range: 19200 - 3500000 | Resolution: 1 | Unit: baud

GNSS_MODE

The GNSS feature is only available on DRS variants with GNSS support. GNSS_MODE must be set to 0 on standard variants.
0: GNSS disabled
1: GNSS enabled, data recording only
2: GNSS enabled, geofence enabled (geofence file has to be provided)

Recommended: - | Range: 0 - 2 | Resolution: - | Unit: -

GNSS_TIMEOUT_DEPLOY

If GNSS is enabled and geofence is used, the parachute deploys when GNSS signal is lost for this period given in seconds. Set to zero to disable this feature.

Recommended: 0 | Range: 0 - 600 | Resolution: 1 | Unit: s

DEPLOY_DELAY Delay between motor-off signal and deployment of parachute given in seconds. This applies to manual as well as automatic deployment.			
Recommended: 0	Range: 0 - 10	Resolution: 0.001	Unit: s
LOG_MODE 0: do not log sensor readings (such as IMU-data) 1: start logging sensor readings at power-on 2: start logging sensor readings at first takeoff, then keep logging until power-off 3: log sensor readings only during flight (start at takeoff, stop at landing, continue at next takeoff, etc.)			
Recommended: 1	Range: 0 - 3	Resolution: -	Unit: -

Table 6: Mandatory parameters

Table 7 shows a list of all optional parameters. Currently, there is only one.

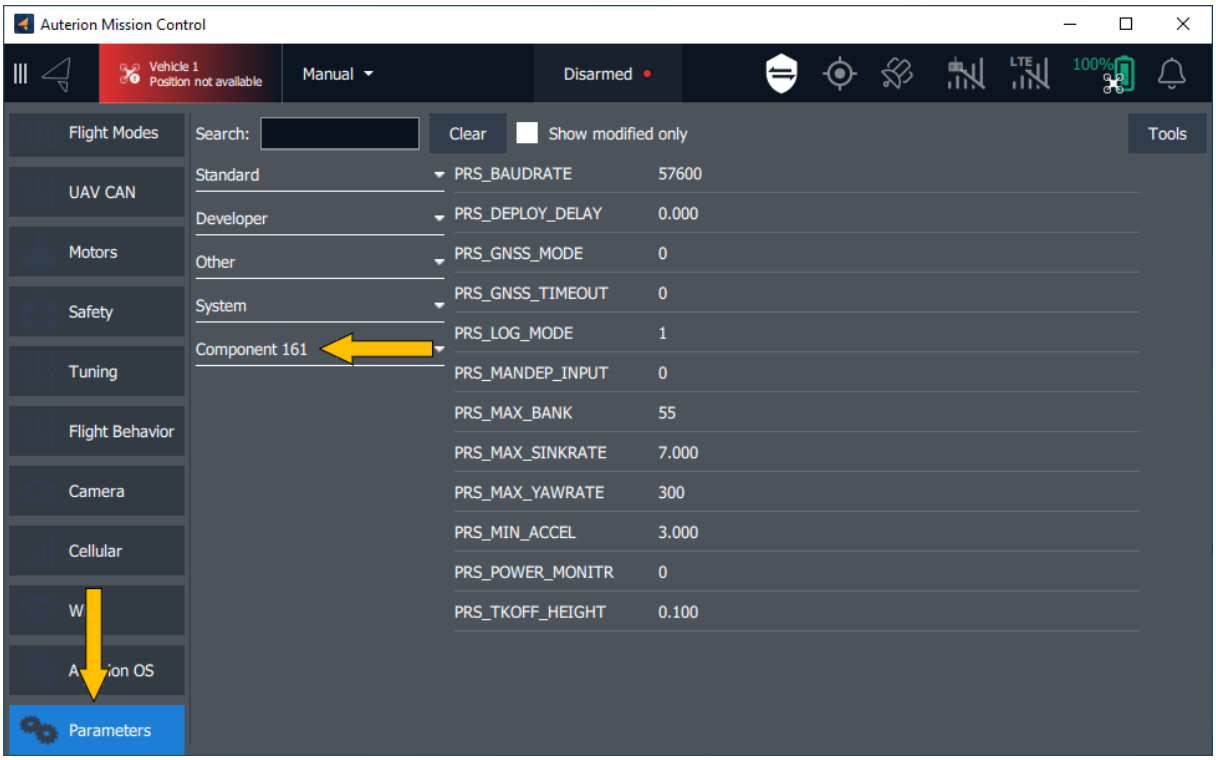
Parameter	Type	Range	Description
DRONE_NAME	text	max. 30 chars	You can specify a custom name which will appear in the logfile.

Table 7: Optional parameters

Caution:
Be careful when choosing the values. Use proper values for your UAV and application. Using improper parameter values may cause the parachute to fail from deploying as well as unwanted deployments.

4.2 Configuring the DRS via MAVLink

Since the MAVLink parameter protocol is implemented in the DRS, you can configure the DRS using a GCS like Auterion Mission Control or QGroundControl without the need to manually edit the configuration-file "config.txt" on the DRS's SD-card. The parameters INTERFACE and UART_BAUDRATE, however, must be set correctly in advance to establish the MAVLink connection. The DRS configuration parameters can then be accessed in **Parameters** > **Component 161**.



Each DRS configuration parameter has a similar, but different MAVLink name because the name length is limited in MAVLink. Their mapping can be found in Table 8. When a parameter is changed via MAVLink, the DRS-firmware also changes the value in the configuration file (config.txt) on the SD-card. Some parameter value changes require a reboot of the DRS to take effect.

DRS parameter name in "config.txt"	MAVLink parameter name	Type
TAKEOFF_HEIGHT	PRS_TKOFF_HEIGHT	FLOAT
MAX_BANK_ANGLE	PRS_MAX_BANK	UINT16
MAX_SINKRATE	PRS_MAX_SINKRATE	FLOAT
MAX_YAWRATE	PRS_MAX_YAWRATE	UINT16
MIN_ACCELERATION	PRS_MIN_ACCEL	FLOAT
POWER_MONITOR	PRS_POWER_MONITR	UINT16
MANUAL_DEPLOY_INPUT	PRS_MANDEP_INPUT	UINT16
UART_BAUDRATE	PRS_BAUDRATE	UINT32
GNSS_MODE	PRS_GNSS_MODE	UINT16
GNSS_TIMEOUT_DEPLOY	PRS_GNSS_TIMEOUT	UINT16
DEPLOY_DELAY	PRS_DEPLOY_DELAY	FLOAT
LOG_MODE	PRS_LOG_MODE	UINT16

Table 8: Configuration parameter mapping

4.3 System Time

The DRS is capable of naming the log-files based on the current date and timestamp. Therefore, the system's time has to be set in advance. This is usually done before shipment but you are free to set it anytime, e.g. to adapt it to your local time zone.

To set the system time, place a file (ASCII text) named "set_time.txt" in the root directory of the micro SD memory card and specify the new date and time formatted like YYYY-MM-DD, HH:MM:SS. Lines beginning with a hash symbol (#) are ignored and can be used as comments.

The following example sets the date to June 21st in 2020 and the time to 3pm.

```
#YYYY-MM-DD, HH:MM:SS
2020-06-21, 15:00:00
```

The firmware will find and parse this file at startup, and if a valid entry is found, it sets the system time accordingly. The file will then be renamed to "set_time_ok.txt" on success or "set_time_fail.txt" if the entry cannot be parsed. This way, the user does not need to manually remove the file after setting the time.

If the MAVLink-INTERFACE is used, then the FW attempts to read the current time and time shift (parameter SDLOG_UTC_OFFSET in PX4) from the flight controller and sets the system time to it if it could be received. The logfile, however, is always created before the read attempt and is therefore named using the system time at startup or the time taken from the file as described above.

4.3.1 Time Zone

Usually, the flight controller reads and adopts the current UTC time from a GNSS module. If you want to have the DRS system time set to your local time instead of UTC time in a Pixhawk environment, just set the parameter SDLOG_UTC_OFFSET to the time difference given in minutes. The DRS adds this value to the time received from the flight controller. See the PX4 user guide for details on SDLOG_UTC_OFFSET.

4.4 Geofence

The geofencing feature is activated according to the parameter GNSS_MODE. You can use the geofence to limit the area of flight. If the UAV leaves this area for two seconds or if the GNSS signal is lost for the time specified by GNSS_TIMEOUT_DEPLOY, the parachute will be deployed. If the system is already outside of the geofence corridor during powering up the DRS system, the LED and buzzer will indicate an error. Do not take off in this case, otherwise the parachute will get deployed immediately.

Please note that only the GNSS variant of the DRS system supports GNSS and thus geofencing. The standard variant does not have a GNSS receiver installed.

The area of flight is polygon-shaped and has a constant height over the whole polygon area. The polygon is specified with the corner coordinates (latitude, longitude) having the allowed flight area between the corners, i.e. from the lower lat/long value to the higher one. This results in the following restrictions:

- The polygon may not be wrapped around 180° longitude (e.g. from 179° longitude to -179° longitude).
- The polygon may neither include the north pole nor the south pole.

If geofencing is used, you must provide a separate file named "geo_fence.csv" in the root directory of the SD-card which defines the flight area limits. The CSV-file must contain the following three columns, each polygon corner in one line:

1. latitude in degrees
2. longitude in degrees
3. upper altitude limit in meters above ground (takeoff position)

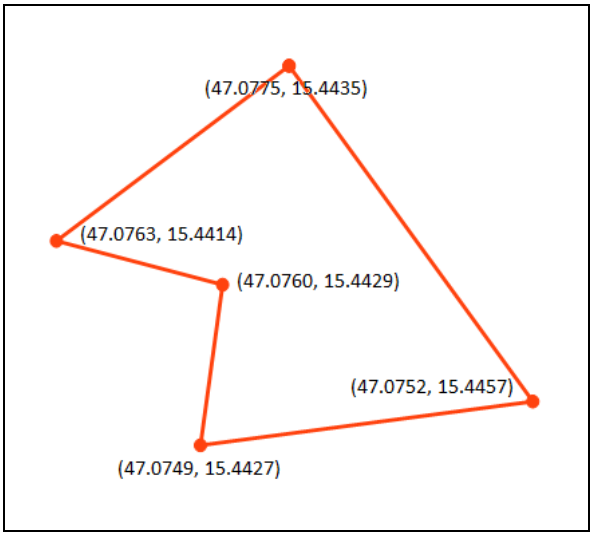
Although an altitude limit is specified for each polygon corner, currently only the altitude limit of the last corner is used for the whole polygon area. It is recommended to use the same value for all corners. Lines beginning with a hash symbol ('#') are ignored and can be used as comments.

Here is an example:

geo_fence.csv

```
# Geofence Example
#lat [deg], long [deg], altitude [m]
47.0775, 15.4435, 60
47.0763, 15.4414, 60
47.0760, 15.4429, 60
47.0749, 15.4427, 60
47.0752, 15.4457, 60
```

The UAV may fly within the polygon up to a height of 60 m above ground.



Alternatively, you can use the web-based tool on the website of Drone Rescue Systems GmbH (see Figure 1) to configure the geofence. To access this tool you must register on our website https://app.dronerescue.com. After drawing the geofence on the map you can download the file called "geo_fence.csv" and place it in the root directory of the micro SD card. The "Above Ground Level" (AGL) altitude is the height limit of the geofence corridor. The DRS geofence software supports up to 50 GPS points.

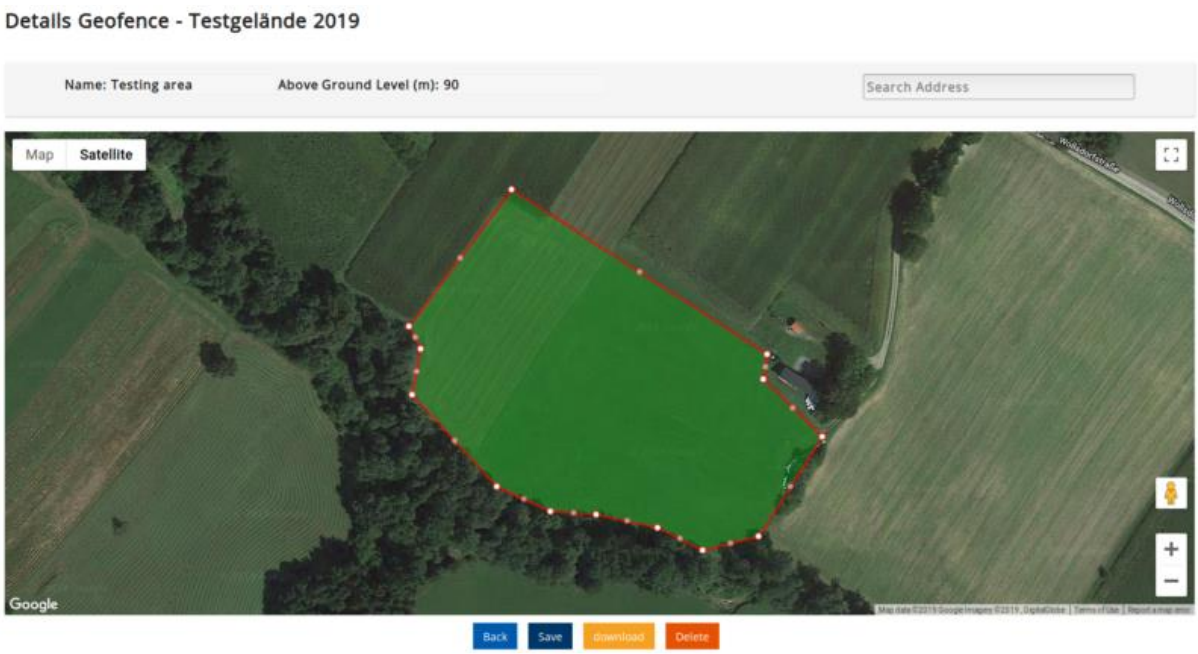
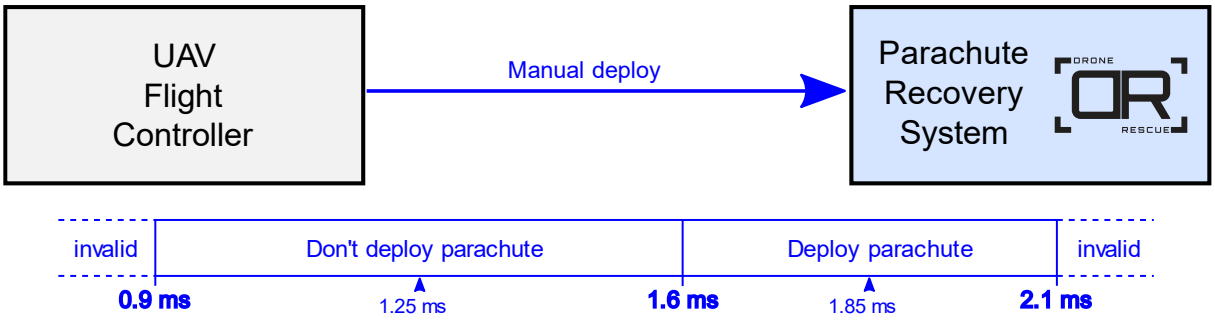


Figure 1: Online tool to configure the geofence

5 Manual Deployment

The parachute deployment can be triggered manually. In the majority of applications this is initiated by the pilot. For this purpose a conventional servo signal (50 Hz PWM signal with a pulse width between 1 ms and 2 ms) is used. It is usually sent from the flight controller or an external RC receiver to the DRS. The DRS will deploy the parachute upon receipt of the trigger event, even if the DRS sensors show no problem.



The valid range for the servo signal is extended to 0.9 ms to 2.1 ms in order to compensate clock frequency errors of RC sender modules. A pulse width below 1.6 ms means normal operation, while a pulse width above 1.6 ms triggers the deployment of the parachute.

To gain some safety and to prevent deployments by mistake during the initialization process and before takeoff, the system waits for a pulse width in the range of the "don't deploy"-state before it completes the INITIALIZATION state.

It is strongly recommended to generate the PWM signal with the nominal pulse widths set to the middle of the particular ranges (i.e., 1.25 ms and 1.85 ms) to avoid unwanted triggering due to clock frequency errors of the sender as well as the receiver of the PWM signal.

Alternatively, an Emergency Trigger Device (optional accessory) with SBUS communication can be used to trigger the parachute deployment. In this case an SBUS signal is used instead of a servo signal. The Emergency Trigger Device and RC Receiver generate the appropriate SBUS signals.

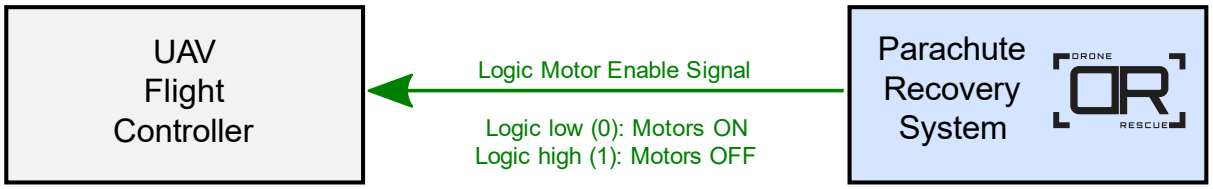
6 Interface description

The interface allows a communication between the DRS and the flight controller or any other computer which controls the UAV. Diverse data and events can be propagated depending on the interface type. The type of interface is selected with the configuration parameter INTERFACE.

6.1 Logic Motor Enable Signal

This is a very simple interface with only one piece of information to be transferred – the motor enable signal. Whenever the DRS decides to deploy the parachute (also in the case of a manual deployment), it informs the flight controller about it so it can stop the motors.

A 3.3V-CMOS voltage level is used for signaling the need to stop the motors. A logic low level indicates normal operation (i.e., motors on) while a logic high indicates to stop the motors.



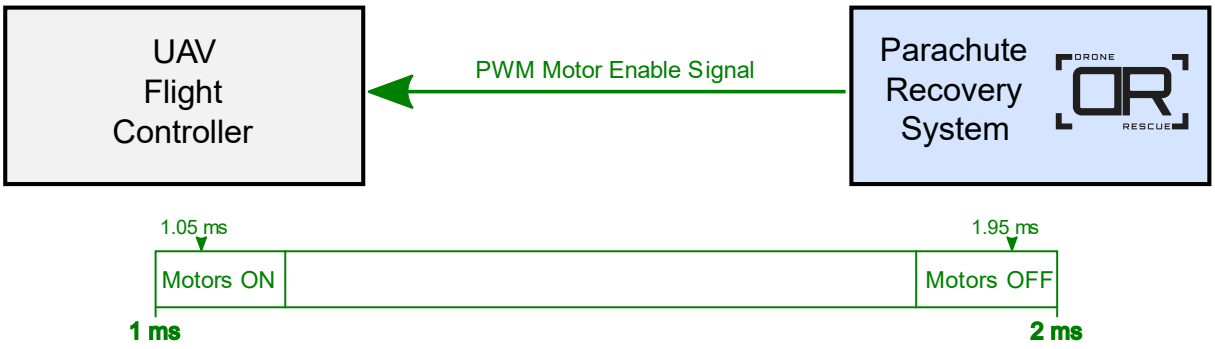
6.2 PWM Motor Enable Signal

This is a very simple interface with only one piece of information to be transferred – the motor enable signal. Whenever the DRS decides to deploy the parachute (also in the case of a manual deployment), it informs the flight controller about it so it can stop the motors.

A PWM signal is used to tell the flight controller to stop the motors. The general specifications are taken from a conventional servo signal (50 Hz PWM signal with a pulse width between 1 ms and 2 ms, 3.3V-CMOS voltage levels). The following pulse widths are generated by the DRS:

- 1.05 ms: Motors ON (normal operation)
- 1.95 ms: Motors OFF (request to stop the motors)

These pulse widths should be appropriate for most RC receivers, but keep in mind that they will deviate somewhat due to clock frequency errors of the sender as well as the receiver of the PWM signal.



6.3 DJI-API (Onboard SDK)

This interface type is activated if the parameter INTERFACE is set to use the DJI-API.

Onboard SDK is used to switch off the UAV motors before the parachute is deployed. The drone needs to be configured as explained in the DRS parachute manual.

6.4 MAVLink Interface

This interface type is activated if the parameter INTERFACE is set to use MAVLink.

The DRS can easily be integrated in a Pixhawk ecosystem (PX4 flight stack, Ardupilot) with a UART connection. It works with MAVLink protocol version 1 as well as version 2. The interface implements the following main features:

- The DRS shares status information which can be shown in a GCS.
- Connection health is observed using HEARTBEAT (#0) messages.
- Before the DRS deploys the parachute it sends the command MAV_CMD_DO_FLIGHTTERMINATION (#185) to stop the motors.
- The autopilot can control the DRS's automatic failure detection and it can deploy the parachute with the command MAV_CMD_DO_PARACHUTE (#208).
- Files can be transferred using MAVLink-FTP.
- The ping protocol is supported.
- The DRS can be configured via the parameter protocol using a GCS like Auterion Mission Control, QGroundControl, etc.
- The DRS tries to retrieve the system time from the autopilot at startup.

The flight controller needs to be configured as explained in the DRS parachute manual.

6.4.1 Enable/Disable the Automatic Failure Detection

After startup, the DRS switches between the MANUAL and AUTOMATIC modes at takeoff and landing according to the internal takeoff/landing detection. This state transition can also be forced with the MAV_CMD_DO_PARACHUTE command which could be sent e.g. by an onboard computer. The command is handled according to the "Action"-parameter as shown in Table 9 (see the official MAVLink documentation for details on this command).

Action	DRS Handling
PARACHUTE_DISABLE (0)	regardless of landed or taken off: • switch to MANUAL mode • disable the automatic failure detection on the DRS • disable the takeoff/landing detection
PARACHUTE_ENABLE (1)	regardless of landed or taken off: • switch to AUTOMATIC mode • enable the automatic failure detection on the DRS • disable the takeoff/landing detection
PARACHUTE_RELEASE (2)	regardless of landed or taken off: • deploy the parachute • disable the takeoff/landing detection

Table 9: Handling of MAV_CMD_DO_PARACHUTE

Note, that the takeoff / landing detection is deactivated after the first MAV_CMD_DO_PARACHUTE command is received. Take care when you land after forcing the AUTOMATIC mode because the automatic failure detection will still be active then and the parachute could be deployed e.g. if you manually tilt the drone over the allowed bank angle (see MAX_BANK_ANGLE) when you pick it up or when you turn the power off and the POWER_MONITOR is active.

7 Operation

7.1 Device States and Signals

An indication light (LED) and a buzzer are used to inform the pilot about the DRS's internal system states as described in Table 10. States with two color entries let the LED blink alternately in the two specified colors, e.g. the LED continuously changes between blue and purple while booting, and when the parachute has been DEPLOYED, the LED cycles through all shown colors rapidly.

State / Blink Colors		Acoustic signal	Description	User action
INITIALIZATION				
blue	purple	-	booting	wait until done (a few seconds)
blue	off	-	waiting for man.dep.	apply PWM signal for manual deployment
blue	cyan	-	waiting for interface	check connection to the interface
blue	white	-	waiting for GNSS	check GNSS reception
blue	yellow	three short beeps	warning	do not take off; check logfile
blue	red	continuous on/off	error	do not take off; check logfile
MANUAL				
green	off	two long beeps (only at landing)	ready for takeoff	take off when you are ready
green	yellow	three short beeps	warning	do not take off; check logfile
green	red	continuous on/off	error	do not take off; check logfile
AUTOMATIC				
green		one long beep	normal flight	-
yellow		three short beeps	warning	land; check logfile before next flight
red		continuous on/off	error	land ASAP; check logfile before next flight
DEPLOYED				
		continuous high/low	parachute deployed	-
UPDATE				
purple	off	-	updating FW	wait until done (a few seconds)

TIMED DEPLOYMENT				
cyan		short beep every 1000/500/100ms	timed deployment	wait for deployment
INCOMPATIBLE HW				
red	yellow	-	incompatible HW	switch power off, contact Drone Rescue Systems GmbH

Table 10: System states

7.2 Takeoff

The system runs through the INITIALIZATION states where it initializes all necessary HW components for the operation and features as configured by the parameters (see chapter 4.1). As soon as the MANUAL state is shown, the DRS is ready for takeoff. Do not take off if a warning or an error is shown.

Right after the takeoff you must observe the LED and buzzer to check if the DRS has correctly detected the takeoff. Hover the UAV above the configured TAKEOFF_HEIGHT over the ground for a few seconds and wait until the DRS switches its state to AUTOMATIC. The automatic failure detection is only active if the DRS is in this mode and shows no warning or error.

Caution:
If the DRS does not detect the takeoff, you must land the UAV because the automatic deployment function is inactive. Switch the power off, wait 10 seconds and repeat the start procedure.

If a failure persists, inform Drone Rescue Systems GmbH or it's reseller and provide the logfile for failure analysis.

7.3 Timed Deployment via File

If your application setup does not offer a possibility to use the manual deployment trigger, then you can use the "timed deployment" feature to test the deployment on the ground. It deploys the parachute after a certain time has elapsed since the DRS was turned on. Activate it by placing a file named "deployment_timer.txt" in the root directory of the micro SD memory card. Specify the time in seconds after the keyword "deploy". Here is an example of the file:

deployment_timer.txt:
specify time of deployment in seconds # in the range of 10 to 60 seconds **deploy 20**

Lines starting with a hash symbol (#) are ignored and can be used as comments. The file is renamed when it is read in order to avoid repeated timed deployments. On success, it is renamed to "deployment_timer_ok.txt". If the deploy time could not be read, it is renamed

to "deployment_timer_fail.txt". The LED and buzzer indicate the TIMED DEPLOYMENT state while the timer is running.

Caution:
Do not take off when the timed deployment feature is active because the parachute will be deployed and the motors will be stopped (if configured so) when the timer runs out. If the UAV is in the air in this moment, it will fall down.