eloptris

EL-N
INS/GNSS Navigation Modules
User Manual

Version 1.0.0

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Revision History

Version	Date	Description	Author
1.0.0	2026-06-12	Initial release	Eloptris

1. Introduction

1.1 Purpose and Scope of This Manual

This manual describes how to set up, configure, operate, and read data from EL-N navigation devices as well as how to do basic troubleshooting.

It covers the practical user workflow: device connection, GNSS antenna setup, CDV application use, device configuration, telemetry selection, data streaming, data recording and basic troubleshooting.

This manual does not provide a detailed explanation of internal navigation algorithms, estimator tuning, factory calibration, or advanced engineering debug procedures.

1.2 Intended Users

This manual is intended for users who install, configure, test, or integrate EL-N devices into external systems.

The reader is expected to have basic familiarity with serial communication, GNSS operation, and interpreting navigation data such as position, velocity, roll, pitch, and yaw.

Advanced knowledge of inertial navigation or sensor fusion is not required for normal device setup and operation.

1.3 Definitions and Abbreviations

Term	Meaning
Body frame	Coordinate frame fixed to the device or vehicle body
CDV	Configuration, Display, and Visualization application
COG	Course over ground, usually derived from GNSS motion
GNSS	Global Navigation Satellite System
ICD	Interface Control Document
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
Moving baseline	Dual-GNSS method used to estimate heading from two GNSS antennas
NED	North-East-Down navigation coordinate frame
PPS	Pulse-per-second timing signal
RTK	Real-Time Kinematic GNSS positioning
UART	Universal Asynchronous Receiver/Transmitter
ZUPT	Zero-Velocity Update

Table 1-1 - Definitions and abbreviations

2. Device Overview

2.1 Product Description

EL-N devices are compact MEMS INS/GNSS navigation modules intended for integration into outdoor unmanned and mobile platforms that require position, velocity, and attitude information in real time.

These devices combine MEMS inertial sensor data with GNSS-based measurements to provide navigation output to the host (flight controller, computer unit, data logger, or some other integration software). The output can be monitored using the Eloptris developed CDV application or parsed directly by 3rd party software using the communication protocol described later in this manual.

2.2 Supported Devices and Variants

This manual applies to the EL-N navigation device family. The supported variants for this manual are listed in Table 2-1.

Device	Description	Main practical difference
EL-N-1	INS/GNSS navigation device with a single GNSS antenna input.	Uses single-antenna GNSS data. Heading can be supported by motion-based course over ground.
EL-N-2	INS/GNSS navigation device with dual-GNSS moving-baseline heading support.	Uses dual-GNSS heading when the moving-baseline solution is valid.

Table 2-1 - EL-N device variants covered by this manual

Unless a section explicitly refers to EL-N-1 or EL-N-2, the term EL-N device refers to both variants.

Figure 1: EL-N navigation devices

2.3 Main Outputs

The EL-N devices output navigation, sensor, GNSS, and status data. The exact set of transmitted data fields depends on the telemetry configuration setting, selected in CDV or by host issued commands.

Typical output categories include:

- Position: latitude, longitude, and altitude.
- Velocity: body-frame velocity values.
- Attitude: roll, pitch, yaw, and quaternions.
- Sensor-related data: selected IMU data.
- GNSS status: fix status, quality indicators, and update information.
- Heading status: heading source and heading validity information.
- Device and filter status: system state, measurement activity, status flags, and error flags.
- Timestamp information for synchronizing received data.

2.4 Typical Use Cases

EL-N devices are intended for integration in outdoor systems where compact navigation output is required. Typical use cases include:

- Unmanned ground vehicles.
- Agricultural and field robotics.
- Unmanned aerial vehicles (fixed wing, multi-rotor, VTOL).
- Unmanned surface vehicles.
- Outdoor mobile robotic platforms.
- Camera, antenna, sensor, or payload orientation support.

2.5 Operating Concept

The normal EL-N first time use can be represented by this simple workflow:

1. Connect the device to power and to the host communication interface (either use USB power/data cable or separate power cable and RS232 cable to the computer unit).
2. Connect the required GNSS antenna or antennas (whether it's EL-N-1 or EL-N-2) to the device.
3. Start the CDV application.
4. Configure platform, communication, GNSS, and telemetry settings as required.
5. Start telemetry streaming.
6. Monitor status and navigation output.
7. Record (log) selected data or decode binary telemetry directly in the host system.

After this setting, device will stream telemetry data as defined by the configuration, and these data can be parsed on different machines using communication protocol defined in the ICD section of this Document.

For field testing, the device should first be evaluated in open-sky conditions with a rigid installation and a known antenna setup. Poor antenna placement, operation near buildings or windows, and unstable antenna mounting can produce misleading results.

3. Hardware Setup

3.1 Device Connectors

EL-N devices use external connectors for power, host communication, and GNSS antenna connection.

For regular operation, EL-N-1 normally needs the power input, main communication interface to the host PC or controller, and GNSS antenna input. EL-N-2 operation also requires the second GNSS antenna input when dual-GNSS moving-baseline heading is used.

Before connecting the device to a vehicle or external controller, it is required to confirm the supply voltage and polarity, communication interface type and antenna connections.

For EL-N-2 operation with a dual-GNSS antenna setup, also confirm that the primary and secondary antenna cables are connected to the correct antenna inputs. This is important for the positioning aspect of the operation. On the EL-N-2 enclosure, there are clear markings for primary and secondary antenna connectors, where “1” points to primary antenna while “2” to secondary antenna connector.

3.2 Main Connector Pinout

The main connector is Harwin G125-FV11605L0R. Figure 2 lists the pinout for the main connector based on the current hardware schematic. Note: Some connector pins are reserved for future use and are not active in firmware version 1.0.0, including CAN and RS-485 interface pins. These pins should be left unconnected unless otherwise specified by Eloptris.

Important: Always verify the delivered cable or harness before applying power. Incorrect wiring of VIN, VUSB, GND, or interface pins may damage the device or the connected host equipment.

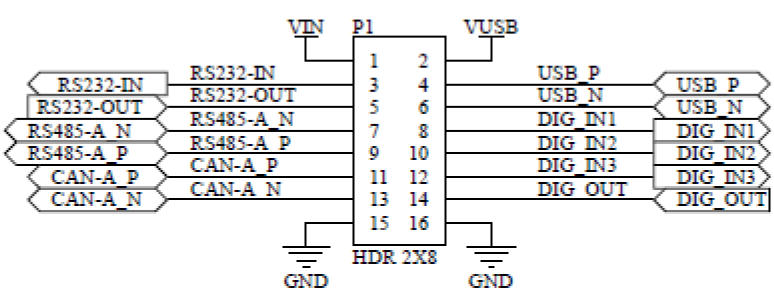

Figure 2: Main connector pinout

3.3 Power Supply Requirements

Connect the device only to a power supply that matches the specified input voltage range and polarity for the delivered device. The supported input range is 5–36 V DC. Do not apply power until the connector wiring and power supply range and polarity have been checked.

The power supply should be stable during device startup and operation. For vehicle testing, avoid loose temporary wiring and avoid powering the device from noisy or overloaded auxiliary lines unless this has been validated.

EL-N devices can use USB for both power supply and data exchange when connected to a laptop or host PC. Alternatively, the device can use a separate DC power supply together with RS-232 data cabling.

3.4 GNSS Antenna Connection

For EL-N-1 operation, connect the GNSS antenna to the sole GNSS connector on the enclosure. Use an active GNSS antenna suitable for the supported GNSS bands of the device (one of recommended antenna families is the u-blox ANN-MB series).

For first validation tests, place the antenna in open-sky conditions. Operation near windows, buildings, trees, metal structures, or other obstructions can compromise GNSS quality and may produce misleading test results.

The antenna cable should be fully seated and mechanically secured. Avoid sharp cable bends, damaged connectors, or temporary antenna placement that can move during testing.

3.5 Dual-GNSS Antenna Connection

For EL-N-2 operation with dual-GNSS moving-baseline heading, connect both GNSS antennas appropriately and mount them on a rigid structure with a fixed baseline.

When defining the antenna positions and baseline distance, take into account that moving baseline heading accuracy generally improves with greater antenna baseline. Therefore, it is recommended to place the antennas as far apart as practical for the host platform. The baseline distance should not be less than 0.2 m, because very short baselines may cause unreliable or even unavailable heading information.

The antennas should remain fixed relative to the device and platform during operation. Flexing mounts, loose antenna bases, or changing baseline geometry can degrade heading performance.

The dual-GNSS solution provides antenna baseline heading, which is the angle between the baseline (line connecting primary to the secondary antenna) and geographic North. To improve flexibility when mounting the antennas on a host platform, the CDV application provides a separate input field for the baseline angle relative to the longitudinal axis of the platform.

For first tests, both antennas should have a clear sky view. Window or indoor antenna positioning should be avoided because they will degrade performance and make misleading test results.

3.6 Communication Connection to PC

For configuration and monitoring with the CDV software application, connect the EL-N device to the PC using the supported communication interface.

The CDV application automatically detects the COM port on which the device is connected to the PC. During startup communication, CDV receives device information such as product type, serial number, firmware version, operation mode and sensor operating status.

Default serial settings are 921600 bps, 8 data bits, no parity, and 1 stop bit (8-N-1).

If CDV cannot connect or telemetry is not received, check the COM port, baud rate, wiring, ground connection, and selected interface type.

3.7 Installation Notes for Vehicle Testing

For vehicle or platform testing, mount the device rigidly to the vehicle structure. The device should not move, vibrate loosely, or change orientation relative to the vehicle during operation. Align the device axes with the vehicle axes as closely as practical. If the device is mounted with an intentional rotation or offset, configure the mounting orientation and lever-arm settings as required in CDV. Mount GNSS antennas rigidly and with clear sky view. For EL-N-2, the two antennas must maintain a fixed baseline. Cables should be secured so that they do not pull on the antennas or device during motion. Initial field tests should be performed in open-sky conditions. A simple test route should include an initial stationary period, straight motion, gentle turns, and several stop periods.

3.8 Hardware Setup Checklist

Table 3-2 provides a basic checklist for first-time setup and field-test preparation.

Item	Check	Notes
Power	Supply voltage and polarity confirmed	Input range: 5–36 V DC
Communication	Correct interface, COM port, and baud rate selected	Default serial settings: 921600, 8-N-1
Primary GNSS antenna	Connected and placed with clear sky view	Required for normal GNSS operation
Second GNSS antenna	Connected and rigidly mounted	Required for EL-N-2 moving-baseline heading
Device mounting	Device fixed rigidly to the platform	Avoid loose or temporary mounting for performance tests
Mounting orientation	Device/vehicle axes understood and configured if needed	Configured in CDV where applicable
Cables	Power, communication, and antenna cables secured	Avoid cable movement during test
CDV connection	Device visible and telemetry received	Verify before field test

Table 3-2 — Basic hardware setup checklist

4. Coordinate Frames and Sign Conventions

4.1 Body Frame

The body frame is fixed to the EL-N device. Sensor measurements, body-frame velocity components, angular rates, and installation orientation are referenced to this frame.

For correct operation, the device axes must either be aligned with the host platform axes or the mounting rotation must be entered in CDV application. The intended platform convention is forward, right, and down for the longitudinal, lateral, and vertical directions respectively. On the device enclosure, there’s clear drawing of body frame axis.

The body-frame axes are defined as follows:

Axis	Positive direction	Typical platform interpretation	Common associated quantities
X	Forward	Longitudinal direction	Forward acceleration, roll rate axis reference
Y	Right	Lateral direction	Lateral acceleration, pitch rate axis reference
Z	Down	Vertical direction	Gravity direction, yaw rate axis reference

Table 4-1 — EL-N body-frame axis convention

4.2 Navigation Frame

Navigation data is expressed in the local North-East-Down (NED) frame unless a specific output field is identified as body-frame data.

In the NED frame, the positive axes are North, East, and Down. Positive vertical displacement and vertical velocity therefore point downward. Altitude, however, is reported using the conventional positive-up representation defined for the corresponding altitude field.

The navigation frame is locally referenced to the Earth and changes as the device moves. Latitude and longitude provide the global position reference, while local navigation quantities use the North, East, and Down convention.

NED axis	Positive direction	Example
N	Geographic North	Positive north velocity
E	East	Positive east velocity
D	Down	Positive downward velocity

Table 4-2 — North-East-Down navigation-frame convention

4.3 Roll, Pitch, and Yaw Definitions

EL-N attitude output describes the orientation of the body frame relative to the navigation frame. Attitude is available as roll, pitch, and yaw angles and as a quaternion.

Roll is rotation about the body X-axis. Pitch is rotation about the body Y-axis. Yaw is rotation about the body Z-axis and represents the horizontal orientation of the platform.

For the normal forward-right-down installation convention, positive roll represents a right-side-down rotation, positive pitch represents a nose-up rotation, and positive yaw increases clockwise when viewed from above.

4.4 Heading Sources

Yaw output is maintained by the navigation filter and can be aided by different heading sources depending on the EL-N variant, configuration, motion state, and measurement validity.

EL-N-1 can use GNSS course over ground when sufficient motion is available. At low speed or standstill, course over ground is not a reliable representation of platform heading.

EL-N-2 can use dual-GNSS moving-baseline heading when the relative-position solution is valid. This heading remains usable at low speed and standstill, provided both antennas have sufficient GNSS visibility and the antenna baseline is correctly configured.

The active heading source and heading-validity information are available in the device telemetry and CDV status display. Integrating software should use these status fields rather than assuming that every yaw sample has the same measurement source or confidence.

Heading source	Typical availability	Main limitation	Applicable device
GNSS course over ground	Platform moving above the configured speed/quality threshold	Represents direction of motion; unreliable at low speed or standstill	EL-N-1 and EL-N-2
Dual-GNSS heading	Valid moving-baseline solution	Requires two antennas, rigid baseline, and adequate GNSS visibility	EL-N-2
Magnetic heading	When supported and enabled by the delivered configuration	Affected by magnetic environment	EL-N-1 and EL-N-2

Table 4-4 — Typical EL-N heading sources

4.5 Mounting Orientation

The preferred installation aligns the EL-N body axes with the platform axes. In this case, the device X-axis points forward, the Y-axis points right, and the Z-axis points down.

When this alignment is not possible for whatever reason, enter the mounting orientation in CDV (in degrees). The mounting rotation defines the fixed angular relationship between the device body frame and the host-platform frame.

Incorrect mounting orientation causes sensor data and attitude output to be interpreted in the wrong platform axes. This may appear as exchanged roll and pitch, reversed signs, or navigation errors during motion.

After configuring mounting orientation, verify the installation before field testing. With the platform level and stationary, roll and pitch should be physically plausible. During a simple controlled tilt or turn, the reported angle and sign should correspond to the platform motion.

Recommended verification sequence:

- Place the platform on a level surface and check roll and pitch.
- Raise the front of the platform and confirm that pitch changes in the expected positive direction.
- Lower the right side or raise the left side and confirm the expected positive roll direction.
- Rotate the platform clockwise when viewed from above and confirm the expected yaw increase.
- Confirm that the configured antenna-baseline angle for EL-N-2 matches the physical installation.

5. CDV Application Overview

5.1 Purpose of CDV

CDV is the Eloptris developed PC application used to communicate with EL-N devices, view device status, configure operating parameters, select telemetry fields, monitor navigation output, and record selected data to a local CSV file.

CDV is intended to provide a practical interface for first-time setup, routine configuration, field-test preparation, and data review. It also allows the user to verify correct device operation before integrating the EL-N binary communication protocol into custom host software.

5.2 Installing and running CDV

CDV application is installed on a Windows PC computer using the installation package supplied with the EL-N device or evaluation package. Follow the installation instructions provided with the software package. The CDV application is intended for use on supported 64-bit Microsoft Windows systems. Supported operating systems are:

Windows 10, 64-bit

Windows 11, 64-bit

CDV application is distributed as a Windows installer package. Administrator privileges may be required during installation.

Before starting CDV application, connect the EL-N device to the PC using either the USB or the RS232 serial interface. If a separate RS-232 connection is used, ensure that the device is also connected to a valid external power supply.

After starting CDV application, it will scan the available communication ports and attempts to identify a connected EL-N device. When communication is established, CDV reads basic identification and status information from the device. That information will be clearly displayed. Information includes product type, serial number, com port and baud rate, firmware version and output data rate.

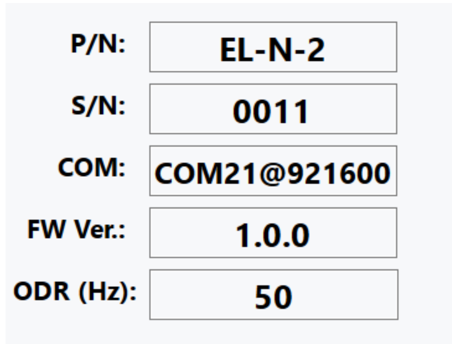

Figure 3: Device information obtained on application start

If there is a problem with connecting with EL-N device, follow this procedure to make sure EL-N device is connected to the PC:

1. Verify that EL-N device is connected to the PC.
2. Open Windows Device Manager.
3. Expand the "Ports (COM & LPT)" section.
4. Verify that the device appears as a USB serial COM port.
5. Start CDV.

If no COM port appears, check the USB cable, USB port, device power, and CH340 driver installation. The USB driver installer can be run again from the driver folder included with the CDV installation package.

5.3 Main Application Areas

The CDV user interface is divided into several functional sections, which are presenting various device related information to the user:

- "Overview" - shows system state, sensor status, GNSS status, heading status, and active error or warning conditions and basic attitude and navigation data.
- "Platform Setup" – used for setting different platform configuration data that are relevant for the device operation, including: gnss lever arm, sensor frame alignment data, baud rate, ODR (output data rate in Hz), mounting orientation and moving baseline axis alignment.
- "Data Output" - used for setting data types that are to be sent from the device in real time as part of telemetry package.
- "IMU and Attitude" – showing real time values of bias corrected gyroscope and accelerometer data.
- "DMC / Compass" – showing real time values of digital magnetic compass values compensated for hard and soft iron effects, as well as magnetic heading.
- "GNSS" – showing real time GNSS navigation data.
- "RTK" – used to connect to the source of RTK connections and start automatic forwarding of RTK packets to the device for improved positioning.
- "Firmware" – used for launching firmware update.
- "Recording" – used for selecting telemetry fields that will be saved to a local csv file for post mission analysis.

5.3.1 Overview

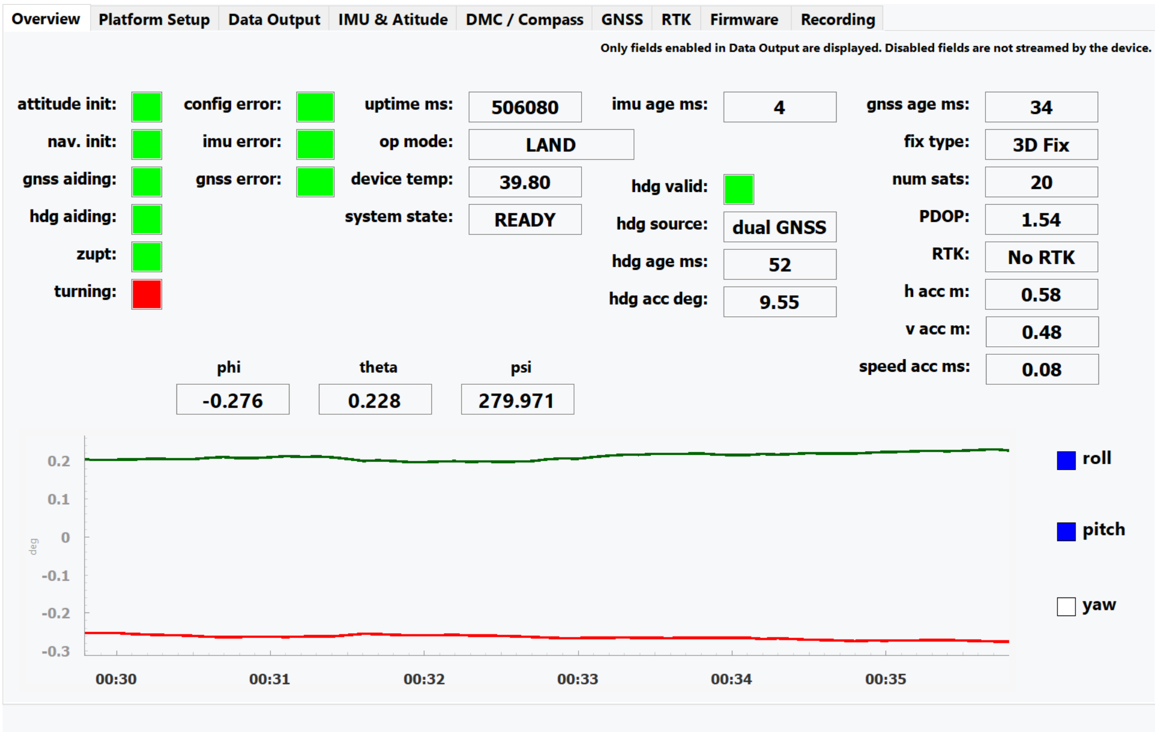

Figure 4: Overview section

Following is the meaning of various elements in the "Overview" section:

"attitude init": shows if attitude navigation module has been initialized properly. If so, color is lime otherwise it's red.

"nav.init": shows if navigation module has been initialized properly. If so, color is lime otherwise it's red.

"gnss aiding": shows if gnss aiding is used for position/velocity correction. If so, color is lime otherwise it's red.

"hdg aiding": shows if external source is used for heading correction. If so, color is lime otherwise it's red.

"zupt": shows if platform is static. If so, color is lime otherwise it's red.

"turning" : shows if platform is turning. If so, color is lime otherwise it's red.

"config error": shows if device configuration has been read properly. If so, color is lime otherwise it's red.

"imu error": shows if IMU is working properly. If so, color is lime otherwise it's red.

"gnss error": shows if GNSS is working properly. If so, color is lime otherwise it's red.

“uptime ms”: shows time device has been working since last power up, expressed in milliseconds.

“op mode”: shows operational mode of the device. It could be: land, fixed wing, multirotor, vtol or sea.

“device temp”: shows device temperature, which is measured at the IMU.

“system state”: shows overall device mode. Could be: init, ready or fail.

“imu age ms”: shows last time of imu data successfully read.

“hdg valid”: shows if aiding heading information is valid. If so, color is lime otherwise it’s red.

“hdg source”: shows the source of heading aiding. Depending on the product, it can be dual GNSS heading, GNSS COG (course over ground) or DMC (digital magnetic compass).

“hdg age ms”: shows the age of the heading aiding information, expressed in milliseconds.

“hdg acc deg”: shows estimated accuracy of the heading aiding source.

“gnss age ms”: shows the age of the gnss position information

“fix type”: shows the type of fix that has been achieved by gnss receiver. Values could be: “No Fix”, “DR Only”, “2D Fix”, “3D Fix”, “Time Only”.

“num sats”: shows number of satellites currently tracked by the receiver.

“PDOP": shows the overall numeric quality of the gnss information.

5.3.2 Platform Setup

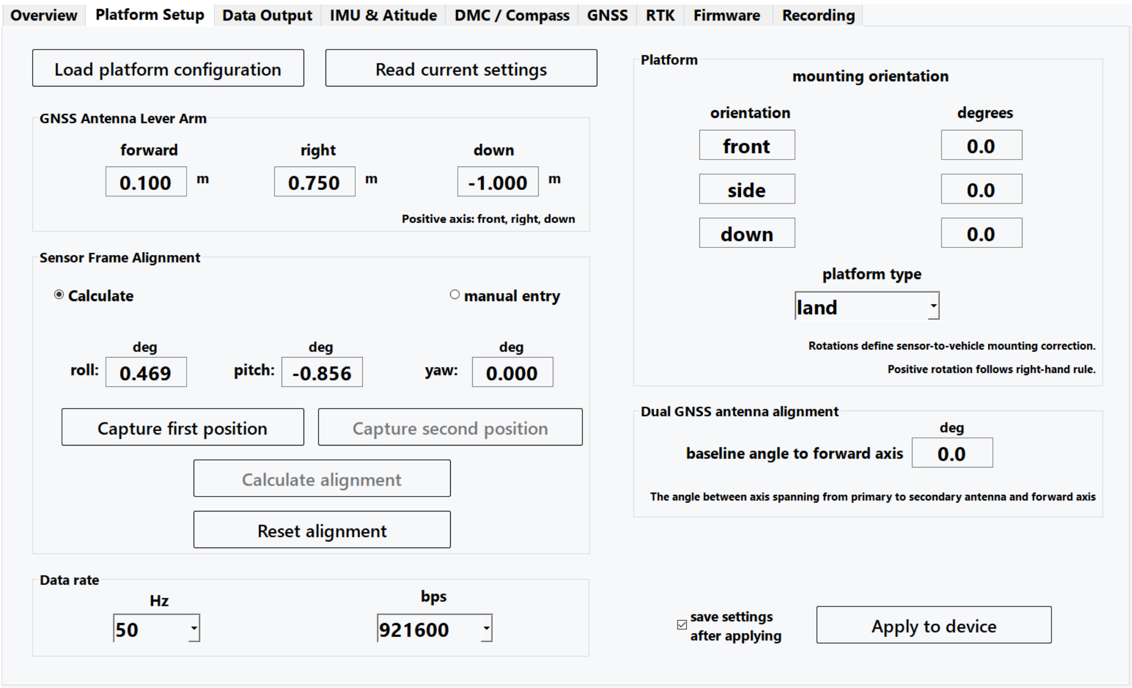

Figure 5: Platform Setup Section

"Platform Setup" section is used to define mechanical installation parameters, operating mode and communication rate, while for EL-N-2 it is also used for setting dual-GNSS antenna alignment.

Correct platform setup is important because the device uses these parameters when transforming sensor measurements into the vehicle frame and when reporting navigation outputs.

"Platform Setup" section is to be used during initial installation, after changing the mechanical mounting position of the device or antennas, or when changing the output data rate or communication baud rate.

"Load platform configuration" button loads platform configuration values from the local CDV configuration file.

"Read current settings" button requests the currently stored platform settings from the connected device and displays them in the "Platform Setup" section. This is useful for checking the active configuration before making changes.

“GNSS Antenna Lever Arm” fields define the position of the GNSS antenna relative to the EL-N device. Lever arm components are entered relative to the vehicle/device body axes:

- “forward”: positive toward the front of the vehicle,
- “right”: positive toward the right side of the vehicle,
- “down”: positive downward.

All lever-arm values are entered in meters and should correspond to the position of the primary GNSS antenna. For EL-N-2, the primary antenna is the antenna connected to GNSS antenna connector 1. Incorrect lever-arm values may introduce position and attitude errors, especially during turns, acceleration, or operation with dual-GNSS heading.

“Sensor Frame Alignment” section is used to define the angular alignment between the EL-N sensor frame and the vehicle frame. The alignment can be determined automatically or entered manually. When automatic calculation is used, CDV application calculates roll and pitch alignment from stationary measurements captured using “Capture first position” and “Capture second position”. After the required positions are captured, the “Calculate alignment” button computes the alignment correction. This function is intended to compensate for small mounting errors when the EL-N device is not perfectly aligned with the vehicle frame.

For normal use on approximately level ground, the vehicle does not need to be moved between the first and second capture. The vehicle should remain stationary during both captures. If the vehicle is standing on a slope with a pitch angle greater than approximately 5 degrees, the vehicle/platform should be rotated by 180 degrees between the first and second capture. In this case, the second capture should be taken with the vehicle facing the opposite direction on the same slope. This allows CDV to separate the mounting alignment error from the slope angle. Automatic calculation determines roll and pitch alignment only. Yaw alignment cannot be determined from stationary accelerometer measurements and must be entered manually if required.

When “manual entry” is selected, roll, pitch, and yaw frame-alignment values can be entered directly. The alignment angles are entered in degrees. “Reset alignment” button clears the stored alignment values.

“Data rate” section defines the telemetry output rate and communication baud rate.

“Hz” field selects the device telemetry output rate, while “bps” field selects the serial communication baud rate.

After changing the baud rate, the host software may need to reconnect using the new baud rate. Use this setting carefully, especially when communicating through third-party software. After changing these parameters, it is recommended to do power reset.

“Mounting orientation” section defines the sensor-to-vehicle mounting correction. The orientation values are entered as rotations about the front, side, and down axes. Positive rotation follows the right-hand rule. These fields should be used when the EL-N device is installed with a known rotation relative to the vehicle frame.

“platform type” field selects the operating mode used by the device.

Supported operating modes are:

- “Land” - Ground vehicle / land platform
- “fixed wing” - Fixed-wing aircraft
- “multirotor” - Multicopter / rotary-wing UAV
- “VTOL” - Vertical takeoff and landing platform
- “Sea” - Marine / surface vehicle platform

The selected platform type affects how the device interprets motion and applies navigation logic.

“Dual GNSS antenna alignment” field defines the angle between the baseline from the primary GNSS antenna to the secondary GNSS antenna and vehicle forward axis. This value is used only for EL-N-2 devices with dual-GNSS heading capability. For EL-N-1 devices, this field may be left at zero or ignored by the device. The angle is entered in degrees. Correct baseline alignment is important for accurate dual-GNSS heading output. The baseline angle should match the physical antenna installation on the vehicle.

“Apply to device” button sends the displayed platform settings to the connected EL-N device. If “save settings after applying” is checked, these settings will be stored in non-volatile memory of the device and remain active after power cycling the device. If this option is not checked, the settings may apply only to the current operating session, depending on firmware configuration. After applying settings, it is recommended to use “Read current settings” to verify that the device accepted the configuration.

5.3.3 Data Output

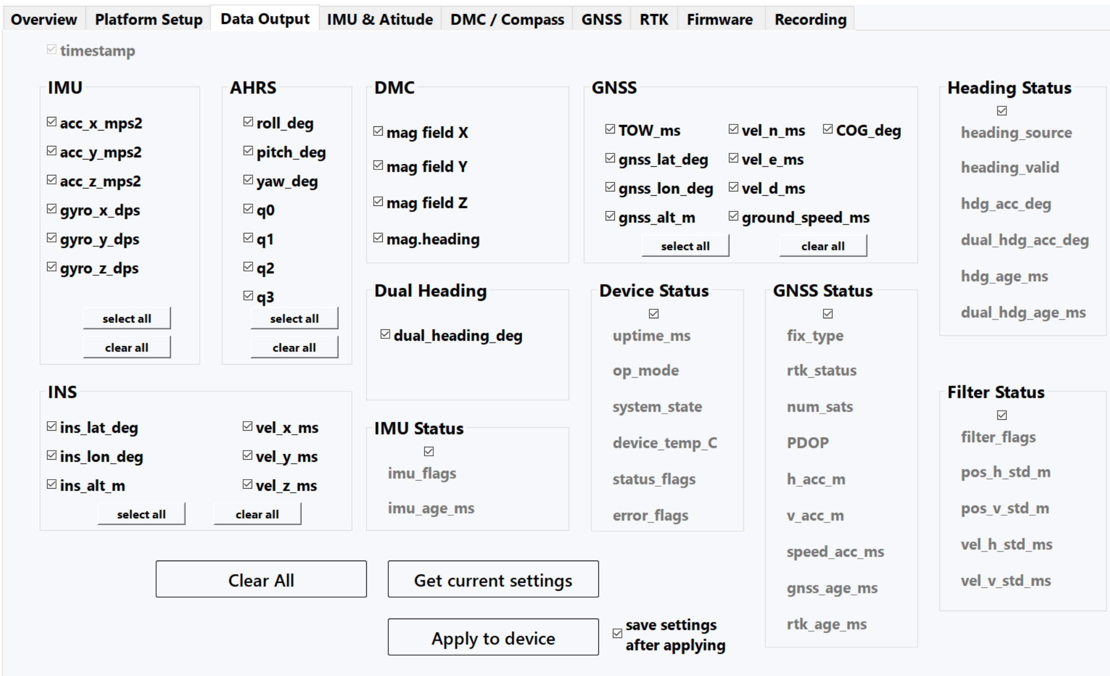

Figure 6: Data Output Section

“Data Output” section is used to select which telemetry fields are transmitted by the EL-N device and displayed or recorded by CDV, or received and parsed by other 3rd party software. The EL-N telemetry message is user configurable. Some fields, such as the timestamp, are always included, while other output groups can be enabled or disabled depending on the application. Reducing the number of selected fields can reduce packet size, logging file size, and parser load.

Telemetry fields are organized into functional groups:

IMU - Raw acceleration and angular-rate measurements
AHRS - Roll, pitch, yaw, and quaternion attitude outputs
DMC - Magnetometer field measurements and magnetic heading
GNSS - GNSS time, position, velocity, ground speed, and course over ground
Dual Heading - Dual-GNSS heading output for EL-N-2 devices
INS - Fused INS position and body-frame velocity outputs
Device Status - Device uptime, operation mode, temperature, system state, status flags, and error flags

IMU Status - IMU data age and IMU status flags
GNSS Status - GNSS fix, RTK, satellite, accuracy, and age information
Heading Status - Heading source, validity, accuracy, and age information
Filter Status - AHRS/INS initialization, aiding status, ZUPT, turn detection, and estimated navigation uncertainty

“timestamp” field is always enabled and is included in each telemetry packet.

Each checkbox enables or disables one telemetry field or one telemetry status section, while “select all” and “clear all” buttons inside a group can be used to quickly enable or disable all fields in that group. The “Clear All” button on the section level clears all telemetry fields across the complete output configuration. For normal logging and customer evaluation, it is recommended to keep at least the following groups enabled:

- AHRS attitude outputs
- GNSS position and status
- INS position and velocity
- Device Status
- GNSS Status
- Filter Status

For detailed sensor analysis, IMU, DMC, and quaternion outputs may also be enabled.

The status groups provide diagnostic and validity information for the telemetry data. These fields are important during testing, commissioning, and log analysis. They should normally be enabled during evaluation because they indicate whether GNSS aiding, heading aiding, ZUPT, filter initialization, RTK status, and error conditions are active. The detailed binary layout and bit definitions for these fields are described in the ICD section of this manual.

“Get current settings” button reads the currently active telemetry field selection from the connected device and updates the Data Output tab. Use this button to verify which fields the device is currently configured to transmit.

“Apply to device” button sends the selected telemetry output configuration to the device. If “save settings after applying” is checked, the selected output configuration is stored in non-volatile memory of the device and remains active after the device is restarted. If this option is not checked, the selected output configuration may apply only to the current operating session, depending on firmware configuration.

Notes for 3rd party software:

It should not be assumed that all telemetry fields are always present. The telemetry packet contains section masks that define which fields are included in each packet. A parser shall decode each telemetry section according to the corresponding section mask. If a field is disabled in this tab, that field is not included in the telemetry payload and the following fields shift accordingly. The ICD chapter provides the exact binary packet format, field order, data types, section masks, and parser examples.

5.3.4 IMU and Attitude

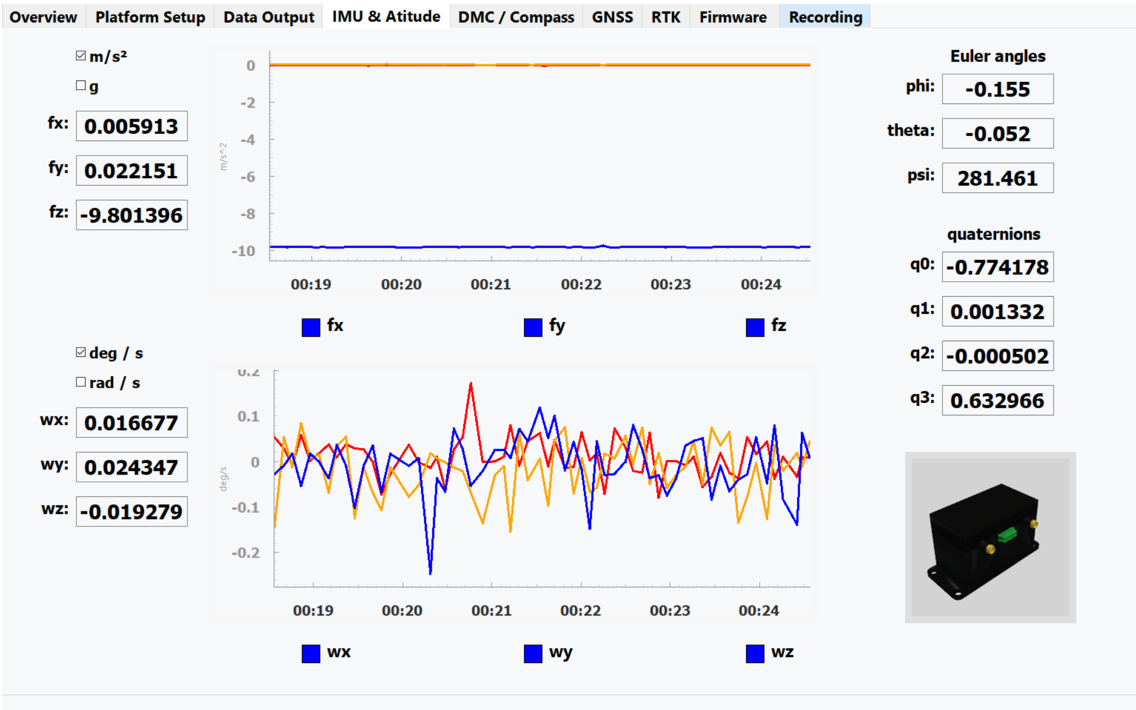

Figure 7: IMU and Attitude Section

"IMU & Attitude" section displays live inertial sensor measurements and attitude outputs received from the EL-N device. This tab is useful for checking that the IMU is operating correctly, verifying sensor orientation and confirming that attitude outputs are stable during stationary operation.

The upper-left section displays acceleration measurements along the EL-N body axes:

- "fx": acceleration (specific force) along the body X axis
- "fy": acceleration (specific force) along the body Y axis
- "fz": acceleration (specific force) along the body Z axis

Acceleration can be displayed in either m/s² or g units, depending on the user's selection. When the device is stationary and approximately level, one acceleration component should be close to the gravity value, depending on the device mounting orientation. The other two components should normally be close to zero, except for small sensor noise, vibration, or mounting tilt. The upper plot shows the recent acceleration history for the selected axes. This makes it easier to observe vibration, sudden motion, or unexpected sensor behavior.

The lower-left section displays gyroscope measurements along the EL-N body axes:

- “wx”: angular rate about the body X axis
- “wy”: angular rate about the body Y axis
- “wz”: angular rate about the body Z axis

Angular rate can be displayed in either deg/s or rad/s, depending on user’s selection. When the device is stationary, angular-rate values should remain close to zero, with only small noise visible. Larger values indicate rotation, vibration, or motion of the platform. The lower plot shows the recent angular-rate history for the selected axes.

“Euler angles” section displays the current attitude solution:

- “phi” : roll angle
- “theta”: pitch angle
- “psi”: yaw / heading angle

Angles are displayed in degrees.

5.3.5 DMC/Compass

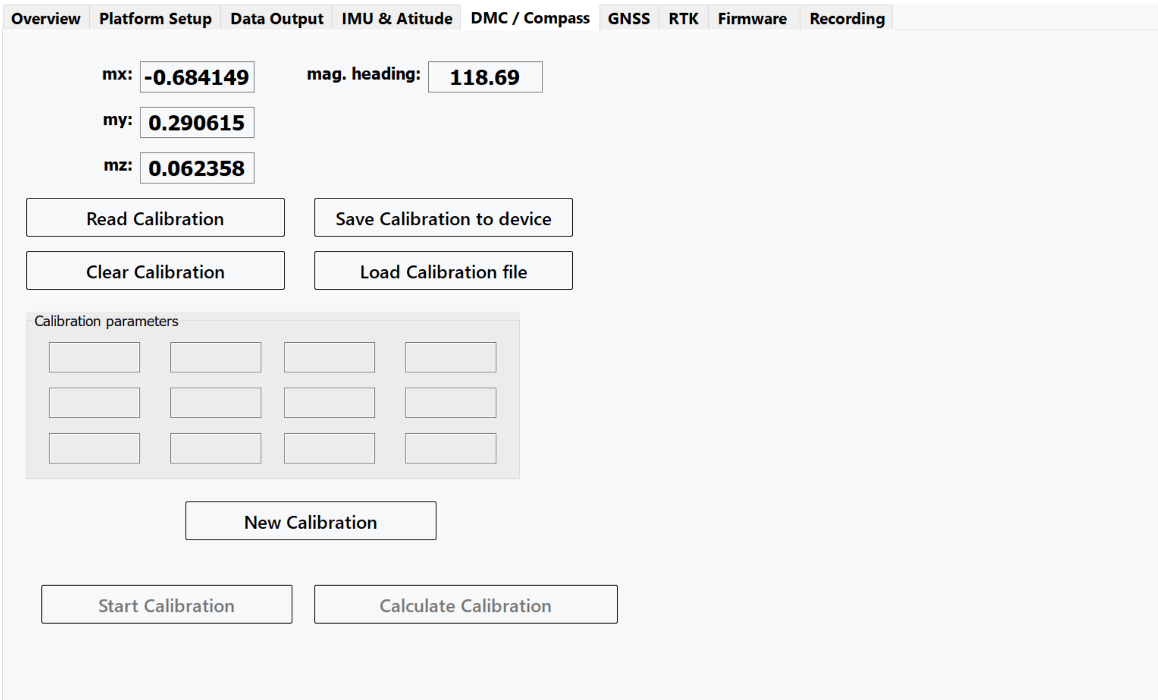

Figure 8: DMC / Compass Section

“DMC / Compass” section displays live magnetometer measurements, magnetic heading, and magnetometer calibration control functions. This section is mainly used during installation, troubleshooting, and compass calibration. During normal operation, the compass can provide a heading reference when other heading sources are compromised and compass is calibrated.

The live magnetometer measurements are displayed as:

- “mx”: magnetic field measurement along the body X axis
- “my”: magnetic field measurement along the body Y axis
- “mz”: magnetic field measurement along the body Z axis

“mag. heading” field displays the heading calculated from the magnetometer measurements after applying calibration parameters. It should be noted that after valid gps position correction has been received, magnetic heading is automatically corrected for magnetic declination, which is calculated automatically using WMM model and local gps coordinates.

Displayed magnetic values are useful for checking whether the magnetometer is operating and whether the device is affected by local magnetic disturbance. Large unexpected changes, unstable readings, or unrealistic heading values may indicate magnetic interference from nearby metal objects, motors, power cables, magnets, or the vehicle structure.

“Calibration parameters” section displays the currently loaded DMC calibration values that are used for compensating hard and soft iron effects. Calibration parameters consist of three bias values and a 3 × 3 scale/correction matrix. These parameters are used to compensate magnetometer offset and scaling errors.

“Read Calibration” button requests the current DMC calibration parameters from the connected EL-N device and displays them in CDV. This function should be used to verify which calibration is currently active in the device.

“Load Calibration file” button loads previously saved calibration parameters from a local file into CDV. After loading a calibration file, the values are displayed in the calibration parameter fields. The calibration is not permanently stored in the device until it is written to the device.

“Save Calibration to device” button sends the displayed calibration parameters to the connected EL-N device, where they are automatically stored in non-volatile memory. This function should be used only after the calibration values are known to be valid. Incorrect magnetometer calibration may cause incorrect magnetic heading and may degrade heading performance when compass heading is used.

“Clear Calibration” button clears the DMC calibration parameters on the device. Use this only when the existing calibration is known to be invalid or when a new calibration will be performed. After clearing calibration, magnetic heading is unreliable until valid calibration parameters are loaded or a new calibration is completed.

“New Calibration” button prepares CDV for a new DMC calibration procedure. During calibration, the device should be moved through different orientations so that the magnetometer can observe the local magnetic field from multiple directions. Calibration should be performed away from strong magnetic disturbances, large metal structures, electrical cables, motors, or magnets. “Start Calibration” and “Calculate Calibration” buttons are used during the calibration workflow. These controls may be disabled until the required calibration state or input data is available.

Notes: Compass calibration should be performed in the final installation environment whenever possible. If the device or nearby equipment is moved after calibration, the magnetic environment may change and recalibration may be required.

For EL-N devices installed on vehicles with significant magnetic disturbance, GNSS-based heading sources may be preferred when available. The detailed binary commands for DMC calibration are handled by CDV and are not part of the public ICD.

5.3.6 GNSS

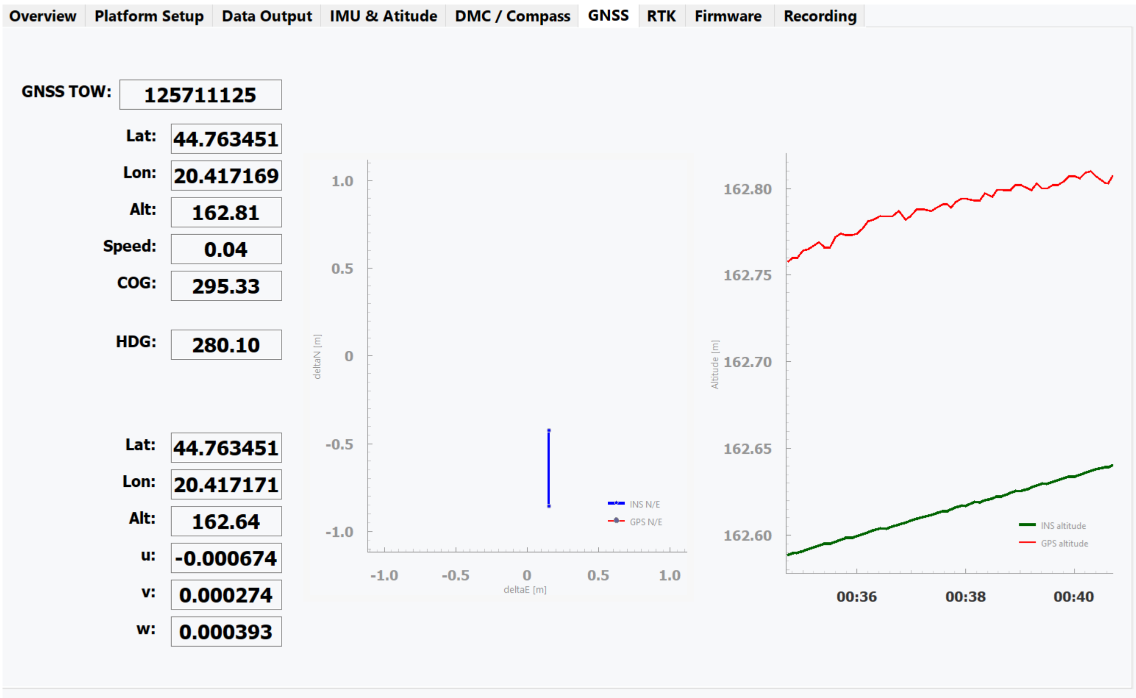

Figure 9: GNSS Section

"GNSS" section displays live GNSS and INS navigation data received from the EL-N device. It is used to monitor GNSS position, speed, course over ground, dual-GNSS heading, INS position, INS velocity, and basic position/altitude consistency between GNSS and INS outputs.

The upper-left part of the tab displays direct GNSS measurements:

- GNSS TOW: GNSS time of week, in milliseconds
- Lat: GNSS latitude, in degrees
- Lon: GNSS longitude, in degrees
- Alt: GNSS altitude, in meters
- Speed: GNSS ground speed, in meters per second
- COG: GNSS course over ground, in degrees
- HDG: heading output, in degrees

COG value represents motion direction over ground and is reliable only when the platform is moving with sufficient speed. At very low speed or while stationary, COG may be noisy or invalid because the direction of motion is poorly defined.

HDG value represents dual-GNSS heading, reported from EL-N-2.

The lower-left part of the tab displays INS navigation outputs:

- Lat: INS latitude, in degrees
- Lon: INS longitude, in degrees
- Alt: INS altitude, in meters
- u: INS body-frame X velocity
- v: INS body-frame Y velocity
- w: INS body-frame Z velocity

The INS outputs are produced by the EL-N navigation filter. They combine inertial measurements with available aiding sources such as GNSS position, GNSS velocity, heading, and zero-velocity detection, depending on configuration and operating conditions. The INS position and altitude may differ slightly from direct GNSS measurements due to filtering, inertial prediction, aiding state, and sensor dynamics.

The center plot shows the relative horizontal position history of GNSS and INS outputs. The plot is useful for checking whether GNSS and INS tracks are consistent during operation. Large separation between the GNSS and INS traces may indicate GNSS degradation, initialization issues, incorrect platform settings, incorrect lever-arm settings, or filter aiding problems. During normal operation, GNSS and INS position traces should remain reasonably close, depending on GNSS quality, dynamics, and filter state.

The right plot shows GNSS altitude and INS altitude over time. This plot is useful for checking vertical consistency between the GNSS receiver and the INS solution. Small differences are expected because GNSS altitude can be noisy and the INS altitude is filtered. Large or growing differences may indicate poor GNSS quality, incorrect initialization, aiding loss, or configuration issues.

5.3.7 RTK

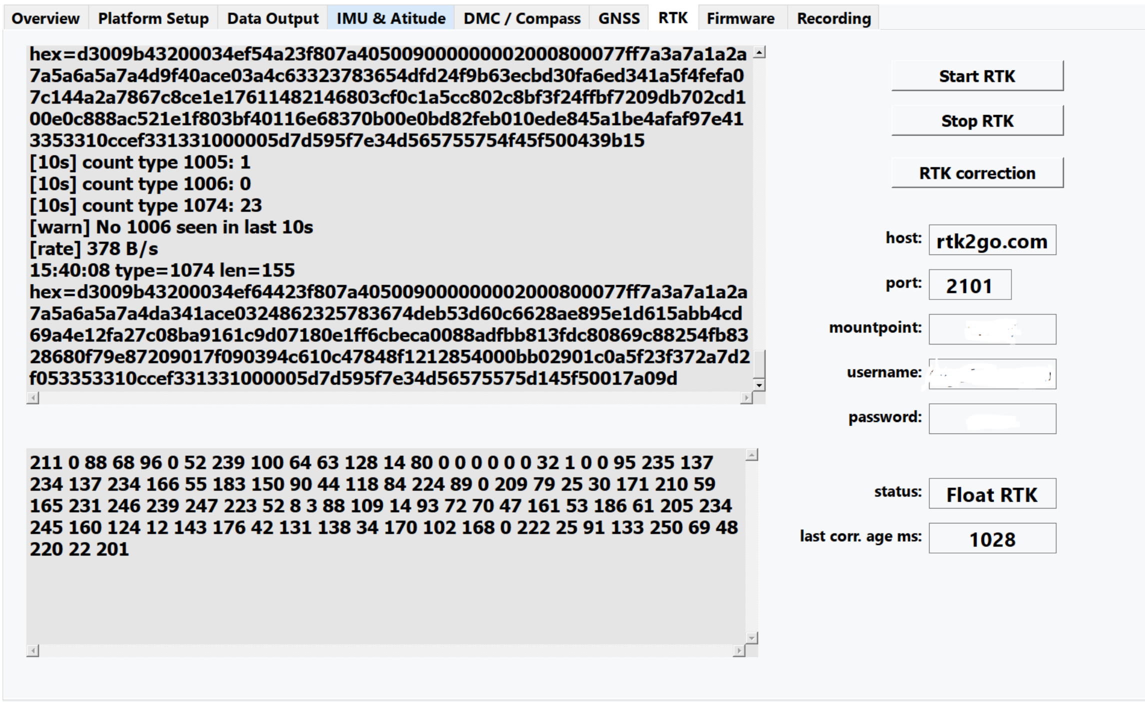

Figure 10: RTK Section

"RTK" section is used to connect CDV to an external RTK correction source and forward correction data to the EL-N device. RTK corrections are typically received from an NTRIP caster and forwarded by CDV to the GNSS receiver inside the EL-N device. When valid corrections are available and the GNSS receiver accepts them, the GNSS solution may improve from standalone GNSS to differential, float RTK, or fixed RTK, depending on signal conditions, correction quality, baseline distance, and satellite geometry. Main prerequisite for receiving RTK corrections is either internet or some other form of connection with the NTRIP caster.

The RTK connection settings define the correction data source:

- Host - NTRIP caster host name or IP address
- Port - NTRIP caster port
- Mountpoint - NTRIP mountpoint used for the correction stream
- Username - NTRIP username
- Password - NTRIP password

These values are provided by the RTK/NTRIP correction service provider.

"Start RTK" button starts the RTK correction connection using the configured host, port, mountpoint, username, and password. When the connection is active, CDV receives RTCM correction frames from the correction source and displays them. "Stop RTK" button stops the RTK correction connection.

“RTK correction” button forwards RTK correction data to the device.

The large text areas on the left side of the tab display received correction data and diagnostic information. This can include raw RTCM frame information, hexadecimal frame data, byte values, message type, message length, and received data rate. This display is mainly intended for debugging and verification. A normal user does not need to interpret the raw correction frame data.

“status” field displays the current RTK/GNSS correction state reported by the device or GNSS receiver. Typical status values may include standalone GNSS, differential GNSS, float RTK, or fixed RTK, depending on receiver state and correction availability.

“last corr. age ms” field shows the age of the most recent correction data in milliseconds. A small and regularly updating correction age indicates that RTK correction data is being received and forwarded. A large or increasing value may indicate that correction data has stopped, the network connection is unavailable, or the correction stream is not being accepted.

5.3.8 Firmware

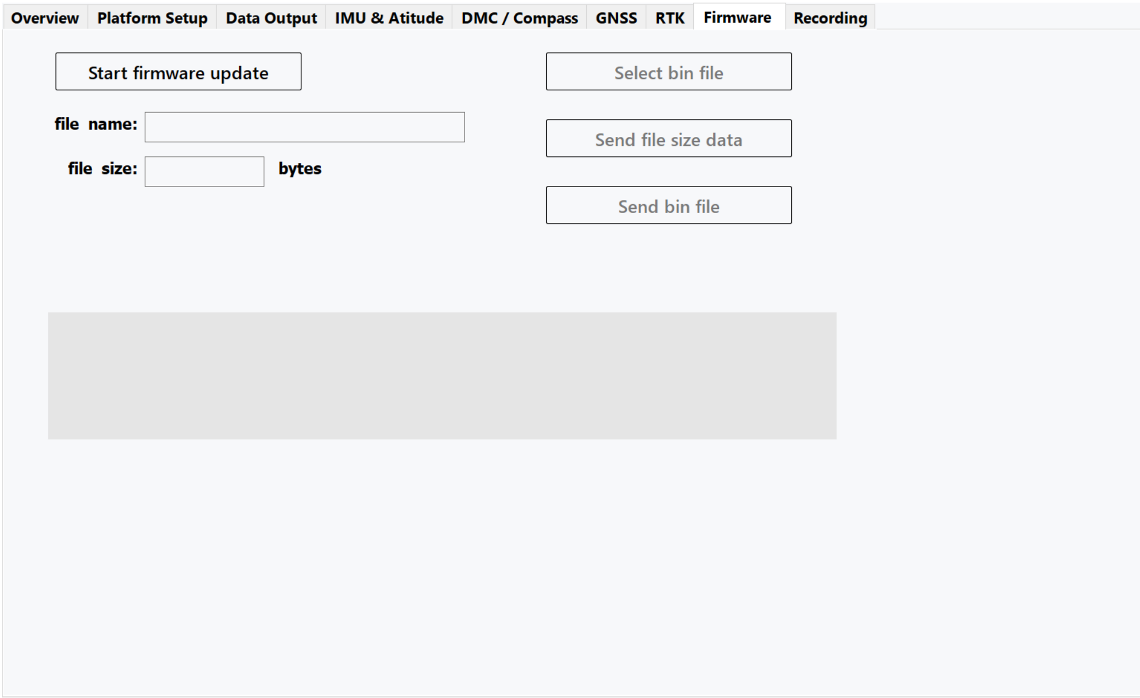

Figure 11: Firmware update section

"Firmware" section is used to update the firmware of the connected EL-N device using the official CDV application. Firmware update is a protected CDV-controlled function. The firmware update protocol is not part of the public ICD and should not be implemented by 3rd party software.

Firmware update process is performed in several steps:

- Start the firmware update procedure.
- Select the firmware binary file.
- Send file size information to the device.
- Wait for confirmation that firmware binary file details are correct.
- Send the firmware binary file.
- Wait for the update process to complete.
- Restart or reconnect the device if required.

"Start firmware update" button starts the update procedure and prepares the device for firmware transfer. Message "Firmware update started" is shown.

"Select bin file" button is used to select the firmware binary file. Note that only binary files supplied by Eloptris are eligible for download onto device.

After a valid file is selected, the "file name" and "file size" fields display the selected firmware file information. "Send file size data" button sends the selected file size information to the device. After that, it is awaited that device sends messages, which are displayed to the user: "Firmware update data verified” and “Device ready for file transfer”. After that button “Send bin file” is enables and by pressing that button file transfer starts. At the end of successful firmware update following message will be displayed to the user: “New firmware successfully uploaded”.

Important Notes

- Only firmware files supplied or approved by Eloptris should be used.
- Do not disconnect power, disconnect the communication cable, close CDV, or reset the device while firmware transfer is in progress.
- Firmware update should be performed only when the device is connected with a stable power supply and a reliable communication link.
- If the firmware update fails or is interrupted, repeat the update procedure using CDV. If the device does not return to normal operation, contact Eloptris support.

5.3.9 Recording

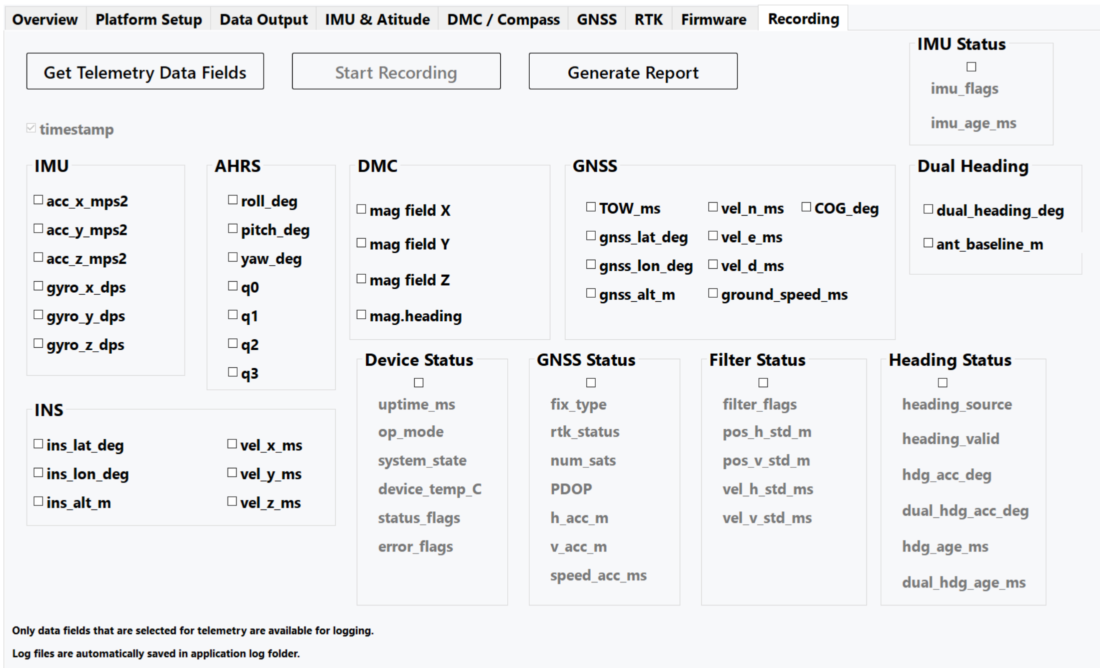

Figure 12: Recording section

"Recording" section is used to select telemetry fields for CSV logging and to generate a test report from recorded data. Only telemetry fields that are currently enabled in the device output configuration are available for logging. If a field is not selected for telemetry output, it cannot be recorded by CDV.

"Get Telemetry Data Fields" button reads the currently available telemetry fields from the active telemetry stream and updates the Recording tab.

Each checkbox selects whether the corresponding telemetry field will be written to the CSV log file. Logging selection is separate from telemetry output selection. A field must first be present in the received telemetry stream before it can be selected for logging.

For normal navigation testing, it is recommended to record at least:

- timestamp
- GNSS position and status
- INS position and velocity
- attitude outputs
- heading status
- filter status
- device status

For detailed troubleshooting, IMU, DMC, quaternion, and additional status fields should also be recorded.

“Start Recording” button starts CSV logging using the selected fields. While recording is active, CDV writes received telemetry data to a log file, which is of csv (comma separated value) type. Log files are automatically saved in the application log folder, which is automatically created for each logging date. Each file has it’s name automatically created in the following pattern: “Logs_”+current_date+ODR[Hz]. In that way each logging session will create separate file.

“Generate Report” button creates a report from recorded telemetry data. The report is intended to help review test results, inspect navigation performance, and identify possible configuration, GNSS, INS, heading, or status issues. Report quality depends on the fields available in the recorded CSV file. If important status fields were not logged, some diagnostic sections of the report may be incomplete.

Notes:

- Before starting a test recording, verify that the required telemetry fields are enabled in the “Data Output” section and visible in the “Recording” tab.
- For evaluation or troubleshooting logs, avoid recording only position fields. Status fields are important because they explain why the navigation solution behaves a certain way.

6. Operating the Device

6.1 Power-Up Sequence

Before applying power, confirm that the power wiring, polarity, communication connection, and GNSS antenna connections match the required device configuration.

After power is applied, the EL-N device starts its internal initialization sequence. The connected sensors and GNSS receiver are checked, previously stored configuration is loaded, and the communication interface becomes available to CDV or host software.

Do not move or disconnect the device while power-up configuration is being exchanged with CDV. Allow the startup sequence to complete before changing settings or beginning a test.

6.2 Initialization

Initialization prepares the inertial sensors, GNSS receiver, navigation filter, and communication interface for operation. The time required to reach the normal operating state depends on sensor status, GNSS reception, stored configuration, and the selected product variant.

6.3 GNSS Acquisition

The GNSS antenna or antennas should be connected before GNSS performance is evaluated. Initial acquisition should be performed outdoors with a clear sky view. Indoor operation or operation near windows may be sufficient for verifying operation and communication, but it should not be used to evaluate positioning or heading performance.

GNSS readiness should be evaluated using the displayed fix status, satellite/solution quality indicators (e.g PDOP), estimated accuracy fields, and update activity available in CDV. A changing position value alone does not confirm that the GNSS solution is suitable for navigation.

When RTK corrections are used, the user should separately verify that correction data is being received and that the GNSS solution has reached the required status for the test.

6.4 Heading Initialization

The heading source depends on the EL-N variant, configuration, motion state, and validity of the available heading measurements.

EL-N-1 uses single-antenna GNSS information and other configured heading sources. GNSS course over ground becomes useful only when the platform is moving with sufficient speed and the GNSS velocity solution is valid. At standstill or very low speed, course over ground should not be interpreted as a reliable vehicle heading.

EL-N-2 can use dual-GNSS moving-baseline heading when both antennas are connected, the baseline geometry is valid, and the receiver reports a valid heading solution. This source can provide heading at low speed or standstill, subject to antenna installation and GNSS conditions.

Before a field test, confirm that the displayed active heading source matches the intended setup. If EL-N-2 does not report dual-GNSS heading, check both antenna connections, baseline installation, sky visibility, and the configured baseline angle.

6.5 Starting Measurement and Telemetry Streaming

After the device has been connected to the CDV and the required configuration has been checked, enable the desired telemetry fields and start measurement or continuous streaming using the applicable CDV control.

Verify the following before starting a log or integration test:

- The correct EL-N product and serial number are displayed.
- The requested telemetry output rate is selected.
- Required status and navigation fields are enabled.
- Timestamps and packet reception are updating continuously.
- GNSS and heading status are suitable for the intended test.
- No persistent device, IMU, or GNSS communication error is active.

When many optional fields are enabled at a high output rate, confirm that the selected interface has sufficient bandwidth. The fixed status content and selected navigation blocks must fit within the configured telemetry rate without causing unstable reception.

6.6 Normal Operation

During normal operation, the device continuously combines inertial and GNSS-related measurements and transmits the configured output to CDV or host software. The user should monitor both the navigation values and the corresponding validity/status information.

Normal operation generally includes continuous timestamps, stable packet reception, plausible attitude and velocity values, active GNSS updates, and no persistent system error. Temporary changes in GNSS fix quality or heading source may occur when the operating environment or vehicle motion changes.

The output rate of the navigation solution can be higher than the GNSS update rate. Therefore, latitude, longitude, GNSS status, or GNSS counters may update less frequently than inertial or filtered output fields. This behavior should not be confused with a communication fault.

If a status changes unexpectedly, record the time and operating condition and save the relevant CSV log. Status transitions are often essential for distinguishing a device fault from a temporary change in GNSS availability or platform dynamics.

6.7 Stopping Operation

Stop CSV logging before disconnecting the device or closing CDV. Then stop measurement or telemetry streaming if the current software version provides a separate control for this function.

After logging has stopped, verify that the CSV file has been saved and can be opened. Disconnect the communication session before removing the USB or serial connection where practical.

Power may then be removed from the device. Do not interrupt an active configuration-save or firmware-update process.

6.8 Recommended First Drive Test

The first field test should verify correct installation and basic navigation behavior rather than maximum performance. Use an open-sky route with safe operating conditions and a simple sequence that is easy to review afterward.

A recommended first test sequence is:

8. Power the device and allow the startup and GNSS acquisition sequence to complete.
9. Keep the platform stationary long enough to verify status, attitude, and heading-source behavior.
10. Drive or move in a straight line at moderate speed.
11. Perform several gentle left and right turns.
12. Include several complete stop periods.
13. Repeat a straight segment in the opposite direction where practical.
14. Stop logging only after the final stationary period.

Avoid using a first test dominated by tunnels, buildings, dense trees, sharp maneuvers, or poor antenna placement. Complex conditions should be introduced only after the basic setup has been verified.

Record the device configuration, antenna setup, approximate route, test purpose, and observed behavior together with the CSV log. These details are required for meaningful support or engineering review.

6.9 Operating Checklist

Table 7-1 provides a compact checklist for routine operation.

Stage	Check	Expected result
Before power-up	Power, polarity, communication, and antenna wiring checked	Connections match the delivered hardware configuration
Startup	CDV detects product, serial number, firmware, and sensor status	Startup exchange completes without persistent error
GNSS	Fix and quality fields update	GNSS status is suitable for the planned test
Heading	Active heading source checked	Source matches EL-N-1 or EL-N-2 operating setup
Telemetry	Timestamp and packet reception update continuously	No repeated reception gaps or checksum errors
Logging	CSV logging started and filename/location confirmed	Required fields are recorded
Shutdown	Logging stopped before disconnecting power	Log is saved and readable

Table 7-1 — Basic operating checklist

7. EL-N Communication Interface / ICD

7.1 Scope

This chapter defines the public serial communication interface used by EL-N devices for telemetry output and selected host-to-device commands. It is intended for customers who need to parse EL-N data or reproduce the supported CDV configuration workflow in their own software.

The public ICD covers continuous telemetry, device identification, platform settings, telemetry/message selection settings, and RTK correction forwarding. The public ICD does not disclose protected firmware update commands or DMC calibration command protocols.

7.2 Communication Model

During normal operation the device continuously streams telemetry. Host commands may be sent by CDV or 3rd party software. Commands that define a response shall be followed by the corresponding device response. RTK correction forwarding is a one-way host-to-device message and does not generate an acknowledgement.

The host shall parse incoming device frames by their message index/type. For commands with a defined response, the response packet indicates the result or returns the requested data. Telemetry continues during normal operation after command handling.

7.3 Common Checksum Rule

Both telemetry/response frames and host command frames use a 16-bit additive checksum. The checksum is calculated over all bytes before the checksum field.

checksum = sum(frame[0 : frame_length_without_checksum]) & 0xFFFF

transmitted bytes = checksum_MSB, checksum_LSB

7.4 Byte Order

Field group	Byte order / encoding	Notes
Device-to-host length fields	uint16 big-endian	LEN_MSB, LEN_LSB
Host-to-device command length	uint8	One-byte command frame length field at byte offset 2
Checksum fields	uint16 big-endian	CHK_MSB, CHK_LSB
Payload float32 values	little-endian	IEEE-754 single precision
Payload uint16/uint32/int32 values	little-endian	Unless explicitly stated otherwise
ASCII/fixed strings	fixed byte arrays	Null termination is not assumed unless specified

7.5 Device-to-Host Telemetry Message

7.5.1 Overview

Telemetry is transmitted periodically by the device using message type 0x01. The telemetry payload is variable length. Section masks define which fields are present in selectable sections. Status sections use one-byte enable flags.

7.5.2 Telemetry Frame Format

Offset	Field	Size	Encoding	Description
0	Preamble byte 1	1	0x45	ASCII E
1	Preamble byte 2	1	0x4C	ASCII L
2	Frame length MSB	1	uint16 BE	Total frame length, high byte
3	Frame length LSB	1	uint16 BE	Total frame length, low byte
4	Message type	1	uint8	0x01 = telemetry message
5...N-3	Payload	variable	see sections	Timestamp, selected data sections, status sections
N-2	Checksum MSB	1	uint16 BE	Checksum high byte
N-1	Checksum LSB	1	uint16 BE	Checksum low byte

The frame length includes preamble, length field, message type, payload, and checksum.

7.5.3 Telemetry Payload Order

Order	Field	Type	Presence rule
1	timestamp_ms	uint32 LE	Always present
2	IMU section mask	uint16 LE	Always present
3	IMU fields	variable	According to IMU mask
4	AHRS section mask	uint16 LE	Always present
5	AHRS fields	variable	According to AHRS mask
6	DMC section mask	uint16 LE	Always present
7	DMC fields	variable	According to DMC mask
8	GNSS section mask	uint16 LE	Always present
9	GNSS fields	variable	According to GNSS mask
10	Dual-GNSS heading section mask	uint16 LE	Always present. EL-N-1 sends 0x0000.
11	Dual-GNSS heading fields	variable	According to dual-heading mask
12	INS section mask	uint16 LE	Always present
13	INS fields	variable	According to INS mask
14	Device status enable	uint8	Always present
15	Device status fields	variable	Only if enabled
16	IMU status enable	uint8	Always present
17	IMU status fields	variable	Only if enabled
18	GNSS status enable	uint8	Always present
19	GNSS status fields	variable	Only if enabled
20	Heading status enable	uint8	Always present
21	Heading status fields	variable	Only if enabled

22	Filter status enable	uint8	Always present
23	Filter status fields	variable	Only if enabled

Each selectable telemetry section starts with a section mask. The mask tells the parser which fields are included in that section. Each bit in the mask represents one possible field. If the bit is set to `1`, the corresponding field is present in the message. If the bit is `0`, that field is not present and no bytes for that field are included. The parser must check the mask bits in the defined field order. When a bit is set, the parser reads that field from the payload and advances the payload index by the size of the field. When a bit is not set, the parser skips that field definition and does not advance the payload index.

For example, if an IMU section uses the following mask definition:

| Bit | Field |

| 0 | acc_x |

| 1 | acc_y |

| 2 | acc_z |

| 3 | gyro_x |

and if the received mask value is: 0x0005 which corresponds to binary value of 0000 0000 0000 0101, which means that bits 0 and 2 are set, so the message contains acc_x and acc_z. Bits 1 and 3 are not set, so `acc_y` and `gyro_x` are not included in the payload.

This rule is the same for all selectable telemetry sections, including IMU, AHRS, DMC, GNSS, Dual Heading, and INS. The only difference between sections is the field table that defines what each bit means.

7.5.4 IMU Section Mask

Bit	Field	Type	Unit	Description
0	fx	float32 LE	m/s^2	Body-frame X acceleration
1	fy	float32 LE	m/s^2	Body-frame Y acceleration
2	fz	float32 LE	m/s^2	Body-frame Z acceleration
3	wx	float32 LE	rad/s	Body-frame X angular rate
4	wy	float32 LE	rad/s	Body-frame Y angular rate
5	wz	float32 LE	rad/s	Body-frame Z angular rate

7.5.5 AHRS Section Mask

Bit	Field	Type	Unit	Description
0	roll_deg	float32 LE	deg	Roll angle
1	pitch_deg	float32 LE	deg	Pitch angle
2	heading_deg	float32 LE	deg	Heading / yaw angle
3	q0	float32 LE	-	Quaternion component 0
4	q1	float32 LE	-	Quaternion component 1
5	q2	float32 LE	-	Quaternion component 2
6	q3	float32 LE	-	Quaternion component 3

7.5.6 DMC / Magnetometer Telemetry Section Mask

Bit	Field	Type	Unit	Description
0	magx	float32 LE	mG	Magnetometer X measurement
1	magy	float32 LE	mG	Magnetometer Y measurement
2	magz	float32 LE	mG	Magnetometer Z measurement
3	magHeading	float32 LE	deg	Magnetometer-derived heading

Note: This is telemetry only. DMC calibration command protocol is CDV-only/service-level and is not disclosed in the public ICD.

7.5.7 GNSS Section Mask

Bit	Field	Type	Unit / scaling	Description
0	gnssTOW	uint32 LE	ms	GNSS time of week
1	latGPS	int32 LE	deg x 1e-7	GNSS latitude
2	lonGPS	int32 LE	deg x 1e-7	GNSS longitude
3	altGPS	float32 LE	m	GNSS altitude
4	gnssSpeedN	float32 LE	m/s	GNSS north velocity
5	gnssSpeedE	float32 LE	m/s	GNSS east velocity
6	gnssSpeedD	float32 LE	m/s	GNSS down velocity
7	gnssSpeed	float32 LE	m/s	GNSS ground speed
8	gnssCOG	float32 LE	deg	GNSS course over ground

7.5.8 Dual-GNSS Heading Section Mask

Bit	Field	Type	Unit	Description
0	dualGnssHeading	float32 LE	deg	Heading from dual-GNSS moving-baseline solution

EL-N-1 shall transmit this section mask as 0x0000 and append no dual-heading fields. EL-N-2 uses the mask normally.

7.5.9 INS Section Mask

Bit	Field	Type	Unit / scaling	Description
0	latINS	int32 LE	deg x 1e-7	INS latitude
1	lonINS	int32 LE	deg x 1e-7	INS longitude
2	altINS	float32 LE	m	INS altitude
3	uINS	float32 LE	m/s	INS body-frame X velocity
4	vINS	float32 LE	m/s	INS body-frame Y velocity
5	wINS	float32 LE	m/s	INS body-frame Z velocity

7.5.10 Status Sections

Section	Enable field	Payload if enabled
Device status	uint8 nonzero	uptime_ms uint32, operation_mode uint8, device_temp_degC float32, system_state uint8, status_flags uint32, error_flags uint32
IMU status	uint8 nonzero	imu_age_ms uint16, imu_flags uint32
GNSS status	uint8 nonzero	gnss_age_ms uint16, fix_type uint8, num_sats uint8, pdop float32, rtk_status uint8, h_acc_m float32, v_acc_m float32, speed_acc_mps float32, rtk_age_ms uint16
Heading status	uint8 nonzero	heading_valid uint8, heading_source uint8, heading_age_ms uint16, heading_accuracy_deg float32
Filter status	uint8 nonzero	filter_flags uint32, pos_h_std_m float32, pos_v_std_m float32, vel_h_std_mps float32, vel_v_std_mps float32

Filter flag bit	Name	Meaning
0	ahrsInit	AHRS initialized
1	insInit	INS initialized
2	gnssAiding	GNSS aiding active
3	hdgAiding	Heading aiding active
4	zuptActive	Zero-velocity update active
5	isTurning	Turn detection active

7.6 Public Host-to-Device Command Interface

7.6.1 Host Command Frame Format

Offset	Field	Size	Description
0	Preamble byte 1	1	0x45 / ASCII E
1	Preamble byte 2	1	0x4C / ASCII L
2	Command frame length	1	Total command frame length including checksum; host commands are limited to < 256 bytes
3	Command index	1	Command identifier or primary command byte
4...N-3	Payload	variable	Command-specific payload
N-2	Checksum MSB	1	Checksum high byte
N-1	Checksum LSB	1	Checksum low byte

Host command frames use a one-byte length field. The length includes all bytes in the host command frame, including preamble, length byte, command index, payload, and checksum.

7.6.2 Device Response Frame Format

Offset	Field	Size	Description
0	Preamble byte 1	1	0x45 / ASCII E
1	Preamble byte 2	1	0x4C / ASCII L
2	Response length MSB	1	Total response frame length high byte
3	Response length LSB	1	Total response frame length low byte
4	Response index	1	Response identifier
5...N-3	Payload	variable	Response-specific fields
N-2	Checksum MSB	1	Checksum high byte
N-1	Checksum LSB	1	Checksum low byte

Device responses use a two-byte big-endian length field. When a response includes msgStatus, values are: 0 = ACK/success, 1 = NACK/failure. msgType is retained in some responses as an internal category field and is not required for public protocol interpretation.

7.6.3 Public Command Overview

Command	Host index/bytes	Device response	Public status
Get Device Identification	Minimal request frame	Device identification response	Public
Get Current Platform Settings	0x0A	0x0A response with settings payload	Public
Set / Apply Platform Settings	0x05 + settings payload	0x05 response with msgStatus	Public
Get Current Telemetry Settings	0x0B	0x0B response with telemetry masks/status enables	Public
Set / Apply Telemetry Settings	0x04 + masks payload	0x04 response with msgStatus	Public
Forward RTK Corrections	0x15 + RTCM frame	No response	Public

DMC calibration commands	various	CDV-only/service	Not disclosed
Firmware update	protected	CDV-only/protected	Not disclosed

7.7 Device Identification

7.7.1 Request

The host sends the Device Identification request during connection/startup. The current CDV implementation uses a minimal request frame without an explicit public command payload.

Byte offset	Field	Value / encoding	Description
0	Preamble	0x45	ASCII E
1	Preamble	0x4C	ASCII L
2	Length	0x07	One-byte command frame length
3	Reserved	0x00	Reserved/current implementation
4	Reserved	0x00	Reserved/current implementation
5	Checksum MSB	uint16 BE	Checksum high byte
6	Checksum LSB	uint16 BE	Checksum low byte

7.7.2 Response

Field	Type	Description
response index	uint8	0x00 = Device Identification response
msgStatus	uint8	0 = ACK, 1 = NACK
msgType	uint8	Internal field; host may ignore for public parsing
ProductLabel	byte[6]	Fixed 6-byte product label
serialNumber	uint16 LE	Device serial number
firmwareRevision	byte[5]	Fixed 5-byte firmware revision field
BaudRate	uint32 LE	Active UART baud rate
ODR_Hz	uint32 LE	Output data rate
dmcReadStatus	uint8	Successful DMC initialization/status indicator
imuReturnState	uint8	Successful IMU initialization/status indicator
deviceOperationMode	uint8	Operating mode enum: LAND, FIXED_WING, MULTICOPTER, VTOL, NAVAL

Note: The product label is fixed length. Firwmare revision should be read like byte[0].byte[2].byte[4].

7.8 Get Current Platform Settings

7.8.1 Request

Byte offset	Field	Value / encoding	Description
0	Preamble	0x45	ASCII E
1	Preamble	0x4C	ASCII L
2	Length	0x07	One-byte command frame length
3	Reserved	0x00	Reserved/current implementation
4	Command index	0x0A	Get Current Platform Settings
5	Checksum MSB	uint16 BE	Checksum high byte
6	Checksum LSB	uint16 BE	Checksum low byte

7.8.2 Response

Field	Type	Unit	Description
response index	uint8	-	0x0A
frontOffset	float32 LE	m	Forward/longitudinal offset
sideOffset	float32 LE	m	Lateral offset
downOffset	float32 LE	m	Vertical/down offset
rollOffsetDeg	float32 LE	deg	Roll frame offset returned in degrees
pitchOffsetDeg	float32 LE	deg	Pitch frame offset returned in degrees
yawOffsetDeg	float32 LE	deg	Yaw frame offset returned in degrees
BaudRate	uint32 LE	baud	UART baud rate
ODR_Hz	uint32 LE	Hz	Output data rate
mountingRotationAngle[0]	float32 LE	deg	Mounting rotation angle 0
mountingRotationAngle[1]	float32 LE	deg	Mounting rotation angle 1
mountingRotationAngle[2]	float32 LE	deg	Mounting rotation angle 2
deviceOperationMode	uint8	enum	LAND, FIXED_WING, MULTICOPTER, VTOL, NAVAL
baselineInstallationAngle	float32 LE	deg	

7.9 Set / Apply Platform Settings

7.9.1 Request Payload

Order	Field	Type	Unit	Description
1	front	float32 LE	m	Forward/longitudinal offset
2	side	float32 LE	m	Lateral offset
3	down	float32 LE	m	Vertical/down offset
4	rollFrame	float32 LE	deg	Roll frame offset; stored internally in radians
5	pitchFrame	float32 LE	deg	Pitch frame offset; stored internally in radians
6	yawFrame	float32 LE	deg	Yaw frame offset; stored internally in radians
7	msgFrequency	uint32 LE	Hz	Output/message rate
8	baudRate	uint32 LE	baud	UART baud rate
9	rotationAngleFront	float32 LE	deg	Mounting rotation angle front
10	rotationAngleSide	float32 LE	deg	Mounting rotation angle side
11	rotationAngleDown	float32 LE	deg	Mounting rotation angle down
12	platform	uint8	enum	LAND=0, FIXED_WING=1, MULTICOPTER=2, VTOL=3, NAVAL=4
13	saveSettings	uint8	boolean	0 = apply only, 1 = save to flash
14	baselineInstallationAngle	float32 LE	deg	Dual-GNSS baseline installation angle; accepted but ignored by EL-N-1

7.9.2 Response

Field	Type	Description
response index	uint8	0x05
msgStatus	uint8	0 = ACK, 1 = NACK
msgType	uint8	Internal field; not used for public interpretation

Note: saveSettings = 1 writes settings to flash.

7.10 Get Current Telemetry / Message Settings

7.10.1 Request

Byte offset	Field	Value / encoding	Description
0	Preamble	0x45	ASCII E
1	Preamble	0x4C	ASCII L
2	Length	0x07	One-byte command frame length
3	Reserved	0x00	Reserved/current implementation
4	Command index	0x0B	Get Current Telemetry Settings
5	Checksum MSB	uint16 BE	Checksum high byte
6	Checksum LSB	uint16 BE	Checksum low byte

7.10.2 Response

Field	Type	Description
response index	uint8	0x0B
imuMsgData	uint16 LE	IMU telemetry mask
ahrsMsgData	uint16 LE	AHRS telemetry mask
dmcMsgData	uint16 LE	DMC telemetry mask
gnssMsgData	uint16 LE	GNSS telemetry mask
dualHdgMsgData	uint16 LE	Dual-heading telemetry mask. EL-N-1 shall read back 0x0000.
insMsgData	uint16 LE	INS telemetry mask
deviceStatus	uint8	Device status section enable
imuStatus	uint8	IMU status section enable
gnssStatus	uint8	GNSS status section enable
headingStatus	uint8	Heading status section enable
filterStatus	uint8	Filter status section enable

7.11 Set / Apply Telemetry / Message Settings

7.11.1 Request Payload

Order	Field	Type	Description
1	imuMessageCounter	uint8	IMU mask
2	ahrsMessageCounter	uint8	AHRS mask
3	dmcMessageCounter	uint8	DMC mask
4	gnssMessageCounter	uint16 LE	GNSS mask
5	insMessageCounter	uint8	INS mask
6	dualGnssHeadingCounter	uint8	Dual-heading mask; EL-N-1 should send 0x00
7	deviceStatusMessageCounter	uint8	Device status enable
8	imuStatusMessageCounter	uint8	IMU status enable
9	gnssStatusMessageCounter	uint8	GNSS status enable
10	headingStatusMessageCounter	uint8	Heading status enable
11	filterStatusMessageCounter	uint8	Filter status enable
12	saveSettings	uint8	0 = apply only, 1 = save to flash

Note: Do not change the Set Message Settings command field sizes to uint16 for all masks. The public ICD must match the current parser and firmware behavior: only the GNSS mask is sent as uint16 in this command; other masks are sent as uint8.

7.11.2 Response

Field	Type	Description
response index	uint8	0x04
msgStatus	uint8	0 = ACK, 1 = NACK
msgType	uint8	Internal field; not used for public interpretation

7.12 RTK Correction Forwarding

7.12.1 Request Payload

RTK/RTCM correction forwarding uses host command index 0x15. The device does not return a response for this command.

Order	Field	Type	Description
1	payload_len	uint8	RTCM payload length calculated by CDV as len(frame) - 6; maximum 255
2	RTCM frame	byte array	Full RTCM frame bytes are appended after payload_len

7.12.2 Response Behavior

There is no device acknowledgement for each RTK correction frame. Host software shall not wait for a response. RTK use shall be verified indirectly through GNSS status telemetry such as RTK status, correction age, fix type, accuracy estimates, or carrier solution information reported by the GNSS receiver.

7.13 CDV-Only / Not Public Protocols

Function	Public ICD status	Manual wording
DMC calibration command protocol	Not disclosed	DMC calibration parameters and commands are handled by CDV/service workflow and are not part of the public ICD.
Firmware update protocol	Not disclosed	Firmware update is supported only through the official CDV application. The firmware update protocol is protected and is not part of the public ICD.

7.14 Parser Implementation Notes

The 3rd party software parser routine should first search for the message preamble (‘E’ ‘L’), read the appropriate length field for the frame direction/type, wait until the full frame is received and verify the additive checksum.

For telemetry, fixed offsets are valid only through the timestamp and the first section mask. After that, all offsets are variable because section masks and status enables control which fields are present.

For command responses, the host should parse by response index and not by payload length alone.

Separate parsing code examples in C and Python are available for 3rd party integrators.

8. Data Logging

8.1 Logging from CDV

The CDV application can record selected telemetry fields to a comma-separated values (CSV) file for later review, plotting, comparison, and support analysis. CSV logging is intended for normal evaluation and field testing because it stores decoded values in a format that can be opened by spreadsheet, plotting, and analysis software.

The set of columns written to the CSV file follows the telemetry fields enabled in the CDV data-output configuration.

Before starting a test, confirm that the required fields are enabled and visible in CDV. Start logging before the relevant test activity begins and stop logging only after the final stationary or shutdown period has been captured.

Recommended logging procedure:

- Connect CDV to the EL-N device and confirm stable telemetry reception.
- Select the telemetry fields required for the planned test.
- Choose or confirm the log-file location.
- Start CSV logging before the vehicle or platform begins moving.
- Perform the planned test while monitoring device and GNSS status.
- Stop logging after the test is complete and confirm that the file was created.
- Record a short note describing the test purpose, installation, and any observed issue.

Important: do not change the telemetry-field selection during a test unless the purpose of the test specifically requires it. Changing selected fields can make comparison between log sections more difficult and may change the packet size or CSV column layout.

8.2 Recommended Logging Fields

The exact field set depends on the test objective. For general installation checks and first drive tests, Table 8-1 provides a recommended minimum set. Additional engineering or diagnostic fields may be enabled when investigating a specific issue.

Category	Recommended fields	Purpose
Time	Device timestamp	Check ordering, sample intervals, and synchronization.
Position	INS latitude, longitude, altitude; GNSS latitude, longitude, altitude	Compare fused and GNSS position and review trajectory behaviour.
Velocity	INS velocity components, GNSS speed, COG where applicable	Review motion, stops, acceleration, and heading-source validity.
Attitude	Roll, pitch, yaw	Review orientation output and transient behaviour.
GNSS status	Fix type, fix-valid flag, number of satellites, PDOP, hAcc, vAcc, sAcc where available	Assess GNSS quality and identify degraded periods.
Heading status	Heading source, heading-valid flag, dual-GNSS validity where applicable	Determine which heading aid was active and whether it was valid.

Device status	System state, measurement-active flag, status flags, error flags	Identify startup, fault, communication, or operating-state changes.
GNSS update indication	GNSS update counter or equivalent freshness field	Distinguish new GNSS measurements from repeated values between updates.

Table 8-1 — Recommended fields for general EL-N test logging

For issue-specific analysis, additional fields may include raw or compensated IMU values, filter innovations, measurement covariance values, turn/ZUPT/cooldown state, GNSS relative-position data, or other diagnostic variables. These fields should be enabled only when they are needed and when their meaning is defined for the user or support engineer.

8.3 Log File Naming

A consistent file-naming method makes test logs easier to identify and compare. CDV may generate a timestamp-based filename automatically. The user may retain that name or append a short test identifier when permitted by the operating system and software workflow.

File naming pattern has following structure:

YYYY-MM-DD_HH-MM-SS_Product_OutputRate.csv

Example:

2026-06-08_10-30-15_EL-N-2_50Hz.csv

8.4 Generate Report

"Generate Report" button creates a formatted test report from recorded telemetry data. This function is intended to help users review recorded test data without manually inspecting the raw CSV file. The generated report provides a structured overview of the test, selected navigation outputs, status information, and relevant plots or summaries based on the fields available in the log file.

The report can be used for:

- quick review of a recorded test,
- comparison of GNSS and INS outputs,
- checking general navigation behavior,
- reviewing important status fields.

The quality and completeness of the generated report depend on the telemetry fields recorded in the CSV log. For best results, record GNSS, INS, attitude, heading status, GNSS status, filter status, and device status fields. To generate a report, first record a log file using the required telemetry fields. After recording is complete, press "Generate Report" button and select the log file to be processed, if prompted by CDV. The generated report is saved in the application output folder.

9. Troubleshooting

This chapter provides basic troubleshooting guidance for common setup, communication, GNSS, heading, telemetry, and data-quality problems. The checks are intended for user-level diagnosis before contacting technical support.

9.1 Device Does Not Power On

If the device does not start or is not detected by the host PC, first verify the power path.

- Confirm that the power source is connected to the correct pins and that polarity matches the main connector pinout.
- For external DC power, confirm that the supply voltage is within the specified 5–36 V input range.
- For USB-powered operation, confirm that the USB cable and host USB port can provide power.
- Inspect the main connector, cable, and harness for loose contacts, damaged wires, or incorrect pin numbering.
- Disconnect unnecessary external interfaces and repeat the power-up test using the simplest supported setup.

Important: Do not repeatedly apply power when connector wiring or polarity is uncertain. Verify the delivered cable/harness and hardware revision first.

9.2 CDV Cannot Connect to the Device

CDV normally detects the connected device, opens the appropriate COM port, and exchanges a startup message.

- Confirm that the device is powered.
- Confirm that the USB or RS-232 connection is physically connected and recognized by the operating system.
- Open the operating-system device manager and verify that a COM port is present.
- Close other applications that may already be using the same COM port.
- Restart CDV and reconnect the device.
- If RS-232 is used, verify that the correct RS-232 input, output, and ground pins are wired.
- Confirm the serial format is 921600 baud, 8 data bits, no parity, and 1 stop bit.

If CDV still cannot connect, record the COM-port number, cable type, power method, and operating-system version before contacting support.

9.3 No Telemetry Is Received

The device may be connected successfully while navigation telemetry is not being displayed or recorded.

- Confirm that CDV shows the device product type, serial number, firmware version, and sensor operating status.
- Confirm that measurement and telemetry streaming are enabled.
- Verify that at least the required navigation fields are selected in the telemetry configuration.
- Check that the selected output rate is supported and that the configured data set is appropriate for the communication link.
- Confirm that timestamps or packet counters increase.
- Stop and restart telemetry streaming.
- Power-cycle the device only after the configuration and communication settings have been checked.

When using custom host software, verify packet preamble detection, payload-length handling, checksum validation, and parser resynchronization.

9.4 GNSS Fix Is Not Available

- Confirm that the primary GNSS antenna is connected to the correct antenna input.
- Confirm that the antenna connector is fully seated and that the cable is not damaged.
- Place the antenna outdoors with a clear sky view.
- Avoid testing beside windows, buildings, trees, large metal objects, or active RF interference sources.
- Allow sufficient time for initial satellite acquisition after power-up.
- Check the GNSS fix status, number of satellites, position-accuracy indicators, and GNSS error flags in CDV.

Indoor or near-window operation may be sufficient for communication checks, but it should not be used to evaluate final GNSS or navigation performance.

9.5 RTK Fixed Solution Is Not Available

A valid GNSS position does not guarantee an RTK fixed solution. RTK performance also depends on correction data, antenna conditions, and receiver status.

- Confirm that the GNSS receiver has a valid fix before checking RTK status.
- Confirm that correction data are being received through the configured correction interface.
- Verify the correction-source settings and network connection where applicable.
- Check that the antenna has clear sky view and that the GNSS signal environment is suitable.
- Check the RTK carrier-solution status and GNSS accuracy indicators.

- Repeat the test outdoors in a less obstructed environment.

Note: Temporary transitions between RTK fixed, RTK float, and standalone GNSS can occur in obstructed or weak-signal conditions.

9.6 Dual-GNSS Heading Is Not Valid

- Confirm that both GNSS antennas are connected to the correct primary and secondary antenna inputs.
- Confirm that both antennas have clear sky view.
- Verify that the antenna mounts are rigid and that the baseline does not move during operation.
- Confirm that the baseline is at least 0.2 m and is measured from the primary antenna to the secondary antenna.
- Verify the configured baseline angle relative to the platform longitudinal axis.
- Check the dual-GNSS validity, carrier-solution, baseline, and heading-accuracy status fields in CDV.
- Repeat the test outdoors before concluding that the dual-GNSS heading function is faulty.

The reported dual-GNSS heading represents the direction of the antenna baseline. The platform heading depends on the configured baseline angle relative to the platform axes.

9.7 Attitude Values Look Incorrect

- Confirm that the device is mounted rigidly and has not shifted relative to the platform.
- Confirm that the body-axis and mounting-orientation settings match the actual installation.
- Check roll and pitch while the platform is stationary on a known level surface.
- Confirm that the active heading source is valid for the current operating condition.
- For EL-N-1, remember that GNSS course over ground is not reliable at very low speed or standstill.
- For EL-N-2, confirm that dual-GNSS heading is valid before evaluating low-speed yaw.
- Repeat the test in open-sky conditions and review status/error fields together with attitude data.

Note: Do not judge attitude performance from a loose bench setup, unstable antenna placement, or near-window GNSS conditions.

9.8 Packet Checksum or Framing Errors

- Confirm the serial format and baud rate.
- Verify the packet preamble, frame length field according to frame type, payload boundaries, and checksum.
- Telemetry and device response frames use a two-byte big-endian frame length. Host command frames use a one-byte command length.

- Confirm that multi-byte values are decoded using the specified byte order.
- Ensure that floating-point fields are decoded as IEEE 754 float values rather than integer bit patterns.
- Reject incomplete or malformed packets and search for the next valid preamble.
- Verify that the host receive buffer is large enough and that the parser can handle partial packets and multiple packets in one read.
- Test with a reduced telemetry selection to separate parser problems from application-processing problems.

Whole missing frames, incorrect field alignment, or implausible values commonly indicate a host parser, packet-length, or resynchronization problem rather than a navigation-filter problem.

9.9 CSV Log Looks Incomplete or Contains Missing Rows

- Confirm that CSV logging was started before the test began.
- Check whether the device timestamp and packet counter advance continuously.
- Check whether missing rows occur at a specific configured output rate.
- Confirm that CDV is not overloaded by unnecessary plots, processing, or an excessive telemetry field selection.
- Compare the logged row count with the device-side packet or output counter where available.
- Preserve the original CSV file and device configuration for support review.

9.10 When to Contact Support

Contact technical support when the basic checks in this chapter do not resolve the issue, or when the problem is repeatable under a controlled setup.

Include the following information:

- EL-N model and serial number.
- Firmware and protocol version.
- CDV version.
- Power method and cable/interface used.
- Device configuration or exported configuration file.
- CSV log containing the issue.
- Approximate test time and the section where the issue occurs.
- Description of device mounting and GNSS antenna placement.
- Photographs of the installation when relevant.
- Expected behavior and observed behavior.

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