

RCSIM GCS — illustrated user manual

Illustrated user guide: tabs, controls, settings and step-by-step procedures. The screenshots show the English interface.

Contents

1. How to use this manual	4
Connection and Tier level	4
2. Menu bar: Options and Help	4
3. Preparing to drive for the first time — sequence	4
4. Cockpit — the operator's everyday workspace	5
Cockpit map	6
5. Configuration — preparing your own station	6
General → Basic: appearance, units and sound	6
General → Advanced: battery and limits	7
General → Developer: reporting a problem	8
Vehicle Profile: model parameters and gears	8
Connection Settings: selecting the actual connection	9
Motion Platform: Thanos motion platform	9
Wheel FFB: steering range and force feel	10
Channel Definitions: what each channel means	11
Control Mapping: assigning the wheel, pedals and buttons	12
Deadzones: stable centre and signal checking	13
Expo Curves: a gentler response	14
Video: USB camera or remote video	15
Extensions and DLC: checking available extensions	15
General — detailed settings guide	16
Connections — detailed operating guide	17
Steering wheel and FFB — detailed operation	24
Assigning controls — detailed operation	28
6. FPV video and OSD selection	32

Edit Layout — your own instrument layout	35
7. Diagnostics — checking the setup before driving	36
8. Mission Planner — mission points and virtual gates	39
9. Navigation — navigation and autopilot settings	40
LiDAR Settings — matching the scan to the surroundings	41
SLAM Engine Settings — a stable map	41
PWF Settings — guidance relative to walls	42
FTG Settings — choosing free space	42
PP Settings — following a path	42
AI Assist Settings and Full AI Settings	42
10. SLAM Robotics — map, points and diagnosis	43
11. RPi Management — administering the vehicle computer	44
12. AI Studio — from recording to model checking	44
01 Collection — selecting training material	44
02 Management — organising and generating the dataset	45
03 Training — training a model	46
04 Export — ONNX and a Hailo model	47
05 Deployment — AI status and mode	48
06 Vision — SSDLite, OWL-ViT, OpenCV and OSD	49
13. Racing Multiplayer — sessions and shared results	51
14. Sim Center Admin — managing multiple stations	53
15. Quick solutions to common problems	54
16. Appendix: verification scope and sources	54

Edition: 14 October 2026. Illustrations: supplied screenshots from 10 October. Button names match the English interface shown in the images; their meaning and the required actions are explained in English. The placement of some controls depends on the version and available extensions.

1. How to use this manual

To configure a steering wheel, go to Configuration. If your setup is ready, start with Cockpit and Diagnostics. Navigation and SLAM Robotics cover navigation and mapping. AI Studio prepares data and models. Racing Multiplayer manages race sessions, while Sim Center Admin manages multiple stations. You do not need all these functions for manual driving.

The illustrations show specific sessions: their IP addresses, channels, values and device models are not a ready-made configuration for your vehicle. Screenshots retain their full resolution; zoom into the relevant area in your PDF reader to read small labels.

Connection and Tier level

- Tier 0: Sound Card PPM — select Audio PPM (Trainer Port) in GCS.
- Tier 1: Arduino/RP2350 Digital to PPM — select the appropriate USB bridge.
- Tier 2: ESP32-CAM — ESP32 WiFi settings.
- Tier 3: ELRS/mLRS, CRSF/MAVLink and EdgeTX/ExpressLRS modifications, such as ER5C V2.
- Tier 4: Raspberry Pi Robotic/Autonomous 5G Platform — including RPi UDP and WebRTC connections.

Wiring and firmware flashing are covered by the separate Tier manuals. Here, you select an already prepared connection path and operate the application. Test Mode (Mock) lets you explore the interface using sample data; it is neither a separate Tier nor confirmation that a vehicle works.

2. Menu bar: Options and Help

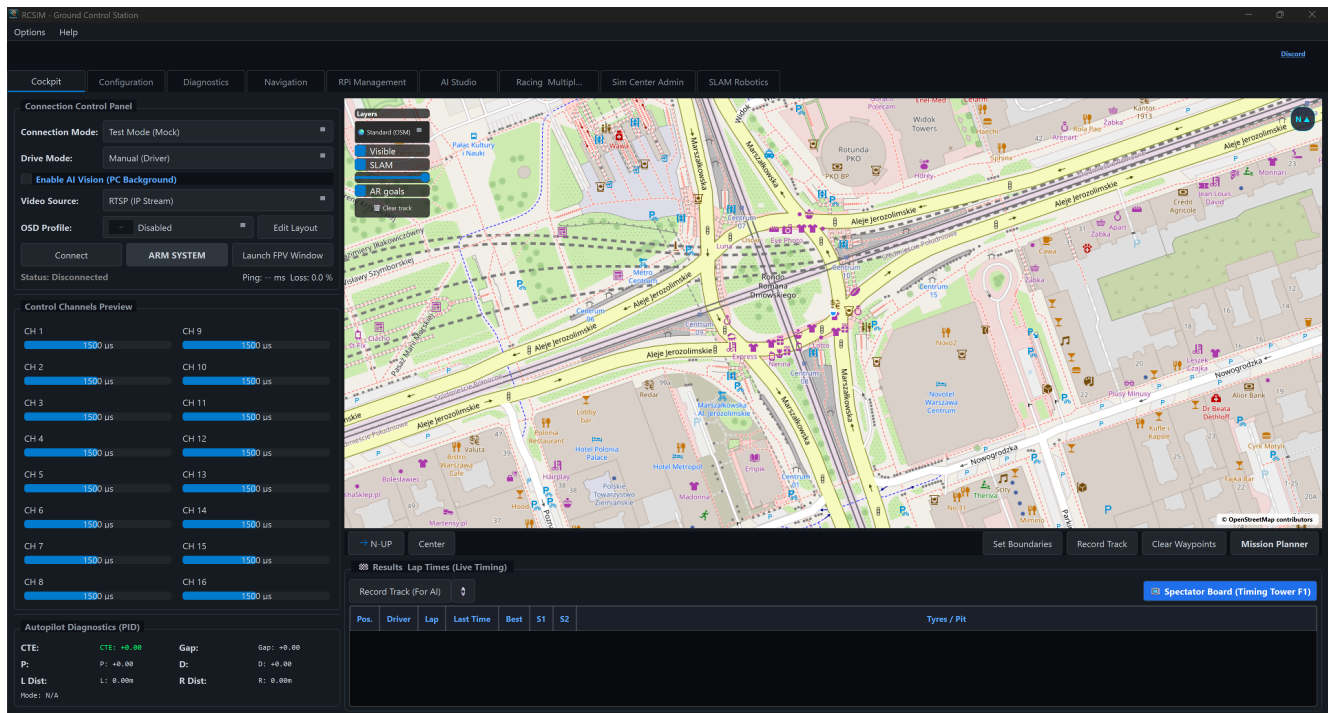
- **Options** → **Language**: select the interface language. This manual explains the names shown in the English illustrations.
- **Options** → **Theme**: select Dark or Light. This changes the station's appearance, not the vehicle.
- **Help** → **User Manual**: opens the manual in the application.
- **Help** → **Check for Updates...**: checks for updates manually. Save your profile before changing versions.
- **Help** → **About**: check application information when reporting a problem.

3. Preparing to drive for the first time — sequence

1. Secure the drivetrain, start GCS and wait for the window to become ready.
2. In Configuration → Vehicle Profile, set up the vehicle profile and gear-changing method.
3. Define channel roles in Channel Definitions; assign the steering wheel, throttle, brake and switches in Control Mapping.
4. Check neutral values in Deadzones. Adjust Expo Curves after assigning the axes correctly.
5. In Connection Settings, select the actual GCS Mode and your device's parameters. Opening a Tier card does not automatically select a transport.
6. Leave Cockpit in Manual (Driver), connect the setup and check the channel preview.
7. In Diagnostics, start refreshing the checklist and check the data your setup actually supplies.

8. For FPV, specify Video Source, select OSD Profile and use Launch FPV Window.
9. After testing channels, directions and failure behaviour, use ARM SYSTEM and begin a cautious manual test.
10. After the test, stop the model, disarm and check its response before disconnecting. Closing the window does not replace securing the drivetrain.

4. Cockpit — the operator's everyday workspace



Cockpit: connection, channel preview and map

The left panel connects the vehicle and selects how to drive; the map shows position and route.

- **Connection Mode** selects the communication path, while **Drive Mode** selects the control method. The illustration uses **Test Mode (Mock)**: readings in this mode are demonstrations.
 - **Control Channels Preview** displays channel values in microseconds. It lets you check steering wheel and pedal responses before enabling the drivetrain.
1. Select the correct **Connection Mode**, previously configured for the vehicle.
 2. Start with **Manual (Driver)** in **Drive Mode**, meaning manual control.
 3. Press **Connect** and check the **Status** description.
 4. Move each axis separately and watch the corresponding channel in **Control Channels Preview**.
 5. Check steering centre and throttle and brake separately; do not judge them solely by the bar's appearance.
 6. Use **ARM SYSTEM** only after checking the connection path and drivetrain behaviour.

Expected result: an active connection and predictable changes on the correct channels. The ARM button state represents an arming request; its effect depends on the transport and vehicle. To end the test, disarm the system and then disconnect the transport.

- **Enable AI Vision (PC Background)** enables image analysis on the computer; it does not replace selecting a driving mode or preparing autonomous functions.

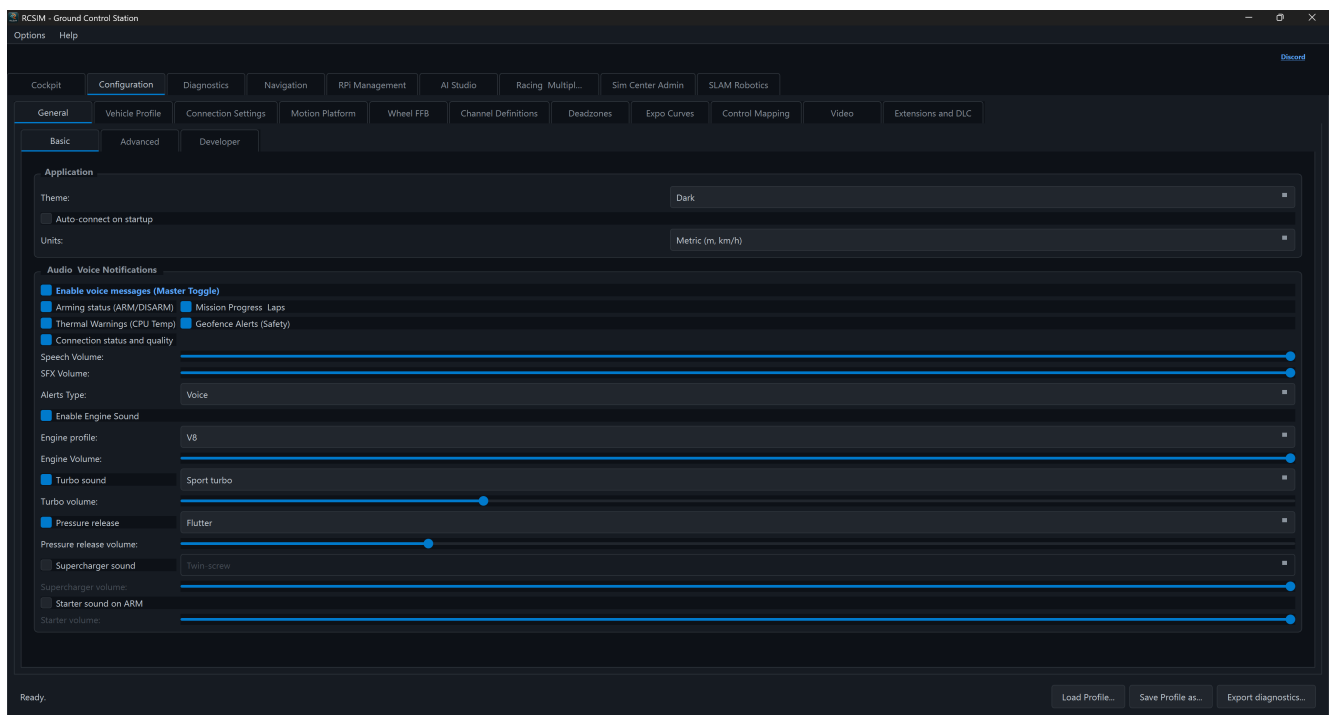
Cockpit map

- **Center** centres the map on the vehicle. **N-UP** places north at the top; switching to **C-UP** rotates the view to match the heading. The **Layers** panel selects the background map and layer visibility, such as **SLAM** and **AR goals**.
- **Record Track** starts recording the drive; pressing it again stops recording.
- **Clear Waypoints** removes mission points; save any route you need before using it.
- **Set Boundaries** opens boundary editing. A line on the map alone does not confirm a drivetrain lockout.
- **Record Track (For AI)** records training data and is a different control from **Record Track**.

5. Configuration — preparing your own station

Here you configure the vehicle, connection, steering wheel, control channels and video source. The English names match the screens shown. Change channels and profiles with the drivetrain secured. The recommended sequence is **Vehicle Profile** → **Connection Settings** → **Channel Definitions** → **Control Mapping** → **Deadzones** → **Expo Curves**, followed by video and optional effects. At the bottom of the tab, **Load Profile...** loads a profile, **Save Profile as...** saves a copy, and **Export diagnostics...** prepares diagnostic data. **Auto-saving...** indicates automatic saving. **Save Mapping** and **Apply and Save** additionally apply to their respective settings; use them after completing those stages.

General → Basic: appearance, units and sound



General Basic — application appearance and audio notifications

Purpose: adapt the application to the operator; these options do not change vehicle performance.

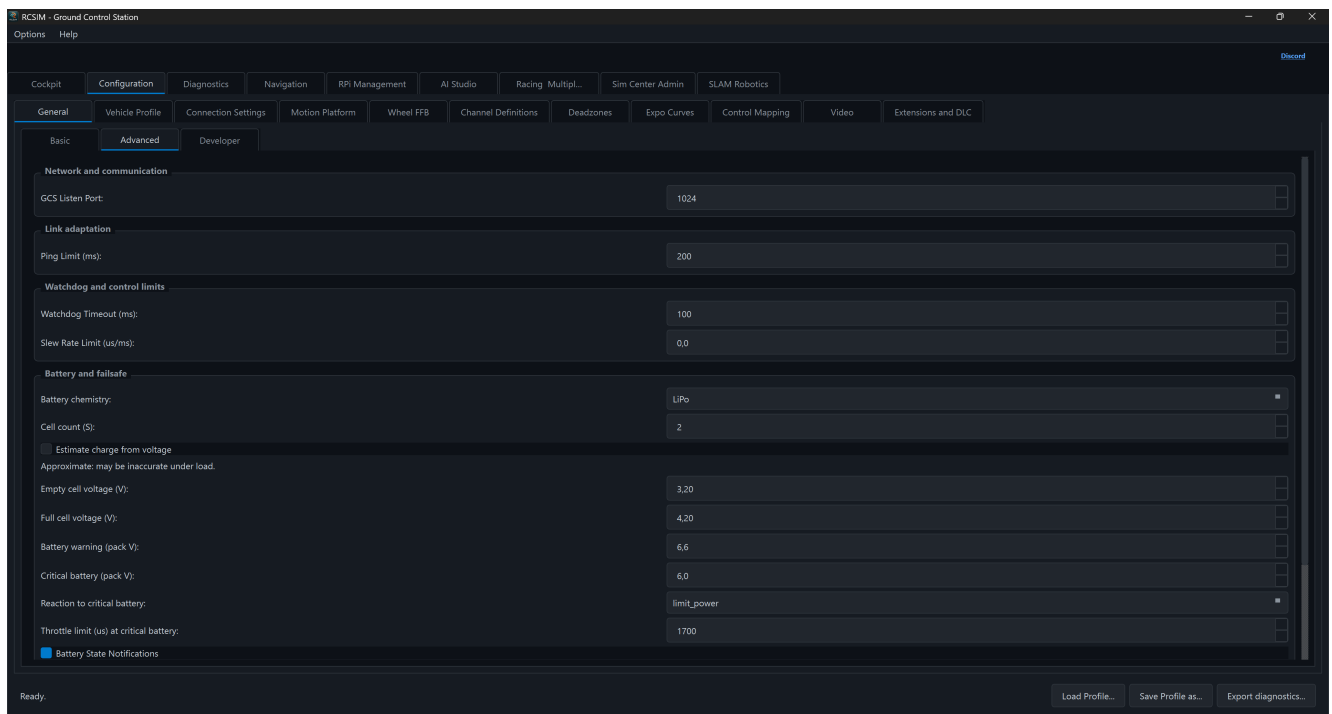
- **Theme** selects the appearance, **Units** selects units, and **Auto-connect on startup** allows automatic connection at startup. Enable automatic connection only after a successful manual test.
- **Enable voice messages (Master Toggle)** is the main announcement switch. Below it, separately select ARM/DISARM, mission progress/laps, temperature, geofence and link status announcements.

- **Speech Volume** controls speech, **SFX Volume** controls effects, and **Alerts Type** selects the notification method. Geofence Alerts are notifications; selecting this option alone does not stop the vehicle.
- **Enable Engine Sound** and **Engine profile/Volume** enable and configure engine sound. Turbo, Pressure release, Supercharger and Starter sound on ARM have separate switches and levels.

Test: enable link status messages, set moderate volume and perform a controlled connection/disconnection. Keep the announcements you can recognise without looking at the screen.

Example: disable engine sound if it masks warnings, while leaving connection notifications active. The expected result is clear information rather than continuously playing noise.

General → Advanced: battery and limits



General Advanced — link settings, watchdog and battery

Purpose: adapt thresholds and limits to the particular station and battery pack.

- **GCS Listen Port** is the station's data receiving port; it must match the sender's configuration. **Ping Limit (ms)** is a link adaptation threshold, not a stated response time.
- **Watchdog Timeout (ms)** sets the supervision time threshold; **Slew Rate Limit (us/ms)** limits the rate of signal change. Do not shorten the timeout blindly; after changing it, check stable operation and the response to link loss. In **Battery and failsafe**, set **Battery chemistry** and **Cell count (S)** to match the pack label. **Empty/Full cell voltage (V)** apply to one cell; **Battery warning (pack V)** and **Critical battery (pack V)** apply to the complete pack.
- **Estimate charge from voltage** estimates the remaining energy. Under load, the result can differ from the actual state of charge; it does not replace measuring and checking the pack.
- **Reaction to critical battery** selects the response, while **Throttle limit (us) at critical battery** sets its throttle limit where the control path implements it. Test the response on the bench; a GCS setting does not replace ESC or receiver protection.

Example: select 2 cells for an actual 2S pack. Do not copy the screenshot's 6.6 V and 6.0 V thresholds without checking — these are settings from that session, not recommendations for every battery.

Check result: cell count, chemistry and voltage reading match the vehicle, and the warning appears at a deliberately chosen threshold.

General → Developer: reporting a problem

This subtab is mainly for diagnosis. It lets you change **Log Level**, open the logs folder and export a ZIP report. When troubleshooting, select **DEBUG** for a short reproduction, repeat the action, export the report and then restore the previous level. Include the event time and the controls you pressed in your description. Hardware neutral-pulse and simulation physics parameters are also here. Leave them unchanged when preparing a normal operator profile. Do not change the neutral pulse instead of mapping the throttle correctly.

Vehicle Profile: model parameters and gears

The screenshot shows the 'Vehicle Profile' configuration window in the RCSIM Ground Control Station. The window has a dark theme and a top menu bar with 'Options' and 'Help'. Below the menu is a tabbed interface with tabs for 'General', 'Vehicle Profile' (selected), 'Connection Settings', 'Motion Platform', 'Wheel FFB', 'Channel Definitions', 'Deadzones', 'Expo Curves', 'Control Mapping', 'Video', and 'Extensions and DLC'. The 'Vehicle Profile' tab is divided into two sections: 'Model Parameters (for V-max calculation)' and 'Gearbox Settings'. The 'Model Parameters' section contains input fields for Motor KV (1000), Voltage (V) (12.00), Teeth (pinion) (16), Teeth (spur) (40), Diff ratio (2.50), Wheel Dia (mm) (100.00), Efficiency (%) (85), Max Speed (m/s) (2.00), and Max Steering (Degrees) (35.00). A 'V-max: 30.76 km/h' label is displayed below these fields. The 'Gearbox Settings' section has radio buttons for 'None', 'Sequential' (selected), and 'H-Shifter'. It also includes a 'Number of gears (forward)' field set to 3, a 'Reverse Power Limit (0.0 - 1.0)' field set to 1.00, and a 'Gear Shift Debounce (s)' field set to 0.30. Below these are 'Target Speed Mapping' options with a 'Use speed mapping' radio button selected and a 'Fill Proportionately' button. A table shows target speeds for Gear 1 (10.3 km/h), Gear 2 (20.5 km/h), and Gear 3 (30.8 km/h). At the bottom, there are 'Load Profile...', 'Save Profile as...', and 'Export diagnostics...' buttons.

Parameter	Value
Motor KV:	1000
Voltage (V):	12.00
Teeth (pinion):	16
Teeth (spur):	40
Diff ratio:	2.50
Wheel Dia (mm):	100.00
Efficiency (%):	85
Max Speed (m/s):	2.00
Max Steering (Degrees):	35.00

V-max: 30.76 km/h

Gear	Target Speed (km/h)
Gear 1	10.3
Gear 2	20.5
Gear 3	30.8

Vehicle Profile — speed calculation and gear-change configuration

Purpose: describe vehicle parameters and how the station handles gears.

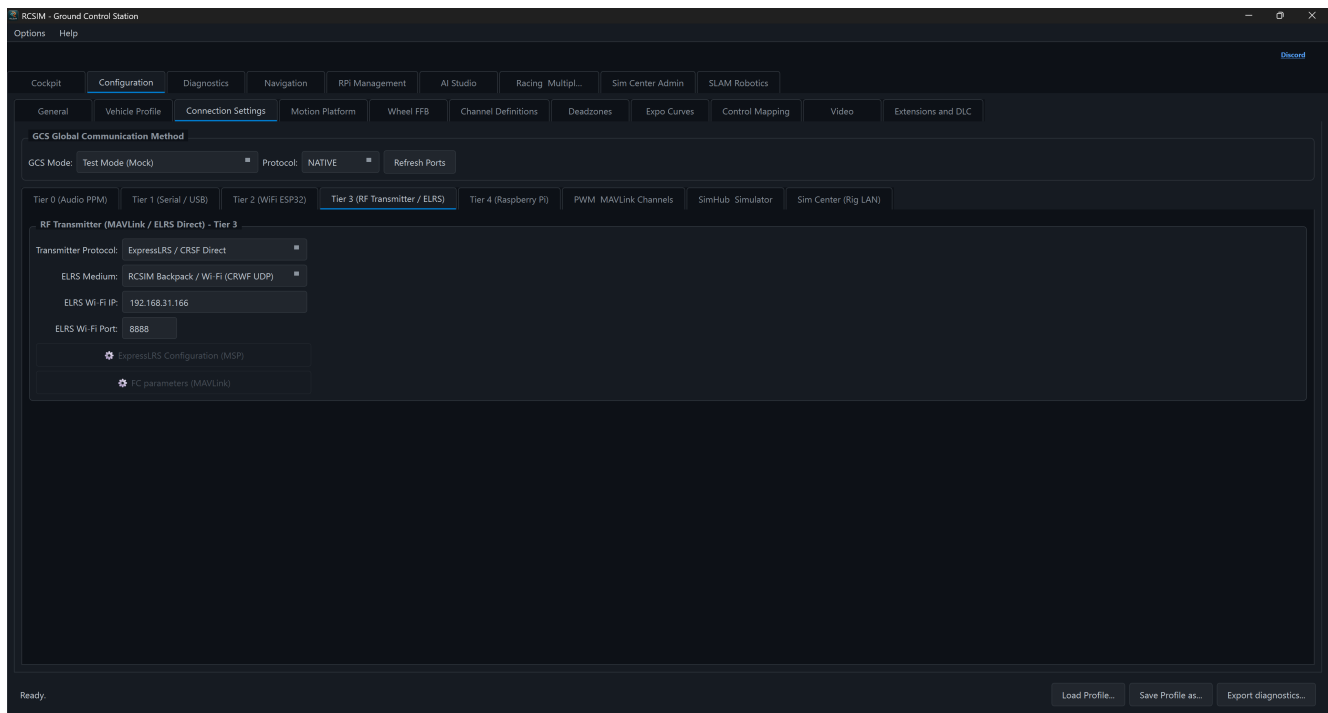
Under **Model Parameters (for V-max calculation)**, enter **Motor KV**, **Voltage (V)**, **Teeth (pinion/spur)**, **Diff ratio**, **Wheel Dia (mm)** and the assumed **Efficiency (%)**.

- **V-max** is a theoretical calculation. ← **From Theory** transfers the result to **Max Speed (m/s)**; note the difference between km/h and m/s. **Max Steering (Degrees)** describes the vehicle's maximum steering angle, not the USB steering wheel's rotation range. In **Gearbox Settings**, select **None**, **Sequential** or **H-Shifter**. Set the number of gears, **Reverse Power Limit (0.0–1.0)** and **Gear Shift Debounce (s)**, the interval that limits accidental repeated shifts.
- **Use speed mapping** enables target speeds for gears. **Fill Proportionately** fills them proportionally using the calculated speed; you can adjust the values afterwards.

Example: for a virtual sequential gearbox, select Sequential and three gears, then fill the targets proportionally. Assign gear changes in Control Mapping and check the sequence before driving.

Expected result: GCS displays the correct gear and profile limits. Calculated V-max is neither a GPS measurement nor a guarantee that the model will reach that speed.

Connection Settings: selecting the actual connection



Connection Settings — GCS mode selection and Tier 3 radio configuration

Purpose: specify how GCS sends controls and receives available data.

First set **GCS Mode** at the top of the window, then the appropriate Tier card. Opening **Tier 3** alone does not change the selected mode — the screenshot still has **Test Mode (Mock)** selected.

- Match **Protocol** to the other end of the connection. **Refresh Ports** updates the list of detected ports after connecting an adapter.
- **Tier 0 (Audio PPM)** is the sound card output, **Tier 1 (Serial / USB)** is Arduino/RP2350, **Tier 2 (WiFi ESP32)** is ESP32-CAM, **Tier 3 (RF Transmitter / ELRS)** is ELRS/mLRS, and **Tier 4 (Raspberry Pi)** is the Raspberry Pi platform. On the Tier 3 card, **Transmitter Protocol** selects the protocol variant, **ELRS Medium** selects the connection type to the module, and **ELRS Wi-Fi IP/Port** specifies its address. Enter your own device's address, not the one in the image. **ExpressLRS Configuration (MSP)** and **FC parameters (MAVLink)** require the relevant working integration. If unavailable, first check the mode, protocol and connection. The remaining cards, **PWM MAVLink Channels**, **SimHub Simulator** and **Sim Center (Rig LAN)**, configure MAVLink channels, simulator integration and a networked station respectively. They are not additional Tiers.
- **Procedure:** select the mode, card and parameters, connect in the cockpit, and check channels and telemetry. Use the appropriate Tier manual for wiring and firmware.

Result: the connection status is correct and known controller movements reach the correct channels. A COM port or visible image alone does not confirm that the whole path works.

Motion Platform: Thanos motion platform

Purpose: configure the operator's moving station. If you do not use a motion platform, you do not need to connect one to control the vehicle.

In the Thanos panel, select **COM Port**, refresh the list (**Refresh**) and connect the device (**Connect**). Check its status before adjusting effect strength. Global settings cover master gain, smoothing, centre sensitivity, maximum input angle and maximum output value. Match the maximum output to the platform controller, not the

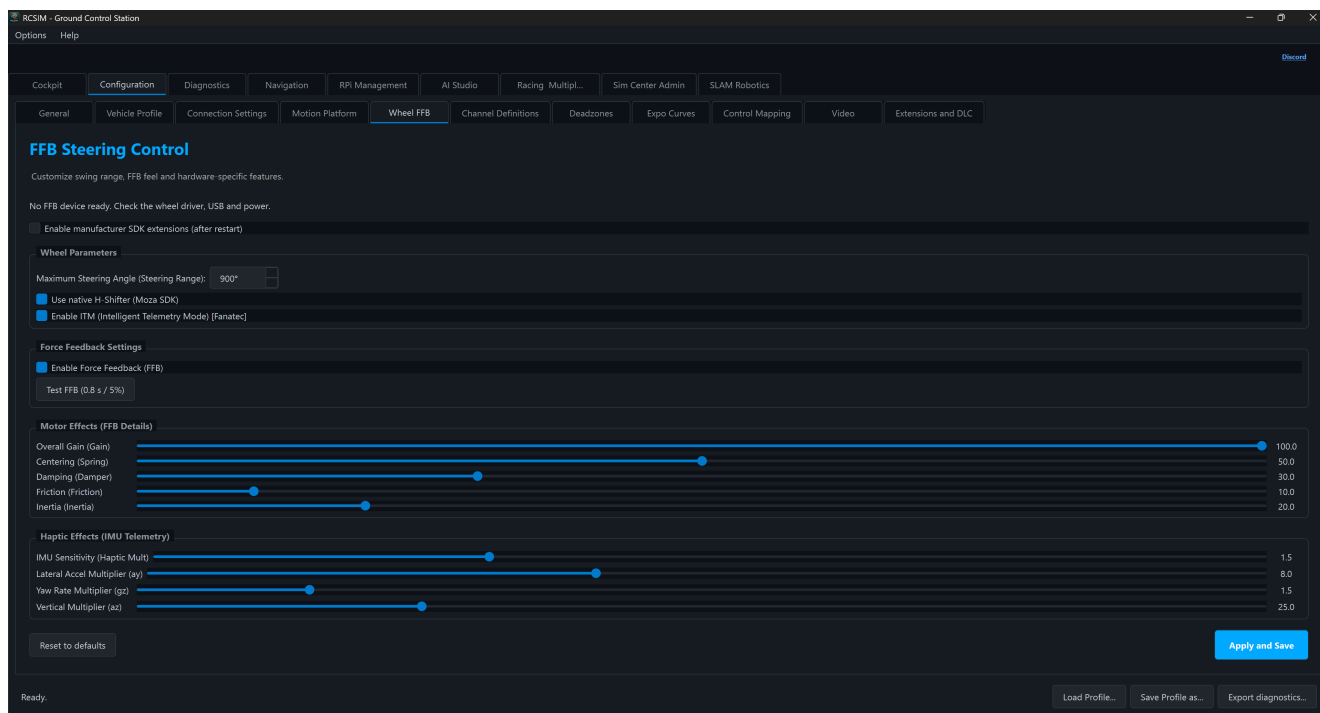
servo channel range. Assign actuators to the left/right front and rear. Tune effects and their inversion only after confirming these assignments.

- **Surge** covers acceleration/braking, **Sway** cornering, **Heave** vertical movement, **Drift Snap** the drift jerk, and **Road Texture** surface irregularities. Increase one effect at a time.

Test: start with low gain, watch the output preview and check the direction of a single movement with clear space around the station. If the direction is wrong, stop the test before changing the inversion.

Result: the correct actuator responds in the expected direction; high gain is not needed to compensate for an incorrect assignment.

Wheel FFB: steering range and force feel



Wheel FFB — wheel test, strength and telemetry effects

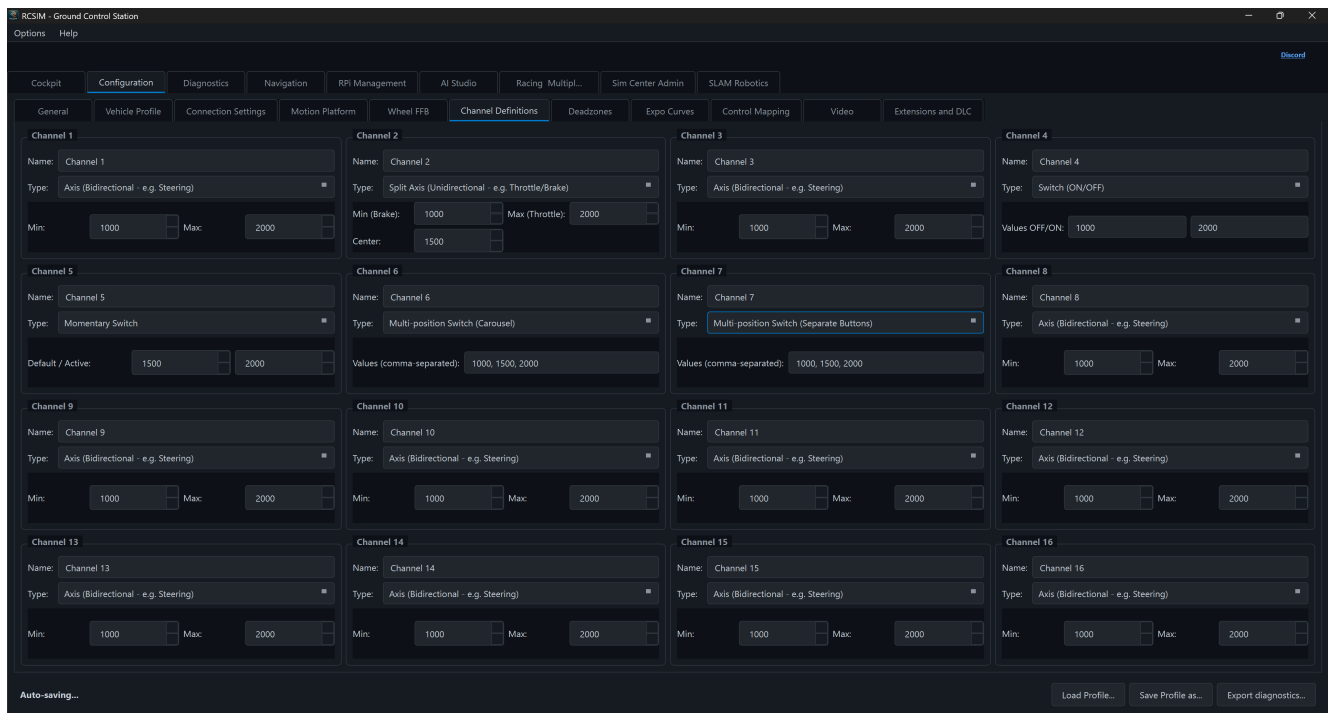
Purpose: set the USB steering wheel's rotation range and Force Feedback effects.

No FFB device ready. Check the wheel driver, USB and power. means that you must check the driver, USB cable and wheel power before tuning.

- **Maximum Steering Angle (Steering Range)** sets the wheel's range. **Enable manufacturer SDK extensions (after restart)** enables manufacturer extensions after restarting; Moza H-Shifter and Fanatec ITM options apply to compatible hardware. Select **Enable Force Feedback (FFB)** and use **Test FFB (0.8 s / 5%)**. This is a short force test without telemetry; keep your hands clear of pinch points.
- **Overall Gain** sets total strength, **Centering** the centring effect, **Damping** damping, **Friction** friction, and **Inertia** inertia. Start with low Gain and adjust one slider at a time. Under **Haptic Effects (IMU Telemetry)**, set overall IMU sensitivity and the contributions of lateral acceleration, yaw rate and vertical movement. These require current sensor data; the hardware test may work even when these effects are absent. Finish with **Apply and Save**. **Reset to defaults** restores the default settings; reassess the strength before driving after a reset.

Example: the test works but there are no road effects while driving — first check IMU telemetry availability rather than maximising Vertical Multiplier. A correct setup produces predictable, controlled force.

Channel Definitions: what each channel means



Channel Definitions — axis and switch types for channels 1–16

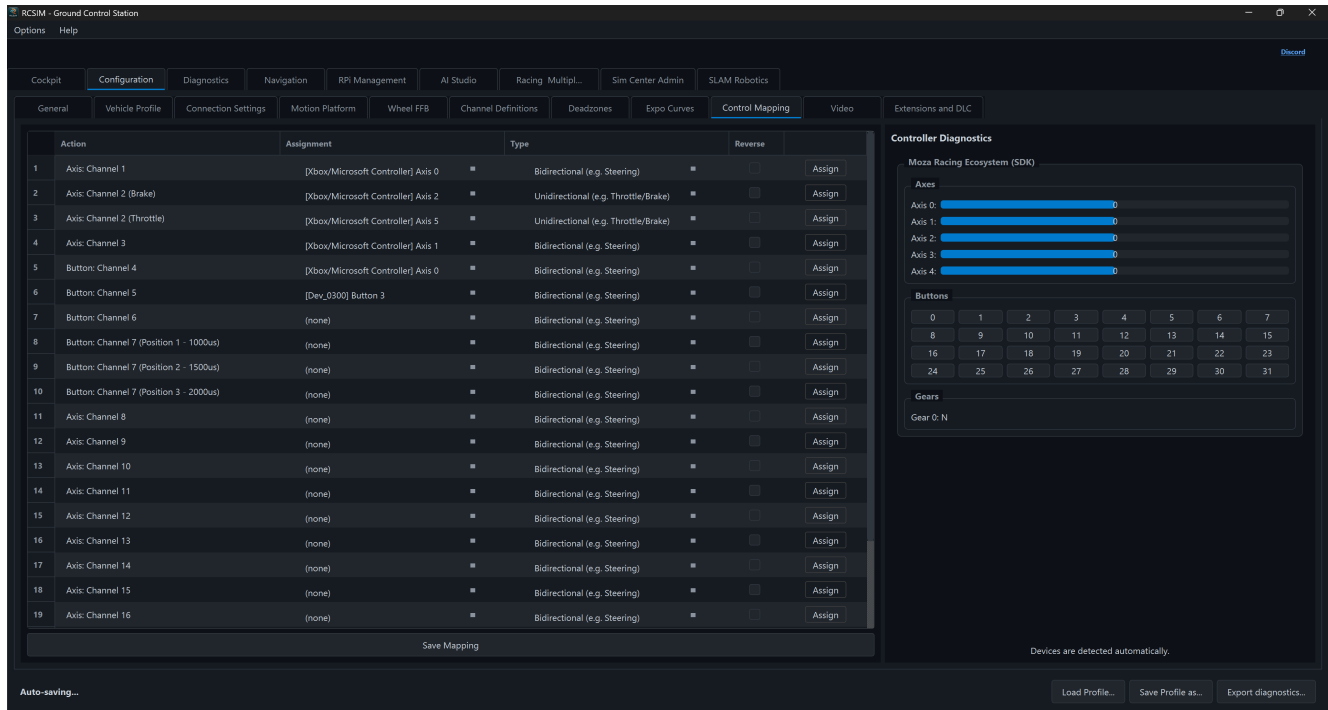
Purpose: define each channel's type and range before assigning a button or axis.

- **Name** provides a readable name. **Axis (Bidirectional)** is a two-way axis, such as steering; **Split Axis (Unidirectional)** allows brake and throttle to be assigned separately to one channel. Set **Min/Max**, and **Center** for a split axis. **Switch (ON/OFF)** has OFF/ON values; **Momentary Switch** has default and active values.
- **Multi-position Switch (Carousel)** steps through values, while **Multi-position Switch (Separate Buttons)** gets a separate assignment for each position. Enter values in order, separated by commas.

Example: name CH1 Steering and select a bidirectional axis; select Split Axis for CH2 throttle/brake. Use the illustrated 1000–2000 range and 1500 centre only if they match the receiver and ESC.

Result: Control Mapping shows the correct actions, such as separate Brake and Throttle or individual switch positions. Defining 16 channels does not mean every transport supports all of them.

Control Mapping: assigning the wheel, pedals and buttons



Control Mapping — input assignments and operator device preview

Purpose: connect actions to the controller's physical inputs. Devices are detected automatically; the right-hand panel displays their axes, buttons and gears.

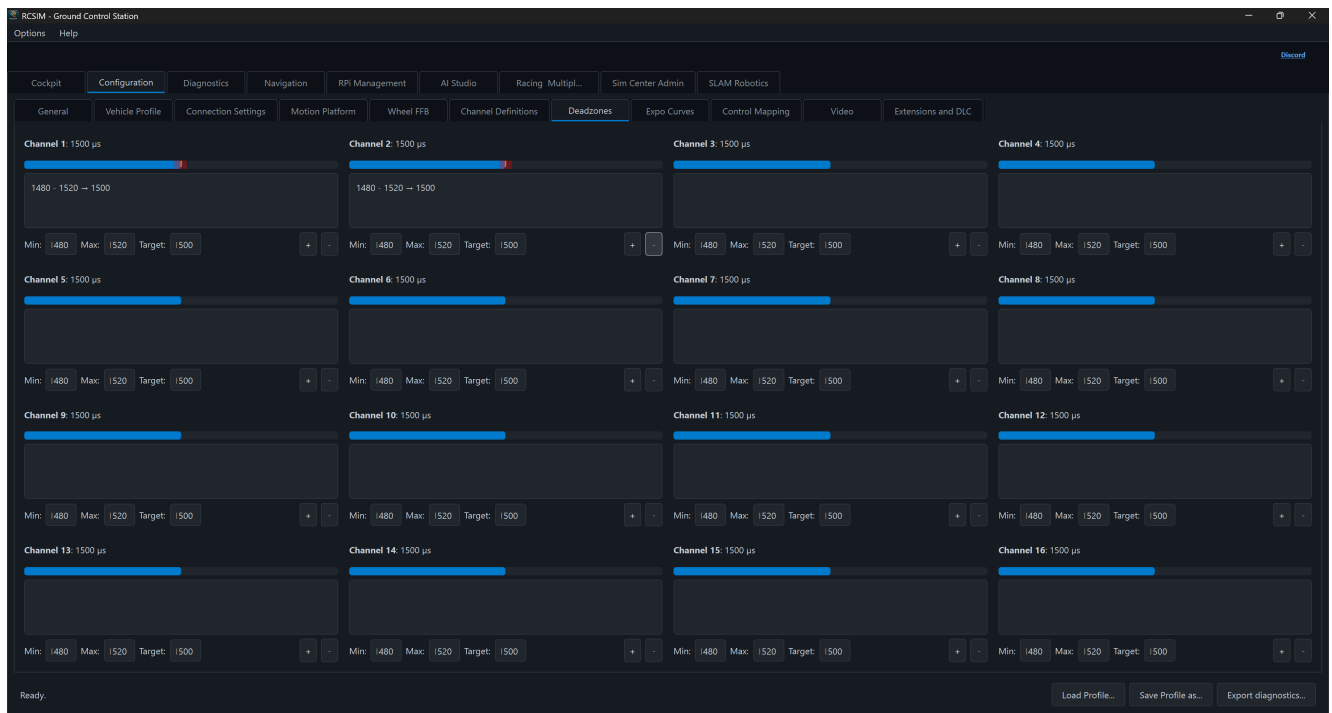
Press **Assign** for an action, then move only the intended axis or press the intended button. Check the device name and input number in **Assignment**. In **Type**, distinguish a bidirectional axis from a one-way pedal. **Reverse** inverts direction. Do not select it merely because an axis number differs from the example.

Example: assign steering to Channel 1, brake to Channel 2 (Brake), and throttle to Channel 2 (Throttle). Axis 0, 2 and 5 in the image belong to a particular controller and are not fixed for every steering wheel.

Move each control in turn and make sure only the intended action responds. Finish with **Save Mapping**.

Result: released pedals do not request movement, steering has the correct direction, and switches select the expected positions. Also check the state after reconnecting the controller.

Deadzones: stable centre and signal checking



Deadzones — live channel values and ranges mapped to neutral

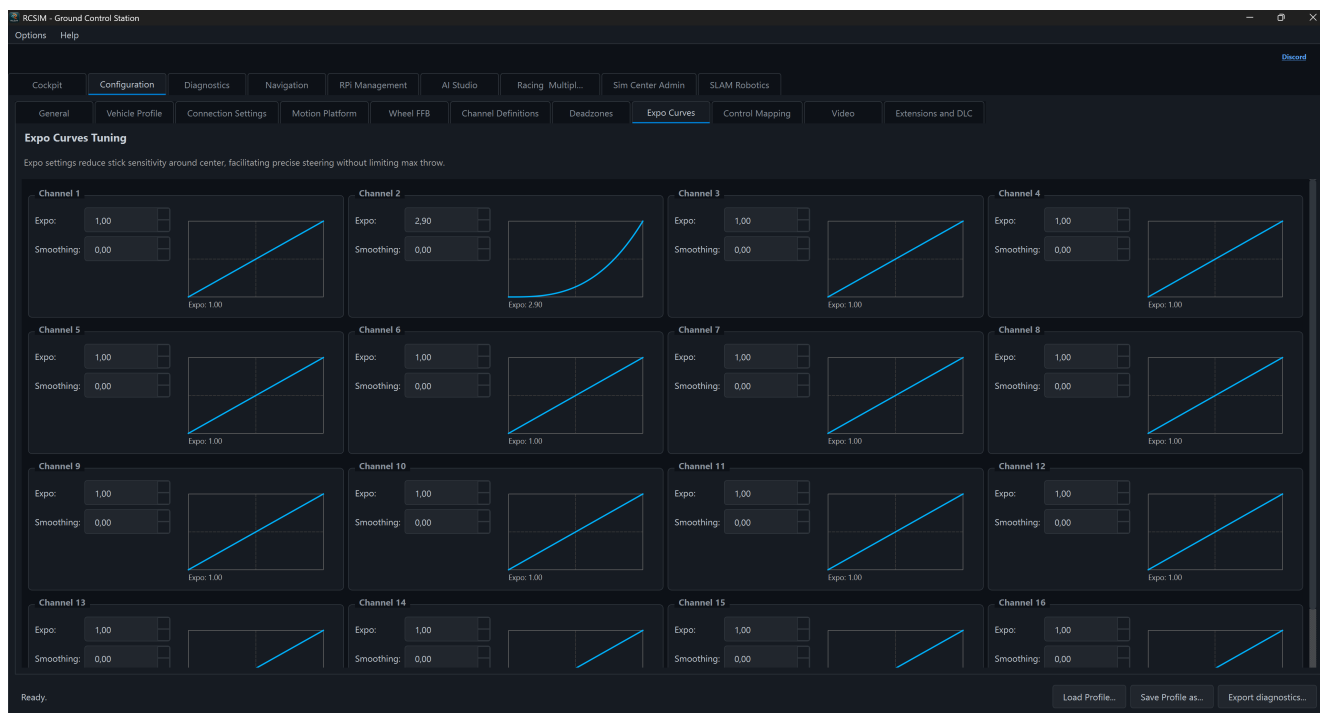
Purpose: remove small, unintentional changes around a set value. This is also a convenient channel-checking screen during configuration.

Each channel displays its current value and a bar. **Min** and **Max** define the interval, and **Target** the replacement value within that interval. Use **+** to add a rule and **-** to remove the selected rule. First observe jitter with the wheel released; set only the range needed to remove it.

Example: **1480–1520 → 1500** stabilises a 1500 centre. Do not automatically apply it to throttle if your ESC's neutral point is elsewhere.

Result: the channel stays neutral when the control is released, while a small deliberate movement outside the zone still produces a response. An overly wide zone makes precise driving harder.

Expo Curves: a gentler response



Expo Curves — linear response and a gentler throttle curve

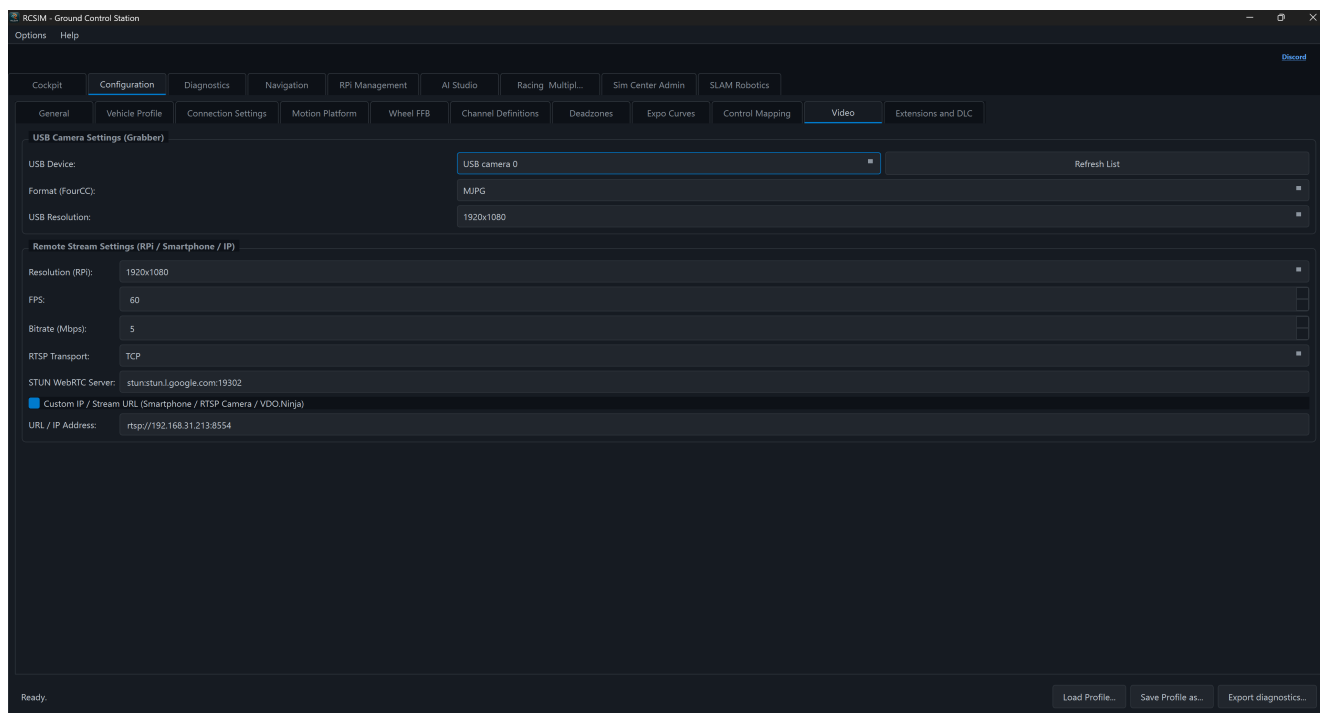
Purpose: adjust sensitivity without changing device assignments or the channel's final range.

- **Expo = 1.00** gives a linear response. Higher values soften the initial response; the graph lets you compare the curve shape immediately.
- **Smoothing = 0.00** adds no smoothing. Increasing it smooths sudden changes but slows the response to input changes. Do not use heavy smoothing to hide incorrect mapping.

Example: the image shows linear CH1 and Expo 2.90 for CH2. Start with a small throttle change, check starting and braking on the bench, then assess behaviour at low speed.

Result: initial movement is easier to modulate, while full input still reaches the expected range. Change one curve at a time.

Video: USB camera or remote video



Video — selecting a USB capture device and remote stream parameters

Purpose: prepare the video source; video configuration does not automatically select the control path.

For a USB camera or capture device, use **Refresh List**, select **USB Device**, then a compatible **Format (FourCC)** and **USB Resolution**. Check the device preview to confirm the setting works. In **Remote Stream Settings**, match **Resolution (RPI)**, **FPS** and **Bitrate (Mbps)** to the sender and link. Entering 60 FPS is a setting, not a guaranteed result.

- **RTSP Transport** selects TCP or UDP for RTSP. **STUN WebRTC Server** applies to WebRTC connections; it is not the camera address. For your own IP camera, phone or service, select **Custom IP / Stream URL** and enter its actual address in **URL / IP Address**. The illustrated RTSP address is an example from a particular station.

Test: start the correct preview in the cockpit and check that the image is current and assess motion delay. If it stutters, reduce resolution or bitrate one at a time and compare the result.

Result: you see the correct camera and current video; confirm control and telemetry separately.

Extensions and DLC: checking available extensions

This subtab displays the name, identifier, status and version of detected extensions. Refresh the list after installation changes; some extensions load when the station starts. A status requiring a newer Core means you need a compatible application version, while a loading error calls for a diagnostic report. Do not try to solve it by changing vehicle channels. **Unlock / Download** carries a notice that downloads will be available in a future update; it is disabled for a loaded extension. Do not treat it as a working installer or proof of purchase. The tab may be labelled **Extensions and DLC** or its translated equivalent, depending on the application's language and version.

General — detailed settings guide

The explanations below supplement the Configuration tab illustrations. Change one area at a time, check the result, and preserve a working profile with Save Profile as.... Loading another profile can also change the connection and controls; check both areas again after loading.

Basic → Application. Theme offers Dark, Light, and System. UI Scaling lets you select Auto or 100–300% in 25-percentage-point increments; changing it requires restarting the application. On a high-resolution display, increase the scale if labels are too small. DPI Adjustment selects PassThrough, Round, or RoundPreferFloor; the application tooltip recommends PassThrough for smooth Windows scaling. After restarting, check that the bottom Configuration buttons fit inside the window.

Units. Metric (m, km/h) and Metric (m, m/s) differ in their speed unit, while Imperial selects imperial units. Read the unit next to each individual field: vehicle profile parameters may require m/s even when the speedometer displays km/h. Enable automatic connection at startup only after checking manual connection with the correct profile.

Basic → Audio and Voice Notifications. Master Toggle is the main speech switch. ARM/DISARM, Mission progress and laps, Thermal warnings, Geofence alerts, and Connection status and quality select notification categories. Speech Volume and SFX Volume range from 0–100; zero mutes the corresponding output. Alert Type selects Both, Voice, or SFX. Choose an option you can hear against the surrounding noise, then check a notification when connecting and disconnecting.

Engine sound. Enable engine sound switches on the rig's sound effects. Engine Profile selects the sound, including L4, L5, L6, V8, V10, ROTARY, BOXER, and EV; Engine Volume sets its level from 0–100. Turbo Sound offers single, twin, and sport variants; Blow-off offers Flutter, quiet, or sharp; Supercharger Sound offers Roots, screw, or centrifugal. Each of these additions has its own enable switch and volume. Starter sound on ARM also has a separate switch and volume. Selecting a sound does not configure the physical motor or ESC.

Advanced → Network and communication. GCS Listen Port accepts 1024–65535. This is the station's local receiving port: in a network connection, the device sending data must direct it to this port and the computer's address. Do not confuse it with the device destination port set in Connection Settings. If the port is busy, check whether another GCS instance is running.

Link adaptation. Ping Limit ranges from 10–1000 ms and sets the adaptation threshold. It does not reduce the network's physical latency. Observe latency in Diagnostics first, then adjust the threshold; a value consistently below normal latency may cause the threshold to be exceeded continuously.

Watchdog and control limits. Watchdog Timeout: 100–5000 ms, in 50 ms increments. A shorter time identifies an interruption sooner but is more sensitive to irregular transmission. Slew Rate Limit: 0–500 us/ms, defining the permitted rate of pulse change. A lower positive limit smooths abrupt changes; it can also delay reaching the requested signal. Check the change in the channel monitor and the response of the actual control path. Station settings alone do not confirm that the receiver's failsafe works.

Battery — what to enter. Battery Chemistry selects LiPo, Li-Ion, or LiFePO4. Cell Count (S) accepts 1–12 and should match the pack. Estimate charge level from voltage enables an approximate state-of-charge reading. Empty-cell and full-cell voltages range from 2.00–4.35 V; choose them according to the chemistry and the pack's documentation. Battery Warning and Critical Battery accept 0–30 V and refer to the entire pack. Set the warning threshold above the critical threshold. Compare the voltage reading with an independent measurement before evaluating the charge percentage.

Battery — response. Available names are limit_power, stop, and rth. Critical-battery throttle limit ranges from 1500–2000 us. Selecting rth does not confirm that Return to Home is configured on the vehicle. Whether the response can be executed depends on the control path and vehicle functions in use; test it for the specific setup. Battery status notifications have a separate checkbox.

Adaptive Cruise Control (ACC). Enable Adaptive Cruise Control activates the function's setting. ACC Min. Distance accepts 0.1–5.0 m; ACC Max. Distance accepts 0.2–15.0 m. Keep the minimum below the maximum. These distances require a reliable measurement source and support in the control path being used; setting values alone does not confirm obstacle detection. Check that distance data is available and fresh before using the function while driving.

Developer — when to use it. When reporting an issue, select **DEBUG**, reproduce one fault, and use **Export report (.zip)**. Open **logs folder** helps locate the event record. After diagnosis, restore the previous level, usually **INFO**; **WARNING** and **ERROR** reduce the amount of information recorded. The **Neutral Pulse** field is labelled “ms” in the interface code, but its 500–2500 range corresponds to the pulse values used by the application. Do not interpret an entered value of 1500 as 1500 milliseconds. For ordinary pedal assignment, leave the hardware parameter unchanged and configure the input in mapping. Acceleration in the **Simulation Physics** group is a simulation parameter, ranging from 1–100.

Check after making changes. Restart the application after changing the scale, then check label readability, the correct profile, and the connection mode. Compare speed units and voltage with the actual setup. Check one audio notification. Save a profile copy only after completing these checks.

Field verification sources: `general_tab_builder.py`, `general_tab.py`, and `general_tab_battery.py` in `RCSIM_PC/pc_app/gui/tabs`. A field's range is the range permitted by the interface, not a recommended value for every model.

Connections — detailed operating guide

Open **Configuration** → **Connection Settings**. Select the actual **GCS Mode** at the top, then set the device parameters below. Opening a Tier tab does not switch the connection. For example, opening **Tier 3** while **Test Mode (Mock)** is selected still leaves GCS in demonstration mode.

Selecting GCS Mode automatically displays the corresponding tab. The reverse action—clicking a tab—does not select the mode. For **Tier 1**, also distinguish **Arduino** from **RP2350** in the upper list.

Common configuration and saving sequence

1. Stop the vehicle, secure the drivetrain, and leave the system disarmed. If a transport is connected, disconnect it in the cockpit before changing the port or protocol.
2. Use **Save Profile as...** to preserve the current configuration under a recognizable name.
3. In **GCS Mode**, select the connection you actually use. Set **Protocol** to match the vehicle service; **NATIVE** and **MAVLINK** are not interchangeable radio names.
4. Complete the appropriate tab using the procedure below. Enter only a number in network port fields, without **COM**, **http://**, or a unit suffix. Select a serial port separately as a **COM** device. The device address and network port are separate fields.
5. After entering text, click another field or press **Tab** to finish editing. Wait for **Auto-saving...** to finish; connection settings do not have a separate **Apply** button.
6. Save a profile copy after making changes. Saving a profile does not connect to the device or send the entire configuration to the vehicle.
7. Go to **Cockpit**, check **Connection Mode**, select **Manual (Driver)**, and press **Connect**.
8. Check **Status**, then independently check the channel monitor, receiver response, and available measurements. A green port status without these checks does not confirm that the model is ready.
9. Check neutral throttle, steering, braking, and the response to disconnecting the PC and losing the relevant link. Only then deliberately arm the system and perform a cautious test.

Refresh Ports refreshes detected serial devices; the global button also refreshes audio devices. It does not install a driver or fix a busy port. **Load Profile...** restores a saved profile, so check GCS Mode, addresses, and devices again after using it.

Tier 0 — sound card and Audio PPM

In **GCS Mode**, select **Audio PPM (Sound Card) — Tier 0** and open **Tier 0 (Audio PPM)**. This is a control signal output for the trainer port, not engine sound playback.

- **Output:** select the physical audio output connected to the transmitter. After connecting a DAC, use **Refresh Audio**. The default output may change when headphones are connected; deliberately select the correct device for a permanent rig.
- **Sample rate:** the list contains 48000, 96000, and 192000 Hz. Choose a rate supported by the device; the highest entry does not prove that the DAC implements it correctly.
- **Polarity:** negative or positive. It must match the transmitter input and setting; change it with the drivetrain secured while checking the radio's channel monitor.
- **Pulse Width:** the width of the short PPM pulse, in μs . This is neither the complete frame duration nor the requested servo position.
- **Frame Time:** the complete frame duration in ms. For a prepared profile, keep the matching value and change it only when deliberately tuning it to the radio.
- **Amplitude:** audio output level, 10–100%. This is not a throttle limit. The setting affects signal recognition by the trainer port.
- **AC Diagnostic Mode: Constant 1500 μs :** when enabled, forces identical neutral pulses on all channels. In this state, the wheel and pedals cannot be used for normal testing of changing channel values.

Step-by-step test:

1. Prepare the cable and trainer port following the Tier 0 guide; do not connect the audio output directly to an ESC.
2. Select the output, a supported sample rate, and PPM settings matching the transmitter. Disable system audio enhancement/processing for this output.
3. Finish editing, connect Audio PPM in the cockpit, and observe the transmitter's channel monitor with the drivetrain secured.
4. If channels drift, enable **AC Diagnostic Mode** and check the stability of the fixed values. Then disable diagnostics before checking the wheel and pedals.
5. Change only one parameter at a time: polarity, amplitude, or pulse settings. Check the radio after each change; disconnect and reconnect the transport if necessary.
6. Confirm trainer control and the response to signal disconnection. Sound alone or an active bar in GCS does not confirm PPM reception.

If it does not work: check that the signal reaches the connected output, that the correct trainer mode is active on the radio, and that the system is not processing the signal. Do not increase amplitude, frame time, and throttle range simultaneously. Audio PPM itself does not provide GPS, IMU, or LiDAR telemetry.

Tier 1 — Arduino or RP2350, digital control to PPM

The **Tier 1 (Serial / USB)** tab contains separate Arduino and RP2350 sections. Filling in the RP2350 section does not replace selecting **RP2350 (Trainer Port)** in GCS Mode.

- **Port:** the correct USB bridge port; identify the device by connecting it and refreshing the list. The additional description next to COM helps identify the device but does not confirm the installed firmware.

- **Baud:** the list contains 9600, 57600, and 115200. The value must match the bridge firmware; do not choose it solely because it is the largest number.
- **Refresh Ports:** use after connecting the bridge or changing USB sockets.

Arduino procedure: select Arduino in GCS Mode, set its port in the Arduino section and a matching Baud rate, finish editing, then connect in the cockpit. Move one axis and check its counterpart in the transmitter's channel monitor.

RP2350 procedure: select RP2350 in GCS Mode, use the port in the RP2350 section and the correct Baud rate. Connect only after the serial monitor or programming tool has released the port. Check control and connection loss in the same way.

Expected result: the bridge receives control, the transmitter sees the correct PPM channels, and released pedals have a safe neutral position. An open-COM indicator does not confirm a signal at the bridge output.

If there is no port: check the data cable, driver, and whether the device appears in the operating system, then refresh the list. **If the port is busy:** close the serial monitor or other application. **If COM works but the radio sees no channels:** check firmware, the PPM cable, and trainer settings using the Tier 1 guide.

Tier 2 — ESP32-CAM, settings and current limitations

In GCS Mode, select **ESP32 (WiFi Lite Mode)**, then **Tier 2 (WiFi ESP32)** below.

- **Firmware Version:** the visible **Tier 2 Pro V4 (CRSF Multi-Link / MicroLink VPN)** and **Tier 2 Classic (Wi-Fi UDP / CSV Telemetry)** variants describe prepared profiles. Selecting one does not flash firmware.
- **Transmission Medium:** visible entries are Wi-Fi UDP, MicroLink VPN, ESP-NOW Link, and USB Serial Port. Selecting USB reveals COM and Baud fields; network variants show IP and port fields.
- **ESP32 / VPN IP Address:** the actual device address reachable from the computer. For local Wi-Fi, this is an address on that network; VPN use requires an independently working route to the device.
- **UDP Control Port:** the port where firmware accepts control commands. This is not the camera port.
- **Serial Port (COM), Baud Rate:** visible after selecting USB; the speed list contains 115200, 420000, and 921600.
- **FPV Camera Port:** the MJPEG service port. Below it, **MJPEG Stream Address** shows the resulting `http://address:port/stream` address; it is an address preview, not confirmation that the camera works.

Important when selecting a variant: in the verified version, the ESP32 connection operates as UDP with CSV control and JSON telemetry reception. Selecting V4, USB, or ESP-NOW in this panel does not start CRSF, a serial port, or a direct ESP-NOW transmitter, respectively. Use compatible UDP/CSV firmware for an ordinary test. Do not assume CRSF firmware compatibility merely because its name appears in the list.

UDP test:

1. Connect the computer to the correct Wi-Fi/router and ensure that you know the ESP32 address.
2. Set the variant matching the actual UDP/CSV firmware, Wi-Fi UDP medium, address, and control port.
3. For telemetry, also check **General** → **Advanced** → **GCS Listen Port**: firmware must send data to the computer's receiving port.
4. Finish editing, connect in the cockpit, and check steering and throttle in turn with the drivetrain secured.
5. Open the prepared MJPEG stream separately from the control test. A correct camera address does not prove compatibility of control commands.
6. If using VPN, first confirm a working network route; selecting MicroLink VPN does not install a tunnel on either the computer or ESP32.

If there is no response: check GCS Mode, address, UDP port, and format compatibility with the firmware. If telemetry is missing, check transmission direction, the computer's address, and its listening port. The test should end with a visible response from the actual outputs, not just movement of a bar in GCS.

Tier 3 — ELRS/mLRS: protocol first, then medium

ELRS/mLRS is the radio system; **CRSF/MAVLink** is the communication protocol. Establish which variant your transmitter and firmware provide. A compatible COM port does not convert CRSF to MAVLink by itself.

In GCS Mode, select **CRSF Direct (Standard ELRS)** or **MAVLink RF (Nomad / XR4)**. Within the Tier 3 tab, match **Transmitter Protocol**. If the main mode is already CRSF Direct or MAVLink RF, changing this field also synchronizes the main selection. If Mock remains selected, changing the protocol on the tab does not disable it.

CRSF Direct over USB Serial

1. Set **Transmitter Protocol: ExpressLRS / CRSF Direct** and **ELRS Medium: USB Serial (COM)**.
2. In **Port**, select the transmitter/dongle interface or a prepared USB-VCP transmitter; in **Baud**, select the speed of that specific connection segment. Available values include 115200, 400000, and 420000; they are not interchangeable for every device.
3. For a transmitter with USB-VCP mode, prepare its USB, trainer, and mixer settings using the Tier 3 guide. GCS does not activate the radio's trainer input for you.
4. Save the profile, connect in the cockpit, and compare GCS channels with the transmitter monitor and receiver output.
5. Check USB/PC loss and RF loss separately. A safe response on one segment does not prove that the other segment's failsafe works correctly.

CRSF over Airlink / Wi-Fi TCP or UDP

In **ELRS Medium**, select exactly **Airlink / Wi-Fi (TCP)** or **Airlink / Wi-Fi (UDP)**, then enter **ELRS Wi-Fi IP** and **ELRS Wi-Fi Port** matching the bridge service. Serial fields are hidden for this variant; Baud does not configure the network link.

First connect the computer to the bridge's network, then connect GCS. Do not switch TCP to UDP hoping it will work without changing the other end. After connecting, check control and telemetry in the same way as over USB.

RCSIM Backpack / Wi-Fi (CRWF UDP)

This selection requires modified RCSIM Backpack firmware, compatible ExpressLRS 4, **Link Mode Normal**, and EdgeTX Master/CRSF trainer configuration with TR channel mixes. An ordinary Backpack without the compatible modification is not an equivalent device.

Select **RCSIM Backpack / Wi-Fi (CRWF UDP)**, enter your Backpack's address and port, finish editing, and connect in the cockpit. Channel and telemetry transmission are provided for this path; the MSP configurator is unavailable for this medium.

After link loss or switching head tracking, disconnect and reconnect GCS, then check the channels. Rehearse this behavior on the bench before a driving test.

CRSF configuration buttons

ExpressLRS Configuration (MSP) opens the module configurator. It can use the active connection or temporarily open the selected port/transport. You do not need to arm the model to open the configurator. A free port and correct parameters are required; do not open the same COM port in another program simultaneously.

The button is unavailable for Backpack CRWF. If it does not work over USB, check the selected port; for TCP/UDP, check the device address. Opening the dialog does not confirm that the module responds to parameter requests.

Raw IMU over CRSF (0x13) opens information about the requirements for the appropriate modification. This is not a switch that adds IMU to an ordinary receiver.

MAVLink RF over a serial port

1. Select GCS Mode **MAVLink RF**, transmitter protocol **MAVLink RF (Airport / Telemetry)**, and **MAVLink Medium: Serial Port (COM)**.
2. Set the port and Baud to match the PC–radio segment. Set **SysID** to the target vehicle/controller identifier, not an arbitrary radio module identifier.
3. Connect in the cockpit and check that the correct vehicle and expected measurements are being received.
4. Only after connecting, open **FC parameters (MAVLink)**. The editor uses the working transport; the button does not open a separate connection to an arbitrary port.
5. Read parameters before writing changes and check the write confirmation. Do not change motion or safety parameters while driving.

MAVLink Airport over TCP or UDP

- **MAVLink Medium:** select Airport Wi-Fi TCP or UDP to match the bridge.
- **MAVLink Airport IP:** the bridge address reachable from the computer, not the address of a configuration page on another network.
- **Airport Port** for TCP or **Destination Port (Backpack Listen Port)** for UDP: the port to which GCS sends data to the bridge.
- **Local UDP Port (Backpack Send Port):** the receiving port on the computer. **Automatic / 0** leaves selection automatic; if the Backpack sends to a fixed computer port, set the correct number.
- **SysID:** the identifier of the correct MAVLink vehicle.
- **ArduPilot telemetry profile (saves bandwidth):** optional message-rate configuration after confirmation by a compatible FC; requires support from ArduPilot 4.0 or later. It is not a universal way to speed up a radio.

UDP direction example: if the bridge listens on 14555 and transmits to the PC on 14550, enter 14555 in the destination field and 14550 in the local field. These are example values: they must match both devices' configuration. Do not enter 14550 in both fields just because it commonly appears in MAVLink guides.

After connecting, check both telemetry reception and control transmission. If telemetry works without control, check the destination port and SysID; if control works without telemetry, check the local port, the PC receiving address, and the firewall. The MAVLink configuration help button explains the requirements of a compatible setup.

Betaflight / INAV (MSP USB) and HYBRID

Betaflight / INAV (MSP USB) in GCS Mode is a separate MSP serial connection. It uses the prepared FC port and speed rather than switching the radio to CRSF. Close other configurators occupying COM, connect, and check controller identification and sensors.

HYBRID (Prefer ELRS + VPN Backup) requires both paths to be prepared: radio MAVLink over a serial port and WebRTC to Raspberry Pi. Enter the radio port/Baud/SysID and RPi address. Selecting HYBRID does not create a VPN or start Pi services.

Test MAVLink RF and WebRTC separately first. Only then check hybrid operation and controlled loss of each path. Do not treat the word “backup” as confirmation of working switchover on your model; verify channel response and recovery time on the bench.

Tier 4 — Raspberry Pi: RPi UDP or WebRTC

In GCS Mode, select **RPi UDP (Network Telemetry)** or **RPi WebRTC (Video + Data)**, then the **Tier 4 (Raspberry Pi)** tab.

- **IP:** the Raspberry Pi address reachable from the computer, either local or accessible through a prepared VPN network.
- **Port:** the RPi service port; this field is read-only on this tab. Do not look for a way to type another number into the greyed-out field.
- **Protocol** at the top: for RPi UDP, match NATIVE or MAVLINK to the actual service configuration. This choice does not automatically convert the entire WebRTC environment.
- **Send config to RPi:** sends a mode/protocol change request over an available channel. It does not install services, establish a missing connection, or replace confirmation from the Pi.
- **Custom IP address / Stream URL:** enables a custom video source, such as an IP camera or phone.
- **Custom Video IP/URL:** enter a complete working RTSP/HTTP address or the appropriate device address. A full URL preserves its own path and port.
- **URL Preview:** shows the addresses resulting from the entry; it does not check whether the server actually works.

RPi UDP procedure: start a compatible vehicle service, set IP and the correct Protocol, finish editing, then connect in the cockpit. Check fresh measurements and control outputs. If data must reach a specific PC port, also check **General** → **Advanced** → **GCS Listen Port** and the Pi configuration.

WebRTC procedure: ensure a working WebRTC service on the Pi and a reachable address, select RPi WebRTC, and connect in the cockpit. Check the data channel and video separately. Selecting a camera address does not replace the control service.

Custom video: for a camera with a separate address, enable the custom stream and enter the full URL. Select the appropriate video source in the cockpit. Test it without arming the model; changing the camera should not be a way to fix missing telemetry.

If there is no connection: check the service, address, network/VPN, and protocol compatibility. **If URL Preview looks correct but the image is black:** check the actual camera service, stream path, and selected video source. **If data drops out:** do not rely solely on the last displayed value; check sample freshness.

PWM & MAVLink Channels — neutral AUX values and output to another station

This tab does not select the vehicle connection. It separates auxiliary-channel neutral values from optional MAVLink UDP telemetry forwarding to an external program.

- **CH3–CH8:** neutral auxiliary-channel values in μs , ranging from 800–2200. Match them to the receiver functions; 1500 is not a universal OFF state for arming, a switch, or a selected mode.
- **Enable MAVLink UDP telemetry forwarding:** enables additional telemetry output, for example to Mission Planner or QGroundControl. This is not the same as GCS Mode MAVLink RF.
- **IP Target:** the address of the computer receiving telemetry. 127.0.0.1 means the same computer on which GCS is running.
- **UDP Port:** the receiving program's listening port, for example 14550 only if that program is configured accordingly.

- **Vehicle Type:** Rover / RC Car, Quadrocopter / Drone, or Boat / Surface Boat. Select the type matching the vehicle being represented.
- **SysID:** the identifier used by this additional telemetry output. Do not confuse it with the radio target set on the Tier 3 tab.

Test: set and check AUX with the drivetrain secured, then start the telemetry receiver, enter its address and port, and enable the output. Success means fresh data in the second program. A missing integration here does not require changing the main control transport.

SimHub & Simulator — rig telemetry and demonstration

Enable SimHub starts an additional telemetry integration. It does not connect to a real vehicle and is not the Thanos platform connection button.

- **IP, Port:** the integration receiver's address and port. For an application on the same computer, you normally use a local address; the port must match its settings.
- **Forza Port:** the output port for the Forza format, matched to the receiver.
- **IMU Units:** auto, g, or ms2. Match the data; if g-force readings are wrong by a factor of ten, check the unit before adjusting the scale slider.
- **Protocol Format:** FH5, FM7, both Forza formats, or AC. Match the receiving program; enabling both formats does not fix an incompatible port.
- **AC Server Address, AC Server Port:** for AC, these define the server listener to which the client must connect and subscribe to telemetry. This operates differently from simply sending Forza UDP.
- **Acceleration Scaling, Gyroscope Scaling:** overall data multipliers. Start at 1.0 to avoid masking a unit problem.
- **Sway, Heave, Surge:** the influence of lateral, vertical, and longitudinal components, respectively; separate inversion switches change their sign.
- **Start Simulator, Stop Simulator:** operate the internal simulated RPi platform. They are separate from GCS Mode **Test Mode (Mock)** and the **Simulator (DonkeyCar)** integration.

SimHub test: confirm actual GCS data first, start the receiver, match the format and ports, then enable the integration. Observe output data with actuators disabled or safely limited. Change sign and scale one at a time.

Testing without a vehicle: select **Test Mode (Mock)** to explore the interface with example data. Do not present the displayed readings as measurements from a real model. **Simulator (DonkeyCar)** requires a prepared external simulator; the internal simulator buttons do not install it or locate its executable.

Sim Center (Rig LAN) — a rig connected to a host

Use this tab on the operator's computer when a central Sim Center host assigns a vehicle to it. In GCS Mode, select **Sim Center Client (Rig Client LAN)**.

- **Host IP Address (Race Control):** the administrator computer's address. 127.0.0.1 works only if the host runs on the same computer.
- **UDP Port:** the host port agreed with the administrator, independent of radio and camera ports.
- **Rig ID:** a number from 1–32 matching the administrator's assignment. Two rigs should not accidentally use the same assignment.
- **Transmission Rate:** selecting 100, 200, or 250 Hz sets input transmission frequency, not a guarantee of total system latency.
- **Automatically switch video when changing cars:** allows the image to follow the assigned vehicle.

- **LAN Video Protocol:** WebRTC (WHEP) or RTSP (H.264/MJPEG), matching the host service.
- **Camera URL Template:** an address containing {host_ip} and {slot_id}, for example a scheme prepared by the administrator for successive cars. Do not remove these placeholders if switching is intended to depend on assignment.

Procedure: agree the host, port, Rig ID, and video format, finish editing, connect in the cockpit, and ask the administrator to assign a car. Before starting, check that the wheel moves the correct model and that the camera shows that same model. Repeat a brief check after an assignment change.

If there is no response: check that the host is running, the Rig ID is correct, and LAN communication works. **If you control a different car from the one you see:** stop the test and check the assignment and video template; do not start a session based solely on a working UDP connection.

Final check after every connection change

The saved profile has the correct GCS Mode, device, and addresses. After reconnecting, channels have not been swapped; released pedals do not request motion. The receiver actually responds, telemetry is fresh, and video comes from the correct model. Connection loss and safe recovery have been tested on the bench. Only this complete set of checks allows you to move from configuration to driving.

Steering wheel and FFB — detailed operation

The **Configuration** → **Steering Wheel FFB** panel adjusts wheel resistance, centering and effects derived from vehicle telemetry. Force Feedback acts on the operator's device. It does not adjust the model's steering servo force or throttle limits.

Configure the steering axis, pedals and control directions first. A wheel that works correctly as a USB controller does not necessarily support FFB forces. The wheelbase also needs power, the correct driver and support for the requested effects.

Readiness information

The message at the top of the panel distinguishes three situations:

- **FFB disabled** — the main effects switch is off.
- **FFB ready via SDL/DirectInput. Manufacturer SDK is not required** — the application has found a device capable of producing force; the message may include its name.
- **No ready FFB device** — check the driver, USB connection and wheelbase power. Increasing the sliders will not resolve this state.

Readiness applies to the FFB output path. It does not confirm fresh telemetry, the correct force direction or support for every conditional effect. The status refreshes periodically, so wait briefly after connecting a device; if it does not change, restart the application.

Steering wheel parameters

Maximum Rotation Angle (Steering Range) accepts **90° to 2520°**, in **10°** steps. This is the total rotation range: 900°, for example, means approximately 450° from center in either direction. Match it to the wheelbase settings and axis calibration.

The field saves a shared range for the Moza, Fanatec and Logitech configurations. Automatically applying the physical range still depends on a working integration for the particular device. Do not assume that entering a number creates a hardware rotation stop on every wheel. After saving, check the center and both axis endpoints; if necessary, set the same range in the manufacturer's software.

Enable manufacturer SDK add-ons (after restart) enables optional manufacturer integrations the next time GCS starts. Basic forces still use SDL/DirectInput. Add-ons provide supporting features such as reading selected accessories, rotation range, LEDs or the display.

Start with add-ons disabled. If you need a manufacturer feature, enable the option, save and restart GCS. If access to the wheelbase becomes unreliable, return to the configuration without add-ons and repeat a short FFB test.

Use native H-pattern Shifter (Moza SDK) saves the choice to use native support for the Moza H-pattern shifter. It requires the appropriate accessory and an available SDK integration. The option alone does not assign gears to channels or replace control mapping and gearbox configuration. After enabling it, check recognition of each shifter position separately.

Enable ITM (Intelligent Telemetry Mode) [Fanatec] concerns supplementary Fanatec device telemetry. In the checked application workflow, it can update the rev LEDs and display using RPM/speed data when the integration is initialized. It is neither a requirement for basic FFB nor a way to enable vehicle sensors.

Enabling FFB and running a short test

Enable Force Feedback (FFB) is the main force-output switch. Turning it off stops the effects controlled by the application. The settings remain visible and can be prepared before enabling FFB again.

Test FFB (0.8 s / 5%) checks the wheel without a vehicle connection or telemetry. The test applies a short pulse in one direction, pauses, then applies a pulse in the opposite direction. Each phase lasts approximately 0.25 s; the complete test takes approximately 0.75 s. The button label rounds this to 0.8 s.

The test uses up to 5% force, further limited by the current **Gain**. This is not 5% expressed in newton-meters or an identical perceived force on every wheelbase. During the test, spring, damper, friction and inertia are set to zero; afterward, the application restores the current settings without another test pulse.

The test requires FFB enabled, a ready device and a positive Gain value. It will not start with **Gain = 0**. The button is temporarily disabled while the test runs. The message **FFB test running...** does not replace physically observing the wheel.

Before the first test:

1. Secure the wheelbase and leave clear space around the rim; prevent the vehicle from moving.
2. Limit maximum force in the wheelbase settings or software, particularly for Direct Drive.
3. Set a low positive Gain, for example 5–10, and set the additional effects to zero.
4. Enable FFB and check the readiness message.
5. Run one test; expect two short, opposite pulses separated by a pause.
6. If the test is too strong or behaves unpredictably, disable FFB and reduce the wheelbase limit before trying again.

A successful test confirms the force-output path to the device. Assessing IMU effects requires a subsequent driving test and a telemetry check.

Five force-effect sliders

All the sliders below range from **0–100**. They are relative effect settings, not torque values in Nm. **Gain** scales the other effects, so a high individual slider setting may feel weak when Gain is low.

- **Overall Strength (Gain)** — overall force amplification. A value of 0 silences the output; 100 means the full level requested by the application, still subject to the wheelbase settings and capabilities. Start with this slider when reducing excessively strong FFB.

- **Centering (Spring)** — force that returns the rim toward center. Increase it if the wheel feels too loose, but do not use centering to hide an axis-calibration error. Excessive spring force makes subtle telemetry changes harder to feel.
- **Damping (Damper)** — resistance to wheel movement. It helps limit rapid oscillations; too much makes the wheel feel heavy and slow. During dynamic effects, the application may reduce damping by 10 points when the force signal is very strong.
- **Friction** — resistance while moving the wheel, providing a sense of mechanical friction. A high value can mask weaker impulses and make small corrections difficult.
- **Inertia** — the rim's inertia effect, subject to device support. If the driver does not support it, the application skips it; a lack of change after adjusting this slider does not necessarily mean all FFB has failed.

When a device lacks native spring, damper or friction effects, the application can reproduce them using constant force based on wheel position and movement. They may then feel different from the wheelbase's native effects. There is no equivalent fallback for unsupported inertia.

Do not enable strong centering in both the wheelbase and GCS without checking their combined effect. During tuning, change one effect at a time and compare the same short test.

Four IMU haptics sliders

These settings are **multipliers**, without a physical unit. The displayed value changes in **0.1** steps. They do not change the sensor scale and should not be used to compensate for incorrect telemetry units.

- **IMU Sensitivity (Haptic Mult): 0.0–5.0** — amplifies additional impulses caused by changes in acceleration. A higher value emphasizes bumps but can also amplify noise. Setting it to 0 silences this component without zeroing the separate ay, gz and az multipliers.
- **Lateral Acceleration Multiplier (ay): 0.0–20.0** — contribution of lateral acceleration to directional wheel force. Increase it only after checking the IMU axes and mounting; incorrect orientation can pull the wheel in the wrong direction.
- **Yaw Rate Multiplier (gz): 0.0–10.0** — contribution of vehicle rotation about the vertical axis. It affects responses during cornering and oversteer. Too high a setting can produce abrupt countersteering and mask other effects.
- **Vertical Multiplier (az): 0.0–100.0** — contribution of vertical acceleration changes to short wheel jolts. It amplifies bumps detected by a real accelerometer. It cannot produce bump measurements when the telemetry contains only vehicle orientation.

Acceleration is converted to m/s^2 and angular velocity to degrees per second. The application separates gravity from motion, so a stationary tilted vehicle should not be treated as a continuous lateral force. Correct units, axes and fresh data are still required for the correct result.

Lateral force increases with the available speed measurement, from zero at rest to full scale at approximately **1.5 m/s, or 5.4 km/h**. This applies to that component, not every possible resistance or impulse. If speed is unavailable, the application does not automatically interpret this as a stationary vehicle; IMU effects may remain active.

Full IMU data versus orientation transmitted over CRSF

Full accelerometer and gyroscope telemetry supports lateral force, rotation and bump effects. **CRSF attitude** data describes orientation instead: roll, pitch and heading angles alone are not measurements of linear acceleration.

For orientation-only telemetry, the application disables simulated accelerometer bumps and derives limited angular-motion effects from consecutive samples. This path limits its force component to 20% before overall Gain. Do not expect the az multiplier to behave identically to a real IMU.

When IMU data becomes stale, the application stops dynamic effects instead of turning a remembered tilt into constant force. Effects also fade out when updates stop, and the driver limits how long an individual effect is held. Force disappearing after telemetry loss is expected; do not compensate by increasing Gain.

Recommended vehicle-tuning order

1. Confirm the short hardware test without telemetry.
2. Disable vehicle propulsion, connect telemetry and check its source, units and freshness in Diagnostics.
3. Set a low overall force; add only a small amount of spring and damper. Initially leave the other effects at 0.
4. Run a controlled low-speed test. Add ay and gz separately, comparing the direction of the force you feel with the vehicle's maneuver.
5. If actual acceleration measurements are available, gradually add az and Haptic Mult, then drive over a small, known bump.
6. Adjust friction and supported inertia last. Excessive baseline resistance can drown out information from the vehicle.
7. Check disabling FFB and its behavior when telemetry is disconnected. Save the configuration after a stable test.

Do not interpret IMU forces as measurements of actual torque at the steering knuckle. They reproduce information from vehicle motion and depend on sensor mounting, surface type and data frequency.

Saving and restoring settings

Apply and Save transfers the panel settings to the configuration and starts saving. Slider changes may take effect immediately and trigger automatic saving, so keeping your hand away from the Save button does not mean the rim cannot respond while you edit settings.

Reset to defaults sets: angle **900°**, FFB enabled, **Gain 100**, **Spring 50**, **Damper 30**, **Friction 10**, **Inertia 20**, **Haptic Mult 1.5**, **ay 8.0**, **gz 1.5**, **az 25.0**. It also enables the native H-pattern shifter and ITM options. It does not reset the manufacturer SDK add-ons selection.

These are the application's reset values, not a safe starting profile for every wheelbase. Because resetting increases Gain to 100, limit force in hardware and secure the rim before using it. After resetting, check the settings before a test or drive.

Troubleshooting

- **Axes work, but FFB status is not ready:** check wheelbase power, the manufacturer's driver and a direct USB connection; controller input and force output are separate functions. Close other applications using wheel forces and restart GCS.
- **The test will not start:** make sure FFB is enabled, Gain is greater than 0, the device is ready and the previous test has finished.
- **The test works, but driving produces no effects:** check IMU telemetry and its freshness. Confirm whether you have full acceleration data or only CRSF orientation; at a measured speed of 0, directional lateral force is muted.
- **Constant pulling while stationary:** check axis calibration and center, IMU orientation, units and the availability of a correct speed measurement. Do not hide the problem with strong Spring.

- **The rim oscillates:** lower Gain and the ay/gz multipliers, check axis signs, then adjust damping. Do not increase all effects at once.
- **Bumps are too aggressive:** reduce az and Haptic Mult; check IMU noise and mounting. When a strong signal is constantly limited, increasing Gain does not increase the information it carries.
- **Inertia makes no difference:** the device may not support this effect. Check diagnostic messages; other effects may still work correctly.
- **The wheelbase keeps its old range after an angle change:** check the setting in the manufacturer's software, SDK integration availability and a GCS restart. Then verify axis calibration.
- **Force fades out after connection loss:** this is expected protective behavior. Restore a valid telemetry stream instead of increasing force.

When reporting a problem, note the wheelbase model, driver version, FFB status text, telemetry transport, short-test result, and Gain and multiplier settings. This helps distinguish a device issue from missing vehicle data.

Assigning controls — detailed operation

Configure controls in this order: channel definitions, device mapping, dead zones, Expo curves, then a cockpit check. Keep the model disarmed and its propulsion secured. First save a separate copy of the vehicle profile to preserve the previous settings.

The channel, its function and the physical controller

A channel is an output control value, such as steering-servo position. Its definition specifies how that value is calculated and which values are allowed. Mapping answers a different question: which physical axis or button controls it? Naming a channel “Steering” does not assign a steering wheel to it. Likewise, detecting the wheel axis does not automatically select a receiver output number.

CH numbers must match the vehicle, transmitter and receiver configuration. CH1 for steering and CH2 for throttle is an example, not a mandatory layout for every model. Also check the channel functions saved in the vehicle profile so automation and driving functions refer to the correct outputs. Do not attempt to change channel numbers merely by swapping names.

GCS displays 16 channels, but the selected bridge may transmit only eight. Check your connection's capabilities before assigning a function to CH9–CH16. After changing a channel's type, check its mapping again: the number of available actions may change.

Channel Definitions

Each channel card contains **Name**, **Type**, and fields specific to that type. Choose a name that will be clear during mapping, such as “Steering”, “Drive” or “Lights”. After editing a text field, confirm it with Enter or move to another field.

- **Axis (Bidirectional — e.g. Steering):** input position corresponds to output position. **Min** and **Max** set the channel endpoints. This is the typical choice for a wheel axis that returns to center.
- **Split Axis (Unidirectional — e.g. Throttle/Brake):** two separate inputs, throttle and brake, control one drive channel. **Min (Brake)** sets the braking side, **Max (Throttle)** the driving side, and **Center** the value when both pedals are released.
- **Incremental Axis (Rate Mode):** input deflection changes position gradually instead of setting it directly. **Speed (us/s)** sets the rate of change, while **Min/Max** set its limits. When the input returns to center, the output retains its reached position.

- **Switch (ON/OFF)**: successive presses toggle the state. **OFF/ON Values** sets the two channel values. Releasing the button does not itself undo the toggle.
- **Momentary Switch**: the active value applies while the button is held. **Default/Active** sets the released and pressed values.
- **Multi-position Switch (Cycle)**: one button cycles through the positions. Enter a list of integer values, such as 1000, 1500, 2000. Commas separate positions; do not enter percentages or units.
- **Multi-position Switch (Separate Buttons)**: each position in the same list has its own action to assign. The last selected position remains active after the button is released.

Channel-value fields allow settings from 800–2200 μ s. This does not mean the servo, ESC and entire transport can safely support the whole range. Start with device-compatible values and limit travel before testing under load. 1500 μ s is a common center value, but is not a universal stop command for every ESC. Keep minimum, center and maximum in a logical order.

Control Mapping — table controls

Action identifies the function to which you are assigning an input. A split axis produces two rows labeled **Throttle** and **Brake**. Separate-button multi-position channels produce one row for each position and its value. The list also contains actions such as **Gear Up**, **Gear Down**, **Gear (Shifter ABS)** and **Arm / Disarm (ARM)**. These are application functions; do not confuse them with an arbitrary AUX channel bearing a similar name.

Assignment shows the recognized device, input type and index. **Type** defines how the physical axis is interpreted: **Bidirectional** for an input that moves both ways from center, **Unidirectional** for a pedal that moves from released to fully pressed. This differs from the output-channel type in Channel Definitions. **Invert** reverses the response direction of the assigned input. **Assign** starts device detection. **Save Mapping** confirms the current assignments.

Use **Assign** to add or change inputs. Do not assume that selecting text in the Assignment list alone changes active control. Test the channel after every change, then save the mapping and profile.

Identify the devices first

Open **Controller Diagnostics** on the right. Each device has its own axes, buttons and, where applicable, **Hats** or **Gears** groups. Axis bars show values of approximately –100 to +100; these are input readings, not output microseconds. Axis 0 or Button 0 is a device index, not channel CH1.

1. Move only the wheel and identify the device name and the axis number that changes.
2. Press only the throttle, then only the brake. Check whether different axes change.
3. Note each pedal's resting position and direction of change.
4. Press the buttons you plan to use and check their indicators.
5. If this panel already shows no response, check the driver and device before mapping.

The wheel, pedals and shifter may be three separate USB devices. They need not share a name or axis numbering. Recheck assignments after changing the USB port or driver mode.

Assign the steering wheel

1. In Channel Definitions, choose the steering channel and **Axis (Bidirectional)**.
2. Name it “Steering” and set **Min/Max** appropriately for the servo and mechanism.
3. In Mapping, find that channel's action and select **Type: Bidirectional**.
4. Click **Assign** without moving the pedals or other controllers.
5. Turn the wheel clearly in one direction. The dialog closes automatically after detection.

6. Check that the assignment contains the correct device name and axis index.
7. Watch the channel in the cockpit: the centered wheel should correspond to neutral steering.
8. Check both endpoints. If the direction is reversed, change **Invert** and repeat the test.

The wizard may automatically select Invert after detecting movement in a negative direction. Always check that field after assignment rather than assuming its state. Do not reverse several settings simultaneously in the driver, GCS and receiver: make one change at a time and check its result.

Two separate pedals → one ESC channel

1. Set the drive channel to **Split Axis**.
2. Set **Center** to the ESC's neutral signal, with appropriate **Min (Brake)** and **Max (Throttle)** values.
3. In Mapping, find the two rows for that channel: **Throttle** and **Brake**.
4. Select **Type: Unidirectional** for both.
5. Click **Assign** beside Throttle and press only the throttle pedal.
6. Click **Assign** beside Brake and press only the brake pedal.
7. Release both pedals and check the channel's neutral value.
8. Press the throttle: the channel should move from center toward Max when a forward gear is selected.
9. Press the brake: the channel should move from center toward Min.
10. If a pedal works backward, correct **Invert** in that pedal's row only.

In this mode, throttle and brake do not create two independent servo outputs. Braking takes priority when both pedals are pressed. Gearbox position affects the result: neutral holds Center, while reverse swaps the output sides used for throttle and braking. Gear power limits may also restrict the range reached with the throttle. If throttle does not change the output despite a correct pedal reading, check the current gear and gearbox profile.

Other pedal configurations

If throttle and brake must control separate vehicle outputs, define two separate channels compatible with its electronics and assign the appropriate axis to each. For a standard axis channel with a unidirectional input, rest corresponds to minimum and full depression to maximum; do not automatically assume a 1500 μ s center.

If both pedals move one shared axis in the controller monitor, the driver is exposing combined-axis mode. Do not assign it as two independent split-axis pedals without checking its behavior. If the hardware allows it, enable separate axes in the device settings and identify them again. Alternatively, use the shared axis as a bidirectional input to one channel, after confirming its center, direction and behavior when both pedals are released.

Buttons, lights, positions and arming

1. Choose the channel intended for the function and the appropriate switch type.
2. For a light toggled by successive clicks, choose **ON/OFF** and set its OFF/ON values.
3. For a function active only while held, choose **Momentary Switch**.
4. For one button cycling through several states, choose **Cycle** and enter the values.
5. For a separate button for each position, choose **Separate Buttons**.
6. Go to Mapping and click **Assign** beside the appropriate action or each position.
7. Press only the intended button; then check pressing and releasing separately.

Do not move axes while assigning buttons. Accidental movement may assign an axis instead of a button. The wizard skips inputs already assigned to other actions to reduce accidental duplicates. If a button is not detected, check whether it already has another assignment. Do not treat a Momentary Switch as a latching safety switch.

Assign **Gear Up** and **Gear Down** to separate paddles or buttons if you want to change the application's gear sequentially. **Shifter ABS** is the direct gear-selection action for a compatible shifter. Assign **Arm / Disarm (ARM)** to an unmistakable button. This does not replace checking how disarming behaves with the actual connection and vehicle.

If the wizard waits for a larger movement

The assignment dialog shows the last device's name, input type, index and value. Move only the intended input to confirm what has been detected. For small movements, such as a load-cell pedal, a **Confirm detected controller** button may appear. Check its description and use it if it identifies the correct input. **Cancel** closes the wizard without accepting the new assignment. Do not exceed the pedal's normal operating force merely to complete detection.

Dead Zones — input range and target value

Each channel has a reading bar, a zone list and three fields: **Min**, **Max** and **Target**. Values are entered in microseconds, not percentages. A zone means: when the calculated channel value is between Min and Max, replace it with Target. The red area on the bar shows the zone; the orange line shows its target.

1. Release the wheel and note small channel fluctuations near center.
2. For example fluctuations of 1495–1505 μ s, enter **Min: 1494, Max: 1506, Target: 1500**.
3. Click **+** to add the zone. This is an example to adapt, not a recommendation for every wheel.
4. Check output stability and the response to a small steering movement beyond the zone.
5. If the initial movement has become too large, narrow the zone.
6. To replace a zone, select it, remove it with **–**, adjust the fields and add the new zone with **+**.

Clicking a list entry fills the fields with its values. Editing the fields alone does not replace that entry; **+** adds another one. Min, Max and Target must be within 1000–2000 μ s, and Min must be less than Max. Avoid overlapping zones: if several match, the first in the list takes effect. Target should match the intended device state, such as neutral steering. Do not use center as the target for a pedal whose correct resting position is minimum.

The bar shows the channel value before it is replaced by the zone target. It may therefore still show small fluctuations even when the cockpit output is stable. Compare both views to judge the result; a dead zone does not change the controller's raw reading.

Expo Curves — sensitivity and smoothing

Each channel has **Expo**, **Smoothing** and a curve preview. **Expo = 1.0** gives a linear response. A value above 1.0 softens the response at small deflections; a value below 1.0 makes the beginning of the movement stronger. The Expo field ranges from 0.1–5.0. This is not an Expo percentage as used by some transmitters.

Smoothing = 0.0 disables this smoothing. Higher values, up to 0.95, average changes more strongly and delay the response to rapid movement. Smoothing does not replace correct calibration or the correct neutral position. For a split axis, the channel setting applies to both components: throttle and brake.

1. First check control with Expo 1.0 and Smoothing 0.0.
2. Increase Expo in small steps if you need a gentler initial steering or pedal response.

3. Compare small, medium and full deflections, and the return to neutral.
4. Add a small amount of smoothing only if you need to damp rapid changes.
5. After every change, also check how quickly throttle releases and braking responds.

The curve shows the response characteristic, not a measurement of the complete model's latency. Expo will not fix swapped throttle/brake assignments or an incorrect axis direction. Resolve assignment problems first, then adjust control feel.

Final check and common problems

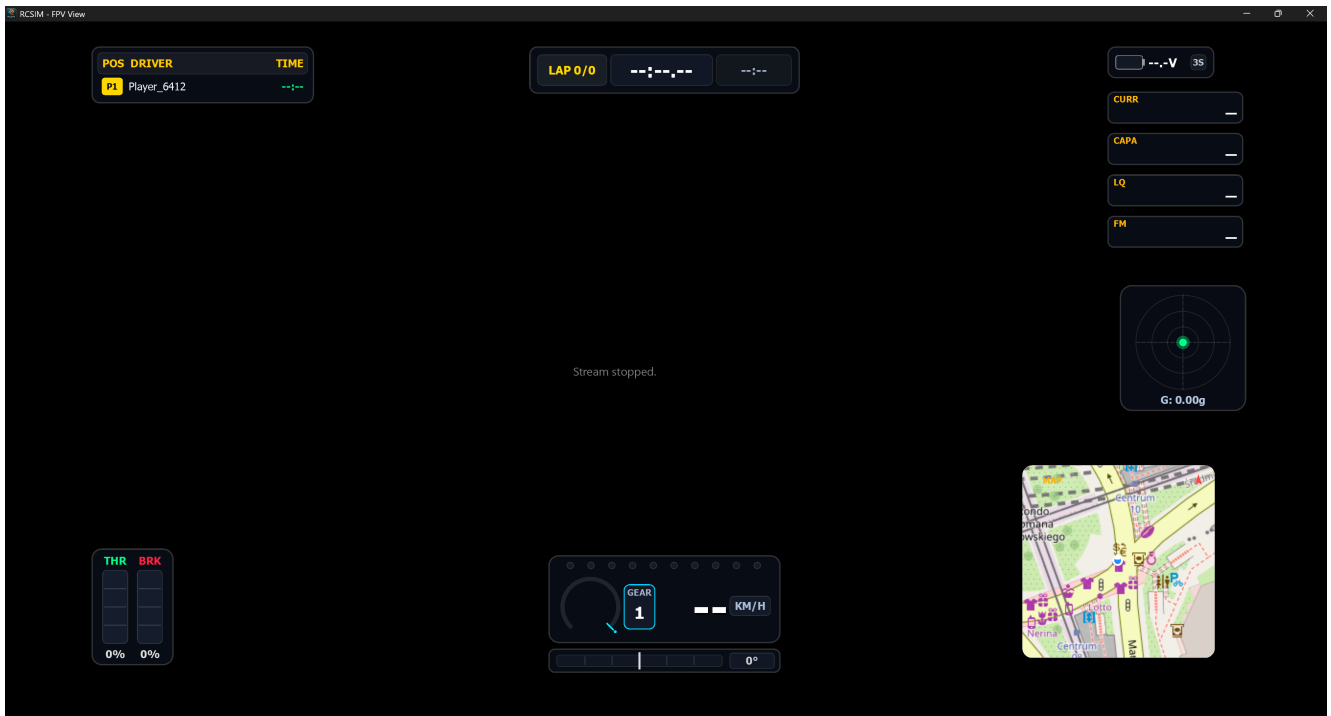
Save the mapping and vehicle profile after completing the changes. Close the wizards, return to the cockpit and check all channels with propulsion secured. Test in order: left steering, center, right steering, throttle, throttle release, brake, brake release, buttons and gear changes. Confirm that each function changes only its intended output. Finally, load the saved profile and repeat a short test to check that the settings persist.

- **No response in Controller Diagnostics:** check USB power, the driver and device mode.
- **The input monitor responds, but the channel does not:** check the correct action, channel type, assignment and active profile.
- **Throttle remains at Center:** check neutral gear and split-axis mode.
- **A pedal activates when released:** check the unidirectional input type and Invert.
- **The wheel works in the opposite direction:** correct Invert for its action, then check both endpoints.
- **The wizard selects the wrong device:** cancel, stop moving other inputs and assign it again.
- **A button cannot be detected:** check existing assignments and its indicator in the monitor.
- **A pedal is missing after changing the split axis:** assign the two new Throttle and Brake rows separately.
- **The channel jumps near center:** check raw input, then use a narrow dead zone with the correct target.
- **The channel responds too slowly:** reduce Smoothing and check travel or power restrictions elsewhere in the settings.
- **Full throttle does not reach Max:** check the gear, power limit, physical pedal range and ESC configuration.
- **CH9 or higher does not reach the model:** check how many channels the selected transport transmits.

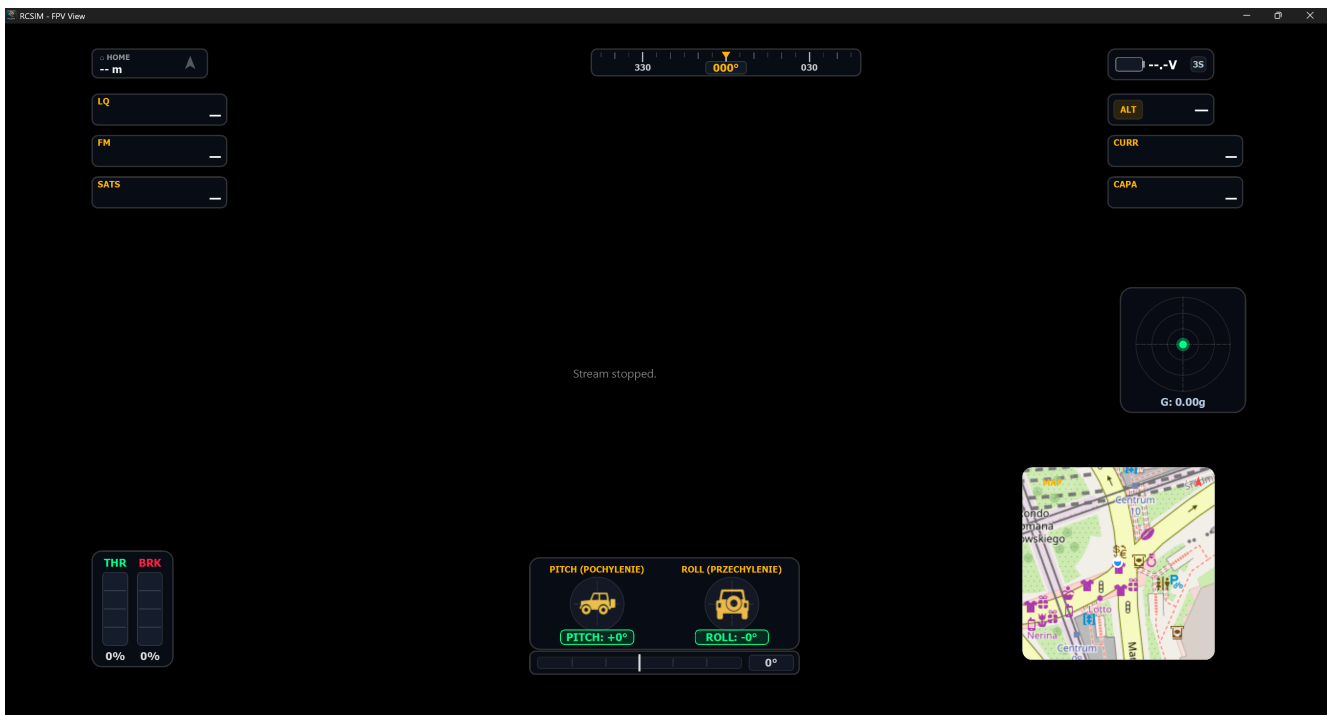
Testing the bars in GCS confirms the application configuration. Separately check receiver, servo and ESC responses, and behavior after loss of the controller or connection.

6. FPV video and OSD selection

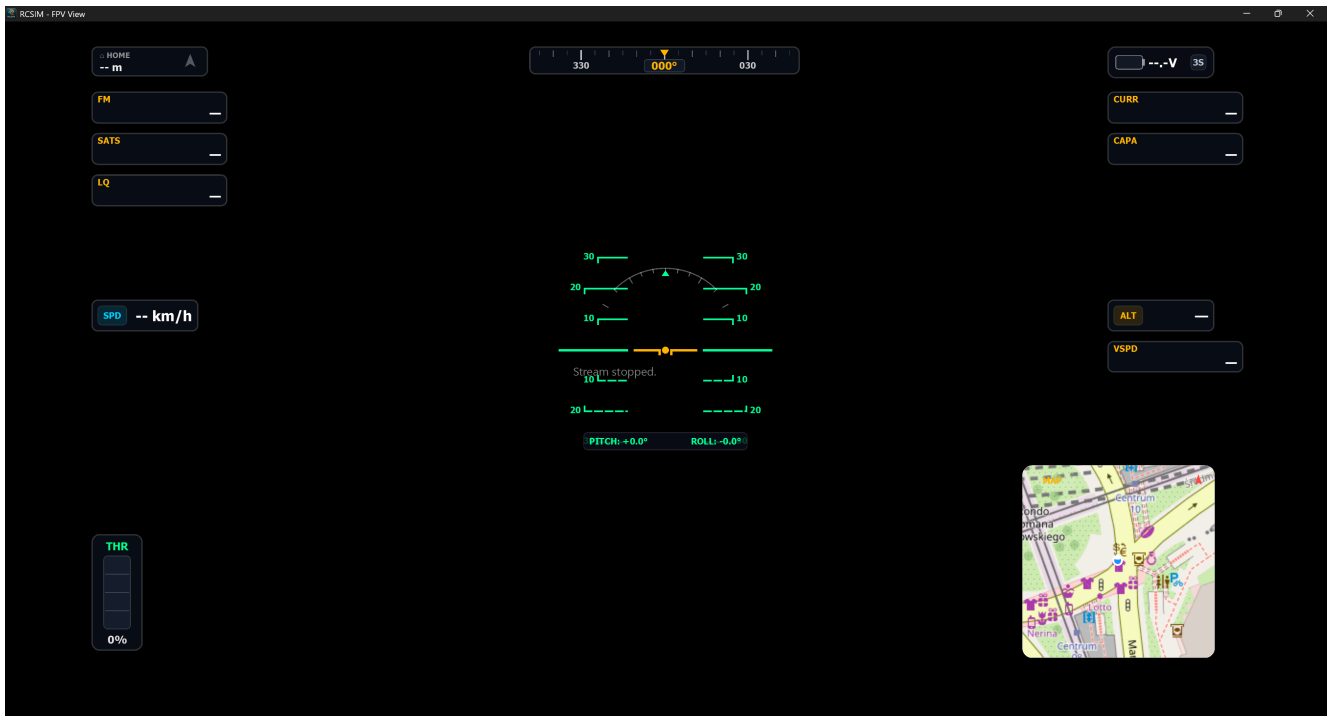
- **Video Source** specifies the image source, **OSD Profile** the instrument layout, and **Launch FPV Window** opens a separate window for camera-based driving.
 - **Disabled** turns off the OSD overlay. The instrument layout does not change vehicle equipment.
1. Specify the configured source in **Video Source**.
 2. Select an **OSD Profile** layout suited to your driving needs.
 3. Press **Launch FPV Window** and check the video and data freshness.
 4. Compare voltage, speed and position with the vehicle's actual state.



Track-driving OSD: times, pedals, gear and minimap

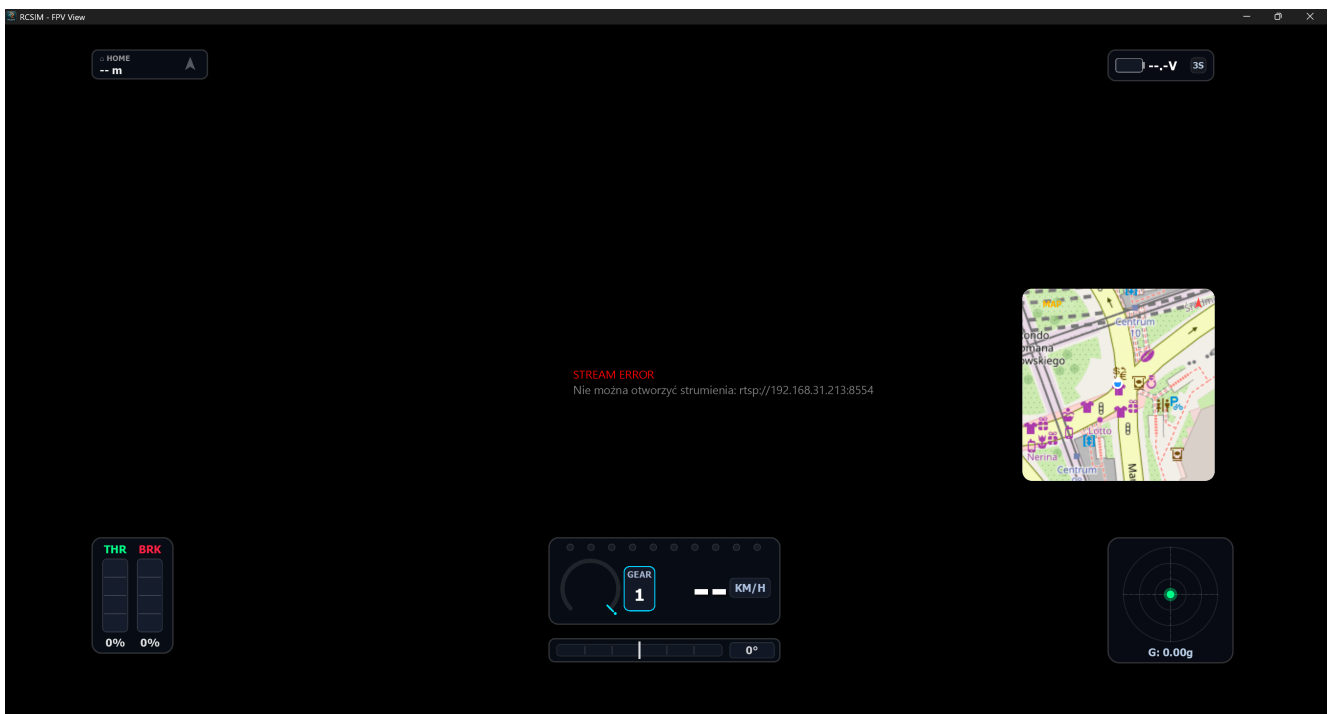


OSD with vehicle roll and pitch



OSD with horizon and aviation instruments

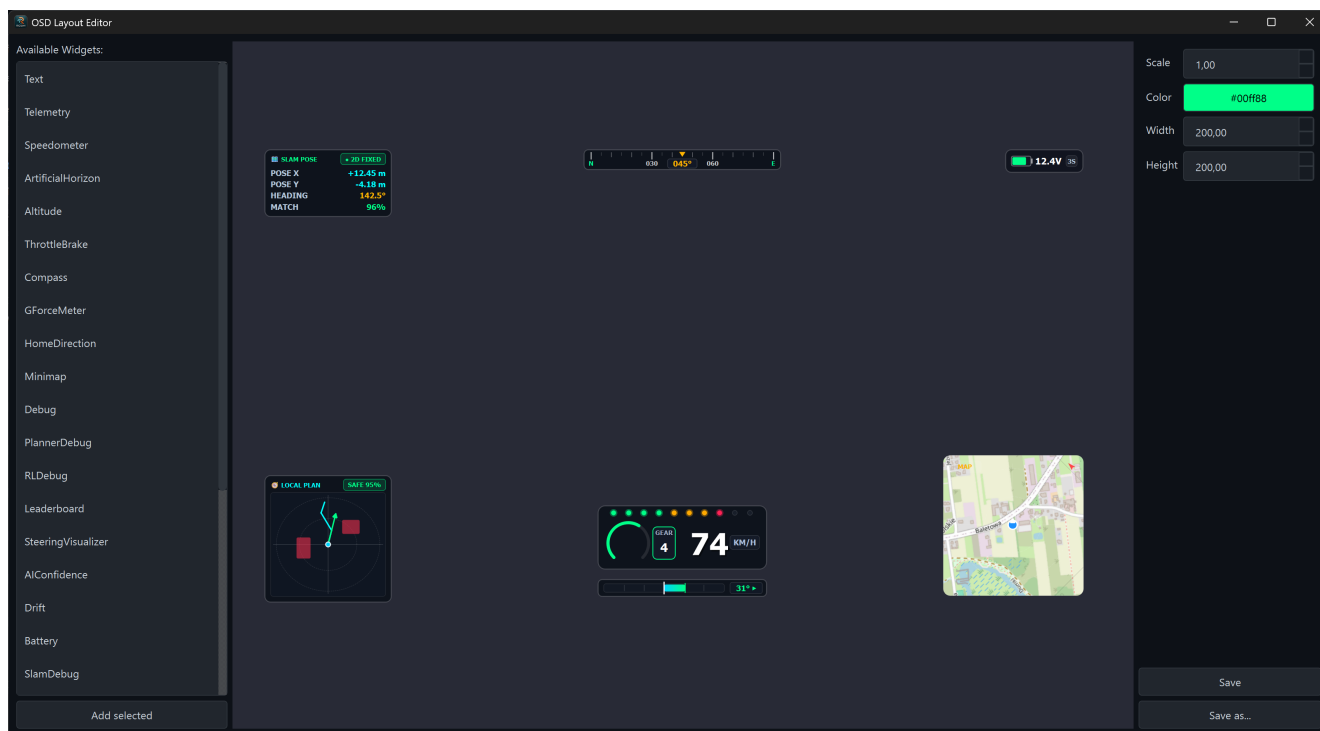
In these illustrations, **Stream stopped.** means the stream is stopped. A black background alone should not be interpreted as a camera failure. Dashes indicate an unavailable displayed reading; they are not a measurement of zero.



Example STREAM ERROR message with the address of a stream that did not open

For **STREAM ERROR**, check the source address, camera availability and network. If OSD works but video does not, diagnose the video source separately from telemetry.

Edit Layout — your own instrument layout

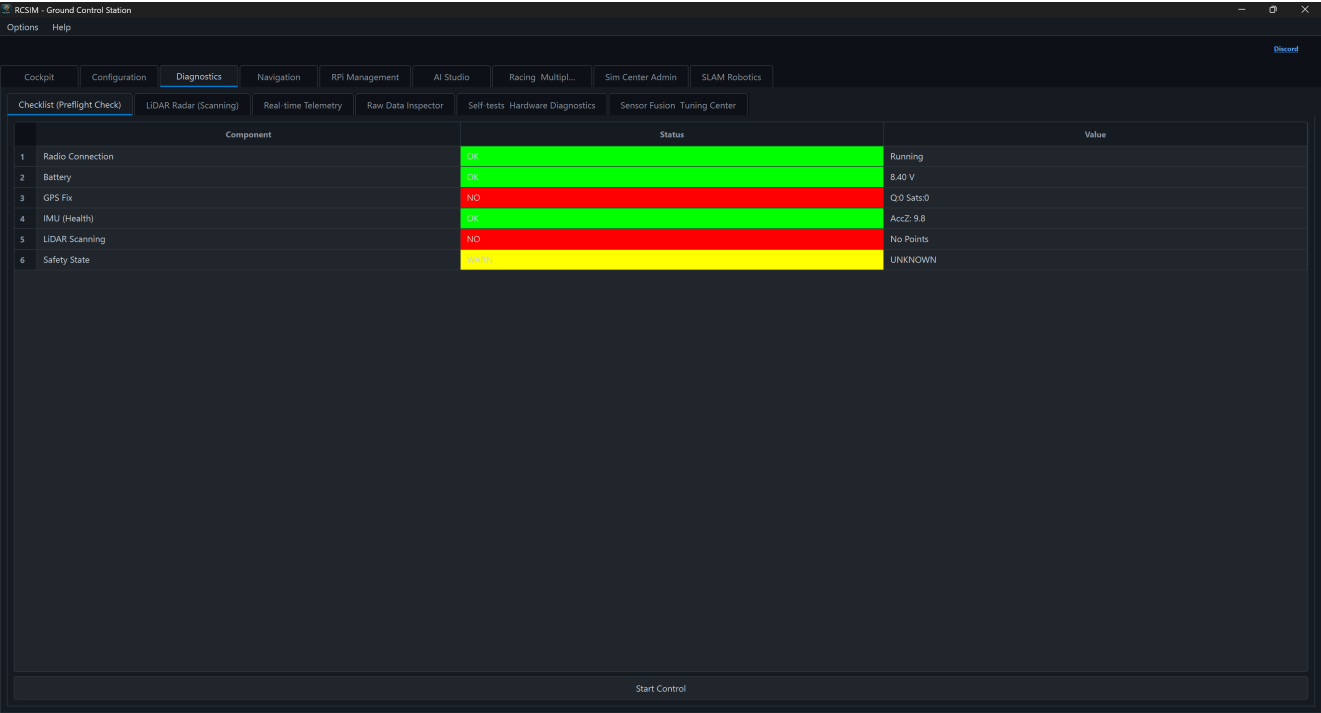


OSD Layout Editor: widget list, canvas and properties

1. Press **Edit Layout** in the cockpit.
2. Select an item in **Available Widgets**, such as **Battery**, **Compass** or **Minimap**.
3. Press **Add selected** or double-click the item name.
4. Drag the item on the canvas; select it to change **Scale**, **Color**, **Width** and **Height**.
5. Remove an unwanted selected item with **Delete**.
6. **Save as...** saves a separate layout file; **Save** saves the current one.

Expected result: a saved layout that can be used as an OSD profile. Numbers in the editor preview help assess appearance; they do not confirm vehicle data.

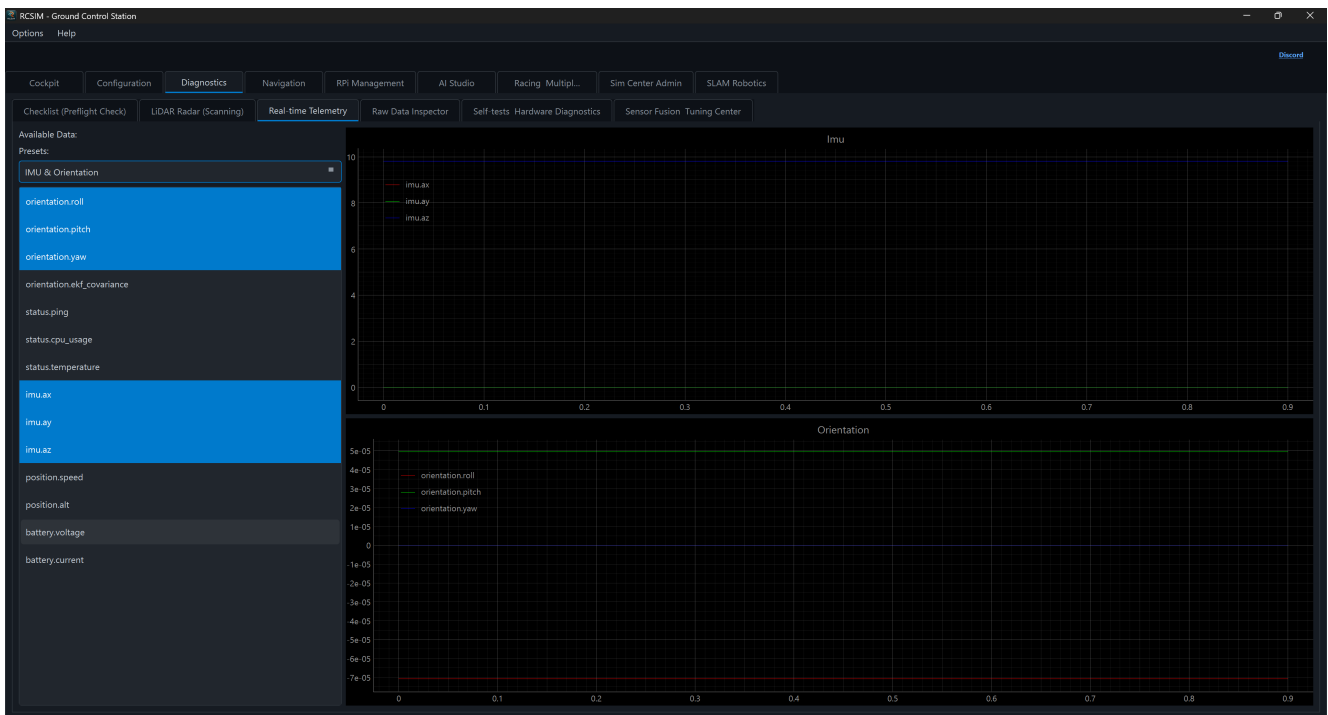
7. Diagnostics — checking the setup before driving



Checklist (Preflight Check): link, battery and sensor status

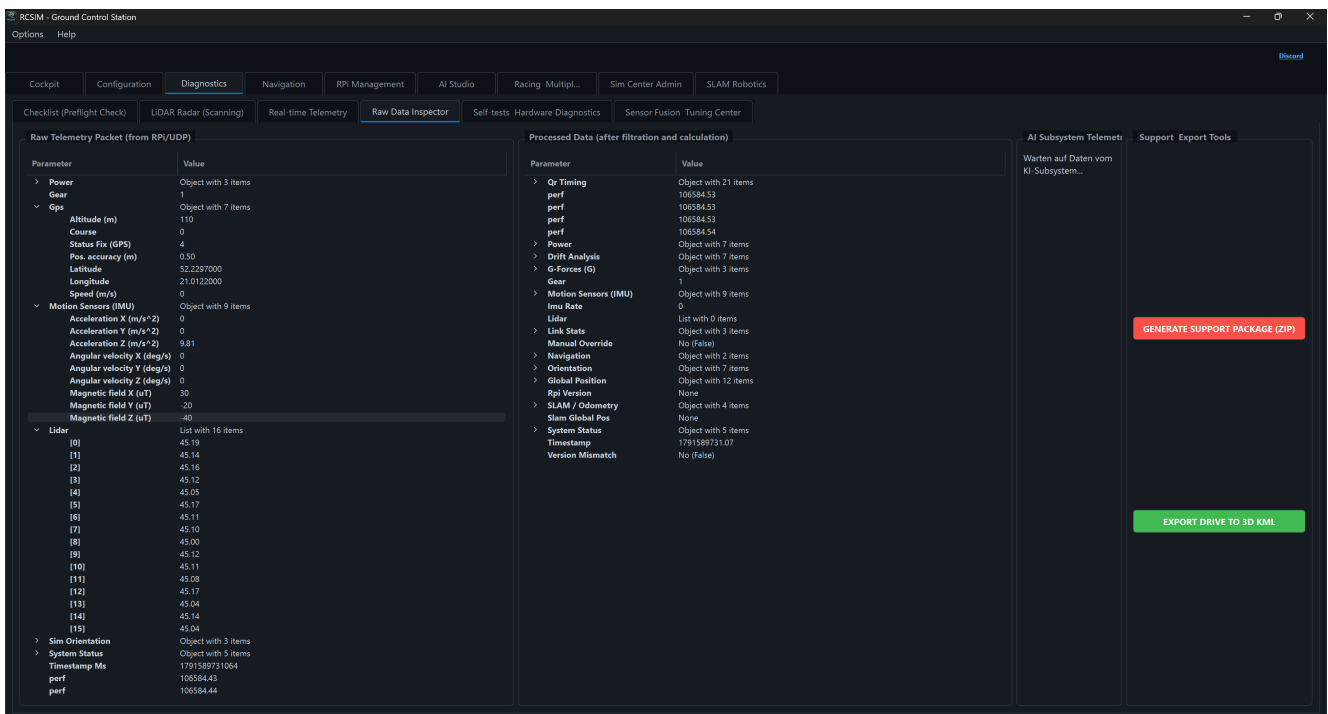
Open **Checklist (Preflight Check)** and press **Start Control**. The button starts refreshing checks, not driving or arming the model. Read both **Status** and **Value**: green **OK**, yellow **WARN** and red **NO** need context. Missing GPS or LiDAR may be correct for a setup without those devices.

- **Safety State: UNKNOWN** needs investigation before relying on safety functions. Expected result: readings that match the setup's actual equipment and condition.
- **LiDAR Radar (Scanning)** shows supplied scan points. If you expect a scan, first check that the platform and selected transport provide it.



Real-time Telemetry: selecting data and viewing plots

In **Real-time Telemetry**, select **Presets**, such as **IMU & Orientation**, or relevant entries in **Available Data**. Make a small, controlled movement and compare plots before and after it. A flat plot may represent a stationary sensor; it alone does not prove failure. Compare axis names and units with the actual connected sensor.

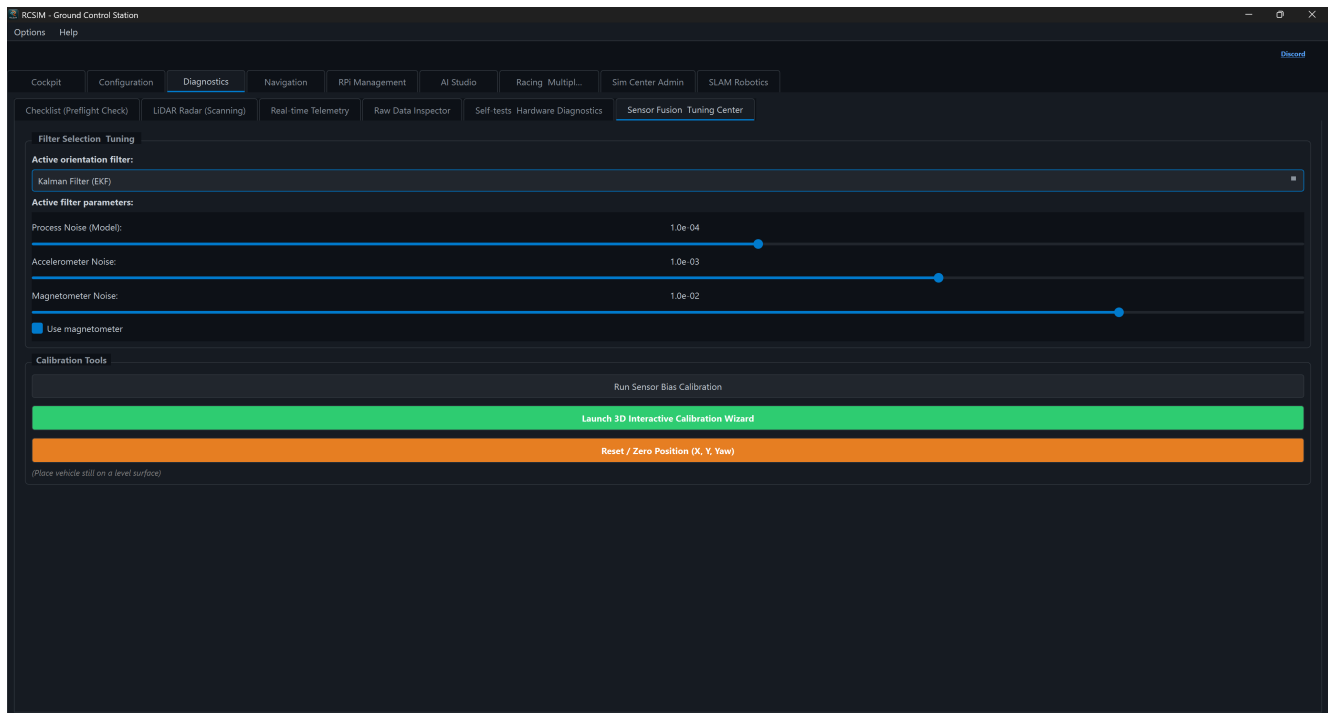


Raw Data Inspector: received packet, processed data and export

In **Raw Data Inspector**, expand the appropriate group in the left and middle columns. The left shows received data; the middle shows processing results. If a reading is already wrong on the left, check the sensor and transmission; if it changes only after processing, check filtering settings and units.

- **GENERATE SUPPORT PACKAGE (ZIP)** prepares a diagnostic package.

- **EXPORT DRIVE TO 3D KML** exports a recorded drive; it requires route data.

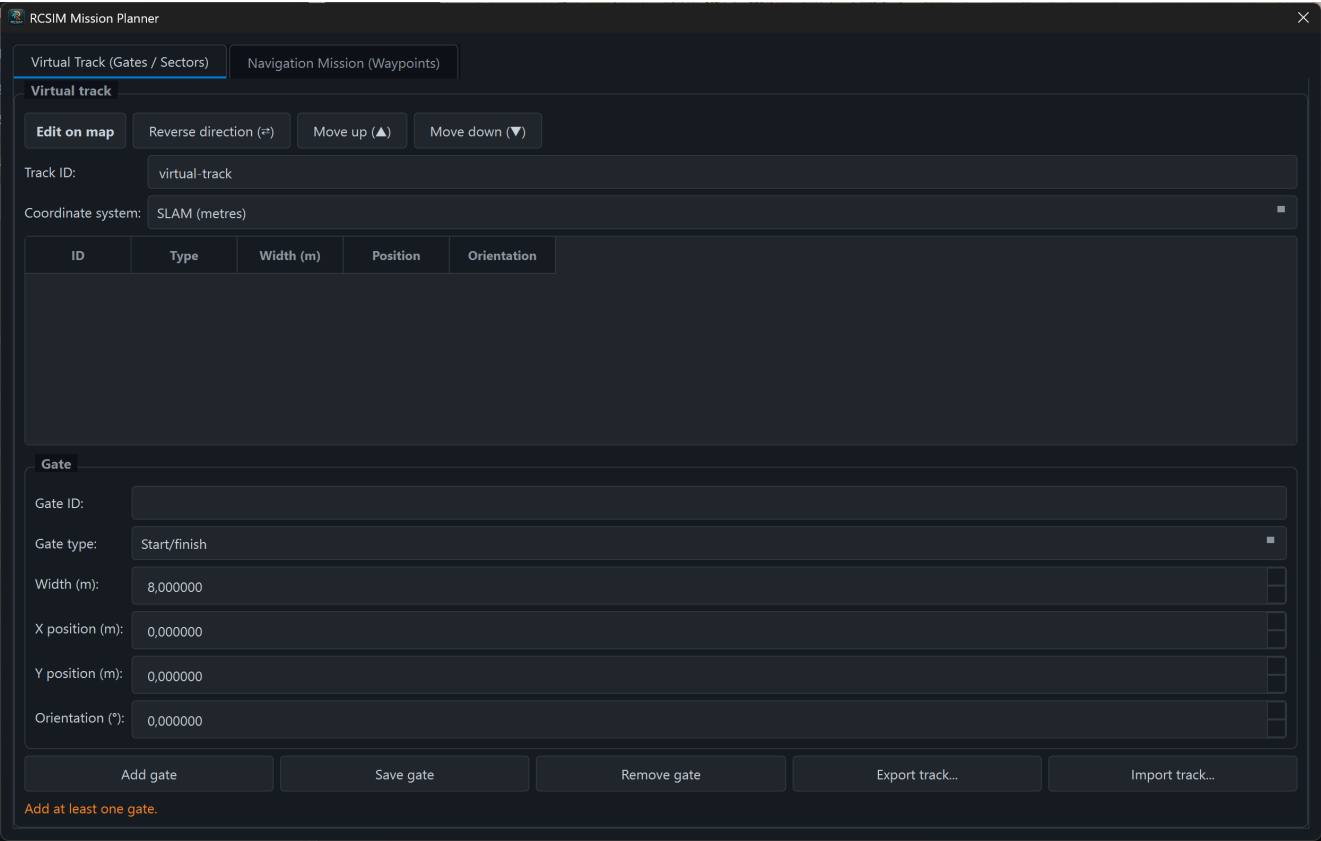


Sensor Fusion Tuning Center: filter selection and calibration tools

In **Sensor Fusion Tuning Center**, select **Active orientation filter** and filter parameters. Save your profile first, then change one parameter at a time and compare plots.

- **Run Sensor Bias Calibration** calibrates sensor bias: keep the vehicle stationary on a level surface and follow the prompts.
- **Launch 3D Interactive Calibration Wizard** opens guided calibration.
- **Reset / Zero Position (X, Y, Yaw)** resets the position reference; it does not replace sensor calibration. In **Self-tests Hardware Diagnostics**, select a test appropriate to the equipment; when testing an actuator, remember that the test may move it.

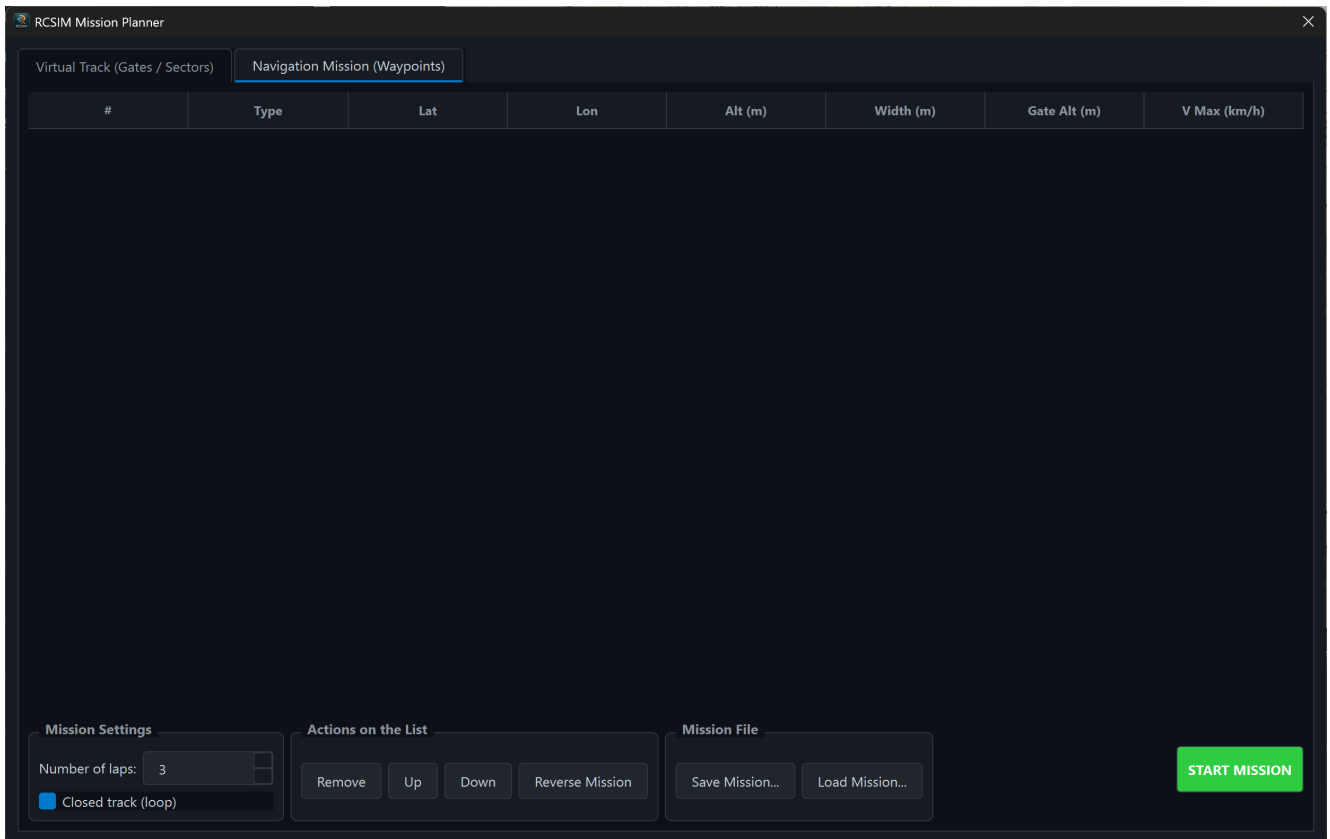
8. Mission Planner — mission points and virtual gates



Virtual Track (Gates / Sectors): creating gates

Open **Mission Planner** from the cockpit. **Virtual Track (Gates / Sectors)** defines the geometry used to measure the drive. Set **Track ID**, select **Coordinate system**, and enter **Gate ID**, **Gate type**, **Width (m)**, position and orientation.

- **Add gate** adds a gate, **Save gate** confirms edits, and **Remove gate** removes the selected gate.
- **Move up**, **Move down** and **Reverse direction** arrange the track sequence.
- **Export track...** saves a track; **Import track...** loads an existing one. Do not mix **SLAM (metres)** coordinates with geographic GPS position.



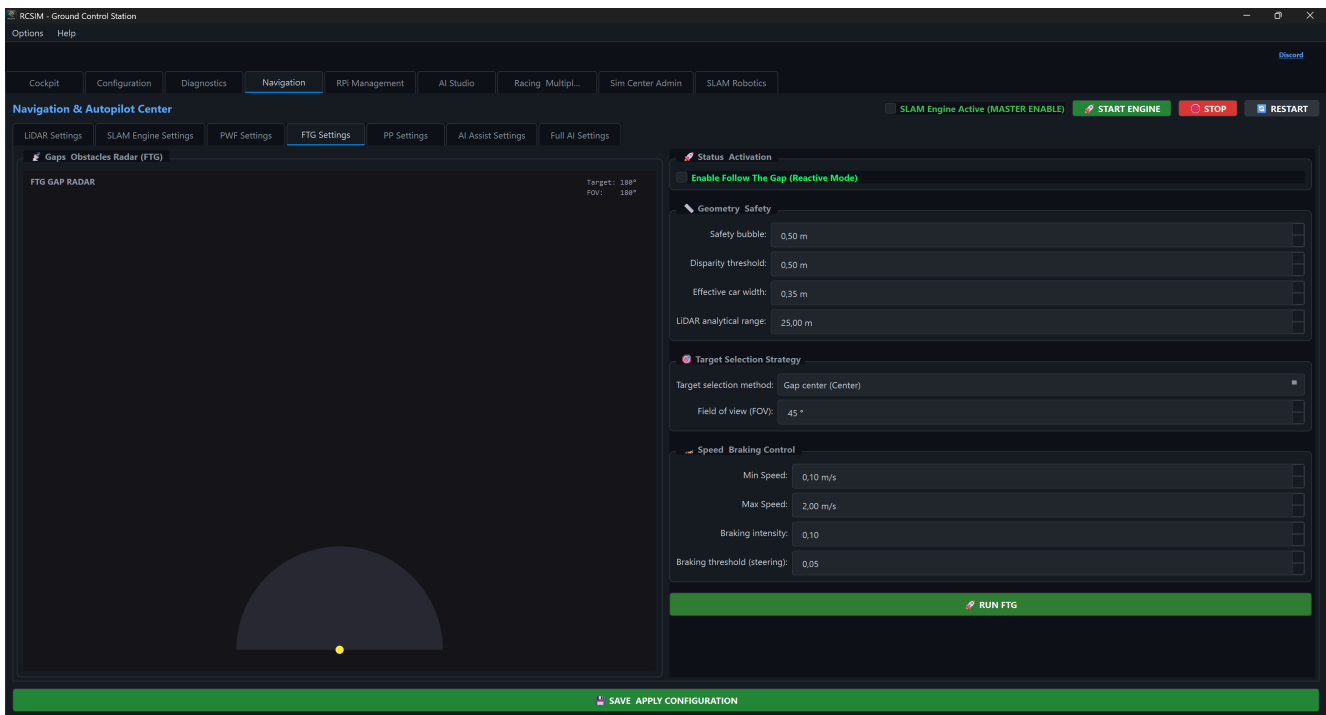
Navigation Mission (Waypoints): point list and mission start

In **Navigation Mission (Waypoints)**, check the order and parameters of points added on the map.

- **Remove**, **Up**, **Down** and **Reverse Mission** change the list. Set **Number of laps** and **Closed track (loop)** to match the intended drive. Save the route with **Save Mission...**; **Load Mission...** restores a saved one.
- **START MISSION** requires a non-empty list and a platform prepared to execute the mission. Saving points or drawing gates alone does not start autonomous driving.

9. Navigation — navigation and autopilot settings

The **Navigation** tab prepares LiDAR measurements, builds a map and selects driving assistance. Changing parameters, starting mapping and starting control are separate actions. First check real sensor data and manual control of the model.



Navigation — radar and FTG settings

At the top are **SLAM Engine Active (MASTER ENABLE)**, **START ENGINE**, **STOP** and **RESTART**. **START ENGINE** starts map processing; it does not yet start autonomous driving. **STOP** stops the active mapping engine. Do not treat it as a universal emergency drivetrain cutoff: you must first test how to interrupt driving on your particular setup.

- **SAVE APPLY CONFIGURATION** saves and applies settings. Some changes synchronise during editing, so do not tune a running autopilot with arbitrary values while driving.

LiDAR Settings — matching the scan to the surroundings

Here you adjust distance scale, scan rotation and mirroring to the sensor's mounting position. Minimum and maximum distance limits reject measurements outside the useful range; filters help reduce noise. The deadzone editor excludes sectors obscured by vehicle parts.

1. Keep the model stationary and place a recognisable obstacle in front of it.
2. Check that its distance and side in the scan match reality; correct scale, rotation or mirroring.
3. Mark only genuine sensor obstructions, then apply the settings.

Expected result: the obstacle appears in the correct direction and at the correct distance. No points does not mean a clear road — check the sensor connection first.

SLAM Engine Settings — a stable map

Map resolution sets grid detail, while point reduction limits processing cost. The matching error threshold and minimum point count affect acceptance of subsequent scans. Enable IMU and speed fusion for sensors supplying verified data.

1. Start with a stationary vehicle and correctly oriented LiDAR.
2. Apply the settings and select **START ENGINE**.
3. Manually move the vehicle a short distance; watch the map, node count and matching error plot.

Walls should remain consistently positioned. Drifting or duplicated obstacles require measurement correction and tuning before planning a drive. Position locking for debugging does not replace vehicle localisation.

PWF Settings — guidance relative to walls

PWF uses surrounding geometry to correct the driving path. Selecting **PID** or **ADRC** changes the available settings. Reversing the steering or throttle sign reverses the relevant output; it is not a way to compensate for incorrectly mounted LiDAR.

1. Prepare a correct scan and a low test speed.
2. Select the controller and check the direction of the response to an obstacle with the drivetrain secured.
3. Save the settings, then use the PWF start button only on a prepared test setup.

Watch the wall visualisation and control outputs. If the vehicle steers towards an obstacle or oscillates, stop the test and correct directions or settings. Do not enable automatic tuning as the first configuration step.

FTG Settings — choosing free space

- **Enable Follow The Gap (Reactive Mode)** enables reactive gap finding. **Safety bubble** defines a buffer around the nearest obstacles, **Effective car width** describes the width used by the algorithm, and **Disparity threshold** concerns distance discontinuities in the scan.
- **Target selection method** selects how the target is chosen within a gap. **Field of view (FOV)** limits the analysed sector, and **LiDAR analytical range** limits its range. **Min Speed**, **Max Speed** and braking settings affect driving pace and slowing through corners.

1. Check the radar and that the model's forward direction is correct.
2. Enter the vehicle's actual width, a conservative buffer and a low maximum speed.
3. Select the target method and FOV range, then save the configuration.
4. Enable the mode and use **RUN FTG**, remaining ready to take over manually.

A target should appear in available space on the radar. FTG reacts to the current scan; it does not promise arrival at a chosen destination or detection of obstacles invisible to LiDAR.

PP Settings — following a path

Pure Pursuit guides the model along a prepared route. Lookahead distance determines how far ahead the steering target lies on the path. The steering limit constrains corrections, while speed and curvature parameters help slow down in corners. Path generation parameters affect clearance from obstacles and route smoothing.

1. Prepare a map, a correct vehicle position and a route or destination in the map view.
2. Generate the path and check its entire course, especially corners and narrow passages.
3. Set a low speed, save the configuration and only then start PP tracking.

Expected result: the visualisation shows the route and lookahead target, and the model corrects its course towards them. A missing route or loss of a reliable position requires stopping the test.

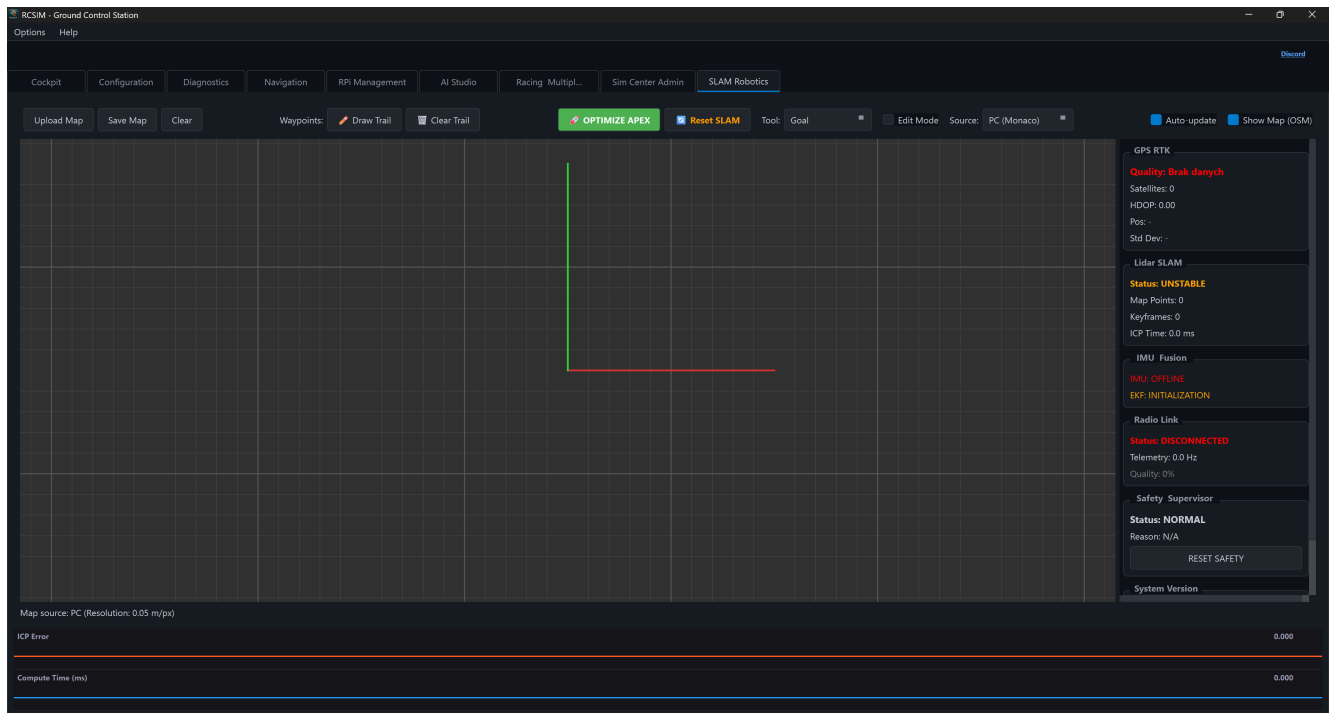
AI Assist Settings and Full AI Settings

- **AI Assist Settings** combines operator control with a selected **PWF**, **FTG** or **PURE_PURSUIT** pilot. Set the assistance contribution, manual takeover threshold and smoothing. First run and check the selected strategy alone, then add a small assistance contribution and check that you can take over with the wheel.
- **Full AI Settings** provides model selection, speed, aggressiveness, braking and throttle ramp settings. Selecting a file does not confirm model compatibility or successful loading. Begin by checking model outputs

and control directions on the bench, then make a short low-speed test. The start button starts control, not model training.

10. SLAM Robotics — map, points and diagnosis

This is a separate map workspace. In the illustrated layout it is available as the **SLAM Robotics** extension tab; its presence depends on the extension being available and loaded. Do not confuse it with the **Navigation** parameter panel.



SLAM Robotics — map and readiness indicators

- **Source** switches the map source between **RPI (Edge)** and **PC (Monaco)**. **Auto-update** controls refreshing, and **Show Map (OSM)** controls background visibility. A geographic background does not confirm local SLAM readiness.
 - **Upload Map** opens a local map file — the illustrated label does not mean it sends the map to the vehicle. **Save Map** saves the map, and **Clear** clears the current view/map data. Save any required result before clearing or using **Reset SLAM**.
1. Select the actual source and check that points are arriving.
 2. Read the right-hand panel: **GPS RTK**, **Lidar SLAM**, **IMU Fusion**, **Radio Link** and **Safety Supervisor**.
 3. Use **Draw Trail** only on a coherent map, mark the route and finish drawing; **Clear Trail** removes those points.
 4. **OPTIMIZE APEX** requests route optimisation. Check the result before using it to guide the model.
 5. **Tool** and **Edit Mode** select a destination or home and edit obstacles. After editing, save the map and check the route again.

The screenshot has no GPS data, IMU is offline and radio is disconnected. **Safety Supervisor: NORMAL** alone in this situation does not confirm readiness for autonomous driving. **RESET SAFETY** does not repair missing data or a connection.

11. RPi Management — administering the vehicle computer

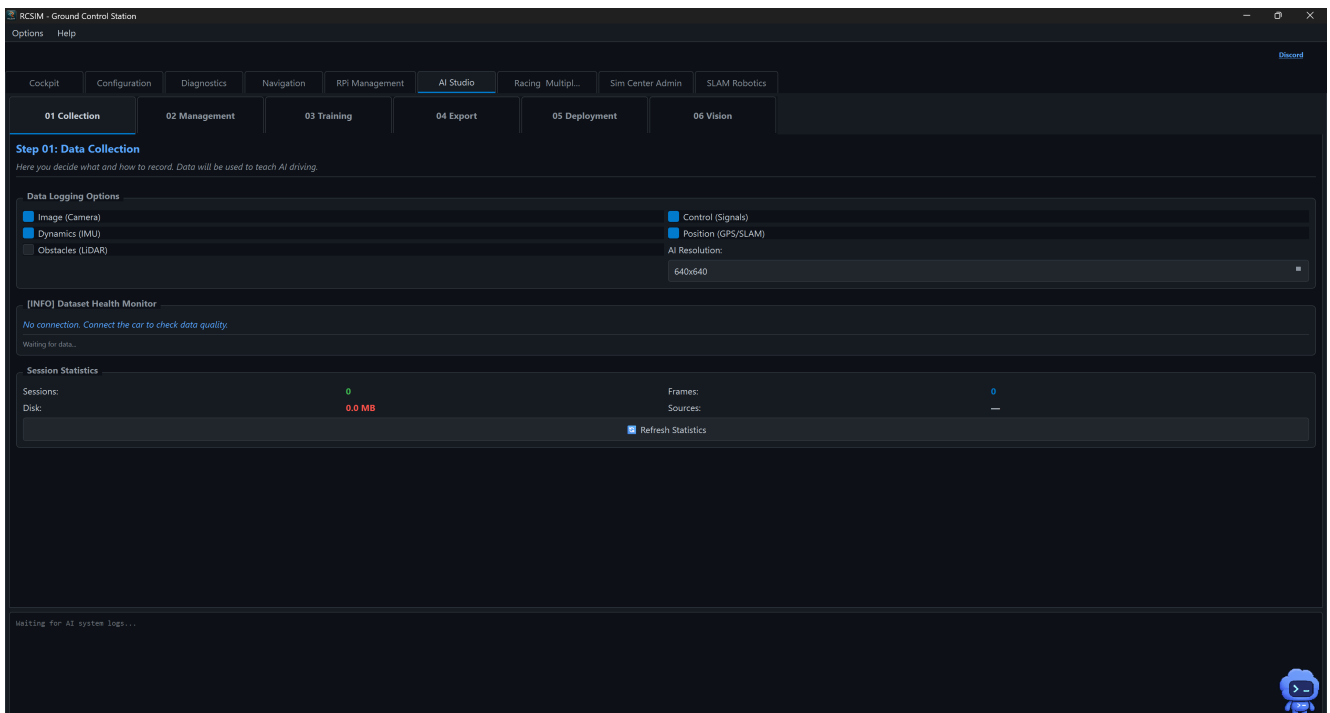
This tab requires an accessible Raspberry Pi and a working administration connection. Check the model, CPU temperature, CPU/RAM load and service status. First use **Fetch Config**, then edit the downloaded values and press **Upload & Save**. Expected result: operation confirmation or an error message; without confirmation, check the connection.

- **START Service**, **STOP Service** and **RESTART Service** control the program on the Pi.
- **RESTART System (Reboot)** restarts the entire computer after confirmation and temporarily interrupts its operation.
- **Live LOGS (Docker)** diagnoses a compatible container deployment.
- **Upload AI Model (.hef/.pth)** opens file selection and prompts for SSH username and password. Transferring a file does not prove that the model is running or compatible with the accelerator. The **Quick Profiles** list is currently disabled; download and edit the configuration manually. The absence of an illustration for this tab in the supplied set does not change its separate administrative role.

12. AI Studio — from recording to model checking

The **AI Studio** tab may be supplied by the **AI Training & Simulation Studio** add-on. Training and detection require the appropriate libraries and models; selecting CUDA does not create GPU support on an incompatible computer.

01 Collection — selecting training material



AI Studio — data sources and quality checking

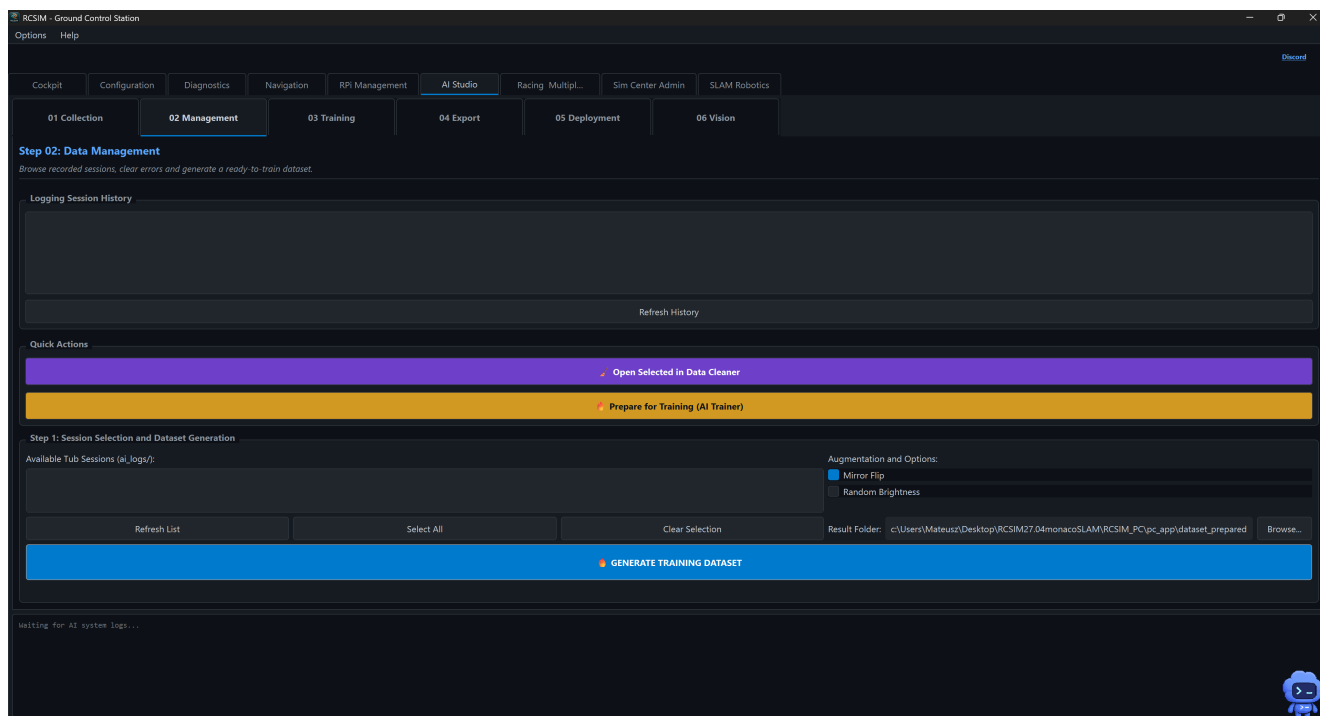
Select available sources: **Image (Camera)**, **Control (Signals)**, **Dynamics (IMU)**, **Position (GPS/SLAM)** and **Obstacles (LiDAR)**. **AI Resolution** sets the size of saved images, not the operator video stream's resolution.

1. Connect the vehicle and check the **Dataset Health Monitor** message.
2. Select sources appropriate for the planned model; do not select sensors that are not supplying data.

3. Return to **Cockpit** and press **Record Track (For AI)** to start recording training data.
4. Make a short, controlled test, then press the same button again to stop recording.
5. Return to **AI Studio** → **Collection** and use **Refresh Statistics**. Check that sessions and frames have increased before making a longer recording.

The illustrated Collection screen has no recording start button; use the specified cockpit button. Selecting sources alone does not start recording. If the frame count does not increase, check active video and data sources. **No connection** means vehicle data quality is not being checked.

02 Management — organising and generating the dataset

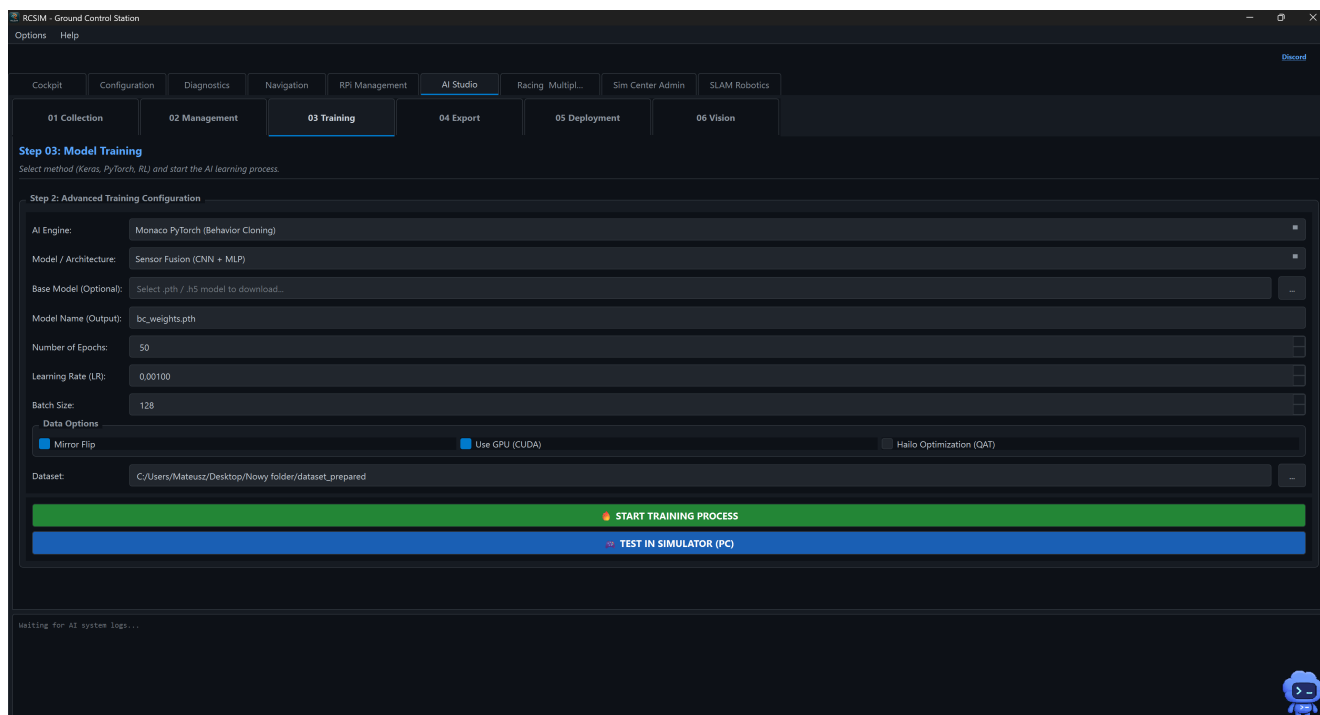


AI Studio — sessions and dataset preparation

Use **Refresh History**, select a session and open **Open Selected in Data Cleaner** to review and reject incorrect material. **Prepare for Training (AI Trainer)** moves to data preparation.

In **Available Tub Sessions**, refresh the list, select sessions and specify **Result Folder**. **Mirror Flip** adds mirrored examples; use it where mirroring preserves the data's meaning. **Random Brightness** is visible, but in the checked version its selection is not passed to the generator — do not assume it changes images. Select **GENERATE TRAINING DATASET** and check the completion message and output folder. An empty list does not produce a useful dataset.

03 Training — training a model

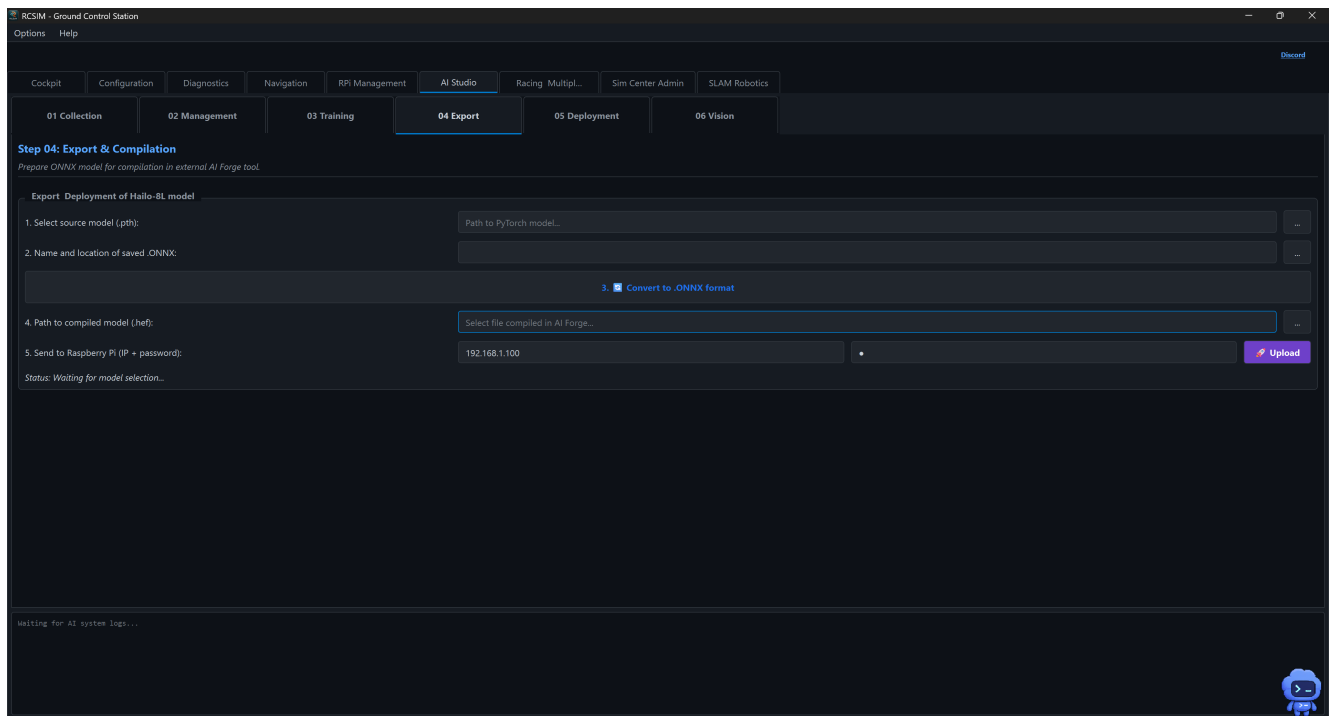


AI Studio — training configuration

Select **AI Engine** and **Model / Architecture**, then specify **Dataset**. **Base Model (Optional)** specifies an earlier model; **Model Name (Output)** names the result. Epoch count, **Learning Rate (LR)** and **Batch Size** determine training behaviour; the screenshot values are examples, not recommendations for every dataset.

1. Check data compatibility with the selected architecture, such as the required sensors for **Sensor Fusion (CNN + MLP)**.
2. Select **Use GPU (CUDA)** and **Hailo Optimization (QAT)** only for a supported environment and model workflow.
3. Use **START TRAINING PROCESS**, watch the log and wait for the output file to be saved.
4. If you have a configured simulator, check the model with **TEST IN SIMULATOR (PC)** before testing it on a vehicle.

04 Export — ONNX and a Hailo model

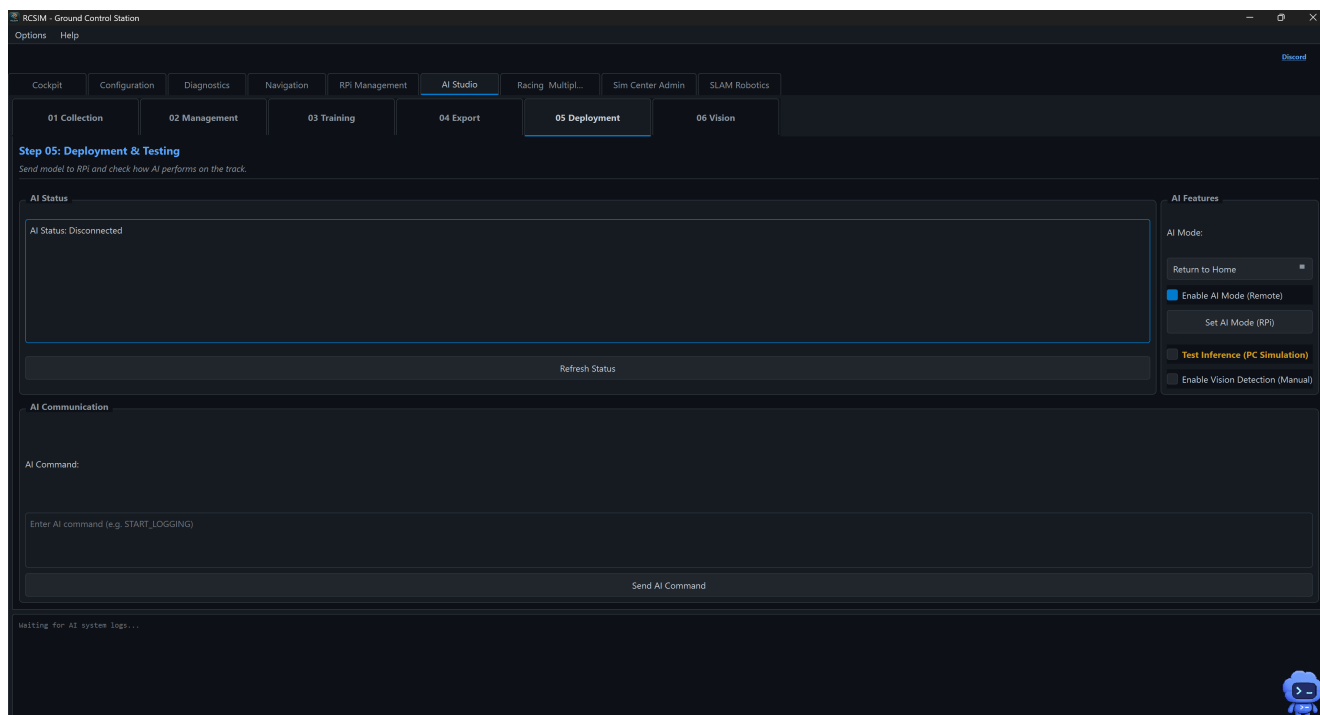


AI Studio — model export and transfer

Specify the `.pth` model and `.onnx` output location, then select **Convert to .ONNX format**. Next compile the model in external AI Forge for the correct accelerator and specify the resulting `.hef` file. ONNX export is not HEF compilation.

Upload requires the Raspberry Pi address, working SSH and the correct password. This panel uses the `pi` account; if the host uses another account, do not assume the address field alone resolves that difference. After transfer, check the active model and actual inference separately — a transfer message does not confirm that the model has started.

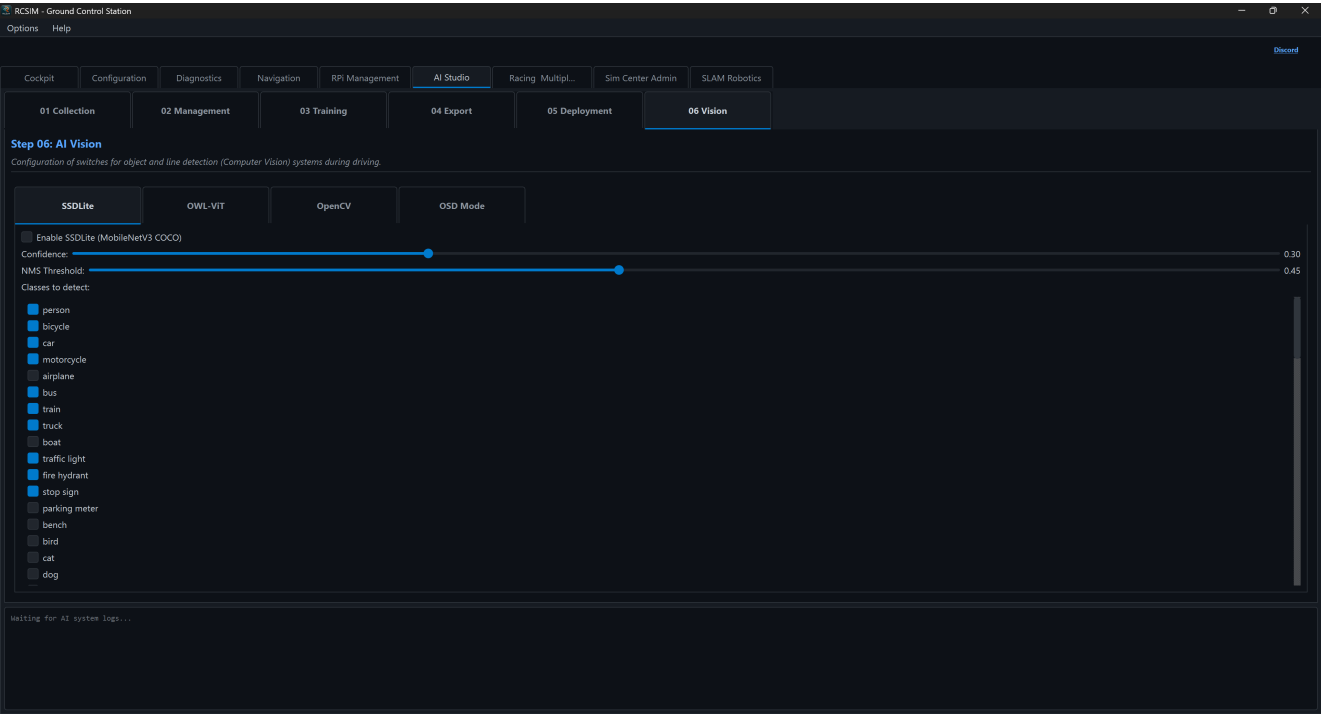
05 Deployment — AI status and mode



AI Studio — connection status and AI commands

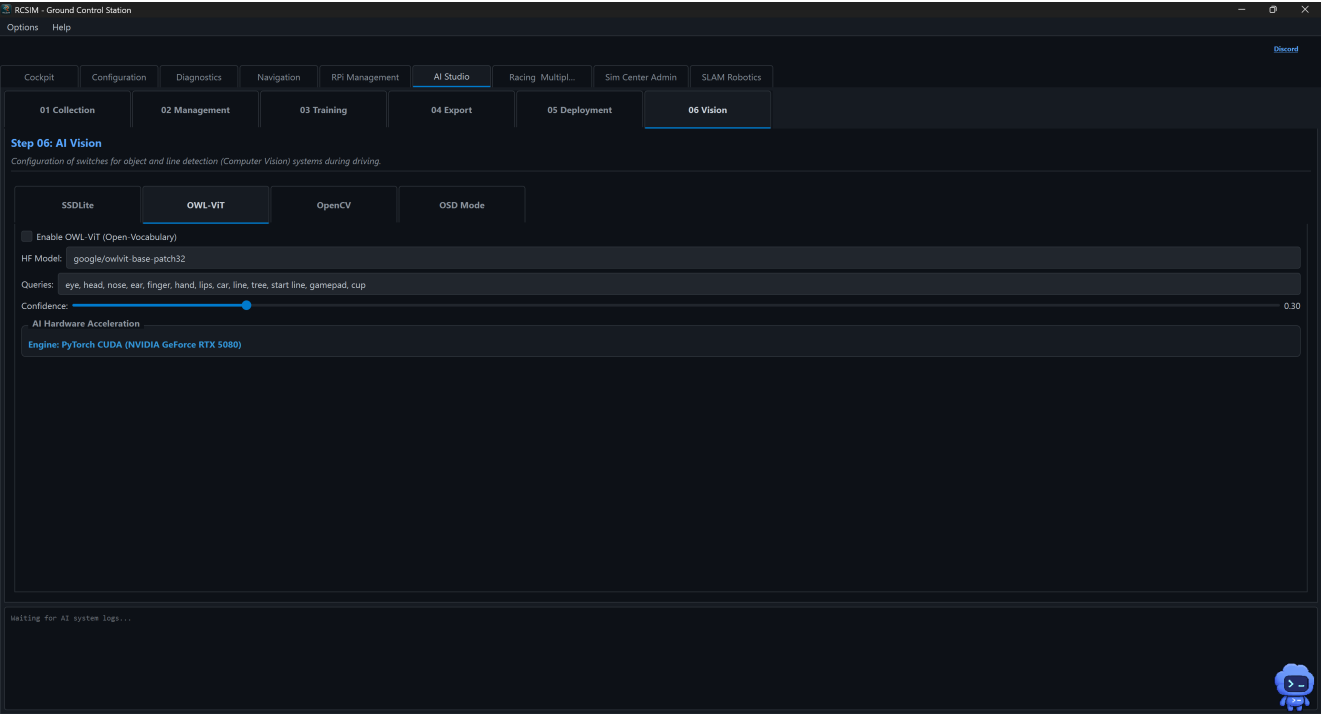
- **Refresh Status** refreshes data. **AI Mode** selects the onboard function, while **Enable AI Mode (Remote)** specifies whether to enable it; **Set AI Mode (RPI)** sends the selection to the connected Raspberry Pi. Changing the list without sending does not confirm a vehicle mode change.
- **Test Inference (PC Simulation)** enables a local test mode; it is not proof that the vehicle accelerator works. **Enable Vision Detection (Manual)** applies to GCS-side detection. **AI Command** and **Send AI Command** manually transmit commands; use only commands appropriate for your system.

06 Vision — SSDLite, OWL-ViT, OpenCV and OSD



AI Vision — SSDLite classes and thresholds

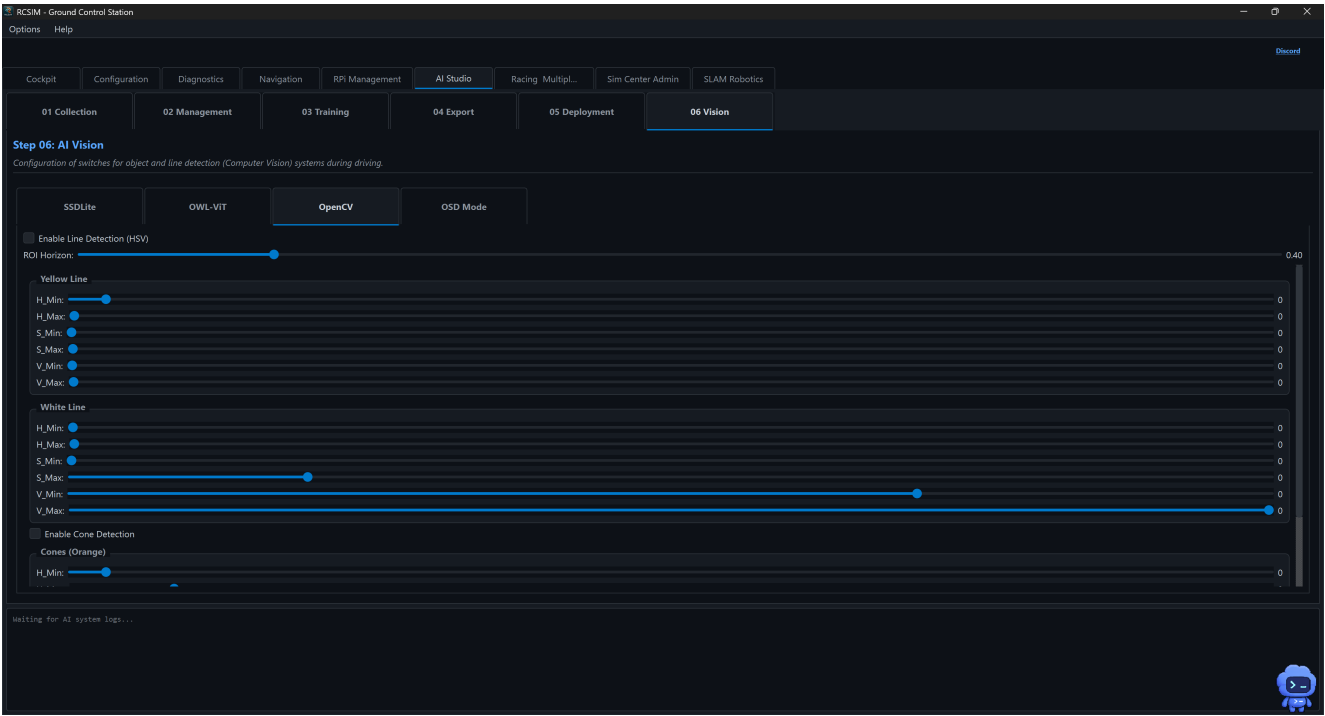
- **SSDLite** detects listed classes, such as people and cars. Enable **Enable SSDLite (MobileNetV3 COCO)**, select the required classes and adjust **Confidence**; a higher threshold rejects less certain detections. **NMS Threshold** affects removal of overlapping detections. Check results on actual video, not just the class list.



AI Vision — OWL-ViT model and queries

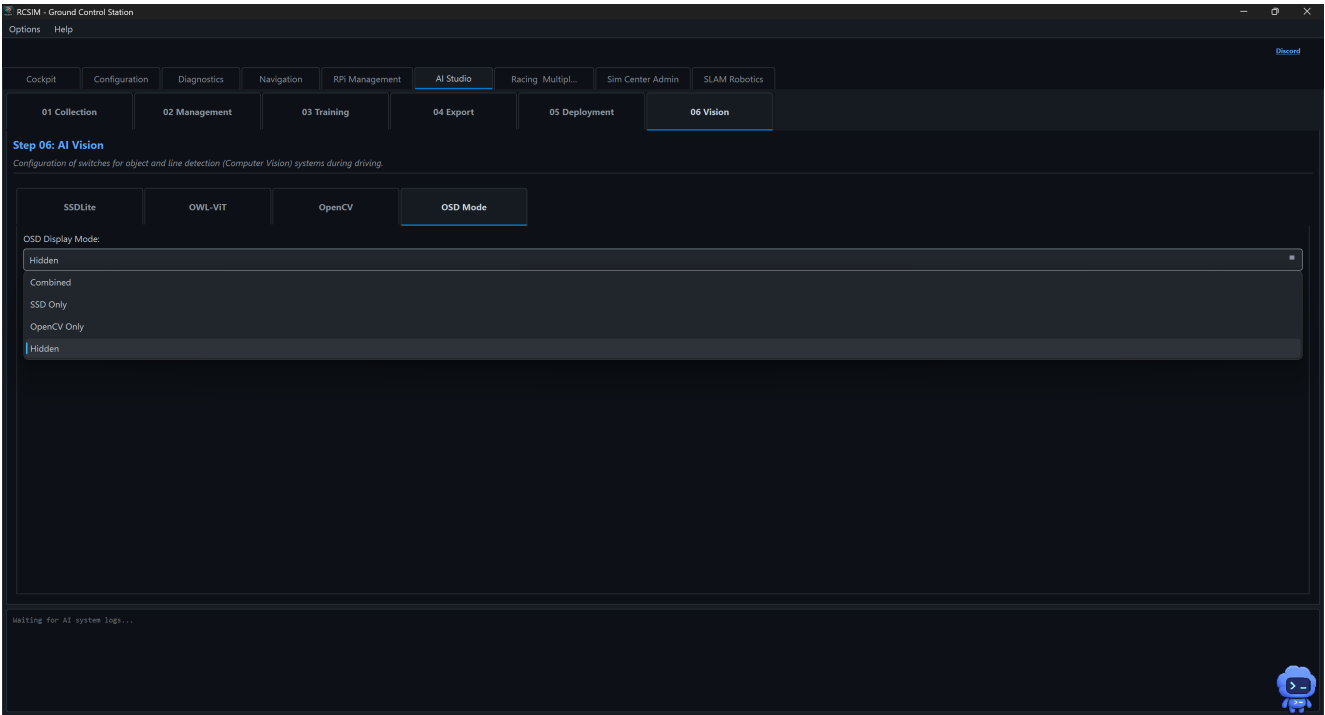
- **OWL-ViT** lets you describe target objects with text. Specify a model in **HF Model**, enter comma-separated terms in **Queries** and adjust **Confidence**. After enabling it, check the model-loading log and detections. **AI**

Hardware Acceleration describes the detected environment on that computer; the screenshot's GPU name is not a requirement for every user.



AI Vision — OpenCV line and cone detection

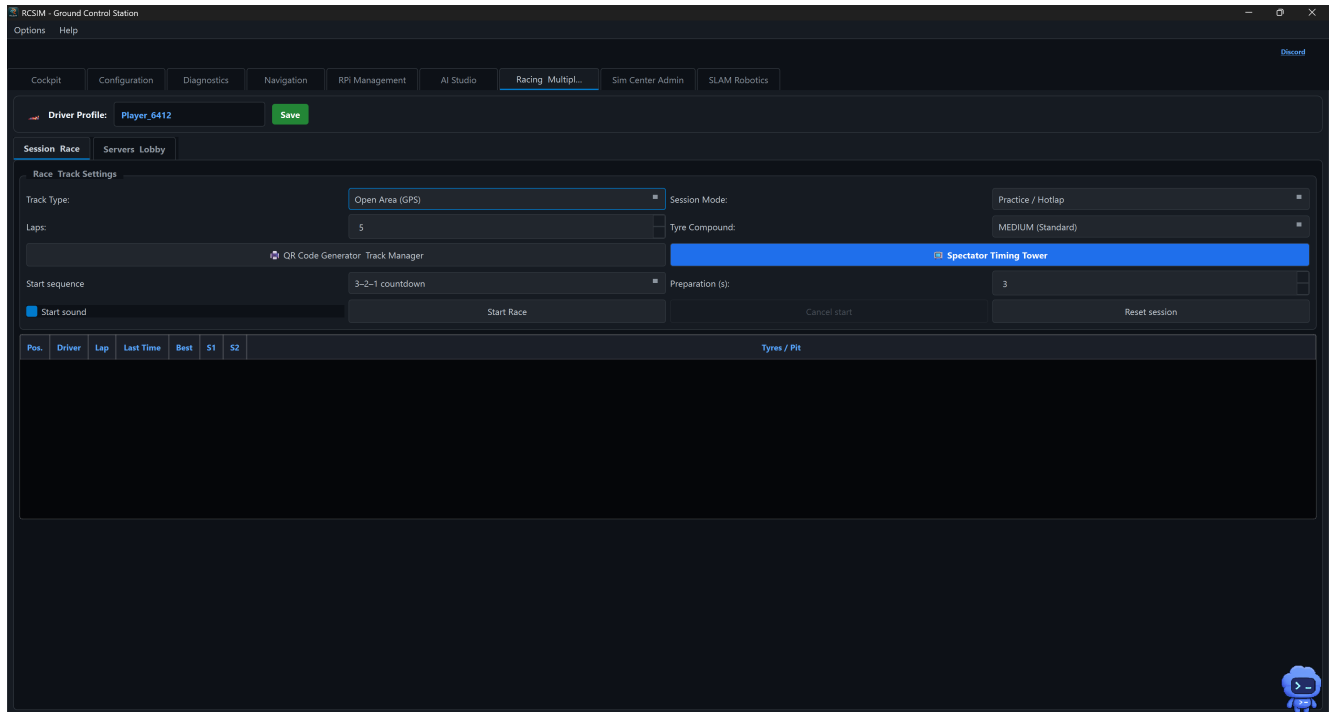
- **OpenCV** provides **Enable Line Detection (HSV)**, **ROI Horizon** and H/S/V ranges for yellow and white lines. A separate **Enable Cone Detection** enables cone detection. Set the image region to the road, tune the ranges for the lighting and check that lines, not background, are detected; zero settings in the image are not a ready-made colour profile.



AI Vision — OSD overlay selection

- **OSD Mode** sets result presentation: **Combined** combines layers, **SSD Only** shows the SSD layer, **OpenCV Only** the OpenCV layer, and **Hidden** hides the overlay. Hiding the overlay is not a command to stop all detectors. After selection, return to cockpit video and check result readability before further tuning.

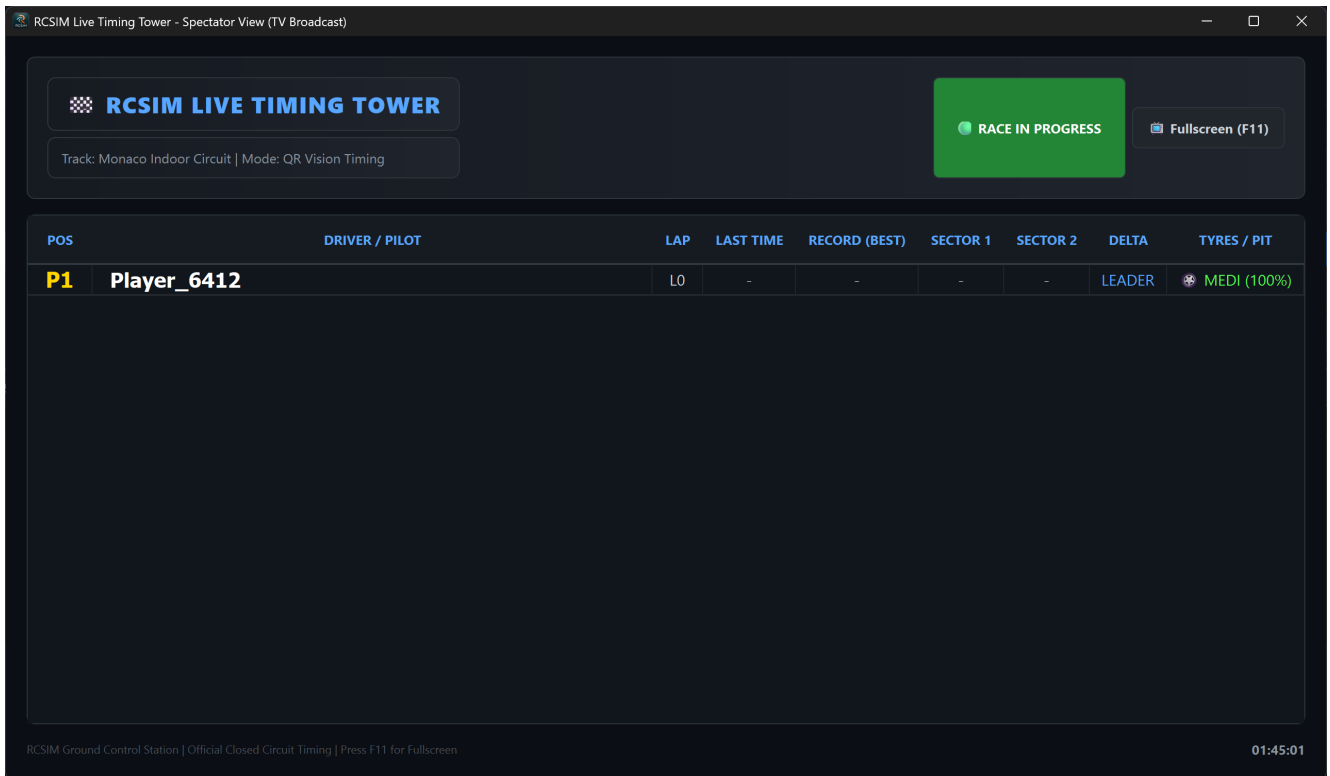
13. Racing Multiplayer — sessions and shared results



Session Race: track, start and timing settings

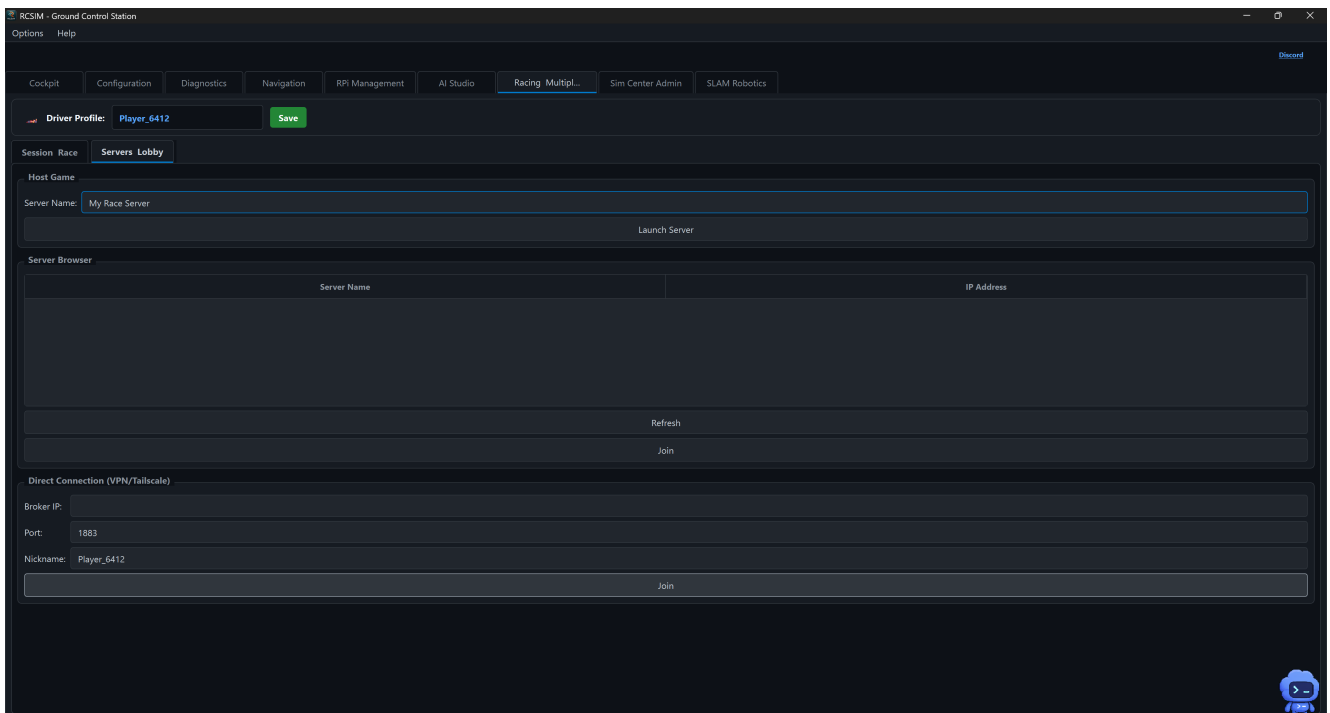
Enter a name in **Driver Profile** and press **Save**. In **Session Race**, select **Track Type: Open Area (GPS)** requires GPS position, while QR mode requires prepared markers and video that allows them to be recognised. Set **Session Mode**, **Laps**, **Start sequence**, **Preparation (s)** and, optionally, **Start sound**.

- **QR Code Generator Track Manager** opens QR track preparation.
- **Start Race** begins the start procedure, **Cancel start** interrupts it, and **Reset session** resets the session.
- **Tyre Compound** and **Tyres / Pit** concern virtual race strategy, not measurement of physical tyre wear.



Spectator Timing Tower: separate results window

- **Spectator Timing Tower** opens the position, lap, sector and best-time table.
- **Fullscreen (F11)** switches the presentation view. Empty times mean no result is available yet.

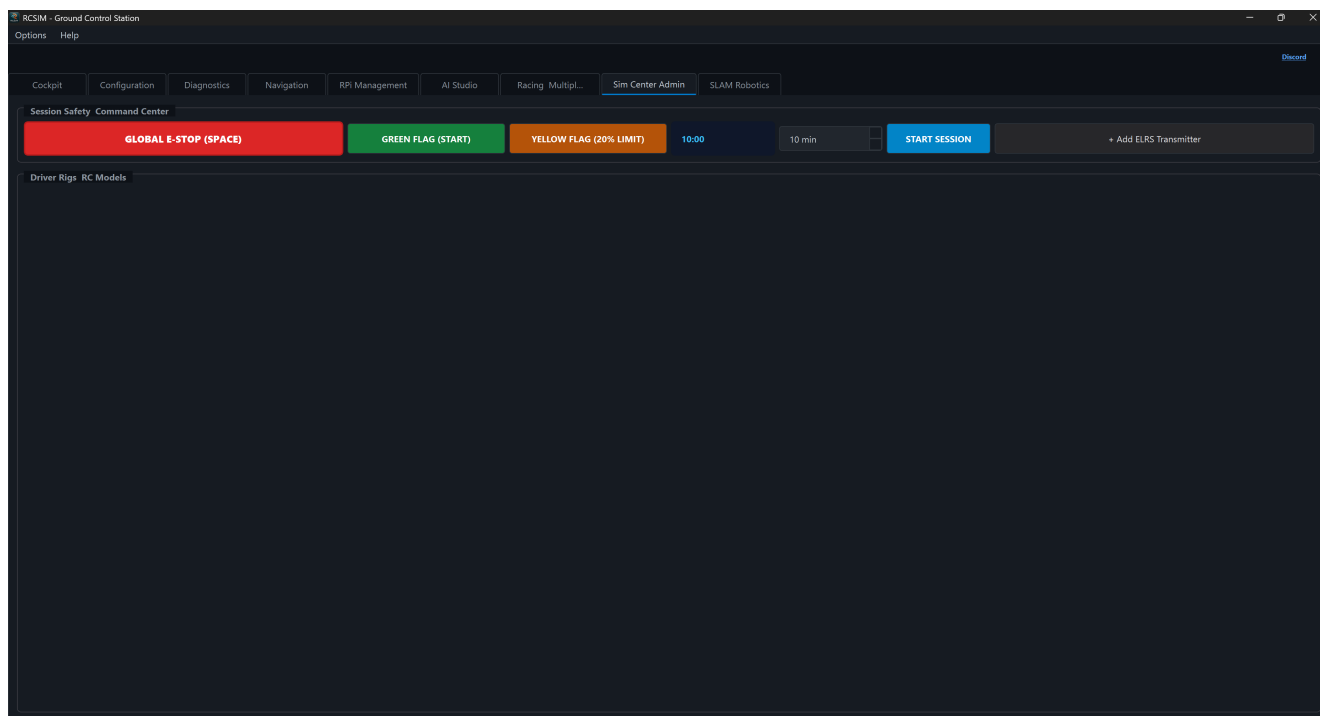


Servers Lobby: starting a host or joining a server

In **Servers Lobby**, the host enters **Server Name** and uses **Launch Server**. A participant selects **Refresh**, selects a discovered server and presses **Join**. For a direct connection, enter **Broker IP**, **Port** and **Nickname**, then the lower **Join** button. The default port is 1883; VPN use requires working connectivity to the host

beforehand. The lobby synchronises the race session; it does not replace configuring control and video for each vehicle.

14. Sim Center Admin — managing multiple stations



Sim Center Admin: shared flags and session timer

- **+ Add ELRS Transmitter** adds a transmitter; the program selects the first available serial port. Check the message containing the port number, especially when several USB devices are connected. After connecting stations, assign the correct vehicle and power profile to each station in **Driver Rigs RC Models**. Set the session duration and use **START SESSION** only after checking assignments: this action also arms supported outputs.
- **GREEN FLAG (START)** restores the green flag; **YELLOW FLAG (20% LIMIT)** applies the session limit.
- **GLOBAL E-STOP (SPACE)** initiates a shared stop for supported control paths. Expected result: correct station assignments, a countdown and the corresponding output response. Check every model's response before admitting participants; the administrator screen alone does not confirm it.

15. Quick solutions to common problems

What you see	What to check in the application
Wheel connected, channel does not respond	Configuration → Control Mapping: device and action assignment. Check the axis reading in the control sources panel.
Channel bar moves, model does not respond	Actual Connection Mode, Connect, port/address and arming. Expo does not repair a connection.
No video, but data is present	Video Source and Configuration → Video: stream address or selected capture device.
FFB test works, but no force while driving	FFB enabled and current IMU data; the hardware test does not require the same telemetry.
No scan or position	Equipment, map source and transport. PPM alone does not carry LiDAR data.
AI Studio or SLAM Robotics is missing	Configuration → Extensions and DLC: extension availability and status in your edition.
AI test displays data, but vehicle does not respond	Distinguish PC Simulation from the model active on the vehicle; check the connection and onboard mode.

When reporting a fault, describe the tab, buttons pressed, expected and actual result, and application version. Attach a diagnostic package if available. Check its contents before sharing.

16. Appendix: verification scope and sources

This manual is based on the supplied screenshots and interface checks in local source code. No physical vehicle tests were performed. The sources below support manual maintenance; you do not need to open them for everyday operation.

- `RCSIM_PC/pc_app/gui/builders/menu_builder.py` and `main_tab_builder.py` — menus and main tabs.
- `RCSIM_PC/pc_app/gui/tabs/cockpit_tab.py` — connection, modes, arming and FPV.
- `RCSIM_PC/pc_app/gui/config_tab.py` and `gui/tabs/` — configuration, profiles and saving.
- `RCSIM_PC/pc_app/gui/osd/osd_editor.py` — OSD layout editor.
- `RCSIM_PC/pc_app/gui/tabs/preflight_check_tab.py` and `gui/diagnostics_tab.py` — diagnostics.
- `RCSIM_PC/pc_app/gui/mission_editor_window.py` — missions and gates.
- `RCSIM_PC/pc_app/gui/tabs/slam_tab.py`, `slam_map_tab.py` and `subtabs/` — navigation and map.
- `RCSIM_PC/pc_app/gui/tabs/remote_management_tab.py` — RPi administration.
- `RCSIM_PC/pc_app/gui/tabs/ai_tab.py` and `gui/widgets/ai_hub/` — AI Studio stages.
- `RCSIM_PC/pc_app/gui/tabs/lobby_tab.py` and `race_control_tab.py` — racing and multiple stations.