

Flight Recording Systems

FRS User Manual

Applicable to P/N 2120

Technical Team
V1.7

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Revision History

Version	Emission	Changes
1.0	Feb 2021	First release.
1.1	Apr 2021	Including On Board recording.
1.2	Sept 2021	Including Real Time Monitor.
1.3	Jan 2022	Updating Installation and Wi-Fi Setup guidelines.
1.4	May 2022	Including more troubleshooting tips and Firewall management.
1.5	July 2022	Including Logbook Feature, RAM mount, P/N 2121 and other minor features
1.6	Oct 2022	Updated Automatic Logbook error messages, X-Plane capability, Flight Line for Google Earth Pro.
1.7	Nov 2022	Adding troubleshooting tips

1 Installation

1.1 Flight Recording Unit installation

1.1.1 Straps

To install the FRU on your aircraft, please follow those tips:

- 1 Install inside the cockpit, in a place that is leveled once in cruising conditions.
- 2 If a flat and level surface is not available, prefer a surface with some pitch bias rather than a roll bias. Flying the FRU with a constant roll bias during a straight cruise may affect the yaw estimate.
- 3 Align the shape of the aircraft drawn down on top of the FRU to be parallel with the heading of the plane, pointing the same heading.
- 4 Avoid closed compartments, prefer canopies. The GPS will have less difficulty in picking up the satellite signal in all attitudes.
- 5 Use the two bands of Dual-Lock provided



Figure 1 - Typical installation

1.1.2 RAM mount

A set of threaded holes is available on the lower shell of the FRU. The holes are designed to match with the footprint of the “RAM Round Plate with Ball” as shown in Figure 2: RAM Round Plate with Ball

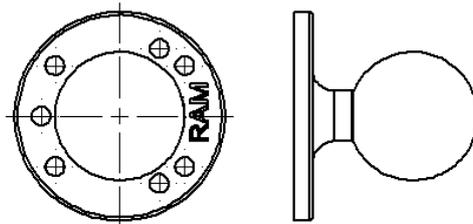


Figure 2: RAM Round Plate with Ball

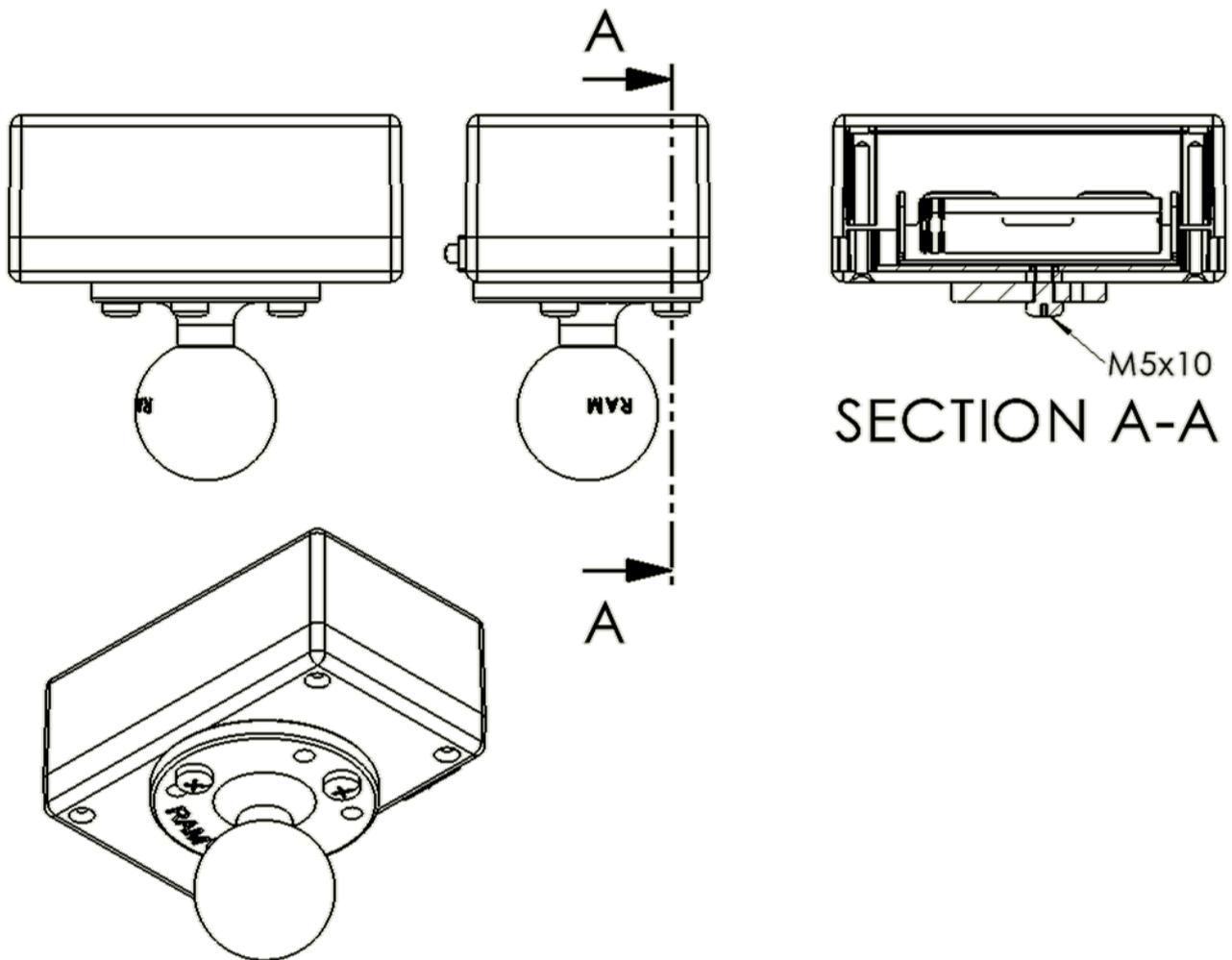


Figure 3: FRU and RAM Mount

To install the FRU on your aircraft, please follow those tips:

- 1 Use the set of three screws M5x10 to tightly fix the RAM mount to the bottom of the FRU.
- 2 Install inside the cockpit.
- 3 Adjust the tilt of the FRU to align with the horizon while in cruising condition.
- 4 Align the shape of the aircraft drawn down on top of the FRU to be parallel with the heading of the plane, pointing the same heading.
- 5 Avoid closed compartments, prefer canopies. The GPS will have less difficulty in picking up the satellite signal in all attitudes.



Do not use longer screws as they may cause damage to the inside of the FRU.

To avoid personal injury during aerobatic flying, make sure the FRU is securely attached to the RAM mount by checking for any backlash prior to every flight.



Use short RAM arms as longer arms could induce resonance on the FRU, leading to erroneous attitude/heading estimates.

1.2 Network setup – Personal computer

- 1 Download and install Zerotier on your PC from www.zerotier.com
- 2 Check the System Tray: the orange Zerotier icon should be visible. Right click on the Zerotier icon, click “Open Control Panel”.

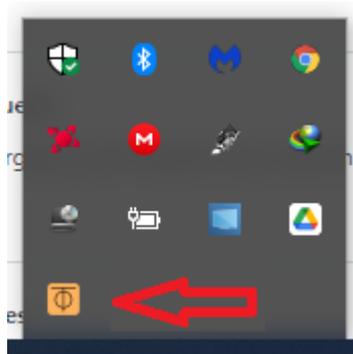


Figure 4: System Tray

- 3 The control panel will be displayed. Copy and paste the Network ID we’ve created for you in the box suggested by the red arrow. You should have this code in the e-mail you’ve received from us.

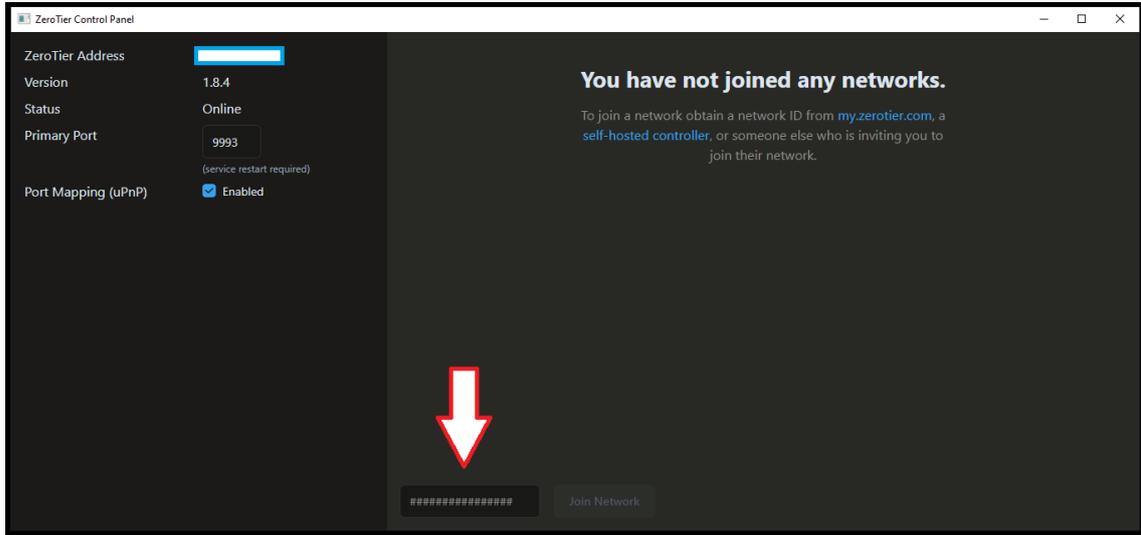


Figure 5: Control Panel 1

- 4 After this procedure, please send us a notification about your action. We'll add your computer to the network. If asked, please allow your computer to be identified on this new network otherwise the connection between the Black box and your PC will not be possible. You should have now the control panel with a Network ID number only as in Figure 6: Control Panel 2.

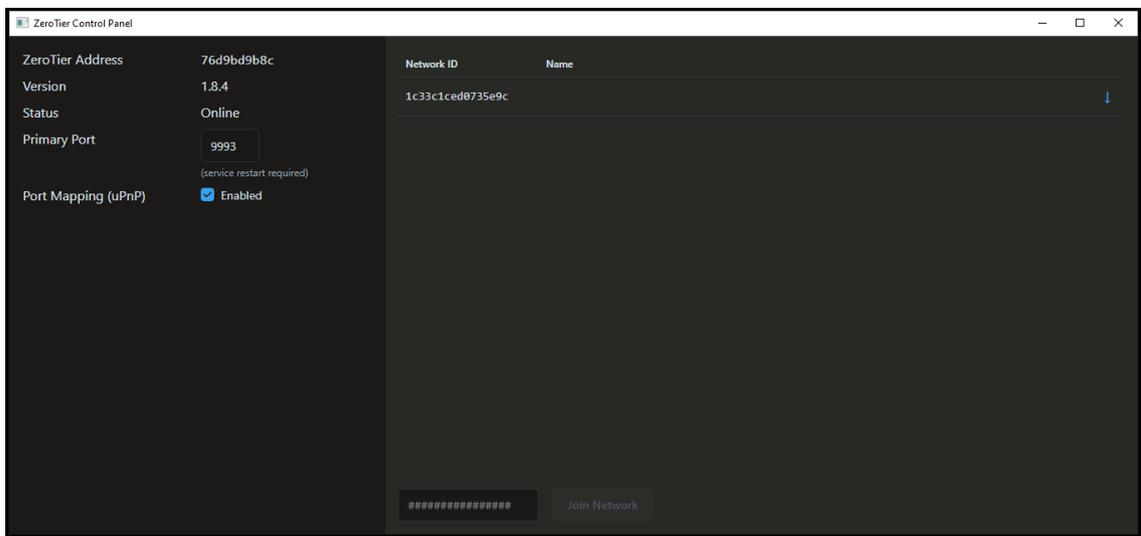


Figure 6: Control Panel 2

- 5 Once we'll add your computer to your new network, your control panel will show both the network ID and the name of your network as in Figure 7: Control Panel 3.

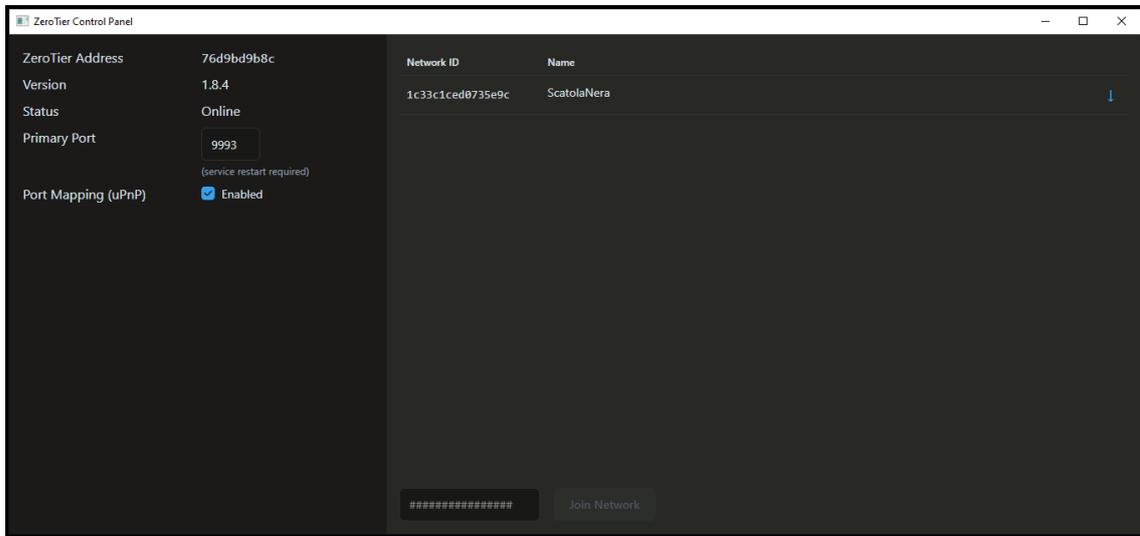


Figure 7: Control Panel 3

6 The network configuration on your PC is now completed.



Ensure your Zerotier version is greater than 1.8.8 (install at least the 1.8.9) as older versions do not work for more than a few hours continuously.

1.3 Network setup – Wi-Fi

Your FRU is already configured to use the following Wi-Fi Credentials:

- Network Name: “**frs**”
- Password: “**frswebservice**”

The same information is reported on the back shell of every FRU.

You can create the following network with your mobile phone by following this procedure:

1.3.1 Android users

- 1 Settings
- 2 Portable hotspot
- 3 Set up portable hotspot
- 4 Set the SSID field to “frs”
- 5 Set the Password field to “frswebservice”
- 6 Security: WPA2-Personal
- 7 Device identification: Default
- 8 Select AP Band: 2.4 GHz Band.
- 9 Turn on the Hotspot

1.3.2 Apple users

- 1 Settings
- 2 General
- 3 About
- 4 Set the name field to “frs”
- 5 Return to Settings
- 6 Mobile data
- 7 Personal Hotspot
- 8 Set the Wi-Fi Password field to “frswebservice”
- 9 Turn on the Hotspot

If you need to add more Wi-Fi credentials to your FRU, write an email to info@flightrecordingsystems.com specifying:

- Network name
- Password

2 Operation

The device shall be installed on your aircraft as per “Flight Recording Unit Installation” section.

Once the FRU is installed, turn on the device. The Status LED will turn solid-blue. Keep the aircraft stationary, with the engine OFF, for one minute to allow the inertial platform to start correctly. In the meantime, the user may perform all normal procedures (loading the aircrafts, belts...).



Figure 8 - FRU

The admissible ambient operating temperature range is from -20°C to 50°C.



Do not leave the FRU unattended under direct sunlight.

2.1 Data recording

To start logging your flight data, turn on the FRU using the Main Switch. The Status LED will turn solid-blue and a new log is created.

To stop logging your flight data, turn off the FRU using the Main Switch. The Status LED will turn off.

As a general rule, the FRU shall be installed and powered ON as the first task and turned OFF as the last task before leaving the aircraft. .



The FRU has enough memory to log all your flights. However, every time the FRU is turned ON, the oldest flight will be deleted to leave space for the new one. A maximum of 10 flights is stored in the FRU, waiting for post-Processing.

2.2 Post-Processing

Check the following paragraphs depending on the purchased solution.

2.2.1 Local Processing (FRS Basic and Advanced)

- 1 Run the app as administrator
- 2 Check your FRU is OFF.
- 3 Turn on the FRU.
- 4 Ensure Wi-Fi connection is available. The Wi-Fi shall be:
 - a. Configured as per Network setup section
 - b. With internet access
- 5 Your data are being downloaded. The process will take a few minutes depending on the duration of the recordings. Wait for the confirmation e-mail.
- 6 Turn Off your FRUs;
- 7 Check your flight data on your Google Drive folder.

2.2.2 Remote Processing (FRS Full)

The data processing service is operative 24/7, remotely.

- 1 Check your FRU is OFF.
- 2 Turn on the FRU.
- 3 Ensure Wi-Fi connection is available. The Wi-Fi shall be:
 - a. Configured as per Network setup section
 - b. With internet access
- 4 Your data are being downloaded. The process will take a few minutes depending on the duration of the recordings and the Wi-Fi speed. Wait for the confirmation e-mail from FRS.
- 5 Turn Off your FRUs;
- 6 Check your flight data on your Google Drive folder.

2.3 Data Visualization and features

The Post-Processing tools are producing two different files:

- 1 .csv files, to be opened with Excel;

- 2 .kmz files, to be opened with Google Earth Pro;
- 3 .csv files, to be opened with CloudAhoj;
- 4 .fdr files, to be opened with X-Plane.

The standard name of the files will be, respectively:

- 1 CALLSIGN_YEAR_MONTH_DAY_HOUR_MINUTE.kmz
- 2 CALLSIGN_YEAR_MONTH_DAY_HOUR_MINUTE.csv
- 3 CloudAhoj_CALLSIGN_YEAR_MONTH_DAY_HOUR_MINUTE.csv
- 4 X-Plane_CALLSIGN_YEAR_MONTH_DAY_HOUR_MINUTE.fdr

The reference time reported in the file name is referred to the start of the recording, in UTC time.

2.3.1 Google Earth Pro

Download and install Google Earth Pro on your desktop.

Once installed, double-click on your “.kmz” files. Google Earth Pro will start.

Three visualization modes are available:

- 1 Aircraft Attitude
- 2 Flight Path
- 3 Flight Line
- 4 Onboard Recording (available in FRS Advanced and FRS Full)

To activate those modes and review your flights, click the corresponding checkbox in the Google Earth Pro “Places” section as shown:

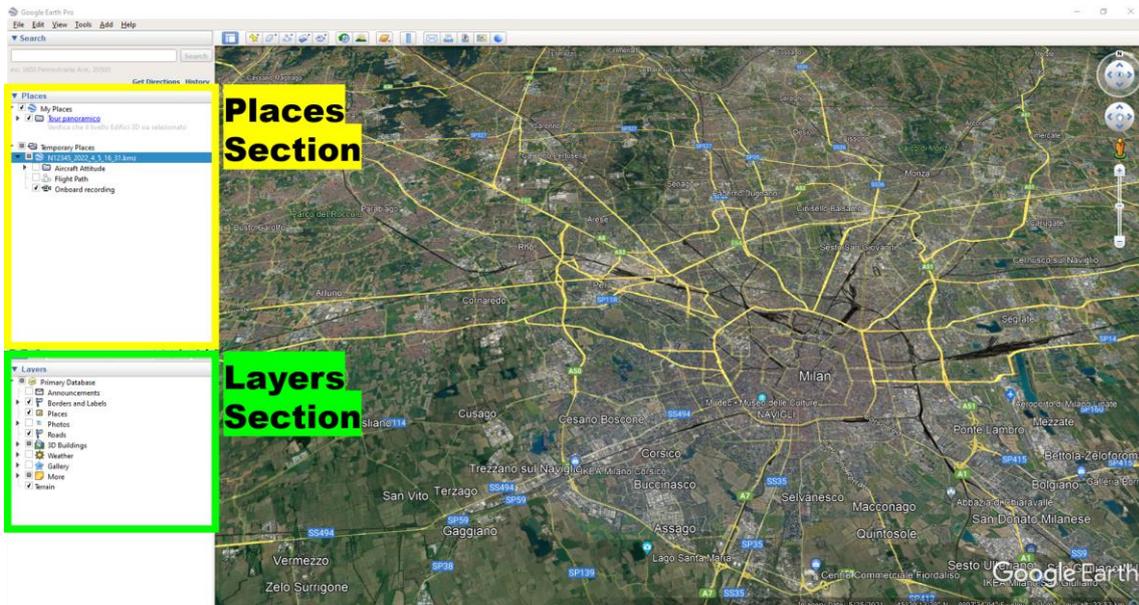


Figure 9 - Google Earth Pro Sections



Figure 10 - Aircraft Attitude

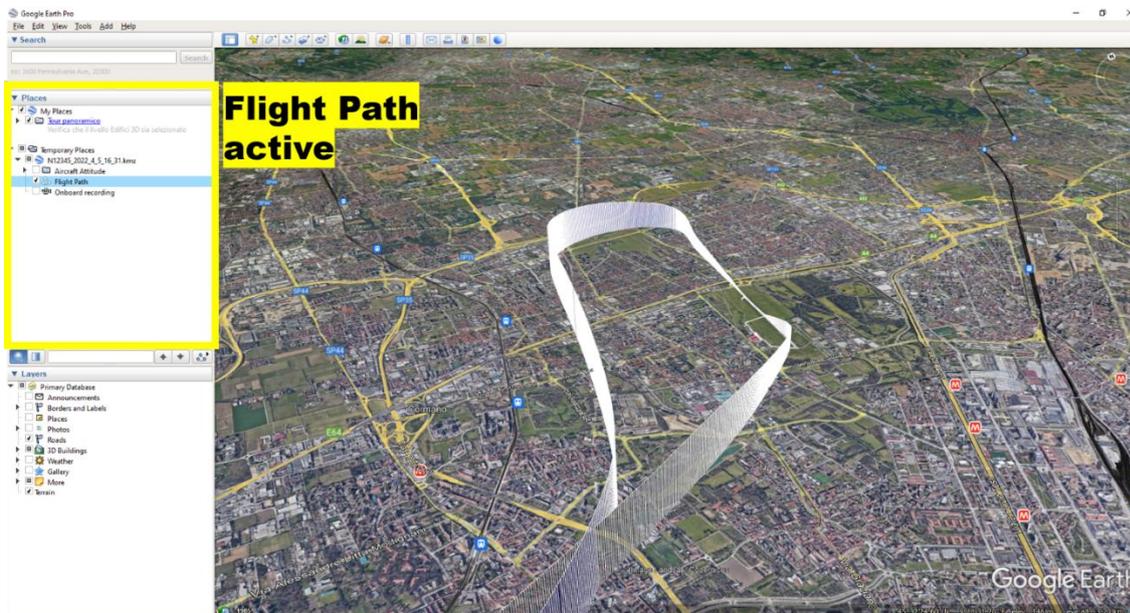


Figure 11 - Flight Path

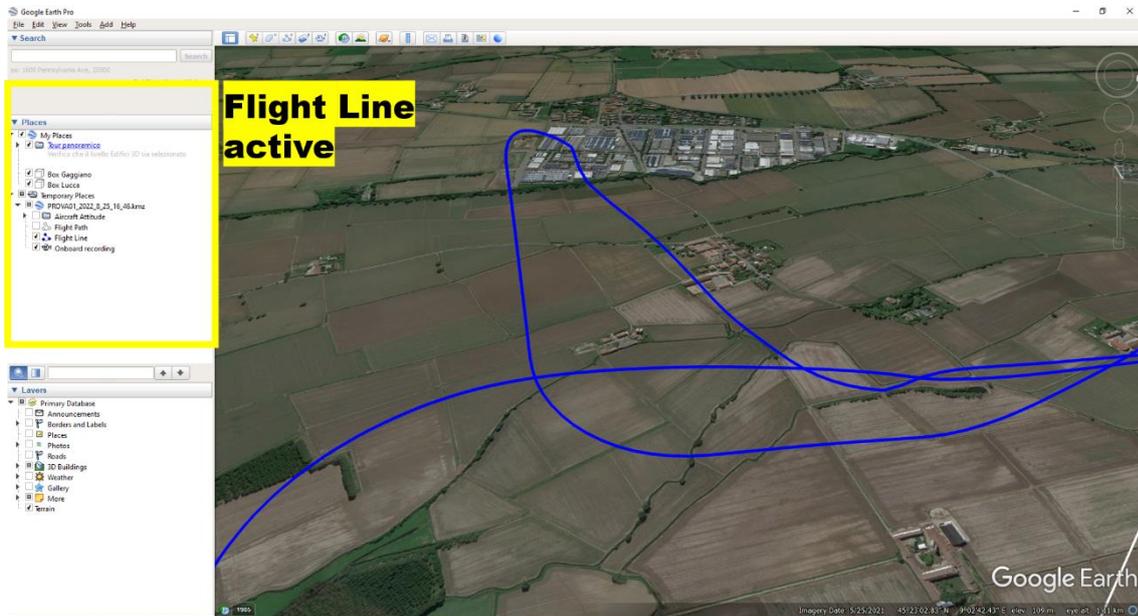


Figure 12: Flight Line

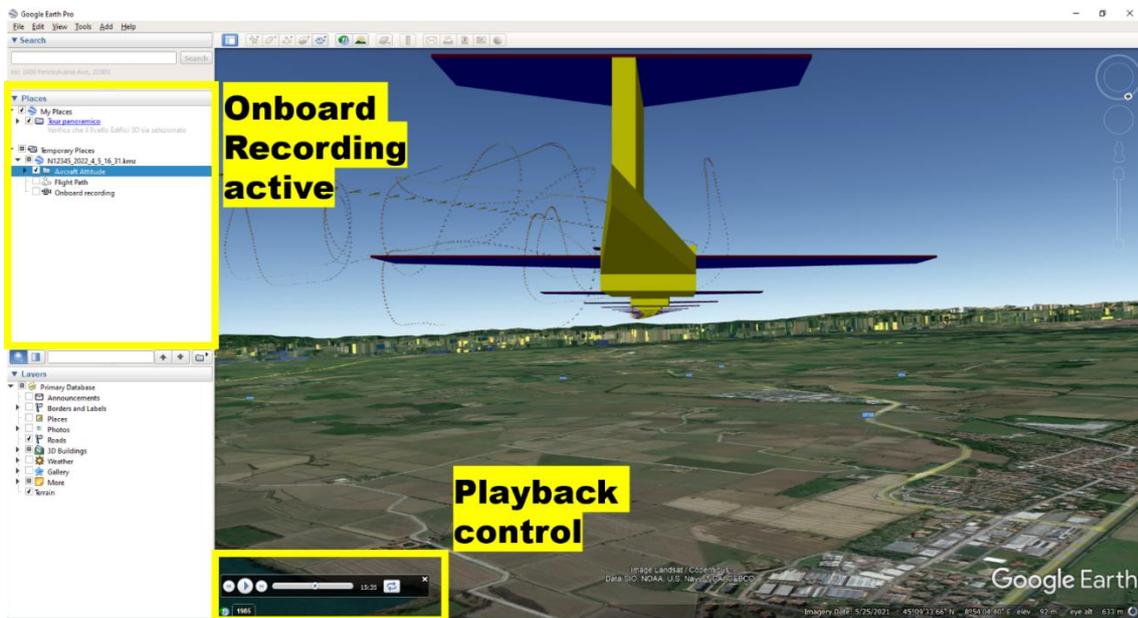


Figure 13 - Onboard recording

2.3.2 Microsoft Excel ®

Comma separated Values files (.CSV) are useful to create routines to automate your flight analysis with custom software you might want to develop for your specific purposes.

The generated CSV file includes all the flight data stored in your FRU. All the log values are separated with a “comma” as shown in Figure 14: CSV File

	A	B	C	D	E	F	G	H
1	Flight Recording Systems - FRS							
2	Website: www.flightrecordingsystems.com							
3	Contacts: info@flightrecordingsystems.com							
4	Data processing: FRS Web Service - Ver 1_88							
5								
6	UTC Block OFF: 2022-07-24 09:39:39							
7	UTC Block ON: 2022-07-24 10:10:15							
8	Block Time: 0:30:36							
9								
10	UTC Hobbs ON: 2022-07-24 09:38:29							
11	UTC Hobbs OFF: 2022-07-24 10:10:26							
12	Hobbs Time: 0:31:57							
13								
14	UTC Takeoff: 2022-07-24 09:44:01							
15	UTC Landing: 2022-07-24 10:08:14							
16	Flying Time: 0:24:13							
17								
18	Engine Time: 0:27:30							
19	Engine Cents: 45.83							
20								
21	Hobbs Time: all OK.							
22	Block Time: all OK.							
23	Flying Time: all OK.							
24	FRU Battery: all OK.							
25								
26	Time [s],Roll_angle [deg],Pitch_angle [deg],Yaw_angle [deg],Latitude [deg],Lon							
27	70.322,1.0,5.2,-0.1,45.5381866,9.199331390921477,133.9,0.1,-0.0,1.0							
28	70.572,0.9,5.1,-0.2,45.53818632852861,9.199331957207086,133.8,0.1,-0.0,1.0							

Figure 14: CSV File

To manually review those data “by hand”, you can follow those steps:

- 1 To open your .csv log file, double-click on the file.
- 2 Click the “A” of your spreadsheet to select all the first column;
- 3 Click the “Data” palette;
- 4 Click “Text to Columns”;
- 5 Following the wizard, you’ll have to choose between “Delimited” and “Fixed width”. Select “Delimited” and click Next;
- 6 In the Delimiters section, click the “comma” checkbox and click “Next”;
- 7 Click “Advanced” and set the dot (.) as decimal separator and nothing as Thousand separator.
- 8 Click Finish. The file is now available as a common Excel spreadsheet.

The original CSV file now is closer to Figure 15: CSV File after text-to-column

	A	B	C	D	E	F	G	H	
1	Flight Recording Systems - FRS								
2	Website: www.flightrecordingsystems.com								
3	Contacts: info@flightrecordingsystems.com								
4	Data processing: FRS Web Service - Ver 1_88								
5									
6	UTC Block OFF: 2022-07-24 09:39:39								
7	UTC Block ON: 2022-07-24 10:10:15								
8	Block Time: 0:30:36								
9									
10	UTC Hobbs ON: 2022-07-24 09:38:29								
11	UTC Hobbs OFF: 2022-07-24 10:10:26								
12	Hobbs Time: 0:31:57								
13									
14	UTC Takeoff: 2022-07-24 09:44:01								
15	UTC Landing: 2022-07-24 10:08:14								
16	Flying Time: 0:24:13								
17									
18	Engine Time: 0:27:30								
19	Engine Cents: 45.83								
20									
21	Hobbs Time: all OK.								
22	Block Time: all OK.								
23	Flying Time: all OK.								
24	FRU Battery: all OK.								
25									
26	Time [s]	Roll_ang	Pitch_ang	Yaw_ang	Latitude	Longitud	Altitude	X Accel [G]	
27	70,322	1	5,2	-0,1	45,5382	9,19933	133,9	0,1	
28	70,572	0,9	5,1	-0,2	45,5382	9,19933	133,8	0,1	

Figure 15: CSV File after text-to-column

With the introduction of the “Automatic Logbook” function, the system automatically recognizes the OFF/ON block time (in UTC) and Engine time and other relevant data. Please refer to “Automatic Logbook” section for any further.

2.3.3 X-Plane

To review your flight in X-Plane:

- 1 Navigate to your aircraft’s FRS log folder;
- 2 Copy (Ctrl + c) the file
“X-Plane_Callsign_Year_Month_Day_Hours_mins.fdr” that you want to review;
- 3 Locate the “replays” folder in your X-Plane installation folder. It should be under “C:\Program Files\X-Plane 10\Output\replays” as shown in Figure 16: X-Plane replays folder.

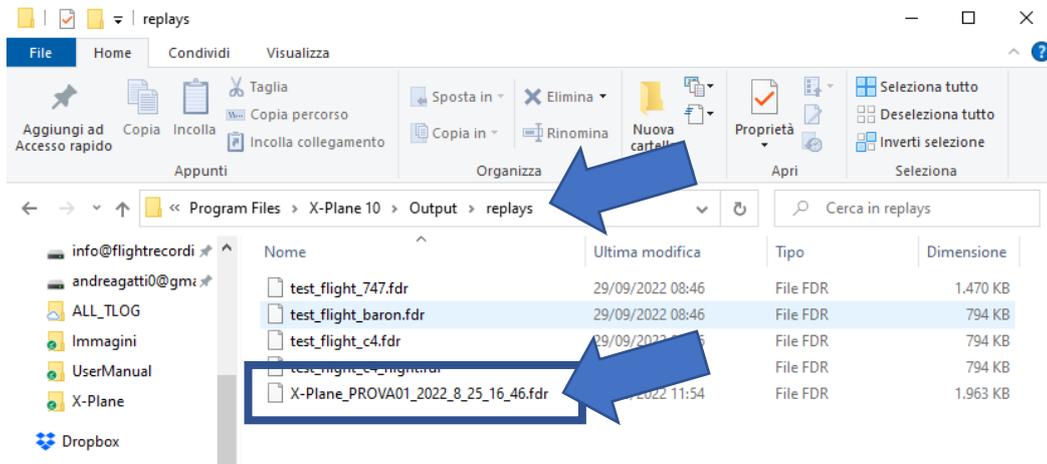


Figure 16: X-Plane replays folder

- 4 Paste (Ctrl + v) the log file in the “replays” folder.
- 5 Start X-Plane
- 6 Navigate in the top dropdown menu, locate “File”, “Load Flight Data Recorder File” as shown in Figure 17.



Figure 17: X-Plane File dropdown menu

- 7 X-Plane automatically will open a new window as shown in Figure 18: X-Plane Flight Data Recorder window

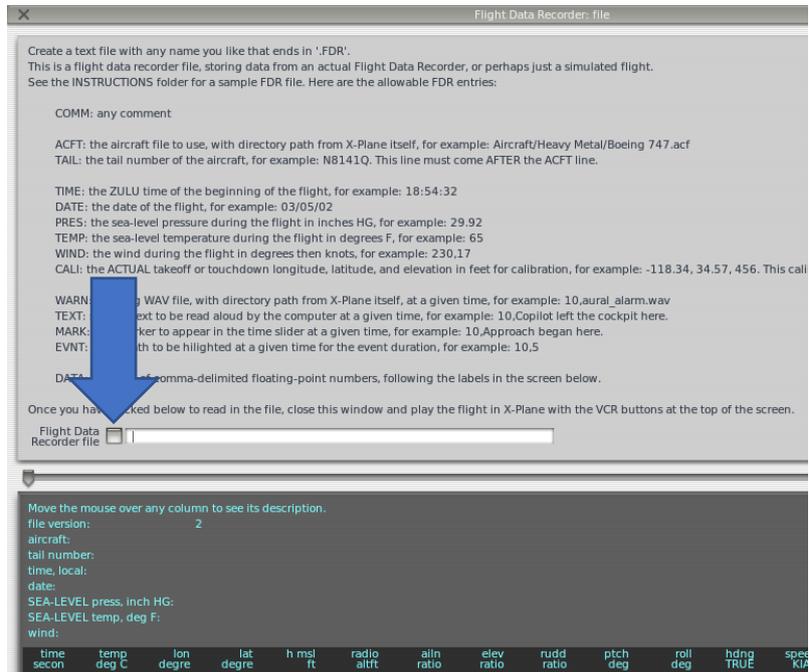


Figure 18: X-Plane Flight Data Recorder window

- 8 Click the squared checkbox as shown in *Figure 18: X-Plane Flight Data Recorder window* to select a log file.
- 9 A new window will appear. Select your log file as shown in *Figure 19: Select X-Plane log file* and click “Open Flight Data”.

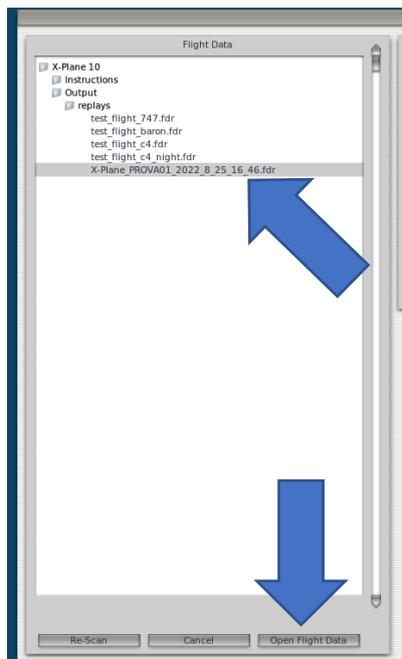


Figure 19: Select X-Plane log file

10 X-Plane will load your flight data. Close the window as shown in Figure 20.

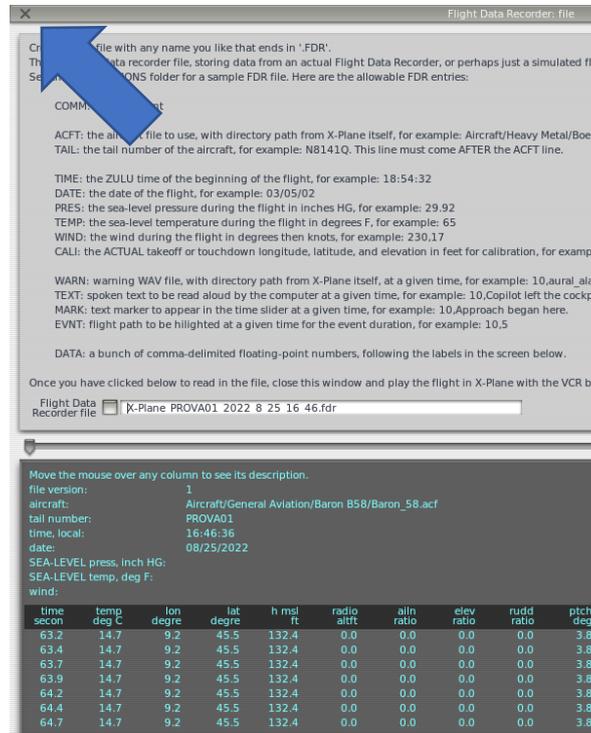


Figure 20: X-Plane has loaded your flight data

11 Use X-Plane as usual. A cursor will appear in the top-center of the screen to drag forward or backward your flight log as shown in Figure 21.



Figure 21: X-Plane flight log replay

2.3.4 Real time monitor

To allow network communications between the FRU and Mission Planner, the user may need to configure the Firewall settings.

In order to let the FRU stream flight data to the ground, the FRU must be connected to a Wi-Fi hotspot as per paragraph “Network setup – Wi-Fi”. A smartphone can be used for this purpose.



Since the data stream is sent across the internet, different internet providers can have a different coverage in some areas. Therefore, if the real time monitor shows some coverage gaps in certain areas, try a different internet provider.

2.3.4.1 Network Firewall setup

- 1 Navigate your PC to find “Windows Defender Firewall” Section as shown in Figure 22: Windows Firewall

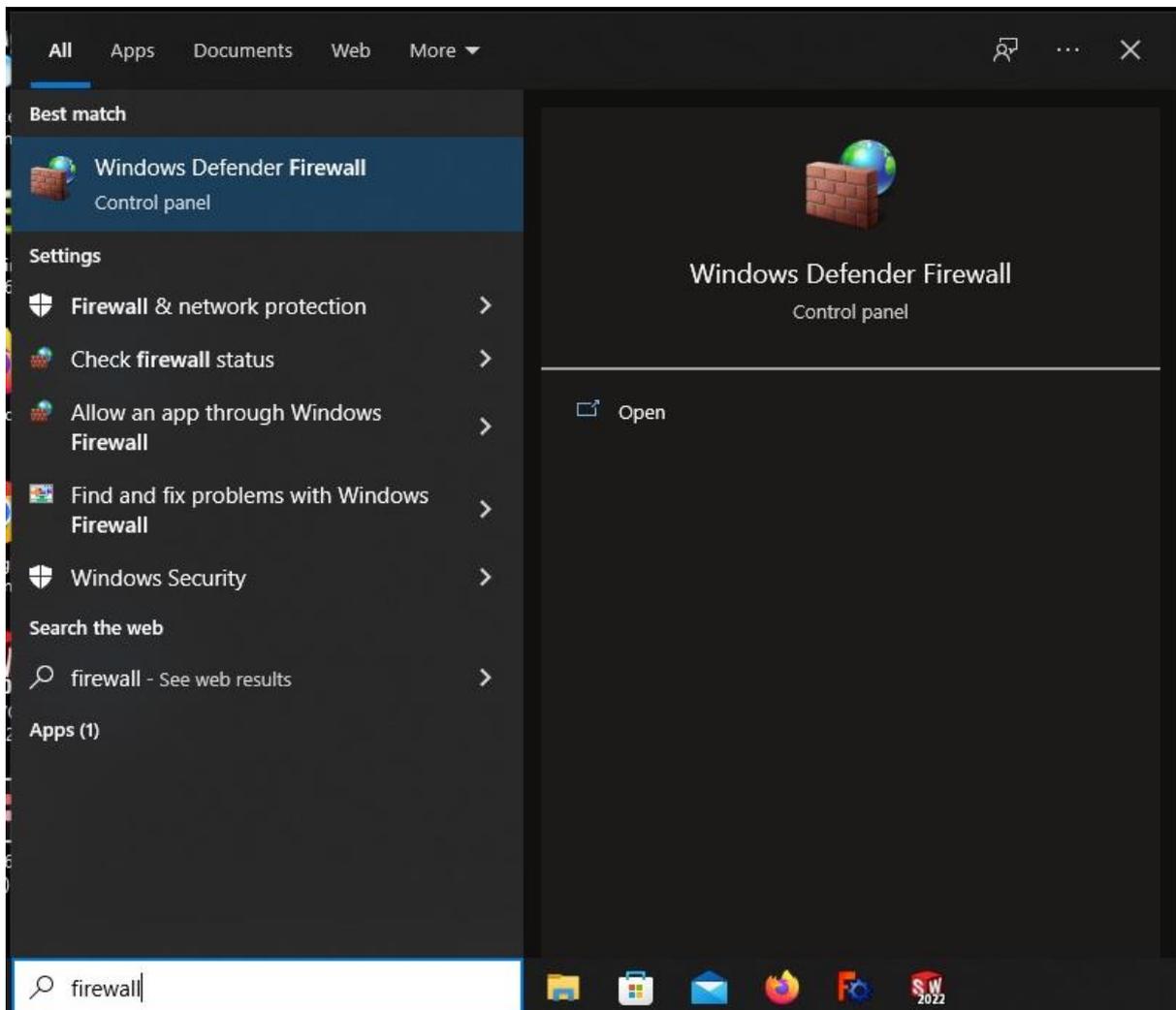
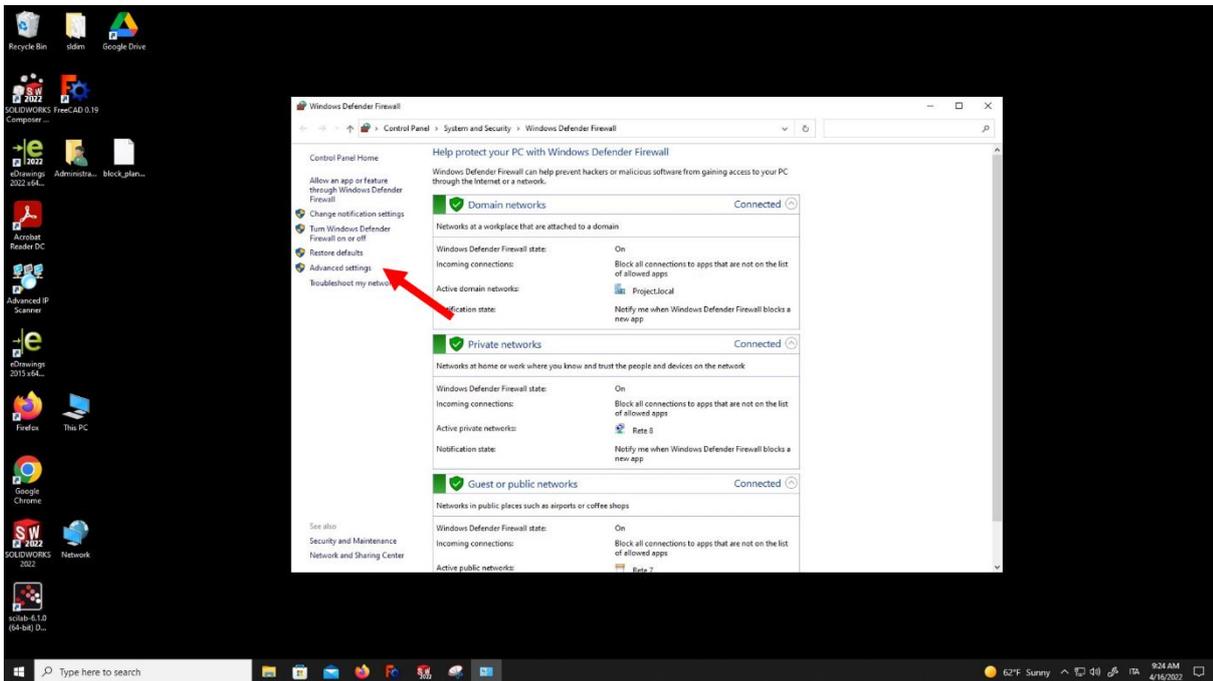
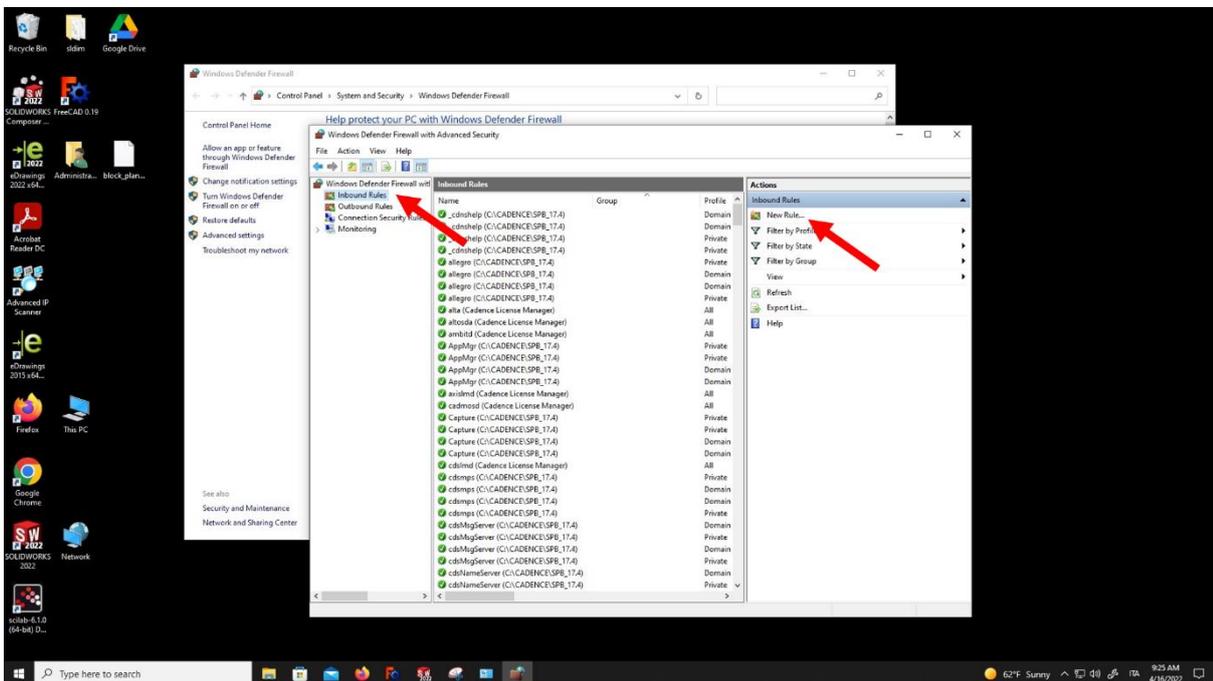


Figure 22: Windows Firewall

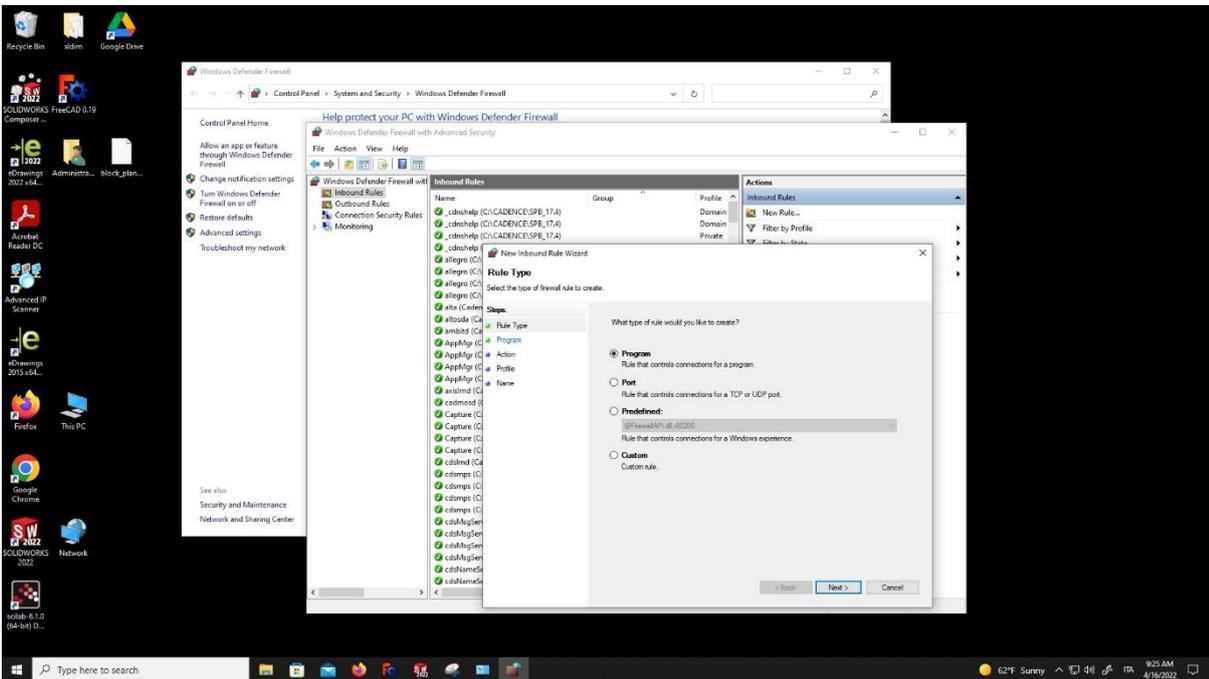
- 2 The Windows Defender Firewall window will open. Click on “Advanced settings”.



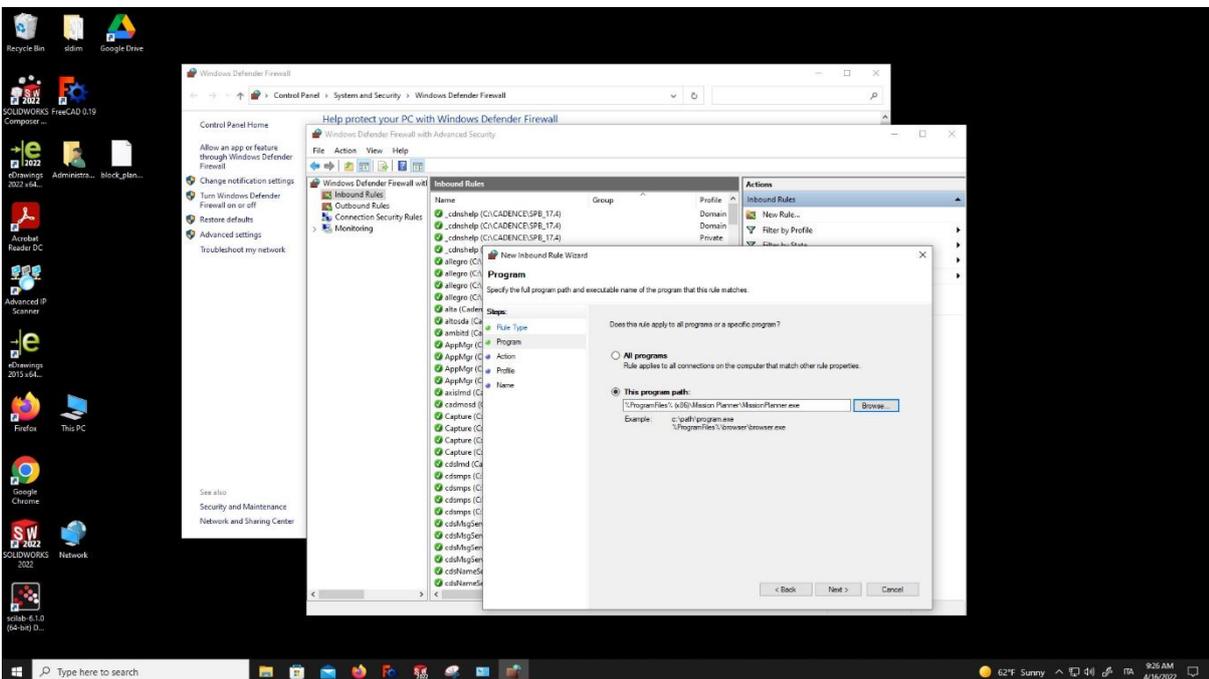
3 Click on “Inbound rules”, “New Rule...”



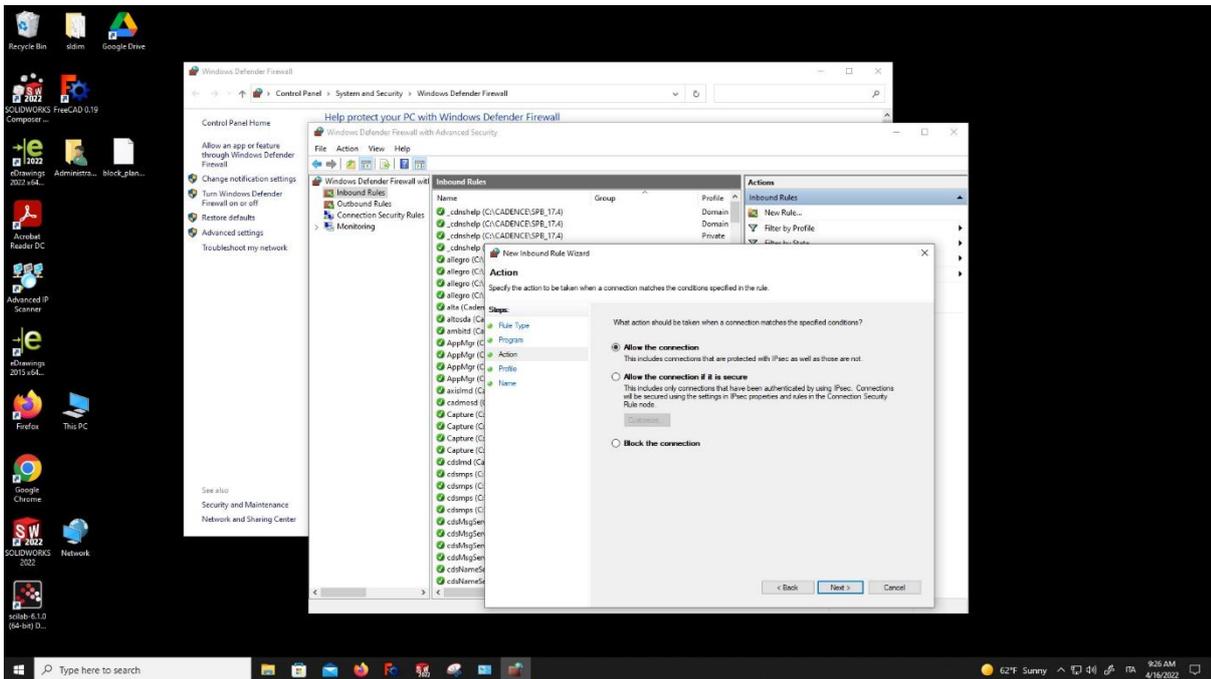
4 The New Inbound Rule Wizard window will open. Select “Program” and click “Next”;



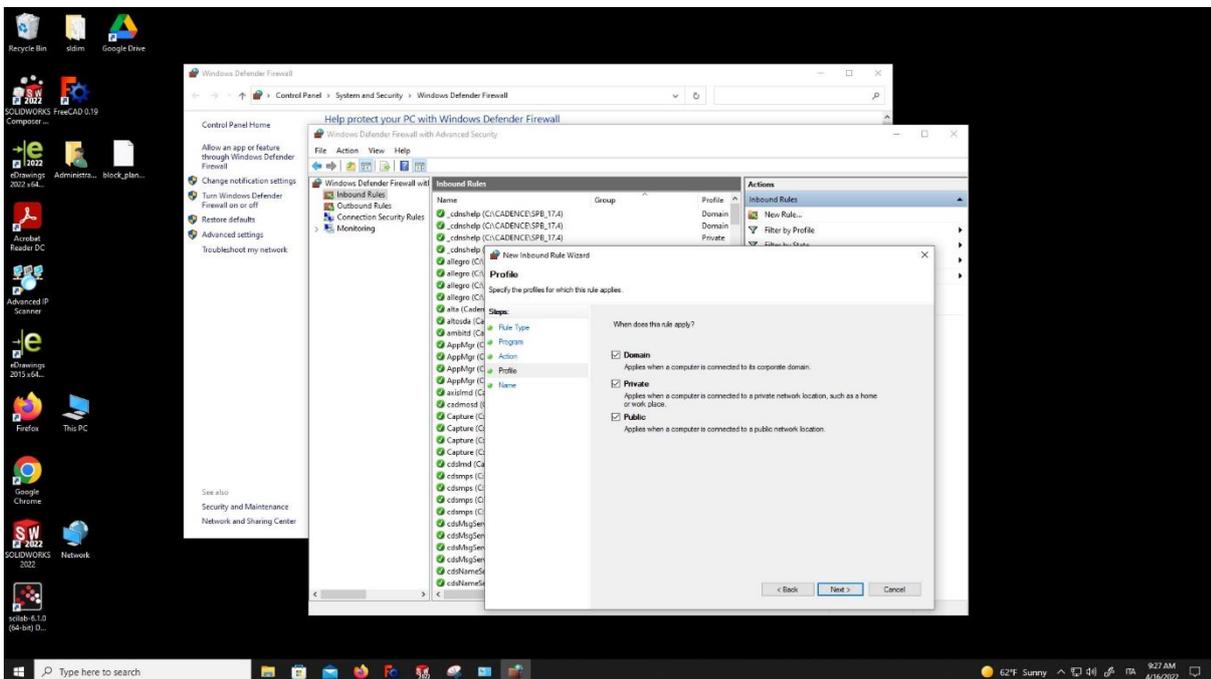
5 Browse for the Mission Planner .exe path in your PC and click “Next”;



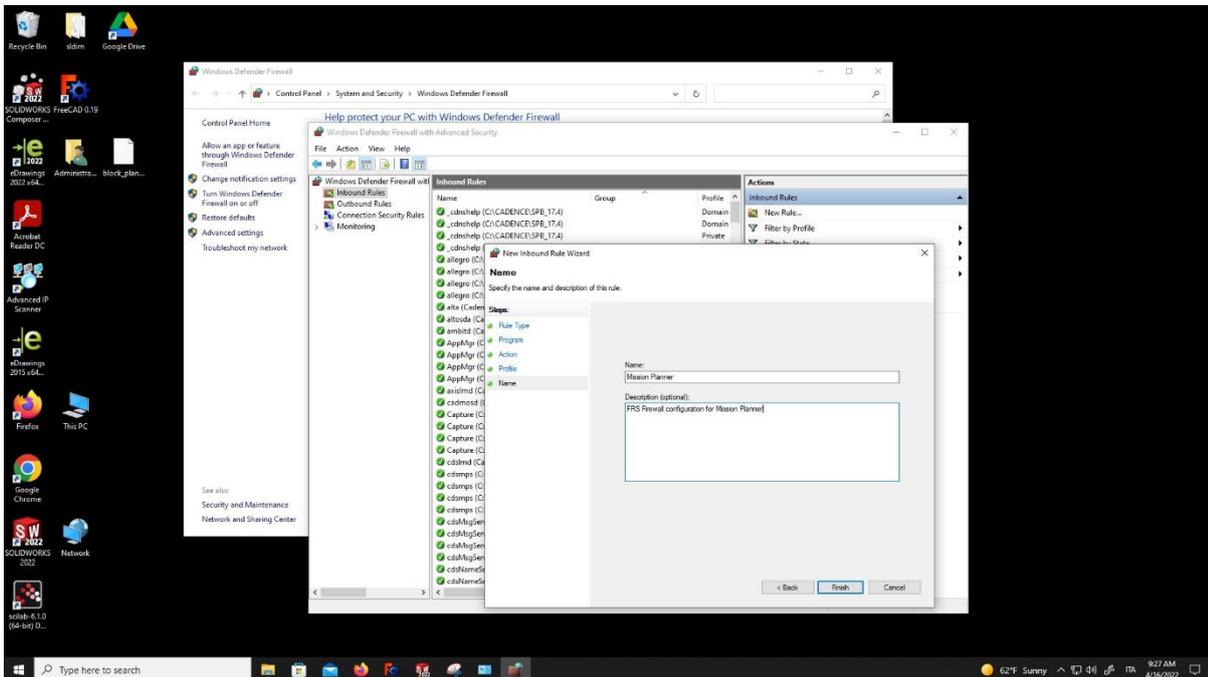
6 Select “All the connection” and click “Next”;



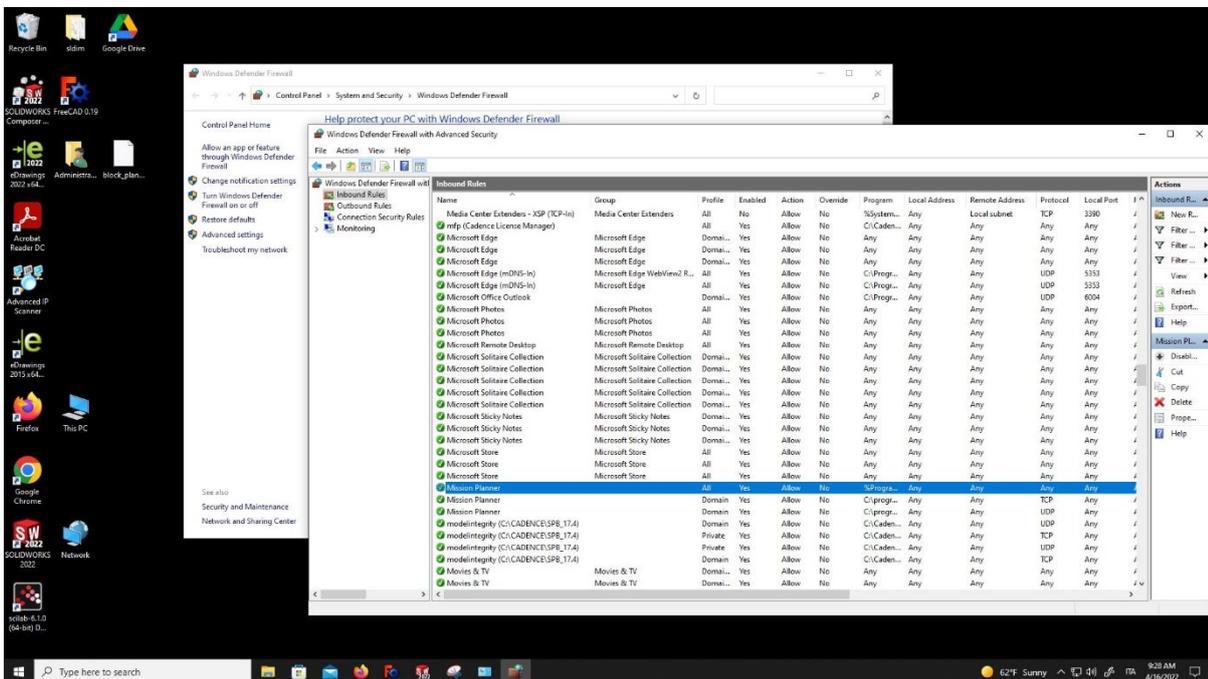
7 Select “Domain”, “Private”, “Public” and click “Next”;



8 Assign a name to this new rule (e.g., Mission Planner). A description is optional;



9 The firewall rules for Mission Planner have been updated successfully.



2.3.4.2 Mission Planner installation

Download and install “Mission Planner” from <https://ardupilot.org/planner/>

- 1 Turn on your FRU and ensure a Wi-Fi connection is available to share real time data over the internet through our VPN.
- 2 In the top-right corner of Mission Planner, select from the dropdown menu “UDP” and click Connect.
- 3 Set the Local port of your device and click OK
- 4 Once the connection is established (Altitude and airspeed will move a little bit, as all the other values) a window “Getting parameters” will appear. Cancel that window since the FRU does not have the parameters that Mission Planner is looking for.
- 5 The real time monitor is up and running.



Figure 23 - Real Time monitor interface

This feature is available only for “FRS Full” users.



Make sure there is no firewall blocking incoming traffic on UDP port. If a stable connection is not achieved, check paragraph 2.3.4.1 and/or ensure the batteries are charged!

2.3.5 Confirmation e-mail

After a successful download, the user will receive a confirmation e-mail to the e-mail address provided.

This e-mail will include all the comments of the user's last flight as shown in the "Automatic Logbook" paragraph.

2.3.6 Automatic Logbook

This function is designed to provide:

- Block Time (*hours:minutes:seconds*)
- Hobbs Time (*hours:minutes:seconds*)
- Flying Time (*hours:minutes:seconds*)
- Engine Time (*hours:minutes:seconds*)
- Engine Cents (*cents of hour*)
- Error messages (*see Table 1: Automatic Logbook error messages*)

All those information is stored in both the CSV file and the confirmation e-mail.

	A	B	C	D	E	F	G	H
1	Flight Recording Systems - FRS							
2	Website: www.flightrecordingsystems.com							
3	Contacts: info@flightrecordingsystems.com							
4	Data processing: FRS Web Service - Ver 1_88							
5								
6	UTC Block OFF: 2022-07-24 09:39:39							
7	UTC Block ON: 2022-07-24 10:10:15							
8	Block Time: 0:30:36							
9								
10	UTC Hobbs ON: 2022-07-24 09:38:29							
11	UTC Hobbs OFF: 2022-07-24 10:10:26							
12	Hobbs Time: 0:31:57							
13								
14	UTC Takeoff: 2022-07-24 09:44:01							
15	UTC Landing: 2022-07-24 10:08:14							
16	Flying Time: 0:24:13							
17								
18	Engine Time: 0:27:30							
19	Engine Cents: 45.83							
20								
21	Hobbs Time: all OK.							
22	Block Time: all OK.							
23	Flying Time: all OK.							
24	FRU Battery: all OK.							
25								
26	Time [s]	Roll_ang	Pitch_ang	Yaw_ang	Latitude	Longitud	Altitude	X Accel [G Y Ac
27	70,322	1	5,2	-0,1	45,5382	9,19933	133,9	0,1
28	70,572	0,9	5,1	-0,2	45,5382	9,19933	133,8	0,1

Figure 24: Automatic Logbook

Using the FRU as per “Operation“ section will lead to an error messages list as shown in Figure 24: Automatic Logbook. The meaning “all OK” for each of the time measurements (Block Time, Hobbs Time, etc) means that the flight has been processed without issues.

Typical error messages are:

Error messages	Solution
<i>“All OK”</i>	The FRU was used as designed.
<i>“Please recharge”</i>	The FRU needs to be recharged.
<i>“FRU was powered ON after engine start”</i> And / or: <i>“FRU was powered ON after block-off”</i> And / or: <i>“FRU was powered ON after take-off: flying time is underestimated”</i>	Turn ON the FRU at least one minute before engine start.
<i>“FRU was powered OFF before block-on”</i> And / or: <i>“FRU was powered OFF before engine stop”</i> And / or: <i>“FRU was powered OFF before landing: flying time is underestimated”</i>	Turn OFF the FRU at least one minute after engine stop.

Table 1: Automatic Logbook error messages



Make sure there the FRU is ON before engine start, as this could result in multiple error messages and wrong engine time computation.

At the same time, make sure the FRU is powered OFF at least 1 minute after the engine has stopped and the aircraft is stationary on the ground, to log all the relevant parameters for the logbook time computation.

3 Handling

3.1 Charging

To charge your FRU, use a 5V battery charger with Type-C USB connector. Minimum rating for the USB charger is 2 Amps. Using a weaker charger could trigger the charger's protections, stopping the process.

Monitor the charging process through the Status LED.

- 1 Red led, solid: Charging is on-going.
- 2 Green Led, solid: Charging is complete.

A full charge may take up to 2h.

Wait for the Green Led before disconnecting the power charger.

3.2 Care

- 1 Do not leave the device unattended during charging and operation.
- 2 Keep away from dust and moisture.
- 3 Do not spray water or any liquid on the FRU. Any liquid that goes into the product may cause a failure.

4 Troubleshooting

Evidence	Solution
When the main switch is ON, the status LED is dark (OFF).	Batteries are empty. Use a mobile phone charger with a minimum rating of 2 Amps.
When connected to the power charger, the Status LED initially turns RED and then turns dark (OFF).	The battery charger is not powerful enough, triggering its protection logic (overcurrent). Try with a more powerful battery charger (2 Amps min).
After 3h of charging, the Status LED is still RED	Use a more powerful battery charger (more amps).
The FRU is not connecting to the Wi-Fi Hotspot of my mobile phone	<p>The device may be connected to another Wi-Fi source (if configured).</p> <p>To force the connection to the hotspot “frs”:</p> <ol style="list-style-type: none"> 1. Turn off the FRU 2. Turn on the Hotspot 3. Turn on the FRU 4. Wait for the FRU to appear in the connected device list <p>If the FRU is still not connecting to the “frs” hotspot, please double check the hotspot settings by repeating paragraph 1.3</p>
Inconsistent heading	<p>This is a common issue if the FRU was not powered ON in static conditions (on the ground, engine OFF if possible). Try following carefully the instructions in chapter 2.</p> <p>If this does not solve the issue, please contact the FRS team.</p>
I'm not receiving any confirmation e-mail	<p>The FRU does not send any email if all the log files have been processed. Please ensure:</p> <ul style="list-style-type: none"> • The spam/deleted emails folder does not contain the confirmation e-mail. • A valid log has been recorded: while logging, the FRU shall be moved to log consistent data. Stationary logs are deleted by default; therefore, do not expect any mail in those circumstances.

5 Specifications

Data	Value
Dimensions (W x H x D)	105 x 45 x 66 mm
Weight	350 g
Power	5V- 2A dc from external USB charger (not included)
Input power connector	USB Type C
Battery	2 x 18650 Li-Ion 2200 mAh
Endurance	More than 5 hours
Operating temperature	-20°C / +50°C (-4°F / 122°F)
Storage temperature	-20°C / +60°C (-4°F / 140°F)

6 Disclaimer

The user assumes full responsibility for the use of the device and any resulting damage.

7 Contacts

For any information, write to: info@flightrecordingsystems.com